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Prospective Elective Neurosurgical Theater Utilization Audit in Pakistan: Problems in a Public Tertiary Care Hospital and Proposed Solutions from Lower-Middle-Income Country

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Abstract

Background In lower-middle-income countries such as Pakistan, public hospitals provide free healthcare but suffer from poor management and misgovernance, negatively impacting service provision. One aspect of this is operating theater time (OTT) utilization. In a 1,600-bed hospital with a 22 million catchment population, we noticed significant delays and inadequate OTT efficiency at the neurosurgery department of Jinnah Hospital, Lahore, Punjab, Pakistan. This audit aimed to analyze the neurosurgical OTT utilization, identify delays, and highlight managerial deficiencies and areas for improvement while comparing our workflow with contemporary international literature.

Materials and Methods We prospectively audited OTT utilization at the neurosurgical department. All elective surgeries from January to April 2021 were included to identify delays concerning patient transfer, anesthesia team arrival, preparation and intubation time, operative time, and anesthesia extubation time.

Results Fifty-six per cent of OTT was utilized operating. Sources of delay included the delayed arrival of anesthesia team (4.7%) and the delay in transferring patients to OT (9.7%). Anesthesia intubation and preparation time accounted for 23% of OT utilization and was significantly longer than the comparable international studies. Extubation time accounted for 5.7% of OT utilization. The issues surrounding transfer delays and prolonged anesthesia time were discussed, with strategies to address them developed with close vital input from our anesthesia colleagues and ward staff.

Conclusion Gross delays relatively simple in nature were identified due to poor management and less than ideal interspecialty coordination. Most delays were avoidable and can be addressed by proper planning, optimization of patient transfer

Keywords
- audit
- neurosurgery
- operating time
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and resources, and, most importantly, improved communication between surgeons, anesthetists, and ward staff. This can ensure optimal use of theater time and benefit all specialties, including ancillary staff, and, most importantly, the patient. A reaudit is warranted to assess the impact of interventions on OTT utilization.

Introduction

Clinical governance is a recognized concept that is strongly emphasized and championed by the British National Health Service. It should be promoted in a healthcare system (especially when public) as it provides a framework for accountability and quality improvement.[1] One aspect of clinical governance that can aid in quality improvement is clinical audit, which allows recognizing areas where service improvement is needed.[1]

Pakistan is a lower-middle-income country (LMIC) with a population of over 220 million. On a national scale, Pakistan suffers from a deficit of 18 million surgeries per year, many lifesaving and straightforward.[2] It is recognized that the reasons contributing to this tragedy include a virtually absent clinical governance system, poor hospital administration, absenteeism, lack of accountability, and a culture that does not promote quality improvement.[3–5] This has led to a somewhat ironic situation, where Pakistan as a LMIC does not meet the demand of the surgical burden in its population, not from a lack of qualified doctors or absence of centers equipped with the latest technology to perform even the most technically advanced contemporary surgeries, but rather a managerial and infrastructural culture which lacks a clinical governance system and hence quality improvement.[2–5]

Neurosurgery in Pakistan, for the masses, is provided by government-funded public hospitals and is free at the point of delivery. There is a wide disparity in neurosurgical centers throughout the country regarding their capacity and resources. Out of the approximately estimated 42 centers nationally, only the quaternary centers at the major teaching hospitals are equipped to provide state-of-the art neurosurgical care and subspecialty niches.[6] Even these centers have an uphill struggle with the resource constraints of a LMIC. Pakistan's overall national healthcare budget from the federal government is a modest 0.6 to 1.19% of the gross domestic product and 5.1 to 11.6% of the development budget.[7] There is now, however, increasing demand for service improvement at public hospitals by the government.[3]

Operating theaters (OT) make up a substantial proportion of a hospitals annual spending, and OT delays have a massive impact on resource utilization.[4] Efficient OT time utilization acts as a surrogate for those successfully admitted and operated upon, reflecting the surgical volume on elective lists.[8] There is sparsity in audits evaluating neurosurgical OT time utilization relative to other surgical specialties from the international literature.[9,10] The limited neurosurgical OT publications are from the developed Western countries[10–12] with only one well-conducted study from India,[9] our neighbor LMIC country that is most comparable to us concerning the issues facing neurosurgery in public sector hospitals. A comprehensive literature search shows that there are no audits inspecting neurosurgical OT utilization in Pakistan. Deficiencies in OT time can lead to loss of revenue and the waste of human resources. Recognizing such perioperative delays is fundamental to developing solutions for improving OT efficiency in any surgical specialty.[8–11,13] It is therefore essential for neurosurgery departments in each country to audit their own OT utilization as the issues faced and areas required for quality improvement are likely to be uniquely different from region to region.

This study aimed to analyze neurosurgery OT time utilization at our neurosurgical center and identify and present our areas for quality improvement. This is the first study from Pakistan to assess OT time utilization for neurosurgery. We postulated that the significant delays were administrative from both our department and the anesthesia department. Thus, our anesthesia colleagues were consulted and closely involved in forming suggestions and recommendations.

Materials and Methods

Setting

Institutional review board deemed this to be a service delivery audit project and thus formal review was not required. After approval, in this observational study, we prospectively analyzed all elective neurosurgical cases at the Department of Neurosurgery, Allama Iqbal Medical College, Jinnah Hospital Lahore, Punjab, Pakistan. A staff nurse performed data collection in each OT on a predesigned proforma and was blinded to the project to minimize bias. The study involved all elective neurosurgical cases from January to April 2021.

We are a national referral center in a 1,600-bed government-funded major teaching hospital. There is a dedicated three OT suite scheduled for elective neurosurgery, operating from 8 AM to 2 PM. The neurosurgery department, its wards, and OT are on the same floor, but OTs are housed in a separate enclosure. Ward staff are responsible for transferring elective surgery patients from the prepared list to preoperative bay. From preoperative bay, OT paramedic staff transports patients to the OT table. Here the anesthesia team arrives, and once the patient is anesthetized, surgery begins. Any surgical case proceeding past 2 PM is continued by operating staff, including resident/registrars and consultants. Neurosurgical nurses, however, change following 2 PM, as does the anesthesia team. When surgery continues past 2 PM, anesthesia cover is only provided by the senior registrar/chief resident. The department of anesthesia at our hospital provides individual cover for each OT in neurosurgery.

Operational Definitions

Delay in arrival to preoperative area: The patient should be present in preoperative area officially by 8 AM. Delay in arrival past 8 AM was documented in minutes.

Transfer time to OT: This was the delay from preoperative bay to the designated theater. Delay was documented when the patient transfer was impeded by logistical issues such as late arrival or absence of theater staff and lack of patient marking. The transfer should be seamless from preoperative bay to OT table and within minutes. Staff from the ward take patients to preoperative bay, from where sterile theater staff transport the patient to OT.

Delay in arrival of anesthesia team: This was the delay in the arrival of the anesthesia team to patients present in OT ready to be anaesthetized. Officially, the anesthesia team should arrive at 8 AM.

Anesthesia preparation, induction, and intubation time: The time taken for anesthesia induction and handover to the surgeon.

Pure operative/surgical time: Time between patient positioning/initial skin incision and wound closure.

Extubation and anesthesia handover time: Time taken by the anesthesia team to extubate the patient and hand them over for either ward or high dependency unit transfer as indicated.

Total time taken by scheduled case: The sum of the parameters above.

Data Analysis

Data were analyzed using Statistical Package for Social Sciences Version 27 (SPSS). Mean times were calculated for each of the mentioned parameters for the same neurosurgical case during the study duration. OT utilization was assessed to identify delays by both the neurosurgical and anesthetics departments.

Results

A total of 148 elective surgeries were performed during the study duration. These are divided into cranial (94 surgeries) and spinal cases (54 surgeries) in ►**Tables 1** and **2**. The tables summarize the theater time utilization, including the mean values for the time consumed for each parameter/delay and how much this contributed to a particular case as a percentage of the total OT consumption for the average of all cases of a particular type. All times were recorded in minutes. The total time consumed purely operating was 59%. However, this was as low as 52% across all spinal cases and 62% across all cranial cases. ►**Fig. 1** pie chart shows theater time utilization over the entire study duration for all neurosurgical procedures. ►**Figs. 2** and **3** pie charts show the same stratified by cranial and spinal cases, respectively.

Following pure operating time, 23% of OT utilization was consumed by anesthesia intubation (as a percentage of total time consumed across all cases). This was 19% for all cranial cases. ►**Tables 1** and **2** show the variation in anesthetic intubation time. Anesthesia extubation and handover of patients following surgery were consistent among all cases, accounting for nearly 5.5% of the entire OT utilization, and they were the same in cranial and spinal cases too. Other sources of delays included the late arrival of the anesthesia team to OT. These late arrivals totaled 382 minutes (6.4 hours) over the 4-month study duration accounting for 5% of the total OT utilization. Again, in spinal surgery, however, the proportion of time lost due to the late arrival of the anesthesia team was higher than cranial cases, accounting for approximately 7% of OT utilization in scheduled spinal and 4% in all cranial cases.

Sources of delays from the neurosurgical department ancillary staff included delays in patient transfer from ward to preoperative bay in the morning at the designated time. This accounted for 5.5% (443 minutes) of all OT time utilization over the study duration for all scheduled cases. Again, when examining all spinal surgery cases alone, there was a significant proportion of delays due to late shifting from ward to the preoperative room, accounting for approximately 9% of OT utilization in all spinal surgery cases. For cranial cases, this was only 4%. Finally, the last identified source of delay resulted from the delay in transferring the patient from preoperative bay to the designated OT. This delay accounted for approximately 4% (343 minutes) of OT time and is the only delay parameter, slightly lower across all spinal cases (~3.3%), and in all cranial cases accounted for and 4.6% of the OT utilization.

Statistical Analysis

A two-proportion Z-Test was used to assess if delay parameters differed across all cranial and all spinal surgeries. Differences between proportions were regarded as significant if p-values were less than 0.05. Spinal surgery suffered significantly more delays where OT utilization for the pure surgical operating time was 10% less than cranial surgeries (52 vs. 62%; $p < 0.00001$). In addition, delay in transfer from ward to preoperative bay, delay in anesthesia team arrival, and anesthesia preparation induction and intubation time were significantly more in spinal surgery (8.9, 6.7, 23.2%, respectively) compared with cranial surgery (4.9, 3.9, 19.5% respectively; p-values < 0.05).

Discussion

In an ideal world, optimal use of the OT should be without cancellations, delays, and should start and close on time. While this theoretical utopia may not be wholly achievable, it is certain that neurosurgeons need to lead efforts to recognize and address unnecessary and avoidable delays in service delivery, streamlining the process on operating days with department staff and colleagues of other specialties. At a department level, we strived to recognize and improve our delays; therefore, we performed this audit to recognize our problems and address them. Clinical audits are shown to be essential in improving service provision, and documentation of perioperative delays is shown to be crucial in developing

Table 1 Operation theater utilization for all elective cranial surgery cases across study duration

All parameters in minutes	MCA aneurysm clipping	VP shunt	Brain tumor excision-iCT NN guided	MVD	Craniopharyngioma-subfrontal translamina terminalis	Pituitary adenoma excision-iCT assisted	3D cranioplasty	CSF leak repair-fluorescein guided endonasal	ICP and brain tissue oxygen monitoring	Wound re-exploration	Posterior fossa-hemangioblastoma	CP angle schwannoma	Posterior fossa decompression-Chiari 1 malformation	Endoscopic third ventriculostomy
Number of cases	8	28	4	8	1	8	4	8	1	8	4	4	4	4
Delay in arrival to preoperative bay	18 (3.3%)	37 (12.9%)	16 (3.5%)	20 (4.3%)	10 (1.7%)	22 (4.4%)	26 (8.8%)	20 (4.5%)	5 (4%)	20 (7.6%)	14 (2.1%)	12 (2.9%)	8 (2.4%)	5 (1.4%)
Transfer time to operating theater	7 (1.3%)	15 (5.2%)	22 (4.8%)	12 (2.6%)	105 (18.1%)	16 (3.2%)	16 (5.4%)	15 (3.4%)	5 (4%)	15 (5.7)	10 (1.5%)	7 (1.7%)	3 (0.01%)	18 (5%)
Anesthesia arrival delay	12 (2%)	18 (6.3%)	7 (1.5%)	14 (3%)	15 (2.6%)	10 (2%)	22 (7.5%)	15 (3.4%)	7 (5.5%)	18 (6.8%)	20 (3%)	32 (7.8%)	13.00 (3.9%)	20 (5.5%)
Anesthesia preparation, induction, and intubation time	125 (23%)	75 (26.1%)	70 (15.4%)	98 (21%)	75 (13%)	108 (21.4%)	70 (23.8%)	83 (19%)	20. (15.7%)	50 (19%)	90 (13.3%)	95 (23.2%)	110 (32.6%)	250 (69.2%)
Pure operative surgical time	350 (64%)	120 (41.8%)	320 (70.3%)	295 (63%)	375 (64.6%)	315 (62.5%)	135 (46%)	280 (63.7%)	90 (70.8%)	142 (53.6%)	510 (75.7%)	225 (55%)	175 (52%)	50 (13.9%)
Anesthesia extubation time	35 (6.4%)	22 (7.7%)	20 (4.4%)	28 (6%)	Patient not extubated and was shifted to ICU on ventilation	33 (6.5%)	25 (8.5%)	26 (6%)	Patient not extubated and was shifted to ICU on ventilation	19 (7.2%)	30 (4.4%)	38 (9.3%)	28 (8.3%)	18 (5%)
Total time taken by scheduled case	547	287	455	467.00	580	504	294	439.00	127	264	674	409	337	361

Abbreviations: 3D, three-dimensional; CP, cerebellopontine; CSF, cerebrospinal fluid; ICP, intracranial pressure; ICU, intensive care unit; MCA, middle cerebral artery; MVD, microvascular decompression; VP, ventriculoperitoneal.
Note: All parameters are in minutes and represent mean time consumed by each parameter across all cases of a particular type of case.

Table 2 Operation theater utilization for all elective spinal surgery cases across study duration

All parameters in minutes	Endoscopic lumbar discectomy	Spinal fixation-percutaneous transpedicular screw fixation	Spinal fixation-open extramedullary transpedicular screw fixation	Spinal tumor-intramedullary	Open lumbar discectomy	Anterior cervical discectomy with interbody fusion
Number of cases	8	20	8	4	6	8
Delay in arrival to preoperative bay	96 (18.3%)	13 (5.3%)	24 (7.3%)	18 (6.3%)	23 (6.3%)	18 (5.5%)
Transfer time to operating theater	8 (1.5%)	18 (7.3%)	3 (0.001%)	11 (3.9%)	13 (3.5%)	13 (4%)
Anesthesia team arrival delay	100 (19%)	9 (3.7%)	8 (2.45%)	10 (3.5%)	9 (2.5%)	13 (4%)
Anesthesia preparation, induction, and intubation time	142 (27%)	57 (23.3%)	42 (12.8%)	75 (26.4%)	81 (22%)	75 (22.8%)
Pure operative surgical time	160 (30.5%)	130 (53%)	230 (70.3%)	150 (52.8%)	220 (60%)	190 (57.6%)
Anesthesia extubation and handover time	19 (3.6%)	18 (7.3%)	20 (6.1%)	20 (7%)	21 (5.7%)	20 (6.1%)
Total time taken by scheduled case	525	245	327	284	367	329

Note: All parameters are in minutes and represent mean time consumed by each parameter across all cases of a particular type of case.

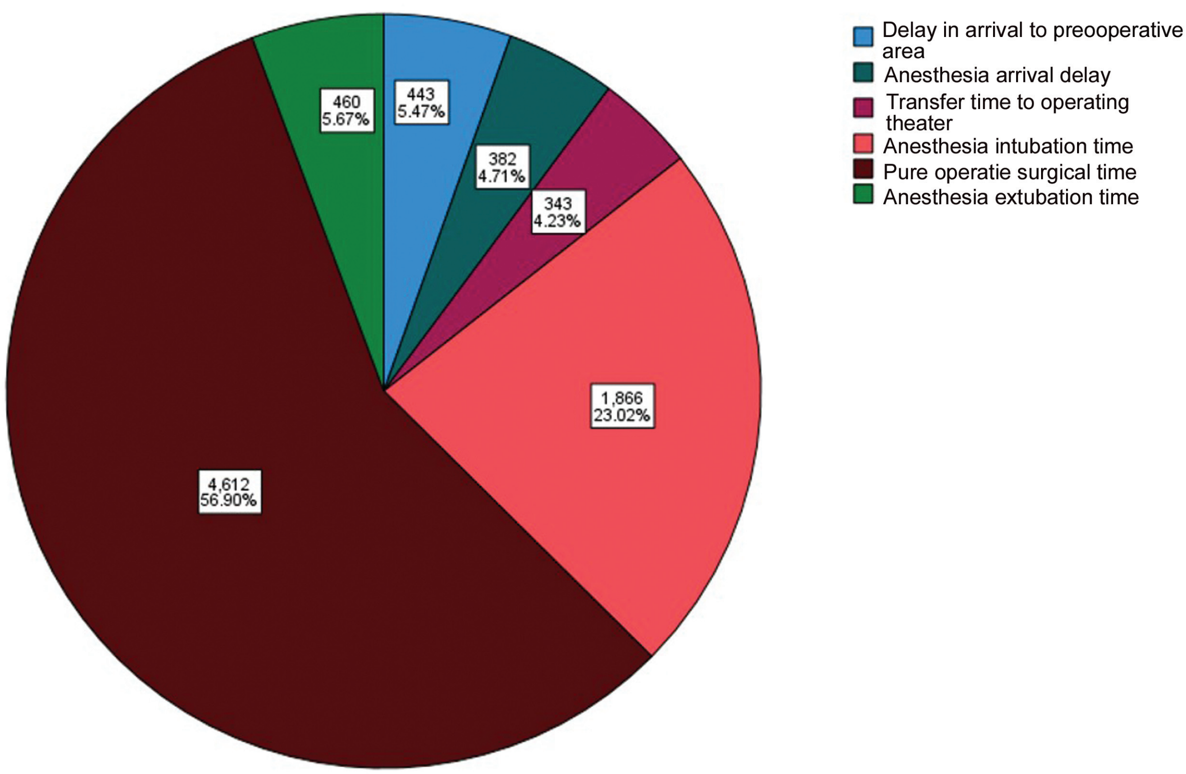

Fig. 1 The operation theater utilization across the study duration as time consumed (minutes) by each parameter for all procedures.

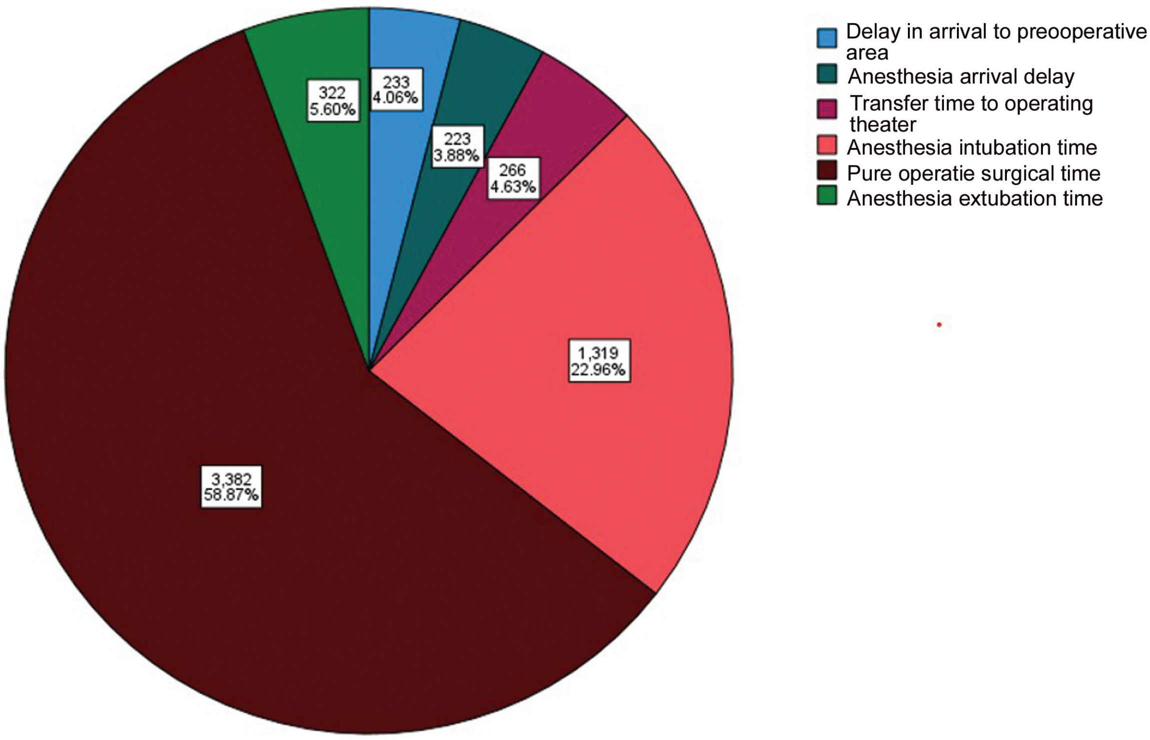

Fig. 2 The operation theater utilization across the study duration as time consumed (minutes) by each parameter for all elective cranial surgeries.

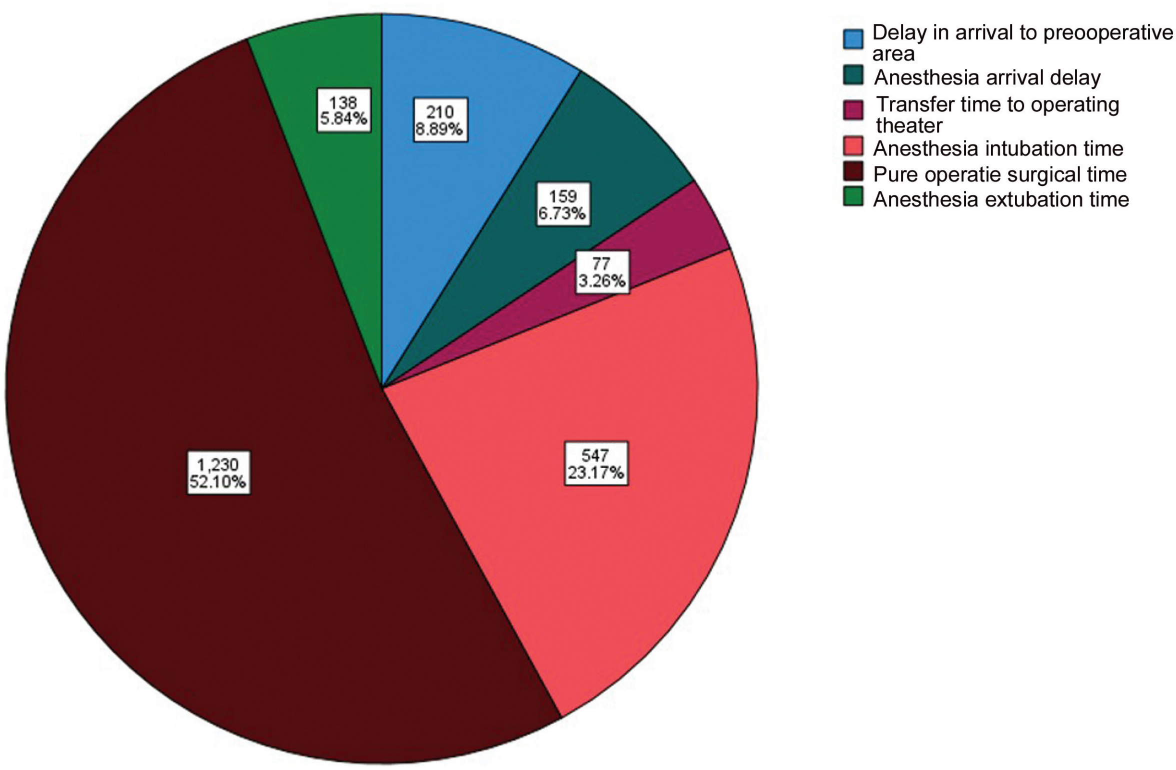

Fig. 3 The operation theater utilization across the study duration as time consumed (minutes) by each parameter for all elective spine surgeries.

solutions to improve OT efficiency in surgical specialities.[11,14]

Overall, OT utilization has been streamlined worldwide, with efficiency improving from 40 to 77% and 81%, while in some instances, recently, 91% from the late 20th century to early 2000.[9] This demonstrates that auditing has identified areas for improvement and led to subsequent improvements in OT utilization. We have identified several gross time delays and poor management structure that significantly impedes workflow efficiency. Our problems, however, are typical for public sector hospitals in Pakistan. Our department's significant sources of delay include late arrival to preoperative area and the transfer from here to the OT. These delays account for approximately 10% of all OT utilization in the study duration. The ward staff is responsible for transferring the patients to the preoperative room outside the theater, both of which are in separate enclosures to the wards. One of the major reasons for this delay was patients being admitted without investigations from other departments, such as an echocardiogram or an endocrine/allied specialty workup. This led to several cases where patients had incomplete investigations the morning of surgery which had to be chased. To address this, we will implement changes to the way patients are admitted as an inpatient. Those requiring elective surgery will need to have most, if not all, investigations completed before admission. This will improve bed space/utilization, and we believe it will also be better for the patient to avoid being admitted for long periods without need while awaiting routine investigations.

Additionally, patients must be immediately transferred to OT once in their preoperative bay by the sterile theater staff, including theater nurses and paramedical staff. Delays have been principally due to lack of case marking and poor communication regarding which OT individual patients are allocated to the night before surgery. We plan to address this by disseminating transparent instruction on which procedure should be designated to which theater, and which registrar/resident and consultant will be operating.

As shown in ►**Table 3**, when comparing our anesthesia preparation and intubation time and our surgical/operating times to the other two studies for common neurosurgical procedures, ours are significantly longer. It may not be appropriate to compare operating times as this will vary enormously for numerous reasons from surgeon to surgeon and center to center, let alone between continents. It is, however, useful to propose reasons for our discrepancy and provide a comparison in the literature. While it is generally acknowledged that longer surgery is associated with more morbidity, our setup is such that while our staff is diverse with subspecialist interests from neurovascular niches to complex spine, we are in the position where we predominantly are training residents and young consultants for a broad general neurosurgical practice. Although this is changing and the need for subspecialists is increasing, general neurosurgery is mostly what trainees will be exposed to in most centers. In the study by our Indian colleagues Saikia et al,[9] the authors mentioned that their pure operative/surgical time was shorter for complex neurovascular procedures than the British study by Iyer et al[12] due to being exclusively operated by neurovascular consultants. In contrast, the latter may have had teaching given to residents/registrars. In our case, for such subspecialty procedures, senior residents and junior consultants are often being supervised by the senior faculty to build proficiency in this area.

Table 3 Comparison of surgical and anesthetic times for common neurosurgical procedures between our study and relevant previous studies

Title	Iyer et al, 2004[12]		Saikia et al, 2015[9]			Our study
Surgery	**Mean anesthesia time (minutes)**	**Mean surgery time (minutes)**	**Mean anesthesia time (minutes)**	**Mean surgery time (minutes)**	**Mean anesthesia time (minutes)**	**Mean surgery time (minutes)**
Brain tumor surgery	37	131	25	222	70	320
Aneurysm	51	213	24	157	125	350
Ventricular-peritoneal shunt	28	60	24	100	75	120
Spinal tumor surgery	31	165	23	189	75	150
Posterior fossa surgery	55	160	29	280	90	510
Open lumbar discectomy	24	115	Not provided	Not provided	81	220
Anterior cervical discectomy	31	57	Not provided	Not provided	75	190
Microvascular decompression for Trigeminal nerve	47	169	Not provided	Not provided	98	295
Foramen magnum decompression	41	118	Not provided	Not provided	110	175
Vestibular schwannoma (retrosigmoid approach)	45	376	Not provided	Not provided	95	225

For us, when senior faculty alone were operating on certain cases such as vestibular schwannomas, where residents were not taught, pure surgical time was significantly shorter than that of our British colleagues (225 vs. 376 minutes). Some comparisons for surgical times, however, may not be appropriate. For example, our brain tumor surgeries had a mean pure operative time of 320 minutes, while this was 222 minutes for Saikia et al[9] and 131 minutes for Iyer et al[12] in our case. As the studies do not provide further details about the type and locations of the tumor, a fair comparison cannot be made. We had used an intraoperative computed tomography scanner for most brain tumor cases that may, in part, have a modest contribution to the increased time.

Similarly, what cases constituted as posterior fossa surgery were not specified by Iyer et al[12] or Saikia et al,[9] but for us, all cases were of hemangioblastomas that are considerably longer than other posterior fossa surgeries. Iyer et al[12] state nothing can be done to reduce pure operative surgical and anesthesia preparation and intubation time. Saikia et al[9] recommend proper coordination between ancillary equipment technicians of spinal fluoroscopy and intraoperative computed tomography scanner. We regularly use both and aim to streamline the teamwork between surgeons and theater staff to reduce operating/surgical time. Furthermore, to reduce the surgical time for resident-led cases, we have acquired an advanced neurosurgery simulator to give more exposure to trainees.

Sources of delays from the anesthesia team included late arrivals to the OT, accounting for approximately 4% of OT utilization (223 minutes) over the study duration. This delay occurred on all OT days and was as low as 7 minutes but usually between 15 and 30 minutes.

Interestingly, our anesthesia preparation and intubation time are two to three times longer than those reported by our British and Indian colleagues.[9,12] While Iyer et al[12] mention that little can be done to reduce anesthesia time, it was felt our anesthesia preparation time was excessive. Unnecessary monitoring without proper patient stratification was discussed with our anesthesia colleagues. Anesthesia was longer for simple spinal surgery cases, even compared with more complicated cranial surgeries. For example, the team inserted central venous pressure and A-lines even in simple spinal surgery cases and generally believed that neurosurgery patients should get aggressive neuromonitoring for all cases. Anesthesia preparation and intubation times were observed to vary with no particular reason and unrelated to the case's complexity. Extubation time, however, was consistent and raised no concern. Both departments are now in the process of reforming the use of intraoperative neuromonitoring in an evidence-based manner. Saikia et al[9] state that their shorter anesthesia preparation time was due to less aggressive invasive neuromonitoring, which is a notion we support and have proposed to our anesthesia colleagues. Finally, to reduce anesthetic preparation time further, it was decided to manage and anesthetized patients in parallel rather than serially. We also believe that this is the reason why spinal surgery cases were longer, as they received anesthesia after cranial surgeries were dealt with.

Perspectives and Suggestions Made in Conjunction with Our Anesthesia Colleagues

Our results were presented to our anesthesia colleagues and jointly discussed by department chairs to address concerns. Our anesthesia colleagues highlighted that the main factors contributing to delays included:

1. Lack of exposure to neurosurgery in the vast majority of anesthesia residency training programs under the two FCPS and MD training program schemes in Pakistan.
2. Lack of ancillary staff support for anesthetist in our neurosurgical theaters.

The discussion on anesthesia raises a much broader and important issue for neurosurgery in Pakistan, which is the virtually absent concept of neuroanesthesia as a (sub)specialty. Despite being the sixth most populous country with a high burden of neurosurgical disease, the World Federation of Societies of Anaesthesiology lists Pakistan with only 1.64 per 100,000 general anesthetists. There is no formal training or post-training fellowship in neuroanesthesia.[15] Our anesthesia colleagues feel there are two issues regarding training; first as a percentage of every hospital in the country that is accredited to provide anesthesia training, the overwhelming majority of hospitals do not have a neurosurgery department as neurosurgery departments themselves are severely lacking in our country and unfortunately many are centralized to major cities,[6,16] thus making the many remaining hospitals have doctors training and qualifying in anesthesia without any exposure to neurosurgery.[6,16] This had led to service by several junior consultant staff in our hospital (senior registrars) who make up the bulk of our anesthesia department, and many of these are not permanent so there are rotating anesthetists whom many of are providing neurosurgery cover for the first time and so face a steeper learning curve. In large teaching hospitals, a single anesthesia department provides cover to all surgical specialties with already limited staff.

The second issue our anesthesia colleagues expressed, and one that is perhaps not as relevant to our immediate delays is the lack of subspecialization in neuroanesthesia. This is specifically the need to have neuroanesthetic consultants in a dedicated neuroscience institute as this may benefit the increasing demand for subspeciality neuroanesthesia in more complex neurosurgical procedures and logistical advantages as a result of having a dedicated neuro anesthesia team.[15,17] The former issue, of general anesthetists lacking neurosurgery exposure in their training impacting even general neurosurgical cases, is more pressing. Our anesthesia colleagues and ourselves are lobbying to move to a dedicated Institute of Neuroscience model. Anesthetists in Pakistan are reforming training to include a longer rotation (>6 months) to neurosurgery/neuroanesthesia during residency by collaborating with hospitals in their localities with neurosurgical departments or those in other cities in proximity. In addition, it is also recognized the need to create postresidency fellowship training in neuroanaesthesia.[15] These two are the long-term goals that are desirable for the developments of both neurosurgery and anesthesia as a specialty in Pakistan.

Examples of lack of staff cited by anesthesia colleague include absence of paramedical supporting staff to assist anesthetists during preparation and intubation. Unlike other surgical departments, at the time of writing it is the neurosurgical OT assistants who assist anesthetists during intubation after which they return to assist the operating neurosurgeons. This issue principally concerns inadequate staffing and is one we as a team are working to address.

At the heart of this article, we hope our recommendations lead to what Naik et al[18] achieved after auditing, streamlining, and improving their OT utilization of their surgical specialties (excluding neurosurgery) at a 1,000-bed tertiary care rural hospital. Most delays are avoidable and can be addressed by proper planning, optimization of patient transfer and resources, and, fundamentally, excellent communication between surgeons, anesthetists, and management staff.[18] This ensures optimal use of time and benefits all specialties (neurosurgery and anesthesia), ancillary staff, hospital managers, and, most importantly, the patient.

The goal of our article was to attempt to quantify the poor efficiency of neurosurgical theater utilization in public sector hospitals in Pakistan and contextualize and discuss the broader factors that contribute. While we discuss the interventions and changes, we are attempting to improve OT utilization, these can only be assessed when we reaudit after gross structural changes are appropriately made and have been in place for an appropriate duration. If we do demonstrate improvement, our strategies may not be completely applicable to every department. Regardless, our setting means that our proposed solutions can provide the foundation for developing personalized strategies for those within a similar setting with similar issues concerning OT utilization and managerial delays in developing countries like Pakistan.

Conclusion

There are significant delays impacting neurosurgery OT utilization. Given that Pakistan's public sector hospitals share management structures, the issues we highlight are common to most neurosurgical departments nationally. Many of these are simple problems due to poor resource management and poor communication between specialties. There is a requirement for long-term structural changes in training. We have proposed solutions to address these, which will be implemented and evaluated in completing the audit cycle.

Ethical Approval

Institutional review board approval was sought. Project did not involved patients and was deemed evaluation of service delivery/audit.

Funding

No funding was received for this study.

Conflict of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria, educational grants, participation in speakers' bureaus, membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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