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Enhancement opportunities in operating room utilization; with a statistical appendix



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ABSTRACT

Background: The purpose of this study was to assess the direct and indirect relationships between first-case tardiness (or “late start”), turnover time, underused operating room (OR) time, and raw utilization, as well as to determine which indicator had the most negative impact on OR utilization to identify improvement potential. Furthermore, we studied the indirect relationships of the three indicators of “nonoperative” time on OR utilization, to recognize possible “trickle down” effects during the day.

Materials and methods: (Multiple) linear regression analysis and mediation effect analysis were applied to a data set from all eight University Medical Centers in the Netherlands. This data set consisted of 190,071 OR days (on which 623,871 surgical cases were performed).

Results: Underused OR time at the end of the day had the strongest influence on raw utilization, followed by late start and turnover time. The relationships between the three “nonoperative” time indicators were negligible. The impact of the partial indirect effects of “nonoperative” time indicators on raw utilization were statistically significant, but relatively small. The “trickle down” effect that late start can cause resulting in an increased delay as the day progresses, was not supported by our results.

Conclusions: The study findings clearly suggest that OR utilization can be improved by focusing on the reduction of underused OR time at the end of the day. Improving the prediction of total procedure time, improving OR scheduling by, for example, altering the sequencing of operations, changing patient cancellation policies, and flexible staffing of ORs adjusted to patient needs, are means to reduce “nonoperative” time.

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1. Introduction

Health care today is faced with several challenges as follows: rising costs, changing demographics, aging population, technological innovations, and changing patients' demands. Hospitals and operating room (OR) departments in particular, aim to improve quality and safety, as well as utilization and efficiency. ORs are cost-intensive, multiprofessional parts of health care organizations [1]. Generally, more than 60% of patients admitted to the hospital are treated in the OR [2]. ORs typically account for more than 40% of a hospital's total revenues and a similarly large proportion of its total expenses [3]. Thus, efficient usage of OR capacity is pivotal.

In ORs, inefficiencies can occur at several moments throughout the day, before, during, between, and after cases [4,5]. OR capacity is often evaluated by the indicator "raw utilization," which is the percentage of allocated OR time that a patient was physically present in the room [1]. The time when there is no patient present in the OR, so-called "nonoperative" time, is the sum of three performance indicators as follows: first-case tardiness (or "late start" as it is referred to in the rest of this article), turnover time, and underused OR time.

Several studies have evaluated OR utilization, mainly by analyzing one aspect of "nonoperative" time, such as late start [5–10] and turnover time [11–13] or the aspects of underused and overused time at the end of the day [14,15]. Most of these studies have focused merely on one hospital, a small number of surgical departments, or simulation of data. Multicenter studies using an extensive empirical data set in view of evaluating OR inefficiencies are scarce. Besides, previous studies have not yet evaluated the way in which all performance indicators interact.

We hypothesized that the three indicators of "nonoperative" time may each negatively impact OR utilization. Therefore, we determined the relationship between late start, turnover time, underused time and OR utilization, in all eight University Medical Centers (UMCs) in the Netherlands. We assessed which indicator had the most negative impact on OR utilization to identify improvement potential. Furthermore, we studied the indirect relationships of the three indicators of "nonoperative" time on OR utilization, to recognize possible "trickle down" effects during the day.

2. Materials and methods

2.1. Research setting

In 2004, the OR departments of all eight UMCs in the Netherlands established a benchmarking collaborative, which has been active up to today. The objective is to improve OR performance by mutual learning from best practices. Each UMC provides data on all surgical cases performed in the individual center to a central OR Benchmark database. This extensive database—today containing more than one million records of surgical cases—is used to calculate key performance indicators of the utilization of OR capacity. These

indicators are based on internationally recognized definitions [16–18].

2.2. Performance indicators

OR time was evaluated by the indicator "raw utilization" (%), which was defined as the total amount of time patients are present in the OR divided by the total amount of allocated block time (generally from 8 AM until 4 PM) per day \times 100%. Block time was allocated to a specific surgical department. The definition of raw utilization excluded turnover time and overused OR time [1,5]. Raw utilization was calculated considering all cases operated on within block time, whether they were elective or emergency cases. However, emergency cases, which started after block time, were not considered for calculating any of the performance indicators.

"Nonoperative" time was assessed by three performance indicators as follows: first-case tardiness (or "late start"), turnover time, and underused OR time. The indicator first-case tardiness (a "late start" of merely the first surgical case of the day) was defined by the difference in minutes 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 [5,6]. The common scheduled starting time was adjusted in case of an intentionally altered starting time [5].

The indicator turnover time represented the cumulative turnover time in minutes per OR day. Turnover time was defined as the time interval between two succeeding cases; the time between one patient leaving the OR and the next patient entering that OR [11], also known as cleaning time [19].

Underused OR time at the end of the day was quantified by the difference in minutes between the actual and scheduled (generally 4 PM) room exit time of the last patient of the day, finishing before 4 PM [20]. The common scheduled finishing time was adjusted in case of an intentionally extended finishing time.

Raw utilization, late start, turnover time, and underused time are indicators measured once per OR day, meaning: once per OR per weekday per hospital (e.g., if an UMC facilitates 20 ORs, 20 OR days were recorded per weekday, if all these 20 ORs were staffed that particular day and allocated to a specific surgical department). One OR day is generally equal to 8 h of block time allocated to a specific surgical department in a specific OR. An OR day was defined as a combination of one OR and one date on which at least one surgical case was performed. Block time was not allocated during weekends or holidays, thus performance indicators were only measured during weekdays.

2.3. Data collection

Data were prospectively collected and analyzed retrospectively for the purpose of this study. All data were registered electronically by the OR nursing staff in the Hospital Information System and validated by the surgeon and anesthesiologist in charge after completion of the operation. Since 2005,

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