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## **Analysis of neuro-theatre utilisation and reasons for cancellation to improve efficiency and productivity.**

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Abstract:

**Aim:** In neurosurgery, much emphasis has recently been placed on theatre cancellation and time utilization as a key hospital management performance indicator. We sought to evaluate our unit's theatre throughput efficiency, and identify the causes of elective surgery cancellations.

**Methods:** We retrospectively audited all scheduled elective neurosurgical procedures over a period of 9 months.

**Results:** Mean theatre utilization time was 47.0%. The common causes of cancellations were lack of theatre time (32%), non-availability of beds in recovery room (18.6%), and insufficient preoperative patient preparation (5.5%).

**Discussion:** Inefficiencies were noted in turnover of patients and inaccurate prediction of operative time. Our theatre utilization time is consistent with available literature, however cancellations of elective surgery waste valuable operative time and resources.

**Conclusions:** A multi- dimensional approach must be taken to improve theatre utilization and reduce cancellation rates. A pre-assessment clinic has been introduced in order to reduce cancellation rates.

**Key words:** Neurosurgery, theatre cancellation, theatre utilization.

## Introduction

Considerable resources are utilized to maintain operating theatres with available anaesthetists, surgeons and theatre staff on a planned schedule. Late cancellation of elective surgical procedures, remains a major challenge to the efficiency of operating theatres. Not only does cancellation prolong waiting times, and cause harm to patients, but also is a waste of resources (Agro 2009, Gillen 2009). Likewise, it is inconvenient to patients and staff, leading to decreased patient satisfaction and diminished staff morale (Tait 1997). In this study we aimed to evaluate our unit's theatre throughput efficiency, to identify where inefficiencies existed and consequently where the greatest improvement might be made. In addition, we sought to identify the causes of day of surgery cancellations and how they might be avoided.

Background: Cancellation of elective procedures can be used as a parameter to assess quality of patient care and management systems. Theatre lists account for a significant proportion of a hospital's expenses approaching one-third of total hospital budget (Dacey 2012). As operating theatre budgets are already strained, increased case throughput must come from improved theatre efficiency instead of increasing the number of theatre sessions.

## Literature review:

Across all surgical specialties, theatre utilization time (TUT) was only 41% (Gil 1983), thirty years ago. Subsequent studies showed improved efficiency as TUT increased from 77% in 1990 (Haiart 1990) to 81% by 1994 (Ricketts 1994) and to 91% by 2000 (Vinukondaiah 2000). This continued improvement in efficiency signifies the impact of audit and clinical governance over the years. For neurosurgical procedures; very little data are available on theatre utilization time (TUT) and theatre cancellation. Three studies investigated theatre efficiency and cancellation in neurosurgery and showed variable TUT, ranging from 56% to 70% (Iyer 2004, Saikia 2015, Kamat 2015).

The lowest TUT was observed in training institutions where the residents perform parts of the procedures. This is confirmed by another study that showed shorter operative time for senior neurosurgeons compared with junior neurosurgeons (Riffaud 2010). Shorter anesthetic time was also noted to improve theatre efficiency. Shorter

anesthetic time can be achieved through performance of multiple tasks simultaneously by trainees and consultant anesthetists (Saikia 2015).

Published literature shows varied cancellation rates across surgical specialties, ranging from 10% to 40% (Gillen 2009, Aaserud 2001, Sanjay 2007). However, many studies suggest that half of surgical cancellations can be preventable (Schuster 2011, Seim 2009). The commonest reasons for cancellation are lack of beds in recovery room, lack of theatre time, emergency cases and improper perioperative preparation (Aaserud 2001, Sanjay 2007).

Numerous methods have been proposed to improve theatre throughput efficiency. Pre-assessment clinic for example, can reduce rate of cancellations due to medical causes (Knox 2009, Heaney 2011). Parallel processing is another method that involves preparing patients for theatre simultaneously as the previous patient's procedure is completed (Keller 2012). This method is most effective in operating lists where multiple, small cases are going to be performed. Simultaneous processing however, requires additional anesthetic staffing and increased costs. Ring fencing is another strategy that aims to improve efficiency by separating elective from emergency procedures in parallel hospital production lines. Ring fencing may have a positive impact in case-mix or high demand for services, but may require additional staffing and costs as well (Kjekshus 2005).

## Methods

After obtaining approval from the local Clinical Audit Department, a retrospective audit was carried out to evaluate the reasons for cancellations of elective neurosurgical procedures. Operating theatres database was reviewed to collect the number of planned, performed and cancelled procedures. These records were then verified with manual records and clinical patient records. All patients scheduled for elective neurosurgical procedures over a period of 9 months were included for data collection (July 2014-March 2015). The reasons for cancellation were then determined.

An elective surgical procedure is said to be cancelled when a patient's name has appeared on the finalised theatre list but the procedure was not carried out on the

scheduled date. In our centre, two operating theatres are allocated for neurosurgery. Elective operating lists begin at 08:30h and are required to be finished by 17:00h. In the event emergency theatres are occupied, any new neurosurgical emergency procedure is performed in an elective theatre by cancelling elective cases. Major surgical cases are performed earlier on the lists, to allow completion of the list by 17:00. Cases are cancelled at about 16:00h if the corresponding procedure has no reasonable prospect of being completed by 17:00h.

Another retrospective audit was approved and carried out to evaluate theatre utilization time. Data were retrieved from manual records and theatre database for all elective neurosurgical operations carried out over a 12-week period (January-March, 2015). Variables recorded included, start time, anaesthesia induction time, surgical time, changeover time and finish time. Theatre utilization time (TUT) was calculated as the percentage of the total allocated theatre time used for actual neurosurgical procedure. Early and late times were determined by operating theatre start time of 08:30. The various time periods in this study were defined as shown in table 1.

Table 1. Details collected for each patient for theatre utilization time study.

Recorded variable	Description
start time	actual time at which patient is taken inside the operating theatre (OT).
Delay in start	difference between scheduled start time and time when patient is shifted to OT.
Anaesthesia induction time	difference between time at which patient is taken to OT to time at which the patient is handed over to the surgeon.
Surgical time	difference between time of beginning of surgery to time of end of surgery.
Change over time	difference between time of shifting of patient out of OT to time at which next patient is wheeled into the OT.
Finish time	time at which the last patient is shifted out of the OT.

Results: 840 planned elective cases were audited over a period of 9 months. The common causes of cancellations were lack of theatre time (32%), non-availability of beds in recovery room (18.6%), other emergency taking priority (9.3%), patients not

showing up (8.2%), unavailability of staff (4.6%), no recorded reason (12.4%) and improper preoperative patient preparation (5.5%) as illustrated in figure1.

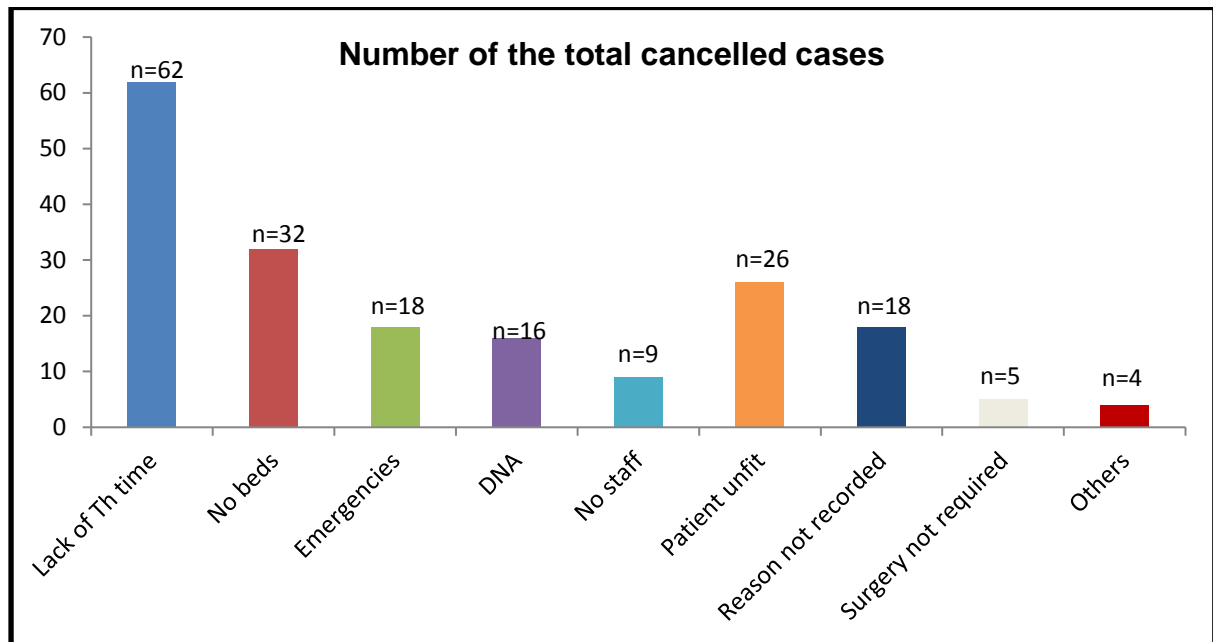
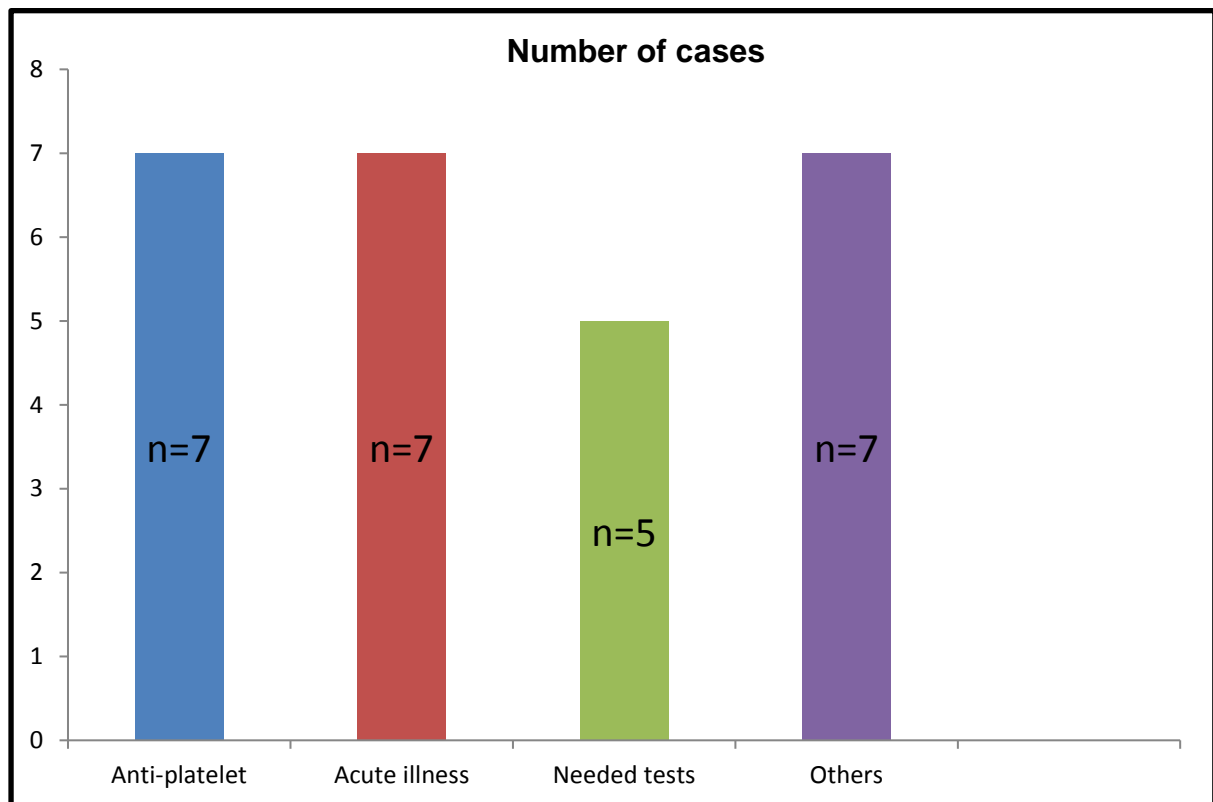


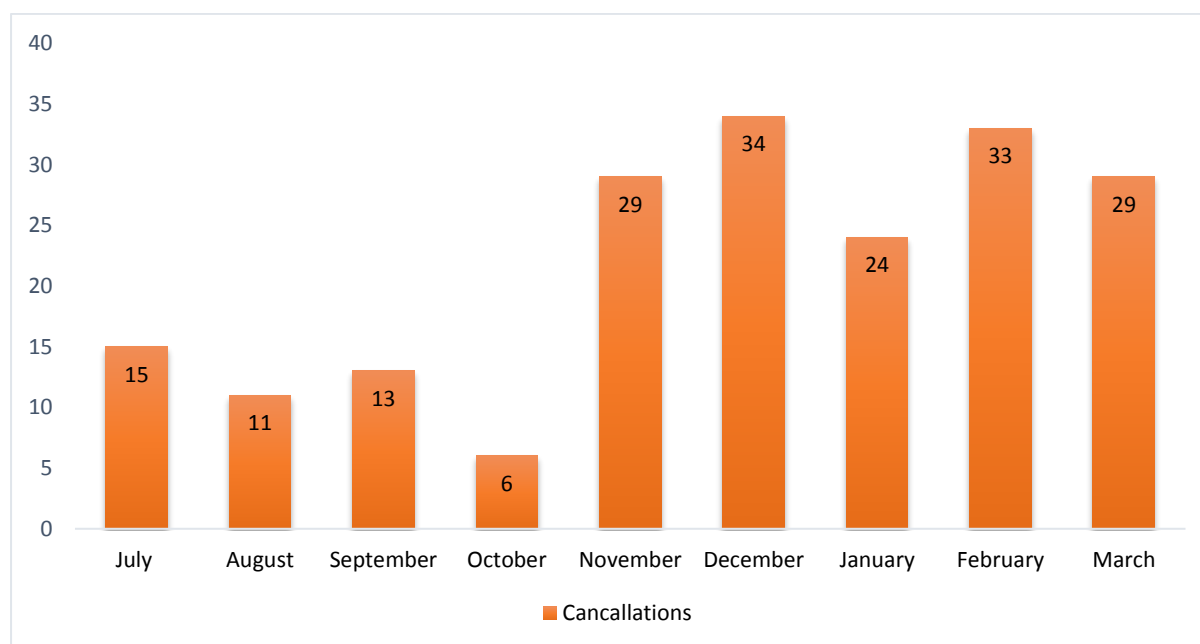
Figure 1. Common causes of theatre cancellation.

Amongst patients with improper preoperative preparation, 5 required further investigations, 7 patients did not stop taking aspirin in time, and 1 patient received incorrect starvation advice, 7 patients had acute illness., as illustrated in figure 2.



*Figure 2. Reasons for unfitness for surgery.*

Rate of elective theatre cancellations by month were also audited, and showed an increase in the number of cancellations in the winter months, as illustrated in figure 3.



*Figure 3. Cancellations of surgery by month.*

Out of 116 theatre sessions, 17 (14.6%) sessions were excluded due to incomplete data. The analysis of the remaining 99 theatre sessions was performed. 242 elective theatre operations were performed in 116 theatre sessions. The ratio of Cranial:spinal was 2:1. The mean surgical times of a cranial and spinal operations were 131, 130 minutes respectively. Among the non-operative times; the average transit, and changing over times were 38.7 and 62.5 minutes, respectively as shown in table 2. The mean surgical time was 131.5 minutes and the anaesthesia time was 39 minutes. Out of the 99 cases, the majority of cases (75%) started within 1hr of the allocated theatre start-time and only 7% over-ran.

*Table 2. Surgical, anaesthetic and non-clinical times.*

Mean Time	Minutes
Surgical time	130.2

Change over time	62.5
Anaesthetic time	39
Over-run time	53.4
Delay in Start	42.4

Theatre utilization time (TUT) dropped from  $47.0 \pm 2.4\%$  to  $38.6\%$  when theatre started late ( $P=0.08$ ). TUT improved to  $70.8\%$  ( $p < 0.01$ ) in overrunning theatres, where theatres were running after 6pm as illustrated in figure 3.

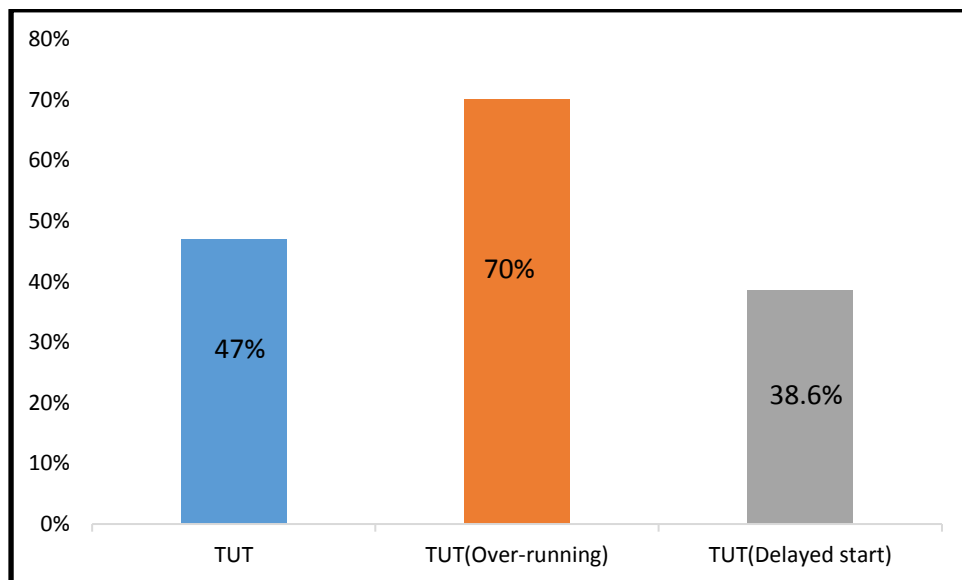


Figure 4. Variation in theatre utilization time (TUT).

## Discussion

There are some limitations of our study. For example, data collected were over a relatively short period and the socio-economic impact of theatre cancellations was not evaluated. But this study serves as a template for future studies. It identified significant areas for improvement and suggested changes which will be implemented for example, a newly appointed theatre manager has started looking into efficient theatre list scheduling and staffing issues and a pre-assessment clinic has also been introduced. These changes will allow the completion of the audit cycle through re-audit after 6 months.



Having to undergo neurosurgery is a major life event for the patient and family, the cancellation of neurosurgical procedures can cause major psychological distress, which may be preventable. Cancellation counts as two of types of waste in terms of rework and idle time. It brings the additional administrative burden of re-scheduling appointments, and affects staff morale. Ideally, operating lists should start on time, be closed on time and no procedures should be cancelled. This ensures optimal utilization of theatres time and time of all staff involved. Such efficiency can subsequently improve quality of health care delivery for hospitalised patients, as well as for others waiting for surgery.

Patients in our unit are currently scheduled for surgery once deemed necessary at an outpatient clinic review. Elective cases are admitted one day prior to surgery and patients are reviewed by an anaesthetist, consented and prepared for surgery. Final version of theatre lists is submitted once bed manager confirms bed availability status.

Published literature shows varied cancellation rates, ranging from 10% to 40% (Gillen 2009, Aaserud 2001, Sanjay 2007). However some studies suggest that half of surgical cancellations may be preventable (Schuster 2011, Seim 2009).

Lack of theatre time is the leading cause for cancellation in our study followed by non-availability of beds. Non-availability of beds is a major factor for theatre cancellation, as it contributes to the delay of procedures and further cancellations due to lack of time. Patients not showing up, unavailability of staff, and improper preoperative preparation are preventable causes for theatre cancellation. Theatre cancellations due to emergency cases may not be prevented; however, cancellations due to lack of time should be prevented with good planning and better theatre time utilization. These result indicate that half of all cancellations may be preventable.

The nature of the surgical procedure had no significant impact on the utilization of the theatre; the average difference in surgical time between cranial and spinal procedures was 1 minute.

An increase in the number of cancellations in the winter months is also noted in this study. This is due to increased number of emergency cases. The low cancellation rates during summer months indicate effective management of annual leave requests.

The timeliness of starting times of theatre sessions is a positive note. Another point to highlight is the significant preparation time of 39 minutes, which can be used more efficiently with both theatre and surgical staff ready to begin after the patient has been anaesthetised.

Our mean TUT was 47% which is comparable to published literature (56%-70%) (Iyer 2004, Saikia 2015). It is worth noting that our hospital is a training centre and some of the procedures are performed by trainees which can prolong surgical time when compared with other studies. TUT can therefore be improved with the utilization of surgical simulation training and exposure to training workshops and courses to improve skill and speed of trainees (Strum 2000). Table 4 compare variability in TUT in neurosurgical theatres amongst published studies.

*Table 3. Variability in TUT in neurosurgical theatres amongst published studies.*

TUT	47% (38.6-70)	56%	57.9%	70%
Study	Our current study	(Iyer 2004)	(Kamat 2015)	(Saikia 2015)

Our study also shows that late-starts and overrun theatres represent obvious sources of theatre inefficiency. Adhering to the starting time reduces the loss of operating theatre time and improves theatres efficiency. Further efforts should also be made to more accurately predict operative times on booking lists.

The introduction of an independent neurocritical care unit could optimise bed management and reduce cancellation rates. Improper preoperative preparation can also be improved with the introduction of pre-operative assessment clinic for all elective cases. A number of recent publications have suggested that the use of pre-operative assessment of patients few weeks before surgery can potentially reduce cancellation of elective surgery (Knox 2009, Heaney 2011). It has also been highlighted that trained nurses can undertake many aspects of the pre-operative assessment, with overall supervision by a consultant anaesthetist. Based on these findings a pre-assessment clinic will be established. It will be led by anaesthetists and

trained nurse-practitioners who will review patients 4-6 weeks prior to date of elective surgery and identify any potential causes for cancellation.

Cancellation rates can also be reduced by careful consideration while producing theatre lists to avoid under or over utilization of theatre facilities.

## Conclusion

Non-availability of beds is a major factor for theatre cancellation, as it contributes to the delay of procedures and further cancellations due to lack of time. The introduction of an independent neurocritical care unit could optimise bed management and reduce cancellation rates. Improper preoperative preparation can be improved with the introduction of pre-assessment clinic for all elective cases. The study also highlights the need for accurate prediction of operative times on booking lists.

The awareness of theatre time utilisation is paramount in designing policies to improve efficiency and flow performance. Less than half of the allocated theatre time is utilised for actual operating. While overrunning seems to improve TUT, it can impact on staff comfort. Looking into the means of shortening the other non-operative times such as changeover time, and avoiding factors that can delay theatre-start may improve operating theatre efficiency.

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