Successful interventions to reduce first-case tardiness in Dutch university medical centers: Results of a nationwide operating room benchmark study

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Abstract

BACKGROUND: First-case tardiness is still a common source of frustration. In this study, a nationwide operating room (OR) Benchmark database was used to assess the effectiveness of interventions implemented to reduce tardiness and calculate its economic impact.

METHODS: Data from 8 University Medical Centers over 7 years were included: 190,295 elective inpatient first cases. Data were analyzed with SPSS statistics and multidisciplinary focus-group study meetings. Analysis of variance with contrast analysis measured the influence of interventions.

RESULTS: Seven thousand ninety-four hours were lost annually to first-case tardiness, which has a considerable economic impact. Four University Medical Centers implemented interventions and effectuated a significant reduction in tardiness, eg providing feedbacks directly when ORs started too late, new agreements between OR and intensive care unit departments concerning “intensive care unit bed release” policy, and a shift in responsibilities regarding transport of patients to the OR.

CONCLUSIONS: Nationwide benchmarking can be applied to identify and measure the effectiveness of interventions to reduce first-case tardiness in a university hospital OR environment. The implemented interventions in 4 centers were successful in significantly reducing first-case tardiness.

Operating rooms (ORs) are of paramount importance to a hospital, given the fact that more than 60% of patients admitted to a hospital are treated in the OR.¹ Efficient use of OR capacity is pivotal since it is considered a high-cost environment but a limited hospital resource.² Because of the aging population and various developments in surgery, demands for OR facilities are likely to increase.³ Moreover,
because of shortages of qualified OR staff, optimal utilization of ORs is an ever-increasing challenge.\(^1\)

In ORs, however, inefficiencies can occur at several different moments during the day. They can occur before, during, between, and after cases.\(^3,4\) First-case tardiness (a “late start” of the first surgical case of the day) is a common source of frustration for patients, management, and the surgical team. Once a case is delayed, a typical “trickle down” effect causes the delay to increase as the day progresses, potentially affecting the rest of the scheduled patients.\(^5\)

This might result in cases finishing late and over-utilization of OR time. Patient satisfaction may be reduced if cases are delayed beyond their scheduled start times, particularly if patients who had to fast are kept waiting for several hours. Cases scheduled later in the afternoon may even be cancelled as a result.\(^6\) This encouraged researchers to study factors that cause first-case tardiness.\(^6-8\) Although the majority of previous research focused on the origin of first-case tardiness, very few practical solutions to the problem have been studied.\(^5,7,9\)

In 2004, the OR departments of all 8 University Medical Centers (UMCs) in the Netherlands established a benchmarking collaboration, which has been active up to today. The objective of the collaboration is to improve OR performance by learning best practices from each other. Each UMC provides data on all surgical cases performed in their center to a central OR Benchmark database. Every 2 months multidisciplinary focus-group study meetings are organized to discuss the results of the data analysis and explore processes and practices “behind the data.” Through promoting dialogue between UMCs a learning environment is created. Furthermore, a national invitational conference is organized once per year to provide a broader learning and knowledge sharing platform. In comparison with the number of professionals attending the focus-group study meetings (approximately 25 to 30 professionals per meeting from all 8 UMCs), these annual conferences are visited by approximately 200 professionals.

The central OR Benchmark database — today containing more than one million records of surgical cases — is used to calculate key performance indicators of the utilization of OR capacity, eg raw utilization, turnover time, under- and over-utilized OR time, and first-case tardiness. These indicators are shared between UMCs, which enables the identification of areas of improvement by comparing one’s own performance to that of other similar organizations.

This extensive database is also used for multicenter research on OR scheduling topics and OR efficiency. In this study, we aim to assess the effectiveness of interventions implemented to reduce first-case tardiness in a university hospital setting and to calculate the economic impact of first-case tardiness.

### Methods

All 8 UMCs in the Netherlands provided data to the central OR Benchmark database on all surgical cases performed at those institutions. If an OR complex of a single UMC was divided into a main location and sub-locations such as a Cancer Center, Children’s Hospital, and Thorax Center, merely the main (largest) inpatient OR location was included. Longitudinal data collection within the OR benchmarking collaboration started in 2005 and is still performed today. An independent data management center administers the central OR Benchmark database. This center provides professional expertise to facilitate the collection and processing of data records. Subsequent to the collection procedure, this center performs reliability checks before data analysis. Data provided by the data management center were used to calculate key performance indicators of the utilization of OR capacity.

The performance of 1 OR day, which is generally equal to 8 hours of block time allocated to a specific surgical department, is commonly evaluated by the indicator “raw utilization.” The time when there is no patient present in the OR, the so-called “nonoperative time,” can be evaluated by 3 performance indicators: first-case tardiness, turnover time, and empty OR time at the end of the day, if cases finish earlier than scheduled. If cases run longer than the regularly scheduled hours of allocated block time, this is termed over-utilized time. All these performance indicators were calculated once per OR day (Fig. 1).

This study focused on first-case tardiness. Data analyzed in this research project were retrieved from the central OR Benchmark database from January 1, 2005 to December 31, 2011. All elective inpatient surgical cases were included. Day care surgery cases as well as nonelective (emergency)
cases were excluded from the study. At the start of the collaboration, data definitions of time intervals were harmonized among all benchmarking participants.10

In 2005, first-case tardiness was already a known problem in Dutch UMCs and a common source of inefficiency for OR management, the surgical team, and patients. This was the primary reason why first-case tardiness was used as a key performance indicator in the OR benchmarking. Three UMCs (UMC2, UMC3, and UMC5) decided to focus their specific efforts on the implementation of interventions to reduce first-case tardiness. UMC8 decided to focus on the implementation of a multidisciplinary preoperative team briefing in the holding area, not intentionally aiming at the reduction of tardiness; however, expecting this could be a beneficial side effect since nonavailability of specific team members is a known cause of tardiness.3,5,8 The other 4 UMCs prioritized different topics for their agenda, eg improving OR scheduling and/or reducing turnover time.

Since 2005 (when data collection started), 2 focus-group study meetings concentrated solely on first-case tardiness. During these meetings, it is custom to openly display the data as well as data analysis results to all benchmarking participants, to provide checks on integrity of the data, and to support discussions on the interpretation of data. During these 2 specific meetings, the interventions that were (going to be) implemented to reduce tardiness were identified and discussed. In 2012, an additional focus-group study meeting was organized around the same topic and the longitudinal data analysis was discussed to determine whether the interventions had proven their success over the past few years. This analysis consisted of exploring the data concerning first-case tardiness of all 8 UMCs from January 1, 2005 to December 31, 2011 using descriptive statistics and box-and-whisker plots. In this particular meeting, OR managers, anesthesiologists, surgeons, anesthesia nurses, OR nurses, and staff advisors of all 8 UMCs were represented (n = 27).

The performance indicator “first-case tardiness” was defined by the difference between the scheduled starting time (generally 8:00 AM) and the actual room entry time of the first patient on that day (per OR). This value was zero if the case entered the OR early or exactly on the scheduled time.11 First-case tardiness is measured once per OR day. The common scheduled starting time was adjusted in case of an intentionally altered starting time. Every minute of first-case tardiness was calculated, as well as the percentage of first cases starting at least 5 min too late. The actual room entry time was prospectively and electronically registered by the OR nursing staff in the Hospital Information System in all individual UMCs during the operation and validated by the surgeon and the anesthesiologist in charge after completion of the operation.

**Statistical analysis regarding interventions**

Data analysis was performed using SPSS statistics Version 20 (IBM Corp, Armonk, NY). Normality of distribution was determined using the Kolmogorov–Smirnov test. First-case tardiness was analyzed with the following descriptive statistics: mean ± standard deviation, median, interquartile range (IQR), and box-and-whisker plots.

The Wilcoxon–Mann–Whitney test – the nonparametric alternative of the independent samples t test – was applied to determine differences between the UMCs that did implement an improvement strategy to reduce first-case tardiness and the UMCs that did not. Every UMC that implemented an intervention was also compared with the other 7 UMCs to establish the impact of each intervention separately.

To measure the influence of implemented interventions to reduce tardiness, a (quasi-experimental) time-series design was applied and multiple time periods over several years before and after the intervention were evaluated.12 For that reason relevant data sets were divided into 4 equal periods of time. The 4 different periods in the time-series design were compared with an analysis of variance (ANOVA). To test if the interventions led to a reduction in first-case tardiness, a contrast analysis was applied: an intervention contrast, a preintervention contrast, as well as a postintervention contrast were tested. Prior thereto Levene’s test was examined. Violations of the basic ANOVA assumptions were examined. The nonparametric alternative to the one-way ANOVA, the Kruskal–Wallis one-way analysis of variance, was used to confirm parametric testing.

**Economic impact**

To assess the economic impact of tardiness, the sum of all lost time (sum of first-case tardiness in minutes) was calculated for every UMC per year. The economic value of time wasted because of first-case tardiness was estimated according to 3 scenarios (A, B, and C). Scenario A was based on a more conservative approach to OR labor cost of $3.35 per regularly scheduled minute of OR time.11 In this scenario, supply costs, indirect costs, anesthesiologist fees, and surgeon fees were excluded. Scenario B was based on OR costs calculated in the clinical OR department of 1 UMC: $13.29 per regularly scheduled minute of OR time including labor costs, supply costs, indirect costs, anesthesiologist fees, and surgeon fees. In both scenario A and B, the economic cost of wasted OR time was divided by the mean number of staffed ORs in that specific year, to allow for valid comparison between all UMCs. In scenario C, occurrences of late starts that lasted for at least 60 min and maximum 120 min were determined (minutes of tardiness multiplied by frequency). Subsequently, this amount was divided first by 60 and then by 120, to indicate how many cases with a total procedure time of 60 min, and a total procedure time between 60 and 120 min, could have been operated on in that idle time. Total procedure time was defined as “patient in” to “patient out” of the OR.

**Relationship between first-case tardiness and raw utilization**

Finally, linear regression analysis was used to identify the relationship between the single predictor variable
“first-case tardiness” (x) and the response variable “raw utilization” (y). Adjusted $R^2$ values were calculated for each UMC. The performance indicator “raw utilization” (%) was defined as the total amount of time patients are present in the OR, divided by the total amount of allocated OR time per day, in a given 8-hour block time (eg 8:00 h until 16:00 h) $\times$ 100%. This excluded turnover time and over-utilized OR time.

**Results**

A total of 190,295 elective inpatient surgical cases, qualifying as first cases of an OR day, were included for analysis. Mean ± standard deviation, median, IQR, and mean percentage of first cases starting at least 5 min too late per UMC during the years 2005 up to and including 2011 are shown in Table 1. These descriptive statistics demonstrated that on an overall level of 8 UMCs in the Netherlands, 43% of all first operations start at least 5 min later than scheduled and that 425,612 min (7,094 hours or 887 8-hour OR days) were lost to this annually. For all inpatient elective first cases of all 8 UMCs, first-case tardiness showed 7 min of reduction in IQR from 23 min in 2005 to 16 min in 2011 (Fig. 2). Data of each UMC and each year showed that first-case tardiness was not normally distributed (Kolmogorov–Smirnov test, $P < .0005$) and skewness values confirmed a positively skewed lognormal distribution.

**Interventions to reduce first-case tardiness**

UMC2 implemented a comprehensive intervention to reduce first-case tardiness in 2007. This intervention effectuated a 7-min reduction in IQR from 18 min in 2007 to 11 min in 2008 and the following years. First, a specific team was assigned to provide feedback directly when ORs started too late, in person, and on the spot every morning, by walking around. Team members consisted of an OR coordinator, anesthesiologist, surgeon, OR nurse, and anesthesia nurse. Second, a change in activities concerning the patient process was realized: the OR nurse, instead of the anesthesia nurse, became responsible for the transport of a patient from the holding area to the OR. Meanwhile, the anesthesia nurse could continue preparing the OR for surgery. Finally, during morning hours a “postcall anesthesiologist” was assigned to avoid tardiness caused by the fact that 1 anesthesiologist covers 2 ORs simultaneously. The Wilcoxon–Mann–Whitney test revealed significant differences ($P < .0005$) in first-case tardiness between UMC2 (mean rank 57,120 min first-case tardiness) and the other 7 UMCs (mean rank 63,723 min).

In UMC3, the original high values of tardiness – especially in the highest 25% of the data – were caused by uncertain post anesthesia care unit (PACU) or ICU availability. The increased percentage of first cases starting at least 5 min too late was caused by the fact that 1 anesthesiologist covers 2 ORs simultaneously. However, tardiness was significantly reduced in 2007 (18-min reduction in IQR from 45 min in 2006 to 27 min in 2007 and further reduced the following years) when a new method of scheduling to control the workloads of PACU and ICU departments were introduced. Furthermore, new agreements between the OR and ICU departments were implemented. Previously, early in the morning deliberation on PACU and ICU availability caused delay for the first patient scheduled for major surgery requiring postsurgical ICU. With the help of a new agreement between OR and ICU, the OR did not have to wait to start the procedure until an ICU bed was officially “released.” If there was no ICU capacity available, an extra temporary ICU bed was created and the OR could start without delay. Moreover, day shift starting time of anesthesia nurses was changed from 7:30 AM to 7:15 AM to generate extra time to prepare the OR. The Wilcoxon–Mann–Whitney test revealed significant differences ($P < .0005$) in first-case tardiness; however, in the opposite direction due to the original high value of tardiness at the starting point: UMC3 (mean rank 65,144 min first-case tardiness) and the other 7 UMCs (mean rank 62,487 min).

UMC5 implemented an intervention to reduce first-case tardiness, which consisted of a shift in responsibilities: before 2007, the anesthesiologist had to be physically present while the anesthesia nurse brought the patient to the OR; since 2007 this was no longer required because of protocol changes. Six minutes of reduction in IQR from 15 min in 2006 to 9 min in 2007 were effectuated. Since 2009 UMC5 used a new method of scheduling to control the workload of PACU and ICU departments. Furthermore, new agreements between the OR and ICU departments were implemented, similar to the “ICU bed release” policy in UMC3. The Wilcoxon–Mann–Whitney test revealed significant differences ($P < .0005$) in first-case tardiness between UMC5 (mean rank 45,378 min first-case tardiness) and the other 7 UMCs (mean rank 64,563 min).

In 2009, UMC8 implemented a multidisciplinary preoperative team briefing in the holding area – because of entrance into the OR – with the objective to improve patient safety. UMC8 did not intentionally focus on the reduction of first-case tardiness; nevertheless, mean tardiness had decreased with 4 min and further reduced the following years, since the implementation of the preoperative team briefing. The Wilcoxon–Mann–Whitney test revealed no significant differences ($P < .883$) in first-case tardiness between UMC8 (mean rank 62,899 min first-case tardiness) and the other 7 UMCs (mean rank 62,857 min).

**Effectiveness of interventions**

Fig. 3 illustrates that the group of 4 UMCs with an intervention effectuated 7 min of reduction in IQR from 20 min in 2005 to 13 min in 2011 ($P < .0005$, Wilcoxon–Mann–Whitney). The other group of 4 UMCs without an intervention showed an IQR of approximately 25 min of first-case tardiness every year.
Results of UMC2 and UMC8 showed a significant difference with regard to the intervention contrast ($P < .0005$). These UMCs also showed that differences in tardiness concerning the preintervention contrast ($P < .566$ and $P < .105$, respectively) and postintervention contrast ($P < .344$ and $P < .498$, respectively) were not significant. UMC5 revealed significant results for the intervention contrast ($P < .0005$) as well as the postintervention contrast ($P < .0005$); the preintervention contrast was not significant ($P < .387$). UMC3 demonstrated significant results for all
3 contrasts with $P$ values of <.0005, <.007, and <.0005, respectively (see Fig. 4 for results of the ANOVA with contrast analysis). Levene’s test was significant ($P < .0005$), thus equal variances between the 4 equal periods (2 before and 2 after the intervention) were not assumed.

**Economic impact**

The total loss because of first-case tardiness calculated from the findings of this study, using scenarios A and B, are shown in Table 2 per UMC and in any investigated year. All calculations were made in US dollars. Regarding economic impact, the intervention implemented in UMC2 effectuated the largest reduction of all interventions, followed by UMC8, UMC5, and UMC3, in that order. UMC2 realized a reduction of 27,392 min of tardiness in 1 year. With scenario A, this meant a shrinkage of $91,763 (6,555 per OR) and with scenario B a shrinkage of $364,040 (26,003 per OR).

Considering the total dataset of all 8 UMCs, scenario C showed 6.5% ($n = 6,790$) of first-case tardiness that lasted at least 60 min and maximum 120 min, which added up to a total amount of 582,437 min of lost time. A number of that 9,707 cases with a total procedure time of 60 min (a mean of 173 cases per year per UMC) or 4,854 cases with a total procedure time between 60 and 120 min (a mean of 87 cases per year per UMC) could have been operated on in that idle time.
Relationship between first-case tardiness and raw utilization

Linear regression analysis demonstrated a significant relationship between first-case tardiness and the variation in raw OR utilization in each UMC ($P < .0005$). On an overall level of all 8 UMCs, 28% of the variation in raw utilization was explained by the variation in first-case tardiness. Adjusted $R^2$ values per UMC ranged from 18% to 34%. Fig. 5 depicts a scatter plot of 1 random UMC (5) showing first-case tardiness in minutes against raw utilization%, $n = 19,534$ inpatient elective first cases, adjusted $R^2$ value is 22%.

Comments

On an overall level of 8 UMCs in the Netherlands, 43% of all first operations start at least 5 min later than scheduled and 425,612 min are lost because of this annually, which has a respectable economic impact. This study also shows that on an overall level of all UMCs, first-case tardiness has decreased since 2005; this decrease persists up to and including 2011 (study period). Moreover, this study demonstrates that 4 UMCs implemented successful interventions to reduce tardiness. These UMCs showed a stepwise reduction in variation of first-case tardiness, in other words a decrease in IQR during the years, which indicates an organizational learning effect. ANOVA with contrast analysis shows that a marked change occurred at the time of the intervention in these 4 UMCs, which indicates the success of their interventions.

The ANOVA with contrast results of specifically UMC3 demonstrated that the trend toward improvement may have been present before the intervention. This finding suggests that the original high value of tardiness of UMC3 at the starting point might be an important determinant for improvement. A high sense of urgency is a critical success factor for a change process to succeed. Purely based on the original values of tardiness from UMC2, UMC5, and UMC8, these centers had less sense of urgency and fewer room to improve first-case tardiness; nevertheless, they did and also succeeded significantly. UMC3 showed the highest relative improvement because of their lower original value and thus having more room to improve than other UMCs.

Inefficient use of OR capacity is a worldwide problem. Previous studies have been carried out with the goal to increase efficiency, allowing additional cases to be performed in the same operating time for the same cost. A number of studies focused explicitly on first-case tardiness. However, these studies were performed within the context of either 1 or 2 (university) hospital(s), only 1 or 2 surgical services within a hospital, or with the
use of data collected in 1 year. This is the first nationwide longitudinal multicenter study that involved repeated and continuous measurement of the same parameters – including first-case tardiness – for a period of 7 years and is, with 190,295 (first) surgical cases, the largest set of OR data published from the Netherlands to date.

Although recent studies have indicated that first-case tardiness does not affect OR efficiency \(^{19,21,22}\) and the “trickle down” effect has been argued against \(^{15,18,19,23}\) first-case tardiness remains of interest because it continues to be perceived as a key performance indicator of inefficiency in the OR.\(^3\) Moreover, this can be confirmed in
the OR practice of all 8 UMCs in the Netherlands, the participants of this benchmark study as 28% of the variation in raw utilization was explained by the variation in first-case tardiness in this study. Also other fundamental elements might be influenced by it in a negative manner. Patient satisfaction may be reduced if operations are delayed beyond their scheduled start times, particularly if patients who had to fast are kept waiting for several hours. Furthermore, delays are a source of frustration for health care professionals and, although time saved by reducing first-case tardiness cannot be accommodated with extra operations, the time saved is still time that can be used for other purposes. The multidisciplinary focus group in this study corroborated that starting on time means less rush at the beginning and potentially throughout the day; and rushing has been identified as one of the factors that lead to an unsafe working environment. In this context, the outcomes of this study may contribute to the improvement of overall OR practice.

With reference to the central OR Benchmark database and specifically the 2 performance indicators analyzed in this study, first-case tardiness and raw utilization, a major concern of the readers could be the distribution of the data and the manner of statistical testing. Data in this study showed a positively skewed lognormal distribution; thus, the assumption of normality was dishonored. ANOVA is considered a robust test against the normality assumption, particularly with large sample sizes \( n \geq 1,000 \), which was the case in this study. This is particularly true for larger sample sizes, since the sampling distributions then have weaker dependence on the shape of the population distribution. In addition, Kruskal–Wallis one-way analysis of variance showed the same results and therefore one-way ANOVA with contrasts was further applied in this study to compare more than 2 groups. Concerning linear regression analysis, normality of data is not a principal assumption. Normality of the error distribution is a principal assumption, which justifies the use of linear regression; yet again, it is not imperative for large sample sizes \( n \geq 1,000 \), which was the case in this study.

Benchmarking is more than performance comparison between organizations. Our nationwide OR benchmarking collaboration focuses mainly on learning from each other, knowledge sharing, discussing strengths and weaknesses, and identifying good practices. Multidisciplinary focus-group study meetings are frequently organized within the collaboration to discuss data analysis results and explore processes and practices “behind the data.” Through promoting dialogue between UMCs, a learning environment is created. The focus-group study meeting within this specific research appeared to be an effective method to identify interventions that were implemented to reduce first-case tardiness (specific goal) in UMC2, UMC3, and UMC5, and also to identify a strategy to improve patient safety, while demonstrating that a reduction in first-case tardiness appeared to be an attractive side effect (in UMC8).

This study has several limitations. First, within a health care system, particularly in a complex and dynamic environment such as the OR, multiple changes occur during any given period. The evaluation of quality improvements, like the interventions to reduce first-case tardiness in this study, frequently rely on weak “before–after” designs. These “other” changes might have produced the preferred improvements, instead of the specific intervention. One way to minimize this possibility is to consider multiple time periods in a time-series design as used in this research. The applied ANOVA with 3 contrasts conveys the extent of background variation and also indicates the extent to which any trend toward improvement may have been present before the intervention. Second, the calculation of the specific economic value because of the loss of OR time in absolute terms also remains complex. This is particularly the case for UMCs that typically have 3 core responsibilities: teaching and training, research, and tertiary patient care. The yearly loss in labor costs was estimated (scenario A), which is a rather conservative calculation method since supply costs, indirect costs, anesthesiologist fees, and surgeon fees are excluded. However, critics will object to this way of calculating the economic value of losing OR time, because the extra minutes gained would not allow any additional cases to be performed. Dexter et al. found that, because of a lack of knowledge and a psychological bias on this topic, OR managers can become fixated on strategies to avoid first-case tardiness. Dexter et al state that first-case delays are small delays in time, which are not clearly economically important, because the costs of reducing these delays are often high and time reduction in each OR is often limited. In addition, Macario suggested – however lacking data to support the claim – that first-case tardiness of up to 45 min remain consistent with efficient performance. That is why, in this study, specific time intervals of tardiness were investigated.
Scenario (C) estimated the economic impact of first-case tardiness by focusing on a specific time interval of tardiness between 60 and 120 min, and found that 9,707 cases with a total procedure time of 60 min or 4,854 cases with a total procedure time between 60 and 120 min could have been operated on in that idle time. This could contribute to the reduction in inefficiency.

Reducing first-case tardiness and increasing the proportion of on-time starts is merely one aspect of efficient use of OR capacity. In ORs, inefficiencies can occur before, during, between, and after cases. Further research is required considering the additional performance indicators in this nationwide multicenter Benchmark database such as turnover time, under-utilized OR time, over-utilized OR time, and the difference between the estimated and actual duration of operations.

In conclusion, first-case tardiness occurs on a daily basis in Dutch UMCs and this has a sizeable impact on OR efficiency. Yet, this study shows that benchmarking can help to overcome this by exchanging best practices and prevent “reinventing the wheel” through organized learning and networking. In accordance with De Korne et al., our study corroborates that benchmarking is highly dependent on social processes and a learning environment parallel to a structured and rational process of sharing performance data. Transfer of knowledge is one of the major targets of the OR benchmarking collaboration. During the 2-monthly organized multidisciplinary focus-group study meetings and the yearly national invitational conference, targets between hospitals are a matter of discussion and presentation. The overall data presentation is accomplished by best practices from different hospitals. Thus, knowledge transfer is performed according to 2 routes: data analysis and best practice sharing.

Overall, this study shows that benchmarking can be applied to identify and measure the effectiveness of interventions to reduce first-case tardiness in a university hospital OR environment.

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References

22. Macario A. The limitations of using operating room utilisation to allocate surgeons more or less surgical block time in the USA. Anaesthesia 2010;65:548–52.