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The Trickle-Down Effect of First-Case Tardiness on Last-Case Cancellation Rates and Operating Room Overutilization Involving Scheduled Surgical Patients in a University Hospital

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ABSTRACT

Objective: To observe the frequency and causes of first-case tardiness and its consequences.

Material and Methods: Six months of data from scheduled surgical patients from 18 operating rooms (OR), under 13 surgical subspecialties, between September 2014 and February 2015, in a tertiary-care university hospital, were collected. We aimed to identify: (1) the rate and tardy time of first-case tardiness, (2) the time of overutilization caused by first-case tardiness, and (3) the cancellation rate due to first-case tardiness.

Results: From a total of 3,965 elective surgical cases, 1,343 qualified as first cases and were included for analysis. Six hundred forty-four cases (48%) started more than 10 minutes later than the scheduled time. The mean (S.D.) tardy time was 25.1 (16.9) minutes. The total tardy time due to first-case tardiness was 16,146 minutes (33.6 8-hour OR days). The late physical presence of surgeons was responsible for most tardy first cases (80.6%). Of a designated OR, in which the first case was delayed, the 419 final cases in the schedule of ORs continued beyond working hours and 65 cases were cancelled. Moreover, of the 52,028 minutes (108.4 8-hour OR days) of OR overutilization, 9,465 minutes (19.7 8-hour OR days) were due to first-case tardiness.

Conclusion: First-case tardiness creates substantial futile time and a trickle-down effect on the subsequent cases of a designated OR-either case cancelation or operating room overutilization.

Keywords: cancellation; efficiency; first case; operating room; tardiness; utilization

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INTRODUCTION

The efficient management of an operating room (OR) requires the thoughtful coordination of many moving parts. Delay in starting surgical procedures in ORs is a common occurrence throughout the world and a common topic of discussion during operating room committee meetings[1]. The on-time first-case start is one metric that sets the stage for other OR efficiency aspects. In the USA, delay in ORs is frequent. A study conducted in one tertiary hospital in southern USA reported a delay rate of 27.2% for the first surgery cases[2]. Moreover, a benchmark study among 13 hospitals in the Netherlands and Belgium showed that surgeries consistently started late for a variety of reasons[3]. Delay in the start of the first surgeries usually causes subsequent delays in other cases[4]. This delay increases the length of hospital stay, the risk of hospital-acquired infection, and the total cost of healthcare services as well as creates dissatisfaction, frustration, and anxiety for patients and their relatives, especially when the patient has fasted for a long time[5]. Furthermore, late starting time increases the hours that the OR is not in use and, therefore, contributes to low productivity as well as negatively impacts both income generation and the timely delivery of services to patients[6].

In addition, OR efficiency is vital to the financial success of a hospital. It is important for hospitals to optimize OR efficiency in order to both lower costs and increase revenue. Costs in ORs derive from the number and man-hours of healthcare personnel needed to take care of patients safely and from the use of expensive equipment. Late starts at the beginning of the day can result in late finishes of cases, thereby causing over-expenditure of time and resources in ORs. Starting the first case of the day late has also been mentioned as one of the factors that lead to an unsafe working environment and increase the risk of healthcare team errors, the stress level of both staff and patients, as well as unplanned cancellations of surgery appointments[4]. However, not all delays are negative in nature; for example, ensuring that patients are well-prepared for surgeries can take time, but it can ensure the best possible outcomes for patients[7].

In a previous study, we explored OR efficiency using 5 parameters: first-case tardiness, time delay, turn-over time, cancellation, and overutilization[8]. In this study, we focused on: (1) the rate of and wasted time due to first-case tardiness, and (2) overutilization time due to first-case tardiness in scheduled surgical patients.

MATERIAL AND METHODS

Design

This study was a secondary analysis of a preceding research[8]. This prospective observational study was conducted in a tertiary-care university hospital. The manuscript was prepared according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline. Based on the availability of data from the previous study, we analyzed patient data from September 2014 to February 2015.

Setting and participants

The research was conducted in a tertiary-care university hospital and included 18 operating rooms from 13 surgical subspecialties. From a total of 3,965 scheduled surgical cases, 1,343 qualified as first cases and were included for analysis. A single eight-hour (8-hour) OR day was defined as a full OR day from 8:30 AM to 4:30 PM during weekdays. The data were collected from multiple surgical services: general, urological, vascular, plastic, pediatric, cardiovascular and thoracic (CVT), trauma, otolaryngological (ENT), obstetric or gynecological (OB-GYN), orthopedic, and neurological surgery as well as data from two other intervention sites related to radiology (a cardiac catheterization center and a radiological intervention unit). We excluded all the first elective and emergency cases in emergency ORs and ophthalmology ORs.

Data collection and procedures

This study aimed to identify (1) the rate and tardy time of first-case tardiness, (2) the time of overutilization caused by first-case tardiness, and (3) the cancellation rate due to first-case tardiness.

We used the following definitions for the analyses:

First-case tardiness was defined as the actual room-entry time of the first scheduled patient being more than ten minutes late than 8:30 AM. When the first cases started behind schedule, the reason for it was recorded, and the last case of the day was monitored as to whether it was cancelled or continued beyond 4.30 PM. When the case started earlier than scheduled, the tardy time was considered to be zero.

Operating room overutilization due to first-case tardiness was defined as an event where the first case of a given OR started late, and the last case continued beyond 4.30 PM. The "time" of OR overutilization due to first-case tardiness was calculated by the daily sum of the "time" equal to the tardy time of a given OR.

Last-case cancellations of any given OR that had a first-case late start were also recorded.

Ethical considerations

The study was approved by the Institutional Human Research Ethics Committee (REC 60-192-08-1). The requirement of an informed consent was waived by the Institutional Review Board (IRB) due to the observational characteristic of our study.

Statistical analysis

The analysis was conducted using R software, version 4.1.0 (R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/). Categorical data were expressed as counts or percentages, and quantitative data were presented as mean±standard deviation (S.D.) or median with interquartile range (IQR), where appropriate. The first-case tardy time of each month was illustrated with a box & whisker plot. The comparison of the tardy time means categorized by month was performed using ANOVA and the Tukey multiple comparison test. A p-value less than 0.05 was considered statistically significant.

RESULTS

From a total of 3,965 elective surgical cases, 1,343 that qualified as first cases were included for analysis. Of the 1,343 first cases, 644 (about 48%) started behind schedule by more than 10 minutes. The mean delay time was 25.1±16.9 minutes. The total tardy time for the whole period of study was 16,146 minutes (33.6 8-hour OR days). Twelve cases started behind schedule by more than 60 minutes. One case started behind schedule by more than 4 hours (Figure 1).

The incidence of first-case tardiness varied from 23.8% to 84.2% among subspecialties. Likewise, the mean delay time varied between 18.8 minutes and 35.35 minutes.

Comparing between months, although the total tardy time in January was much greater than in other months, mean tardy times were not significantly different.

In the ORs where the first cases started late, the last 419 cases (65%) continued operating beyond normal working hours (4:30 PM), and 65 cases (10.4% of total cancellations) were cancelled at the last minute due to time insufficiency (Figure 2). Moreover, of the total 52,028 minutes (108.4 8-hour OR days) of OR overutilization, 9,465 of them (19.7 8-hour OR days) were due to first-case tardiness. The data regarding the first-case tardiness, last-case cancellations, and OR overutilization due to first-case tardiness are shown in Figure 2.

There were multiple reasons for the first cases starting behind schedule. The most common was a surgeon-related reason (534 cases), with the late physical presence of surgeons being responsible for the majority of

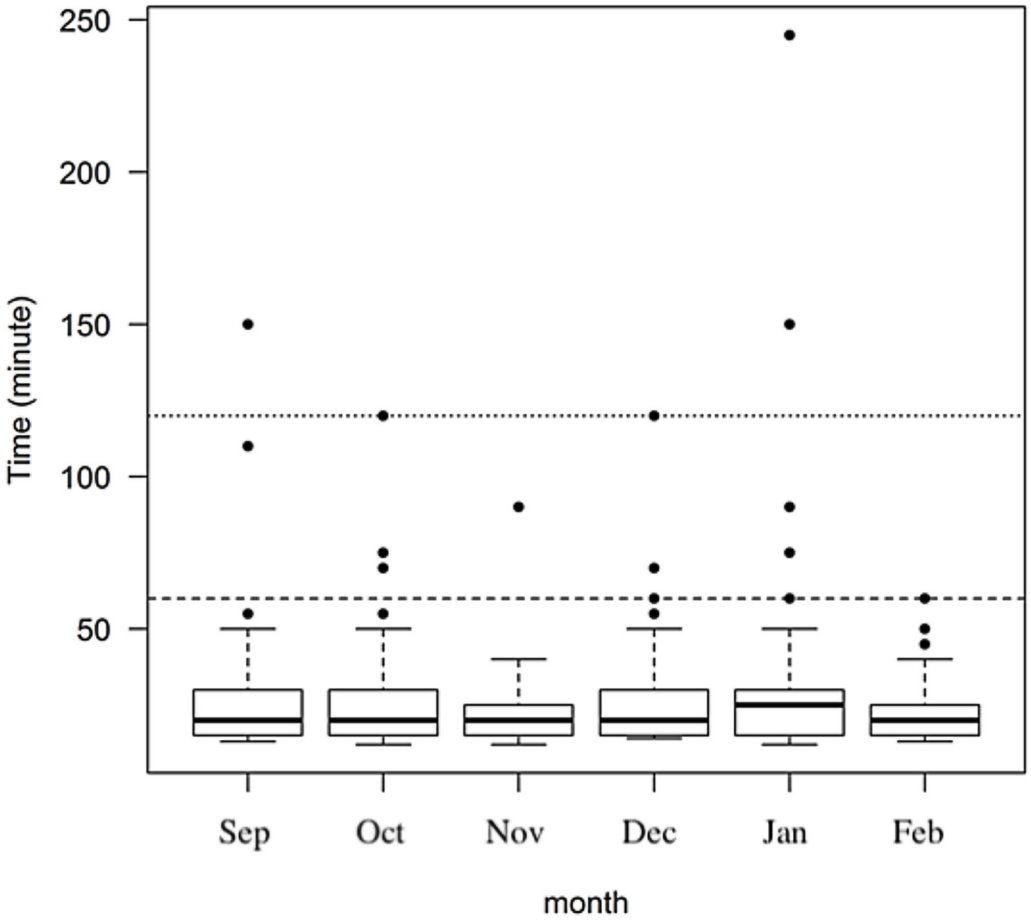

Figure 1 Box & Whisker plot of first-case tardy time each month (September to February). The dashed line represents a 60 minutes time point behind schedule. The dotted line represents a 120 minutes time point behind schedule

cases (80.6%). The other factors were OR team-related (77 cases), patient-related (32 cases), anesthesia-related (22 cases), and other issues (11 cases). The second most common reason was the delay in transferring patients from wards to ORs (39 cases). The details of the delay in starting first-case surgeries are shown in Table 1.

DISCUSSION

Our results provide evidence concerning first-case tardiness and its impact on the last-case cancellation rate and operating room overutilization among scheduled surgical patients in a university hospital.

The operating suite is a sophisticated area where the collaboration of a variety of units in a hospital is required. Moreover, OR efficiency is affected by many factors that are difficult to control, for instance, the internal patient transport system, which governs the transfer of patients within a hospital.

Our study determined the futile time when the first case starts behind schedule, while highlighting how

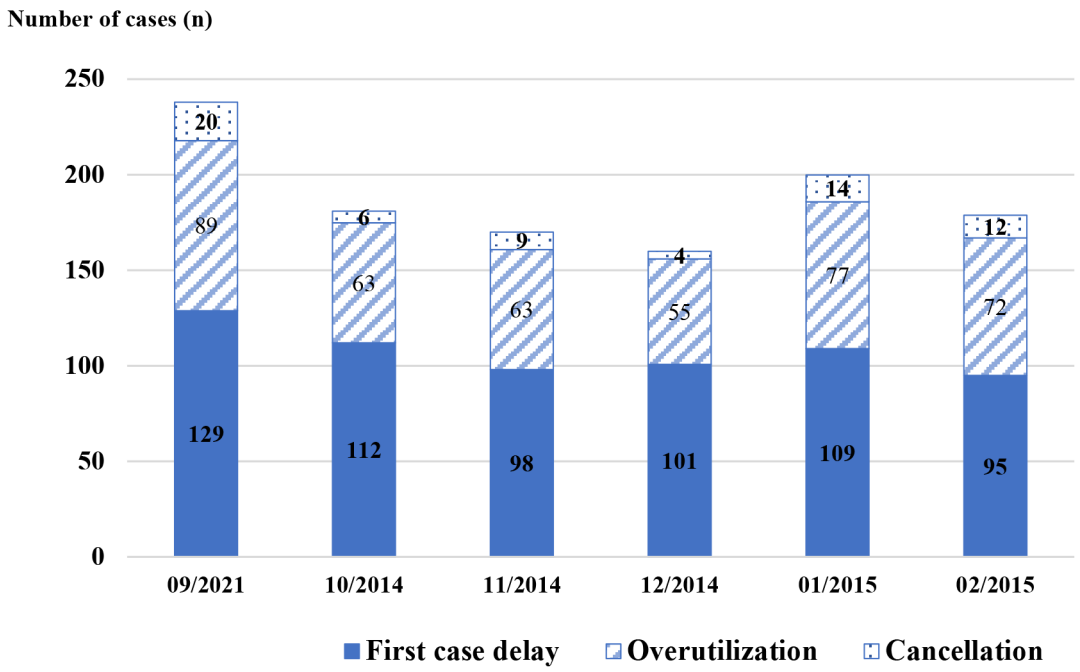

Figure 2 The numbers of first-case delays, overutilization and cancellations due to first-case tardiness each month

Table 1 Percentages of first cases of the day that started on time versus late between September 2014 and February 2015

Month	Total number of first cases	Late first cases: n (%)	Mean ± S.D. in minutes late in first cases (min)	Median ± IQR in minutes late in first cases (min)	Total first-case tardiness time (min)
September 2014	270	129 (47.78)	25.30±16.2	20 (15, 30)	3,264
October 2014	223	112 (50.22)	25.44±16.2	20 (15, 30)	2,849
November 2014	228	98 (42.98)	21.26±9.8	20 (15, 25)	2,083
December 2014	228	101 (44.30)	25.95±14.8	20 (15, 30)	2,621
January 2015	200	109 (54.5)	28.88±27.1	25 (15, 30)	3,148
February 2015	194	95 (48.97)	22.96±8.7	20 (15, 25)	2,181
Total	1,343	644 (47.95)	25.1±16.9	20 (15, 30)	16,146

S.D. = standard deviation; IQR = Interquartile range

it impacts the subsequent cases and how this wasted time leads to a negative economic impact on in-hospital expenditures. Moreover, there are less-tangible costs, e.g., patient suffering and staff dissatisfaction, to take into consideration.

The inefficient use of the OR capacity is a worldwide problem. It has been found that one of the most common causes of conflict among operating team members is the delay in the first case[9]. Although recent studies have indicated that first-case tardiness does not affect OR efficiency[10-12] and its "trickle-down" effect has been argued against[1,10,13,14], first-case tardiness remains of interest because it continues to be perceived as a key performance indicator of inefficiency in ORs[4]. However, Dexter et al.

found that first-case delays were small delays in time, which were not economically important because the costs of reducing such delays were often high, and the ensuing time reductions obtained in each OR were often limited[15]. Moreover, the reduction of first-case tardiness is merely one aspect of the efficient use of OR capacity.

According to the proposed benchmark of the Association of Anesthetists of Great Britain and Ireland (AAGBI), a case is considered late if the start-up delay is more than 10 minutes[16]. This benchmark is considered to be one of the standards used to define surgery-case tardiness. However, it should be noted that AAGBI proposes a more stringent standard, i.e., that less than 10% of the scheduled surgery cases should start more than 10 minutes late. In our study, 48% of cases started more than 10 minutes later than scheduled. When compared with the standard proposed by AAGBI, our study had a higher number of late-start cases. Balzer et al. found that 66% of their first cases deviated from the scheduled start time by at least 10 minutes, and that the deviations in timeliness were 15 ±72 (mean±S.D.) minutes[17]. Meanwhile, Vinukondaiah et al[18]. and Ciechanowicz et al[19]. reported that 43.6 % and 22% of their first cases started late, respectively. However, Ciechanowicz et al[19]. used the definition of a delay being more than 15 minutes late in beginning surgery cases. Another study conducted in a tertiary-care hospital found a 67% rate of first-case late starts[20]. As it can be seen, the percentage of delayed cases and the length of delays in starting the first case of the day differ from one hospital to another.

Overdyk et al[21]. and Kumar et al[20]. cited surgeon unavailability as the most common reason for starting the first case late at the rates of 9.4% and 11.5%, respectively. Similarly, in South Africa, a study conducted by Van[22] found that starting time delays in ORs involved mainly surgeon-related factors. In another study conducted in India, the majority of reasons for first-case tardiness were related to surgeon and anesthetist availability[18]. Our study also showed similar results, whereby delays due to surgeon-related factors were responsible for 534 cases (83.4%) of late starts. In addition, Talati et al[23]. found that tardiness in the transfer of patients from wards to ORs accounted for delays in 44.6% of their cases, in contrast with the 6.1% rate found in our study. Likewise, a benchmark study among 13 hospitals in the Netherlands and Belgium showed that, for a variety of reasons, surgeries consistently started late[3].

Moreover, Balzer et al. found that when the first case started late, as the day progressed, the degree of schedule time deviation increased, resulting in more delays for later cases in the day[17]. This phenomenon is directly linked to OR overutilization and cancellations. Delays require medical personnel to work longer than expected, and this out-of-hour work is associated with after-hour cost increases for hospitals in the form of overtime pay. In our study, when the first case of the day started late, in 65% of cases, operations extended beyond the official working hours (4:30 PM), and 10.4% of total cancellations were last-minute actions due to insufficient time to perform the scheduled surgery. Similarly, Pandit et al[10]. found that 50% of cases had operating times extended beyond the routine working hours, and 25% of case cancellations were last-minute. Meanwhile, Garg et al[24]. and Talati et al[23]. have reported that the rates of cancellation due to time factors were 59.7% and 78.1% of cases, respectively. Their cancellation rates far exceeded that of our study.

Since first-case tardiness occurs daily in our hospital, and about half of the total first cases tend to start later than scheduled, this delay has a sizable impact on the efficiency of our ORs. We recommend that future studies on this topic focus on creating and implementing strategies aimed at reducing the percentage of OR cases starting late, the average tardiness start time, and the OR overutilization time.

Limitations and future directions

There are several limitations in this study. First, a Hawthorne effect is inevitable. All the participating surgical unit staff were well aware of the monitoring conducted for the purposes of our study. The study protocol was officially announced prior to the commencement of the study. As a consequence, we speculate that our data reflect a better-than-usual performance from every team member as they tried their best to start the OR cases as early as they could. Despite the fact that records were kept by anesthetists, the tardy time in our study was not notably different throughout the study period. For future research, employing an automated recording system in ORs may alleviate any potential bias associated with human involvement. Secondly, our study represents results from one institute, which is a tertiary-care governmental university hospital. Therefore, its findings may not be generalizable to hospitals with different systems. Thirdly, we did not explore the root causes of the major reason for first-case tardiness, i.e., the surgeons' inability to be present in operating rooms on time. Since our institute is a teaching hospital, academic activities and emergency consultations may affect the ability of surgeons to be available in ORs according to the scheduled times. This issue should be addressed in future research. Furthermore, we hypothesized that if the first case starts on time, the last case will not run beyond 4.30 pm. The duration of time of the last case that can be reduced will, therefore, be equal to the tardy time of the first case. Thus, if this duration of overutilization due to first-case tardiness is reduced, the cost related to overutilization will also be reduced. Using "time" as a surrogate of cost instead of monetary value has a drawback because overtime payments might be 1.5-2 times more expensive than service-hour payments. This means that our hospital can save not just a payment equal to 9,465 minutes (19.7 8-hour OR days) but one equivalent to 14,197.5 minutes (29.6 8-hour OR days) or 18,930 minutes (39.4 8-hour OR days) instead. For future research, calculating labor costs would give a more accurate insight into wasted resources. Finally, case cancellations might not only happen in the final case but also in the 2 or 3 cases before that. The last case that was cancelled might not be rescheduled for the next morning, which adds another hidden cost of patients missing their surgery. However, we conducted this study to gain a broad view of our operating rooms' productivity, so we did not explore those details. They can be the focus of further studies in the future.

Strength

We used an objective measurement of tardiness; neither self-reports nor questionnaires were used.

CONCLUSION

First-case tardiness creates substantial futile time and a trickle-down effect on the subsequent scheduled cases of an OR-either case cancelations or operating room overutilization.

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