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Postacute Care Services Use for Dysvascular Amputees
A Population-Based Study of Massachusetts

ABSTRACT

Objective: Rehabilitation and other postacute care services utilization for persons with a lower limb amputations due to dysvascular disease is important information for physiatrists, therapists, patients, and health-policy planners. The purpose of this study was to examine rates of inpatient rehabilitation services use in a statewide population.

Design: Massachusetts Hospital Case Mix and Charge Data for 1997 were used to select persons with dysvascular limb amputations. Disposition locations after amputation were analyzed.

Results: There were 2487 persons who incurred a lower limb amputation, with the majority being white (94%), male (58%), and elderly (69 yrs). Most had diabetes (62%) or peripheral vascular disease (51%). The most common disposition was home (33%), with 16% receiving inpatient rehabilitation after amputation. Persons with transtibial and transfemoral amputations were the most likely to receive inpatient rehabilitation, 28% and 19% respectively.

Conclusions: Sixteen percent of dysvascular amputees received inpatient rehabilitation services. This was higher than the 1997 rate for Maryland (12%) and suggests geographic differences in services utilization. Prospective studies are necessary to examine outcomes for persons receiving rehabilitation services in different care settings to define the optimal rehabilitation venue for functional restoration. Development of more specific International Classification of Diseases, Ninth Revision–Clinical Modification codes for dysvascular amputations would further research and public policy efforts.

Key Words: Amputation, Rehabilitation, Prosthesis, Peripheral Vascular Disease, Diabetes
By far the most common cause for lower limb amputation is peripheral vascular disease and diabetes. A recent investigation using national Hospital Cost and Utilization Project data demonstrated that the rates of lower limb amputations due to peripheral vascular disease and diabetes have increased by 27% in the United States from 1988 to 1996. In contrast to dysvascular amputations, limb amputations due to trauma and cancer significantly declined by 50% and 43%, respectively, during the same period.

The complete or partial loss of a lower limb often occurs in older persons with underlying peripheral vascular disease or diabetes. Other causes of limb loss or deficiency—trauma-related amputations, those resulting from limb malignancies, and those secondary to congenital anomalies—occur less frequently. Previous studies examined the epidemiology of dysvascular limb loss. Other investigators examined the outcomes for cohorts of amputees who received inpatient or outpatient rehabilitation services. Despite considerable information about the types of interventions available and the prevalence of dysvascular limb loss, little is known about postacute care rehabilitation services utilization. Rehabilitation services today are provided at comprehensive inpatient rehabilitation units attached to acute care hospitals or free-standing rehabilitation hospitals. These services are also administered in skilled nursing facilities, at outpatient rehabilitation facilities, and at home through home health care. Understanding utilization of rehabilitation services and other postacute care rehabilitative interventions is important from a public policy perspective and from a rehabilitation viewpoint. Such information provides a foundation of basic understanding from which to judge whether rehabilitation services use is appropriate. Despite the importance of dysvascular amputations and the potential for enhancement of function through appropriate rehabilitation, little is known about the utilization of rehabilitation services among dysvascular amputees. The purpose of this study was to determine the settings utilized after surgery for rehabilitation care by persons sustaining dysvascular lower limb amputations using a large statewide population.

METHODS
Massachusetts Hospital Discharge Database
To meet the primary study aims, we selected hospital discharge data maintained by the state of Massachusetts. Level IV, Massachusetts Hospital Case Mix and Charge Data for 1997, contains information on persons admitted to general, acute care hospitals. Information from Veterans Affairs Medical Centers, psychiatric hospitals, military hospitals, nursing homes, and chronic care hospitals are not included.

Massachusetts data were useful for this study because of several important characteristics. Encrypted patient codes were available that allowed identification of multiple admissions and discharges for a given individual over a defined period of time, in this case, the 1-yr period of 1997. This provided a complete picture of inpatient hospital use and facilitated the identification of incident amputations and subsequent ipsilateral amputations at higher levels or new amputations of the contralateral limb.

Massachusetts Hospital data contain patient demographics, source of admission, primary and nine secondary diagnoses, and the primary procedure code and nine secondary procedure codes using International Classification of Diseases, Ninth Revision–Clinical Modification (ICD9-CM) classification system. Length of stay, discharge destination, and charge information is included as well. Vital to the aims of this study, Massachusetts data contain information regarding discharge location after acute hospital care. This information provided the means of examining inpatient rehabilitation services utilization.

Sample Selection
The study population was selected by defining those persons who underwent an amputation procedure, then subclassifying them by cause of amputation: trauma-related, congenital, cancer-related, or dysvascular. Our sample of interest was the group of dysvascular amputees with lower limb amputations in 1997. Unfortunately, there are no specific ICD9-CM codes for dysvascular amputations, and for this reason, we relied on a strategy of eliminating persons with limb amputations due to conditions that were more precisely specified. We first selected all discharges with a procedure code for limb amputation or reattachment (ICD9-CM 84.1–84.19, 84.2–84.29, 84.91, 84.0–84.09). Persons with ICD9-CM diagnosis codes for traumatic amputations (895–897.7, 885–887.7), congenital limb deficiencies (775.2–775.29, 755.3–755.4), and cancer (ICD9-CM 170.4–170.8, 171.2–171.3) were identified. Codes for trauma and congenital limb loss and for cancer have greater specificity, and persons with these pathogeneses for their amputations were excluded from the sample. We also selected from this remaining group only those persons undergoing an amputation of the lower limb because this was the target sample for the purposes of this study.

The initial (index) amputation for each subject
in this sample was identified. Subsequent admissions for amputation procedures and other nonamputee-related admissions were identified and flagged. Discharge level information was then collapsed into person level information by linking all amputation- and nonamputation-related discharges across the year. Dispositions to rehabilitation services were then defined after the index amputation and any subsequent amputations.

Amputation discharges were classified into mutually exclusive categories according to the level of the amputation. Hospital discharge data and ICD9-CM amputation procedure codes do not allow identification of the side of the amputation. The first amputation to occur during the year 1997 was assumed to be the index amputation. A steady state was assumed for the incidence rates for repeat amputations for persons incurring them in 1997. For example, those amputees from 1997 requiring further amputations in 1998 are assumed to be balanced by an equal number of amputees from 1996, having subsequent amputations in 1997. If amputations subsequent to the index amputation were at a higher level, it was considered to involve the same lower limb as the first amputation. If the level of a succeeding amputation was at the same level or at a lower level than the initial amputation, then this patient was considered to have undergone a contralateral amputation and was reclassified as a bilateral amputee. An important exception to this algorithm was persons with toe amputations. Subsequent toe amputations were considered to have involved the same side and not the contralateral limb. Again, this logic was necessary due to the inability of ICD9-CM codes to precisely identify the limb (right or left) that undergoes amputation surgery or which toe was removed. In addition, ICD9-CM codes do not allow identification of persons who have bilateral lower limb amputations during the same admission. Comorbidities were identified by searching for them in the diagnosis variables during the index amputation admission.

RESULTS

Descriptive information regarding the 1997 sample of amputees from Massachusetts is shown in Table 1. The majority of amputees were white (94%), men (58%), and elderly (mean age of 69 yrs). Most had diabetes (62%) or peripheral vascular disease (51%). Sixteen percent had at least two amputations in 1997. The majority of initial amputations involved the toe (41%), with the second most common level being transtibial (22%). Four percent of the sample went on to have bilateral lower limb amputations.

In Table 2, the rates of postacute care services use for patients after their initial amputations are shown. Home (with or without home care services) was the most frequent disposition (33%), skilled nursing facilities were the second most frequent disposition location (32%), followed by inpatient rehabilitation facilities (16%). Four percent died during the acute hospitalization. The “other” category in Table 2 reflects dispositions such as transfers to other acute care hospitals.

DISCUSSION

Rehabilitation services are provided at different levels of intensity depending on care settings. Inpatient rehabilitation units provide the highest level of services. The present study demonstrated that relatively few dysvascular amputees (16%) received comprehensive inpatient rehabilitation after acute hospitalization. In the absence of outcome information, it is unclear whether this represents underutilization of optimal inpatient rehabilitation services or appropriate use of less intense rehabili-
itation services in alternative care settings. Strengthening, joint range of motion to prevent contractures, and ambulation training with and without a prosthesis are important areas of intervention. Maintenance of medical stability is another rehabilitation goal, along with the creation and implementation of a discharge plan suited to the unique needs of the individual patient. Persons with dysvascular amputations rarely receive their prostheses during inpatient rehabilitation admissions because the residual limb is not fully healed.20–25

Several factors may influence discharge from the acute care service to an inpatient rehabilitation unit after amputation. Patients who are deemed to be at a high level of function such that more intense inpatient services are unwarranted are less likely to be admitted. Amputees considered too ill, medically unstable, or deconditioned to participate in a more intense therapy program might be discharged to a setting where less intense therapy is provided, such as a nursing home. Those patients with strong family caregiver support in the home may opt to return home with home health care.

Understanding regional variations in care is important to determine underuse or overuse of appropriate services. To assess regional variations, the results of the present study can be contrasted with those from the state of Maryland. An epidemiologic study of the Maryland population using hospital discharge data to examine postacute care rehabilitation services after a lower limb amputation secondary to peripheral vascular disease over a 12-yr period was conducted.21 Although increasing over time, discharge of patients with major lower limb amputations to comprehensive inpatient rehabilitation settings remained relatively low at 9.6% overall. When comparing postacute care rates across the two states, Massachusetts and Maryland, figures for Maryland in 1997 are most appropriate.21 In 1997, in Maryland, 12% of dysvascular lower limb amputees received inpatient rehabilitation—lower than the rate for Massachusetts (16%) found in the present investigation. In contrast, in Maryland, 54% of amputees were discharged to skilled nursing facilities, higher than the 32% rate in Massachusetts. For persons with more disabling levels of amputation, transtibial and transfemoral, Maryland rates of inpatient rehabilitation use over the 12-yr study period were 14% and 8%, respectively.21 In contrast, 28% of transtibial amputees and 19% of transfemoral amputees in the state of Massachusetts were discharged to inpatient rehabilitation facilities—double the utilization rates for persons with these levels of amputations in Maryland. Marked differences in the use of inpatient rehabilitation facilities and skilled nursing facilities by Massachusetts amputee patients compared with those in Maryland are of concern from both cost-effectiveness and appropriateness of care perspectives. The reasons for these geographic variations in rehabilitation services use are unclear and suggest varying practice standards or reimbursement policies from third-party payors. Maryland is a diagnosis-related group– exempt state with an all-payor system, which likely influences to some extent inpatient rehabilitation utilization. Racial differences between Maryland and Massachusetts are considerable, with few African Americans in Massachusetts relative to Maryland. There are marked racial differences in amputation rates, with African Americans having 4-fold greater risks of dysvascular limb loss than white persons.26,27 A study involving a national database would be necessary to fully explore these variations. These differences in utilization rates underscore the need for outcome studies to inform caregivers and third-party payors regarding the optimal rehabilitation venue for delivering these services to amputees. Compelling outcome studies would provide the foundation for care guidelines and serve to potentially ameliorate the geographic differences in care for these amputees.

In a similar investigation, assessing postacute

### TABLE 2 Postacute care disposition by incident amputation level for the total sample of dysvascular amputees in 1997 in Massachusetts

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<th>Initial Level</th>
<th>n</th>
<th>Home, with or Without Home Care</th>
<th>Skilled Nursing Facility</th>
<th>Inpatient Rehabilitation</th>
<th>Died</th>
<th>Other</th>
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<tr>
<td>Toe</td>
<td>1010</td>
<td>553 (54)</td>
<td>262 (26)</td>
<td>93 (9)</td>
<td>10 (1)</td>
<td>92 (9)</td>
</tr>
<tr>
<td>Foot/ankle</td>
<td>405</td>
<td>149 (37)</td>
<td>113 (28)</td>
<td>49 (12)</td>
<td>15 (4)</td>
<td>79 (19)</td>
</tr>
<tr>
<td>Transtibial</td>
<td>541</td>
<td>47 (9)</td>
<td>200 (37)</td>
<td>150 (28)</td>
<td>24 (4)</td>
<td>120 (22)</td>
</tr>
<tr>
<td>Through knee, transfemoral, hip disarticulation, or pelvic amputation</td>
<td>531</td>
<td>72 (13)</td>
<td>229 (43)</td>
<td>100 (19)</td>
<td>51 (10)</td>
<td>79 (15)</td>
</tr>
<tr>
<td>Total</td>
<td>2487</td>
<td>821 (33)</td>
<td>804 (32)</td>
<td>392 (16)</td>
<td>100 (4)</td>
<td>370 (15)</td>
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care rehabilitation services for persons incurring traumatic amputations, Dillingham et al.\textsuperscript{9} reported that 19.5% of transtibial and 23.4% of transfemoral trauma-related amputees were discharged to an inpatient rehabilitation setting after acute care. These rehabilitation utilization rates were higher than for dysvascular amputees in Maryland.\textsuperscript{21}

In a study of traumatic amputees, Pezzin et al.\textsuperscript{28} analyzed the long-term outcomes for 78 traumatic amputees treated at the University of Maryland Shock Trauma Center in Baltimore, MD. These investigators assessed functional and vocational outcomes for traumatic lower limb amputees identified an average of 7 yrs after amputation. The number of nights in a comprehensive inpatient rehabilitation center after amputation was significantly associated with less pain and better physical functioning many years after amputation.\textsuperscript{28} Postacute care discharge to a rehabilitation center similarly improved long-term vocational outcomes.\textsuperscript{28,29} This study suggested that long-term functional and vocational outcomes are positively enhanced by inpatient rehabilitation services after trauma-related amputation.

Although the current population-based study provided a comprehensive view of rehabilitation and other postacute care services utilization, there were limitations involved in this investigation. There are no specific ICD9-CM codes that identify a person sustaining amputations that result from, or are related to, peripheral vascular disease in the legs. Dysvascular amputations are often the final common sequela in a variety of clinical pathways. The development of a nonhealing foot ulcer due to poor circulation, for example, can result in a limb amputation. Severe unremitting vascular limb pain or claudication may also require a person to incur a lower limb amputation. Cellulitis in a foot with limited blood supply, a potentially life-threatening condition if sepsis develops, may also prompt a limb amputation. Acute arterial thrombosis or overwhelming sepsis resulting in distal limb infarction are other events that can lead to amputation. Development of more specific ICD9-CM codes for amputations reflecting the contribution of peripheral vascular disease and diabetes to the occurrence of limb loss, although a difficult task, would further research and public policy efforts to more accurately identify these persons. This is particularly important because rates of dysvascular amputations are increasing in the United States.\textsuperscript{1}

**CONCLUSION**

This study documented use of postacute rehabilitation services after dysvascular amputations for a large, statewide population. Persons with major dysvascular lower limb amputations utilized comprehensive inpatient rehabilitation services 16% of the time and more frequently (one third of the time) received care in skilled nursing facilities after their amputations. There were geographic variations when comparing rates in Massachusetts with those from Maryland. The long-term consequences and functional outcomes for persons receiving rehabilitation services in different care settings should be systematically studied and contrasted across settings to determine the optimal rehabilitative strategy. Public policy development and surveillance, health services planning, and research efforts would all be greatly enhanced by creation of ICD9-CM codes specific for persons undergoing amputations as a result of peripheral vascular disease processes with precise specification of level and side of limb amputation.

**REFERENCES**


Long-Term Medical Care Utilization and Costs Among Traumatic Brain Injury Survivors

ABSTRACT

Objective: To examine billing patterns and predictors of healthcare utilization and costs associated with traumatic brain injury.

Design: Retrospective cohort study of healthcare billings for 63 survivors of traumatic brain injury, over a 19-mo period, using a state-sponsored Medicaid program. The relationship of indicators of injury severity and disability to billings and payments was investigated. Mean age at time of injury was 33 yrs. Mean highest Glasgow Coma Scale rating immediately after brain injury was 8.

Results: A total of $795,635 was billed to Medicaid for 3,950 services and medications used. A total of $281,897 was paid for these billings out of the Medicaid account studied. Billings were used for statistical analyses, as they were considered the most stable indicator of cost. Motor deficits at discharge from inpatient rehabilitation (FIM™ motor score) showed inverse relationships to total billings (rho = −0.42, P < 0.001), subcategories of billings reflecting equipment and supplies (rho = −.26, P = 0.020), and outpatient billings (rho = −0.27, P = 0.015). Change in FIM motor scores during inpatient rehabilitation was inversely associated with billings (rho = −0.40). Change in FIM motor scores provided unique information in predicting utilization after accounting for demographic characteristics and severity of injury.

Conclusions: Motor disability and improvement during inpatient rehabilitation were significant predictors of billings after traumatic brain injury. Initial severity of brain injury was not a significant factor in utilization.

Key Words: Brain Injuries, Costs, Cost Analysis, Cost Control, Utilization
T
raumatic brain injury (TBI) affects the functional and financial status of an individual and the entire family. The financial effect of TBI also extends to society as a whole, in terms of healthcare costs and disability funding. Of these issues, health care is a major financial challenge. Individuals with disabilities, including TBI, have a higher-than-average rate of healthcare utilization and corresponding costs. In particular, they experience a range of medical issues that are otherwise uncommon. Examples include urinary-tract infection and pressure ulcers—two conditions that are most often preventable. Individuals with disabilities also have an increased vulnerability to disease relative to the general population, and they require a more lengthy treatment to address common health conditions. Health-related activity limitations associated with TBI also may increase costs due to increased frequency of events such as outpatient visits and hospital admissions. In addition, impairments in cognitive status associated with TBI may adversely affect long-term physical health status via poor adherence to recommended treatment regimens. Complex medication and therapy protocols can place high demands on cognitive ability. Although research on treatment adherence among adult TBI survivors is sparse, studies of other populations have demonstrated that deficits in executive functioning, memory, and attention are associated with poor adherence to medication regimens, appointments kept, and other treatment protocol. Thus, wellness promotion for individuals with disability may require additional preventative measures, and efforts to identify persons at risk for complications due to poor adherence are essential to this goal.

While enduring an increased need for medical services, individuals with disabilities may find their challenge is compounded by barriers in accessing outpatient health care, providing a disincentive for pursuing early intervention and providing incentive for later use of emergency services. These factors are likely to contribute greatly to costs associated with disabilities. The necessity of disability-friendly medical care is a high priority, both to best serve patients with disabilities and to control costs. Identifying factors associated with increased use of the emergency department may be helpful in psychoeducation of survivors and their caregivers and in designing effective interventions to increase use of traditional outpatient and specialized primary care in lieu of emergency services.

The focus of this study was the assessment of long-term utilization and costs associated with TBI over time. Research on the unique needs of this clinical population is sorely lacking. Thus, one goal of this study was to provide descriptive information regarding relative utilization of healthcare services among this group. A second goal was to explore predictors of such utilization. In general, it was expected that severity of motor deficits would be positively related to utilization and cost of medical intervention. Specific hypotheses included the following. First, it was expected that severity of motor deficits would be particularly predictive of increased costs for primary care, medications, and medical equipment and supplies. Moreover, it was expected that improvement during the rehabilitation stay would be inversely associated with utilization of follow-up medical interventions. Second, it was expected that severity of TBI would be positively related to intensity of medical follow-up, as reflected in increased utilization of the emergency department and medications.

**METHOD**

**Participants**

Archival data from 63 individuals who survived a TBI (11 women and 52 men) were examined. Cause of injury at our center is roughly 46% violence, 29% auto collisions, 12% falls, and 13% other. Participants were enrolled in the Rehabilitation Institute of Michigan Primary Care Program and were at least 1 yr postinjury at entry into the study protocol. The sample ranged in age from 17 to 63 yrs (mean = 32.0, SD = 9.6 yrs). Average age at time of injury was 33 yrs. African Americans comprised 82% of the sample (n = 52), whereas 6% (n = 4) were white, 2% (n = 1) were Hispanic, and 10% (n = 6) were multiracial or of unknown racial/ethnic background. The average of Glasgow Coma Scale (GCS) scores was 8, using the highest score for each participant in the 24 hrs immediately after brain injury, which reflects a severe brain injury for most of the participants. The average number of months that participants sought medical services was 13, with a minimum of 2 mos and maximum of 19 mos. These data were available for 53 of 63 subjects.

Each of the patients was enrolled in the Rehabilitation Institute of Michigan Primary Care Program, which offered collaborative primary care involving internal medicine and physical medicine and rehabilitation providers. This program was co-sponsored by the Michigan Medical Services Administration of the Michigan Department of Social Services. The program offered access to care for persons with disabilities by housing the clinic within the rehabilitation center, with transportation available via wheelchair-accessible vans. Specialty care was provided on site rather than requiring participants to travel to other facilities within the medical center. Care was coordinated, with
routine care provided by internists and physiatrists, who made referrals to specialists as needed. All patients enrolled in the program were assigned a primary caregiver but were permitted to access care via traditional outpatient services.

**Measurement**

The GCS\textsuperscript{10,11} was used as an index of severity of acute trauma. This widely used, 15-point scale distinguishes between posttraumatic states of altered consciousness from the mildest state of confusion to deep coma. The scale assesses three dimensions of coma severity: eye opening, verbal, and motor response to various forms of stimulation. A GCS score of 3–8 indicates a severe injury, 9–12 indicates moderate injury, and 13–15 indicates mild injury.\textsuperscript{9}

The FIM™ instrument\textsuperscript{12,13} is a widely used measure of functional ability. Research on this 18-item, observer-rated instrument indicates that it consists of two domains: motor functioning and cognitive functioning. Each item is assigned a rating that represents the patient’s level of independence for skills in areas such as mobility, self-care, and cognitive function. Item ratings range from 1 (complete assistance required) to 7 (total independence).

Healthcare utilization and cost outcomes were codified in the following manner: Billings were used as an index of utilization, as they reflect an instance of a service, medication, or supply. Subcategories of billings included home health care, primary care, outpatient services, medications, medical equipment and supplies, inpatient treatment, residential treatment, transportation, and case management by the State of Michigan. Costs are reflected in the charge (i.e., amounts billed for services, medication, or supplies). Although billing data do not reflect actual cost to service providers, nor the actual amount reimbursed, they do allow a broader examination of utilization and cost because billing data were available from all medical service providers, not just within our own hospital system. Payments from the specific Medicaid program were included for comparison with charges, although there are a number of factors to consider in the interpretation of these figures. First, some participants in the study may have been required to make copayments for services or medication. Second, some participants may have had additional insurance that contributed payments. Third, negotiations between the medical center administration and various governmental entities has resulted in additional payments to the medical center, in large lump sums, to cover costs during and beyond the study period. It is not possible to incorporate these payments into these analyses. Overall, therefore, payments as represented in this dataset may underrepresent costs, and charges are considered a more consistent representation of cost. Intensity of medical follow-up was measured by the number of professional services sought during the study period, as reflected by billings for those services. Intensity was also reflected by the frequency of billings in the study period. TBI complications were reflected by billings associated with TBI-related International Classification of Diseases, ninth revision, codes. Comorbidities were reflected by billings associated with International Classification of Diseases codes reflecting known comorbidities of TBI (e.g., seizure disorder, hemiplegia).

**Design and Statistical Analyses**

A database was provided by the State of Michigan Medical Services Administration detailing individual billings, charges per billing, Current Procedural Terminology codes, and International Classification of Diseases codes when relevant. Data were examined for a 19-mo period (March 1997 to October 1998). Before analysis, the variables were screened for assumptions of univariate and multivariate parametric tests. Each of the billing outcome variables showed significant skew. Some of these variables were amenable to transformation, which improved normality and linearity to within acceptable limits for parametric analyses. These transformed variables were used in parametric analyses (e.g., multiple regression) and are noted as such where appropriate. For the sake of parsimony and consistency, nonparametric statistics (e.g., Spearman’s rho) were used in sets of analyses that examined outcomes containing variables that were not amenable to transformation.

**RESULTS**

Total billings, charges, and payments for the 63 study participants were calculated for the entire 19-mo study period. These are detailed in Table 1, tabulated by type of service provider and type of billing. Some relatively infrequent billing subtypes accounted for a large proportion of the amount charged for the group. Residential care, home health care, and state case management billings accounted for only 15% of total billings, but these contributed nearly half the total charges and 27% of Medicaid payments for the sample. These billings reflect services provided to survivors placed in transitional living facilities, services provided by home healthcare aide companies, and oversight by the Michigan Family Independence Agency, respectively. Together, these billings may reflect utilization and costs associated with burden of care and supervision. The amount of charges is remarkable also because only about a third of the participants
required these services. Medications were highly utilized, accounting for 39% of total billings and 19% of Medicaid payments but only 7% of charges. Outpatient services (excluding primary care program services) were likewise highly utilized, contributing 21% of total billings and accounting for 24% of total charges and 31% of Medicaid payments. In contrast to expectations, primary care program and medical equipment billings were fairly infrequent and inconsequential for the study, together accounting for 13% of total billings, 4% of total charges, and 6% of Medicaid payments. In fact, billings were seldom for true durable medical equipment such as wheelchairs or orthotics. Most of these billings were for medical supplies. Likewise, emergency room visits did not contribute substantially, accounting for 12% of billed services, 8% of all charges, and 7% of Medicaid payments.

The survivor’s median daily charge and payment were calculated to provide cost figures that may be generalizable outside of this particular sample, although perhaps not generalizable beyond the urban, primarily African-American population. Such calculations are necessary because the participants were variable in both the number of days in which they participated in the primary care program and in the number of days they were served by the particular division of Medicaid studied. The calculations were made by dividing each participant’s charges and payments by the number of days the participant was served in the program. The median values of the resulting distributions for total billings and billing subtypes are included in Table 1. Median charges and Medicaid payments are exhibited in Table 2 for the most common billed services.

Examination of diagnosis codes associated with billings revealed a wide variety of reasons for services. Headache was the most common specifically treated issue (136 billings, 3% of all billings). Conduct disturbance was associated with 93 billings (2% of all billings), and there were 76 billings for convulsions (1.7% of all billings). Hypertension stood out as another frequent problem (71 billings, 1.6% of all billings), albeit not directly related to brain injury. Medication utilization gives another indirect view of the medical issues for this sample. The most commonly utilized medications are presented in Table 3. Anticonvulsant/mood stabilization medications collectively accounted for a small majority of all medications purchased (7%). Analgesic and nonsteroidal anti-inflammatory drug purchases accounted for another 4%.

Each of the charge variables showed severe positive skew, which can distort the relative representations of the subcategories. A Friedman’s test, which is the nonparametric equivalent of a repeated-measures analysis of variance, was conducted to evaluate the relative charges within each category and yielded a significant result: $X^2 (7, n = 63) =$
The test indicated that outpatient charges ranked highest (mean rank = 5.90), followed by medications (mean rank = 5.60), primary care (mean rank = 4.87), home health care and residential (mean rank = 4.74), emergency department (mean rank = 4.72), case management (mean rank = 4.17), medical equipment and supplies (mean rank = 3.17), and inpatient (mean rank = 2.82) charges. Post hoc contrasts ($P < 0.05$) indicated that outpatient charges were significantly greater than medication charges, which were significantly greater than three statistically equivalent categories primary care, emergency department, and home health care. Those three categories were significantly greater than case management and medical equipment, which were statistically equivalent to each other and significantly greater than inpatient charges.

Fifty-six percent of the patients ($n = 35$) had emergency department billings after rehabilitation discharge, whereas 76% ($n = 48$) had primary care program billings, and 78% ($n = 49$) had outpatient billings. Mann-Whitney tests, which are nonparametric comparisons of two independent samples, were conducted to evaluate whether patients who used the emergency department had greater intensity of medical interventions than those who did not. These tests indicated that for patients who used the emergency department, more professional services overall ($U = 310$, $Z = 2.49$, $P < 0.01$),

| TABLE 2 Median charges and payments for the most common medical billings |
|-------------------------------------------------|-----------------|-----------------|-----------------|
| Service                                         | Median Charge   | Median Payment  | Frequency of Charges |
| Established patient office visit evaluation/    | $29.00          | $14.55          | 23 (0.5%)        |
| management level II                             |                 |                 |                  |
| Outpatient clinic visit                         | $74.00          | $19.68          | 278 (6.5%)       |
| Office visit evaluation/management level II    | $42.00          | $21.00          | 98 (2.3%)        |
| Office visit evaluation/management level IV    | $74.00          | $30.65          | 82 (1.9%)        |
| Medication review                               | $39.00          | $30.26          | 18 (0.4%)        |
| Emergency room                                 | $294.00         | $105.64         | 51 (1.2%)        |
| Emergency room visit level III                  | $128.00         | $30.07          | 85 (2.0%)        |
| Emergency room visit level IV                   | $196.00         | $52.38          | 22 (0.5%)        |
| Lab test, phenytoin level                       | $44.50          | $17.30          | 22 (0.5%)        |
| Lab test, auto CBC and PLT CT                   | $47.13          | $7.08           | 18 (0.4%)        |
| Speech therapy                                 | $39.00          | $36.09          | 18 (0.4%)        |
| CT scan                                         | $205.00         | $125.23         | 17 (0.4%)        |

CBC, complete blood cell count; PLT CT, platelet count; CT, computed tomography.

| TABLE 3 Most frequent prescriptions filled for the sample |
|----------------------------------------------------------|-----------------|-----------------|
| Medication                                               | Medication Type  | Frequency of Prescriptions |
| Albuterol, 90-μg inhaler                                 | Bronchodilator  | 48 (3.0%)        |
| Carbamazepine (Tegretol)                                 | Anticonvulsant/mood stabilizer | 145 (9.5%) |
| Phenytoin (Dilantin)                                     | Anticonvulsant/mood stabilizer | 93 (6.1%) |
| Depakote                                                 | Anticonvulsant/mood stabilizer | 47 (3.0%) |
| Neurontin, 300 mg                                        | Anticonvulsant/pain | 16 (1.0%) |
| Diocto, 60 mg/15 ml of syrup                             | Laxative        | 32 (2.2%)        |
| Docusate sodium, 100-mg capsule                          | Laxative        | 33 (2.2%)        |
| Acetaminophen/codeine 3                                 | Analgesic       | 56 (4.0%)        |
| Ibuprofen                                                | Analgesic       | 93 (6.1%)        |
| Naproxen                                                 | Nonsteroidal anti-inflammatory drug | 21 (1.4%) |
| Mevacor, 20-mg tablet                                    | Antihyperlipidemic | 25 (1.6%) |
| Triameterene/HCTZ 37.5/25 CP                            | Diuretic        | 21 (1.4%)        |
| Zyprexa                                                  | Antipsychotic   | 19 (1.2%)        |
| Norvasc                                                  | Anti-angina, Antihypertension | 18 (1.2%) |
| Ambien, 10 mg                                           | Hypnotic        | 34 (2.2%)        |
| Phenobarbital                                            | Barbiturate     | 17 (1.1%)        |
| Amitriptyline HCL                                       | Antidepressant  | 24 (1.6%)        |
| Paxil, 20 mg                                             | Antidepressant  | 18 (1.2%)        |
| Trazodone                                                | Antidepressant  | 24 (1.6%)        |
| Zoloft                                                   | Antidepressant  | 50 (3.3%)        |
more medication prescriptions ($U = 310, Z = 2.51, P < 0.01$), and greater total billings ($U = 363, Z = 1.78, P = 0.040$) were billed than for patients who did not use the emergency department. The frequency of TBI-related billings did not differ significantly between the groups who did and did not use the emergency department ($U = 453, Z = 0.51, P = 0.681$); however, there was a trend toward greater billings for comorbid illness among the emergency department users ($U = 391, Z = 1.37, P = 0.085$). It is noteworthy that the two groups did not differ significantly on indices of injury severity, such as GCS score at admission ($U = 329, Z = 0.29, P = 0.778$) or FIM score at discharge ($U = 397, Z = 1.28, P = 0.20$). $\chi^2$ analyses indicated that patients who used the emergency department after rehabilitation discharge utilized primary care program services (77% of billings) about as frequently as patients who did not use the emergency department (primary care program = 75% of billings): $X^2 (1, n = 63) = 0.04, P = 0.843$. Taken together, these results indicate that the emergency department was not used in lieu of the primary care program in this sample; however, emergency department users had more health problems.

### Motor Deficits and Intensity of Medical Follow-Up

The relation of motor deficits to healthcare utilization and costs was evaluated in two ways. First, the simple correlations between level of motor deficits at admission and discharge and outcomes were examined. Second, using multiple regression, we tested the hypothesis that rehabilitation of motor deficits (calculated as the change in motor deficits from admission to discharge) would have a unique, positive (i.e., cost lowering) effect on outcomes, beyond that accounted for by demographic characteristics.

Spearman’s rho correlation coefficients indicated that motor deficits at discharge from inpatient rehabilitation (FIM motor score) showed significant, inverse relationships to total charges ($r = -0.42, P < 0.001$) and to subcategories of charges reflecting medical equipment and supplies ($r = -0.26, P = 0.020$), home health care ($r = -0.52, P < 0.001$), and outpatient charges ($r = -0.27, P = 0.015$). Thus, as predicted, increased severity of motor deficits was associated with increased costs. However, contrary to prediction, FIM motor discharge showed weak and nonsignificant correlations with primary care program ($r = -0.19$) and medication ($r = -0.08$) charges.

Rehabilitation of deficits was calculated as difference scores on the FIM instrument (i.e., discharge – admission) for both motor (FIM motor change) and cognitive (FIM cognitive change) functioning. FIM motor change was significantly correlated with (log of) total charges ($r = -0.40$), whereas FIM cognitive change showed a weak relation to (log of) total charges ($r = -0.19$). Multiple regression analyses tested the hypothesis that rehabilitation of motor deficits during the inpatient stay has a substantial effect on cost, even after controlling for age and sex. Predictors for the analyses included age, sex, and FIM motor and cognitive scores at admission and indices of change during rehabilitation for both motor (FIM motor change) and cognitive (FIM cognitive change) functioning. With (log of) total charges as the dependent variable, the total model accounted for 29% of the variance: $F_{(6,55)} = 3.68, P = 0.004$. Examination of the squared semipartial correlations ($sr^2$), which indicate the amount of unique variance attributable to each predictor, indicated that FIM motor change ($sr^2 = 0.17$) contributed the most unique variance to the prediction of total charges. Sex was the next best unique predictor ($sr^2 = 0.04$), followed by FIM motor at admission ($sr^2 = 0.02$). Age, FIM cognitive score at admission, and FIM cognitive change score each contributed <1% unique variance to the predictive model.

### Severity of Injury and Intensity of Medical Follow-Up

GCS total scores at admission were available for 53 participants. Spearman’s rho correlations indicated that severity of injury as measured via GCS scores showed a weak and nonsignificant relationship with number of professional services sought after discharge ($r = 0.15, P = 0.144$), medication charges ($r = 0.16, P = 0.126$), emergency department costs ($r = 0.03, P = 0.423$), and primary care charges ($r = 0.22, P = 0.055$). GCS total, however, showed a significant relationship to home healthcare charges ($r = 0.30, P = 0.014$). Similar to the findings indicating the importance of motor functioning in hypothesis 1, GCS motor score at admission showed slightly greater correlations than did GCS total with follow-up needs: number of professional services ($r = 0.28, P = 0.029$), home healthcare charges ($r = 0.35, P = 0.007$), and primary care charges ($r = 0.27, P = 0.032$) were significantly related to GCS motor admission scores, whereas emergency department charges were not related ($r = 0.04, P = 0.387$).

Using GCS classification criteria, the sample was divided into three injury-severity groups: 11 patients (21%) with mild TBI (GCS >13), nine patients (17%) with moderate TBI (GCS 9–12), and 33 patients (62%) with severe TBI (GCS 3–8). Kruskal-Wallis tests, which are the nonparametric analog of one-way analysis of variance, indicated that the groups were statistically equivalent on each of the follow-up indices: number of profes-
sional services sought after discharge \((P = 0.361)\), emergency department charges \((P = 0.933)\), home healthcare charges \((P = 0.161)\), primary care program charges \((P = 0.561)\), and medication charges \((P = 0.587)\).

The pattern of results indicated that costs rose as a function of GCS score, which was contrary to the prediction. The null finding regarding emergency department services may be partly explained by the sizable proportion of patients \((44\%)\) who did not have any emergency department billings post-discharge, which restricted the distribution and attenuated the potential for correlation.

**DISCUSSION**

The present findings provide some insight regarding healthcare utilization and costs (as reflected by billings) after TBI in the population studied. The findings support the central hypotheses regarding motor disability as a predictor of costs. Motor disability was associated with total charges after inpatient discharge, with a strong relation to home healthcare charges, and modest relations to costs incurred for durable medical equipment and outpatient services. Contrary to the hypotheses, however, the relationship between motor disability and prescription charges was not strong. Access to transportation services provided by the primary care program offered an ideal situation for patients to utilize outpatient care services as needed, which would likely translate to increases in overall charges and the subcategory of outpatient costs among persons with mobility impairments. Motor function showed weak relation to use of the primary care program and its strongest relation to home healthcare charges. Moreover, it is noteworthy that the extent of improvement in motor function during the rehabilitation stay showed a substantial inverse relation to costs, and it provided unique information in predicting costs, even after accounting for demographic characteristics such as age and sex, and severity of motor and cognitive disabilities at the time of hospital admission.

The hypothesis regarding severity of injury and intensity of services was not supported, except for a modest relationship with home healthcare charges. Instead, costs were inversely associated with injury severity. It is possible that severe TBI presented with disabilities or disincentive for accessing medical care. Perhaps barriers to services (despite the primary care program), cognitive impairments, and higher burden on caregivers were factors in underutilization of services. The finding of equivalence in utilization for mild, moderate, and severe injury subgroups, however, argues against the possibility that those with severe injuries were unable to fully utilize services due to disability.

Participants did not primarily utilize either the emergency department or primary care program clinic; the bulk of services were provided in traditional outpatient settings. The choice of site of service did not seem to relate to level of disability. Survivors of brain injury, being generally younger and more able to ambulate relative to those disabled by other causes, may not have needed the provisions of the primary care program as much as other, older, and more deconditioned disability groups. More than half of these patients, however, used the emergency department at least once during the study period. Those that did use the emergency department seemed to have a greater amount of health problems associated with TBI, despite being equivalent in severity of TBI and disability at discharge from inpatient rehabilitation. Although the most straightforward explanation is that injury-related problems in this subgroup of participants was simply more frequent, it is also possible that these participants may have tended to delay their pursuit of health care until the concern became emergent and required greater intensity of care.

Limitations of the present study include the relatively small sample obtained within one hospital system that offered relatively ideal access to care. The study included only Medicaid data and does not include potential concurrent charges and payments for patients with co-insurance. Although available data did identify some individual participants with co-insurance, it is possible that other participants also had co-insurance, without apparent evidence of it in the database provided by the State of Michigan. However, given that Medicaid is routinely billed first, the presence of co-insurance would have the effect of attenuating the charge findings (i.e., the range of charges would have been greater) and would have little or no effect on frequency of services billed.

Another limitation is that billings were used as a representation of costs to allow an assessment of total healthcare costs, not just those for the home hospital system. Billing data do not reflect true costs to providers and do not necessarily reflect the amount paid by individuals and society through Medicaid. Therefore, billing charges should be regarded as an overestimate of true costs, and Medicaid payments described here should be considered an underestimate.

Future research might employ designs that parallel research on treatment adherence to investigate the influence of cognitive status on healthcare utilization and outcomes, using neuropsych-
logic tests of specific cognitive domains such as executive functioning and memory.

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REFERENCES
Reliability and Validity of a Wheelchair Collision Test for Screening Behavioral Assessment of Unilateral Neglect After Stroke

ABSTRACT


Objective: To examine the reliability and validity of a new wheelchair collision test (WCT) for screening behavioral unilateral neglect in people with stroke.

Design: A total of 19 patients with left hemiplegia resulting from first-ever stroke (mean ± SD, 61.9 ± 25.8 days after onset) were examined with the WCT, whereby the patient was asked to propel a wheelchair to pass four round chairs arranged in two rows. Separate tests were done using two different distances between the chairs: 120 and 140 cm. The number of collisions with the chairs was recorded. The Catherine Bergego Scale was used to evaluate behavioral unilateral neglect. Because unilateral neglect has an unfavorable impact on rehabilitation, the FIM™ instrument was used to determine the function of daily activities.

Results: Test–retest reliability ranged from 0.68 to 0.97 in different situations in the WCT. The rate of agreement tested by Kappa statistics between the WCT and Catherine Bergego Scale was higher when the distance between chairs was 120 cm than when the distance was 140 cm (0.68 vs. 0.58). Spearman’s rank-correlation coefficient between the WCT and Catherine Bergego Scale was 0.72 (P < 0.001) if the distance between the chairs was 120 cm and 0.75 (P < 0.001) if the distance was 140 cm. The WCT and Catherine Bergego Scale correlated well with the FIM instrument. Spearman’s rank-correlation coefficient between the Catherine Bergego Scale and FIM total score was −0.70 (P < 0.001).

Conclusion: The WCT is a simple screening test with high test–retest reliability and validity to evaluate behavioral unilateral neglect.

Key Words: Wheelchair, Stroke, Behavior, Unilateral Neglect
Unilateral neglect (UN) is a common neuropsychologic disorder after stroke and an important indicator of a poor functional outcome.\textsuperscript{1–3} The most common assessment relies on results of a battery of paper-and-pencil tests that include cancellation, line bisection, or drawing tasks.\textsuperscript{4–6} Paper-and-pencil tests do not reveal whether the patients exhibit UN in daily life. Patients showing no UN by these tests may exhibit directional bias in their daily life.\textsuperscript{7} The frequency of UN has varied according to the tool used. For example, Bowen et al.\textsuperscript{8} reported a range from 13% to 82%. This may be caused by differences in difficulty among tasks and the fact that some tests are more precise than others and can detect a milder degree of neglect.\textsuperscript{9}

In recent years, interest has increased in developing instruments that emphasize functional treatment-related assessment. Azouvi et al.\textsuperscript{10} proposed a functional scale consisting of ten items related to neglect that represent activities of daily life (such as dressing, washing, eating, communication, exploratory activities, and moving around), which is called the Catherine Bergego Scale (CBS). The CBS requires careful observation of activities of daily life and thus takes a relatively long time to perform. The aim of this study is to establish a simple method to determine if the patient has UN in their daily activities.

The wheelchair is among the most important therapeutic devices used in rehabilitation. Its use is closely related to daily activities. Neglect can cause problems in navigating the environment, as patients tend to bump into objects in their way. Webster et al.\textsuperscript{11} established a real-time wheelchair obstacle course, but they only compared this test with a paper-and-pencil test, and the wheelchair obstacle course requires a large space. Actually, they used an indoor theater.\textsuperscript{11,12} Yoneda et al.\textsuperscript{13} proposed another wheelchair test, whereby patients propelled the wheelchair passing between four round chairs placed on the floor and counted the number of collisions with the chairs. They found a good relationship between results of this test and a visual analog scale used to reveal hemineglect.\textsuperscript{13} Because this test is very easy to perform in a rehabilitation ward, we wanted to explore its test–retest reliability and validity. At first, we placed the chairs at distances of 100 cm from each other as reported by Yoneda et al.,\textsuperscript{13} but we found that even for healthy people, it is rather difficult to pass around the chairs without colliding. Therefore, in this study, we used this wheelchair collision test (WCT) but modified the distance between chairs reported by Yoneda et al.\textsuperscript{13} to assess behavioral UN and compared it with CBS. Because patients with UN have poor recovery of functional status,\textsuperscript{1} we also investigated the relationship of this test with the FIM\textsuperscript{TM} score.

**Subjects and Methods**

**Subjects**

This study was performed with the approval of the hospital ethics committee and with consent of patients. All patients admitted to our rehabilitation unit from July 2003 to November 2003 were candidates for this study, and subsequently, 19 patients with stroke (12 men, 7 women) were enrolled. The inclusion criteria were: (1) first-ever stroke, (2) left hemiplegia, (3) period of >7 days after admission, and (4) a lesion proved by computed tomography or magnetic resonance imaging of the brain. Patients with a low level of consciousness and the inability to cooperate with the assessment were excluded. Among the enrolled patients, 15 patients had an infarctive stroke and four had a hemorrhagic stroke. Mean age ± standard deviation was 65.2 ± 10.9 yrs and mean time since stroke onset was 61.9 ± 25.8 days (range, 23–115 days). A total of 11 healthy people (mean age, 62.3 ± 9.9 yrs; three men, eight women) served as age-matched control subjects. The control subjects were all on the staff of the rehabilitation unit.

**Tests**

**WCT**

Conventional manual wheelchairs with armrests and footrests were used in this study. Subjects propelled their own wheelchairs. Four round chairs, 45 cm in height and 31 cm in diameter, were used. The four chairs were arranged in two parallel lines on the floor, with two in the front row and two in the back row. The distance between the center point of the front chairs and rear chairs was 120 cm and 140 cm. The right-left distance between the two chairs in each row was also 120 cm and 140 cm. One of the rear chair was in the middle of the front two chairs. The starting point of the wheelchair was 2 m from the front row and at the midline between the two chairs in the back row (Fig. 1). The patients were instructed, “Please propel the wheelchair, passing between the four chairs without colliding into any of the chairs.” If the patients could not understand the instructions, the experimenter demonstrated the action by himself. If the chair was displaced by wheelchair collision, the chair was replaced rapidly, and the patient was asked to pass the chairs again. If a patient could not pass a chair after colliding with it, the experimenter explained to the patient how to adjust the direction of the wheelchair. In such a situation, the collision was only counted once; this may be improper. When any part of the wheelchair collided with any chair, it was recorded as a collision. The
wheelchair could collide with the same chair repeatedly.

The patients were asked to pass the chairs in eight trials in the following order: in the left direction for two trials with chairs separated by 120 cm, in the right direction for two trials with chairs separated by 120 cm, in the left direction for two trails with chairs separated by 140 cm, and in the right direction for two trials with chairs separated by 140 cm. The sum of collisions with each chair was counted. Patients colliding with a chair or chairs were operationally considered to have UN. Approximately 10 mins was required to fulfill the eight trials.

The reason we used these two trials (120 and 140 cm) was to explore which distance is suitable for this test. The distance of 100 cm had been used before this study, but soon we found it is rather difficult to pass the chairs without colliding with them, even for the healthy controls. Thus, we increased the distance to 120 cm. We used the distance of 140 cm because we wanted to know the upper limit of distance between chairs in this test.

The 11 healthy controls were asked to perform the same tests using only their right arm and right leg to imitate the patients’ situation in propelling the wheelchair. All the above tests were administered by the same rater (doctor) who did not know the results of the patients’ CBS scores.

CBS

The CBS was performed within the same week as the WCT by the doctor in charge of the patient, who was unaware of the results of the WCT. The doctor observed the daily activities of the patient in the ward, corridor, and rehabilitation room. The CBS includes ten items that correspond to common everyday life situations. For each item, a 4-point scale was used, ranging from 0 (no neglect) to 3 (severe neglect). A score of 0 was given if no spatial bias was observed; a score of 1 was given in case of mild neglect, with the patient always exploring the right hemispace first, going slowly and hesitatingly toward the left, and showing occasional left-sided omissions; a score of 2 (moderate neglect) was given if the patient showed clear and constant left-sided omissions or collisions; and a score of 3 (severe neglect) was given when a patient was totally unable to explore the left hemispace. A total score was calculated (range, 0–30). According to the total CBS scores, we divided the patients into four groups: no UN (0 points), mild UN (1–10 points), moderate UN (11–20 points), and severe UN (21–30 points).

FIM Instrument

Functioning related to activities of daily living was assessed by the FIM instrument the same week as the WCT. All of the items on the FIM instrument were measured. The total FIM score, motor subscore, and cognitive subscore were used for the statistical analysis. The FIM instrument was scored by occupational therapists who did not know the results of the CBS and WCT.

Statistical Analysis

Intraclass correlation coefficients (ICC [2,1]) were used to assess the test–retest reliability between the two trials, respectively, of movement to the right and to the left. The ICC was interpreted as follows: 1.0 = perfect agreement, 0.99–0.81 = almost perfect agreement, 0.80–0.61 = substantial agreement, 0.60–0.41 = moderate agreement, 0.40–0.21 = fair agreement, 0.20–0.01 = slight agreement, and 0.0–0.1 = poor agreement. Although there may be a learning effect in the second trial, we also expected each participant’s initial performance to correlate well with the subsequent performance. We used two statistical methods to compare the results of the WCT and CBS. First, the rate of agreement between the WCT (expressed by no collision and collision) and the CBS (expressed by no neglect [total CBS score = 0] and neglect [total CBS score ≥1]) was tested by the Kappa statistical method. An Excel worksheet for Kappa statistics based on Kohn’s original equation was used. According to the study by Lyden and Lau, the Kappa score range from 0.21 to 0.40 is fair, 0.41 to 0.60 is moderate, 0.60 to 0.80 is substantial, and 0.80 to 1.00 is almost perfect. Second, the relationship between the total number of collisions (four trials) for each patient and the total score of CBS was analyzed by Spearman’s rank-correlation coefficient. The relationships between the results of the WCT or CBS and FIM scores were also analyzed by Spearman’s rank-correlation coefficient.
RESULTS

WCT

All 19 patients performed the WCT. All collisions involved contact with chairs on the left side. No one collided with the chairs to the right.

When the distance between the chairs was 120 cm, 11 patients (57.9%) collided with the chairs during the four trials (left direction, two trials; right direction, two trials). Of those patients who collided with chairs, the total number of collisions per patient in the four trials ranged from 2 to 33. However, if the distance between chairs was 140 cm, five patients (26.3%) collided during four trials (left direction, two trials; right direction, two trials). The number of collisions per patient ranged from 4 to 15.

The results of test–retest reliability are shown in Table 1. ICCs were higher in the two trials of the left direction when the distance between chairs was 120 cm and in the two trials of the right direction when the distance between chairs was 140 cm. However, ICCs were low in the two trials of the left direction and two trials of the right direction when the distance was 140 cm. None of the 11 healthy controls collided with chairs during any of the trials.

CBS

All 19 patients were measured by the CBS to evaluate behavioral UN. A total of 13 patients (68.4%) were found to have hemineglect in their daily activities (CBS scores of 1). The mean score of CBS was 8.00 ± 8.92. Among patients with UN, six patients had mild UN, five patients had moderate UN, and two patients had severe UN.

Relationship Between the WCT and CBS

The rates of agreement and Kappa scores between the WCT (expressed by no collision and collision) and the CBS (expressed by no neglect and neglect) are shown in Table 2. The values of Kappa scores were interpreted as fair. The agreement rate and Kappa scores with CBS were higher with the 120-cm distance than with the 140-cm distance (0.68 vs. 0.58).

The relationship between the number of collisions and the CBS total score is shown in Figure 2. Spearman’s rank-correlation coefficient between the WCT and CBS was 0.72 ($P < 0.001$) at the 120-cm distance and 0.75 ($P < 0.001$) at the 140-cm distance. In contrast to the rate of agreement and Kappa score, the correlation coefficient was higher when the distance between chairs was 140 cm.

Relationships Among the WCT, CBS, and FIM Instrument

Both the WCT and CBS test had significant negative correlations with the FIM motor, FIM cognition, and FIM total scores ($P < 0.01$) (Table 3).

DISCUSSION

In this study, we attempted to establish a new objective measurement to evaluate behavioral UN. Because the interrater reliability of the CBS has been found to be acceptable,18 we used this scale to evaluate whether patients had UN and compared the findings with the WCT.

Many stroke patients with moderate to severe stroke use wheelchairs for mobility while performing daily activities. Thus, it is important to know if the patient can propel the wheelchair safely and skillfully. In the study of the wheelchair obstacle course established by Webster et al.,11,12 subjects twice traversed a 61-m course demarcated by rope that required three right and three left turns, with six obstacles occurring to each side. Right-hemisphere stroke patients with left-hemispatial neglect struck more objects on their left and ran directly into obstacles placed in their path. Yoneda et al.13 proposed a new, simple, and quantitative scale to test for UN. They required the patients to pass between four chairs, as mentioned in this study, but with the chairs placed at a distance of 100 cm from each other. They found a good relationship

<table>
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<tr>
<th>Distance</th>
<th>Direction</th>
<th>First Trial</th>
<th>Second Trial</th>
<th>ICC</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 cm</td>
<td>Left</td>
<td>2.05</td>
<td>1.11</td>
<td>0.69</td>
<td>0.36–0.87</td>
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<td></td>
<td>Right</td>
<td>1.94</td>
<td>1.94</td>
<td>0.97</td>
<td>0.95–0.99</td>
</tr>
<tr>
<td>140 cm</td>
<td>Left</td>
<td>0.42</td>
<td>0.42</td>
<td>0.87</td>
<td>0.69–0.95</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>0.94</td>
<td>0.42</td>
<td>0.68</td>
<td>0.36–0.86</td>
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</table>

120 cm, distance between chairs; 140 cm, distance between chairs; ICC, intraclass correlation coefficient; CI, confidence interval.
between results of this test and a visual analog scale used to reveal hemineglect.

There may be a trend for patients to propel the wheelchair to the left using only the right limbs, and skills in utilizing the wheelchair may affect the results. To clarify this situation, we had age-matched, healthy controls do the same tests using only their right arm and leg to propel the wheelchair. They had never used a wheelchair previously and were not allowed to practice before the test. They negotiated the path around the chairs without collisions in any of the trials. When testing patients, all the chairs involved in collisions were on the patient's left side, probably indicating left-space UN.

Test–retest reliability was higher in the two trials of the right direction when the distance between the chairs was 120 cm (ICC = 0.97) and in the two trials of the left direction when the distance was 140 cm (ICC = 0.87) and lower in the reverse situations. In the two trials of the left direction with a distance of 120 cm, the number of collisions decreased markedly only in one patient, which caused the low ICC in the two trials of the left direction. In the two trials of the left direction with a distance of 140 cm, only three patients collided with a chair; thus, the reason for the high ICC value was this majority of noncolliding patients. Only in the right direction with the 140-cm distance were the colliding times in the second trial decreased markedly, resulting in a low ICC value. Because this trial was the final trial in the test, patients may have become more skilled in negotiating the wheelchair around the chairs. Also, because the distance between chairs was larger, the wheelchair could be propelled further to the right.

With respect to concurrent validity, we compared this test with the CBS. The rates of UN (colliding times ≥ 1) were lower in the WCT (57.9%, 120-cm distance; 26.3%, 140-cm distance) than in the CBS (76.8%), as reported.10 Because the CBS consists of ten items of activities of daily living, the higher rate of UN is reasonable. All of our patients were first-ever patients with left hemiplegia, but in the CBS study, only patients with a right hemisphere lesion were included (patients with lesions in the brainstem and cerebellum were excluded).

When comparing the results of WCT and CBS by Kappa statistics, the rate of agreement was higher when the distance between chairs was 120 cm and lower when it was 140 cm (0.68 vs. 0.58). The Kappa scores were fair in both situations. The number of collisions in the WCT strongly correlated with the CBS total scores, and Spearman's rank-correlation coefficient was higher if the distance between chairs was 140 cm (0.75 vs. 0.72). This result is in contrast to the rate of agreement that showed that the distance of 120 cm was better for the purpose. When the distance was 120 cm, the number of collisions fluctuated if the CBS scores were <10 points. However, when the distance was 140 cm, none of the patients with CBS scores of

<table>
<thead>
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<th>Table 2 Rates of agreement between wheelchair collision test and Bergego Scale (CBS)</th>
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<tbody>
<tr>
<td>Number of Patients</td>
</tr>
<tr>
<td>120 cm</td>
</tr>
<tr>
<td>No collision</td>
</tr>
<tr>
<td>Collision</td>
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<tr>
<td>140 cm</td>
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<tr>
<td>No collision</td>
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<tr>
<td>Collision</td>
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<td>120 cm, distance between chairs; 140 cm, distance between chairs.</td>
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</table>

FIGURE 2 Relationship between number of collisions in the wheelchair collision test and Catherine Bergego Scale (CBS) total scores. The values of 120 and 140 cm are the distances between chairs. Spearman’s rank-correlation coefficient: r = 0.72, P < 0.001 (120 cm); r = 0.75, P < 0.001 (140 cm).
evaluate behavioral UN. The results showed that results of this test positively correlate well with the CBS score and negatively correlate with the FIM score. It is a simple and objective screening method. Further research on the WCT should investigate the interrater reliability and try to determine if this test can predict the final FIM score and evaluate the efficiency of treatment.

REFERENCES

| TABLE 3 | Spearman’s rank-correlation coefficients between the wheelchair collision test (WCT), Catherine Bergego Scale (CBS) scores, and FIM scores |
|----------|---------------------|---------------------|---------------------|---------------------|
| Test     | FIM Motor           | FIM Cognition       | FIM Total           |
| WCT      |                     |                     |                     |
| 120 cm   | −0.73<sup>a</sup>   | −0.78<sup>a</sup>   | −0.75<sup>a</sup>   |
| 140 cm   | −0.57<sup>b</sup>   | −0.62<sup>b</sup>   | −0.64<sup>b</sup>   |
| CBS total| −0.70<sup>a</sup>   | −0.82<sup>a</sup>   | −0.79<sup>a</sup>   |

120 cm, distance between chairs; 140 cm, distance between chairs.

<sup>a</sup> P < 0.001.

<sup>b</sup> P < 0.01.
Reliability and Validity of a Self-Report FIM™ (FIM-SR) in Persons with Amputation or Spinal Cord Injury and Chronic Pain

ABSTRACT


Objective: To evaluate the reliability and validity of a self-report FIM™ (FIM-SR) in two samples of adults with disabilities.

Design: Participants in a clinical trial of amitriptyline for pain (n = 84 with spinal cord injury [SCI], n = 38 with amputation) provided responses to the study measures via telephone interview. Reliability was estimated using Cronbach’s alpha and test–retest correlation coefficients, and validity was examined by comparing FIM-SR scores with the Craig Handicap Assessment and Reporting Technique (CHART) by comparing the CHART scores between the participants with SCI and amputation, and by comparing CHART scores between subjects with different levels of SCI.

Results: In the SCI sample, the FIM-SR demonstrated adequate reliability, and correlational analyses supported the validity of the FIM-SR motor scales. In addition, the FIM-SR motor scales discriminated subjects with different diagnoses (SCI vs. amputation) and injury levels (paraplegia vs. tetraplegia). The psychometric properties of the entire FIM-SR in the amputation sample and of the FIM-SR cognitive scales in the SCI sample were difficult to determine due to a ceiling effect in which these scale scores were skewed toward the top end of the range.

Conclusions: The FIM-SR motor scales and total FIM-SR score are reliable and valid measures of perceived functional independence in individuals with SCI. However, all of the FIM-SR scales in the amputation sample, and the FIM-SR cognitive scales in the SCI sample, seem to be less useful measures of functioning due to subjects reporting high levels of independence. The FIM-SR should be retested in amputation samples with more variable levels of functioning.

Key Words: FIM™ instrument, Reliability, Validity, Amputation, Spinal Cord Injury
Standardized scales that measure functional limitations are useful for determining the rehabilitation needs of persons with disabilities. The FIM™ Instrument was developed to evaluate rehabilitation progress and has been used successfully with numerous clinical populations, such as persons with stroke, AIDS, SCI, hip fracture, multiple sclerosis, traumatic brain injury, dementia, and cancer. The original FIM instrument is completed by trained clinicians, but a self-report version (FIM-SR) has the advantage of reducing the clinician time and effort required for administration. In addition, it is possible that patient perspectives on independence may differ from those of clinicians, and patient perceptions of their own level of independence may play an important role in efforts toward rehabilitation. A self-report version of the FIM instrument may therefore provide an important additional tool for assessing patient independence.

One self-report version of the FIM motor scales (i.e., excluding the scales that assess independence in communication and social cognition), developed by Hoening et al., has been used successfully in several samples of persons with disabilities, such as persons with SCI and multiple sclerosis. Another self-report version of the FIM instrument, which also includes the cognitive FIM items (called the FIM-SR), was developed by Grey and Kennedy. Preliminary evidence has supported the reliability and validity of this self-report version of the FIM instrument in several disability groups, such as individuals with SCI and neuromuscular disease.

Despite promising preliminary research on the psychometric properties of self-report versions of the FIM instrument, many unanswered questions remain concerning the relative strengths and weaknesses of the FIM-SR. Although the FIM-SR may be easier to use than the clinician-scored FIM instrument in studies with limited resources, the FIM-SR may not be appropriate for all disability groups. More research is needed to establish the psychometric properties of the FIM-SR in disabled populations.

The current study sought to examine further the psychometric properties of the version of the FIM-SR by Grey and Kennedy in a sample of individuals with SCI and a sample of individuals with acquired amputations and phantom limb pain using data from two clinical trials of amitriptyline for chronic pain. We assessed reliability by using measures of both internal consistency and test-retest stability, and validity by (1) examining the associations between the FIM-SR and another measure of physical functioning, (2) examining the ability of the FIM-SR to discriminate between the two diagnoses (SCI and amputation), and (3) in the SCI sample, between levels of injury (tetraplegia vs. paraplegia).

Our hypotheses were as follows: (1) the FIM-SR would be a reliable measure in both samples; (2) validity would be supported by significant associations between the FIM-SR motor scales and another self-report measure of physical functioning; (3) the FIM-SR motor scales, but not the cognitive scales, would discriminate between the diagnostic groups (SCI and amputation); and (4) in the SCI sample, the FIM-SR motor scales, but not the cognitive scales, would discriminate between levels of injury (paraplegia and tetraplegia).

**Materials and Methods**

**Subjects**

In the clinical trials, community residents with either SCI or amputation were approached through notices in newsletters and area clinics serving individuals with SCI or amputation and through mailing lists of patients treated for amputation at Harborview Medical Center (a regional trauma center) and patients treated for SCI at the University of Washington’s Northwest Regional SCI System, a comprehensive, interdisciplinary service delivery model system funded in part by the National Institute on Disability and Rehabilitation Research, Department of Education. Potential

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**Objectives:** On completion of this article, the reader should be able to (1) identify the characteristics of individuals and patient populations that can limit the utility of self-report measures for those individuals or populations, (2) list important psychometric strengths and weaknesses of a self-report version of the FIM™ instrument (FIM-SR) in two samples of persons with disabilities, and (3) articulate possible reasons for relatively low reliability and validity coefficients for some of the FIM-SR subscales.

**Level:** Advanced.

**Accreditation:** The Association of Academic Physiatrists is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing medical education for physicians.

The Association of Academic Physiatrists designates this continuing medical education activity for a maximum of 1.5 credit hours in Category 1 of Physician’s Recognition Award of the American Medical Association. Each physician should claim only those hours of credit that he or she actually spent in the education activity.

**Disclosure:** Disclosure statements have been obtained regarding the authors’ relationships with financial supporters of this activity. There is no apparent conflict of interests related to the context of participation of the authors of this article.
participants were asked to contact the investigators if they were interested in learning more about the study.

Eligibility criteria were essentially the same for both studies. Potential participants were included if they had: (1) either an amputation or SCI >6 mos before enrollment; (2) pain for ≥3 mos; and (3) average pain rating in the last month of ≥2 (for amputation) or ≥3 (for SCI) on a 0–10 scale. In both studies, individuals were excluded if they were <18 or >65 yrs of age, had a history of cardiovascular disease or abnormalities in a screening electrocardiogram, had seizures, were pregnant, were receiving any type of antidepressant medication, or were consuming more than two alcoholic drinks per day. The Institutional Review Board of Good Samaritan Hospital approved the SCI study, and the University of Washington Human Subjects Review Committee approved both studies. A total of 38 amputation subjects (18% of those eligible) and 84 SCI subjects (54% of those eligible) enrolled in the studies.

A more detailed description of the participants in each of these two randomized, double-blind studies can be found in their primary reports.20 Briefly, in the amputation trial, there were 39 subjects who received one of the two medications (active placebo benztrapine mesylate, n = 19; amitriptyline, n = 19); one of these subjects dropped out of the study completely, and four subjects started but did not complete the medication trial (three due to side effects and one due to beginning another antidepressant) but completed posttreatment measures and were included in the current study. Of the remaining 38 participants, the mean age was 44.58 yrs (SD = 11.38 yrs), and 91% were men. Mean time since amputation was 10.99 yrs (SD = 10.19 yrs), ranging from 6 mos to 33 yrs. Injury was the most frequent cause of amputation (73.7%), followed by infection (18.4%), gangrene (13.2%), vascular disease (13.2%), tumor (5.3%), and diabetes (5.3%); “other” was endorsed by 13.2%. Level of amputation was as follows: 2.6% hand, 7.9% above elbow, 7.9% hip, 31.6% transfemoral, 2.6% knee, 36.8% transtibial, 2.6% ankle, 2.6% foot, and 5.3% toes. One participant had both a left transtibial amputation and a right toe amputation; another had both right and left toe amputations. Average pretreatment phantom limb pain was 3.66 (SD = 1.79) on the 0–10 numeric rating scale.

In the SCI trial, there were 84 subjects who received either amitriptyline (n = 44) or an active placebo (benztropine mesylate, n = 40); one subject did not complete the medication trial due to side effects but provided posttreatment data and was included in the current study. The mean age was 41.43 yrs (SD = 10.02 yrs), and 80% were men. Mean time since injury was 13.96 yrs (SD = 9.36 yrs), ranging from 8 mos to 43 yrs. Neurologic level of injury was cervical for 53.6% of subjects, followed by thoracic for 38.1% and lumbar/sacral for 7.1%. Neuropathic (SCI) pain and mechanical spine pain were the most common primary pain problems; overuse pain and neuropathic pain were the most common secondary pain problems. Average pretreatment pain was 5.27 (SD = 1.79) on the 0–10 numeric rating scale.

**Measures**

**FIM-SR**

Pretreatment and posttreatment interviews included a self-report version of the FIM instrument20 that contains 18 items summed to create the following six scales: self-care (e.g., feeding, grooming, and dressing), sphincter control (e.g., bladder and bowel management), mobility (e.g., transferring in and out or on and off of a bed, toilet, or tub), locomotion (e.g., walking, wheelchair use, use of stairs), communication (e.g., comprehension, expression), and social cognition (e.g., social interactions, problem solving, memory). Overall motor, cognition, and total summary scores were also be calculated. On each item, participants rated their level of independence on a variety of daily activities on a 1–7 scale, on which 1 = “total assistance is needed (i.e., do about 0% yourself)” and 7 = “you are completely independent.” Participants were allowed to indicate if the item was not applicable to them. Scale scores are created by summing the responses to each item in that particular area of functioning so that possible scores range from the number of items in the scale to seven times the number of items (i.e., the total FIM-SR score ranges from 18 to 126).

**Craig Handicap Assessment and Reporting Technique (CHART)**

The CHART is a measure that assesses the extent to which respondents fulfill the roles typically expected of able-bodied persons.21 The CHART asks respondents to quantify their activities and daily lives in various ways. For this study, we chose to examine the two scales of the CHART related to physical functioning, which are quantified as follows: physical independence (hours per day that care is required) and mobility (hours per day out of bed and days per week out of the house). The physical independence scale measures an individual’s ability to sustain a customary effective independent existence. The mobility scale assesses an individual’s ability to move about effectively in his or her surroundings. The other three scales of the CHART (occupation, social integration, and...
economic self-sufficiency) were not included in the current study because they do not relate as directly to the functional abilities assessed by the FIM-SR but, rather, pertain more to social and occupational roles. The CHART total score was included as an overall measure of participants’ level of handicap. Each scale score is calculated using a weighting process so that most able-bodied persons would receive the maximal attainable score of 100 points, and lower scores indicate a greater degree of handicap. The CHART has demonstrated excellent test–retest reliability (ranging from 0.80 to 0.95 for subscale, and 0.93 for overall, CHART scores over a 1-wk period).21 Validity has been demonstrated by the generally high correspondence between self-reported ratings and ratings of the person by proxies (family members or friends) and by the ability of the CHART to discriminate among groups of persons rated by rehabilitation professionals as having either high or low levels of handicap.21

Procedures

We analyzed data from two completed trials of amitriptyline for the treatment of chronic pain in persons with disabilities (either SCI19 or amputation20). Procedures were essentially the same for both trials. Demographic information and baseline study measures, including the FIM-SR and the CHART, were completed via telephone interviews before randomization. Subjects in both trials were then randomly assigned to receive either amitriptyline or an active placebo (benztropine mesylate) that could produce dry mouth, a common side effect of amitriptyline; participants were asked to take study medications daily for 6 wks. The FIM-SR and the CHART were again given via telephone interviews at posttreatment. Research staff blind to subject treatment assignment conducted all telephone interviews. The amitriptyline trials were not found to be efficacious for pain or pain-related disability, and no differences in FIM-SR or CHART scores were found between treatment and placebo groups.19,20 Therefore, the treatment and placebo groups could be combined in our analyses, and we could be reasonably sure that any changes in FIM-SR and CHART scores from pretreatment to posttreatment were not due to treatment effects.

Data Analysis

To assess reliability, we examined internal consistency (Cronbach’s alpha) coefficients at both pretreatment and posttreatment, and test–retest coefficients (correlations of pretreatment and posttreatment scale scores), for all scales in both samples. Convergent construct validity was evaluated by examining the associations of the FIM-SR motor scales and a measure of handicap, the CHART.21 To further assess validity, we examined the ability of the FIM-SR at pretreatment to discriminate between diagnostic groups and, in the SCI sample, the ability of the FIM-SR at pretreatment to discriminate between levels of injury. For both of these sets of analyses, we conducted an omnibus multivariate analysis of variance (with all nine scales as the dependent variables) to determine if there were group differences overall, followed by univariate t tests to help understand any overall significant group differences. For scales with unequal variances, we used separate (as opposed to pooled) variances in the univariate analyses.

RESULTS

Reliability

Pretreatment and posttreatment mean and standard deviation values are presented in Table 1. The internal consistency coefficients (Cronbach’s alpha) for each of the FIM-SR scales at both pretreatment and posttreatment are presented in Table 2. In both samples, the internal consistency reliability (ICR) for the FIM-SR was higher at posttreatment (second administration); several explanations are possible: low sample sizes (especially in the amputation sample) may have contributed to variable coefficients, individual participants may have answered items more consistently in the second administration due to a possible learning effect, or greater variability in item responses across participants may have increased reliability coefficients. An examination of the mean and standard deviation values (Table 1) shows that there was indeed greater variability at posttreatment (e.g., in the cognitive scales in the SCI sample and the motor scales in the amputation sample), but we cannot determine why this was the case.

In the SCI sample, the self-care, sphincter control, and mobility scales and the motor and total summary scales demonstrated excellent ICR at both time points. ICR was lower for the communication and social cognition scales and the cognitive summary scale at pretreatment, but it was improved at posttreatment. ICR was weak in the locomotion scale at both time points, which may be due, in part, to the fact that the two items of the locomotion scale are not necessarily related; 76% of the participants with SCI in the current sample chose the maximum score for independence in walking/wheelchair use, whereas 55% chose the minimum value of independence in use of stairs. Moreover, the correlation between these two items was low and negative (r = −0.09) in the SCI sample. For the SCI sample, the (pretreatment to posttreatment) test–retest correlations for most of the scales related to motor function (self-care, sphincter control, mobility, and motor summary
scale) and for the FIM-SR total summary scale were also excellent. The test–retest coefficients for one of the motor scales, locomotion, and all of the cognitive scales were lower but in the acceptable range. An examination of the distribution of scores in the SCI sample identified both a restricted range and a ceiling effect for only the cognitive subscales, communication and social cognition, with 88% and 76% of the SCI sample reporting the maximum possible score in those areas, respectively.

In the amputation sample, the ICR indices varied from low to moderate for most of the scales at pretreatment but improved at posttreatment so that the self-care, mobility, and social cognition scales, and the summary scores, were in the acceptable range. In addition, ICR for the sphincter control scale at both time points could not be computed because the score was constant; all participants with amputation reported the highest level of independence in this area. Of the motor scales, the test–

### Table 1: Mean (standard deviation) values at pretreatment and posttreatment and differences in self-report FIM™ (FIM-SR) scale scores at pretreatment as a function of disability group (spinal cord injury [SCI] vs. amputation [AMP])

<table>
<thead>
<tr>
<th>FIM-SR Scale</th>
<th>Possible Range</th>
<th>SCI (n = 84)</th>
<th>AMP (n = 38)</th>
<th>t (AMP vs. SCI)</th>
<th>SCI (n = 84)</th>
<th>AMP (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-care</td>
<td>6–42</td>
<td>33.57 (12.73)</td>
<td>40.68 (2.47)</td>
<td>−4.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.87 (13.14)</td>
<td>41.24 (2.11)</td>
</tr>
<tr>
<td>Sphincter</td>
<td>2–14</td>
<td>10.61 (4.83)</td>
<td>14.00 (0.00)</td>
<td>−6.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.58 (4.81 )</td>
<td>13.94 (0.23)</td>
</tr>
<tr>
<td>Mobility</td>
<td>3–21</td>
<td>15.24 (7.57)</td>
<td>20.34 (1.02)</td>
<td>−6.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.24 (7.56 )</td>
<td>20.11 (2.34)</td>
</tr>
<tr>
<td>Locomotion</td>
<td>2–14</td>
<td>9.07 (2.65)</td>
<td>12.21 (2.17)</td>
<td>−6.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.07 (2.65  )</td>
<td>12.87 (2.04)</td>
</tr>
<tr>
<td>Communication</td>
<td>2–14</td>
<td>13.77 (0.72 )</td>
<td>13.61 (0.75)</td>
<td>1.18</td>
<td>13.60 (1.45 )</td>
<td>13.68 (0.78)</td>
</tr>
<tr>
<td>Social cognition</td>
<td>3–21</td>
<td>20.46 (1.37)</td>
<td>20.00 (1.83)</td>
<td>1.40</td>
<td>20.05 (2.19 )</td>
<td>20.05 (1.49)</td>
</tr>
<tr>
<td>Motor</td>
<td>13–91</td>
<td>68.49 (25.55)</td>
<td>87.24 (4.14)</td>
<td>−6.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>67.75 (26.15)</td>
<td>85.76 (13.26)</td>
</tr>
<tr>
<td>Cognitive</td>
<td>5–35</td>
<td>4.24 (1.85)</td>
<td>33.61 (2.35)</td>
<td>1.46</td>
<td>33.65 (3.47)</td>
<td>33.73 (1.98)</td>
</tr>
<tr>
<td>Total</td>
<td>18–126</td>
<td>103.86 (24.26)</td>
<td>120.84 (4.80)</td>
<td>−6.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>101.40 (27.26)</td>
<td>122.06 (6.61)</td>
</tr>
</tbody>
</table>

<sup>a</sup>P < 0.001.

### Table 2: Internal consistency indices (Cronbach’s alphas; pretreatment and posttreatment) and test–retest reliability coefficients of self-report FIM™ (FIM-SR) scales in both spinal cord injury (SCI) and amputation (AMP) samples

<table>
<thead>
<tr>
<th>FIM-SR Scale</th>
<th>Internal Consistency</th>
<th>Test–Retest Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCI (n = 84) Pre Post</td>
<td>AMP (n = 38) Pre Post</td>
</tr>
<tr>
<td>Self-care</td>
<td>0.97 0.97</td>
<td>0.57 0.70</td>
</tr>
<tr>
<td>Sphincter</td>
<td>0.98 0.96</td>
<td>−&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mobility</td>
<td>0.97 0.98</td>
<td>0.32 0.93</td>
</tr>
<tr>
<td>Locomotion</td>
<td>−0.14 0.20</td>
<td>0.15 0.58</td>
</tr>
<tr>
<td>Communication</td>
<td>0.65 0.95</td>
<td>0.30 0.55</td>
</tr>
<tr>
<td>Social cognition</td>
<td>0.39 0.67</td>
<td>0.71 0.61</td>
</tr>
<tr>
<td>Motor</td>
<td>0.97 0.97</td>
<td>0.55 0.88</td>
</tr>
<tr>
<td>Cognitive</td>
<td>0.63 0.91</td>
<td>0.75 0.69</td>
</tr>
<tr>
<td>Total</td>
<td>0.95 0.94</td>
<td>0.57 0.87</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cannot be computed because the Sphincter scale scores were constant in the AMP sample.
<sup>b</sup>P < 0.005.
<sup>c</sup>P < 0.01.
retest coefficients for the self-care and locomotion scales in the amputation sample were in the acceptable range but weaker for the motor summary scale and the mobility scale. Of the cognitive scales, the test–retest coefficient for the communication scale was in the acceptable range, whereas test–retest coefficients for the social cognition and the cognitive summary scales were weak and nonsignificant.

An examination of the distribution of scores in the amputation sample identified both a restricted range and a ceiling effect for all subscales, indicating that large proportions of participants reported high levels of independence in each domain. The following proportions of participants with amputation reported the maximum possible score in the six areas: self-care, 74%; sphincter control, 100%; mobility, 84%; locomotion, 82%; communication, 90%; and social cognition, 79%. Both the ICR and test–retest coefficients were difficult to interpret due to the skewed distributions of all scale scores in the amputation sample.

### Differences in the FIM-SR as a Function of Diagnosis

Differences in mean FIM-SR scales as a function of diagnosis are presented in Table 1. The omnibus multivariate analysis of variance for differences in the nine scale scores was significant ($F_{7,114} = 7.65, P < 0.001$). In univariate analyses, separate variances were used (due to unequal variances) for all of the scales except communication. As can be seen, and as predicted, participants with SCI reported significantly lower scores on the FIM-SR self-care, sphincter control, mobility and locomotion scales and on the overall motor and total summary scores, compared with participants with amputations. In contrast, no significant differences between diagnostic groups were found on the FIM-SR communication, social cognition, and overall cognitive scale scores.

### Differences in the FIM-SR as a Function of Level of Injury

The differences in the FIM-SR scale scores as a function of the level of injury in the SCI sample are

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**TABLE 3** Concurrent validity of motor subscales and total scale of the self-report FIM™ (FIM-SR) using physical independence, mobility, and total scores of Craig Handicap Assessment and Reporting Technique (CHART), in the spinal cord injury (SCI, $n = 84$) and amputation (AMP, $n = 38$) samples

<table>
<thead>
<tr>
<th>FIM-SR Scale</th>
<th>CHART Subscales and Total Scale</th>
<th></th>
<th>SCI</th>
<th>AMP</th>
<th>SCI</th>
<th>AMP</th>
<th>SCI</th>
<th>AMP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical Mobility Total Score</td>
<td></td>
<td>SCI</td>
<td>AMP</td>
<td>SCI</td>
<td>AMP</td>
<td>SCI</td>
<td>AMP</td>
</tr>
<tr>
<td>Self-care</td>
<td>0.52$^a$</td>
<td>-0.08</td>
<td>0.32$^a$</td>
<td>-0.12</td>
<td>0.27$^b$</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphincter</td>
<td>0.52$^a$, c</td>
<td>-</td>
<td>0.32$^a$, c</td>
<td>-</td>
<td>0.30$^a$, c</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>0.46$^b$, c</td>
<td>0.21</td>
<td>0.26$^b$, c</td>
<td>0.13</td>
<td>0.24$^b$, c</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion</td>
<td>0.13</td>
<td>0.17</td>
<td>0.26$^b$, c</td>
<td>0.13</td>
<td>0.23$^b$, c</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>0.51$^a$, b</td>
<td>0.09</td>
<td>0.26$^b$, c</td>
<td>0.13</td>
<td>0.29$^b$, c</td>
<td>0.39$^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total score</td>
<td>0.49$^a$, b</td>
<td>0.02</td>
<td>0.30$^a$</td>
<td>0.37$^a$</td>
<td>0.26$^a$, c</td>
<td>0.54$^a$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^aP < 0.01$.  
$^bP < 0.05$.  
$^c$Cannot be computed because the Sphincter scale scores were constant in the AMP sample.
The omnibus multivariate analysis of variance for differences in the nine scale scores was significant ($F(7,75) = 6.17, P < 0.001$). In univariate analyses, separate variances were used (due to unequal variances) for the following scales: self-care, sphincter control, mobility, motor, and total. As predicted, the FIM-SR self-care, sphincter control, mobility, motor, and total scales scores were significantly lower in SCI participants with tetraplegia compared with participants with paraplegia. The only motor scale that did not differ according to level of injury was the locomotion scale, which may lack reliability based on its low internal consistency, presented above. Also as predicted, the FIM-SR communication and social cognition scales and the cognitive summary scale did not differ significantly as a function of the level of injury in the SCI sample.

### DISCUSSION

In this study, we examined the psychometric proprieties of a self-report version of the FIM instrument (the FIM-SR) by examining measures of reliability, convergent construct validity, and ability to discriminate between type of disability condition (SCI and amputation samples) and, in the SCI sample, between levels of injury (paraplegia or tetraplegia). The current findings provide support for the reliability and validity of the FIM-SR (in particular, the FIM-SR motor scales) for assessing functional independence in persons with SCI and pain but do not support this measure for assessing independence in persons with acquired amputation.

The psychometric properties of all six subscales of the FIM-SR in the amputation sample, and the two cognitive subscales in the SCI sample, were difficult to determine due to the fact that these subscales demonstrated a restricted range and a ceiling effect, in which most respondents reported scores at the top end of the range. A restricted range has the effect of making reliability and validity coefficients less accurate reflections of the true psychometric properties of a scale. Because they contain more items, and hence more variability, the summary scale scores (motor, cognitive, and total) are likely to have stronger psychometric properties (e.g., higher reliability and validity coefficients, on average). It should be noted that, for the most part, reliability and coefficients for the summary scales were adequate in both samples.

It is clear, however, that the FIM-SR has limited utility for this group of persons with amputation, given that most respondents reported very high levels of independent functioning. Consistent with these results, Muecke et al.22 examined the use of the original FIM instrument with persons with lower limb amputations, concluding that the FIM instrument was not particularly good at predicting rehabilitation outcomes in this population. Our findings suggest that the FIM-SR may not provide much useful information when used with community samples of persons with amputation, such as ours, who may have been living with amputations for several years. However, it is possible that clinician or proxy ratings of functional independence in this group would be different com-

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**TABLE 4** Differences in the self-report FIM™ (FIM-SR) scale scores as a function of level of spinal cord injury (paraplegia vs. tetraplegia) in the spinal cord injury sample

<table>
<thead>
<tr>
<th>FIM-SR Scale</th>
<th>Paraplegia Mean (SD) n = 38</th>
<th>Tetraplegia Mean (SD) n = 45</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-care</td>
<td>41.45 (0.95) a</td>
<td>26.78 (14.26)</td>
<td>-6.88</td>
</tr>
<tr>
<td>Sphincter</td>
<td>13.37 (0.88) a</td>
<td>8.24 (5.56)</td>
<td>-6.09</td>
</tr>
<tr>
<td>Mobility</td>
<td>19.50 (3.15) a</td>
<td>11.53 (8.34)</td>
<td>-5.93</td>
</tr>
<tr>
<td>Locomotion</td>
<td>9.58 (2.50)</td>
<td>8.58 (2.71)</td>
<td>-1.74</td>
</tr>
<tr>
<td>Communication</td>
<td>13.84 (0.59)</td>
<td>13.71 (0.82)</td>
<td>-0.82</td>
</tr>
<tr>
<td>Social cognition</td>
<td>20.42 (1.22)</td>
<td>20.51 (1.50)</td>
<td>0.30</td>
</tr>
<tr>
<td>Motor</td>
<td>83.89 (5.01)</td>
<td>55.13 (28.60)</td>
<td>-6.63</td>
</tr>
<tr>
<td>Cognitive</td>
<td>34.26 (1.72)</td>
<td>34.22 (2.00)</td>
<td>-0.10</td>
</tr>
<tr>
<td>Total</td>
<td>75.37 (4.50)</td>
<td>57.44 (18.14)</td>
<td>-6.40</td>
</tr>
</tbody>
</table>

*P < 0.001."
pared with self-report, given that studies have found proxies tending to report higher levels of disability compared with self-ratings.\textsuperscript{23–25} For example, one study found that almost 20\% of wheelchair users did not report they had a disability, despite the fact that wheelchair use has become a widely recognized symbol for disability.\textsuperscript{27} Persons with amputation may rate themselves as functionally independent and, perhaps, not disabled, despite the use of a prosthesis or the need to take extra time on certain tasks.

The FIM-SR may be more useful in subpopulations of persons with amputation who have more variable functioning, such as those with new amputations, comorbid conditions, or multiple pain problems. For example, a previous study found that pain in each of three pain sites (phantom limb, residual limb, and back) uniquely contributed to pain interference with functioning in a sample of individuals with acquired amputation.\textsuperscript{26} Future research should examine, in a larger sample, the ability of the FIM-SR motor scales to discriminate among individuals with different levels of amputation or different types of pain.

In the SCI sample, the FIM-SR demonstrated excellent reliability for the overall total score and for all but one of the motor scales, locomotion, whose low reliability is consistent with similar findings in a study of persons with neuromuscular disease.\textsuperscript{18} The FIM locomotion scale may have low reliability because it actually assesses three different aspects of locomotion that are not necessarily related: walking and wheelchair use (both incorporated in a single item) and use of stairs.\textsuperscript{18} Thus, when using this measure to examine treatment outcomes in persons with SCI, it might make the most sense to examine each item separately rather than to use the composite locomotion scale score.

In the SCI sample, the FIM-SR communication and social cognition scales and the cognitive summary scale showed lower internal consistency coefficients at pretreatment (although they improved at posttreatment) and lower test–retest coefficients, again due to a restricted range and ceiling effect. These results are also consistent with previous studies. In a sample of persons with neuromuscular disease, for example, reliability indices for these scales were also lower than the other FIM-SR scales.\textsuperscript{18} Similarly, in a previous study of the FIM instrument in an SCI sample,\textsuperscript{14} the communication scale correlations between clinician and self-ratings were weak and nonsignificant due to a ceiling effect in both types of ratings (see also Hall et al.\textsuperscript{27}).

Regarding validity, our results show that the FIM-SR motor scales and the total summary score demonstrate good convergent construct validity in the SCI sample, as evidenced by significant associations with the scale scores of the CHART. These findings supporting the construct validity of the FIM-SR motor scales are consistent with previous research with the version of the self-report FIM instrument by Hoenig et al.,\textsuperscript{15} which excludes the two subscales related to cognition. With an SCI sample, their self-report FIM instrument demonstrated significant associations between the FIM-SR total score and several objective criteria, such as hours of personal assistance, the number of affected limbs, the amount of motor impairment, and the amount of combined limb-motor impairment.\textsuperscript{16} In a study of persons with SCI or multiple sclerosis, their self-report FIM instrument demonstrated excellent predictive validity for healthcare utilization as measured by the frequency of hospitalization, hospital lengths of stay, and discharge destination.\textsuperscript{17}

Although the evidence supported the psychometric properties of the FIM-SR motor scales in the SCI sample, a restricted range and ceiling effect was observed for the scores of the FIM-SR cognitive scales. Persons with SCI are not as likely as some other disability populations to have cognitive deficits, and for those who do have cognitive deficits, such deficits may not necessarily be apparent from self-report measures such as the FIM-SR. In research with other medical conditions, the relationship between self-reported cognitive problems and objective neuropsychologic assessment remains unclear.\textsuperscript{28,29} Future studies should examine the validity of the FIM-SR cognitive scales in other populations in which the independence of cognitive functioning might be more affected and more variable (as with some individuals with cerebral palsy, multiple sclerosis, or brain injury). There may be situations in which some measure of patient perception of functioning would be useful; for example, in settings in which patients with cognitive deficits are encouraged to better understand their limitations. In such situations, the present findings suggest that the FIM-SR cognitive summary score may be adequately reliable for this purpose in samples of patients with SCI. Even when rated by clinicians, however, the FIM instrument cannot be used as a substitute for comprehensive neuropsychologic assessment.\textsuperscript{30}

Our results indicated that FIM-SR scales are sensitive to expected differences between SCI and amputation in their patterns of disability. Additional support for the validity of the FIM-SR in persons with SCI is found in the scales’ ability to discriminate between different levels of SCI. As predicted, the motor scales reflected less functional independence when the individuals had a high level of injury (tetraplegia) compared with a lower level.
of injury (paraplegia). Following our predictions, the cognitive scales were not significantly different between persons with tetraplegia compared with paraplegia, indicating that both groups were reporting similar levels of functional independence in cognitive and communication daily activities.

There are several limitations to the current study that should be noted. First, both of the measures used in this study (CHART, FIM-SR) were self-assessments obtained via telephone interview. Therefore, some of the variance of the associations between the FIM-SR and the validity criterion (CHART) may be due to shared method variance. Future research could clarify this issue by examining the association between the FIM-SR scales and more objective measures of patient independence. Related to our self-report methodology, studies of other health issues have found that different methods of self-report can produce subtly different results (e.g., studies of medication adherence\(^1\) or health symptoms\(^2\)). We have found that telephone interviews result in more complete data collection; however, we do not know if our results can fully generalize to paper administration of the FIM-SR.

Regarding validity, this study was not able to fully examine the validity of the FIM-SR cognitive scales because we did not have a related criterion measure of cognition and communication. In addition, the other psychometric properties of the cognitive scales were more difficult to examine due to the ceiling effect on these scales in both samples. However, preliminary (albeit limited) evidence for validity of the cognitive scales can be seen in the fact that no significant differences were found between diagnostic groups or, for the SCI sample, between levels of injury, as predicted. Additional research comparing the FIM-SR cognitive scales with other measures of cognition and communication in samples with greater variability is necessary to provide stronger evidence of their validity and utility. The validity of FIM-SR in this study was only tested in samples of individuals with both a disability (SCI or acquired amputation) and chronic pain, which may limit generalizability to samples without pain. Concerning SCI, however, a previous study supported the psychometric properties of the FIM-SR in a sample of patients with SCI who did not necessarily have chronic pain\(^3\).

Lastly, test–retest measures were taken before and after a trial of amitriptyline, and we do not have test–retest data over a period in which no treatment occurred. Amitriptyline was not found to be effective in either trial for reducing pain or demonstrating significant improvement in any secondary outcome measure\(^4\);\(^5\) however, it is possible that there were pretreatment-to-posttreatment differences for some individuals or differential responses to the FIM-SR and the CHART. It would be helpful for the psychometric properties of the FIM-SR to be retested in a sample of people with amputations not undergoing treatment.

As noted by Grey and Kennedy\(^6\),\(^7\) the FIM-SR can be most useful when given careful prior thought about its purpose and relevance in a study or clinical setting. Despite the limitations of the current study, our findings provide strong support for the reliability and validity of the FIM-SR motor scales and positive (but limited) support for the validity of the FIM-SR cognitive scales for assessing functional independence in persons with SCI. These findings provide clinicians and researchers who work with persons with SCI another option for assessing perceived independence in functioning. The availability of a self-report measure of functional independence may be particularly useful in situations in which there are limited resources for obtaining observational measures of functioning or in which a measure of patient perceptions of independence is particularly important. The findings also indicate that the FIM-SR may be less useful and valid for assessing functional independence in individuals who have been living with acquired amputation for 6 mos or longer due to the high levels of independence they report, although it remains possible that this measure could be more useful in the early stages of adjustment to amputation.

ACKNOWLEDGMENTS

We thank Amy Hoffman for her contributions in database management and Sally Fitts and Vicki Smith for their contributions in data collection.

REFERENCES


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CME Self-Assessment Exam Questions

CME Article Number 1: A. Masedo Gutierrez, et al.

1. Which person characteristic that could limit the utility of a self-report measure listed below was mentioned in the paper as it might impact the utility of the FIM-SR?
   A. Severe motor deficits, limiting the individual’s ability to hold a pen or pencil.
   B. Profound cognitive deficits, limiting the individual’s ability to reliably rate themselves on the domain of interest.
   C. Profound affective disturbance (e.g., anger, anxiety), limiting the individual’s objective view of his or her abilities.
   D. Strong ‘desire to please’ the clinician, causing the individual to provide a rating that he/she thinks the clinician wants.

2. Which population characteristic that could limit the utility of a self-report measure listed below was mentioned in the paper as it might impact the utility of the FIM-SR?
   A. A tendency to provide ratings across all levels of the rating scale (“range” effects), which can restrict the ability of the rating to predict other measures.
   B. A tendency to focus on one’s behavior when responding to questions (“behavioral bias” effects).
   C. A relatively high level of disability (“disability” effects), which can make individuals focus too much on what they cannot do rather than on what they can do.
   D. A tendency to score at the upper range of the measure (“ceiling” effects), which limits the information that can be obtained using the measure in that population.

3. In the sample of patients with SCI who participated in this study, the internal consistency (Cronbach’s alpha) of the FIM-SR Total score was:
   A. Barely adequate (0.60–0.70).
   B. Adequate (0.70–0.80).
   C. Good (0.80–0.90).
   D. Excellent (0.90 or greater).

4. In the sample of patients with acquired amputation who participated in this study, the internal consistency (Cronbach’s alpha) of the FIM-SR Total score was:
   A. Inadequate (less than 0.60).
   B. Barely adequate (0.60–0.70).
   C. Adequate (0.70–0.80).
   D. Good (0.80–0.90).

5. One of the possible reasons for the low reliability of the FIM-SR Locomotion scale discussed in the paper was:
   A. The FIM-SR Locomotion scale assesses three different aspects of locomotion that may not be strongly related to each other.
   B. The FIM-SR Locomotion scale items may be difficult to understand for many patients.
   C. The low number of items in the FIM-SR Locomotion scale makes high reliability very difficult to achieve.
   D. The domain of mobility/locomotion can be highly variable, which makes reliable assessment of this domain difficult to achieve.
The answers to any essay questions must be typed or computer printed on a separate piece of paper and attached to this page.

After finishing this exam:
1. Check your answers with the correct answers on page 178.
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CME EVALUATION & CERTIFICATION

March 2005 CME Self-Assessment Exam 179

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Sex-specific care of musculoskeletal impairments is an increasingly important topic in women’s health. It is estimated that virtually all women experience some degree of musculoskeletal discomfort during pregnancy, and 25% have at least temporarily disabling symptoms. Given the high prevalence of these disorders, it is imperative for physicians treating musculoskeletal disorders to be very familiar with appropriate diagnosis, prognosis, and treatment.

This article will review the current knowledge and evidence-based medical research available on this topic. There are few randomized, controlled studies in this area. Much of the available literature is based on case series and on expert opinion based on clinical practice experience. Further research is needed to establish true evidence-based practice in this area.

Goals of This Review Article

The purpose of the review is to provide a guide for appropriate differential diagnosis, evaluation, and management of the regional musculoskeletal and peripheral neurologic disorders that affect women during pregnancy and the postpartum period. To accomplish this, the following will be provided: (1) an overview of relevant regional musculoskeletal anatomy, (2) a discussion of hormonal and biochemical changes of pregnancy as they relate to the musculoskeletal anatomy, and (3) specific conditions and their management.

Structure of the Pelvic Walls

The pelvic walls are formed by bones and ligaments partly lined with muscles and covered with fascia. The pelvis has anterior, posterior, and lateral...
**FIGURE 1.** Psoas and iliacus muscles. Netter illustration used with permission from Icon Learning Systems, a division of MediMedia USA, Inc. All rights reserved.
walls, with an inferior wall or floor (Fig. 1). The anterior pelvic wall is a shallow wall formed by the posterior surfaces of the pubic bones and symphysis pubis. This is an easily identified landmark on most women. The posterior pelvic wall is a more extensive wall that consists of the sacrum, coccyx, and piriformis muscle. The lateral pelvic wall is a component of the pelvis formed by part of the innominate bone, the obturator foramen, sacrotuberous and sacrospinous ligaments, and the obturator internus muscle and fascia. The inferior pelvic wall or pelvic floor consists of the levator ani muscles, coccygeus, and pelvic fascia and is accessible to palpation only via internal pelvic or rectal examination.

Joints of the Pelvis

Sacroiliac joints are synovial joints. Very strong posterior and interosseous sacroiliac ligaments connect the sacrum to the ilium. These ligaments are clinically very important during pregnancy. The symphysis pubis is a cartilaginous joint between the two pubic bones. The joint is surrounded by ligaments and is subject to substantial mechanical stresses during pregnancy. The sacrococcygeal joint is a cartilaginous joint that is joined by ligaments.

Sex Differences of the Pelvis

When compared with the male pelvis, the female pelvis has distinct anatomic features that facilitate parturition. In general, the female pelvis is broader, with a rounder, ovoid shape and a roomier pelvic cavity. The ischial tuberosities are everted. The sacrum is shorter, wider, and flatter, and the anterior pubic arch is rounder and wider than that of the male anterior pubic arch.1

Nerves of the Pelvis

The lumbosacral trunk passes down into the pelvis and joins the sacral nerves as they emerge from the anterior sacral foramina. From a clinical perspective, the important nerve branches that are associated with clinical syndromes of pregnancy and childbirth include: sciatic, obturator, femoral, lateral femoral cutaneous, pudendal.

Physiologic Changes of Pregnancy

Soft-tissue edema during pregnancy is reported by approximately 80% of women, with findings most notable during the last 8 wks of pregnancy.2 Increased fluid retention can predispose to tenosynovial or nerve entrapment (see below, “Peripheral Nerve Entrapment”).

Ligamentous laxity is another physiologic change of pregnancy. It is related to the production of the hormones relaxin and estrogen. In animal studies, relaxin is associated with remodeling from large-diameter to small-diameter collagen fibers.3 Relaxin is known to remodel pelvic connective tissue and activate the collagenolytic system.4 There may be a correlation between mean serum relaxin levels during pregnancy and symphyseal pain or low back pain. There is an initial increase of relaxin levels until a peak value at the 12th week followed by a decline until the 17th week. Thereafter, stable serum levels around 50% of the peak value were recorded.5

Weight gain during pregnancy is normal. In combination with ligamentous laxity, there may be increased joint discomfort. A 20% weight gain during pregnancy may increase the force on a joint by as much as 100%.2

Hyperlordosis of pregnancy may be seen as a gravid uterus inducing forces and accentuation of an anterior pelvic tilt. The sacroiliac joints resist this forward rotation. As the pregnancy progresses, both forward rotation and hyperlordosis increase as the sacroiliac ligaments become lax. These factors contribute to increasing mechanical strain on the low back, sacroiliac, and pelvis.2

Symphysis pubis widening begins during the 10th to 12th week of pregnancy under the influence of the hormone relaxin. This can be associated with tenderness and is usually exacerbated by exercise. Normal widening does not exceed 10 mm.6

Pubic Pain of Pregnancy

There is a spectrum of disorders affecting the pubic symphyseal region during pregnancy and parturition. Pubic symphyseal regional pain occurs as a result of increased motion related to the ligamentous laxity referred to above. In a recent European study, it is estimated that the prevalence of this condition is 1 in 36 women.7 Mild cases of symphysis inflammation generally respond to rest and ice. Osteitis pubis is characterized by bony resorption about the symphysis followed by spontaneous resossification.2 The pregnant or postpartum woman has a gradual onset of pubic symphysis pain, followed by rapid progression over the course of a few days to excruciating pain radiating down the inside of both thighs, exacerbated by any movement of the limbs. The prognosis for recovery is invariably good, with a self-limited course that lasts from several days to weeks before gradually subsiding.8,9 Occasionally, the course of groin/pubic pain may be quite prolonged and should be treated with initial bedrest followed by ambulation with a walker as tolerated. Anti-inflammatory agents can be given to affected women after parturition. Intrasympphyseal injection of lidocaine and steroid may shorten the duration of symptoms.10

Rupture of the symphysis pubis refers to a true rupture of the ligaments supporting the symphysis
pubis and is only rarely reported. This is believed to occur as a result of the wedge effect of the forceful descent of the fetal head against the pelvic ring, usually during delivery, creating a separation of >1 cm.11 In another case series, it is suggested that symphyseal rupture can occur as a result of forceful and excessive abduction of the thighs during labor.12 Characteristically, there is a sudden pain in the region of the symphysis pubis, sometimes an audible crack, followed by radiation of pain to the back or thighs. A gap may be palpable with associated soft-tissue swelling. Treatment is generally conservative. Initial bed rest in a lateral decubitus position with a pelvic binder is indicated. Progression to weightbearing as tolerated with a walker is appropriate when symptoms permit. Complications are rare, and subsequent vaginal delivery is possible.13 In extremely rare circumstances, persistence of symptoms may warrant surgical stabilization with open reduction and internal fixation.14

Severe pelvic dislocation of pregnancy is extremely rare. Cases reported are associated with difficult parturition. Patients sustain simultaneous rupture of the symphysis pubis and sacroiliac joints, with resultant pelvic dislocation. All patients in a series from Boston developed persistent sacroiliac pain after being managed with closed reduction. The authors suggest consideration of an operative approach to patients with symphyseal diastasis of >4.0 cm.15

Low Back Pain of Pregnancy

The epidemiology of low back pain in pregnancy demonstrates incidence rates of approximately 50% among retrospective reviews.16,17 Low back pain rates have been found to increase with advancing maternal age, back pain during a previous pregnancy, and an increasing number of previous births.16 A recent study by Wang et al.18 interestingly demonstrated increased low back pain in younger women. No consistent relationship has been found with height, weight, or weight gain of the mother or weight of the baby.11 It is reported that only 32% of women with low back pain during pregnancy report this to their prenatal providers, and only 25% of prenatal care providers recommended a specific treatment. Nearly 30% of women are forced to stop performing at least one daily activity because of low back pain over the course of their pregnancy.18

Low back pain is also reported in 30–45% of women in the postpartum period.19 The main factors associated with development of postpartum back pain were previous episodes of back pain. Risk factors associated with persistent back pain after 24 mos seem to be the onset of severe pain early during gestation and the inability to reduce weight to prepregnancy level.19,20

Low back pain during pregnancy has multiple causes, and the relative frequency of these causes have not been fully established. These causes include: mechanical strain, pelvic ligamentous laxity, sacroiliac pain, vascular compression, spondylolisthesis, discogenic pain, and hip pathology (please refer to section on the hip).

One popular theory for the cause of nonspecific low back pain of pregnancy posits that the enlarging gravid uterus and accompanying compensatory lumbar lordosis contribute to substantial mechanical strain on the lower back. In addition, the tendency for pelvic rotation is increased as the lumbar lordosis increases. These altered biomechanics, in combination with relaxation of the pelvic and sacroiliac joints under the influence of relaxin, may further increase strain on the pelvis and low back.2,11,17

Lumbar disk herniations of pregnancy, although relatively uncommon, are estimated to occur in approximately 1 in 10,000 cases of lumbosacral pain of pregnancy.21 During pregnancy, noncontrast magnetic resonance imaging can be performed to identify the pathology. To date, no recognized adverse biological effects of magnetic resonance imaging on the developing fetus have been identified, although the long-term effects of magnetic resonance imaging on the developing fetus have not been fully evaluated.22

Another hypothesis suggests that the vascular system may play an important role in the pathogenesis of back pain during pregnancy. In a 1992 study, Fast and Hertz23 hypothesize that prolonged time in the supine position leads to obstruction of the vena cava. They further suggest that increased pressure and venous stasis in combination with a decrease in basal oxygen saturation may lead to hypoxemia and compromise the metabolic supply of the neural structures, thus resulting in pain.

In susceptible women, pregnancy may be a factor for the development of degenerative spondylolisthesis.24 In women with previously diagnosed spondylolisthesis, no increase in low back pain or increase in slippage during pregnancy was found.25 As in other individuals with spondylolisthesis, low back pain may be unrelated to the presence of this anatomic finding and may be caused by disk, facet joint, or muscle abnormalities.

History and Physical Exam

The pregnant woman with low back pain generally reports lumbar or pelvic/sacroiliac pain aggravated by weightbearing and activity. Sitting, rest, recumbency, and use of a supportive pillow often ameliorate the symptoms. Occasionally, there is a vague accompanying posterior thigh or ingui-
nal radiation of pain into the leg. True nerve root pain is uncommon.

The physical examination of the pregnant woman with back pain should begin with a standard neuromuscular exam that includes observation, palpation, range of motion, muscle imbalances, and a thorough neurological examination. In addition, the examiner should assess posture and degree of lordosis. Occasionally, a “step-off” sign will be appreciated in the lumbar spine and may suggest spondylolisthesis. Tenderness is often present over the sacroiliac joints and lumbar paraspinal muscles. Sacroiliac compression tests, bimanual compression over the iliac crests, and Patrick’s test all may elicit sacroiliac pain. A careful examination of the hip should be performed as well.

Treatment

The majority of patients with low back pain will respond to activity and postural modifications. Scheduled rest periods with elevation of the feet to flex the hips and decrease the lumbar lordosis help relieve muscle spasm and acute pain.\textsuperscript{26} A regular exercise program before pregnancy reduces the risk for back pain during pregnancy.\textsuperscript{26} During pregnancy, exercise may be initiated once the acute pain is controlled. Sitting pelvic tilt exercises and aquatic exercise have been shown to decrease pain intensity.\textsuperscript{27,28} Exercise to increase strength of the abdominal and back muscles is also recommended.\textsuperscript{29} Please refer to the physical therapy section later in this article for specific exercises.

Several studies suggest that use of a nonelastic maternity support binder may reduce symptoms of posterior pelvic pain.\textsuperscript{26,30} Other physical modalities of treatment may include mobilization of the sacroiliac region.\textsuperscript{31} A recent retrospective, observational study of 167 patients with low back and pelvic pain of pregnancy demonstrated improvement in 72% of patients treated with acupuncture administered during the second and third trimesters. No significant adverse effects were noted.\textsuperscript{32}

The medication of choice for pain relief is acetaminophen because antiprostaglandins (aspirin and nonsteroidal anti-inflammatory drugs) are relatively contraindicated in pregnancy because they can cause premature closure of the ductus arteriosis in the fetus if given at or near term. Other medications that the United States Food and Drug Administration rates class B (no evidence of risk in humans during pregnancy) may be considered for pain control during pregnancy. These include cyclobenzaprine, oxycodone (if used for short periods not near term), and prednisone. Care should be carefully coordinated with the obstetrician.

There is no literature examining the safety or efficacy of epidural steroid injections during pregnancy. In our clinical experience, translaminar epidural steroid injections, performed without any fluoroscopic guidance, can be performed safely by an anesthesiologist or interventional pain specialist with extensive experience in epidural injections in pregnancy.

Surgery for lumbar disk herniation during pregnancy with cauda equina syndrome or progressive neurologic deficit can be safely undertaken. Brown and Levi\textsuperscript{33} report a case series of three pregnant women who were successfully treated this way.

Peripheral Nerve Entrapment: Neuropathies of Pregnancy and the Puerperium

Peripheral nerves are susceptible to injury in the pregnant, laboring, and postpartum woman by several mechanisms, including compression, traction, ischemia, and less commonly, laceration. As would be expected biomechanically, labor and delivery are more likely to compromise the lumbosacral plexus and lower limb peripheral nerves, whereas activities of daily living and child care, especially those requiring repetitive or prolonged positioning of the upper limb, are associated with upper limb peripheral nerve injury. Upper limb neuropathies (such as median neuropathy at the wrist) can also occur during pregnancy due to peripheral edema.

Mechanisms of Peripheral Nerve Injury

Compression and traction are the most common mechanisms of peripheral nerve entrapment in pregnancy and the puerperium. Compression neuropathies are most common in anatomic locations where excessive pressure can occur (median nerve in the carpal tunnel) or in superficial nerves (common peroneal nerve at the fibular head). The endoneurium, a connective tissue matrix of collagen and fatty tissue, surrounds individual nerve fascicles, absorbing shock and dissipating pressure. Nerves with tightly packed fasciculi and thin endoneurium are more susceptible to compression. Pregnancy-related swelling and prolonged positioning increase compressive forces, resulting in increased prevalence of compression neuropathies in pregnancy and postpartum childcare activities.

Labor and delivery is also associated with compressive mononeuropathies and lumbosacralplexopathies.\textsuperscript{34–36} Traction neuropathies result when the stretch applied to the nerve exceeds the neural and connective tissue elastic capacity. Intrinsic
nerve characteristics, such as the amount of perineurium, the lamellated sheaths of perineural cells, and collagen fibrils, have been implicated in differential risk of traction injury. A combination of compression and stretch may result in decreased perineural blood flow and ischemic injury. Less severe injuries that cause focal demyelination and conduction block are the most common type in pregnancy and the puerperium. These neuropathies are generally short-lived and have a good recovery.

Carpal Tunnel Syndrome (Median Neuropathy at the Wrist)

Hand pain is the second most frequent musculoskeletal symptom of pregnancy, with carpal tunnel syndrome (CTS) frequently the cause. The median nerve can be entrapped at the wrist in the enclosed space formed by the carpal bones and the overlying transverse carpal ligament. CTS typically presents with pain and paresthesias in the first three digits of the hand, often bilaterally, and is most frequently diagnosed during the third trimester. The rate of CTS varies from 2% to 25% in pregnant women. The pain can worsen at night or during the day with repetitive wrist flexion or extension. Peripheral edema has been implicated in pregnancy-related CTS and is most common in older, primiparous women. Prolactin and fluid retention coupled with prolonged, awkward positioning of the wrist and hand may cause CTS related to nursing. The symptoms of CTS frequently resolve within days to weeks after labor and delivery; 95% of women have resolution of symptoms within 2 wks postpartum. In one study, women with onset of CTS symptoms early during pregnancy had prolonged time to recovery after delivery.

Nonsurgical management of CTS is appropriate in pregnant women because the majority of patients obtain relief after delivery. In pregnant women symptomatic enough to require treatment, splinting of the wrist in a neutral position is recommended. More than 80% of women had good relief of symptoms using thermoplastic night splints for 2 wks. Serial electrophysiologic studies done before and after splinting in one case study demonstrated rapid improvement in physiologic measures, mirroring clinical improvement. Education on correct positioning of the hand and wrist for occupational and childcare activities should be provided to women with CTS during and after pregnancy. Steroid injections are useful in patients who are not responding to conservative measures, mirroring clinical improvement. Education on correct positioning of the hand and wrist for occupational and childcare activities should be provided to women with CTS during and after pregnancy. Steroid injections are useful in patients who are not responding to conservative measures.

Meralgia Paresthetica (Lateral Femoral Cutaneous Neuropathy)

The lateral femoral cutaneous nerve is a pure sensory nerve supplying sensation to the anterolateral thigh. It passes slightly medial and inferior to the anterior superior iliac spine after exiting the pelvis by traveling under the inguinal ligament. Injury to the nerve causes burning, pain, or numbness in the region of innervation, known as meralgia paresthetica syndrome. Pregnancy along with obesity, diabetes mellitus, trauma, belt pressure, and anatomic variation are risk factors for meralgia paresthetica. A nested case-control study found that pregnant women had 12 times the likelihood of meralgia paresthetica compared with nonpregnant patients in a primary care setting. In patients in whom the lateral femoral cutaneous nerve bisects the inguinal ligament, the accentuated lumbar lordosis of pregnancy is thought to lead to increased risk of nerve compression. Lateral femoral cutaneous neuropathy was the most common finding in a prospective study of postpartum lumbosacral spine and lower limb nerve injuries resulting from labor and delivery. Cesarean delivery may infrequently lead to meralgia paresthetica from a wide incision, stretching, or retractor placement, although the prevalence does not vary substantially with method of delivery.

As with CTS, pregnancy-related meralgia paresthetica syndrome typically resolves after delivery. The diagnosis is typically clinical; the nerve conduction study of the lateral femoral cutaneous nerve can be difficult to obtain, even in healthy, asymptomatic individuals. Recommendations for pregnant patients include avoidance of tight-fitting clothing along the hips or repetitive carrying of older children on the ipsilateral hip. Several authors postulate that intrapartum nerve injury can be reduced by attention to laboring practices. Consideration of frequent position changes for laboring, with avoidance of prolonged hip flexion, may reduce compression on the lateral femoral nerve. In addition, shortening pushing time by allowing the fetus to descend into the perineum without active maternal pushing may reduce nerve compression or traction.

Femoral Neuropathy and Other Intrapartum Maternal Nerve Injuries

The incidence of lumbosacral spine and lower limb nerve injuries related to labor and delivery varies in studies, depending on sample size and study methodology. A retrospective study using International Classification of Diseases, Ninth Edition, codes for nerve injury studied charts over 16 yrs for >140,000 women and found 0.08% incidence of nerve injury. The authors concluded
that improvements in modern obstetric practice might be responsible for a reduction in nerve injury rates of almost 5% since the turn of the century.\textsuperscript{53} A more recent prospective study of >6,000 women who delivered in a 1-yr period found an almost 1% (0.92%) rate of injury.\textsuperscript{36} Injury rate was not associated with obstetric anesthesia but rather nulliparity and prolonged pushing. Many studies are limited by lack of electromyographic documentation because the injuries are frequently of limited duration and new mothers may not follow up for an electrodiagnostic study before symptom resolution. The majority of nerve injuries resolve over weeks to months.

Femoral neuropathy has been documented as a consequence of labor and delivery. During a prolonged second stage of labor, compression of the femoral nerve under the inguinal ligament may occur. Stretch or ischemia of the intrapelvic, poorly vascularized portion of the femoral nerve may be another mechanism of injury, as the femoral nerve does not descend through the true pelvis.\textsuperscript{34} However, in cases in which the iliopsoas muscle is found to be weak along with the quadriceps, the lesion may be proximal to the inguinal ligament, where branches to the iliopsoas arise.\textsuperscript{54} Femoral neuropathy can result in significant functional impairment, particularly in ascending and descending stairs, walking, and transferring from sitting to standing. Physical therapy evaluation and assistive-device training is mandatory before hospital discharge.

**Lumbosacral Plexopathies**

Lumbosacral plexopathies resulting in proximal or distal lower limb weakness can occur. Plexus-associated foot drop can result from compression of the peroneal division of the sciatic nerve in the pelvis or compression of the common peroneal nerve at the head of the fibula.\textsuperscript{49} Common peroneal nerve compression at the fibular head was documented in laboring women both from hand placement and squatting.\textsuperscript{55–58} Obturator nerve palsies have been described as related to labor and delivery. The nerve crosses the pelvic brim and may be compressed by the descending fetal head or instrumentation used for fetal evacuation.\textsuperscript{49,53}

**Upper Limb Pain**

DeQuervain’s tenosynovitis is an inflammatory condition of the abductor pollicis longus and extensor pollicis brevis tendons of the first dorsal compartment of the wrist. It can develop in pregnancy or during the postpartum period, with localized pain along the radial aspect of the wrist. Fluid retention related to hormonal status is suspected in the pathophysiology in pregnant and lactating women. Overuse during childcare activities is also implicated.\textsuperscript{59,60} Symptoms may persist until nursing is discontinued.\textsuperscript{61}

The clinical diagnosis is based on history, symptom location, and local tenderness over the first dorsal compartment. Provocative maneuvers include Finkelstein’s test, in which the pain is provoked with ulnar deviation of the wrist with the thumb flexed inside a closed fist. Symptoms are usually self-limited and respond to conservative management, including thumb spica splints, icing, and activity modification. Oral anti-inflammatory medications can be used in the postpartum patient, and corticosteroid injections to the tendon sheath are used in pregnancy and postpartum. Local corticosteroid injections were shown to be more efficacious than splinting in a study of 18 patients.\textsuperscript{62} Occasionally, operative treatment is necessary in the postpartum period.\textsuperscript{63}

**Lower Limb Pain: Hip Pain of Pregnancy**

Hip pain in the pregnant woman can present with progressive symptoms and can lead to significant disability. There are several rare but worrisome entities that must be considered when a pregnant woman presents with complaints of hip pain. As noted earlier, there are conditions of the low back and pelvic girdle that can present with associated hip pain and should be included in the differential diagnosis. Likewise, intraarticular hip pathology can refer to the pelvis and back and can be misdiagnosed as pelvic instability. It is important to test hip range of motion, with the pelvis and lower spine maintained in a stable position, to differentiate intraarticular hip pathology from referred pain.\textsuperscript{11} In any pregnant woman presenting with antalgic gait, transient osteoporosis of the hip or osteonecrosis of the femoral head must be considered.

Transient osteoporosis of the hip is a rare condition that presents with weightbearing hip pain, usually in the third trimester of pregnancy. Plain anteroposterior radiography of the pelvis with properly positioned lead shielding may reveal osteoporosis of the femoral head and neck with preserved joint space.\textsuperscript{54,65} Magnetic resonance imaging reveals high-intensity signal in the bone marrow on T2-weighted images.\textsuperscript{66,67} Early recognition and treatment with protective weightbearing will allow the condition to be self-limited and without long-term sequelae.\textsuperscript{2} The use of antiresorptive bone agents, including calcitonin and bisphosphonates, shortened the duration of the symptoms both in pregnant and postpartum patients.\textsuperscript{68,69} However, the use of bisphosphonates during pregnancy is controversial. Several groups have found that gestational exposure to bisphosphonates was associated with decreased fetal bone health.
growth. Bisphosphonates may have an effect on fetal serum calcium levels. If clinicians choose to start treatment before delivery, serum calcium levels should be monitored closely. There have been no reports of congenital abnormalities associated with use of bisphosphonates in animal teratology studies. The prognosis for natural recovery is good if the osteoporosis is associated with pregnancy and not related to preexisting osteoporosis predating the pregnancy. Failure to diagnose this condition can result in fracture, which can result in the need for surgical intervention.

Avascular necrosis of the femoral head has been reported in pregnant women with no additional risk factors for avascular necrosis. Several theories regarding the pathogenesis have been proposed, including higher adrenocortical activity combined with weight gain and higher levels of female sex hormones in conjunction with increased interosseous pressures. The symptoms typically occur in the third trimester, with weight-bearing pain in the hip, pelvis, or groin and, at times, radiating to the knee. Radiographic and magnetic resonance imaging can delineate the pathology, with partial femoral head involvement in most cases. Restricted weight bearing is initiated to prevent progression of femoral head necrosis, with definitive treatment after delivery as appropriate.

**Other Causes of Lower Limb Pain During Pregnancy**

In a case-controlled study, about 100 postpartum and matched nulliparous controls were surveyed regarding lower limb pain complaints. The postpartum subjects were twice as likely as the nulliparous controls to have symptoms of leg and foot pain. The majority of the postpartum women noted the onset of lower limb pain during the second or third trimester of pregnancy. History of regular exercise was not protective or causative of pain related to pregnancy.

Ligamentous laxity may be associated with lower limb injury. A case study documented transient laxity of the anterior cruciate ligament in a pregnant woman during her third trimester and postpartum period. This patient’s anterior cruciate ligament reconstruction was performed 2 mos before conception. Relaxin-related dissociation of large collagen fibrils was thought to be causative. The mechanism of ligamentous pain production may be secondary to strain. Ligaments, especially at the site of bony insertion, lie on a bed of well-vascularized and highly innervated insertional angle fat. There are numerous nerve endings at the attachment sites. The differential diagnosis in pregnant and postpartum women with musculoskeletal pain should include other bone, joint, and soft-tissue structures in addition to ligaments. For instance, the labrum of the hip or meniscus of the knee may be at greater risk of injury during pregnancy. Two cases of pregnant women presenting with acute locking of the knee were reported, including urgent arthroscopic repair of a torn meniscus. History of previous injury in the area, current injury in adjacent areas, or systemic metabolic conditions such as pregnancy-related osteoporosis could be associated with an acute musculoskeletal injury in pregnant women.

Sacral and tibial stress fractures, rib fractures, and vertebral fractures are documented in pregnant women related to osteoporosis. In a case study of a pregnant woman with normal lumbar and femoral bone density, bilateral sacral stress fractures were related to stress fracture due to unaccustomed loading in the last trimester.

Recurrent ankle sprains or patellofemoral symptoms are a theoretical risk during pregnancy that women should consider in their exercise planning. Local treatment of acute lower limb musculoskeletal injury includes rest, ice, compression, and elevation. Protected mobility with orthoses or protected weight bearing with assistive devices should be employed in relation to injury with similar clinical reasoning as in the nonpregnant population. Careful observation of women who become pregnant within a few months after anterior cruciate ligament reconstruction is recommended.

As with other medical conditions, surgery is done during pregnancy only in the setting of acute, debilitating musculoskeletal conditions. If surgery is deemed necessary, local and regional anesthetics are used due to their better safety profile because first-trimester general anesthesia is associated with a slightly increased risk of spontaneous abortion.

**Guidelines for Exercise in Pregnancy and the Postpartum Period**

Girls and women are becoming more involved in and adept at exercise and competitive sports. Moderate exercise (at least 30 mins most days of the week) across the life span is the recommendation for health and well-being of all Americans. Women are being encouraged by their healthcare providers to exercise moderately during pregnancy unless they have any of the contraindications noted in the recommendations of the American College of Obstetrics and Gynecology (ACOG). The ACOG recommendations include both absolute (i.e., incompetent cervix) and relative (i.e., poorly controlled hypertension) contraindications (refer to Tables 1–3 and ACOG). The level of fitness and activity before pregnancy is the main determinant of exercise during pregnancy; however, a nonexercising woman may be open to exercise counseling during pregnancy, a time when she may be focusing on her own health.
Maternal and Fetal Effects of Exercise in Pregnancy

Numerous studies on the health risks and benefits of exercise in pregnancy to both mother and fetus have been performed. Exercise recommendations have evolved over the last several decades. Traditionally, women were instructed to reduce exercise, and nonexercisers were told not to initiate exercise when pregnant.8 6–8 8 These conservative recommendations came out of concerns for the fetus with strenuous exercise and physical labor, including disturbances in growth. Persistent elevation in maternal body temperature during the first trimester, the time of neural tube closure and organogenesis, has been linked to birth defects.87 Pregnant women should maintain moderate exercise intensity, with loose fitting clothing in ventilated areas, to help prevent persistent elevation in body temperature. Maternal concerns related to exercise include increased risk of musculoskeletal injuries.89 Later in pregnancy, the reversal of the hyperglycemic response may cause hypoglycemia in an exercising mother due to increased fetoplacental energy demands.90

More recent studies have not confirmed the increased risk to mother or fetus with moderate aerobic or strength-training exercise in women with uncomplicated pregnancy.91–94 In fact, one study showed that participation in moderate recreational activity the year before pregnancy and during early pregnancy was associated with reduced preeclampsia risk.95 Exercise may also prevent gestational diabetes and is recommended when diet alone does not provide normalization of blood sugars in pregnant women.96,97 Women involved in physical conditioning programs during pregnancy had a more favorable subjective outcome and had decreased cesarean section rates and infants with higher Apgar scores.98

Specific Exercise Guidelines During Pregnancy

The American College of Gynecology provides general guidelines for exercise during pregnancy.85 Women who were inactive before pregnancy or whose pregnancy is complicated by medical or obstetric problems are advised to seek medical advice for specific individualized exercise recommendations.85 For pregnant women previously active in recreational sports and exercise, the 2003 ACOG guidelines recommend women should continue to be active during pregnancy and “modify their usual routine as medically indicated.” For competitive athletes engaged in strenuous sports, they note that information is limited and recommend “close medical supervision.”

The 2003 Canadian practice guidelines

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**TABLE 1** Absolute contraindications to aerobic exercise during pregnancy*

<table>
<thead>
<tr>
<th>Condition</th>
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<tr>
<td>Hemodynamically significant heart disease</td>
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<tr>
<td>Restrictive lung disease</td>
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<tr>
<td>Incompetent cervix/ceciage</td>
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<tr>
<td>Multiple gestation at risk for premature labor</td>
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<tr>
<td>Persistent second or third trimester bleeding</td>
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<tr>
<td>Placenta labor during the current pregnancy</td>
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<tr>
<td>Ruptured membranes</td>
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<tr>
<td>Preeclampsia/pregnancy-induced hypertension</td>
</tr>
</tbody>
</table>


**TABLE 2** Relative contraindications to aerobic exercise during pregnancy*

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Severe anemia</td>
</tr>
<tr>
<td>Unevaluated maternal cardiac arrhythmia</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
</tr>
<tr>
<td>Poorly controlled type 1 diabetes</td>
</tr>
<tr>
<td>Extreme morbid obesity</td>
</tr>
<tr>
<td>Extreme underweight (BMI &lt;12)</td>
</tr>
<tr>
<td>History of extremely sedentary lifestyle</td>
</tr>
<tr>
<td>Intrauterine growth restriction in current pregnancy</td>
</tr>
<tr>
<td>Poorly controlled hypertension</td>
</tr>
<tr>
<td>Orthopedic limitations</td>
</tr>
<tr>
<td>Poorly controlled seizure disorder</td>
</tr>
<tr>
<td>Poorly controlled hyperthyroidism</td>
</tr>
<tr>
<td>Heavy smoker</td>
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</tbody>
</table>


**TABLE 3** Warning signs to terminate exercise while pregnant*

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Vaginal bleeding</td>
</tr>
<tr>
<td>Dyspnea prior to exertion</td>
</tr>
<tr>
<td>Dizziness</td>
</tr>
<tr>
<td>Headache</td>
</tr>
<tr>
<td>Chest pain</td>
</tr>
<tr>
<td>Muscle weakness</td>
</tr>
<tr>
<td>Calf pain or swelling (need to rule out thrombophlebitis)</td>
</tr>
<tr>
<td>Preterm labor</td>
</tr>
<tr>
<td>Decreased fetal movement</td>
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<tr>
<td>Amniotic fluid leakage</td>
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</tbody>
</table>

for exercise in pregnancy and the postpartum period, issued jointly by the Society of Obstetricians and Gynecologists of Canada and the Canadian Society for Exercise Physiology, provide more specific recommendations.99 Previously sedentary women should be counseled to begin with 15 min of continuous exercise three times per week and work toward a goal of 30 min four times per week. A case-control study of low-birth weight infants (<15th percentile for gestational age) found that the odds of having a low-birth weight infant increased by >4 fold in women exercising five times a week and greater during late pregnancy.100 The odds of low birth weight were over twice as great in mothers who exercised moderately two times a week or less. Low birth weight infants of exercising mothers are not necessarily subject to the usual risks of low birth weight.101

The Canadian guidelines also review practical issues of exercise intensity, recommending the use of the Borg Scale of Perceived Exertion, with target rating of 12–14 (somewhat hard) for exercise. Using a percentage of maximal heart rate is not appropriate during pregnancy due to a blunted heart rate response to exercise.102 The “talk test” is another proxy for maintaining moderate intensity; if the exercising mother is not able to maintain a conversation, she may be overexercising. The Canadian recommendations go beyond the ACOG guidelines in including initiation of pelvic floor exercises in the immediate postpartum period and advising mothers that moderate exercise while nursing does not negatively affect breast milk composition or infant growth.

Both the American and Canadian guidelines warn against activities with high risk of falling or abdominal trauma. They make specific mention of avoiding scuba diving and being thoughtful about acclimatization for high-altitude exercise. These guidelines also include specific warning signs to discontinue exercising, such as vaginal bleeding, preterm labor, or excessive shortness of breath (Table 3 from ACOG).

Further information on the benefits of specific exercise programs during pregnancy will likely be forthcoming given the fact that women are increasingly likely to exercise throughout their pregnancies. Pregnant women and their healthcare team should be more thoughtful about the risk of maternal inactivity for both mother and infant.

**Aspects of Rehabilitation: Physical Therapeutics**

Physical modalities for treatment of musculoskeletal disorders of pregnancy may be especially useful for low back and pelvic pain; however, there are special considerations for use during pregnancy. The treating physician should work closely with a physical therapist experienced in this area. A few of the commonly used modalities will be reviewed below for safety and contraindications during pregnancy.

Well-trained physical and occupational therapists with specific interest in this area can be extremely helpful in assisting the pregnant woman with management of musculoskeletal dysfunction. Therapists can provide appropriate exercise and education in body mechanics, ergonomics, posture, energy conservation, and activity modification (Table 4).

**Physical Agents: Considerations in Pregnancy**

Treatment with physical agents may be limited by precautions or contraindications when the energy produced by the agent or the physiologic effects of the agent may reach the developing fetus. These effects may not be understood completely or agreed on. In a recent review, pregnancy is believed to be a contraindication to therapeutic ultrasound in 80% of the sources reviewed. Superficial heat is contraindicated according to 27% of the sources reviewed.103

Heat may produce maternal hyperthermia; therefore, precaution should be considered with hot pack application to the low back and abdomen, utilizing extra toweling. Diathermy is contraindicated due to the effect of deep heat and exposure to electromagnetic fields.104 Similarly, immersion in a warm whirlpool or hot tub can produce maternal hyperthermia. Therapeutic ultrasound to produce a heating effect is also contraindicated in any area that may reach the developing fetus. Because fetal development may be affected by even subtle influences, most therapists tend to be cautious and avoid the use of therapeutic heating modalities for the pregnant woman with musculoskeletal complaints.

There are no data available in the medical literature regarding the use of cervical or lumbar traction during pregnancy. Lumbar traction belts

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**TABLE 4 Therapy goals for musculoskeletal dysfunction of pregnancy**

<table>
<thead>
<tr>
<th>Therapy goals for musculoskeletal dysfunction of pregnancy</th>
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<tbody>
<tr>
<td>Promote improved posture and body mechanics</td>
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<tr>
<td>Promote proper exercise techniques for pre and post partum periods</td>
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<tr>
<td>Improve awareness and control of the pelvic floor</td>
</tr>
<tr>
<td>Maintain abdominal muscle function, correct diastasis recti if needed</td>
</tr>
<tr>
<td>Provide education about pregnancy, birth and safe post partum exercise progression</td>
</tr>
<tr>
<td>Prevent impairments that can occur during pregnancy</td>
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may cause excessive pressure on the abdomen and should be avoided. Cervical traction should be used with caution due to ligamentous laxity of pregnancy.

Electrical stimulation should not be applied in areas of the low back, abdomen, or hip/pelvic girdle to avoid the potential to reach the fetus. Electrical current effects on the fetus are not fully understood. Interestingly, no adverse effect on the fetus was found in the most recent animal studies when electrical stimulation was performed on the S1 nerve root.

The electrical current of transcutaneous nerve stimulation may be used safely during uncomplicated labor and delivery for pain control. In a meta-analysis of six randomized, placebo-controlled trials, transcutaneous nerve stimulation was found to provide some relief of back pain. Physical therapists can instruct patients in the use of transcutaneous nerve stimulation and appropriate electrode placement before delivery date.

Orthoses and Pregnancy

Physical therapists can assess the pregnant woman with back pain for the use of a lumbosacral orthosis. Limited evidence has been found to support the effectiveness of back supports in the general population. A pilot study evaluating the use of maternity back supports found a reduction in pain scores in a small population. Several orthoses are available for the maternity patient. Several orthoses are available for the maternity patient. Beaty et al. found that the Mother-To-Be orthosis (CMO, Barberton, OH), a Velcro and elastic lumbar and abdominal binder adjustable for the growing abdomen, did not adversely affect the hemodynamics of the mother or fetus.

Therapeutic Exercise

Exercise in normal-temperature pool water is advantageous to the pregnant woman. Buoyancy has the effect of unloading joints to ease painful movements. Aquatic exercises also help to control peripheral edema, common in pregnant women. The lower heart rate response with exercise in water is another reason favoring its use. Land exercise causes greater heat storage and sweat loss. Pelvic floor muscle training during pregnancy has been shown to prevent urinary incontinence during pregnancy and after delivery. A recent study by Morkved et al. demonstrated that participants in a 12-wk intensive pelvic floor muscle training program during pregnancy had significantly less urinary incontinence during pregnancy and 3 mos after delivery.

Individualized physical therapy programs have been found more effective than group sessions for the reduction of pain and sick leave due to back pain in pregnancy. The individual sessions included exercise, postural training, and ergonomics once weekly over a 5-wk period (see supplemental material containing photos of exercises at http://www.amjphysmedrehab.com/pr/ep/apps/club. htm?sessionid=CnjUhF2s6d72X32aFs11Mbh86Cqe MWC0ia8TqBIbZV5Hipakm1h!-1778183981!-949 8560319000!-1?idx=6&cursorname=S.sh.2.14.15.17. 18&fieldname=s1_100&an=00002060-20053000-00006).

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Paraplegia Secondary to Progressive Necrotic Myelopathy in a Patient with an Implanted Morphine Pump

ABSTRACT

We present an individual with chronic low back pain who was treated with an implanted morphine pump, which provided very good pain relief for 16 mos. However, the patient developed acute paraplegia secondary to progressive necrotic myelopathy, a rare form of transverse myelitis. The cause of this patient’s neurologic deficit was unclear. Three months after the onset of paralysis, a trial of discontinuation of the intrathecal morphine was performed to exclude the morphine as a reversible cause of paralysis. Within 24 hrs after his pump was depleted, his pain became significantly worse. He was maintained on oral opioids for 6 mos, and his pain was only partly controlled, with a daily average visual analog scale score of 7/10. There was no improvement in his neurologic status after stopping the intrathecal morphine therapy, and several consecutive magnetic resonance images of the spine demonstrated radiologic progression of spinal cord involvement. The patient developed classic opioid side effects of excessive somnolence and constipation. Intrathecal morphine therapy was re-instituted, and the patient reported a significant decrease of his pain, an improvement in quality of life, and no complications related to pump functioning.

Key Words: Paraplegia, Implanted Morphine Pump, Necrotic Myelopathy, Neurologic Complications, Intrathecal Catheter, Granuloma
intrathecal morphine pumps remain rare. Most of these events are related to the development of an inflammatory mass lesion at the tip of the catheter or incorrect medications administered through the implanted intrathecal catheter system.2,3

Progressive necrotic myelopathy (PNM) is a rare form of transverse myelitis that includes acute or subacute spinal cord dysfunction. It is primarily characterized by paraplegia, a horizontal level of sensory impairment, spinocerebellar ataxia, and areflexia not associated with secondary causes such as compressive lesions, trauma, or malignant infiltration.3,4 A recent study characterized several features that were consistently present, including illness onset after the age of 40, initial pain and leg weakness, urinary incontinence, and limb flaccidity in the absence of the spinal shock. They seem to be coupled with an ascending sensory loss that becomes established in the upper thoracic region. Reasonable certainty in the diagnosis of PNM can be achieved when a patient with myelopathy exhibits the particular clinical, cerebrospinal fluid (CSF), magnetic resonance imaging (MRI), and electromyographic findings.4

Our work presents the case of an individual who developed acute paraplegia secondary to PNM during intrathecal morphine treatment for stable chronic lower back pain. This work delineates the long-term management of a patient with a rare neurologic disorder and the concomitant use of an implantable morphine pump.

**CASE REPORT**

A 49-yr-old, right-hand-dominant man presented in our pain clinic for a refill of his intrathecally implanted morphine pump. The pump was placed by an outside physician 20 mos before this patient’s first visit to our clinic. The device, an Arrow model 3000 morphine pump (50 ml capacity with a flow rate of 0.5 ml) had been intrathecally implanted to treat intractable lower back pain unrelieved by surgery and to minimize his use of oral opioids. The pump provided very good pain relief, with a morphine dose of 3.2 mg/day. The patient was able to completely titrate out the use of all oral opioids 8 days after initial pump placement. His pain management was satisfactory for approximately 16 mos. Subsequently, however, he began to experience episodic spastic, sharp right flank area pain followed by right side, lower limb weakness and continuous loss of sensation in the lower limbs for up to 2 mins at a time. These events increased in frequency to the point that they occurred multiple times per week. He later developed an acute onset of flaccid paralysis of his lower limbs in August 2002, 13 mos after the morphine pump was implanted. His spouse reports that several days before developing this acute weakness and sensory loss, the patient had an episode of severe, intense lower back pain, which was thought to be the passing of kidney stones. Over the next 2 days he experienced complete paraplegia and sensory loss at and below the T10-T11 level. He was hospitalized and admitted to the neurology service where cervical, thoracic, lumbar, and brain MRIs were performed. The lumbar spine MRI, without contrast, at admission revealed spondylosis and degenerative changes. The implanted catheter was identified entering the thecal sac at the L2-L3 level, with no evidence of mass lesion or granulation tissue. However, the lumbar spine MRI, with and without contrast, obtained 2 days later clearly showed multiple areas of hyperintense noncontiguous T2 signal within the lower thoracic cord, without abnormal enhancement from the T9 level through the conus involving left and right sides of the cord. A concomitant brain MRI showed scant areas of hyperintense T2 foci involving predominantly the left basal ganglia and pons. CSF analysis showed an elevated white blood cell count, elevated protein at 65 mg/dl (normal, 10.0–42.0 mg/dl) without oligoclonal bands, immunoglobulin IgG/total protein ratio of 0.15 (normal 0.03–0.14), and immunoglobulin G of 9.9 mg/dl (normal, 0.5–6.1 mg/dl). Clinically, the patient remained areflexic, with complete bilateral lower limb paralysis. Seven months after the onset of paraplegia, he was first referred to the pain clinic because of escalating pain and an interest in restarting his morphine pump. His last routine pump refill was performed 2 mos after the onset of his neurologic deficit. To exclude toxic effects of morphine and associated pump mechanical complications as a cause of the patient’s paraplegia, the pump had been allowed to run until it was empty. Within 24 hrs after his pump was depleted, his pain became significantly worse. His pain was described as 10/10 on a visual analog scale (VAS). The pain was described as feeling like being cemented from the waist and down to toes, with the most severe pain around the abdominal wall. The quality of pain was an intense aching with a burning sensation. Physical examination demonstrated a moderately obese man in moderate distress (VAS 10/10). He was alert, responsive, cooperative, and obviously very concerned about his situation. Muscle strength and sensory examination were normal on bilateral upper limbs. There was a flaccid paralysis (muscle strength 0/5 on manual muscle strength testing scale for all muscle groups in the bilateral lower limbs) and areflexia and loss of pinprick and light touch sensation distally from the T6 level and minimal preservation of proprioception. For interim analgesia,
he was started on a prepump dose of OxyContin, 100 mg, three times daily. This resulted in only partial pain relief (VAS 8/10). The MRIs of the lumbar, thoracic and cervical spine 3 and 7 mos after the onset of paraplegia showed progression of radiologic findings, with diffuse discontinuous myelitis of the cord, which begins at the level of C7 and extends distally to the conus medullaris, with worse involvement at the level of T6 and T7 and with associated necrosis at these levels. Needle electromyography performed 7 mos after the onset of paralysis demonstrated acute denervation without signs of reinnervation in bilateral thoracic and lumbar paraspinal muscles and lower limb muscles. A nerve conduction study showed negligible compound motor action potential but normal sensory nerve action potential from the lower limbs. Spine MRI findings, CSF analysis, electromyography/nerve conduction study findings, and the clinical presentation were all consistent with a diagnosis of PNM.

At this point, the patient was using only oral opioids for analgesia, and his pain was only partially controlled (VAS 7/10). His implanted pump was inactive. Subsequently, he developed the classic opioid side effects of excessive somnolence and constipation. After an extensive discussion with the patient and his family regarding the risks and benefits, we mutually agreed to restart the intrathecal morphine cognizant of the PNM diagnosis. The patient was placed in the supine position, and the pump pocket site was identified. Using sterile technique under fluoroscopic guidance, the implanted morphine pump was interrogated. Initially, 5 ml of fluid was aspirated from the catheter and analyzed by the clinical laboratory. Results showed protein and glucose levels that were consistent with normal CSF. No cellular components were present. By the clinical laboratory. Results showed protein and glucose levels that were consistent with normal CSF. By fluoroscopically tracking its flow pattern, we were able to verify the full patency of the catheter. Next, the pump was filled with 50 ml of preservative-free saline and allowed to run at its present rate for 30 days. During this time, the patient reported no complications with the pump and no changes in his neurologic status. When the patient returned for his follow-up evaluation, the remaining 20 ml of normal saline was extracted from the pump. This sham trial confirmed the pump and the catheter were completely operational. The pump reservoir was then filled with 50 mg of preservative-free morphine. The patient stated that with oral opioids alone, his average VAS was 7/10 and that his mean daily VAS was >6/10. After restarting the intrathecal morphine treatment, his symptoms and his VAS scores gradually improved. He still was experiencing pressure-like pain in his lower limbs and around the abdominal wall, but the intensity and frequency of exacerbations became significantly less. Thirty days after initiation of morphine therapy, the average VAS was 4/10, and his oral opioids dose was significantly decreased. This patient is now 10 mos post re-initiation of his implanted pump. Oral doses of opioid have decreased to MS Contin, 15 mg three times daily, with only occasional MS IR, 15 mg, for pain during periods of increased activity. His quality of life has significantly improved, and he did not report any complications related to the morphine pump functioning.

**DISCUSSION**

The use of intrathecal catheters and pumps for the administration of morphine has drawn increased interest since the discovery of opioid receptors in the spinal cord. It provides a more targeted delivery of potent analgesics while minimizing the side effects encountered with systemic drug administration. Although nonmalignant pain responds to intrathecal morphine therapy, it is more appropriately used only after maximizing other analgesics options. Our patient had a morphine pump implanted for intractable lower back pain unrelieved by very high-dose oral opioids and spine surgery.

Although neurologic complications secondary to implanted catheters and intrathecally delivered medications are uncommon, they have been described in the literature. One study reports an intrathecal granuloma developing around the tip of intrathecal catheter, causing spinal cord compression. Although the origin and prevalence of these masses are unknown Blount et al. suggested that these masses may represent indolent infection. Paraplegia secondary to a sterile epidural abscess alone near the tip of the surgically implanted epidural morphine infusion pump catheter has been described. It is possible that infusion of high doses of morphine, along with associated local pH changes, causes a local inflammatory reaction that can serve as a nidus for a compressive granuloma. The cluster of eight patients with neurologic complications after incorrect administration of intrathecal methadone and perhaps other unintended agents in patients with implanted morphine pumps was recently reported. Several animal studies demonstrated that intrathecal injection with a high dose of morphine could induce transient spastic paraparesis after a noninjurious interval of spinal cord ischemia. Postmortem neurohistopathology studies in patients with cancer after long-term, continuous intrathecal infusion containing morphine failed to definitely implicate the drug in any histopathologic abnormalities.

Our patient presented with acute paraplegia and ascending clinical and radiologic progression...
of spinal cord injury. Radiologic imaging studies at admission confirmed that there were no complicating aspects related to the catheter placement. A complete spine MRI 7 mos after the initial onset of neurologic symptoms showed progression of radiologic findings, with lower cervical and upper thoracic spinal cord involvement and radiologic evidence of spinal cord necrosis at the T6-T7 level. Physical examination revealed progression of level of injury from T10-T11 to the T6 level within 7 mos after the onset of paraplegia. After extensive neurologic evaluations, the patient was diagnosed with PNM. PNM has an incidence of 1–4 new cases per million people per year, with no sex or familial predisposition. Hallmark features of this disorder are demonstrated by onset after the age of 40 yrs, leg pain and weakness, sensory loss, and urinary incontinence. In addition to the saltatory progression and pain, more prominent findings include atrophy, areflexia, and limb flaccidity in the absence of spinal shock. Although oligoclonal bands were not identified in the CSF, most patients had elevated CSF protein concentrations. Collectively, these findings differentiate this PNM from typical multiple sclerosis. Our patient presented with rather atypical, abrupt onset of the myelopathy and then paraplegia. Katz and Ropper, in a review of nine cases, indicated, that three of nine patients diagnosed with PNM had abrupt onset of paraplegia. In the other patients, the early illness advanced more indolently, with a gradual progression of weakness and urinary incontinence. By depleting the morphine pump reservoir and maintaining the patient with only oral narcotics, we were able to rule out mechanical problems as a source of his neurologic deficit. Interestingly, the patient reported that the pain quality significantly changed after the onset of paraplegia. Initially after developing paraplegia, the pain was sharp/tearing, with bilateral lower limb radicular aching. After several months of his illness, the patient described the pain as feeling like being cemented from the waist and down, with the worst area of pain circumscribing the abdomen. This perception is corroborated by studies that demonstrate 80–94% of patients with idiopathic myelopathy have numbness, paresthesias, or band-like dysesthesias. It seems that our patient developed spinal cord injury pain, which is neuropathic pain below the level of the lesion in an area without normal sensation. In addition, the transitional zone pain, which has been defined as pain located within two dermatomes above or below the neurologic level, was a prominent complaint.

Finally, this patient responded very well when the intrathecal morphine pump was refilled and reactivated. He readily confirmed decreased pain intensity, an improved sleep pattern, and a more active/self-supportive quality of life. He reported no advancement of neurologic deficits within the first 60 days after re-initiation of treatment and continued to experience significant pain relief with improved quality of life.

This report discusses a unique case of acute paraplegia secondary to PNM in a patient already using an implanted morphine pump. In this study, it was important to discern that the patient’s neurologic deficit was not attributable to pump complications or intrathecal morphine toxicity. Moreover, we have shown that an intrathecal morphine therapy could be re-initiated to produce very good pain relief. These results also suggest that long-term, effective analgesia using an implanted pump is safe and effective in patients experiencing PNM. However, further studies regarding the use of intrathecal morphine therapy in patients with myelopathy are needed.

REFERENCES
Frontal Contusions Imaging and Behavioral Consequences

Ross D. Zafonte, DO; Joseph Ricker, PhD; Howard Yonas, MD; Amy Wagner, MD
From the Departments of Physical Medicine and Rehabilitation (RDZ, JR, AW) and Neurological Surgery (HY), University of Pittsburgh, Pittsburgh, Pennsylvania.

A 38-yr-old man was involved in a motor vehicle crash and was noted to have an initial postresuscitation Glasgow Coma Scale score of 7. Computerized tomographic imaging revealed bifrontal hemorrhagic contusions. The patient began to follow commands at day 5, but he remained in posttraumatic amnesia for several weeks. Memory dysfunction and deficits in executive control persisted throughout the acute rehabilitation period.

Frontal contusions are often the result of sufficient inertial loading and acceleration combined with a sudden stop (i.e., head impact or abrupt change in the direction of the head’s movement, which is often referred to as deceleration). This series of events may cause the brain to come into abrupt contact with one or more internal surfaces of the skull. Because the posterior areas within the skull are relatively smooth, primary contusion injuries in the posterior portions of the brain are rare in the absence of direct trauma to the occiput or posterior skull regions. More frequently, however, the anterior and inferior portions of the brain (the frontal poles, orbitofrontal cortex, and anterior temporal lobes) become contused against the bony prominences of the skull (e.g., sphenoid wing and temporal fossa). The expansion (or blossoming) of the contusion may result in extensive frontal edema and hemorrhage either early after injury or even days later and may require neurosurgical intervention.

The above example demonstrates a case of acute frontal contusions (Fig. 1) that evolve to show a wide area of frontal hemorrhagic edema (Fig. 2) and, subsequently, signs of early bifrontal encephalomalacia. This case demonstrates a version of hemorrhagic edema blossoming, as depicted in Figure 2. This injury pattern may result in localized contusion of the cerebral cortex and immediate underlying white matter. In the more chronic phase, such lesions are better demonstrated via magnetic resonance imaging.

Functionally, the frontal cerebral cortex is known to be involved in numerous cognitive activities, among them, executive control and memory. The construct of executive control encompasses numerous functions, but it is generally defined as the capacity to organize, plan, execute, and...
change cognitive functions. Executive control is a critical aspect of cognition that is commonly impaired after traumatic brain injury.\(^1,2\) In fact, although individuals and clinicians often report or emphasize memory as being a primary functional concern, executive control dysfunction might be the most disabling aspect of cognitive compromise after brain injury.\(^3,4\) The prefrontal cortex is of great importance in the processing of episodic memory. Finally, injury to the frontal cortex may lead to disturbances of mood and behavior.

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CME Self-Assessment Exam

Answers

*American Journal of Physical Medicine & Rehabilitation*  
Vol. 84, No. 3 • March 2005

**CME Article Number 1**  
*A. Masedo Gutierrez, et al.*

1. B  
2. D  
3. D  
4. A  
5. A
Abstracts of the Scientific Papers and Posters Presented at the Annual Meeting of the Association of Academic Physiatrists

Tucson, Arizona
February 22–26, 2005

AMERICAN PHYSIATRIC EDUCATION COUNCIL SPECIAL AWARD FOR PAPERS ON ERRORS IN MEDICINE

THE 24 HOUR BOUNCE BACK: WHY DO SOME PATIENTS REQUIRE EARLY TRANSFER FROM THE REHABILITATION HOSPITAL BACK TO ACUTE CARE?

Sunny R. Kim, MD, Bruce M. Gans, MD, Scott Millis, PhD

Rehabilitation hospitals and units are experiencing pressure to admit patients from acute care hospitals earlier and earlier in the course of their acute injury or illness. Clinicians speak of this as patients coming to them “quicker and sicker.” With more rapid transfer to rehabilitation hospitals comes the increasing potential for the need to return the patient to the acute care setting because of medical problems. The nature of these early transfers back to acute care has not been well characterized. To determine the preventable causes for these rapid transfers to acute care, we decided to study this issue at a very large freestanding rehabilitation hospital. Objective: To quantify and characterize reasons for transfer back to acute care within 24 hr of admission to the rehabilitation hospital. Method: A retrospective chart review of 6712 total discharges over a 12 mo period of time was conducted. 123 patients who were transferred out to acute care within 24 hr of admission were identified. Each of these patient charts was reviewed by a single investigator to identify the clinical events and circumstances that related to the acute hospital transfers. The principle reason for acute transfer was categorized as either urgent or elective in nature. The transfers were further described according to the type of clinical problem identified by the transferring physician. These were coded as either: 1) pulmonary; 2) cardiac; 3) central nervous system (CNS); 4) gastrointestinal (GI); 5) suspected pulmonary embolism (PE); 6) suspected deep vein thrombosis (DVT); or 7) anemia. Results: Elective transfers accounted for 14.6% of the total, while 85.4% were urgent in nature. Of the urgent transfers, cardiac and pulmonary emergencies together represented the most common (37.4%) reasons for transfer, followed by CNS (17.9%), GI (9.8%), suspected DVT (8.9%), anemia (6.5%) and suspected PE (4.9%). The most common elective transfer causes were cardiac and pulmonary (12.8%), closely followed by anemia (12.5%). Most of the bounce backs (24.4%) occurred on a Friday. Weekend transfers accounted for 23.6% of the study group. Discussion: This study provides qualitative insight into the clinical reasons for early transfers from the rehabilitation hospital. It suggests that there may be both pathophysiologic factors (medical complications occurring in the natural course of clinical disorders, medical errors (missed or under treated complications in the acute care setting), and systems issues (weekend staffing and practice patterns) at play. These data provide direction for future studies to more clearly delineate these causes, and to test prevention strategies. Introduction: Errors in medicine have a direct and profound impact on patient lives. The health care industry has adopted fewer fail-safe systems to prevent errors from occurring as compared with other industries such as manufacturing and aviation. Since the Institute of Medicine’s landmark report indicating that as many as 98,000 Americans die annually from medical errors, there has been a growing interest in devising fail safe systems including medication alert systems, electronic patient records and error reporting methods. Medical errors that occur in the rehabilitation setting, however, have not been extensively studied. Only one study exists in the literature by Lee and Bryant, which reports a 6.1% transfer error rate in the rehabilitation setting. The rehabilitation unit and freestanding rehabilitation hospitals almost always admit patients in transition from the acute care hospital. This transition requires the transfer of accurate patient information with regards to plans of care, medications and reports of relevant diagnostic studies. There is always a risk of errors occurring during this transition which could adversely affect patient outcomes. In addition, clinicians are experiencing that acute care hospitals seem to be under pressure to discharge patients earlier in their medical course, with multiple comorbidities, which increase the demands on the clinical care provided at rehabilitation facilities. A failure in appropriate transition for this care, or the inappropriate transfer of unstable patients to rehabilitation may be associated with the need for an early transfer back to an acute care hospital. We hypothesized that the transfer of patients back to the acute care hospital within 24 hr of admission, (the 24 hr bounce back), would very likely be associated with a failure in one or more of the systems in operation to transition patient care. Since the nature of these early transfers back to acute care has not been well characterized, we decided to study these events over a 12 mo period at a very large freestanding rehabilitation hospital. By analyzing these events, we hoped to determine possible patterns and indications of systematic problems and failures of care delivery that could be anticipated and prevented in the future. Methods: A retrospective chart review of all 6712 discharges from the Kessler Institute for Rehabilitation that occurred over a 12 mo period of time was conducted. These charts were reviewed by a single investigator (SRK) to determine the clinical events and circumstances that related to the acute hospital transfers. The principle reason for acute transfer was categorized as either urgent or elective in nature. The transfers were further described according to the type of clinical problem identified by the transferring physician as documented in the medical records. There were coded as being either: 1) pulmonary; 2) cardiac; 3) central nervous system (CNS); 4) gastrointestinal (GI); 5) suspected pulmonary embolism (PE); 6) suspected deep vein thrombosis (DVT); or 7) anemia. Table 1 shows the characteristics of each category that were used to characterize the discharge. Results: 892 patients (13% of admissions) were identified who were transferred out to an acute care hospital. From this group, 123 patients (1.8% of admissions) were identified who were transferred out to acute care within 24 hr of admission. Of this group, elective transfers accounted for 14.6% of the total, while 85.4% were urgent in nature. Of the urgent transfers, cardiac and pulmonary emergencies together represented the most common (37.4%) reasons for transfer, followed by CNS (17.9%), GI (9.8%), suspected DVT (8.9%), anemia (6.5%) and suspected PE (4.9%). The most common elective transfer causes were cardiac and pulmonary (12.8%), closely followed by anemia (12.5%). Weekend transfers accounted for 23.6% of the study...
Background: Somatosensory input is required for motor learning and for recovery of function after cortical and subcortical lesions such as stroke. For example, reduction of somatosensory input by local anesthesia impairs motor control in healthy subjects. Similarly, patients with large-fiber sensory neuropathy display characteristic abnormal motor behavior. Further evidence for the role of somatosensory deficits in patients with stroke, is the finding that somatosensory deficits are usually associated with slower recovery of motor function. When normal volunteers are exposed to prolonged peripheral nerve stimulation they experience in-creased excitability of the cortical representations of the muscles innervated by that nerve that last up to 60 min. This type of nerve stimulation is associated with transient improvement in functional measures, which is thought to be mediated by peripheral nerve stimulation. We investigated the hypothesis that somatosensory deficits in patients with stroke are associated with delayed recovery of motor function.

Methods: We conducted a randomized, single-blind, sham-controlled study comparing peripheral nerve stimulation (PNS) with sham stimulation. Participants were assigned to one of two groups: PNS or Sham. The PNS group received 2 hr of peripheral nerve stimulation at an intensity that induced transient improvement of motor function. The Sham group received 2 hr of sham stimulation. Participants performed 2 hr of training after PNS or Sham stimulation. The training consisted of 30 min of practice followed by 30 min of formal practice. The training was performed under the effects of PNS or Sham stimulation. The effects of PNS were evaluated with the use of somatosensory testing and the Jebsen-Taylor Test (JTT) before and after training. The Jebsen-Taylor Test is a standardized, functional, motor task that assesses hand function.

Results: There were no differences in attention and fatigue levels or interventional effects. However, there were improvements in hand function and hand function measures after PNS. The post hoc analysis showed that there were significant differences in hand function after PNS compared to Sham (Paired t-test, t = 2.1, p < 0.05). The post hoc analysis also showed that there were significant differences in hand function after PNS compared to Sham (Paired t-test, t = 2.1, p < 0.05).

Discussion: These findings suggest that peripheral nerve stimulation (PNS) enhances motor learning of a functional task in chronic stroke patients.

Faculty Award

PERIPHERAL NERVE STIMULATION (PNS) ENHANCES MOTOR LEARNING OF A FUNCTIONAL TASK IN CHRONIC STROKE PATIENTS

Pablo Celnik, MD, Friedhelm Hummel, MD, Rebecca Wolk, Leonardo G. Cohen, MD

THE ELECTRODE STORE PAPER PRESENTATIONS

Fellow Award

BIOLOGICAL TREATMENT OF DEGENERATIVE DISC DISEASES: GENE THERAPY APPROACHES

Yejie Zhang, MD, PhD, Howard S. An, MD, Frank M. Phillips, MD, Eugene J-M.A. Thonar, PhD

Introduction: Low back pain is a common clinical problem that has enormous socio-economic impact in today’s aging population. In the USA, medical costs attributable to back pain exceed $50 billion annually. Although the etiology of back pain is probably multi-factorial, lumbar intervertebral disc (IVD) degeneration is associated, perhaps causally, with low back pain. Degenerative discs are characterized by altered matrix composition and reduced cell number. As an alternative to the surgical removal of the diseased disc, biological treatment with a growth factor may promote matrix repair and restore physiologic function. IVD
matrix synthesis may be promoted by stimulation of disc cells by growth factors or genes that allow for sustained expression of growth factors. We suggest that such growth factors/gene could be delivered by a physiatrist (direct injection into the IVD under fluoroscopic guidance), thus providing new treatment modality. We postulated that it is feasible to treat mild to moderate IVD degeneration, when viable IVD cells are still present, by directly transducing the cells via the injection of adenovirus expressing growth factors. However, with advanced disc degeneration, the number of viable IVD cells is diminished, thus limiting the potential for a successful reparative response. Cell transplantation may provide the degenerated IVD with metabolically active cells capable of a more extensive and holistic restoration of growth factor accumulation. Autologous chondrocytes are readily available and are phenotypically similar to disc cells and, therefore, represent an appealing cell-type for transplantation. Objective: To identify specific growth factors that may prove useful in future in vivo testing, we directly compared the effects of adenovirus expressing twelve different bone morphogenetic proteins (AdBMPs) on matrix formation in vitro. In addition, based on findings from that study, five of the twelve AdBMPs were selected to examine the effects of transplanted articular chondrocytes with nucleus pulposus cells via paracrine mechanisms. Study design: First, we hypothesized that the effects of AdBMPs differ due to their inherent biological properties. To select the best AdBMP for treatment of degenerative disc disease, bovine nucleus pulposus cells were transduced with twelve different AdBMPs and proteoglycan accumulated during the culture period were compared. Second, we hypothesized that transplantation of autologous chondrocytes transduced ex vivo with AdBMPs into the degenerated IVD would provide sustained release of growth factor as well as stimulate native disc cells via a paracrine effect. We evaluated the effects of coculturing articular chondrocytes transduced with five AdBMPs on proteoglycan accumulation by nucleus pulposus cells in vitro. Methods: Recombinant adenoviruses expressing human BMP-2, -3, -4, -5, -7, -8, -10, -11, -12, -13, -14, -15, or green fluorescent protein (GFP, as control) were constructed. To compare the effects of AdBMPs on matrix accumulation by direct transduction, we transduced the nucleus pulposus cells cultured on monolayer at a concentration of 10,000 cells/cm². AdBMP were included at the time of plating for 16 hr at an optimized multiplicity of infection, and cells were cultured for six days. Recombinant human BMP-7 (rhBMP-7 100 ng/ml) was included in the culture medium as a positive control. To study the effects of transplanted articular chondrocytes with nucleus pulposus cells via paracrine mechanisms, five of the 12 AdBMPs (AdBMP-2, -4, -5, -7, -10, -13) were selected, based on findings in the above study. Articular chondrocytes released from young adult bovine hooves were then cultured in monolayer, at 10,000 cells/cm². AdBMPs were included in the cultures at the time of plating for 16 hr at an optimized multiplicity of infection. Nucleus pulposus cells released from discs from young adult bovine tails were then encapsulated in alginate beads at 2000,000 cells/mm³. Alginate beads containing nucleus pulposus cells were transplanted in the medium of the chondrocyte cultures in nine beads per well. After six days of coculture, the contents of total sulfated proteoglycans in the beads were measured as previously described. Results: AdBMP-2, -4, -5, -7, -8, -10 or -13 effectively stimulated proteoglycan accumulation by bovine nucleus pulposus cells (P < 0.05). AdBMP-7 was as effective as the direct administration of rhBMP-7. Based on these results, five of the twelve AdBMP constructs were selected for further coculture study. Articular chondrocytes transduced with AdBMP-7, -10 or -13 were more effective than cells transduced with the other AdBMPs caused in stimulating proteoglycan accumulation by nucleus pulposus cells (P < 0.05). Again, nucleus pulposus cells cocultured with articular chondrocytes transduced with AdBMP-7 accumulated a similar amount of proteoglycans as cells stimulated directly by the addition of rhBMP-7. Conclusions: We have shown, for the first time, that AdBMPs can stimulate matrix accumulation by bovine nucleus pulposus cells, with AdBMP7 being the most effective. Furthermore, we have shown that transduced articular chondrocytes cocultured with nucleus pulposus cells were effective in stimulating native cell proteoglycan accumulation by the latter, with AdBMP-7 and-10 being the most effective. Significance: Treatment of degenerative disc disease with growth factors could provide Physiatrists with a powerful new treatment modal- ity. In the clinical setting, where repeat injection of rhBMP-7 into IVD is not feasible; a one-time delivery of the therapeutic gene might be a more effective strategy. We propose that for treatment of mild to moderate IVD degeneration, genes expressing BMPs could be directly injected into discs; however, for treatment of advanced IVD degeneration, where viable cells are few in number, transplanation of articular chondrocytes transduced with BMP genes ex vivo is more appropriate.
acertics revealed a positive correlation between the width of the tendon on the post game ultrasound and the subject’s weight ($R = .632$ and $p = .009$). The echogenicity (selection/reference) of the post game ultrasound images were negatively correlated with weight ($R = -.744$ and $P = 0.001$). Their electromyographic characteristics were not seen in the pre game images. Discussion: This study found that after exercise the tendon width positively correlated with weight and after exercise the echogenicity negatively correlated with weight. The decrease in echogenicity likely represents an increase in fluid in the tendon. Increased fluid in the tendon likely represents edema and may also be the cause of the increase tendon width. Thus, in individuals with higher body weight there are more inflammatory changes after exercise. One may argue that these changes may be attributed to the weight alone; however, this is unlikely as there was not a significant correlation with weight and the tendon width on the pregame ultrasound. These results are not surprising when one considers that rolling resistance, and thus work needed to propel a wheelchair is directly related to weight. The results are consistent with reports indicating a positive correlation between body mass index and shoulder MRI and x-ray abnormalities in subjects with SCL. Based on these results it is important to continue to emphasize the importance of weight control in wheelchair users. Further studies are needed to validate our results. Studies with a larger sample size and better control of pre game activity are needed as these were limiting factors in our study. A better understanding of the pathophysiology may help identify ways to prevent shoulder injuries in this population whose mobility depends on a healthy arm.

**RMSTP Paper Presentations**

**THORACIC SPINALIZATION ELICITS DIFFERENTIAL SYNAPTIC STABILITY AND REMODELING IN FAST AND SLOW MUSCLES OF ADULT RAT HINDLIMBS**

Anthony S. Burns, MD, A. Tessler, and Y.-J. Son

In adult animals, complete transaction of the mid-thoracic spinal cord paralyzes anatomically intact hind limbs. Much of the motor deficit and compensatory recovery have been attributed to spinal effects on motor neurons distal to the lesion. Surprisingly little information is available about the effects of spinal cord injury on neuromuscular stability, which might substantially influence the motor deficit and spontaneous recovery. We spinalized adult rats at T9 and immunohistochemically examined the synapses of fast and slow muscles innervated by lumbar motor neurons. At 2 wk, the synapses of fast muscles such as extensor digitorum longus (EDL), tibialis anterior (TA), and lateral (LGC) and medial (MGC) gastrocnemius underwent substantial modifications, including sprouting of nerve terminals, partial disassembly of original synapses and new synapse formation along terminal sprouts. Synaptic remodeling was greater in fast muscles and even varied among them (EDL>TA>LGC>MGC). In contrast, synapses in slow soleus muscle (SOL), were affected least: ca. 23.6% showed short terminal sprouts (compared with 62.8% in EDL) without obvious synapse assembly or disassembly. The weaker effect in SOL was not due to delayed reactivity. Almost all SOL endplates maintained the original configuration of their synapses even after spinalization of 2 or 5 mo when synapses in fast muscles demonstrated extensive sprouting and elongation (e.g. 65.9% EDL endplates at 2 mo). Spinal cord injury therefore elicits marked neuromuscular plasticity, which affects differentially the synaptic stability and remodeling of fast and slow muscles. Supported by NIH K12HD01997–6, NS45091, NS24707, VA Medical Research Service.

**ELECTROMYOGRAPHIC (EMG) CHARACTERIZATION OF THE MDX MICE: AN ANIMAL MODEL FOR DUCHENNE MUSCULAR DYSTROPHY**

Jay J. Han, Jennifer J. Ra, Richard T. Abresch, Lawrence R. Robinson, Jeffrey S. Chamberlain and Greg T. Carter

The mdx mouse is an animal model of Duchenne muscular dystrophy (DMD). Although much is known about the histologic, biochemical, and functional characteristics of mdx muscles, very little is known about their electromyographic characteristics. Currently, there is no established method of performing an electromyographic (EMG) study using a mouse model. Initially, we tested various different methods and components including monopolar vs. concentric or different sized needle electrodes. We found that a combination of a 27 gauge monopolar needle electrode, a nearby reference needle electrode, with an adhesive ground electrode placed at the distal limb yielded acceptable signal to noise ratio, with reproducible and quantifiable motor unit action potentials (MUAPs). A total of 34 animals (16 C57/B10 wild-type and 18 mdx) divided into four age groups (10–12 wk, 10–12 mo, 18 mo, and 24 mo) were examined and evaluated using automated trigger and delay function to average and quantify different MUAPs from the tibialis anterior and the gastrocnemius/soleus muscles. Whenever possible, more than ten different MUAPs were recorded from each animal and the amplitude, duration, phasicity, and the presence of late components were examined. Both the young and old wild-type mice showed normal insertion activity, no fibrillation or positive sharp wave potentials, with normal motor unit morphology. In contrast, the mdx mice displayed increased insertional activity, significant spontaneous potentials, presence of complex repetitive discharges, and MUAPs with increased phasicity, often with late components. This study represents the first attempt at EMG characterization of the mdx mice at various ages through its life span and demonstrates that mdx muscles display EMG characteristics similar to that found in DMD. The results also suggest that EMG might be a useful tool for future studies evaluating therapeutic interventions in a mouse model of muscular dystrophy.

**IMPAIRMENT IN FINGER INDIVIDUATION AFTER SUBCORTICAL STROKE**

Prerit Raghavan, Electra Petra, John Krakauer, Andrew Gordon

Corticospinal tract lesions due to stroke can lead to persistent deficits in fine motor control and digit individuation. We examined the ability of nine patients with chronic subcortical stroke to individuate their digits compared with nine age-matched healthy control subjects. The subjects performed self-paced cyclical flexion-extension movements of each digit from the metacarpalphalangeal joints. They were instructed to move only the instructed digits while keeping the remaining digits stationary. Joint angular excursions were recorded using the Cyberglove. Individuation indexes were calculated based on the extent of movement of the instructed digit in relation to the noninstructed digits. Statiorinity indexes were calculated by examining the ability of subjects to keep the noninstructed digits still during the flexion-extension movements of the instructed finger. The results demonstrate significantly lower individuation indexes for the individuals with stroke compared with controls. However, the thumb and index fingers retained better individuation in stroke patients as in the control subjects. Statiorinity indexes did not correlate with the individuation indexes and varied between the digits in stroke patients, but correlated with the individuation indexes in control subjects. Moderate correlations were noted between the individuation indexes and tests of manual dexterity (Purdue Pegboard test and fine motor components of the Wolf Motor Function Test). The results suggest that subcortical lesions affect digit individuation, although the pattern finger individuation is similar to that in control subjects. Moderate correlations with tests of manual dexterity suggest that abilities other than finger individuation contribute to fine motor skill.

**SCIENTIFIC PAPER PRESENTATIONS**

**ACUTE MEDICAL ILLNESSES NECESSITATING TRANSFER FROM ACUTE REHABILITATION FACILITIES TO AN ACUTE CARE HOSPITAL: ITS EFFECT ON REHABILITATION LENGTH OF STAY AND FUNCTIONAL INDEPENDENCE**

Clinton Faulk, MD, Scott Morioka, MD, James Wells, MD/MPH

Objective: To determine the effect of serious acute medical illnesses on rehabilitation length of stay (LOS) and functional independence measure (FIM). Design: Retrospective cohort. Setting: Regional rehabilitation hospital with spinal cord, traumatic brain injury, stroke, general rehabilitation and an attached tertiary care hospital. Participants: All admissions to the regional rehabilitation inpatient facility over a 26 mo period, January 1st, 2002 through February 29th 2004. Main Outcome Measures: Total rehabilitation LOS, initial FIM score, final FIM score, and FIM gain. Results: There were 2698 admissions over this 26 mo period. Of these 2698 admissions, 203 required transfer back to an attached tertiary care hospital (7.5%). Of these 203, 87 (42.8%), returned to complete their rehabilitation course, 89 (43.8%) were discharged from the attached tertiary care hospital without further inpatient rehabilitation and 27
VITAMIN D DEFICIENCY AND OSTEOPOROSIS: HIGHLY PREVALENT IN MEN AND WOMEN ADMITTED TO SUBACUTE REHABILITATION FACILITY BOSTON MASSACHUSETTS DURING SUMMER

Leonid M. Shinchuk, MD, Nadia Huanchahuari, Dianne Ingersoll, Michael F. Holick

Vitamin D deficiency is a major risk factor for development of osteoporosis and bone fractures. The goal of this study was to determine the extent of vitamin D deficiency and prevalence of osteoporosis in patients admitted to a subacute rehabilitation facility after an acute hospitalization. Patients taking vitamin D supplements, pregnant or nonproficient in English were excluded. Forty-two consecutive patients admitted end of June and July were offered to participate in the study. Eighteen (19.1%) declined, four (9.5%) were nonproficient in English, five (11.9%) were taking calcium and vitamin D supplements. Twenty-five patients gave an informed consent for determination of their vitamin D status by measurement of their serum 25-hydroxyvitamin D [25(OH)D] level and evaluation of bone mineral density using Hologic Bone Densitometer. 25(OH)D levels were determined by competitive protein binding assay. A questionnaire was provided to assess dietary vitamin D intake and sun exposure. Enrolled patients had a mean age of 57.5 ± 15.6, 15 male (60%), 10 female (40%), 13 white (52%), 10 African Americans (40%), 2 Hispanic (8%) that was comparable with the demographics of the entire unit over the same period of time. The overall prevalence of vitamin D deficiency (25(OH)D <20 ng/ml) was 52% (53% of males, 50% of females). The prevalence of osteopenia (t-score < -1) was 44% (53% of males, 30% of females); osteoporosis (t-score < -2.5) was 20% (20% of males, 20% of females). From forty-two patients admitted, none of the male patients and only 5 (11.9%) all white female patients were taking calcium and vitamin D supplements. Vitamin D deficiency and metabolic bone disease was highly prevalent in both men and women who were admitted to subacute rehabilitation facility during summer months. Despite previous reports in literature, vitamin D deficiency remains undiagnosed and undertreated in this most vulnerable group of patients.

INTERVENTION TO IMPROVE TEAM FUNCTIONING

Dale Strasser, MD, Alan Stevens, PhD, Judith Falconer, PhD, Susan Bowen, PhD

This paper describes a six month team training intervention that was designed to improve interdisciplinary team functioning and patient outcome in inpatient stroke rehabilitation. Fourteen inpatient VA rehabilitation team members participated in the multi-component intervention composed of training in problem-solving skills and the use of information feedback. Team members (OT 19%; PT 21%; SW 3%; SLP 3%; RN 34%; MD 10%) were 80% female with an average of 13 yr of experience and 9 yr at the facility. Before the intervention, teams were surveyed on their perceptions of team functioning (team leadership, managerial practices, social climate and interprofessional relations). These data were summarized and returned to the local PI (usually the attending physician) as a baseline profile of their team functioning and an assessment of need – thus constituting the initial portion of the information feedback. The core of the intervention consisted of a 2.5 day workshop with two members from each team (MD and other team member) the telephone or videoconference follow-up by senior project staff. At the Conclusions of the workshop participants had selected one or more areas for improvement within their team and developed a plan of action. Problems identified included; coordination of treatment, professional role delineation, staff and retention, and postdischarge services. Postintervention, eleven of the fourteen teams implemented one or more solutions listed in their problem-solving plan. Twelve of the teams were either somewhat positive or very positive about having achieved solutions at 6 mo of follow-up. Six months following the workshop teams were re-surveyed on team functioning and this data were summarized and provided again to the local PI.
The effects of the team training intervention on patient outcomes are currently being evaluated in a national randomized clinical trial.

**RATE OF PROGRESSION OF SCOLIOSIS AFTER INTRATHecal BACLOFEN PUMP IMPLANTATION**

**Linda E. Krach, MD, Kevin Walker, MD, Lane Rapp, Steven E. Koop, MD**

**Objective:** To compare the rates of progression of scoliosis before and after intrathecal baclofen (ITB) pump implantation. **Subjects:** Skeletally immature individuals with CP who had at least 2 pre- and 2 post-ITB pump implantation spinal x-rays. **Methods:** Retrospective chart, database, and radiographic reviews. Radiographs were measured for presence of spinal curvature, pattern of curvature, Cobb angle, and pelvic obliquity. Rates of progression of scoliosis were calculated pre- and post-ITB pump implantation. **Main Results:** Thirty-six individuals met the inclusion criteria. 61% were male, mean age at implant was 10.8 yr, and 83% were GMFCS level 5. For those individuals who had curves before initiation of ITB, the location of the apex of the largest curve preimplant was significantly correlated with the rate of progression of the curve postimplant, the lower the apex the greater the progression ($P = 0.025$). Also, those with more impairment as measured by GMFCS had larger curve progressions postimplant ($P = 0.022$). Of the 36 subjects, 12 had a postimplant rate of progression less than the preimplant rate, 23 had a post curve rate greater than prepump rate and 1 had no scoliosis pre- or postimplantation of pump ($P = 0.018$). **Conclusions:** Individuals with greater functional impairment have the greatest risk for progression of scoliosis after initiating ITB. This is consistent with the knowledge that those who have cerebral palsy with the greatest neurologic involvement are at the greatest risk to develop scoliosis. Those who had lumbar curves preimplant were more likely to show progression of their curves postimplant.

THE “BRAIN INTEGRATION®”; REHABILITATION PROGRAM: A NEW HOLISTIC TREATMENT APPROACH

**Juan Martina, MD, Gert Geurtsen, Victor Voerman**

**Introduction and background:** The consequences of a brain injury (BI) can have a tremendous impact on both the patient and his family. Many individuals with BI experience serious problems at a later stage, after having gone through hospital care followed by primary rehabilitation. The problems lie mostly in the areas of living, work and/or leisure time, social contacts and relationships. The Brain Integration Program® (BIP) aims toward re-integration in these areas, according to a standardized treatment with a modular structure. The BIP introduces a new standard for delivery of rehabilitation services by shifting the rehabilitation focus from a medical perspective to a psycho-pedagogic holistic oriented approach. **Objective:** To determine the effectiveness of the BIP on the short and long term Design, subjects and setting: Patients are prospectively assessed 3 mo before start of treatment, at start and end of treatment and at one year follow-up. Group 1 comprises 17 patients who were measured 3 mo before the start of treatment and at start of treatment. Group 2 consists of 26 patients assessed at the start and the end of treatment. This multiple baseline design across subject is applicable in a treatment setting when a blind, randomized control group is not applicable. Assessment is performed using validated social and emotional rating scales and questionnaires. **Results:** Analysis of data were made by parametric t tests. Preliminary results show that there are no significant differences between the two assessments before treatment in group 1. However, there is a significant difference observed at the posttreatment assessment in group 2 when compared with the pretreatment measurement. **Discussion and conclusions:** Since no difference was observed between the pretreatment assessments in group 1, we believe that there is no spontaneous recovery. Although the long term effect is yet unknown, the difference between the pretreatment and after treatment assessments in group 2 indicates that the BIP is effective in resolving the needs of these patients.

**DIAGNOSTIC VALUE OF CERVICAL DISCOGRAPHY IN MANAGEMENT OF CERVICAL DISCOGENIC PAIN SECONDARY TO WHIPLASH INJURIES AND ITS PREDICTIVE VALUE FOR CERVICAL FUSION**

**Victor W. Isaac, MD, Faisal M. Zaman, MD, Michael J. DePalma, MD, Curtis W. Slipman, MD**

**Disclosure:** None. Background: Cervical discography is a diagnostic tool in the evaluation of cervical axial pain secondary to a whiplash injury. **Objective:** To assess the utility of the diagnostic value of cervical discography in the management of cervical discogenic pain. Study design: Critical analysis of current literature. Methods: A database search of MEDLINE, PUB MED, EMBASE, COCHRANE. Discussion: Cervical injuries related to motor vehicle accidents may be associated with cervical disc injuries. Discography is an intricate procedure in which many factors affect the generation of reliable data that can assist the clinician to diagnose discogenic pain and refine the treatment algorithm. Approximately 84% of chronic whiplash patients have discographically proven painful discs. In most cases, anterior cervical disectomy and fusion at the symptomatic levels consistently relieved the majority of symptoms. Seventy to 89% of patients experience good or excellent results after cervical fusion at the level(s) indicated by provocative discography. Conclusions: The cervical disc is a source of axial neck pain following a whiplash event that is amenable to cervical discectomy and fusion. Key Words: discogram, cervical discogenic pain, whiplash injuries and cervical fusion.

**THE INFLUENCE OF CRITICAL ILLNESS POLYNEUROPATHY & MYOPATHY ON REHABILITATION OUTCOME AND LENGTH OF STAY OF THE BRAIN INJURED PATIENT: A CASE REPORT**

**Erin Watson, MD, Scott Morioka, MD, James Wells, MD, MPH, Jacinta McElligott, MD**

**Setting:** Acute inpatient hospital. **Description:** 48 yr-old male, sustaining multiple trauma in a motorcycle crash including severe brain injury, multiple fractures and abdominal injuries. Complications included prolonged ventilator dependence (6 wk), septic shock, acute respiratory distress syndrome, enedrome and hypoxic encephalopathy. Patient presented with profound lower motor neuron weakness. Imaging studies of the spine were negative. Electrodiagnostic studies (EMG/NCN) done soon after transfer to rehabilitation demonstrated severe generalized myopathy and severe primarily axonal sensory-motor polyneuropathy consistent with severe critical illness polyneuropathy/myopathy (CIP). With the diagnosis of CIP the rehabilitation team anticipated favorable but prolonged recovery on the acute intensive TBI program, taking into account the patient’s severe losses of strength, endurance, and pulmonary reserve. The Uniform Data System (UDS FIM) score improved from 33 on admission to 87; however the rehabilitation length of stay was 36 days compared with average LOS of 21 days for the same impairment group code. Discussion: CIP is associated with prolonged medical and functional recovery from primary critical illnesses. As a comorbidity, CIP has a...
significant effect on the difficulty for the patient and staff in attaining functional gains. The EMG/NCS is a valuable diagnostic tool, providing the team with understanding of the severity of the neurological disorder, thus anticipating a need for an extended stay in rehabilitation. Conclusions: If not diagnosed, CIP superimposed on other rehabilitation conditions can lead to unanticipated prolonged lengths of stay and diminished functional recovery. Physiatrists should suspect the presence of CIP in patients with prolonged hospitalizations presenting with disproportionate weakness. Diagnosis of CIP by NCS/EMG guides the therapeutic course and assists the team, patient and family regarding functional prognosis and time frames. Key Words: traumatic brain injury (TBI), rehabilitation, Critical Illness Polyneuropathy, FIM.

TRAUMATIC BRAIN AND ORTHOPEDIC INJURY: A PROSPECTIVE MATCHED COMPARISON OF ACUTE IMPAIRMENT AND DISABILITY COMPARISON AT ONE YEAR
Magaly Noél, MD, Allen W. Brown, MD, James F. Malec, PhD, Anne M. Moessner, RN

Methods: This is a prospective matched comparison study in the setting of a tertiary Level 1 Trauma academic medical center and Traumatic Brain Injury Model System (TBIMS). The participants were enrolled in three groups: (1) Moderate-Severe TBI (worst GCS ≤13 or presence of neuroimaging abnormalities), n = 106, (2) Mild TBI (worst GCS ≥12 and absence of neuroimaging abnormalities), n = 87, and (3) Orthopedic injuries with no evidence of brain injury, n = 82. Orthopedic and Mild subjects were matched to Moderate-Severe subjects by age, gender, and level of education. The main outcome measures were the TBIMS protocol physical examination (assessment of cognition, bulbar function, balance, sensation, muscle tone, limb coordination and strength) during acute hospitalization and the Disability Rating Scale (DRS) during acute hospitalization and at one year. Results: Limb fractures occurred in 84% of Orthopedic subjects, 52% of Mild subjects, and in one Moderate-Severe subject. In general, total impairment was greatest in Orthopedic subjects. For individual components of the physical examination, cognitive and bulbar impairment was greatest for Moderate-Severe TBI subjects, and impairment of sensorimotor/mobility function was greatest for orthopedic subjects. Acute disability was greatest for Orthopedic subjects and least for Mild TBI subjects. Disability at one year was greatest for Moderate-Severe subjects. When controlled for level of acute disability, disability at one year improved most after orthopedic injury. Conclusions: Orthopedic subjects had the greatest percentage of limb fractures and the greatest acute impairment and disability. Traumatic orthopedic injury is associated with greater impairment in mobility, while moderate-severe TBI is associated with greater impairment in cognitive and bulbar function. Disability after traumatic orthopedic injury improves greater and is significantly less at one year than disability after moderate-severe TBI.

A PROSPECTIVE STUDY OF ACUTE HOSPITAL COSTS AFTER TRAUMATIC BRAIN AND TRAUMATIC ORTHOPEDIC INJURY
Peter K. Kubitz, DO, Allen W. Brown, MD, James F. Malec, PhD, Nancy N. Diehl, MS

Methods: This is a prospective matched comparison study in the setting of a level 1 trauma academic medical center and Traumatic Brain Injury Model System. The participants were hospitalized patients prospectively enrolled in three groups: (1) Moderate-Severe TBI (worst GCS ≤13 or presence of neuroimaging abnormalities), n = 106, (2) Mild TBI (worst GCS ≥12 and absence of neuroimaging abnormalities), n = 106, (2) Mild TBI (worst GCS ≥12 and absence of neuroimaging abnormalities), n = 87, and (3) Orthopedic injury with no evidence of brain injury or disease, n = 82. Orthopedic and Mild subjects were matched to Moderate-Severe subjects by age, gender, and level of education. The main outcome measures were length of hospitalization and hospital costs (total and categorized). Results: Median length of hospitalization and median total costs was significantly greater for Moderate-Severe TBI compared with the other groups. Average daily cost was greatest after mild TBI. Costs per patient by cost category were greatest for Moderate-Severe subjects in almost every category. Conclusions: On average, total costs after Moderate-Severe TBI were nearly double those for the other groups. Mild TBI subjects had significantly higher average daily costs compared with Moderate-Severe TBI subjects but a significantly shorter length of stay.

These findings suggest that, among these groups, decreasing hospital length of stay would have a greater economic impact after TBI than after traumatic orthopedic injury.

EARLY UNPLANNED DISCHARGES FROM INPATIENT REHABILITATION
Maureen L. Carney, MD, MBA, Peter Esselman, MD

Introduction: Inpatient rehabilitation facilities are under increasing pressure from the Prospective Payment System to increase efficiency. Discharges from a rehabilitation facility within 3 days of admission due to acute medical or surgical problems are not cost effective and provide questionable patient benefit. Such discharges raise the question whether these patients were appropriate for admission. Methods: A retrospective review (1995-2003) identified patients discharged from inpatient rehabilitation due to an acute medical or surgical problem within three days of admission. Data obtained included diagnosis, length of stay, age, reason for discharge, and ultimate discharge destination. Results: Of 3072 patient admissions, 250 (8%) were discharged for acute medical reasons, and 55 (22%) of those were within three days. Of these 55 early discharges, 33% had a TBI, 33% SCI, 24% CVA, 9% amputations and 38% were over the age of 70. This represents 1.8% of all patients with TBI, 2.5% of SCI, 1.7% of CVA, and 10.2% of amputations. When patients discharged early, only 47% were ultimately discharged home compared with approximately 80% of all discharges. Frequent reasons for early discharge were pulmonary (16%), noncranial bleeding (16%), and neurologic changes (15%). While infection accounted for 22% of the total group of unplanned discharges, only 13% of those discharged in the first 3 days were due to infection. Discussion: Early discharges to acute care were distributed across diagnostic groups, but there was a higher rate in those admitted due to amputations. The results demonstrate that patients at risk for complications resulting in early discharge are more likely to be older, and are less likely to ultimately be discharged to home. This information helps focus attention on patients at higher risk for premature discharges and aids in evaluation of admission criteria regarding the medical stability of these patients.

CHALLENGES IN TELEMEDICINE PROSTHETIC CLINIC
Judith B. Kosashid, MD

Background: Clement J. Zabicki VA MC in Milwaukee established a Telemedicine Prosthetic Clinic (PC) with Iron Mountain (IMVAMC) in 1998. IM-VAMC is a Veterans Affairs facility 206 miles away from Milwaukee. The purpose of the Telemedicine PC is to provide equal access and timely intervention of prosthetic evaluation and prescription to veterans who live in remote areas. The significant reduction in patients' travel time with the same clinical outcome would optimize customer service and patient satisfaction. Design and Participants: The Telemedicine PC is a monthly multidisciplinary clinic run by the Milwaukee-VAMC PC team. The IM-VAMC is attended by a physical therapist, a community Certified Prosthetist, and the patient. Physical exam, directed by the physiatrist in Milwaukee, is performed either by the IM PT or the Prosthetist. The videoconference device includes a Tandberg video system; data are transmitted across the network utilizing the H.323 standard. The dynamic bandwidth allows clear and smooth video communication. The 153 male veterans served to date had a mean age of 63 with 73% BKA, 18% AKA, 4% bilateral lower extremity amputation, 1% knee disarticulation, 4% upper extremity amputations (3% BE, 1% AE). Majority (81%) needed evaluation and prescription of permanent prosthesis, modification or parts replacement. Fewer (19%) needed evaluation and prescription for initial prostheses. Challenges: Technical issues have included broken telemedicine equipment (2) resulting in clinic cancellation and relocation to a different building; and clinician difficulty with controlling remote camera. A small clinic room made assessment of gait difficult and the echo sound quality at times interfered with communication. Perhaps the greatest challenge felt by the clinician was in assessing skin condition on the residual and intact limbs. Despite the challenges, the latest patient satisfaction survey performed by Milwaukee-VA Prosthetics and Sensory Aids Program indicated a high level of satisfaction (score 4.7 out of 5). Technical improvements in control of the remote camera with user friendly customized menu for the clinician would be an area of further interest.

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LOW PEAK EXERCISE BLOOD PRESSURE RESPONSE: A STUDY TO EXPLORE PHYSIOLOGIC AND PROGNOSTIC ASSOCIATIONS
Chetan Malik, MBBS, Ritu Malik, MBBS, John P. Naughton, MD, J.C. Shieh, MD

Objective: To explore the relation of Low peak exercise systolic blood pressure response to prognostic indicators of CAD, and abnormal cardiac structure or function. Method: Medical records of 261 patients were reviewed for stress test data, demographic information, and medications. Maximum METs, Rate pressure product (RPP) and Long Beach VA prognostic score (LBVAS) were used to determine prognosis. 194 patients had 2D-echo and/or cardiac nuclear scans done just before or after the stress test. 11 potential cardiac abnormalities were listed. A score was assigned based upon the number and severity of identified abnormality present in each patient. Ejection Fraction was also determined from the 2D-echo. Results: 47 out of 261 patients had peak exercise SBP < 140 mmHg, the remaining 214 patients had peak exercise SBP > 140 mmHg. Mean age: 60.5 yrs. (SD = 2.2), Males = 254, Females = 7. Comparison between the two groups (peak exercise SBP < 140 mmHg and peak exercise SBP > 140 mmHg) established that: Maximum METs (mean (SD) 6.6(2.3) vs. 8.6(2.6), P < 0.000), RPP (mean (SD) 14,679(2492) vs. 23,665(5087), P < 0.000), LBVAS (mean (SD) 10.6(3.1) vs. -2.0(2.8) P < 0.000) and Ejection Fraction (mean (SD) 50.6(12.2) vs. 55.1 (8.8) P = 0.01) were significantly lower in patients with peak exercise SBP < 140 mmHg. This group had significantly higher Cardiac abnormality score (mean 2.0 vs. 0.8 P = 0.005). Conclusions: Low peak exercise SBP is a poor prognostic marker for CAD and should also be used to evaluate results of exercise stress tests. Low peak exercise SBP seems to be related to abnormal cardiac structure or function. We recommend a prospective study to validate our results.

VERTICAL EXCURSION OF CENTER OF GRAVITY IN RELATION WITH CONTRA-LATERAL LIM KINEMATICS IN POST-STROKE HEMIPLEGIC GAIT
Sun G. Chung MD, PhD, Joon Beom Hong, Tai Ryouan Han
Poststroke hemiplegia affects walking patterns of the contra-lateral limb (CLL) as well as the hemiplegic limb (HL). The kinematic deviations of the CLLs of hemiplegic patients were analyzed in relation with the displacement of the center of gravity (COG) to evaluate the compensatory contributions of the CLLs. Three dimensional gait analyses using an optoelectronic system were undertaken in 12 hemiplegic subjects caused by unilateral supratentorial strokes and 10 controls. Fifteen markers were used for walking trial at self-selected, comfortable speed. The COG was estimated from pelvic markers. Vertical excursion of the COG (Vcog) during walking was measured in the stance phase of each limb. The elevation of COG in the stance phase of the CLL. The compensatory elevation of COG was contributed mainly by the pelvic obliquities and dynamic components of the ankle dorsiflexion. More attention to the kinematic deviations of the CLL would be needed to characterize and monitor the poststroke hemiplegic gait.

POSTER BOARD PRESENTATIONS

POSTER BOARD 1: REHABILITATION OF A TRIPLE AMPUTE AMPUTEE COMBAT CASUALTY: A CASE REPORT
Brandon J. Goff, DO, Jeff M. Gambel, MD

Patient: A 22-yr-old soldier injured during Operation Iraqi Freedom. Case: The soldier was struck by a rocket propelled grenade which caused immediate life-threatening injuries. He underwent massive resuscitation in the field by combat medics and was treated emergently in Iraq, Germany, and Walter Reed Army Medical Center. He arrived in Washington, DC on day six. The following amputations were performed: left transradial amputation, right hip disarticulation, and left transfemoral amputation. Initial goals were that the patient should have the option of walking again and that he should become proficient bimanually for routine activities. He was fitted with a myoelectric arm, a body-powered arm, and a cosmetic arm including multiple hand terminal devices. He was fitted with a right bucket hip socket and left thigh quadrilateral socket with bilateral C-legs. Main Results: At one year postinjury, the patient was functioning at a Modified Independent level for mobility, transfers, ambulation, and ADLs. He was ambulating efficiently with prosthetic legs, using both an axillary and a platform crutch for unlimited distances. He continues to exceed all goals. Discussion: Rehabilitation of a triple amputee is an unusual challenge that will likely increase in frequency with the increased survivability of the modern battlefield. Increased safety of personal body armor, advanced training for combat medics, forward positioned surgical trauma teams, rapid medical evacuation out of theater etc. As more patients with severe, multiple traumas and amputations survive, there will be a greater need for innovative and comprehensive multidisciplinary approaches for their complicated rehabilitation.

POSTER BOARD 2: DRAMATIC RECOVERY IN AN ACUTE SPINAL CORD INJURY PATIENT: A CASE REPORT
Shawn Dalton-Bethea, MD, Peter H. Gorman, MD

Disclosure: None. Setting: Inpatient. Program: Acute spinal cord injury rehabilitation. Case Description: 42 yr old female presented to a local ER 24 hr after the onset of sequential bilateral lower extremity weakness with without trauma. Initial evaluation revealed incomplete (ASIA C) paraplegia, hyperesthesias of the left dorsal foot, and coarse distal left upper extremity tremor. During her acute and rehabilitation course, she displayed marked inconsistencies on her physical exam between staff on a daily basis. There was no personal or family history of neuromuscular disorders. The patient denied any particular stressors during her multiple psychiatric interviews. Assessment/Results: CT and MRI of the thoracolumbar spine revealed no cord compression or contusions. Psychic evaluation suggested the diagnosis of conversion disorder. Malingering was excluded based on the lack of secondary gain. The patient had complete recovery the morning before her scheduled somatosensory evoked potential (SSEP) study. Discussion: Conversion disorder presenting as spinal cord dysfunction is anecdotally very common, but reports in the literature are infrequent. Physicians are reluctant to label a patient in view of the possibility that an undiscovered organic lesion (e.g., multiple sclerosis) may be present. SSEPs and/or motor evoked potentials can be used in differentiating organic disease from conversion. As illustrated in this case, the presence of an obvious psychiatric stressor in the history is not necessary to make the diagnosis. Although not attempted here, hypnosis has played a useful role in prior studies. Conclusions: Conversion reaction presenting as acute spinal cord dysfunction requires more investigation. Evoked potentials and hypnosis are considered useful adjuncts in the diagnosis. The diagnosis remains one of exclusion, but it is likely more common than the literature would suggest. The diagnosis of malingering associated with secondary gain should also be excluded.

POSTER BOARD 3: FACTITIOUS PARAPLEGIA WITH SECONDARY GAIN: A CASE REPORT
Shawn Dalton-Bethea, MD, Peter H Gorman, MD

Setting: Inpatient. Program: Acute spinal cord injury rehabilitation. Case Description: A 26-yr-old male who had been forcibly extracted through the passenger window by the police, presented with acute paraplegia to a trauma center. Initial examination was consistent with L1 ASIA B paraplegia. CT and MRI of the spine revealed a small CS–6 disc bulge with no cord contusion or compression. Initial rehabilitation center examination revealed a right C5 motor level and the new onset of a right hand tremor. During rehabilitation, the patient exhibited gross motor inconsistencies. He was seen by psychotherapists who monitored movements of other lower functioning patients during therapy. During off hours, however, ancillary staff noted him to ambulate independently in his room. Assessment/Results: Psychiatric evaluation suggested the diagnosis of malingering based on both the lack of organic cause as well as the presence of secondary gain. The patient repeatedly mentioned to staff that a lawsuit against the police was being pursued. The patient

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subsequently made a complete recovery in less than two weeks. Discussion: Malingering is defined as the exaggeration of physical or psychological symptoms for secondary gain. The distinguishing clinical feature is the conscious nature of the condition. In this case, the patient potentially could have financially gained from a pending lawsuit against the police. One must exclude transient spinal shock due to actual spinal injury in the evaluation of this type of presentation. Evoked potentials could be helpful in this regard. Malingering can also be confused with conversion disorder, except that conversion is not associated with secondary gain. Conclusions: Malingering presenting as an acute spinal injury is rarely reported in the literature. The diagnosis remains one of exclusion, but it is likely more common than the literature would suggest.

POSTER BOARD 4: CANCER REHABILITATION: ARE WE MEETING OUR PATIENT'S NEEDS?
Clifford R. Everett, MD, Ushma Patel, Annie Philip
Objective: To determine subjective rehabilitation needs in a population of patients with cancer. Design: Qualitative Interview. Patients were interviewed by a physiatrist not involved in the care of the patient. The patients were presented with ten broad-based and open-ended questions designed to elicit their views in each of the following areas: pain, spirituality, mobility, ADLs, cognition, nutrition, speech, and emotional well being. Setting: Inpatient medical oncology unit. Participants: Thirty patients with a diagnosis of cancer were chosen from the oncology unit, who agreed to be interviewed in an anonymous manner. Interventions: Not Applicable. Main Outcome Measure: Using qualitative techniques phrases and answers to questions were annotated and grouped by subject. These were then analyzed for corroboration. Results: All patients reported moderate to severe pain despite treatment with analgesics, difficulty with their ADL’s, difficulty with mobility, depressed mood, deficits in cognition, and fears concerning returning home. All patients felt their spiritual needs had been met. 60% of patient had decreased food intake due to painful mouth sores. 20% of patients reported weight loss. 40% of patients reported impairments in communication. Conclusions: The treatment of cancer has seen major strides made in recent years. With this remarkable progress, patients are being diagnosed earlier, receiving more aggressive treatment regimens, and making commensurate advances in morbidity and mortality. This progress has created a new population of patients surviving cancer but burdened with impairments. A closer scrutiny of this population raises new concerns. Often the management of this very serious condition supersedes the need to address the many other impairments and needs a patient may experience. Our study shows that within our sample of patients fundamental rehabilitation needs continue to be a concern. It is our intention to use these results in a future study to validate a survey that will help to further investigate these issues in larger populations. By including rehabilitation goals in overall cancer management strategies, we can strive to preserve quality-of-life in saved lives.

POSTER BOARD 5: PATIENT EXPECTATIONS AND PRACTITIONER SELECTION IN PHYSICAL THERAPY
Clifford R. Everett, MD, Rohaan Mehta, MD, Patrick Mucilli, PT, Brianna Obert, PT, Rajeev K. Patel, MD
Purpose: To determine expectations and areas of importance to patients when selecting a physical therapist. Background: Understanding the determinants of physical therapy provider selection as well as patient expectations from treatment, and meeting those expectations may increase patient satisfaction. However, research involving patient expectations and practitioner selection is scarce. A standardized tool is needed to measure patient expectations and practitioner selection to promote beneficial outcomes for patients and greater overall satisfaction. Design: Descriptive, practice-based qualitative interview. Setting: Outpatient orthopaedic physical therapy clinic. Methods: Twenty-five patients with a diagnosis of low back pain were interviewed in an anonymous manner in one outpatient orthopedic physical therapy clinic. The first 25 patients who were interviewed during the testing period were chosen for the study. Patients were interviewed by physical therapists not involved in the care of the patient. The patients were presented with ten broad-based questions designed to elicit their views about their expectations of care and how they selected their physical therapist. Results and Conclusions: The results of this study indicate that patients selected their physical therapist at the direction of a referring physician. Most patients expect at least some benefit from physical therapy for treatment of low back pain. Despite receiving care from physicians and other providers, patients continue to demonstrate pain avoidance behavior and little understanding of the natural history of their conditions. A questionnaire was drafted to include specific questions on the themes of natural history, past treatments, self reliance and self efficacy, and patients’ ideas about their pain. This will help determine if a physician treating low back pain should focus on triage to a practitioner with similar beliefs about treatment as the patient, or on education to mirror the physician’s beliefs.

POSTER BOARD 6: SEX AND YOUNG ADULTS WITH SPINA BIFIDA: WHAT ARE THE ISSUES?
David Berbrayer, MD, BSC(MED), FRCP, DABPM&R
Background: Adult spina bifida has limited sexual knowledge compared with their nondisabled peers. The most frequent resource is the school with parents as distant second choice. Hypothesis: To determine the effect of the educational environment on the desire of adults with spina bifida to know more about sex. Methods: Ten adults with spina bifida, aged 18–36 were recruited. The Sexual Knowledge Interview Schedule (SKIS) was used to assess general knowledge. Both quantitative and qualitative analysis of data were done. Results: Five female and five male spina bifida interviewed. Attendance at high school for the physical disabled did not increase sexual knowledge. There was no male/female difference in comprehension of sexual education. Three themes emerging from qualitative analysis: 1. Unable to formulate a question about sex & spina bifida; 2. Difficulties in sexual relationship; and 3. Concerns about having children. Conclusions: 1. 70% participants want more sex education; 2. School environment & parents did not provide adequate sex education; 3. Young adults unclear how to ask questions about sex; and 4. Physicians need training about sex & disability.

POSTER BOARD 7: THE USE OF COMPLEMENTARY AND ALTERNATIVE MEDICINE IN ADULT CEREBRAL PALSY
David Berbrayer, MD, BSC(MED), FRCP, DABPM&R
Background: Previous studies have not investigated complementary and alternative medicine (CAM) in adult cerebral palsy (CP). Hypothesis: To qualitatively analyze the use of CAM by adult cerebral palsy. Methods: Ten adult (over 18 yr) cerebral palsy individuals participated in semistructured interviews. Participants were asked open-ended questions related to demographics, use of conventional medicine, and complementary therapies. A Framework Analysis approach was used to interpret field data and generate themes. Results: Seven of ten participants had utilized at least one type of CAM previously. The most commonly used complementary therapies were aquatherapy, message therapy, hippotherapy and chiropractic manipulation. CAM was used to supplement successes achieved through traditional treatments and fill gaps in the service provision of physiotherapy and occupational therapy. Conclusions: 1. Majority of adult CP patients in this study either use CAM or request information about CAM; 2. There exists a need to validate the use of CAM in adult CP; and 3. Barriers to use of CAM include physician knowledge and acceptance, costs, awareness, accessibility to services, and need for supports. Key Words: complementary therapies; cerebral palsy; rehabilitation.

POSTER BOARD 8: CORRELATION BETWEEN SHOULDER EXAMINATION AND MAGNETIC RESONANCE IMAGING FINDINGS: CASE REPORTS
Chiwai Chan, DO, Elizabeth Heilman, MD, Kamala Shankar, MD
Setting: Outpatient physical medicine and rehabilitation clinic. Patient or Program: Two patients with shoulder pain, which after physical examination required further evaluation by Magnetic Resonance Imaging (MRI) are randomly selected from November 2002 to November 2003. Case Description or Program Description: Patient 1 is a 55-yr-old male with chronic right shoulder pain and decreased range of motion. Physical examination revealed active abduction of 130 degrees; flexion, 150 degrees. Right empty can test was positive. Biceps, triceps and deltoid strength were pain limited. The diagnostic impression was rotator cuff tendonitis. Patient 2 is a 73-yr-old male with complaint of left shoulder pain. Physical examination revealed active left shoulder abduction of 80 degrees; flexion, 70 degrees. Empty can and Hawkins’ test were positive. The diagnostic impression was rotator cuff tendonitis, adhesive.

March 2005
EXTRAARACHNOIDAL FLUID COLLECTION AFTER SPINAL LAMINECTOMY

Setting: Inpatient Rehabilitation Unit of a tertiary care teaching hospital.

Case Description: Patient 1: A 62-yr-old female. Case Description: The patient had lumbar laminectomy performed to treat spinal stenosis with severe leg pain. Upon discharge, the patient presented with a gradual onset of lower extremity weakness and impaired balance. Her symptoms subsequently progressed, prompting MRI imaging of the spine, which revealed a large fluid collection at the laminectomy site. MRI scan revealed a very large fluid collection at the laminectomy site, extending into the spinal canal was also seen. Assessment/Results: Repair of the CSF fistula with durotomy, marsupialization of arachnoid, water-tight closure of dura and repair of lateral recess were done by neurosurgeons. MRI scan revealed a large fluid collection at the laminectomy site, extending into the spinal canal. The patient was transferred to PM&R eleven days later with signs of upper motor neuron deficits. Limited progress was achieved in 3 wk of acute inpatient rehab, secondary to severe lower extremity pain and hypothesis, a major contributing factor. Left lower extremity muscle strength remained 3/5 proximally and only 1/5 distally. By the fourth week, her endurance markedly improved and she achieved basic ADL independence. She initially presented with a gradual onset of lower extremity pain and weakness progressing rapidly to quadriplegia and respiratory failure requiring ventilator support. Assessment/Results: During hospital stay the patient deteriorated rapidly and developed ventilator failure requiring ventilator support. The patient also developed deep vein thrombosis and bilateral pulmonary embolism requiring placement of IVC filter. The patient did not respond to IVIG and required admission to ICU. Early recognition and treatment may be important considering the young age of the patient, female sex and no previous history of cardiac disease. Only 1% of patients with GBS make good recovery, 2–12% die from complications related to myocardial infarction and pulmonary embolism. Autonomic changes can cause hypotension and respiratory failure. Patients diagnosed with GBS should be monitored closely in hospital and may require admission to ICU. Early recognition and treatment may be important in the long term prognosis.

POSTER BOARD 11: THORACIC SPINAL STENOSIS CAUSED BY CALCIFIED EXTRUDED DISC: A CASE REPORT

Radana Dooley, MD, Adam C. Isaacson, MD, Ajendra Sohal, MD, Sanjeev Agarwal, MD, Lyn D. Weiss, MD

Setting: Acute inpatient rehabilitation unit. Patient: A 63-yr-old white, recently retired female. Case Description: The patient was transferred to our acute inpatient rehabilitation facility 10 days post T10–11 decompression laminectomy performed to treat spinal stenosis with severe myelopathy secondary to a calcified extruded disc. Three months before surgery the patient was an independent community ambulator and ADL independent. She initially presented with a gradual onset of lower extremity weakness and impaired balance. Her symptoms subsequently progressed, prompting MRI imaging of the spine, which revealed a large calcified T10–11 extruded disc. Patient developed marked lower extremity weakness with bowel and bladder incontinence prompting emergency decompression laminectomy. After the surgery her symptoms worsened. Despite cord decompression laminectomy continued to be hyporeflexic without signs of upper motor neuron deficits. Limited progress was achieved with 3 wk of acute inpatient rehab, secondary to severe lower extremity pain and hypothesis, a major contributing factor. Left lower extremity muscle strength remained 3/5 proximally and only 1/5 distally. By the fourth week, her endurance markedly improved and she achieved basic ADL independence. Discussion: Thoracic spinal stenosis caused by a nontraumatic disc herniation is an uncommon, frequently overlooked and challenging diagnosis. This is because symptoms are nonspecific and there is a paucity of clinical manifestations. Only 1% of patients with significant thoracic disc herniations are clinically symptomatic.

Conclusions: Significant neurological and functional recovery was achieved despite prolonged thoracic spinal cord compromise (as the result of a calcified extruded vertebral disc) with extensive inpatient rehabilitation following surgical laminectomy and decompression.

POSTER BOARD 12: CSF FISTULA WITH INTRADURAL EXTRAARACHNOIDAL FLUID COLLECTION AFTER SPINAL SURGERY: A CASE REPORT

Radana Dooley, MD, Adam C. Isaacson, MD, Ajendra Sohal, MD, Sanjeev Agarwal, MD, Walter Gaudino, MD, Radana Dooley, MD, Lyn Weiss, MD

Setting: Inpatient Rehabilitation Unit of a Tertiary Care Hospital. Patient: A 62-yr-old female. Case Description: The patient had lumbar laminectomy, decompression and spinal instrumentation for spinal stenosis. After initial uneventful postoperative period, patient complained of persistent headaches which were worsened by bending forward. Neurological signs were positive only for mild sensory deficit in right lower extremity. MRI scan revealed a very large fluid collection at the laminectomy site bulging into the para spinal muscles. Adjacent dural defects, poor overlying soft tissue coverage, scar tissue, radiation, tight closure of dura and repair of lateral recess were done by neurosurgeons. Patient reported gradual improvement in symptoms and progressed well in rehabilitation program. Discussion: Incidental durotomy is a frequent complication of lumbar spine surgery with a reported incidence of 0.3% and 13%. Incidence is much higher in more complicated cases such as spinal dysraphism, dural tearing during revision surgeries. The majority of dural tears heal spontaneously. However large dural defects, poor overlying soft tissue coverage, scar tissue, radiation, infection, nutritional deficits, steroids and elevated CSF pressure can contribute to poor healing of dural tears. In this case, the development of
"trapped" CSF collection in the subdural-extra-arachnoidal compartment secondary to a punctate durotomy was unique. Conclusions: CSF fistulas are relatively rare complications following spinal surgery. They may be associated with variety of signs and symptoms including headaches, infection, radiculopathy, and myelopathy. MRI is the most sensitive modality of choice. With decreasing postoperative hospital stay and early intensive rehabilitation after spinal surgery, Physiatrists and therapists should be aware of the possibility of postoperative dural leak and associated signs and symptoms to avoid long term and sometimes serious complications.

POSTER BOARD 13: EFFECT OF HIV MEDICATIONS ON METHADONE: A CASE REPORT
Sanjeev Agarwal, MD, Krishna Lingala, MD, Ajendra Sohal, MD, Lyn D. Weiss, MD

Setting: Pain clinic of a tertiary care hospital. Patient: 50 yr old white male. Case Description: 50 yr male with history of HIV on antiretroviral medications. Hepatitis B and C, LA–5 spinal stenosis, cervical stenosis, s/p C5–7 spinal fusion, s/p thoracotomy and rib resection was attending the pain clinic for chronic pain syndrome. Assessment/Results: He was on high doses of narcotic analgesics and gabapentin which failed to control his pain adequately. He was started on Methadone for better pain management. He was recently started on Trizivir (Abacavir, lamivudine and Zidovudine) and Nevirapine from HIV clinic. He reported of return of symptoms after being started on HIV medications. Discussion: Methadone is metabolized in liver by the P 450 system with a half life of 24–36 hr. N-demethylation of methadone results in formation of metabolites which are excreted in the urine and bile. Abacavir is known to increase methadone clearance and Nevirapine decreases methadone levels by 46%. Methadone also increases time to peak concentration and decreases peak concentration of Abacavir. Methadone may also increase effect of Zidovudine. It is known that interactions occur between methadone and some HIV-related medications. However, their characteristics cannot be reliably predicted based on current understanding of enzyme induction and/or inhibition, or through in vitro studies. Clinicians have to rely on their judgment. If a methadone-maintained patient is recently started on HIV-related medication, particularly an NRTI, describes withdrawal symptoms, and no other reason is evident, an empiric trial of raising the methadone may be an appropriate response. Conclusions: It is critical for physicians prescribing methadone to HIV-positive patients on antiretroviral medications to be aware of interactions between them. The potential interaction can influence the success of either or both treatments.

POSTER BOARD 14: UNUSUAL PRESENTATION OF MENINGIOMA: A CASE REPORT
Sanjeev Agarwal, MD, Walter Gaudio, MD, Victor Isaac, MD, Lyn Weiss, MD

Setting: Inpatient Rehabilitation Unit of a tertiary care teaching hospital. Patient: 26 yr old female. Case Description: 26 yr old female with past medical history of hypertension and multiple miscarriages was admitted with complaints of nausea, headache, right sided weakness, parasthesia in right lower extremity, ataxia, shortness of breath, episodic palpitations, blurring of vision and slurred speech since delivery about 8 mo ago. Assessment/Results: Physical examination was positive for wide base gait with tendency to tilt toward right, positive Romberg’s sign, absent deep tendon reflexes and 4/5 muscle strength in right lower extremity. MRI scan revealed a large cerebellar mass on right side. Cranitomy and tumor resection was done and histopathologically it confirmed to be a meningioma. Patient showed marked clinical improvement during her rehabilitation stay. Discussion: Meningiomas constitute the largest subgroup of all intracranial tumors with an incidence of 2–3/100,000, 3:2–2:1 female/male ratio and peak incidence in sixth to seventh decades of life. Meningiomas are usually slow growing benign neoplasms causing symptoms by compression of adjacent structures or by increased intracranial pressure. Malignant meningioma constitue 1–10% of all meningiomas. Surgical resection is the mainstay of the treatment in benign neoplasms with completeness of resection being the single most important prognostic factor for recurrence. MRI scan is the diagnostic modality of choice. Conclusions: Meningioma is not a very common clinical entity in younger age group and can become symptomatic during pregnancy because of change in size due to hormonal influences. Clinicians should be aware of this possibility and include meningioma in differential diagnosis when evaluating such a patient. Early diagnosis and referral to neurosurgeon may be indicated to prevent long term sequelae. Key Words: Meningioma, Weakness, Rehabilitation.

POSTER BOARD 15: LOW BACK PAIN OF PREGNANCY IN ASSOCIATION WITH VASCULAR ENGORGEMENT OF THE EPIDURAL VENOUS PLEXUS: A CASE REPORT
Alexios G. Carayannopoulos, DO, MPH, Joanne P. Borg-Stein, MD

Disclosure: None. Setting: Tertiary Care University Hospital. Patient: A 40 yr old primigravida female. Case Description: The patient, with a history of Rheumatoid Arthritis, presented in her third trimester with a two-week history of acute-onset, predominantly nocturnal, low-back pain, associated with extreme intolerance to supine positioning. The 10/10 pain was worse at night and interfered with sleep. She denied any change with Valsalva, saddle anesthesia, sphincter disturbance, or weakness of the lower extremities. On musculoskeletal exam, she had lumbar lordosis, sacro-ilac tenderness, and exquisite interspace tenderness at L4–5 and L5-S1 with severe localized pain on active extension. Neurological Exam was normal. Diagnostic MRI was significant for a small annular tear without herniation and prominent engorgement of the epidural veins from L4 to S2. Assessment/Results: The patient had complete resolution of symptoms upon premature rupture of her membranes at 29 wk and subsequent delivery at 34 wk gestation. She remained pain-free at follow-up. Conclusion: Although previous reports suggested that this is the first case, to our knowledge, of a published MRI film showing vascular congestion of the epidural venous plexus temporally related to the case of a pregnant female with severe axial, nocturnal, positional-related low back pain, a very common complication of women during pregnancy. Conclusions: Vascular distention of the lumbar epidural venous plexus, an uncommon but reported circulatory compensatory response to postural changes of pregnancy, should be considered in the differential diagnosis of acute onset low back pain in the setting of late pregnancy, especially when presenting nocturnally, or when associated with the supine position. Although not usually relieved by rest, it usually resolves following delivery.

POSTER BOARD 16: NEUROMUSCULAR REHABILITATION OF A PATIENT WITH MELAS SYNDROME: A CASE REPORT
Paul Singh MD, Chris Reger MD

Setting: Tertiary Care Hospital. Patient: 23 yr old African American female with MELAS syndrome (Mitochondrial myopathy, Encephalopathy, Lactic acidosis, and Stroke-like symptoms) with progressive neuromuscular weakness and debilitation. Case Description: This patient was admitted for generalized weakness. Hospitalized weakness was significant for status epilepticus stabilized by Dilantin. Brain MRI showed high signal intensities in the left temporo-occipital cortices consistent with a stroke-like syndrome. Physiatry evaluated the patient for functional status. Assessment/Results: The patient had previously been independent with her ADL’s. When initially evaluated by physiatry, her motor exam was 4/5 throughout with Ashworth +1 spasticity of upper extremities, and hyperreflexive lower extremities. She had dysmetria bilaterally and a wide based, ataxic gait. Transfers required moderate assistance and she used a cane to maximally ambulate 50 feet. While in acute rehab, she improved with decreased spasticity in upper extremities, becoming independent with transfers, and ambulating 300 feet without device. Discussion: MELAS is a rare neurodegenerative disorder resulting in shortened lifespans. The genetic defect is a mutation in mitochondrial DNA causing neuronal death. This case presents a male with a status epilepticus during ages 4–15 with weakness, visual problems, and seizures. Physically, patients may have cognitive problems, short stature, muscle weakness. Other findings are hemianopsia, ataxia, and tremors. Laboratory abnormalities include elevated lactate and creatinine kinase from myopathy. Brain MRI show lesions reflecting hyperemia and vasogenic edema. Muscle Biopsy confirms diagnosis and EEG can confirm seizure activity. There is no cure for MELAS syndrome. Treatments include dietary supplements aimed to deter disease progression. Co-enzyme q10 may ameliorate weakness by increasing ATP production, l-carnitine, an amino acid derivative, may also be efficacious. Conclusions: Physiatrists should have knowledge and awareness of MELAS syndrome and other neurodegenerative disorders to augment the rehabilitative effort. Gait training, balance, and fine coordination target the main areas of affected patients’ rehabilitation.

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POSTER BOARD 17: REHABILITATION OF A PATIENT WITH WEGENER’S GRANULOMATOSIS: A CASE REPORT
Paul Singh MD, Chris Reger MD

Patient: 70 y/o Caucasian male with newly diagnosed Wegener’s Granulomatosis (WG) with impairment in ADL’s and mobility. Case Description: This patient with CAD, DM II presented with a recent history of increasing shortness of breath, lower extremity edema, and mildly painful, bruised fingertips. Medical workup diagnosed WG, and the patient responded to oral cytotoxic and intravenous salmeterol.Physiatry was consulted to evaluate the patient’s functional status. Assessment/Results: The patient had previously been independent. Initial physiatric evaluation showed slow moving, tender, ecchymotic distal phalanges, +2 lower extremity edema, and deconditioning. In acute rehab, therapy focused on joint protection for ADL’s using phalangeal splints, wash mitts for bathing, and emphasizing palmar rather than digital gripping. Other focuses were cardiovascular conditioning and edema control including gentle diuresis, compression hose, and timed elevation of lower extremities. He improved from being moderate assistance in transfers and self care to mostly independent. Gait increased from 30–300 feet with a cane.

Discussion: Wegener’s Granulomatosis is a necrotizing granulomatous vasculitis that affects mainly small and medium arteries of the respiratory tract and kidneys. Patients typically present with pulmonary symptoms although renal disease is common. Other organ systems involved include musculoskeletal (myalgias and arthralgias), skin (purpuric lesions) and nervous (mononeuritis multiplex). Diagnosis is made by clinical suspicion, laboratory testing for antibodies to cytoplasmic antigens (C-ANCA) and proteinase (PR3), and confirmed by tissue biopsy. Mortality in untreated Wegener’s Granulomatosis is high and standard treatment involves cyclophosphamide and corticosteroids. The sequelae of the disease process and treatment can leave patients with impairments in ADL’s. Conclusions: Early physiatric intervention in patients with Wegener’s Granulomatosis can upgrade self-care ADL’s by focusing on joint protection techniques, special adaptive devices, pain control, and reconditioning. The physiatrist’s knowledge of WG and other autoimmune diseases augment the rehabilitative effort.

POSTER BOARD 18: PANCOAST TUMOR: AN ATYPICAL PRESENTATION OF BREAST AND CHEST PAIN
CPT Arthur Jason De Luigi, DO, MAJ (P) Erik Dahl, MD

A 72-yr-old Asian female was referred for evaluation of low back pain. While obtaining the history related to her low back pain, the patient reported a 1-wk history of pain in her right breast radiating to her scapula without concomitant weakness or sensory changes. Review of symptoms and physical exam were unrevealing. Plain radiograph of the chest revealed a right upper lobe mass. CT/MRI confirmed a mass extending into the brachial plexus. The patient was diagnosed with a Pancoast tumor. An electrodiagnostic evaluation revealed a lower trunk brachial plexopathy. The patient’s symptoms resolved after treatment with chemotherapy and radiation therapy. Although Pancoast Tumors are rare among lung cancers, they are recognized as the most common metastatic malignancy involving the brachial plexus. Ninety percent present with shoulder pain and most note sensory changes in the medial upper extremity and axilla with weakness in the muscles of the lower trunk of the brachial plexus. However, an atypical presentation of chest pain without neurologic signs can occur, as seen in this patient. The dermatomal distribution of the upper thoracic nerve roots per anatominists is variable. T1 is localized to the upper arm without innervation to the skin of the axilla or chest, whereas other dermatomal depictions demonstrate that T1 predominantly affects the upper chest. Therefore, any physician confronted with a patient with this complaint should be cognizant of these anatomic variations and be suspicious of a process involving the upper thoracic nerve roots or the lower trunk or the brachial plexus.

POSTER BOARD 19: CASE REPORT: STIFF-PERSON SYNDROME: FUNCTIONAL IMPROVEMENT WITH PHYSICAL AND OCCUPATIONAL THERAPY
Tanya Weissman, MD, Lei Lin, MD, PhD, Sara Cucurullo, MD, Thomas Strax, MD, Krishna Urs, MD

Stiff-Person syndrome is a rare and disabling disorder of the central nervous system. It is characterized by muscular rigidity and episodic spasms of the axial and limb musculature. Axial musculature is typical and most severely involved. The stiffness eventually leads to contractions of the affected joints that may result in inability to ambulate and severely decreased ADLs. We report a 49 yr old Jamaican female who was diagnosed with Stiff-Person syndrome two years ago based on clinical examination, EMG findings of continuous activity MUAP in a normal pattern that cannot be silenced by contraction of antagonist muscle. In addition the patient had elevated anti-GABA antibodies with resulting deficiency of GABA which may play a role in the pathophysiology of the disease. She presented to us after a prolonged hospitalization with uncontrollable stiffness and painful back and total body spasms lasting up to 10 min at a time. She could not walk, stand or sit in a chair due to severe spasms, weakness and orthostatic hypotension. The patient underwent a 2 wk course of intense rehabilitation directed at a “unique” approach addressing axial and limb stiffness via modification of exercises based on specific patient needs including incorporation of daily use of stretcher chair was to increase sitting tolerance. Upon discharge the patient was able to sit in a chair for up to 4 hr a day and required less assistance with her ADL’s. The number of her spasms and overall stiffness had improved. This unique case report will discuss the role of the physiatrist in addressing all the functional issues of rehabilitation in Stiff-Person Syndrome. Specifics about how this was accomplished will be elaborated. Emphasis will be placed on intervening early in this mysterious disease to maximize functionality.

POSTER BOARD 20: ULTRASOUND EVALUATION OF THE MEDIAN NERVE BEFORE AND AFTER INTENSE WHEELCHAIR ACTIVITY
Heather Walker, MD, Michael Boninger, MD, Brad Impink, Andrew Malkievicz, Rory Cooper PhD

The prevalence of Carpal tunnel Syndrome is between 49 and 73% in the population of wheelchair (WC) users. This high prevalence is thought to be due to the repetitive work required for manual WC propulsion. We used ultrasound to investigate the effect of WC activity on the cross sectional area (CSA) of the median nerve in 18 male subjects participating in wheelchair sports. Ultrasound images were collected at the levels of the distal radius and pisiform on subjects’ nondominant arm before and upon completion WC basketball or quad rugby. Custom software, which blinded investigators to timing, was utilized to determine CSA, width, and height of the median nerve. A significant decrease in the mean CSA of the median nerve was seen following the sporting event (before: 10.23 ± 3.30 mm²; after: 9.57 ± 2.98 mm²; P = 0.007). A trend toward decreased height of the nerve following WC activity was also noted (P = 0.067). A previous ultrasound study showed increased CSA after a cutting activity. We believe that the decrease in CSA of the median nerve following WC activity was due to impact forces at the wrist during WC propulsion. Future studies are needed to further evaluate the relationship between WC activity and acute median nerve changes, and to investigate interventions that minimize this impact.

POSTER BOARD 21: A CASE OF CHRONIC PAROXYSMAL HEMICRANIA RESPONDING TO BOTULINUM TOXIN A
Albert C. Recio, MD, PT, Joanne Borg-Stein, MD

Botulinum toxin A represents a novel option for patients with chronic pain conditions. Recent case series and randomized, double-blind, placebo-controlled studies have demonstrated that botulinum toxin A is effective in migraine and tension type headaches. The use of botulinum toxin in the management of chronic paroxysmal hemicrania is not reported. We present a patient with chronic paroxysmal hemicrania who experienced substantial improvement of her headache with a documented increased in headache free days and improvement of her functional status. This case demonstrates that botulinum toxin type A should be considered in the treatment of chronic paroxysmal hemicrania.
Second year medical students at our institution participate in a patient-based short course. The 150 medical students divide into 30 groups of five students each. Each student is responsible for learning one aspect of the patient’s care from various experts, then teaching his or her classmates how that specialist is involved in patient care. The patient presented with a stroke with residual right hemiparesis and dysphagia. Physicians discussed medical complications and management of stroke patients. Those 30 students then rejoined their group of 5 and served as expert teachers on the field of Physical Medicine and Rehabilitation. A patient-based case in the preclinical years, with students serving as learners and teachers, can improve understanding of the role of specialists in patient care. It is an excellent opportunity to introduce students to the field of Physical Medicine and Rehabilitation in the preclinical years. Future plans include a similar course for first year medical students.

**POSTER BOARD 23: PHEOCHROMOCYTOMA PRESENTING AS A STROKE: A CASE REPORT**
Montserrat Torne-Perez, Nemesio Herrera

Disclosure: None.

Setting: Adult rehabilitation unit.

Patient: 47 yr-old male with right hemiparesis and dysarthria.

Case Presentation: 47 yr-old male who presented to the hospital with sudden onset of right hemiparesis and dysarthria. Initial head CT scan and MRI revealed a left basal ganglia intraparenchymal hemorrhage. His blood pressure upon admission was 115/80. Angiogram was normal. Patient was admitted to our rehabilitation unit after stabilization. His past medical history was unremarkable except for 5–6 yr history of non treated episodic anxiety attacks.

Assessment/Results: Physical examination was significant for right-sided weakness (upper extremity of 2/5 and lower extremity of 5/5) and bilateral Babinski. Patient was wheelchair bound and successfully completed his inpatient rehabilitation without further events.

Discussion: A Pheochromocytoma is a rare tumor arising from the chromaffin tissue. Diagnosis is important because in most cases resection of the tumor is curative. To our knowledge, two other cases have been reported in pediatric population presenting with hemorrhagic stroke. Pheochromocytoma presents as a stroke in 10% of cases. Pheochromocytoma is a relatively new, minimally invasive, treatment of compression fractures. It consists of injecting methyl methacrylate cement into a fractured vertebrae. Originally, a bilateral percutaneous transpedicular approach for the placement of the vertebroplasty introducer has been described. This technique can be very demanding and places the nerve root and spinal cord at risk of injury. Single-track postero-lateral approach is a new even less invasive technique for insertion of the vertebroplasty introducers, which provides bilateral spread of cement inside of a fractured vertebral body. We present a case of a patient with intractable spinal pain secondary to lumbar spine pathologic fractures as a result of multiple metastatic lesions, who failed conservative management. Successful pain management was achieved using a single-track, postero-lateral percutaneous vertebroplasty at two levels.

Conclusions: Transpedicular vertebroplasty is reported to be effective route for delivery of methyl methacrylate into fractured vertebral bodies.

**POSTER BOARD 24: POSTEROLATERAL PERCUtANEous VERtEBROplASTY for treatment of intractABLE BACK pAIN in a PATIENT WITH METASTATIC CANCER**
Ghada Hanna, MD, Abraham Jack Kabazie, MD, Rick Pellant, DO, Nader F. H. Abdel Massieh, MD

Introduction: Metastasis to the lumbar spine is a common cause of pathologic compression fractures in patients with advanced cancer. Severe back pain can preclude ambulation of already debilitated patient. The natural course of fracture consolidation can take months. Treatment options in this situation might be very limited. Percutaneous vertebroplasty is a relatively new, minimally invasive, treatment of compression fractures. It consists of injecting methyl methacrylate cement into a fractured vertebral body. Originally, a bilateral percutaneous transpedicular approach for the placement of the vertebroplasty introducer has been described. This technique can be very demanding and places the nerve root and spinal cord at risk of injury. Single-track postero-lateral approach is a new even less invasive technique for insertion of the vertebroplasty introducers, which provides bilateral spread of cement inside of a fractured vertebral body. We present a case of a patient with intractable spinal pain secondary to lumbar spine pathologic fractures as a result of multiple metastatic lesions, who failed conservative management. Successful pain management was achieved using a single-track, postero-lateral percutaneous vertebroplasty at two levels.

Conclusions: Transpedicular vertebroplasty is reported to be effective route for delivery of methyl methacrylate into fractured vertebral bodies.

**POSTER BOARD 25: WITHDRAWN**

**POSTER BOARD 26: PROXIMAL UPPER EXTREMITy MOTOR NERVE CONDUCTION USING SURFACE ELECTRODES: RECORDINGS FROM THE SUPRASPINATUS, INFRASPINATUS, DELTOID, AND BICEPS**
Erika R. Cottrell, MD, Ralph M. Buschbacher, MD, Jason K. Sorg, James M. Lohman

Proximal nerve conduction studies are performed infrequently, but can be useful in diagnosing proximal lesions, such as isolated neuropathies of the supraspinal, myocutaneous, and axillary nerves. Normal values have been derived for these studies but have some limitations. Kreaford obtained a large database but did not derive side-to-side comparisons. Gassel described normal latencies but did not include amplitudes. Both authors recorded with needle electrodes for the suprascapular nerve, which is useful in deriving latency but not amplitude. Casazza and Clark suggested that superficial recordings can be done on the supraspinatus and infraspinatus muscles. The deltoid and biceps are commonly studied with superficial electrodes. This study’s purpose was to obtain normals for surface recordings of the supraspinal, myocutaneous, and axillary nerves. Data were collected for latency, amplitude, duration, and area, including side-to-side comparisons. The effects of age, race, sex, height, and BMI were also studied. After obtaining informed consent, 100 subjects were enrolled. For the suprascapular and myocutaneous nerves, height affected latency, with increasing height leading to greater latency. For the axillary nerve, increased BMI correlated with decreased amplitude. Gender affected the amplitude of these 3 nerves, with males greater than females for biceps and deltoid, and males less than females for infraspinatus. The upper limit of normal (ULN) latency for subjects ≤160 cm was 4.1, 3.7, and 4.8 ms, and for those 170 cm ≥160 cm was 5.3, 5.3, and 5.5 ms for infraspinatus, supraspinatus, and deltoid respectively. Latency to the biceps for subjects <160 cm was 5.3, 160–170 cm was 5.6, and 170 cm was 5.8 ms. The ULN for side-to-side latency differences were 0.4, 0.5, and 0.4 ms for infraspinatus, supraspinatus, and deltoid respectively. Latency to the biceps for subjects <160 cm was 5.3, 160–170 cm was 5.6, and 170 cm was 5.8 ms. The ULN for side-to-side latency differences were 0.4, 0.5, and 0.4 ms for infraspinatus, supraspinatus, and deltoid respectively.
POSTER BOARD 27: COMPARISON OF THE RED AND NEAR-INFRARED LASERS IN NON-INVASIVE MEASUREMENT OF SKIN BLOOD FLOW IN THE LOWER EXTREMITY

Charles F. Kunkel, MD, MS, Claudio M. Carvalho, DO, MS, Milena D. Zirovich, Oscar U. Scremin, MD, PhD, Stephen F. Figoni, PhD

Objective: Report normal flux ratio values of skin blood flow in healthy subjects using the Laser Doppler Imager (LDI), and determine differences between red and near-infrared lasers. Methods: Cross-sectional study measuring flux with LDI in sixty subjects across three age groups. Ten sites on the leg and foot were warmed to 44°C until transcutaneous (Tc)PO2 reached steady-state. One heated and three unheated area sites were scanned with the LDI. Flux values were measured using red (l = 633nm) and near-infrared lasers (l = 830nm). Subjects: Convenience sample of sixty subjects consisting of healthy men (n = 26) and women (n = 34) from three, equal sized age groups: 20–39, 40–59, and 60–80. Results: Red laser mean flux ± SE values were 52.3 ± 1.4 at the unheated areas and 337.3 ± 5.5 at the heated areas with a mean flux ratio of 8.0 ± 0.1. Near-infrared laser mean flux ± SE values were 41.2 ± 1.4 at the unheated areas and 294.5 ± 5.6 at the heated areas with a flux ratio of 8.4 ± 0.1. Comparison of mean flux ratios for both laser wave-lengths showed small but statistically significant differences between lasers, although absolute differences were not large. Conclusions: Values in this study provide a normal reference range for identifying patients at risk for dermal ischemia and can be used to estimate healing potential for wounds and amputation sites. Consistent differences found comparing red and near-infrared wave-length lasers may indicate that either of the lasers are clinically acceptable if compared with respective normative values.

POSTER BOARD 28: EFFECTS OF AGE, GENDER AND LOCATION ON SKIN BLOOD FLOW IN THE LOWER EXTREMITY USING THE LASER DOPPLER IMAGER

A.M. Erika Scremin, MD, Hyung S. Kim, MD, Resa L. Oshiro, Jana M. Baumgarten

Objective: Determine differences in skin blood flow after thermal challenge by age, gender and location using a Laser Doppler Imager (LDI). Study Design: Perfusion units (Flux) were measured at 10 predetermined sites in the foot and calf after warming with a probe set at 44°C. Heated and corresponding unheated sites were scanned with red (l = 633nm) and near-infrared lasers (l = 830nm). Subjects: Convenience sample of sixty subjects consisting of healthy men (n = 26) and women (n = 34) from three, equal sized age groups: 20–39, 40–59, and 60–80. Results: There were no significant differences in mean flux ratios among age groups (P = 0.12). There was no significant variation among sites in comparison to gender (P = 0.24). Mean flux ratio for all regions pooled ± SE values for the red laser in males and females were 7.8 ± 0.2 and 8.2 ± 0.2 respectively. Mean flux ratio ± SE values for the near-infrared laser in males and females were 8.2 ± 0.2 and 8.6 ± 0.2 respectively. Plantar foot sites demonstrated lower mean flux ratios ± SE for red (4.9 ± 2.6) and near-infrared (5.3 ± 2.5) lasers, as compared with red (9.0 ± 3.5) and near-infrared (9.7 ± 3.3) lasers at the calf sites. Conclusions: LDI scanning demonstrated enhanced skin blood flow after heating. Age and gender did not affect flux measurements. However, plantar surface flux ratios were lower than those of calf sites.

POSTER BOARD 29: BEDRAIL COMPRESSION OF RADIAL NERVE

Christopher Castro, DO, Gerald Felsenthal, MD

Case Description: 78 yr-old female who presented with a 3 wk history of right arm weakness after she had been found by ancillary staff at an assisted-living facility with her arm hanging over a bedrail. The duration of compression is not known. Before this incident, the patient had good strength in her right arm. The day after the incident, the patient noticed weakness in her right arm, and noticed a wrist drop. On physical examination, the patient had a clinically obvious wrist drop and a linear skin abrasion over her proximal right medial arm. Motor: weakness of right deltoid, biceps, triceps, ECR, APB, and interossei. Sensation: difficult to assess. Reflexes: symmetric and present for biceps, brachioradialis, and triceps. Methods/Data: EMG of the right upper extremity was performed. Abnormalities: extensor carpi radialis muscle showed increased insertional activity, 3–4 + positive sharp waves, 3–4 fibrillation potentials, and a decreased summation pattern. The biceps brachii showed 3+ complex repetitive discharges. The first dorsal interosseous showed questionable 1+ sharp waves and a decreased summation pattern. Nerve conduction study was not performed because of family concerns about tolerating the procedure. Impression: Mononeuritis multiplex with most significant compression of radial nerve. Conclusions: Patients in assisted-living facilities or nursing homes who require bedrails as physical restraints are at risk of trapping an extremity against the bedrail. If not attended to in a timely manner, these patients can potentially develop a compression neuropathy of the affected extremity.

POSTER BOARD 30: WHEN A “RULE OUT STROKE” DIAGNOSIS IS CONFUSED WITH “SATURDAY NIGHT PALSY”: CASE REPORT AND DISCUSSION OF FINANCIAL RAMIFICATIONS

Cristin McKenna PhD, MD

Ms. M. is a 60-yr-old female patient with a history of hypertension and chronic liver disease who presented to the emergency room with a new onset of right wrist weakness. She was evaluated by emergency medicine physicians, and admitted to the medical service with an admitting diagnosis of “rule out TIA/CVA.” Neurology service was called on consultation to provide an initial description of the patient in communicating among different physicians was “right-sided weakness” and “rule out TIA/CVA.” A full stroke workup was initiated including CT of the head, MRI of the head with and without gadolinium, MRA of the head and neck, and carotid duplex scan. Physical examination by the admitting team led to suspicion that the patient had an isolated lesion of a peripheral nerve, namely the radial nerve. The clinical suspicion that this patient had a stroke was decreased by this physical examination yet the “full stroke workup” ultimately proceeded. As medical technology advances, the tests which can help to diagnose certain illnesses become more plentiful and expensive. Judicious use of these tests is sometimes difficult to institute once a presumptive diagnosis is made. In this case “rule out TIA/CVA” led to several expensive tests which were of limited diagnostic value for this patient. An examination of the appropriate workup for suspected stroke with attention to cost, and a discussion of radial nerve palsy are presented.

POSTER BOARD 31: DIFFUSE MOTOR NEUROPATHY: AN UNUSUAL PRESENTATION IN QUADRIPARESIS DUE TO CERVICAL HERNIATED NUCLEUS PULPOSUS (HNP)

Albert V. Retodo, MD, Paul Thananopavada, MD, Raymond Millan, MD, James Wells, MD

Patient: 39-yr-old male with history of cocaine abuse became quadripa- retic after a fall. He was brought to the emergency department and was hypertensive and quadriplegic. Extensive workup at an outside hospital revealed subacute basal ganglia white matter changes; cervical MRI showed C5-C6 lesion consistent with transverse myelitis or tumor. Lumbar puncture had slightly elevated protein and glucose. 2D echo was normal. Blood cultures were negative. All studies were by report and no images were available to us for 7 days after his transfer to the SCI unit from an outside hospital. Arriving at the SCI unit (9 days postevent), he had an initial diagnosis of transverse myelitis. The SCI team determined he had a C6 ASIA B SCI level. EMG/NCS studies done 2 days after admission (11 days after acute event) showed a severe generalized, subacute, incomplete motor neuropathy in all four limbs. EMG/NCS done 4 days later showed a bilateral acute C-6 radiculopathy with persistent signs of motor neuroopathy below the level of injury. Upon receiving his initial MRI, a clearly evident C5-C6 HNP with cord compression and cord edema was seen. Neurosurgery did a C5-C6 anterior cervical disectomy and fusion. Upon return to rehabilitation, 5 days postoperatively, he showed improved function at the C6 ASIA C level. Discussion: This case involves unusual electrodiagnostic presentation consistent with motor neuroopathy in a case of acute cervical HNP with severe cord edema. Subsequent electrodiagnostic testing revealed the evolution of his acute process. Fasciculations and other unusual spon- taneous activity can be seen many levels below an injury causing a myelopathy. The electromyographer must be aware of the diverse con- ditions that can cause findings consistent with neuroopathy and provide...
appropriate and timely follow up studies to better elucidate the condition as it evolves and not be misled by radiologic reports that are not accompanied by images.

**POSTER BOARD 32: EFFECT OF CONTINUOUS INTRATHecal BACLOFEN ON SCOLIOSIS IN SKELETALLY IMMATURE INDIVIDUALS WITH CEREBRAL PALSY**

Linda E. Krach, MD, Kevin Walker, MD, Lane Rapp, Steven E. Koop, MD

Objective: Evaluate the relationship between scoliosis and the use of intrathecal baclofen (ITB) in skeletally immature subjects with cerebral palsy. Subjects: Participants were identified from a consecutive series, who had undergone implantation of ITB pumps. 112 individuals (48 females and 64 males) had greater than 1.5 yr follow-up, adequate radiographic follow-up and a diagnosis of CP. Methods: Retrospective chart, database, and radiographic reviews. Radiographs were measured before pump implantation and at six monthly intervals postoperatively, until most recent follow-up. Radiographs were measured for presence of spinal curvature, pattern of curvature, Cobb angle, and pelvic obliquity. Main Results: Mean age at implant was 8.76. 54.5% were GMFCS level 5, 25.3% level 4, 17.0% level 2 and 1.8% level 1. 52.0% had no scoliosis before implant, 28.4% curve of <20 degrees, 18.6% curve of 20-70 degrees and 1%70 degrees. For presence or absence of a curve, age at implant approached significance (P = 0.056). Mean GMFCS level increased as severity of curve increased (P < 0.001). After median follow-up of 3.9 yr (range 1.5-9.5), the number with scoliosis had increased, 14.3% had no scoliosis. Lumbar curves increased postimplant. Thoracolumbar double curves increased from 10.8% preimplant to 27.7% postimplant. Conclusions: Progression of scoliosis was noted after initiation of ITB. This is not surprising however, as these individuals were relatively severely involved and tended to be implanted before their adolescent growth spurts. Our findings are consistent with previous reports that indicated 60-80% of individuals with spastic quadriplegia develop scoliosis. The number of lumbar curves increased.

**POSTER BOARD 33: NEPHROGENIC FIBROSING DERMOPATHY (NFD), A NEWLY DESCRIBED CONDITION: CHALLENGES IN THE REHABILITATION OF THIS CONDITION: A CASE REPORT**

Mark J. Harris MD, MPH, Erwin Manalo, MD, James D. Wells, MD, MPH, Clinton Faulk, MD

Case: 39-yr-old woman admitted to the nephrology service 2 wk before her transfer to the rehabilitation service due to a 6-wk history of bilateral distal extremity pain with the development of hard patches in her skin which generalized throughout her extremities and trunk. This “hardness” worsened the patient difficulty with ambulation, transfers and activities of daily living (ADLs). Extensive medical workup revealed the presence of NFD and excluded scleroderma and like conditions. At transfer to Rehabilitation she was debilitated and contracted through many joints due to NFD. Her medical history was significant for diabetes-hemodialysis-dependant, gastroesophageal reflux disease, gastroparesis, and distal sensory polyneuropathy. The features of NFD, a condition associated with renal failure and hemodialysis, include progressive thickening of skin and subcutaneous tissues throughout the body, in extremities and trunk, with limited joint ranges in more severe cases, as in this patient. Restricted range of motion in many joints complicated her rehabilitation process. The patient was unable stand erect owing to lack of range of motion, most notable in the knees, ankles and hips. Passive range of motion in the same joints was severely limited, although muscle strength was relatively preserved. The patient had severe distal polyneuropathy on physical exam. However, nerve conduction studies were not done due to markedly thickened skin. After 20 days in the rehabilitation hospital, she progressed in independence, though she remained nonambulatory, with mobility at the wheelchair level and with many other limitations of transfers and ADLs. Conclusions: Rehabilitation of patients with cutaneous and dermal thickening due to NFD differs significantly from the general population in that adequate range of motion for independence may not be gained by discharge. Furthermore, a multidisciplinary approach including other specialties must be used and will add value for treatment options and management of this rare and disabling condition.

**POSTER BOARD 34: CLUSTER AND MATCHING ANALYSIS TO DETERMINE THE SIMILARITY OF COMMUNITY INTEGRATION PROGRAMS FOR PEOPLE WITH BRAIN INJURY**

Mel B. Glenn, MD, Richard Goldstein, PhD, Elizabeth A. Selleck, MPH, Michelle Rotman, BS

Background: No studies are available comparing the outcomes of outpatient community integration programs for people with brain injury with respect to program characteristics that might be responsible for differences in client outcome. Objective: To determine which community integration programs, surveyed with respect to a number of characteristics (e.g., staff-to-client ratio, program intensity, time spent in the community), are similar enough to allow assessment of the influence of one or two characteristics on program outcome. The ideal situation would be for programs to match on seven of eight key characteristics. Design: Cluster and matching analyses. Results: Questionnaires surveying a number of program and client characteristics were completed for 49 facility-based outpatient community integration programs. Eight key characteristics most likely to influence client outcome were chosen. Cluster analysis was used to determine which programs were closest with respect to these characteristics. Among those programs, there were at least three clinically relevant differences between any two programs in the eight characteristics compared. On a separate matching analysis, no two programs matched on seven or eight characteristics according to predetermined, clinically relevant matching criteria. Only two matched on six characteristics. Two groups of four programs each matched on five characteristics. Conclusions: The clusters or matched groups are not similar enough for use in planning a study comparing and contrasting programs using a limited regression (using other predictors of client outcome such as age and preinjury employment status). The results are disappointing from the point of view of one hoping to compare the outcomes of two programs, as no program was similar for seven of eight characteristics, which would have been the ideal situation for studying a single characteristic’s influence on outcome. Regression could be used to study programs matching on fewer than seven characteristics, but a larger number of subjects would be needed.

**POSTER BOARD 35: HYPOGONADISM AFTER INJURY: TOTAL SERUM TESTOSTERONE LEVELS RELATED TO TYPE OF TRAUMATIC INJURY**

Scott Swasey DO, Ebby Varghese MD, Michael Acuff, MD, Martin K. Childers, DO, PhD, Laura Schopp, PhD

Objective: Test the hypothesis that total serum testosterone (TST) levels are lower in traumatic brain injured (TBI) patients than nonbrain-injured, multi-trauma (MT) patients. Design: Retrospective review. Setting: Inpatient rehabilitation center. Participants: 85 consecutive males ages 18–66, MT (n = 50) with no documented brain injury vs. TBI (n = 35). Main Outcome Measures: TST levels, hemoglobin (Hgb) level, time of TST drawn, age, and time from injury. Results: With normal limits ranging from 247ng/dl - 800ng/dl, depending on age and time of day, the mean n(Hgb) with no documented brain injury 35. Main Outcome Measures: TST levels, hemoglobin (Hgb) level, time of TST drawn, age, and time from injury. Results: With normal limits ranging from 247ng/dl - 800ng/dl, depending on age and time of day, the mean and std. dev. for TST levels in the MT group were 138ng/dl and 95.4ng/dl respectively. The mean and std. dev. for TST levels in the TBI group were 213ng/dl and 118.0ng/dl respectively. A comparison of TST levels, while controlling for age, demonstrated the TBI group had significantly higher (P < 0.01) TST levels than the MT group. There was no correlation between age or time since injury and TST levels in either group. Conclusions: Data do not support the hypothesis that TBI patients have lower TST levels than nonbrain injured MT patients. Our findings are surprising and may suggest TST secretion might be affected by generalized trauma to a greater extent than disruption of the hypothalamic-pituitary-gonadal axis.

**POSTER BOARD 36: REHABILITATION ISSUES IN OCULOPHARYNGEAL MUSCULAR DYSTROPHY**

Katarzyna Machlarz, MD, Shailendra Hajela, Jeffrey Nissinson

Oculopharyngeal muscular dystrophy (OPMD) is an adult onset disease with worldwide distribution. It usually presents in the fifth or sixth decade with progressive bilateral ptosis, dysphagia and, less frequently, with proximal limb weakness later in the disease. OPMD is usually transmitted as an autosomal dominant trait but a rare autosomal recessive form has also been described. Case Report: We present a case of a
forty-five year old female with OPMD who was admitted to an acute rehabilitation facility with functional decline following aspiration pneumonia. Discussion: OPMD presents in adults with two cardinal symptoms, namely ptosis and dysphagia. Later, other extracocular and voluntary muscles can be affected (Brias, 2005). Dysphagia presents in OPMD due to decreased pharyngeal peristalsis and impaired relaxation of the cricopharyngeus muscle. Initially this is treated with modification of food texture and compensatory swallowing strategies. Later, surgical intervention in the form of cricopharyngeal myotomy or upper esophageal dilation is done. PEG placement is done as a last resort to maintain nutritional status. Aspiration pneumonia is a recognized complication in these patients. Early ptosis is managed with visual compensatory techniques. When it becomes incapacitating, blepharoplasty is indicated. Upper extremity weakness is managed with ADL training and strengthening exercises. Weight bearing exercises and light-weight orthoses, to assist with ambulation and to reduce contractures, should be instituted early for lower extremity involvement. The exercise program should be modified to avoid muscle fatigue and repetitive stress injuries. Vocational issues may need to be addressed. Life expectancy is normal in these patients.

POSTER BOARD 37: NEUROSARCOIDOSIS: A CASE REPORT

G.J. David MD, U.Tandra MD

Setting: Acute Inpatient Rehabilitation. Patient: 34-year-old male with functional impairment secondary to Neurosarcoidosis. Case Description: The patient presented with one week history of ataxia, incontinence of bowel and bladder, dizziness and headache. He was found to have paresis, cognitive impairment. MRI of head and spine revealed communicating hydrocephalus, extensive leptomeningeal involvement with nodular enhancements, abnormal signal of most of the thoracic and cervical cord and the nerve roots of cauda equina. Chest CT revealed bilateral lymphadenopathy. Biopsy of meninges confirmed the diagnosis of Neurosarcoidosis. Ventriculoperitoneal shunt was placed and steroid therapy was initiated. He received three weeks of acute rehabilitation and was discharged home with the level of intermittent daily supervision for coginition, supervision for ambulation, and contact guard assistance to close supervision for activities of daily living. Discussion: Neurosarcoidosis is an uncommon but severe, sometimes life threatening manifestation of sarcoidosis, which is a disease of unknown etiology. The present evidence suggests active sarcoidosis results form exaggerated cellular immune response to either foreign or self-antigens. Sarcoidosis occurs in approximately 30 per 100,000 in the U.S. The frequency of neurological involvement is generally 5%. The frequency is thought to be an under-estimate due to the silent manifestation of the disease and unavailability of tissue diagnosis in all cases. The presentation of the disease varies from symptoms of mononeuropathy and peripheral nerve involvement to central nervous system involvement that can cause significant functional impairment. Conclusion: Neurosarcoidosis resembles many diseases ranging from CIDP and Multiple sclerosis to Myositis and autoimmune diseases. An increasing awareness of this condition is important in the practice of rehabilitation to adequately diagnose, treat, and promote functional independence of the individual. Key Words: Neurosarcoidosis, Rehabilitation; Sarcoidosis; Immune response.

POSTER BOARD 38: STRIDOR IN THE STROKE PATIENT: AN URGENT CASE OF ACUTE GOITER

Krishna D. Parameswar, MD, Theresa M. McCarthy, DO

Acute stridor is rare in the Rehabilitation setting, with respiratory distress in a stroke patient usually attributed to aspiration or infection. Goiter induced stridor has occasionally been reported in the emergency room literature where ENT or anesthesiology is called to preserve the airway. This case report examines an 84-year-old female who developed acute stridor with respiratory distress due to a goiter-obstructed airway. Case Description: An 84-year-old female was admitted to the acute rehabilitation unit with right hemiplegia, expressive aphasia and dysphagia with extensive drooling and starvation feeding aversion. She was actively participating in therapies and had started consuming a pureed diet with thickened liquids. During her fourth week of therapies, she developed unexpected wheezing with a loud stridor. She denied any chest pain or shortness of breath. Her respiratory rate was 24, pulse 100, oxygen saturation 97%, and she had scattered rhonchi with an inspiratory wheeze. Despite medical nebulizers and oxygen, the stridor continued. A/P and Lateral x-rays of the neck showed soft tissue enlargement and tracheal narrowing in the oropharynx. A CT of the neck revealed an enlarged and irregular left thyroid lobe, an inhomogeneous right lobe and tracheal deviation from left to right. She was transferred to the intensive care unit for medical management and oxygen therapy. She was intubated. Since surgical or medical intervention. Although rare, goiter must be considered in the differential diagnosis for any acute airway obstruction.

POSTER BOARD 39: THE RELATIONSHIP OF INTERNAL TOPOGRAPHY OF PERONEAL NERVE AT THE FIBULAR HEAD AND ELECTRODIAGNOSTIC FINDINGS

Tae-Du Jung, MD, Je-Ho Kim, MD, Sun-Kun Chung, MD, Tai-Ryoon Han, MD

Objective: Although peroneal nerve at the fibular head is one of the most common nerve which can be easily entraped, there are rarely studies which evaluated both anatomy of peroneal nerve and electrodiagnostic findings. Therefore we would like to find the relationship of internal topography of peroneal nerve and electrodiagnostic findings. Method: Six limbs of 3 cadavers are evaluated to know how the peroneal nerve is innervating the muscles of lower extremity. We observed the fibular tunnel and extracted the peroneal nerve at that point. We stained it with hematoxylin and eosin to observe the observed internal topography of peroneal nerve with microscopy. Additionally we compared it with electrodagnostic findings of 24 patients with peroneal neuropathy. Results: In cadaver dissection, we observed that peroneal nerve has many nerve fascicles and is innervating the muscles of lower extremity with a rule. We also observed it with microscopy. Superficial peroneal nerve (SPN) is located most laterally. Deep peroneal nerves (DPN) to extensor digitorum longus (EDL), extensor hallucis longus (EHL), extensor digitorum brevis (EDB), tibialis longus (TA) are in order from laterally to medially. In electrodiagnostic studies of 24 patients, 3 nerve fascicles of SPN, DPN to EDB, TA are evaluated. 16 patients are common peroneal neuropathy and 8 patients are deep peroneal neuropathy. In 22 limbs of the former, the abnormalities of SPN, DPN to EDB, TA are 22, 22, 22 in order at nerve conduction study (NCS) and 22, 21, 17 in order at electromyographic study (EMG) respectively. In 11 limbs of the latter, the abnormalities of DPN to EDB, TA are 10, 2 in order at NCS and 11, 11 in order at EMG respectively. Conclusions: We observed SPN, DPN to EDB, EHL, EDB, TA are in order from laterally to medially. We can find there is the relationship of internal topography at the fibular head and electrodiagnostic findings in peroneal nerve.

POSTER BOARD 40: EVALUATION OF SKIN ISCHEMIA BY TRANSCUTANEOUS OXYGEN AND LASER-DOPPLER IMAGING MEASUREMENTS

Stephen F. Figoni, PhD, RKT, Oscar U. Scremin, MD, PhD, A. M. Erika Scremin, MD, Charles F. Kunkel, MD, MS

Transcutaneous oxygen (Tc-P02) and laser-Doppler imaging (LDI) are two methods to assess perfusion of skin in ischemic extremities in patients with peripheral vascular disease. The purpose of the study was to assess relationships between Tc-P02 and LDI flux in subjects with severe leg ischemia and age-matched normal controls. The subjects were a convenience sample of 34 adult males with severe leg ischemia (n = 18) and healthy age-matched controls (n = 16). Five predetermined leg skin sites were heated to determine values of Tc-P02 and skin perfusion. Mean LDI flux and corresponding ratios and differences were recorded and paired to Tc-P02 values obtained at the same sites. Factorial ANOVA and post hoc contrasts were used to compare variables between ischemic and control groups and among the five sites. Regression of Tc-P02 on LDI flux were separately performed for each location in both groups. LDI flux in nonheated areas did not differ significantly (p = 0.05) between groups. In contrast, LDI flux of heated areas, as well as the ratios and differences between heated and nonheated areas within sites, were significantly lower (p < 0.05) in the ischemic group. Regression coefficients of Tc-P02 on LDI flux of heated areas were significantly different from zero for all sites in the ischemic group, but not in the control group. Failure of Tc-P02 to correlate with LDI flux in the control group suggests that it does not estimate skin perfusion in healthy skin. In addition, the wide range of Tc-P02 values
observed at given levels of LDI flux in normal and ischemic regions raises questions about the accuracy of clinical estimates of perfusion using this method. LDI may reliably detect ischemia only when skin perfusion is enhanced by local heating.

**POSTER BOARD 41:** CAN ETHICS BE TAUGHT? DEVELOPING A CREATIVE CURRICULUM FOR A PM&R RESIDENCY PROGRAM

Matthew G Hodges, DO, Mary Ann Miknevich, MD, Leesa DiBartola, PhD, and Ellen Mustovic, MD

Caring for patients is a complex task involving ethical influences such as autonomy, systems dynamics, and financial consideration. The ACGME established ethics, including ethics, as a core competency. Education literature supports that lecture alone is not the most effective way to learn new skills and competencies. Given these considerations, the question arises: How can we best prepare residents to manage ethical issues in a competent and compassionate manner? This residency program implemented a creative curriculum for teaching ethics. Method: We created a multidimensional curriculum to engage residents in interactive learning experiences specific to ethics. Teaching methods included: 1) interactive sessions with a medical educator, 2) interactive learning with residents and ethics students, and 3) retreats on medical ethics. Interactive sessions, delivered by cases, experiential exercises, debate, and standardized patient interviews, included topics of communication, abuse, end of life, managing mistakes, and cultural competence. The ethics students met with residents on the rehabilitation unit, participated in patient rounds, team meetings, and presented cases. The retreat included experiential team building and cultural competence exercises, and discussion of ethics and professionalism. Results: Residents reported a heightened awareness of ethics as a direct result of this integrated educational approach. Involving professionals from backgrounds in ethics and medical education provided a creative way to offer an enriched learning experience with strong clinical relevance. Evaluation includes: resident self-evaluation, patient survey, standardized patient interviews, and the 360-degree assessment instrument. Conclusions: Creative and integrated education provides a more comprehensive and longitudinal approach to the teaching and learning about medical ethics.

**POSTER BOARD 42:** BILATERAL DORSAL ULNAR CUTANEOUS HANDCUFF NEUROPATHY: A CASE REPORT

Sanjeev Agarwal, MD, MS, Krishna Lingala, MD, Lyn Weiss, MD

Setting: Outpatient Rehabilitation Unit. Patient or Program: 50 yr old male prisoner. Case Description: A 50-yr-old man was referred for NCS/EMG for bilateral burning pain, tingling and numbness on medial/dorsal aspect of forearm and 4th and 5th digits for 3 wk. Three weeks before electrodiagnostic study he was arrested and handcuffed by a policeman. He denied weakness. Assessment/Results: On physical examination no muscle weakness was found in the upper limbs. Biceps, brachioradialis, pronator teres, and triceps reflexes were 2+ and symmetric. A well delineated cutaneous sensory deficit was present over the medial one and half fingers bilaterally. Nerve conduction studies of the motor and sensory divisions of median, ulnar and dorsal cutaneous branch of ulnar nerve bilaterally were performed. No significant abnormalities were noted except a decreased amplitude of bilateral dorsal cutaneous branch of ulnar nerve with normal conduction velocities. Discussion: Handcuff applications may result in compression of peripheral nerves at the wrist. Superficial radial handcuff neuropathy is the most common injury, although injuries to the median, ulnar, and multiple nerves have all been described. It is probably inevitable that any restraint procedure offering compression of peripheral nerves at the wrist. In clinical medicine, the pattern of weakness of facial muscles is used to make diagnostic decisions. As early as 1850, Robert Bentley Todd attempted to distinguish lesions in the brain from the peripheral nerves on the basis of the pattern of facial weakness when evaluating patients at the bedside. However, a review of the basic science literature indicates that commonly accepted explanations and significance of the pattern of facial weakness is not consistent with anatomical or physiologic studies. Historically, paralysis of facial muscles has been divided into “upper motor neuron injury” (UMN) and “lower motor neuron injury” (LMN). Patients who experience a stroke in the cortex or internal capsule have UMN injury and cannot close their eyelids or smile on command. They are, however, able to wrinkle their forehead, raise their eyebrows, and completely close their eyes. Patients with LMN injury, in addition to the aforementioned impairments cannot raise their eyebrow. Patients with Bell's Palsy may experience these LNM clinical deficits, although lesions in the brainstem at the level of the facial nucleus may also cause similar findings. The classical explanations for these clinical findings are that the contralateral facial nucleus receives innervation from the cerebral cortex and the lower motor neurons receive unilateral innervation from the contralateral cerebral cortex. However, a review of the historical literature is not consistent with the explanation: Specifically, there is no direct anatomical evidence in human beings that the facial nucleus (upper or lower part) receives any innervation from the cortex. There is some evidence of supranuclear innervation in studies of four human subjects. Furthermore, several tracing studies in monkeys indicate that the upper facial nucleus receives very little cortical innervation from either the contralateral or unilateral cortex. In fact, in monkeys, the lower motor nucleus receives more cortical projections. Although the commonly accepted explanation for central facial weakness may provide a good framework for clinical discussion, it is not supported by the science.

**POSTER BOARD 43:** UPPER MOTOR NEURON VS. LOWER MOTOR NEURON FACIAL PALSY: DOES THE SCIENCE SUPPORT THE CLINICAL EXPLANATION?

William Andrew Graham, PhD, Ariana J. Vora, MD, Shanker Nesathurai, MD

In clinical medicine, the pattern of weakness of facial muscles is used to make diagnostic decisions. As early as 1850, Robert Bentley Todd attempted to distinguish lesions in the brain from the peripheral nerves on the basis of the pattern of facial weakness when evaluating patients at the bedside. However, a review of the basic science literature indicates that commonly accepted explanations and significance of the pattern of facial weakness is not consistent with anatomical or physiologic studies. Historically, paralysis of facial muscles has been divided into “upper motor neuron injury” (UMN) and “lower motor neuron injury” (LMN). Patients who experience a stroke in the cortex or internal capsule have UMN injury and cannot close their eyelids or smile on command. They are, however, able to wrinkle their forehead, raise their eyebrows, and completely close their eyes. Patients with LMN injury, in addition to the aforementioned impairments cannot raise their eyebrow. Patients with Bell's Palsy may experience these LNM clinical deficits, although lesions in the brainstem at the level of the facial nucleus may also cause similar findings. The classical explanations for these clinical findings are that the contralateral facial nucleus receives innervation from the cerebral cortex and the lower motor neurons receive unilateral innervation from the contralateral cerebral cortex. However, a review of the historical literature is not consistent with the explanation: Specifically, there is no direct anatomical evidence in human beings that the facial nucleus (upper or lower part) receives any innervation from the cortex. There is some evidence of supranuclear innervation in studies of four human subjects. Furthermore, several tracing studies in monkeys indicate that the upper facial nucleus receives very little cortical innervation from either the contralateral or unilateral cortex. In fact, in monkeys, the lower motor nucleus receives more cortical projections. Although the commonly accepted explanation for central facial weakness may provide a good framework for clinical discussion, it is not supported by the science.

**POSTER BOARD 44:** CASE REPORT: ELECTRODIAGNOSIS OF CRITICAL ILLNESS ASSOCIATED POLYNEUROPATHY AND MYOPATHY IN A POLYTRAUMA PATIENT: PITFALLS AND COMPLICATIONS IN THE DIAGNOSIS OF THESE COEXISTING ENTITIES

Scott S. Morioka, MD, Albert V. Retodo, MD, Hemal V. Mehta, MD, James D. Wells MD, MPH

A 48-yr-old man sustained closed traumatic brain, abdominal and thoracic viscera, skeletal and soft tissue injuries in a motorcycle crash. Multiple surgeries were required during the resuscitative period. His hospital stay was complicated by ventilator dependence with prolonged weaning (40 days), sepsis, malnutrition and surgical procedures. Electromyography (EMG) and nerve conduction studies (NCS) were requested to assess a finding of quadriparesis. Physical findings included impaired proprioception in both feet, areflexia, strength testing worse proximally in the arms and distally in the legs; prominent scar tissue over a right radial artery monitor site with a positive Tinel’s sign at that same location. Electrodagnostic findings showed: absent sensory nerve action potentials (SNAP) in legs, increased latency with low amplitude potentials in arms; compound muscle action potentials (CMAP) absent responses in legs, and slowed conduction velocities in arms. EMG in every extremity, distally and proximally, as well as lumbar and thoracic paraspinals, and the orbicularis oculi was done. Distal muscles of the lower extremities had abnormalities consistent with polyneuropathy, whereas proximal muscles were consistent with myopathy. Upper extremity muscles had findings consistent with predominant myopathy, as did the orbicularis oculi. The most distal muscles of the upper extremities had mixed findings of neuropathy and myopathy. The results of this study indicated: 1) severe generalized subacute axonal sensory and motor polyneuropathy; 2) a subacute moderately severe axonal and demyelinating sensory motor right median neuropathy at or about the wrist. Discussion: Although critical illness associated polyneuropathy and myopathy are well-recognized, to date it has been unusual to document both pathologies coexisting in a patient. In addition, this

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contraction. Further support for a protective role of dystrophin during muscle fiber preparations from GRMD and normal dogs incurred equivalent fiber preparations from GRMD and normal dogs, respectively. Our findings stretch the mean force deficit was 27.07% activated (pCa 4.5) and rapidly stretched.

Canine fibers to glycerol-detergent skinning solution to disrupt the sarcolemma. The sarcolemmal protein, dystrophin, is thought to provide protection from contraction-induced muscle damage. A canine model of inherited dystrophin deficiency, termed golden retriever muscular dystrophy (GRMD) allows for analysis of muscle tissue following experimental interventions. We previously demonstrated that compared with normal controls, GRMD dogs incur greater than normal muscle fiber damage following repeated eccentric muscle contractions. In the present study, we used detergent skinning to disrupt the sarcolemma and dystrophin complex, so that neither GRMD nor normal fiber preparations would contain any measurable dystrophin. Thus, we tested the alternative hypothesis that when maximally-activated and stretched, detergent-skinned fiber preparations from GRMD and normal dogs incur equivalent amounts of damage as measured by the loss of isometric force (force deficit). Methods: We treated both GRMD (n = 22) and normal (n = 18) canine fibers to glycerol-detergent skinning solution to disrupt the sarcolemma. Skinned fibers from GRMD and normal dogs were calcium-activated (pCa 4.5) and rapidly stretched. Results: After a single 30% stretch the mean force deficit was 27.07% ± 3.9% and 29.7% ± 4.8% in fiber preparations from GRMD and normal dogs, respectively. Our findings support the hypothesis that activated stretched fibers show less dystrophin damage from GRMD and normal dogs incur equivalent amounts of damage as measured by force deficit. These data provide further support for a protective role of dystrophin during muscle contraction.

Guillain-Barre syndrome (GBS) is a disorder in which the body’s immune system attacks part of the peripheral nervous system. Although the exact pathophysiology of this syndrome is yet to be fully elucidated, it has been noted that many cases begin after a viral or bacterial infection. However, recently there have been some case reports associating malignancies such as Hodgkin’s lymphoma, small cell lung cancer, breast cancer, renal cell carcinoma, and adenocarcinoma of gall bladder with GBS. Both GBS and neurologic paraneoplastic syndromes are likely to have an immunologic basis. We would like to report a case of GBS possibly associated with nonsmall lung cancer. 71-year-old man presented with 2-week history of rapidly progressive bilateral lower extremity weakness. He was admitted to the local hospital and diagnosis of GBS was made based on results of nerve conduction studies and CSF analysis. On admission, a chest radiograph was obtained which showed evidence of right basilar consolidation and a cavity lesion in right mid lung zone. After admission, he experienced worsening of the lower extremity weakness and started to experience some mild respiratory difficulties. Chest CT scan and PET scans confirmed the right basilar lung nodule, and also showed hypermetabolic foci in the left sacrum and in the right axilla. The lung nodule was thought to have metastasized to the left sacrum and right axillary lymph node. The right axillary lymph node was biopsied, which showed a metastatic poorly differentiated and undifferentiated nonsmall cell carcinoma with focal squamous features. Serum Anti Yo and antineuronal antibodies (Anti Hu) were negative but serum Campylobacter Jejunii Ab was positive. The patient received two, 5 day-courses of intravenous immunoglobulin therapies with minimal benefits and was subsequently transferred to acute rehabilitation.

Polymyositis is an idiopathic inflammatory myopathy manifested by proximal muscle weakness, elevated CPK, myopathic and neuropathic changes including fibrillations and positive waves, as well as muscle biopsy evidence of inflammation. Although pulmonary involvement may occur at any time during the course of the disease, cardiac involvement is very rare. Patients with heart or lung involvement have higher morbidity and mortality. Early initiation of rehabilitative intervention improves prognosis. A 58 yr old African American female with past medical history significant for rheumatoid arthritis, presented to a local hospital with complaints of general fatigue, joint pain and myalgias. Elevated CPK was noted on her blood work and the patient was admitted for further work-up. EMG and muscle biopsy were performed which lead to the diagnosis of necrotizing polymyositis. The patient was treated with high dose steroids and IVIG. Hospital course was complicated by pneumonia, rhabdomyolysis, hepatitis and pericarditis. Echo revealed cardiac tamponade, which led to subsequent emergent pericardial window with drain placement. The patient also had bilateral pleural effusions and anasarca secondary to hepatitis. She was referred to us for rehabilitation more than a month later with severe proximal, greater than distal weakness. Initially her treatment course consisted of addressing issues of weakness, preventing contractions and cardiac and endurance issues. Strict cardiac precautions and monitoring were adhered to. The patient showed good clinical improvement. Upon discharge she was able to ambulate independently with bilateral AOFOs and was almost completely independent with her ADLs. This unique report will discuss the role of the physiatrist in addressing all the functional, as well as cardic rehabilitation issues of polymyositis. Specifics about how this was accomplished will be elaborated. Emphasis will be placed on intervening early in the disease process to improve outcome.
POSTER BOARD 49: A LONGITUDINAL ANALYSIS OF LIMITATIONS IN ACTIVITIES OF DAILY LIVING: DATA FROM THE MEDICARE CURRENT BENEFICIARY SURVEY

L. Chan, A. Shumway-Cook, K. Yorkston, M. Ciol, B. Dudgeon, J.M. Hoffman

Objective: Disablility can be transitory in nature with some older adults becoming disabled and then recovering. To better understand the dynamic nature of disability, we performed a longitudinal analysis of the elderly, assessing changes in their functional limitations over time. Methods: Retrospective cohort study using data from 28,588 respondents in the Medicare Current Beneficiary Survey, a yearly, in-person survey sponsored by Medicare. Each year, community dwelling respondents were asked questions regarding limitations in Activities of Daily Living (ADL). Data were collected between 1991–2001 and each respondent had at least three years of data. Respondents were categorized into groups based on their responses in the first two years: no disability (0 ADL limitations in year 1 and year 2), new disability (0 in year 1 and 1 or 2 in year 2), catastrophic disability (0 in year 1 and 3 in year 2), recovered (1 in year 1 and 0 in year 2), stable disability (1 in year 1 and the same in year 2), improving disability (2 in year 1 and decreased by at least 1 in year 2), and worsening disability (1 in year 1 and increased by at least 1 in year 2). Results: 39.5% of the patients had no disability, 7.1% were newly disabled, 1.3% were catastrophically disabled, 6.4% recovered from disability, 9.2% had stable disability, 9.8% had improvement, and 7.0% had worsening disability. Females and those of older age were more likely to be disabled. For those with improving disability, 38.1% recovered fully (0 ADLs) in year 3. For those who recovered in year 2, 68.1% maintained recovery in year 3. Conclusions: 40% of this population experienced ADL limitations within the first two years they were surveyed. However, this disability was dynamic in nature. A substantial percentage of people recovered and this improvement persisted.

POSTER BOARD 50: OMOVERTEBRAL BONE: A CURIOSITY SEEN WITH SPRENGEL DEFORMITY OF THE SCAPULA

Shailendra Hajela, MD, Eathar Saad, MD, Avital Fast, MD

Introduction: An omovertebral bone (OB), first described by Willett and Walsham in 1880, is present in 25–50% of patients with Sprengel deformity of the scapula. The OB is attached to the transverse and/or spinous processes of the lower cervical vertebrae and the medial scapula with either an osseous, synchondrosis or articular articulation. Case Report: A case of Klippel–Feil syndrome with Sprengel deformity of the scapula and an omovertebral bone, is presented. Discussion: An omovertebral bone is seen in 25–50% of patients with Sprengel deformity of the scapula. Willett and Walsham (1883) speculated that the omovertebral bone is a part of the scapula that fuses with the cervical spine secondarily. The OB is thought to be an abnormal development of the epiphysis at the vertebral border of the scapula, homologous to the suprascapular bone of the lower vertebrates such as frogs and thornback scates. Certain fish have structures resembling OB whereas amphibia have very large suprascapular bones. Suprascapular bones are not seen in mammals and reptiles. Large suprascapular extensions of the scapula, which overlie the vertebral column, in close proximity to the spinous processes, are seen in reptiles and early mammals. The Sprengal deformity with OB is commonly seen in females. It causes restriction of the suprascapular range of motion as well as a cosmetic problem due to the prominence of the superior medial angle of the scapula. OB is best visualized by 3-D CT scan. Surgical resection is commonly performed at a young age in symptomatic patients.

POSTER BOARD 51: THINKING OUTSIDE THE JOINT: COMPLEX REGIONAL PAIN SYNDROME OF THE KNEE.
A CASE REPORT

Monica J. Carrion - Jones, MD, Diana Turner, MD, Rick Pellant, MD, A. Jack Kabazie, MD

Objective: To encourage physicians to include Complex Regional Pain Syndrome (CRPS) in the differential diagnosis of isolated knee pain. Setting: Interventional pain clinic of an academically affiliated community hospital. Case description: A 22 y/o female presented with right knee pain after falling. A bone scan and MRI were normal. Symptomatic treatments included narcotic and TCA medication, physical therapy, and 2 arthroscopic surgeries. After 9 mo of persistent symptoms, reevaluation in the pain clinic revealed allodynia, hyperesthesia, and hyperalgesia, as well as decreased temperature and hyperpigmentation of the anterior knee. A QSART study was obtained, with abnormal findings of excessive sympathetic fiber activity. Assessment/Results: Based on IASP criteria, a diagnosis of CRPS Type I was made. The patient underwent two lumbar sympathetic blocks with minimal symptomatic relief; however, these were conducted 10 mo after the original injury. Discussion: The combined features of allodynia, hyperalgesia, skin discoloration and altered temperature in this case should alert the clinician to consider CRPS in the differential diagnosis of the patient’s symptoms. The lack of relief from the sympathetic blocks would not exclude the diagnosis if the syndrome was in the atrophic (late) stage. Conclusions: Although CRPS is an uncommon condition, and typically not associated with the knee, it is well worth consideration in unremitting extremity pain. If not diagnosed and treated at an early stage, CRPS can become progressively disabling. On the other hand, treatment within months of the first symptoms often results in remission. Key Words: Knee Pain, CRPS, Rehabilitation

POSTER BOARD 52: EXPERIENCE WITH DISABILITY, PERCEPTION OF DISABILITY AND ITS IMPORTANCE IN MEDICAL EDUCATION AND INTEREST IN PM&R: A SURVEY OF MEDICAL STUDENTS

Florence T. Wang, Alex Moroz, MD

Objective: The incidence of pathologies associated with the aging population has increased, including those that result in impairment, disability and handicaps. Little is known whether the new generation of physicians of the 21st Century is prepared to adapt to this phenomenon, much less of their perception of the need to be trained to work with the disabled. Our goal was to assess current medical students’: (1) degree of exposure to people with disabilities, (2) perception of the need to learn about working with such patients, and (3) perception of degree of formal education of caring for such patients. Results: Eighty-six of 300 medical students from one medical school responded to a standardized survey. Forty(47%) respondents reported they had no or little interaction with disabled people; 23(27%) respondents reported they had some; 23(27%) reported they had a lot of interaction with such patients. Eighteen(21%) did not feel comfortable working with disabled patients; 30(35%) felt somewhat comfortable; and 38(44%) felt more or definitely comfortable. In response to whether physical disability has an impact on one’s medical condition, 11(13%) felt it does not; 9(11%) felt it does somewhat; 7(8%) felt it definitely or greatly impacts one medically. When asked about comfort in assessing patients’ functional status, 49(57%) did not feel comfortable; 25(29%) felt somewhat comfortable; and 12(14%) definitely felt comfortable in assessing functional status. Seventy students (81%) felt they had received none or little exposure; 10(12%) felt they had received some; and 1(1%) felt they had definitely been educated. No student felt that learning about working with such patients was not beneficial; 7(8%) felt it was somewhat helpful; and 7(8%) felt it was definitely or greatly beneficial. When asked about the field of medicine which greatly deals with such patients or PM&R, 12(14%) did not or had little interest; 27(31%) were somewhat interested; and 47(55%) were definitely or greatly interested. Conclusions: While the majority of medical students surveyed (88%) felt that physical disability had an impact on one’s medical condition, most also felt they had little interaction with such patients. Additionally, 81% felt they had received little or no education about impairment, disability, or handicaps, and 86% felt uncomfortable assessing a patient’s functional status. The majority of students also reported feeling uncomfortable working with disabled patients. The fact that 92% felt that there is a need to learn about working with such patients and that more than half were interested in learning about PM&R may indicate inadequate response of medical education to the changing needs of society rather than the lack of interest in caring for disabled patients.
This study examined whether a regular conditioning exercise program 1) increase social activity, perceived quality-of-life, and physical activity; 2) decrease impairments, disability, handicap; 3) prevent medical complications. Design: The study was a quasi-experimental design with repeated measures. Four subjects were taught a home exercise conditioning program and had periodic visits for evaluation of the measured variables. Repeated measures were taken weekly for the first month then monthly for 3 mo and then again at 6 mo. Methodology: Subjects were living in the community with inclusion criteria: medical clearance from the primary physician, informed consent, residual hemiparesis or bilateral paresis, ability to ambulate with or without an assistive device, a minimum score of 24 on the mini-mental state exam, and discharge from any rehabilitation program at least 6 mo before beginning the study. Exclusion criteria were active congestive heart failure, severe peripheral vascular disease, chronic conditions that limit daily exercise, and significant dementia. The general conditioning home exercise program consisted of 1) a brief warm up stretching 2) a progressive low intensity walking program 3) strengthening exercises for the specific muscles that were identified as weak. Data collected during the study included 1) exercise tolerance using the 6 min walk, observational gait analysis, measurement of oxygen consumption (VO2), heart rate, blood pressure, and perceived exertion; 2) activities of daily living and social function using the FIM (FIM), Frenchay Activities Index, SF36, and the Quality of Life Scale; and 3) physical functioning as measured by trunk and extremity muscle strength, range of motion of involved joints, ambulation ability, muscle tone, and posture. Findings: The data were inconclusive with the small sample size, but the pilot study did identify challenges: difficulty with carryover, recurrent medical instability (hypertension, seizure), and varying compliance in home program. Interestingly, subject motivation and carryover, recurrent medical instability (hypertension, seizure), and varying sample size, but the pilot study did identify challenges: difficulty with carryover, recurrent medical instability (hypertension, seizure), and varying compliance in home program. These differences could not be accounted by age differences. The findings of this study showed that Hispanics patients showed the greatest FIM gain during inpatient rehabilitation for stroke. Also Hispanics and Caucasian with left side stroke had more FIM gain.

POSTER BOARD 55: ETHNIC DIFFERENCES IN FIM GAIN FOR INDIGENT PATIENTS UNDERGOING STROKE INPATIENT REHABILITATION
Moses J. Keng, MD, Daniel E. Graves, PhD, Kwai-Tung Chan, MD, Faye Y. Chiou-Tan, MD
Objective: To explore ethnic differences in FIM gain during rehabilitation following stroke. Design: Retrospective analysis of database. Setting: County hospital in large urban city. Participants: 171 sequential adult patients admitted to a stroke rehabilitation unit between 1/00 and 10/03. Main Outcome Measures: FIM and FIM gain. Results: 83 African American, 68 Hispanic and 20 Caucasian patients were included in the study. There was a statistical significant difference between the ethnicities and side of injury (F = 3.078, df = 6&300, P = 0.006). Admit FIM score for all ethnicities were higher for right side involvement than left side. FIM gain was higher for Hispanic (31.4 ± 2.1 SE) and Caucasian (28.4 ± 5.1 SE) with left side stroke but this was reverse for African American (18.9 ± 2.8 SE). When looking at type of stroke only FIM gain was significant (F = 3.165, df = 4&300, P = 0.014). Admission FIM score was lowest for Hispanics (56.1 ± 2.8). Significant difference was observed between Hispanics and African American (mean difference 11.2 ± 4.4 SE and P = 0.012). As for FIM gain, Hispanic and Caucasian gained more than did African American but the difference is significant only between Hispanic and African American (mean difference 5.02 + 2.5 SE and P = 0.045). These differences could not be accounted by age differences. Conclusions: The findings of this study showed that Hispanics patients showed the greatest FIM gain during inpatient rehabilitation for stroke. Also Hispanics and Caucasian with left side stroke had more FIM gain.

POSTER BOARD 56: COCCYDYNA SUCCESSFULLY TREATED WITH GANGLION IMPAR BLOCKS: A CASE SERIES
Charles J. Buttaci DO, PT, Patrick M. Foye, MD, Todd P. Stitik, MD
Objective: To determine the efficacy of fluoroscopically-guided ganglion Impar blocks in the management of coccydynia. Research Method: Case series reviewing the results from six patients encompassing 20 procedures for coccydynia. Intervention: Six patients between the ages of 28 and 76 yr were treated with fluoroscopically-guided ganglion Impar blocks to manage their coccyx pain after more conservative measures (including oral medications, donut cushions etc.) failed to provide adequate relief. The mechanisms of injury included falls, MVA’s, postpartum onset, and possible congenital anomalies, all without evidence of fracture. Each diagnosis of coccydynia was based on history, location of pain and response to previous diagnostic and therapeutic procedures. Discussion: The ganglion Impar (ganglion of Walther) is a solitary retroperitoneal sympathetic ganglion that represents the termination of the paired paravertebral sympathetic chains and provides sympathetic innervation of the perineum. The use of ganglion Impar blocks are a well documented technique used to relieve coccyx/perineal pain. To our knowledge, this is the largest study confirming the successful use of these fluoroscopically-guided nerve blocks in managing coccydynia. Results: Each of the 20 injections produced significant relief. The percentage of relief per injection varied from 20–75%, with the majority of patients reporting 50–75% relief per injection, generally lasting weeks to months. Typical for these injections, analgesic benefit in many patients eventually began to wane, but generally the pain still responded well to repeat injection. Conclusions: These results suggest that the application of 0.5% bupivacaine to the ganglion Impar provides significant relief from intractable coccyx generated pain. Often, repeat injections are necessary.

POSTER BOARD 57: LATERAL ANKLE PAIN IN A MIDDLE-AGED RUNNER: OVERUSE SYNDROME VS. PERONEUS QUARTUS ANOMALY
Gary P. Chimes, MD, PhD, Todd P. Stitik, MD
This 49 yr old gentleman presented with new onset bilateral ankle pain. He was without pain until 30 days prior, when he had begun a new regimen of running for 30 min t.i.w. on a flat asphalt surface. After one month, he developed pain on the lateral aspect of both ankles with bilateral swelling. Conservative management with rest and ibuprofen ameliorated his left ankle pain, but his right ankle pain persisted. Examination was significant for bilateral pes planus, tenderness along the biceps posterior ligament, anterior talofibular ligament, and sinus tarsi. He also had pain with passive foot inversion. On flexibility testing, he had 50 degree popliteal angles bilaterally, and Ely’s test revealed an angle of 85 degrees and 75 degrees in the right and left quadriceps respectively. The patient was running in old tennis shoes, which demonstrated excessive wear along the lateral aspect of the heel. Initially, it was felt that his right lateral ankle pain was due to an overuse syndrome, and was treated with a COX-2 inhibitor and advised to purchase new running shoes. Upon return 2 wk later, the patient’s right lateral heel pain persisted despite discontinuing running. An MRI of the ankle was therefore ordered and revealed a nondisplaced stress fracture of the distal fibular metaphyseal region and the presence of a peroneus quadratus tendon. The peroneus quadratus is an anomalous accessory tendon present in 6–22% of the human population, constrains movement of the peroneal muscles, and is associated with lateral ankle pain. We felt that the most likely cause of lateral ankle pain in this patient was the presence of the anomalous peroneus quadratus, and should be considered as part of the differential of lateral ankle pain. The patient’s pain improved with a Swede-O brace to stabilize inversion and eversion.

POSTER BOARD 58: THE PM&R WARDEN: ONE YEAR EXPERIENCE WITH A COMPUTERIZED PATIENT SIGN-OUT SYSTEM
Robert Brown, DO, Anatoly Shalnov, MD, Mary Ann Miknevich, MD
General rehabilitation rotations in our physical medicine and rehabilitation residency program involve three different sites: acute and subacute rehabilitation units in the main hospital and an acute unit in a satellite
hospital. Maintaining accurate and updated patient information is critical to facilitating communication between resident physicians, attendings, and staff members as well as providing overall good patient care. Objective: To improve communication between resident physicians and attendings using an on-line software tracking system. Method: We implemented a patient tracking software application which utilizes patient information including: name, age, medical record number, location, code status, diagnosis, past medical history, medications, allergies, treating physicians, and ongoing management issues. This password protected database is linked to the hospital intranet and is available on every hospital computer. Access is also available from the internet through a secure server. To assess the efficacy of this process, a survey tool was created and administered to resident and attending physicians. Results: Residents on inpatient rehabilitation rotations are responsible for entering and updating patient data on a daily basis. The on-call resident and attending are able to access this patient data to aid in key management decisions. Conclusions: Based on survey results, it was determined that despite the initial time required to maintain the sign-out system, the implementation of this patient tracking database has improved communication between residents and attending physicians. It has also improved efficiency during patient rounds, and has enhanced patient care in the rehabilitation units in our program.

POSTER BOARD 59: LOW BACK PAIN WITH RETAINED BULLET FRAGMENTS AMENABLE TO ZYGOPHYSEAL JOINT INJECTIONS: A CASE REPORT
Charles J. Buttaci, DO, PT, Patrick M. Foye, MD, Todd P. Stittik, MD
Case Description: A 61-yr-old male with a history of a gunshot wound to the back 14 yr ago was referred to a University Physical Medicine Department for management of low back pain. He reported that he never required surgical removal of the bullet as he was without any neurological deficits, had no evidence of spine instability and was advised that the procedure would involve significant risks. He began to experience a dull lumbosacral ache 4 yr after the injury that was nearly completely relieved with an “injection of the spine” for approximately 10 yr. The patient’s symptoms insidiously returned and were not relieved with oral medications or physical therapy. Imaging studies revealed bullet and bone fragments occupying the spinal canal at L3-4 producing severe central spinal stenosis, neuroforaminal narrowing and zygapophyseal joint DJD at L4-5 on the left. His physical exam was most consistent with zygapophyseal joint arthropathy. He underwent therapeutic fluoroscopic guided left L4-5 and L5-S1 zygapophyseal joint injections with a significant reduction in his symptoms, 60% decrease in pain. Conclusions: The patient’s response suggests that the primary pain generator was zygapophyseal joint mediated. It is likely that the pathology was related to post traumatic zygapophyseal joint arthropathy as opposed to the bullet and bone fragments producing spinal stenosis. Discussion: Currently there is no consensus regarding the optimum management of patients with pain related to retained bullet fragments in the spine. Current study exists regarding the benefit of surgical management. Although multiple findings may be present on diagnostic imaging, it is imperative to correlate these results with the physical exam if spinal injection procedures are being considered. The patient’s response indicates that posttraumatic zygapophyseal joint pain due to a gun shot wound can respond to intraarticular zygapophyseal joint corticosteroid injection.

POSTER BOARD 60: SURVEY OF PM&R RESIDENT PHYSICIAN AWARENESS OF SPORT & LEISURE ACTIVITIES FOR THE DISABLED
Jerry T. Staley, MD, Greg Woroszowicz, MD, MBA
Method: Emails containing a link to an online survey were sent to 80 directors of PM&R residency programs around the country. The program directors were asked to forward the link to the resident physicians in their program. A total of 98 resident physicians completed the survey. Results: Only 37/98 (40%) of respondents received a lecture on sport & leisure activities for the disabled and only 53/98 (54%) had been educated about these activities by an attending physician. While 35/98 (37%) had covered an able-bodied sporting event, only 10/98 (10%) had covered a sporting event for the disabled. 62/98 (63%) and 63/98 (64%) respectively, were interested in learning about activities for Amputee and SCI patients while only 34/98 (35%) and 37/98 (38%) respectively, were interested in learning about activities for TBI and Stroke patients. Although 69/98 (70%) indicated that they were at least somewhat aware of the sport and leisure activities available to patients and discussed these activities with their patients, 86/98 (88%) indicated that they were interested in learning more about these activities. Conclusions: Sport and leisure activities play a vital role in the physical, mental and emotional well-being of a person. They contribute to quality-of-life, aid in integration back into the community and can reduce depression, stress and anxiety. As rehabilitation physicians it is important that we educate ourselves and our patients about the opportunities for sport and leisure activities that are available to them. The results of this survey indicate that there is room for improvement in both the structured education of resident physicians regarding sport and leisure activities for the disabled and in the involvement of resident physicians in these activities. The results also indicate that an overwhelming majority of PM&R resident physicians are interested in learning more about these activities.

POSTER BOARD 61: MEASURING THE IMPACT OF COMMUNITY EDUCATION ON BICYCLE-Helmet KNOWLEDGE AND SAFETY COMPLIANCE
Nazih Iskander, MD, Jeffrey Ward, MD, Maryanne Henderson, DO
Traumatic brain injury (TBI) is a social and economic catastrophe on both personal and national levels, but it is a preventable disease. TBI can range from being mild, to a deep coma and even death. Many of the mild traumatic brain injuries are frequently not reported. This presents a challenge to the real estimate of TBI. Statistics have shown that each year: Objective: Measure the impact of community education on bicycle-helmet knowledge and safety compliance. Method: Interactive PowerPoint presentation directed to school children between 12 and 15 yr of age with a pre- and a postpresentation survey/questionnaire. Results: Two tests are distributed to the audience pre- and postpresentation to measure the short term impact on the audience. They consist of 11 questions, in the multiple-choice format. Every question has 3–4 choices, with one correct answer. The answer sheets are anonymous. They have the following attributes: 1. They are written in an easily understandable form; 2. The questions are also explained to the audience; and 3. The purpose of the test is to: Assess the delivery of the content of the presentation, and to assess the impact of the presentation in the decision-making process of the audience on using the bicycle helmets in the future. Conclusions: Interactive community education has an essential impact on enforcing school age children to wear a helmet and adhere to safety compliance to prevent brain injuries while riding bicycles and other recreational vehicles.

POSTER BOARD 62: ACUTE PSEUDOGOUT SYNOVITIS OF THE LUMBAR ZYGOPHYSEAL JOINT
Julian Sosner, MD, Simonetta Sambataro, MD, Marilyn Ramos-Lamboy, MD
Study Design: A case of low back pain diagnosed as pseudogout by lumbar facet joint is reported. Objective: To present an unusual cause of low back pain seldom reported in English literature. Summary of Background Data: There have been a significant number of cases reported of calcium pyrophosphate dihydrate (CPPD) deposition in the spine. In most instances, the lgmentum flavum is the affected structure resulting in diverse degrees of cervical or lumbar canal stenosis as well as cervical myelopathy and/or myeloradiculopathies. CPPD has also been reported to be a rare cause of symptomatic lumbar synovial cysts. However, there was only one previous report of acute pseudogout attack affecting the lumbar facet joints. Methods: A 49-yr-old male with no previous history of pseudogout presented with lower back pain of six months duration. An axial magnetic resonance imaging scan demonstrated bilateral joint effusion at the level L4/L5 consistent with synovitis. Fluoroscopically guided aspiration of both L4/L5 facet joints yielded 0.2 ml of synovial fluid, which was sent for analysis. Each joint was than injected with 0.2 ml of synovial fluid, which was sent for analysis. Each joint was then injected with a mixture of corticosteroids and anesthetic. Results: Complete resolution of symptoms was achieved within one week of the procedure. The patient was referred to Rheumatologic evaluation for further work-up. Conclusions: Although reported cases of low back pain secondary to calcium crystal deposition in the facets are scarce, it is important to include this entity in the differential diagnosis of low back pain even in the absence of past medical
POSTER BOARD 63: ANAEROBIC POWER AND MUSCULAR STRENGTH IN PREadoLESCENTS WITH HIV AND CONTROLS: A PILOT STUDY
Suzanne Gutierrez, Jose G. Conde, MD, MPH, Eduardo Ramos, MD, Walter Frontera, MD

Objective: To determine the anaerobic power and muscular strength in preadolescents with HIV disease. Design: Cross-sectional design. Setting: Human performance laboratory at the University District Hospital at the Puerto Rico Medical Center. Participants: Fifteen adolescents (8 females and 7 males) with HIV classification A & B attending an investigational treatment program at the Pediatric University Hospital. Fifteen seronegative controls matched by age and gender. Main Outcome Measures: Power of lower extremities was measured using the Wingate Anaerobic Power Test on a MONARK cycle ergometer (mean power in watts). Muscle strength of the dominant knee extensors (peak torque/body weight X 100) was tested using an isokinetic dynamometer at 60 deg/sec. Statistical analysis was performed using the Wilcoxon Signed-Rank Test. Results: No significant differences between the control group and study group were detected on muscle strength testing. The study group presented a lower anaerobic power (mean power) compared with controls (P = 0.4). Conclusions: This exploratory study suggests that HIV-infected preadolescents present lower anaerobic power compared with uninfected controls. This finding is compatible with possible enzymatic impairment in the glycolysis metabolic pathway of HIV-infected patients. The current study design cannot discriminate between HIV-infection and treatment for HIV infection as the potential cause for these findings. However, lower anaerobic power may have a profound effect on activities of daily living that involve bursts of energy expenditure among these patients.

POSTER BOARD 64: FRACTURE NON-UNION IN A PATIENT WITH SPINAL CORD INJURY: A CASE REPORT
Ferdinand J. Fornoso, DO, Harry Schwartz, MD

Disclosure: None. Setting: University Affiliated Rehabilitation Hospital. Patient: A 43 yr-old male with a history of a T4 ASIA D spinal cord injury. Case Description: This patient is a 43 yr-old man with a history of multiple gunshot wounds in 1995 resulting in trauma to the T4-T6 vertebrae and SCI. In March 2003 he suffered a fall resulting in a bimalleolar fracture of the left distal tibia and fibula. He underwent immediate open reduction and internal fixation. The patient was maintained nonweight bearing until September 2003. After being told that his fracture was healed, he was allowed to advance to weight bearing as tolerated with the use of a CAM boot and admitted to an inpatient rehabilitation unit. Following a short stay, the patient was discharged to an outpatient physical therapy regimen. After one month with little gain, the patient presented to our outpatient clinic complaining of inability to negotiate steps. It was felt that the patient might benefit from admission to our spinal cord injury unit. During his admission, the patient did not progress with gait or stairs. Plain x-rays of the ankle revealed no appreciable callus formation adjacent to opposed, but fused fracture fragments. The patient went on to have a triple arthrodesis of the ankle as a rescue procedure. Assessment/Results: In light of an adequate nonweight bearing period coupled with orthopedic clearance, the diagnosis of fracture nonunion was delayed. Discussion: The incidence of osteoporosis in spinal cord injury is well described; however, to our knowledge, this is the first report of a nonunion fracture in a patient with a spinal cord injury. Conclusions: This case illustrates that in the ambulatory SCI population, the diagnosis of fracture nonunion must be entertained in a patient who does not progress as expected.

POSTER BOARD 65: CRANIAL BLAST INJURY: REVIEW OF TWO CASE STUDIES
Henry Lew, MD, PhD, Ann Lee, MD, Tiva Hanjan, MD, Andy Nguyen, MD

Explosive munitions are commonly used in support of military operations. Despite aggressive protective measures, blast injury is an inherent risk in modern warfare. Cranial blast injury is becoming a frequent cause of traumatic brain injury in the United States because aggressive protective measures protect the body but not head or limbs. Blast injury presents with a complex spectrum of sequelae and symptomatology ranging from brain injury to craniofacial fractures and deformity. We report two case studies of young military personnel who suffered significant cranial blast injuries from high energy improvised explosive devices in the line of combat. Sequelae of cranial blast injury include musculoskeletal and soft tissue injuries of the face and limbs, intracranial injury to the brain and its vasculature, and damage to peripheral sensory organs. Other significant injuries that are not immediately life threatening include visual and hearing impairment as well as cognitive deficits due to neurotrauma. The above issues are often left undiagnosed until later on in the course of hospital care and recovery. Patients who survive the acute phase of cranial blast injuries frequently present to an acute rehabilitation ward. It is important for physicians to be aware of these potential injuries to adequately provide treatment and guide rehabilitation efforts. Our cases are presented to highlight the potential multifaceted nature of diagnosis, treatment, and rehabilitation of this type of patient.

POSTER BOARD 66: FUNCTIONAL AND NEUROMUSCULAR RECOVERY FOLLOWING LUMBOSACRAL PLEXOPATHY FROM AN ILIOPOSAS HEMATOMA
Rahul D. Abrol, MD, Gouri Chaudhuri, MD

Case Description: A 74-yr-old male was admitted to an acute care hospital with a fever, and was found to have abnormal LFTs, gallbladder abscess, and cardiac arrhythmia. The interaction of these entities makes this case unique and teaches a valuable lesson. The patient was started on antibiotics and Coumadin concurrently and was discharged to home without instructions regarding INR monitoring. Six days later, he returned to the hospital complaining of bilateral leg weakness. Further medical workup revealed right iliopecto hematomata with compression of the lumbosacral plexus causing weakness of both legs. He was taken off Coumadin. Subsequently, he underwent a cholecystectomy and was transferred to the rehabilitation hospital. He improved in mobility and muscle strength but remained weak in his right quadriceps muscle, resembling a ground reaction AFO. Interventions: Management for leg spasms and orthostatic hypotension were done. Ground reaction AFO was provided to assist with ambulation. Functional electrical stimulation was used on the right leg. Results: Upon admission to the rehabilitation hospital, the patient had severe neuromuscular weakness of bilateral lower extremities. He showed significant gains during the inpatient stay. Motor strength improved by 1–2 grades in most of the muscles affected in the lower extremities. Transfers and ambulation distances, with the use of a ground reaction AFO, improved to stand-by assistance. Also, the patient’s mobility FIM had improved. Discussion: Lumbosacral plexopathy due to an iliopecto hematomata is a serious condition that creates a great challenge for patients, caretakers, and health care providers. Prompt diagnoses and immediate medical management followed by rehabilitation, is imperative. Close monitoring of INRs is indicated for patients receiving antibiotics and Coumadin. Conclusions: Significant functional outcomes can be achieved in patients with lumbosacral plexopathy due to an iliopecto hematomata with rehabilitation.

POSTER BOARD 67: FUNCTIONAL AND NEUROMUSCULAR RECOVERY FOLLOWING CEREBROVASCULAR ACCIDENT FROM A SEATBELT INJURY
Rahul D. Abrol, MD, Gouri Chaudhuri, MD

Case Description: This is a unique case of a 43-yr-old female who suffered a stroke as a result of a seatbelt injury. The patient was involved in a motor vehicle accident in which she was a restrained front seat passenger. Upon physical exam, she was found to have severe left hemiplegia with loss of sensation, and right-sided preferential gaze. Workup revealed a right middle cerebral artery infarct. Apparently, the patient had suffered an occlusion of the right carotid artery from the seatbelt, as a diagonal abrasion was found across the neck. Later it was noted that the patient also had dysphagia and bowel/bladder incontinence. She was stabilized and transferred to the rehabilitation hospital. Interventions: Many challenges arose during the inpatient stay, including depression, diplopia, neck muscle spasticity, pain, head tilt, sitting and trunk imbalance, and difficulty in ambulation. Medications, conventional therapeutic modalities, and massage techniques were utilized. A left AFO was provided for
Upon further workup, MRI showed a lumbar epidural abscess around the history of low back pain thought to be caused by musculoskeletal strain. With unilateral lower extremity weakness due to Pott’s disease of spine.

Gait training, VFSS was done for a diet upgrade. Bowel/bladder training was implemented. Results: At admission to the rehabilitation hospital, the patient was totally dependent. The patient showed gains in motor strength of the left leg, by 2 grades, and paresthesias were treated with Neurontin. Ambulation is now possible, with the use of a left ground reaction AFO. Also, diet level was upgraded with improved oral intake. Conclusions: Cerebrovascular accidents are common, but the manner in which this occurred is not. In this unusual case, a common safety device achieved its primary goal, which is saving a life, yet in the process caused a major illness. Fortunately, functional and neuromuscular gains were achieved in order for the patient to live the best life possible.

**POSTER BOARD 68: JAPANESE ENCEPHALITIS AND BELL’S PALSY**

Peter Lux, MD, Ib R. Odderson, MD, PhD, Peter Hashisaki, MD

Bell’s palsy and encephalitis can both have viral etiologies, but they rarely occur concurrently. We report a unique case where a 22 yr-old woman with Japanese encephalitis developed Bell’s palsy. On return from Thailand she became febrile, dysarthric, and developed laryngeal incompetence requiring intubation. While on the inpatient rehabilitation service she developed left upper and lower facial weakness with partial eye closure. A MRI showed mild enhancement of the vertical portion of the facial nerve. A short course of steroids and acyclovir was completed and two months after onset of symptoms she had essentially recovered fully and was working. Treatment and rehabilitation issues for the patient are discussed.

**POSTER BOARD 69: COMPARING THE OUTCOMES OF AN OUTPATIENT PHASE II CARDIAC REHABILITATION PROGRAM IN A COHORT OF ELDERLY VA VETERANS**

Manoj Mithal MBBS, PhD, Carl V. Granger, MD, John P. Naughton, MD, Richard T. Linn PhD

Introduction: Coronary artery disease is associated with physical disabilities as reported in data from the Framingham Study. Cardiac rehabilitation aims at preventing and delaying disability so as to enable independent functioning and delaying institutionalization. Objective: The objective of this study was to compare outcomes within a cohort of participant’s participating in a standard outpatient phase II cardiac rehabilitation program. Methods: Twenty-seven veterans enrolled in the VA Western New York Healthcare System (VAWNHCs) Phase II Cardiac Rehabilitation Program were prospectively followed over a period of 12 wk. Patients were assessed and post completion using the Graded Exercise Test (GXT) and the Lifeware Quality of Life Measure. Results: The 27 patients were split into two groups based on patient’s performance on the pre GXT. Group A (n = 12) GXT ≤ 5MET (Metabolic Equivalent) NYHA classification III and IV and Group B (n = 15) GXT ≥ 5MET NYHA classification Class II and I. The GXT level achieved is a direct indicator of physical and cardiovascular function. The mean age of patients in Group A (n = 12) was 66.8 yr and in Group B (n = 15) 62.5 yr. Patient’s in-group A reported a higher percentage of comorbidities such as: Diabetes Mellitus (50%), Peripheral Vascular Disease (35%), Cerebrovascular accidents (16.6%), Chronic Lung Disease (16.6%). The higher cardiovascular limitation in-group A was associated with a lower subjective physical function level in-group A (69.2) as compared with group B (83.5%). The mean change in the GXT level from pre to post in group A was 61.3% whereas it was 40.6% in group B. Changes in other parameters such as physical function, affective function and pain were positive and similar in both groups. Conclusions: The study demonstrates the usefulness of an outpatient phase II cardiac rehabilitation in an elderly more limited population vis a vis a less limited group.

**POSTER BOARD 70: REHABILITATION OF UNILATERAL LOWER EXTREMITY WEAKNESS DUE TO LUMBAR EPIDURAL ABSCESSES CAUSED BY POTT’S DISEASE: A CASE STUDY**

Michael Y. Chang, DO, Philip J. Poulos, MD

Setting: Tertiary inpatient rehabilitation hospital. Patient: A male patient with unilateral lower extremity weakness due to Pott’s disease of spine. Case Description: 29 yr old male previously healthy admitted with 2 mo history of low back pain thought to be caused by musculoskeletal strain. Upon further workup, MRI showed a lumbar epidural abscess around the thecal sack without vertebral involvement and a right psoas abscess. Subsequently, patient developed left hip flexor, adductor, abductor, and ankle dorsiflexor weakness without bowel and bladder involvement. He underwent drainage of abscess and subsequent cultures were consistent with the diagnosis of extrapolumary tuberculosis (Pott’s disease). Assessment/Result: Our goal was to maximize his functional independence in ambulation and activities of daily living and return him to his previous occupation. Discussion: To our knowledge this is the first review of this kind described in the rehabilitation literature. A broad review of literature was conducted with particular focus on factors affecting functional recovery after Pott’s disease. Predictors of functional outcome after spinal tuberculosis include extent of spinal involvement, aggressiveness of antituberculous regimen, and the use of surgical intervention. Spondylitis without narrow involvement is a positive predictor for neurological and functional recovery. Thus, these patients can be treated conservatively without surgical intervention according to the literature. In this case, the patient was able to regain functional ambulation and become independent with ADL after a course of aggressive inpatient rehabilitation. Conclusion: Functional outcome predictors to be considered in rehabilitation of extrapolumary tuberculosis.

**POSTER BOARD 71: TO STUDY THE RELATIONSHIP BETWEEN CHANGE IN PHYSICAL FUNCTION AND/OR EMOTIONAL STATUS AND “RATE OF CHANGE IN PAIN” IN BACK PAIN PATIENTS**

Chetan Malik, MBBS, Carl V. Granger, MD, Carol Russell

Objective: To study the relationship between change in Physical function and/or Emotional Status and “Rate of change in pain” in Back pain patients. Method: The study involves retrospective analysis of data on patients with back pain from the LIFEwareSM System. Patient data were collected from outpatient physical therapy clinics from all around the country. Records of patients with back pain of duration less than 182 days, age 18 – 65 yr, and treatment duration 7–60 days were selected for the study. Patients’ pain was assessed using 2 measures: the Painfree measure, a 6-item measure used to assess the qualitative dimension of pain, and the LIFExwareSM Visual Analog Scale (LVAS), a quantitative measure of pain. Physical function was measured using the BMc, a 10-item measure. Affective state was measured using the Placid, a 7-item measure. Painfree, LVAS, BMc and Placid rate of change were calculated by dividing change in the respective variables between two assessments by the interval between the assessments. Parametric statistics and linear regression were used for analysis. Results: Sample size was 2813 (1151 males and 1662 females). Mean age was 45.3 (SD = 11.9) years, mean duration of back pain was 43.3 (SD = 43.5) days, mean treatment duration was 29.5 (SD = 13.3) days. Painfree measure improved in 2133 (75.8%) and did not improve in 680 (24.2%) patients. Mean Painfree rate of change was 0.70 (SD = 1.04). LVAS improved in 2215 (78.7%) and did not improve in 598 (21.3%) patients. Mean LVAS rate of change was 1.19 (SD = 1.51). A more rapid Painfree rate of improvement was seen in patients who had more rapid improvement in LVAS, BMc and Placid (r-square = 0.40). A more rapid LVAS rate of improvement was seen in patients with more rapid improvement in Painfree and BMc (r-square = 0.43). Conclusions: More rapid improvement in pain is seen in patients who demonstrate more rapid improvement in Physical function and/or Affective state. Treatment of back pain should address all three dimensions.

**POSTER BOARD 72: WITHDRAWN**

**POSTER BOARD 73: CONSERVATIVE TREATMENT OF QUADRILATERAL SPACE SYNDROME: A CASE REPORT**

Annu Maratukulam, MD, U. Ghazi, K. Wedemeyer, R. Mitra

Background: Quadrilateral space syndrome is an entrapment neuropathy of the axillary nerve and posterior humeral circumflex artery as they pass thru the quadrilateral space of the shoulder. Patients present with paresthesias, muscle weakness and tenderness of arm, forearm, hand and shoulder. Diagnosis is a challenge because of this syndrome’s nonspecific presentation. History of Present Illness: A 32-yr-old right-hand dominant male presents with spontaneous onset of left posterior shoulder pain, weakness and paresthesias. The pain was aggravated by cervical range of motion and prolonged driving; lying supine lessened the pain. Past medical history included childhood seizures. Physical Exam: Shoulder
- Normal muscle bulk/tone; full ROM; tenderness along posterior shoulder; negative provocative maneuvers. Neuro - 4/5 strength in left shoulder abd-supraspinatus. There was decreased sensation to fine touch in the distribution of the left axillary nerve. Diagnostic Tests: X-rays of shoulder and cervical spine were normal. Suprascapular n. block was performed with minimal benefit. & a subsequent MRI of the shoulder demonstrated signal abnormality within the teres minor and inferior deltoid muscle. Treatment: The patient was given NSAIDs and physical therapy program emphasizing stretching & strengthening of the deltoid muscle, as well as modalities including e-stim and ultrasound. He demonstrated significant improvement over the course of 3 mo, returning to full strength. Conclusions: Because of the nonspecific presentation of quadrilateral space syndrome it is often confused with more common shoulder pathologies. This case demonstrates the need for a detailed evaluation, diagnostic blocks, and high clinical suspicion to determine the etiology. The case also demonstrates that patients can gain significant relief with focused conservative therapies and modalities, thus preventing future surgery.

**POSTER BOARD 74: RECOVERY FROM ACUTE CENTRAL CORD SYNDROME CAUSED BY HIGH VELOCITY MISSILE INJURY: A CASE REPORT**

Vivekanand Manocha, MD, Gregory Nemunaitis, MD, Gary S. Clark, MD, CPE

Objective: To describe the outcome of a high velocity missile injury causing indirect acute spinal cord injury with a central cord pattern of damage. Design: Case Presentation. Methods: Medical Record Review. Results: An 18-yr-old male was admitted to the hospital after sustaining a gunshot wound to the back of the neck. Immediately after the injury, he had limited movement of his arms and legs and was given a diagnosis of C2 ASIA C Tetraplegia with a motor score of 20. A CT of the spine revealed a left to right bullet trajectory with right laminar fracture of C3 and bullet fragments penetrating the right lateral mass of C2–3. Cervical myelogram showed evidence of cord edema at C5, as well as a small focal area of dural injury, without frank extravagation of contrast suggesting an indirect mechanism of injury. He was admitted to acute spinal cord rehabilitation unit with the diagnosis of C4 ASIA C Tetraplegia with a central cord pattern and a motor score of 26. Over the course of two months he made significant improvement in mobility, transfers, and activities of daily living. At 1-mo follow up in the outpatient clinic, his level of injury had improved to C4 ASIA D with a motor score of 74. He also regained continence of bowel and bladder. This case is an example of an acute spinal cord injury with a pressure wave induced central cord pattern of damage caused by a high velocity missile injury outside the central canal. Conclusions: The recognition of acute spinal cord injury caused by a missile injury is important as it may imply the potential for significant recovery, warranting aggressive treatment in the acute rehabilitation setting.

**POSTER BOARD 75: PERCUTANEOUS ENDOSCOPIC GASTROSTOMY TUBE PLACEMENT THROUGH THE TRANSVERSE COLON OF STOMACH CAUSING INTRACTABLE DIARRHEA: A CASE REPORT**

David T. Burke, MD, MA, Alexis G. Carayannopoulos, DO, MPH

Disclosure: None. Setting: Acute Rehabilitation Hospital. Patient: A 73-yr-old male with traumatic brain injury. Case Description: The patient is a 73-yr-old male, status posttraumatic brain injury, with an insuffi- cient intake of nutrition, requiring enteral feeding. The patient had limited movement of his arms and legs and was given a diagnosis of C2 ASIA C Tetraplegia with a motor score of 20. A CT of the spine revealed a left to right bullet trajectory with right laminar fracture of C3 and bullet fragments penetrating the right lateral mass of C2–3. Cervical myelogram showed evidence of cord edema at C5, as well as a small focal area of dural injury, without frank extravagation of contrast suggesting an indirect mechanism of injury. He was admitted to acute spinal cord rehabilitation unit with the diagnosis of C4 ASIA C Tetraplegia with a central cord pattern and a motor score of 26. Over the course of two months he made significant improvement in mobility, transfers, and activities of daily living. At 1-mo follow up in the outpatient clinic, his level of injury had improved to C4 ASIA D with a motor score of 74. He also regained continence of bowel and bladder. This case is an example of an acute spinal cord injury with a pressure wave induced central cord pattern of damage caused by a high velocity missile injury outside the central canal. Conclusions: The recognition of acute spinal cord injury caused by a missile injury is important as it may imply the potential for significant recovery, warranting aggressive treatment in the acute rehabilitation setting.

**POSTER BOARD 76: FEASIBILITY STUDY OF THE BRAINGATE NEURAL INTERFACE SYSTEM FOR INDIVIDUALS WITH QUADRIPLEGIA**

Jon Mukand, MD, PhD, Steve Williams, MD, Gary Polykoff, MD, David P. Apple, Jr., MD

Objective: Develop an implantable device to provide quadriplegic individuals with an output signal directly from the brain to a computer. Design: Clinical trial. Setting: Outpatient clinics, patient homes. Participants: Up to five quadriplegic patients. Intervention: Implantation of BrainGate® neural sensor on the motor cortex surface. The sensor is connected to an amplifier, a signal processor, a decoder, and a patient-computer interface. The decoder correlates neural signals to desired actions using mathematical algorithms. These data are used to develop a mechanism for cursor control. Main Outcome Measure: Safety assessment and ability to move a computer cursor to targets on the computer screen. Results: The FDA and local IRBs have approved the feasibility study. One individual has undergone successful implantation and recovery. This individual is able to control a cursor on a computer screen using motor cortex neuronal movements that have been correlated with neural signal patterns. The authors will present the underlying neural data and proof of concept, including a demonstration of the patient using the BrainGate as an assistive device. Conclusions: By deriving signals directly from the cerebral motor cortex, the BrainGate® may allow people with severe weakness of the upper extremities to control a computer cursor with only neural activity. Through the computer interface, the device could be used for a variety of assistive technologies for more independent living.

**POSTER BOARD 77: ULNAR NEUROPATHY AT THE ELBOW IN A THIRD BASEMAN WITH MEDIAL ELBOW INSTABILITY DIAGNOSED BY SHORT SEGMENT INCREMENAL STUDY (SSIS) TECHNIQUE: A CASE REPORT**

Clinton Faulk, MD, Kathia Baucaige, MD, Albert Retodo, MD, James Wells, MD MPH

Setting: Outpatient rehabilitation clinic. Patient: 17-yr-old female softball player with chronic elbow pain. Case Description: This patient presented to sports medicine clinic seven months before the diagnosis of right ulnar neuropathy at the elbow by EMG/NCS SSIS technique. She initially presented with insidiously worsening right medial epicondylar pain, ulnar distribution paresthesias and early fatigue of the hand, which prevented her from playing. On initial exam she had normal hand grip and interosseous strength, full range of motion of the arm and hand, and 2+ valgus elbow laxity. Her ulnar nerve was subluxable and her throwing mechanics were poor. Prolonged conservative therapy was unsuccessful. Assessment/Results: MRI and MRI arthrogram were done and were negative for an ulnar collateral ligament injury. She underwent right elbow ultrasound with stress views indicating possible strain. She was seen 2 mo later for her 1st EMG/NCS, which was normal and did not include SSIS. Repeat EMG/NCS was done 4 mo later, at which time she had persistent symptoms. The 2nd EMG/NCS showed moderate severity demyelinating right ulnar neuropathy at or about the elbow present only on SSIS motor study and not on standard ulnar motor or sensory studies. She is awaiting ulnar collateral ligament reconstruction. Discussion: Injuries to the elbow, forearm and wrist account for more than 25% of sports-related injuries. Chronic elbow injuries are typically caused by repetitive activity. This is particularly true for throwing because it causes medial traction and lateral compression of the elbow. Ulnar nerve lesions...
are the most common nerve injury in throwing and often related to poor technique. Conclusions: SSIS technique diagnosed ulnar neuropathy at the elbow in a softball player with chronic medial elbow pain and laxity. EMG/NCS’s correlate with severity of the disease and have varying sensitivity. SSIS techniques improve the likelihood of finding a true positive result.

POSTER BOARD 78: CESSATION OF SIALORRHEA IN A POST-STROKE PATIENT FOLLOWING BOTULINUM TOXIN TYPE A INJECTIONS: A CASE REPORT

Patricia J. Hantsch, MD, Eric R. First, MD

Setting: Rehabilitation hospital outpatient clinic. Patient: A 42 yr old black female with sialorrhea secondary to stroke. Description: A patient four years poststroke with severe sialorrhea received a total of 40U (20 U per parotid gland) of botulinum toxin type-A (BTX-A) (Allergan, Inc.), which was reconstituted with 0.9% preservative free normal saline to a concentration of 100 U/ml. This dose was equally divided among two sites in each parotid gland using surface landmarks and electromyography to confirm needle location. At three month follow-up, the patient reported slightly decreased sialorrhea. Over the next one and a half years, the patient received serial BTX-A injections every 3–5 mo, for a total of 6 injection cycles. Due to recurrent sialorrhea, the total dose was incrementally increased on subsequent injections to a final total dose of 100 U for each of the last 3 injections. Assessment/Results: Since her last injection, the patient has not reported any significant sialorrhea. In addition, no sialorrhea has been noted by the clinician during several re-evaluations. There were no side effects noted by patient, and in fact, her swallowing and speech subjectively improved over the treatment period. Discussion: This is the first reported case, to our knowledge, of complete cessation of sialorrhea for an extended period of time. Since the average total dose of BTX-A for sialorrhea is 25–50 U, we are attributing this outcome to using a much higher dose (100 U) of BTX-A.

A-ABEX: ASSOCIATION BETWEEN COMPLEX REGIONAL PAIN SYNDROME TYPE 1 AND SOLAR INJURY

Leon Margolin MD, PhD

Disclosure: None. Setting: Tertiary care hospital. Patient: A 30-yr-old generally healthy female of Ashkenazi Jewish origin. Case Description: The patient was hospitalized because of severe, painful erythema, severe local tenderness, and nonpitting edema over both shins that developed 3 days after she sunbathed for more than 6 hr. The patient reported severe allodynia and hyperesthesia and impaired sudomotor function over the area of the sunburn that was not compatible with any dermatomal distribution or single nerve area. The erythema had a purplish hue in dependent position and brightened when the leg was raised. There was no history of photosensitivity and the patient was not on any medication. Physical examination was unremarkable, except for the swelling, erythema and tenderness, CBC, chemical panels, and ESR were within normal limits and markers of collagen vascular disease, including ANA, anti-DNA, anti-Ro and anti-La were negative. Ultrasonography of leg veins and vena cava for the whole extent was within normal limit. Leg x-ray was normal, bone scan was not performed. The patient refused x-ray was normal, bone scan was not performed. The patient refused the bone scan; however, the leg was brightened when the leg was raised. There was no area of the sunburn that was not compatible with any dermatomal distribution or single nerve area. The erythema had a purplish hue in dependent position and brightened when the leg was raised. There was no history of photosensitivity and the patient was not on any medication. Physical examination was unremarkable, except for the swelling, erythema and tenderness, CBC, chemical panels, and ESR were within normal limits and markers of collagen vascular disease, including ANA, anti-DNA, anti-Ro and anti-La were negative. Ultrasonography of leg veins and vena cava for the whole extent was within normal limit. Leg x-ray was normal, bone scan was not performed. The patient refused x-ray was normal, bone scan was not performed. The patient refused

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Disease modifying agents for noncancer and cancer chronic pain activity. We strongly advocate testing of matrix metalloproteinase inhibitors that these effects were associated with a marked reduction in MMP-2 activity. Setting: Neuromuscular disease clinic.

Arjang Abbasi, DO, RRT, John Robert Bach, MD

D-ABEX: LUNG INSUFFLATION CAPACITY - A TECHNIQUE TO MEASURE DEEP LUNG INSUFFLATIONS

Anirԡn Abbas, DO, RRT, John Robert Bach, MD

Setting: Neuromuscular disease clinic. Objective: To describe a simple technique to measure lung insufflation capacity (LIC) and its clinical relevance for patients with neuromuscular disease. Design: Two patients unable to “air stack” to deep lung volumes because of failure of glottic closure were insufflated to deep lung volumes and those volumes measured by spirometry. Method: A Y adapter is connected to an anesthesia interface over the patient’s nose and mouth, a manual resuscitator, and a spirometer. A one way valve is placed at the elbow of the manual resuscitator permitting lung inflation but no exhalation. Air is delivered to the patient via the resuscitator-ornasal mask. Air volumes are delivered until deep lung expansion is observed and back resistance increased to the point of making it difficult to further expand the lungs. The capped exhalation port of the spirometer is then uncapped so that the lung deflates and the exhaled air enters and is quantified by the spirometer.

Thus, glottic closure is unnecessary for insufflation or for exhalation volume measurement. Results: Two patients with vital capacities of 770 ml and 1520 ml were insufflated to measured volumes of 1700 ml and 2700 ml, respectively, even though their air stacking volumes did not exceed their vital capacities. Conclusions: Deep lung insufflations are critical to maximize cough flows and maintain lung and chest wall compliance. Despite loss of glottic closure, they can be measured in this manner.

POSTER BOARD 79: INFECTIOUS DISKITIS: AN UNCOMMON CAUSE OF LOW BACK PAIN

Michael Mehnert, MD, Thomas Agesen, MD, Gerard Malanga, MD

A 64 yr-old male presented with two weeks of low-back pain, with a possible inciting event of heavy lifting at work. The patient had been seen by his employer’s physician for work-related back pain. Subsequently, he developed fevers and night sweats, with productive cough and back pain. Shortly thereafter the back pain returned, and nonsteroidal antiinflammatories and muscle relaxants were prescribed without relief. He was referred to a back specialist who ordered magnetic-resonance imaging (MRI) studies of the spine. This demonstrated slight degeneration of the L3-L4 disk and marrow alteration about the L3 vertebral body without frank marrow edema. The patient’s night sweats recurred prompting a bone scan and thin-cut computed tomography scan of the lumbar spine. These were unremarkable. With persistence of pain despite medications and continued fevers, a repeat MRI was ordered approximately five weeks after the onset of pain. This demonstrated narrowing edema about the L3-L4 levels consistent with infectious diskitis. The patient was hospitalized; blood cultures grew staphylococcus aureus. He was treated with six weeks of intravenous antibiotics followed by oral antibiotics. His back pain diminished during the treatment, and full recovery by six months was noted. Infectious diskitis is an uncommon primary infection of the nucleus pulposus, with secondary involvement of the vertebral end-plate and body. This illness is treatable, and should be considered in the differential diagnosis of back pain in individuals with constitutional symptoms. The diagnosis may be obscured by concomitant infections (and their treatment). As in this case, initial studies may be negative and vigilance required in making the diagnosis.

POSTER BOARD 80: COMPARATIVE RESPONSIVENESS OF THE NECK DISABILITY INDEX, THE NECK BOURNEMOUTH QUESTIONNAIRE AND THE PAIN VISUAL ANALOG SCALE IN PATIENTS WITH CHRONIC, UNCOMPlicated NECK PAIN

Ralph E. Gay, DC, MD, Tomothy J. Madson, PT, Kathy R. Cieslak, PT

Introduction: Neck pain is a common musculoskeletal problem. Outcome of neck pain treatment is often measured with patient-completed questionnaires. The psychometric performance of these outcome tools may vary depending upon the characteristics of the population tested. The purpose of this study was to compare the responsiveness of the Neck Disability Index (NDI), the Neck Bournehoum Questionnaire (NBQ), and the pain Visual Analog Scale (VAS) in patients with uncomplicated, chronic neck pain (3 mo) treated by physical therapists. Methods: A prospective longitudinal study with questionaire administration preand posttreatment was approved the IRB. Subjects were recruited from patients referred for physical therapy treatment of neck pain. Exclusions were cervical radiculopathy/myelopathy, symptomatic shoulder pathology/shoulder trauma, fibromyalgia/widespread pain, motor vehicle collision within 3 yr, and contraindication to cervical mobilization. Subjects were treated a maximum of 12 times in a 4 wk study period and measures were completed pre and posttreatment. Outcomes were effect size (sensitivity) and two-way Spearman’s correlation coefficient between measures (concurrent validity). Results: Subjects included 7 males and 16 females with mean (SD) age 49.6 (14.6) years. Mean (SD) pretreatment questionnaire change scores and VAS change (NDI/VAS 0.54, NBQ/VAS 0.46). Conclusions: The NDI and the NBQ performed comparably in this population. They likely measure different aspects of the neck pain experience as evidenced by only moderate correlation between change scores. Yet, they are similarly sensitive to clinical change and have acceptable concurrent validity.
POSTER BOARD 81: THE NEED FOR TREATMENT OF ASYMPTOMATIC CLOSTRIDIUM DIFFICILE IN AN INPATIENT TRAUMATIC BRAIN INJURY POPULATION

Ghada Ahmed, MD, Sylvia A. Duraski, MS, APRN, BC, CRNN-A, CBIS

Setting: Free standing acute rehabilitation facility. Description: The toxin Clostridium difficile is commonly seen in those patients receiving anti-biotic therapy. It results in a spectrum of symptoms from mild diarrhea to colitis. Brain injured patients in a rehabilitation hospital are commonly diagnosed and treated for Clostridium difficile diarrhea. Treatment is recommended after a patient presents with symptoms, which include abdominal pain, diarrhea, and fever, and has a positive toxin identified in the stool culture. This case study describes several patients with brain injury who were identified to have experienced a functional decline during their inpatient rehabilitation course. Significant diagnostic testing was performed and all medical causes for the functional decline were ruled out. These patients demonstrated decreased arousal, motivation, and participation in therapy with no fever, abdominal pain or diarrhea. During diagnostic testing, these patients were identified to have a positive Clostridium difficile toxin in stool culture. Each patient underwent a two-week treatment course of Flagyl. Assessment/Results: After two-week treatment with Flagyl, all patients returned to baseline functional status and continued to make gains in rehabilitation treatment. Discussion/Conclusions: Treatment of asymptomatic Clostridium difficile in a brain-injured patient who experiences an unexplained decline in function should be considered.

POSTER BOARD 82: THE RELATIONSHIP BETWEEN AGE, BMI, SELF-REPORTED AGGRESSIVENESS, AND INJURY WITH NOVEL MEASURES OF AGILITY AND STRENGTH IN A SKIING/SNOWBOARDING POPULATION

Dana L. Martini, DO, B. Candice Pack, DO, Alan W. Chu, MD, Tagreed M. Khalaf, MD, Michael Boninger, MD

Objective: To design novel tests that may provide insight into risk of injury in skiers and snowboarders, and to determine if the novel tests are related to subject characteristics and each other. Design: A cohort study involving a convenience sample of skiers and snowboarders. Setting: Local ski club meetings. Participants: 7 females and 11 males volunteered to participate in this study (mean age 30 ± 11 yr). Interventions: The participants underwent a preseason physical examination which included newly designed measures of agility and strength. Age, height, weight, and self-perceived level of skiing and/or snowboarding aggressiveness were obtained. Participants performed a preseason examination at the beginning of the season. Participants were contacted at the end of the ski/snowboard season and completed a postseason questionnaire, recording injuries sustained. Main Outcome Measures: Combined calculations of agility/perceived effort and strength/perceived effort. Results: Sixteen participants were successfully contacted in the post season; 7 reported injury. Poorer performance on agility tasks was correlated with a higher age (r = -0.506, P = 0.03), and self-report BMI (r = -0.473, P = 0.052), and poorer performance on strength tasks was correlated with a higher BMI (r = -0.499, P = 0.049). Participants ranking themselves as more aggressive skiers/snowboarders trended toward better performances on agility tasks (P = 0.060). No significant difference was demonstrated between subjects who did and did not report injury with performance of the novel agility and strength tasks. Conclusions: This study demonstrates external validity with respect to the new measures of agility and strength created by the research team. Significant correlations between injury and the novel preseason examination may be achieved by both increasing participant numbers and by repeating the novel tasks for test-retest reliability.

POSTER BOARD 83: ANTERIOR INTEROSSEOUS NERVE SYNDROME: AN UNCOMMON CAUSE OF DEEP WRIST PAIN

Akshat Shah, MD, Ellen Novick, MD

A 56-yr-old male is referred for EMG/NCS to rule out CTS. He complains of 1 yr of moderate right elbow pain and achy deep pain with dysesthe-sia in the dorsum of the wrist. The pain is intermittent and worsened with elbow flexion and becomes unbearable when using a mouse. He denies numbness and tingling in the fingers but admits to occasional neck pain without radiation to his wrist. Treatment has thus far been aimed at a diagnosis of lateral epicondylitis. He has tried a counterforce strap, an elbow sleeve, over the counter NSAID’s and physical therapy all having no great effect. There has been no diagnostic testing to date. On examination there was full cervical ROM, negative Spurling’s sign, 5/5 MMT in the upper limb and hand intrinsics. Sensation was intact in all dermatome levels and peripheral nerve distributions and upper extremity distributions of the upper extremity were normal and symmetrical. There was mild diffuse wrist pain radiating to the proximal forearm on carpal compression test. Phalen’s test was negative. Tinel’s was negative. There was tenderness of the lateral epicondyle without radiation of pain. He was able to make the OK sign but could be broken. EMG/NCS results (Full table with Poster): Routine median and ulnar motor, sensory, and F wave studies were normal. EMG of the cervical paraspinals, deltoids, biceps, triceps, Pronator Teres, APB, and FDI were normal. EMG of the Pronator Quadratus and the FPL showed spontaneous activity but full recruitment. This patient has electrophysiological evidence consistent with mild AIN Syndrome. The etiology may be secondary to chronic cocontraction of the muscles given his concomitant overuse injury. This diagnosis may be considered in patients with diffuse dorsal wrist dysthesia.

POSTER BOARD 84: A VIRTUAL REALITY ASSISTED EXERCISE PROGRAM FOR PATIENTS AFTER CORONARY ARTERY BYPASS GRAFTING SURGERY

Tien-Yow Chuang, MD, Pei-Hsin Lin, MD

Objective: The purpose of this study was to examine the efficacy of a virtual reality (VR) assisted exercise program for patients after coronary artery bypass grafting (CABG) surgery. Participants: In this prospective randomized controlled study, patients after submitting to CABG surgery were recruited from 2001–2003. Thirty-two patients were involved in this study and were allocated randomly into two groups. In the outpatient rehabilitation program, 16 subjects (n = 7) performed a VR-assisted exercise protocol consisting of virtual staircase climbing, running, and strength training using the Naughton protocol was employed as the pre- and post-protocol investigation in both groups. During the exercise testing, heart rate and blood pressure were carefully monitored. Readings from the rating of perceived exertion (RPE) according to the Borg’s 6–20 point scale were taken every 3 min. Results: The two-sample t test revealed significant differences in the maximal treadmill speed, the test duration, the physiologic cost index, and the energy expenditure between the groups during the tests. The paired t test showed significant improvements in (maximum- baseline) HR and (maximum-baseline) VO2 after both VR and non-VR training. Conclusions: Incorporating VR in treadmill training, as our results suggest, was superior to conventional exercise protocols. The patients adapted to a higher walking speed, to a shorter testing period, and carried out their training more effectively with less energy expenditure.

POSTER BOARD 85: CERVICAL NERVE ROOT AVMULATION: CORRELATION OF MAGNETIC RESONANCE IMAGING, ELECTRODIAGNOSTIC AND INTRAOPERATIVE FINDINGS

Pei-Hsin Lin, MD, Po-Yi Tsai, Tien-Yow Chuang

Objective: The purpose of this study was to demonstrate the correlation of magnetic resonance imaging (MRI), electrodiagnostic and intraoperative findings in cervical nerve root avulsion injury. Participants: In this prospective study, patients who have been clinically diagnosed as having traumatic brachial plexus injury were referred for electrophysiological examination and magnetic resonance imaging surgery for 2002–2003. Thirty-seven patients diagnosed as having partial or complete cervical nerve root avulsion by electrodiagnostic examination or MRI were included. Among them, 19 patients received surgical exploration. Methods: Electrophysiologic examination was performed for diagnosing, localizing the lesion, and grading of the severity as mild, moderate or severe according to the modified Dumitru’s and Wilbourn’s scale. MRI of C-spine was performed, using sagittal T2-weighted images for 2002–2003. Thirty-seven patients diagnosed as having partial or complete cervical nerve root avulsion by electrodiagnostic examination or MRI were included. Among them, 19 patients received surgical exploration. Methods: Electrophysiologic examination was performed for diagnosing, localizing the lesion, and grading of the severity as mild, moderate or severe according to the modified Dumitru’s and Wilbourn’s scale. MRI of C-spine was performed, using sagittal T2-weighted images for 2002–2003.
as MRI did than surgical findings, with four cases with identical results in MRI and surgical findings. The agreements on the components of lesions between surgical findings and electrophysiological as well as MR results were 73.7% and 79%, respectively. Our study also demonstrated the correlation between the presence of meningocele and avulsion lesions. Conclusions: This study demonstrated that both electrophysiological and MRI play crucial roles in preoperative assessment. The concordance in diagnosing and localizing the cervical nerve root lesions also indicated that these two evaluation tools are complementary rather than mutually exclusive.

POSTER BOARD 86: WITHDRAWN

POSTER BOARD 87: THE USE OF CT-BASED 3-D MODEL CONSTRUCTION TO AID IN THE FITTING OF UPPER EXTREMITY PROSTHETIC SOCKETS IN PATIENTS WITH HETERO TOPIC OSSIFICATION: A CASE SERIES
Kevin F. Fitzpatrick, MD, Paul F. Pasquina, MD, Stephen L. Rouse, DDS, Amanda E. Turner, PA-C, Kristin Gulick, OTR, CHT, John Miguélez, CP

We report two cases of patients with upper extremity amputations who experienced difficulty with prosthetics fitting as a result of heterotopic ossification (HO) at the sites of socket-limb interface. Prosthetics fitting in each case was aided by CT-based 3-D model construction of the residual limb. Patient 1: A 28 yr-old male, inflicted in a rocket-propelled-grenade (RPG) blast during military combat, who sustained a right wrist disarticulation and a left transradial amputation. The patient developed significant HO at his left distal residual limb. Prosthetics fitting was limited by skin breakdown and pain as a result of this HO. Patient 2: A 31 yr-old male who was also injured by an RPG blast, sustaining a right shoulder disarticulation in addition to b/l pneumothoraces and a large liver laceration. The patient developed significant HO at the site of his shoulder disarticulation. Prosthetic fitting was limited by pain and concern for skin breakdown as a result of this HO. 3-D models of each patient’s residual limb were constructed utilizing fine cut CT imaging, sophisticated modeling software, and stereolithography. These models were then used to aid in the construction of prosthetic sockets. The models were useful in the design of the prosthetic interface by improving the anatomical contouring of the socket and in assisting in identification of anatomic anomalies for avoidance of stress to those areas. Discussion: To date, no reports of successful use of 3-D modeling to aid in prosthetics fitting and construction have been published. With the large number of combat casualty amputees seen in recent military conflicts presenting with HO, methods for fitting prosthetic devices to difficult limbs has reached a heightened level of importance. Conclusions: CT-based 3-D modeling presents a valuable tool to aid in the design and manufacturing of prosthetic sockets in difficult cases. Studies to further delineate its role in various clinical circumstances are warranted.

POSTER BOARD 88: IMPAIRED SEMANTIC PROCESSING IN PATIENTS WITH TBI
Henry Lew, MD, PhD, Kristina Liu, James Chen, John Poole

Background: Cognitive deficits from traumatic brain injury (TBI) may greatly affect quality-of-life. Our prior research has demonstrated that P300 event-related potentials (ERP) to simple stimuli are an objective and sensitive reflection of cognitive state in TBI patients. We expanded upon our earlier ERP investigations by employing a semantic categorization task. The goal of this study is to develop an ecologically relevant measurement to better predict TBI patients’ recovery. Procedure: 8 TBI patients and 5 healthy controls were asked to classify 10 common animal words and 40 nonanimal words. The animal words (20%) were used as rare/target stimuli interspersed among the nonanimal words (80%) that served as frequent/nontarget stimuli. We analyzed two ERP responses, the N4 and P6 components, which prior research has found related to semantic processing. Results and Discussion: Healthy controls had larger amplitude responses to rare/target stimuli than to frequent/nontarget stimuli, both in the N4 (P = 0.01) and P6 (P = 0.05) components. In contrast, TBI patients did not show this pattern in either component. The absence of this differential response in TBI patients suggests a failure to distinguish relevant from irrelevant stimuli. This finding may be related to other ERP research documenting impairments in P50 inhibition (Arciniegas 2004) in TBI patients. A larger sample size is required to support our preliminary finding.

POSTER BOARD 89: FUNCTIONAL OUTCOME AFTER ATRAUMATIC THORACIC DISC HERNIATION: CASE SERIES
Mireda Martinez-Sanchez, MD, Edwardo Ramos, MD, William Mickeo, MD

Objective: To determine the functional outcome of patients that underwent surgical decompression due to thoracic disc herniation. Method: Patients admitted to Health South Rehabilitation Hospital in San Juan, Puerto Rico, with the diagnosis of spinal cord compression due to thoracic disc herniation between the years 1999–2003 were evaluated. None of the patients included in our study had history of trauma as the cause of the thoracic disc herniation. Demographic data were obtained for each one of the patients included in our study. Results: Three patients were included in our study; two females and one male, age (RPG) blast during military combat, who sustained a right wrist disarticulation and an ankle-foot orthosis (AFO); none of the patients was a community ambulatory. All of the patients achieved modified independence in the activities of daily living (ADL) at wheelchair level and recovered voluntary bowel and bladder control. Upon reevaluation, all the patients had completed from 9 to 21 mo of outpatient rehabilitation. Discussion: Thoracic disc herniation has a great variety in its clinical manifestations. This condition can cause catastrophic neurologic deficits. Although our patients achieved modified independence in the ADL at wheelchair level; none of them was able to achieve community ambulation. This finding could be explained by lack of adequate motor control of the lower extremities, old age, and/or fear to fall. It is interesting to ask whether the functional outcome could be better with early diagnosis and treatment of this condition.

POSTER BOARD 90: TRAINING ENGINEERING STUDENTS IN THE SPECIAL NEEDS OF CHILDREN WITH COMPLEX DISABILITIES
Jacob A. Neufeld, MD, MSPH, George H. Masiero, Eugenio A. Monasterio, MD, Suzanne L. Stevens, PhD

Introduction: The care of patients with congenital and acquired disabilities is complex and requires close collaboration between professionals in medicine and allied health. Assistive technology can play a significant role in rehabilitation. The Division of Peds/PM&R of VCU and Children’s Hospital developed a summer internship for students of the VCU School of Engineering to expose students to the special engineering needs of children with disabilities. Goal: 1. Develop long-term collaboration and integration of engineering into the rehabilitation team; 2. Educate engineering students to the issues and approaches used in the prescription of assistive technology; and 3. Develop and apply clinically relevant assistive technology products. Discussion/Methods: Engineering students have not consistently had direct contact with Patients to understand the issues involved in their care and daily life. Early exposure to real life scenarios may stimulate students to consider further training in biomedical engineering. First hand access to engineers by patients and assistive technology teams can also improve individualization of technology, promoting use. Two interns were enrolled in the division of Pediatric Physical Medicine and Rehabilitation of VCU and Children’s Hospital during summer of 2004 internship. To expose them to all rehabilitation equipment needs, they observed and participated in rehabilitation rounds, equipment clinic, rotated with respiratory therapists, observed urologic assessments, participated in the gait and EMG laboratories. A small Area Health Education Grant provided interns salaries and equipment. This research was part of required internships and research projects for the VCU Departments of Mechanical, Electrical and Biomedical Engineering. Conclusions: Rehabilitation engineering plays a critical role in treating patients. Early exposure of engineering students to clinical rehabilitation will increase their interest in pursuing rehabilitation careers. Plans have been initiated to develop a permanent internship program that will stimulate engineering students to consider a rehabilitation focus while also impacting patient function.
POSTER BOARD 91: AN UNUSUAL ANATOMIC VARIANT OF MARTIN GRUBER CROSSOVER
Arjang Abbasi, DO, Chae Im, MD

Setting: Outpatient rehabilitation clinic. Case Description: 56 yr old male with the chief complaint of pain in bilateral hands and numbness and tingling in the fingertips for the past 3 yr was referred for electrodagnostic evaluation. Findings: Electrodagnostic results were consistent with a clinical diagnosis of moderate to severe Carpal tunnel syndrome bilaterally. Patient was also diagnosed with bilateral Martin Gruber Anastomosis (MGA) confirmed by recording the CMAP on 1st dorsal interosseous and stimulating at ulnar wrist, followed by ulnar elbow and median elbow. In the left arm, we obtained an ulnar CMAP of 11.9mV at the wrist, with a drop to 6.8mV below the elbow and increasing to 10.8mV above the elbow. We performed multiple stimulations at various locations and intensities above the elbow to eliminate the possibility of volume conduction. We concluded that the patient most likely has a dual crossover of median and ulnar nerves in the left arm, one across the forearm and one above the elbow.

Discussion/Results: MGA is the most common anomalous innervation of the hand involving a communication between the median and ulnar nerves. The incidence is reported to be between 8–34% with 68% of the patients affected bilaterally. The electrodagnostic studies in this case reveal a diagnosis of a dual crossover of median to ulnar nerve in the left arm, one located proximally at the distal humerus level and the second one in the forearm. No cases of double crossover in the arm have been reported in the literature. Clinicians must be aware of this anatomic variant since it can be detected electrodagnostically.

POSTER BOARD 92: THE RELATIONSHIP BETWEEN FATIGUE AND ENDOCRINE ABNORMALITIES IN PEOPLE WHO HAVE SUSTAINED TRAUMATIC BRAIN INJURY
Hima S. Doppalapudi, MD, Michelle Miller, DO, Scott Millis, PhD, Jonathan L. Fellus, DO, Brent E. Masel, MD, Randal J. Urban, MD, Jonathan Dunn, MD, Elie P. Elovic, MD

Objective: To examine the relationship between fatigue, depression and endocrine abnormalities in outpatient traumatic brain injury (TBI) patients and to explore their interrelationship between these factors, overall quality-of-life, and community integration. Design: Convenience sampling. Setting: Outpatient care facilities. Participants: 21 TBI patients, with a definitive diagnosis of TBI at least three months before enrollment, moderate to severe head injuries based on the 24 hr Glasgow Coma Scale, ages 18–55 yr. Interventions: One time visit obtaining blood samples, Subjective measures of fatigue, sleepiness and mood. A pencil and paper task assessing mental vigilance and a measure of neuromuscular fatigue. Main Outcome Measures: The following scales, test scores, and blood levels will be evaluated: Fatigue Severity Scale(FSS), VAS-f; Epworth Sleepiness Scale(ESS), Beck Depression Inventory(BDI-II), SF-36, Community Integration Questionnaire(CIQ), Digit Vigilance Task(DVT), a timed wall-sit task, and blood levels of 9 a.m. serum cortisol, free T4, testosterone, prolactin and insulin growth factor-1(IGF-1). Results: Data analysis performed with SPSS 11.0 demonstrated significant negative correlation between IGF-1 values and the FSS (P = 0.002), ESS (P = 0.01), BDI-II (P = 0.01) and VAS-f (P = 0.003)These results are suggestive of a relation between lower levels of IGF-1 and more severe fatigue, sleepiness, and depression. IGF-1 values positively correlated with CIQ (P = 0.025) scores, suggesting that higher levels of IGF-1 indicate greater community integration. Quality of life as measured by the SF-36( P = 0.667) did not correlate with IGF-1 as well as the measure of neuromuscular fatigue timed, wall-sit(P = 0.493). In contrast to anticipated findings, higher AM cortisol levels were positively correlated with the FSS(P = 0.003). Conclusions: This preliminary study suggests that there may be a significant relationship between fatigue and endocrine abnormalities in TBI patients. Subjective reporting of fatigue was correlated with specific endocrine abnormalities. Endocrine abnormalities also showed some correlation with community integration but not quality-of-life. Further study is indicated.

POSTER BOARD 93: DEEP VENOUS THROMBOSIS IN PEDIATRIC TRAUMATIC BRAIN INJURY PATIENT: A CASE REPORT
Harsh Govil, MD, MPH, Barbara Wechsler, MD, Judy Hall, PNP

Methods: Review of Medical Record. Case Description: We present a case of 8 yr old girl who was struck by a van while riding her bike. She had an initial Glasgow coma scale of 3 and was intubated at the scene. She had loss of consciousness and amnesia. CT scan of head showed an amount of subarachnoid, intraventricular hemorrhage and bilateral frontal lobe contusions. Imaging also revealed an occipital condyl fracture and bilateral nondisplaced clavicle fractures. She had no lower extremity fractures but did have a very deep laceration of her proximal left calf. A left femoral central line was placed in the emergency department for central venous access and CVP monitoring. The patient also had increased intracranial pressures so a bolt was placed by neurosurgery and the pressures were closely monitored. On day five of admission she was noted to have left lower extremity edema and venous Doppler revealed acute deep venous thrombosis of the leg involving the superficial femoral through the external iliac vein. A vena cava filter was placed because of contraindication to anticoagulation. Discussion: The incidence of deep venous thrombosis in the pediatric population has been reported to be lower than the adults. Major risk factors for DVT in children include: Trauma, indwelling catheters, venograms studies, infection, spinal cord injury and surgery. In pediatric patients, the diagnosis of DVT may be overlooked because suspicion is low. Currently, the most common diagnosis of children seen as inpatients of rehabilitation is traumatic brain injury. Clinicians working in acute brain injury rehabilitation should be aware of deep venous thrombosis in pediatric population, for its early detection and intervention.

POSTER BOARD 94: RADIAL NERVE ENTRAPMENT AS AN UNUSUAL COMPLICATION OF HETEROTOPIC OSSIFICATION AFTER TRAUMATIC BRAIN INJURY: A CASE REPORT
Jeffrey A. Strakowski, MD, Michael D. Carpenter, MD, Ernest W. Johnson, MD

Heterotopic ossification (HO) is a known complication of central nervous system trauma and can lead to painful and immobilized joints and diminish function. Rarely, nerve entrapments can occur as a result of an abnormal deposition of bone matrix. To the best of our knowledge, radial nerve entrapment has not been reported as a complication of this condition. A 36 yr old woman suffered a severe traumatic brain injury (TBI) during a motor vehicle accident. She was hospitalized for many months but display no motor weakness with the exception of a right facial neuropathy as a result of a basilar skull fracture. She later developed limitation of motion of the right elbow and subsequently noticed progressive weakness or the right wrist and digit extensors. Examination for assessment of those complaints revealed an ankylosis of the right elbow at 80 degrees. She also displayed decreased appreciation to light touch and pin prick in a radial distribution as well as weakness of extension of the right wrist and digits. Electrodiagnosis revealed neuropathic motor unit recruitment in the radial innervated muscles below the level of the brachioradialis. Stimulation of the radial motor nerve above and below the elbow with recording from the extensor digitorum communis revealed an 80% decrement. The distal radial sensory nerve action potential was relatively normal. Further diagnostic work-up revealed HO about the elbow. After determining the HO was mature, surgical resection was performed. Interoperative findings showed the radial nerve encased in the HO. Follow-up clinical examination and electrodiagnosis revealed complete recovery of the neurapraxic radial neuropathy.

POSTER BOARD 95: CHRONIC PAIN EXACERBATED BY CONSTIPATION IN SPINAL CORD INJURY: A CASE STUDY
David Binder MD, Hammam Akbik, MD, Heidi Wnennemer, DO, MA, Beth Tammaro, RN, BSN, CRRN

Many spinal cord injury patients self-report increased pain periodically. Pain in the SCI population is a common occurrence that can be detrimental to the rehabilitation process. Constipation in SCI has been previously associated with abdominal pain. However, the precise relationship between constipation and chronic pain has not been adequately studied. The following is a case study illustrating that constipation can
increase chronic pain in an SCI patient. We retrospectively studied the relationship between the daily pain scores using numeric scale and the use of PRN pain medication with the size of bowel movements over the course of 2 mo. Our data indicates that pain increased during periods of constipation but just before an evacuation with a 50% decrease in the pain scores and the use of pain medication just after a major bowel movement. There was an inverse relationship between the size of bowel movements and the number of PRN pain medications utilized. The importance of monitoring opioid side effects i.e., constipation and regular effective bowel evacuation in SCI patients cannot be underestimated. Our data illustrates the relationship between constipation and pain. This study showed that not only the regularity, but also the size of bowel movements affected pain levels. The positive benefit of decreased pain can have monumental impact on a patient’s function and quality-of-life. It is reasonable to consider an aggressive bowel program as well another tool in the management of pain.

POSTER BOARD 96: ELECTRODIAGNOSIS OF OVERLAPPING ACUTE INFLAMMATORY DEMYELINATING PERIPHERAL NEUROPATHY AND TRANSVERSE MYELITIS: A CASE REPORT
Taha Jamil, MD, Jeffrey A. Strakowski, MD, Robert H. Wyatt, MD, Ernest W. Johnson, MD

The overlap syndrome of acute inflammatory demyelinating peripheral neuropathy (AIDP) and transverse myelitis (TM) is rare and difficult to differentiate clinically. We present a case that illustrates the value of electrodiagnosis in assisting with this situation. A 76 yr old woman presented with a two week history of thoracic back pain and weakness and paraparesis in the lower limbs. She developed difficulty rising out of chair and walking and experienced several falls. Her past medical history was significant for breast cancer and cerebral aneurysm which required clipping. Examination revealed slightly less than antigravity strength in the muscles of both lower limbs. No clear motor weakness was noted in the upper limbs. Gross proprioception was normal in both the upper and lower limbs, however, there was diminished appreciation to pin prick and light touch below T12. Muscle stretch reflexes were diminished in the upper limbs and absent in the lower limbs. She also displayed new onset neurogenic bowel and bladder. Cerebral spinal fluid analysis revealed increased protein and no white or red blood cells. Magnetic resonance imaging could not be performed due to the presence of cerebral metallic clips. Lumbar x-rays and computerized-tomography-myelogram were unremarkable. The working diagnosis was transverse myelitis however electrodiagnostic studies were ordered to rule out other etiologies. Needle electromyography (EMG) showed decreased motor unit recruitment patterns at slow firing rates (8–12Hz) in the lower limbs. In contrast, the upper limbs displayed normal recruitment throughout, with the exception of mildly neuropathic motor unit recruitment in the hand intrinsics. The nerve conduction studies showed low amplitude long duration sensory nerve action potentials, low amplitude compound muscle action potentials and prolongation and blocking of F-waves in both the upper and lower limbs. Somatosensory evoked potentials showed median latencies near the upper limit of normal but the tibial latencies were significantly prolonged. The electrodiagnostic findings led to the conclusion of coexistent AIDP and subsequent appropriate treatment with intravenous immunoglobulin, to which she responded rapidly.

POSTER BOARD 97: ADJUNCTIVE MUSCULOSKELETAL SONOGRAPHIC IMAGING TO FACILITATE LOCALIZATION OF TARGETED HYPERTONIC MUSCLES DURING BOTULINUM TOXIN CHEMODENERVATION PROCEDURES
Stuart A. Yablon, MD, Zizhuan Li, MD

Background: Botulinum toxin neuromuscular chemodenervation (BTX) injection requires successful localization of an appropriately targeted muscle to yield optimal response when treating patients with motor disorders such as spasticity or dystonia. While several techniques are available to facilitate localization, electromyography (EMG) in conjunction with needle electrical stimulation (ES) is effective for injecting the vast majority of clinical important hypertonic muscle groups. There exist clinical situations, however, when visualization of the targeted hyper tonic muscle might provide additional effectiveness or safety when localizing a muscle for chemodenervation procedures. Study Design: Case series. Objective: Illustrate the relative utility of adjunctive sonographic imaging during performance of BTX injection for dysfunctional hypertonia in patients with difficult-to-localize targeted muscle groups. Methods: Four patients underwent musculoskeletal sonographic imaging (Advanced Technology Laboratories HDI 5000, Bothwell, WA) of targeted muscles (iliopsoas, pectoralis minor, latissimus dorsi, longus, flexor digitorum longus, flexor digitorum superficialis) in conjunction with needle electromyography and electrical stimulation, during performance of BTX injections for spastic hypertonia. Dose and concentration of BTX injection varied, depending upon the muscle selected. Results: Videorecording of each procedure verified that sonographic imaging facilitated visualization and localization of targeted muscles and avoidance of inadvertent perforation of adjacent structures. Conclusions: While EMG/ES localization is sufficient for the vast majority of BTX injections for spasticity, we find adjunctive sonographic imaging helpful for targeting the following hypertonic muscles/scenarios: 1) trunk muscles in the very thin/fragile/obese patient; 2) iliopsoas/hip flexors; and 3) prior surgical tendon release/transfer involving targeted muscle.

POSTER BOARD 98: THE “BULGING SKULL DEFECT SIGN” AS AN INDICATOR OF POSTTRAUMATIC OR POST-STROKE HYDROCEPHALUS
Zizhuan Li, MD, Stuart A. Yablon, MD, Domenic P. Esposito, MD

There is strong evidence from prospective, uncontrolled trials that surgical decompression for brain swelling (decompressive craniectomy [DC]) improves outcome after TBI and stroke, and this procedure has experienced a “revival” during the last decade. Few class I studies are available, however, to determine the relative efficacy or the incidence of adverse effects associated with this procedure. Hydrocephalus (HC) may occur after severe TBI or hemorrhagic stroke, with accompanying adverse outcome. We report upon a series of seven patients that underwent DC for management of severe brain swelling after acquired brain injury, and were subsequently admitted to the neurorehabilitation hospital setting. In each patient, a prominent bulge was appreciable on admission physical examination. Subsequent neuroimaging studies confirmed the presence of hydrocephalus. Management included ventriculoperitoneal shunting in five patients, with spontaneous resolution observed in two patients without surgical intervention. A bulging skull defect, as opposed to a sunken craniectomy defect, should alert the clinician caring for the neurorehabilitation patient that HC may be present. Treatment of HC in these cases may include VPS, although spontaneous resolution may occur.

POSTER BOARD 99: CHALLENGES FOR THE REHABILITATION TEAM IN THE SETTING OF A PATIENT WITH BECKER’S MUSCULAR DYSTROPHY AND END-STAGE DILATED CARDIOMYOPATHY ON A VENTRICULAR ASSIST DEVICE WAITING HEART TRANSPLANT: A CASE REPORT
Mira Shin, MD, Joseph Hanak, MD

The rehabilitation service of a tertiary care medical center was consulted to provide a management plan that would assist in reconditioning a 33 yr-old male with Becker’s Muscular Dystrophy. The patient had been placed on a ventricular assist device secondary to end-stage dilated cardiomyopathy as a bridge to heart transplantation. In this case, we describe a man who became severely deconditioned after a period of prolonged bedrest in the hospital due to multiple medical issues. The patient’s debilitated condition and nonambulatory status ultimately prevented him from meeting criteria necessary to be placed onto the transplant list. We discuss the rehabilitation challenges faced in developing a safe cardiopulmonary physiotherapy program due to lack of current standard protocols for this patient population. Patients with muscular dystrophy are known to have perioperative risk due to respiratory muscle weakness. Thus, we also discuss the ethical challenges faced in attempting to provide rehabilitation to a muscular dystrophy patient with a limited lifespan and minimal endurance. This case illustrates that as the population of patients with myopathies continues to age with complex cardiopulmonary challenges, the academic physiatrist continues to play...
a critical role in coordinating the multiple disciplines of physical medicine, rehabilitation and ethics in preparation for transplantation.

POSTER BOARD 100: THE EFFECT OF BOTULINUM TOXIN PLUS BEHAVIORAL THERAPY AND CIMT ON MOTOR FUNCTION IN STROKE: A PRELIMINARY REPORT
Charles E. Levy, MD, Clare Giuffrida, PhD, Lorrie Richards, PhD, Sandy Davis, PT, Stephen E. Nadeau, MD

Upper limb hemiparesis is a devastatingly common sequela of stroke. Constraint-induced movement therapy can restore function in those who are able to meet the minimal motor criteria of 10° of extension in the wrist and two fingers and 10° of thumb abduction. Unfortunately, many with poststroke spasticity are unable to meet these criteria. Although botulinum toxin A (BTXA) is effective in reducing poststroke spasticity, it has not been employed to improve volitional movement in the upper limb in stroke. Hypothesis: BTXA combined with a program of evidence-based behavioral therapy could help individuals with chronic poststroke upper limb hemiparesis meet the minimal motor criteria and thus be eligible to be enrolled into a course of CIMT. 12 spastic individuals 6 mo poststroke unable to meet minimal motor criteria received 300–400 U of BTXA, and behavioral therapy for 1 hr 3x/wk for 4 wk. Results: Seven of 12 displayed increased volitional control of the hand. Four of 12 were able to meet minimal motor criteria; 2 agreed to 2 wk of CIMT and completed 24 wk follow up. Discussion: Function improved in the short term, but declined as spasticity re-emerged. Conclusions: BTXA plus behavioral therapy and CIMT function improved in the short term, but declined as spasticity re-emerged.

POSTER BOARD 101: RECOGNIZING SPINAL CORD TUMORS IN THE PEDIATRIC POPULATION
Regina P. Foley, MD, Vikki A. Stefans, MD, Sonia Williams, MD

Objective: To identify common and uncommon clinical presentations of spinal cord tumors in the pediatric population. Design: Case report and literature review. Setting: Pediatric rehabilitation unit in a university/state hospital. Interventions: Not applicable. Conclusions: Intramedullary spinal cord tumors are relatively uncommon central nervous system neoplasms, accounting for four to ten percent of pediatric CNS tumors, which is significantly more common than in the adult population. Their diagnosis is often missed or delayed not only due to their rarity, but to their often nonspecific presenting symptoms and findings. Pain can precede definite weakness, reflex changes, or sensory impairment. Progression of these CNS tumors may be missed, as repeated detailed examinations would be required to monitor their course. If initial findings do not lead the clinician to refer for diagnostic imaging, these tumors can have devastating outcomes, leading to extensive permanent weakness, impaired sphincter function, bowel and bladder dysfunction, and loss of independent mobility. If the diagnosis is made early, prompt intervention can result in little to no long-term neurological deficit. We present a case with poor outcome, which was initially mistaken for malingering, and review the common and uncommon clinical presentations of pediatric spinal cord tumors to include age of onset, neurological deficits, pain, and associated syndromes.

POSTER BOARD 102: DIGITAL NERVE INJURY, BEYOND THE RING ELECTRODE: A CASE REPORT
Monica J. Carrion-Jones, MD, Jacqueline J. Wertsch, MD, Jennifer A. Kennedy, MD

Objective: This case report illustrates the limitations of traditional ring electrodes in evaluating isolated digital nerve injuries and the need for isolated digital nerve studies. Setting: Electrodiagnostic Laboratory of an Academic Center. Case Description: 59 y/o female referred to our laboratory for constant numbness in her right ring finger present since a second surgery forDupytren’s contracture eighteen months prior. Other medical history included a carpal tunnel release twenty years prior, diabetes mellitus and multiple giant cell tumor resection surgeries in the forearm. On physical exam the only positive finding was focal decreased sensation reproducibly documented on the ulnar aspect of her right ring finger. Assessment/Results: Nerve conduction studies of the right hand were performed. Radial, median (index) and ulnar (little) sensory and ulnar motor to hypothenar and FDIM were normal. Ring finger paired antidromic studies were normal with median nerve wrist stimulation but no response was obtained with ulnar nerve stimulation. To evaluate whether this reflected an anatomic variation with entire median supply to hand, ring finger instead of two fingers and 10° of thumb abduction. Unfortunately, many with poststroke spasticity are unable to meet these criteria. Although botulinum toxin A (BTXA) is effective in reducing poststroke spasticity, it has not been employed to improve volitional movement in the upper limb in stroke. Hypothesis: BTXA combined with a program of evidence-based behavioral therapy could help individuals with chronic poststroke upper limb hemiparesis meet the minimal motor criteria and thus be eligible to be enrolled into a course of CIMT. 12 spastic individuals 6 mo poststroke unable to meet minimal motor criteria received 300–400 U of BTXA, and behavioral therapy for 1 hr 3x/wk for 4 wk. Results: Seven of 12 displayed increased volitional control of the hand. Four of 12 were able to meet minimal motor criteria; 2 agreed to 2 wk of CIMT and completed 24 wk follow up. Discussion: Function improved in the short term, but declined as spasticity re-emerged. Conclusions: BTXA plus behavioral therapy and CIMT show promise to increase volitional control in chronic stroke. Further research should target sustaining and amplifying gains and diminishing the re-emergence of spasticity.

POSTER BOARD 103: THE IMPACT OF CONCUSSIONS AND FACIAL INJURIES ON PROFESSIONAL BULL RIDING
Laura W. Lee, MD, MBA, Mary G. Bryant, MD

Bull riding, unlike many other professional sports, has no guidelines for return to play after concussion, and helmets are not required. We hypothesize that in light of this policy, the leading cause of missed events is head concussions. Injuries reported from 28 of 29 events from the Professional Bull Riders 2003 Built Ford Tough Series were retrospectively analyzed. In these events, the bulls’ horns were filed to at least the diameter of a silver dollar. Bull riders in this series were in the top tier of a 3 tiered system. An orthopaedic surgeon was present at each of these elite events to assess and treat injuries. 72 bull riders sustained 157 injuries. On average, an injured rider missed 2.28 rides or events due to injury. 16 riders sustained 20 concussions and 24 riders sustained facial or head lacerations or fractures. No helmets were noted to have been worn by the riders with concussions or closed head injuries. The concussions resulted in a total of 3 missed events or rides and the facial and head lacerations and fractures resulted in a total of 5 missed events or rides. Five of the top 20 finishers sustained a total of 7 concussions and 2 face or head lacerations or fractures during the season. Since world ranking depends on total points scored, riders often continue to ride despite injury and against the advice of their physician. From this data, it is inferred that concussions were not perceived as serious injuries. However, studies have shown that mild, cumulative injuries can cause debilitating cognitive deficits. Therefore, the incidence of concussion should be monitored and riders should be encouraged to wear helmets with face masks to decrease risk of injury. Furthermore, return to play guidelines, as used in other sports, should be implemented.

POSTER BOARD 104: PREDICTORS OF OUTCOME FOR INTRA-ARTICULAR SACROILIAC JOINT INJECTIONS IN PATIENTS WITHOUT SPONDYLOARTHROPATHY
Usama Ghazi, DO, Matthew Kale Wedemeyer, MD, Annu Maratukalam, MD, Rajorshi Mitra, MD

There is wide debate in the literature regarding the efficacy of intrarticular sacroiliac joint injections (IASIJ), and even the accuracy of tests used to diagnose this clinical entity. In this study we sought to evaluate the efficacy of fluoroscopic guided IASIJ, and determine predictive factors for successful outcomes in patients without spondyloarthropathy. Retrospective chart review was used to collect data from 14 patients (without spondyloarthropathy) who had undergone IASIJ. Inclusion criteria were patients with (+) provocative SI joint maneuvers (Gaenslin’s, Fabere’s, Point test) who failed conservative management with medications, therapy and modalities. Exclusion criteria included patients with sacral fractures, lumbosacral surgery, contrast allergies or known spondyloarthropathy. Success was defined as 50% relief at 2 wk post injection. Chi Square analysis was used to determine significance of relationships between outcome to patient age (< or 40 yr old), preinjection VAS pain level (mild <3/10, moderate 4-6/10, and severe 7/10), and cause of SI pain (trauma vs. other). Our results indicated poor correlation for prediction of IASIJ outcomes in patients without spondyloarthropathy, with patient age or the three common etiologies of SIJ pain (pregnancy, trauma, lumbar DJD). We found significant positive relationship between outcomes in people with severe pain before injection (VAS 7/10). This relationship was not present when evaluating patients with mild pain (<3/10) or moderate. March 2005 Meeting Abstracts 229

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Facet arthropathy is a potential cause of low back pain (LBP). The reported prevalence of facet joint pain for patients with chronic low back pain ranges from 10–75%. To date, no reliable means exist to support a clinical diagnosis of lumbar facet joint pain without invasive techniques. A limited number of studies have attempted to establish a correlation between any clinical or radiographic tests for facet joint pain and the standard of fluoroscopically guided blocks. Retrospective chart review was used to collect data from fourteen patients with low back pain who underwent intraarticular fluoroscopy guided infiltration of corticosteroids (Kenalog) and anesthetic (1% Lidocaine). Using the Visual Analog Scale to evaluate pain relief, twelve of the fourteen patients (85%) experienced a reduction in pain by 50% or more immediately post procedure. All fourteen patients experienced at least a 30% reduction in pain immediately post procedure. Of the twelve patients who experienced more than a 50% reduction in pain, eleven (92%) had MRI evidence of degenerative facet arthritis or reactive facet edema. Ten (83%) had positive facet maneuver findings (pain reproduced by extension and rotation toward the symptomatic side) on clinical exam. These results suggest that either a positive MRI or facet loading maneuver may reasonably predict lumbar facet arthropathy as a source of low back pain. This is a pilot study and further investigation with a larger sample is needed.

**POSTER BOARD 105: THE PREDICTIVE VALUE OF MRI AND FACET LOADING MANEUVERS IN DIAGNOSING FACET ARTHROPATHY AS A SOURCE OF LOW BACK PAIN**

Matthew Kale Wedemeyer, MD, Usama Ghazi, DO, Annu Maratukalam, MD, Rajorshi Mitra, MD

Facet arthropathy is a potential cause of low back pain (LBP). The reported prevalence of facet joint pain for patients with chronic low back pain ranges from 10–75%. To date, no reliable means exist to support a clinical diagnosis of lumbar facet joint pain without invasive techniques. A limited number of studies have attempted to establish a correlation between any clinical or radiographic tests for facet joint pain and the standard of fluoroscopically guided blocks. Retrospective chart review was used to collect data from fourteen patients with low back pain who underwent intraarticular fluoroscopy guided infiltration of corticosteroids (Kenalog) and anesthetic (1% Lidocaine). Using the Visual Analog Scale to evaluate pain relief, twelve of the fourteen patients (85%) experienced a reduction in pain by 50% or more immediately post procedure. All fourteen patients experienced at least a 30% reduction in pain immediately post procedure. Of the twelve patients who experienced more than a 50% reduction in pain, eleven (92%) had MRI evidence of degenerative facet arthritis or reactive facet edema. Ten (83%) had positive facet maneuver findings (pain reproduced by extension and rotation toward the symptomatic side) on clinical exam. These results suggest that either a positive MRI or facet loading maneuver may reasonably predict lumbar facet arthropathy as a source of low back pain. This is a pilot study and further investigation with a larger sample is needed.

**POSTER BOARD 106: SUBJECTIVE AND OBJECTIVE EVALUATIONS OF CARBON FIBER REINFORCED PLASTIC LEG ORTHOSE FOR POLIO SURVIVORS**

Kenji Hachisuka, MD, Satoru Saeki, Futoshi Wada, Tetsuya Okazaki

Introduction: A carbon fiber reinforced plastic orthosis has advantages of weight, appearance, and durability, and may be beneficial to polio survivors with gait disturbance. Therefore, we examined the subjective and objective evaluations of the carbon fiber reinforced plastic knee-ankle-foot orthosis (carbon KAFO) for polio survivors. Methods: The subjects were 10 polio survivors, who were prescribed a carbon KAFO for gait disturbance. Their average age was 48.5 ± 9.1 yr, and 9 and one subjects had paralysis of bilateral and unilateral legs, respectively. Three months after completion of the carbon KAFO, they were asked to explain their own impression of walking with the carbon KAFO with a visual analog scale for 10 items. Oxygen consumption during walking and physiologic cost index were measured at the most comfortable speed with a telemetric respiratory gas analyzer: Meta Max 3B, Cortex Biophysik, Germany. The measurement was performed during walking barefoot, walking with their ordinary KAFO, and walking with their carbon KAFO in random order. Results: Ten subjects were prescribed 11 carbon KAFO. The period of completion, including usage of the tentative orthosis, was 46 ± 23 days (range: 19–80). The carbon KAFO weights 380–410g less than the previous KAFO. From the visual analog scale, the carbon KAFO was rated as good, and, especially, the items of velocity, walking distance, fatigue during walking, and safety during walking were rated very good. From oxygen consumption and PCI, 6 subjects had no difference in oxygen consumption and PCI among barefoot, carbon KAFO, and ordinary KAFO, but 4 subjects showed increase in velocity and decrease in O2 cost and physiologic cost index. Conclusions: The carbon KAFO was superior to the ordinary KAFO in subjective evaluation, and improved gait efficiency in 40% of the subjects using the carbon KAFO.

**POSTER BOARD 107: WHEELCHAIR USE AND FREQUENCY OF TRANSFERS AMONG PERSONS WITH PARAPLEGIA**

M. Christina Reyes-Littaua, MD, RPT, Alicia Koontz, PhD, RET, Michael Boninger, MD, Trevor Dyson-Hudson, MD, Bradley Impink, BS

Objective: The purpose of this study is to report among SCI subjects:1) the length of time they spend in a wheelchair, 2) the frequency of transfers, and 3) how these variables interact with demographic factors, age, duration of SCI and injury level. Design: We conducted a retrospective, cohort study with a convenience sample of paraplegics. Data were collected using a Pain and Activity Questionnaire, completed through a telephone interview. Participants: Forty-two males and fifteen females participated. The average age was 42.36 ± 11.33 yr, with an SCI level at least T1 and below, occurring over 1 yr before the start of the study, and wheelchair propulsion as their primary means of mobility. Results: There was a significant negative correlation between age and the frequency of transfers in a day using Pearson correlation (r = 0.437). However, there was no association between frequency of transfers with the level of injury or duration of SCI. There is also a significant negative correlation between the duration of wheelchair use and the injury level using Spearman’s rho correlation (r = 0.010). Duration of the SCI was not correlated with the hours/day in a wheelchair. Conclusions: This is the first study to report the hours/day of wheelchair use and frequency of transfers in paraplegics. Age is an important predictor in performing transfers. The duration of wheelchair use was affected by SCI level. This knowledge will allow us to identify SCI subjects who are at higher risk for developing complications such as pressure ulcers. Programs to educate them on prevention, lifestyle changes and more vigilant follow-up need to be in place on order to ensure continued quality-of-life.

**POSTER BOARD 108: BMI IN PARAPLEGICS**

Kevin White, MD, Navneet Gupta, Paul Sandford, Farhad Sepah Panah

Study Design: Retrospective Chart Review. Objective: To identify the prevalence of overweight and severely overweight (obese) in paraplegics. Setting: Hospital in both inpatient and outpatient setting. Methods: A retrospective chart review of all the patients registered in the current database diagnosed as paraplegic was undertaken. The following data were noted and collected for each patient and included age, sex, height, date of assessment of the height, weight, date of assessment of the weight, duration of spinal cord injury. The body mass index was subsequently calculated for each patient and the prevalence of overweight and obesity were determined. Results: There was a total of 191 patients registered in the database with paraplegia. Of the total number of patients, 101 were ASIA A, 26 were ASIA B, 24 were ASIA C and 40 were ASIA D. Of the ASIA A 62% were overweight and 24% were obese, ASIA B 64% overweight and 38% obese; ASIA C 71% overweight and 50% obese; ASIA D 85% overweight and 45% obese. Conclusions: Overweight and obesity are problems of a significant magnitude in paraplegics. The severity of overweight and obesity in paraplegics seems to increase with improved function.

**POSTER BOARD 109: PERCEPTIONS OF MANUAL MEDICINE AND STRATEGIES FOR IMPLEMENTATION IN PM&R RESIDENCY PROGRAMS: A RESIDENT SURVEY**

Wendi Lundquist, DO, Monica Steiner, MD, Andy Barker, DO, Susan Reich

Objective: To increase understanding of pediatric residents’ perceptions, current utilization and strategies for implementation of manual medicine. Method: Using a three part questionnaire, AAPMR affiliate members with an email address available on the AAPMR website were surveyed via email attachment. Data were gathered and tabulated using an excel spreadsheet. Results: Responses were received from 60 residents (90.2%) of a potential 558 that received the email. This represented 36.78% (46%) of residency programs. 40% were osteopathic, 58.3% were allopathic and 1.7% were allopathic with training in manual medicine. 85% felt MM should be a part of the PM&R residency programs. 81.7% stated they would like to practice MM during training. Residency provided training in 33.3%. Of these, the most common form was at conference and independent reading of the

**POSTER BOARD 108: BMI IN PARAPLEGICS**

Kevin White, MD, Navneet Gupta, Paul Sandford, Farhad Sepah Panah

Study Design: Retrospective Chart Review. Objective: To identify the prevalence of overweight and severely overweight (obese) in paraplegics. Setting: Hospital in both inpatient and outpatient setting. Methods: A retrospective chart review of all the patients registered in the current database diagnosed as paraplegic was undertaken. The following data were noted and collected for each patient and included age, sex, height, date of assessment of the height, weight, date of assessment of the weight, duration of spinal cord injury. The body mass index was subsequently calculated for each patient and the prevalence of overweight and obesity were determined. Results: There was a total of 191 patients registered in the database with paraplegia. Of the total number of patients, 101 were ASIA A, 26 were ASIA B, 24 were ASIA C and 40 were ASIA D. Of the ASIA A 62% were overweight and 24% were obese, ASIA B 64% overweight and 38% obese; ASIA C 71% overweight and 50% obese; ASIA D 85% overweight and 45% obese. Conclusions: Overweight and obesity are problems of a significant magnitude in paraplegics. The severity of overweight and obesity in paraplegics seems to increase with improved function.
literature. 61.7% stated that MM was not provided. Of those, 76.3% agreed with including it as part of PM&R training with required rotation (26.7%), elective rotation (33%), conferences (30%) and videotape (15%). 45% were allowed to practice manual medicine and 31.7% of residents were not. Supervision was obtained by osteopathic (21.7%), non-osteopathic (20%) and nonosteopathic with MM training (20%) and 3.3% by all three. In response to managing need for supervision, 80% of residents felt attendings should become more familiar with MM and 50% felt programs should hire more attendings trained in MM. Greater than 100% responses occurred due to multiple responses for one question. Conclusions: The results of this survey of PM&R residents demonstrate continued interest in manual medicine and improved manual medicine instruction in residency programs since 1993. However, an unmet need still exists. Availability of trained supervising attendings likely is a barrier in training and implementation. A majority of residents felt the best way for PM&R residency directors to manage this is to become more familiar with manual medicine and hire more attendings trained in MM.

POSTER BOARD 110: ELECTRICAL STIMULATION FOR DYSPHAGIA: A CASE STUDY AND REVIEW

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Patient: The patient is a 51 yr-old man with dysphagia who presented to our brain injury rehabilitation unit one month after his stroke. Case description: Since the stroke, our patient had been on a puree diet with thickened liquids and had not progressed. The patient received 30 min of electrical stimulation daily to the muscles involved in swallowing for six days. Research by Freed et al. 2001, Leelaminit et al. 2002, and Power et al. 2003 is carefully examined in this paper. Results: Our patient improved from a diet of puree with thickened liquids to a regular diet after only 6 sessions. Despite imperfections in design, the current literature makes a strong argument for the usage of electrical stimulation in dysphagia. Discussion: The usage of electrical stimulation has gained popularity in the rehabilitation of post surgical patients, musculature strengthening, improvement of audition, and retardation of atrophy of denervated muscle. Although the Food and Drug Administration approved electrical stimulation for dysphagia in June 2001, many physiatrists do not make electrical stimulation part of their treatment strategy. In addition, electrical stimulation is used by a very small number of speech therapists. Conclusions: We conclude that usage of electrical stimulation for dysphagia is a safe and effective modality that has been underused. With proper education, it is hoped this method will gain popularity and become part of a standard rehabilitation protocol.

POSTER BOARD 111: COEXISTENCE OF AS WITH BJHS: ARE THEY COMPLEMENTARY TO EACH OTHER?

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Objective: To present cases of coexistence of pathologically opposite conditions ankylosing spondylitis (AS) and benign joint hypermobility syndrome (BJHS). Design: We evaluated the clinical findings of 25 cases of ankylosing spondylitis with overlapping clinical picture of benign joint hypermobility syndrome. Results: There were 23 males and 2 females with the mean age of 25.92 ± 7.54 yr (age range 17–41 yr). The mean duration of the disease was 6.25 ± 6.72 yr. The mean Beighton’s score for joint hypermobility syndrome was 6.36 ± 1.32. Schobers test was positive in 13 patients and 23 patients were positive for HLA-B27. ESR was elevated in 24 patients and 68% patients were with grade II saccroiliitis. Cardiovascular, ophthalmologic complications were also observed in some patients. Ligament and meniscus injuries were observed in 3 patients. It was observed that many of the patients had contractions of major joints along with spinal deformity and simultaneously they had hypermobility in other major and smaller joints. Conclusions: Coexistence of these two opposite disorders causes confusion and thus delay in the diagnosis and management, leading to further disability. Hypermobility can be advantageous for a stiff spine and for major joints. By the care of the joints and spine with proper exercises program further deformities and soft tissue injuries can be prevented.
and resultant severe corroborative spinal stenosis who were offered surgical intervention met our inclusion criteria. Demographic data, symptom and injection specifics were collected for analysis. Additionally the need for surgery following injection was obtained. Results: Nine patients met our inclusion criteria. Initial data analysis suggest excellent short and intermediate term efficacy of snri with some patients able to avoid surgical intervention at 23 mo. Discussion: This study suggests that patients were able to achieve significant short and intermediate term relief of symptomatology and delay, and in some cases, obviate the need for reconstructive spine surgery. Conclusions: This preliminary retrospective chart review suggests snri may be an effective intervention in the management of radicular pain due to degenerative scoliosis curves of greater than 40 degrees and resultant severe corroborative spinal stenosis.