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Estimating Obstetric Anaesthesia Workload: Number of Deliveries Compared to Time-Based Workload

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Abstract

Background: Number of deliveries is utilised to estimate obstetric anaesthesiologist workload; however, this may not reflect true workload. The goal of this analysis was to assess if including type of procedure, time required and length of each shift would better predict clinical workloads.

Methods: We queried the electronic medical records at a high volume, academic centre for 12 consecutive months of maternal deliveries. Data extracted included delivery type, analgesic/anaesthetic procedure and whether delivery occurred during weekday, weeknight or weekend shifts. To generate an hourly comparison of shifts of varying duration, procedures were divided by the number of hours per shift. To calculate obstetric anaesthesiology time-based workload, delivery type was multiplied by estimated time associated with the analgesic/anaesthetic procedure.

Results: A total of 4,598 deliveries occurred in the 12-month study period. The caesarean delivery rate was 32%, and labour epidural rate was 85%. 1,564 anaesthetic procedures occurred during weekdays and 2,557 occurred during the weeknights and weekends. After accounting for the duration of each procedure and hours per shift, mean ± standard deviation time-based workload ratio was 0.68 ± 0.12 on weekdays versus 0.36 ± 0.07 on weeknights and weekends.

Conclusion: Relative workload based on deliveries alone suggests 41% less workload during the weekday, whereas accounting for duration of each procedure and hours per shift resulted in an 89% greater workload on weekday shifts. The study highlights the importance of considering analgesic/anaesthetic procedures and estimates of time taken to perform them, not just number of deliveries when considering obstetric anaesthesiology workload.

Keywords: Anaesthesia, epidural/utilisation, anaesthesia, obstetrical/utilisation, anaesthesia department, hospital/organisation and administration, delivery, obstetric/statistics and numerical data, workload

Introduction

The ability to efficiently and safely render care in dynamic medical settings such as the labour unit is related to the balance between staffing and patient census. The labour unit is a staffing-intense medical location, requiring resources across multiple service lines (including obstetrics, nursing, paediatrics/neonatology and anaesthesiology, as well as technicians and other unit personnel). Typically, staffing levels are increased during weekday daytime hours in order to mirror the increased numbers of scheduled procedures and patient visits that occur during that time. Staffing levels typically decrease during off-peak hours; however, some studies have indicated higher rates of morbidity occur during these time periods which may be related to suboptimal staffing.[1–4] In models focussed solely on patient safety, staffing levels would be maximal at all times in order to immediately accommodate unanticipated events (eg, natural or man-made disaster). Unanticipated events can create surges in patient census and/or acuity that can potentially overwhelm medical teams. However, with healthcare spending in the United States at nearly 19% of gross domestic product, an environment of extreme financial pressure exists in medicine.[5] Optimal physician and medical staffing have the potential to reduce healthcare costs without compromising patient safety.

In surgical domains, previous studies have analysed caseload in order to determine workload and staffing needs.[6–8] In obstetrics, the number of deliveries has been used as a surrogate for workload. No optimal model existed to

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estimate workload of obstetric anaesthesiologists. An analysis in Scotland determined that more deliveries occurred at larger hospitals, and that procedural frequency (eg, epidural rate for labour analgesia [LA] and caesarean delivery [CD]) was increased at these larger centres.[9] Yentis further suggested that number of anaesthetic interventions should replace number of deliveries as the definitive measure of obstetric anaesthesia activity, particularly given the variable rate of anaesthetic interventions between hospitals.[10]

Although the number of anaesthetic interventions is more relevant to staffing allocation levels than hospital delivery rate, such data may still not represent actual workload for obstetric anaesthesia services, because time is not incorporated as a variable. The aim of this study was to achieve greater granularity with respect to actual anaesthesiologist workload by allocating average times for placement of neuraxial block for LA and provision of anaesthesia for CD.

Methods

The study was conducted at Lucile Packard Children's Hospital Stanford, California. All data utilised for this study were obtained from deidentified, administrative electronic health records. The hospital is a high volume, tertiary care, academic centre with dedicated 24/7 in-house anaesthesia personnel in the obstetric unit. The obstetrical anaesthesia team consists of residents, fellows and attendings. During the weekday (Monday through Friday 7 AM to 5 PM), there are two residents, 2-3 fellows and one attending on service, and during the weeknight (Monday through Friday 5 PM to 7 AM) and weekend (Saturday 7 AM to Sunday 7 AM, Sunday 7 AM to Monday 7 AM) shift, there is one resident and one attending, with in-house and off-site backup staff available for excess volume or acuity. Stanford University Institutional Review Board exemption was obtained prior to the data analysis.

We queried the administrative electronic medical record (EMR) data for 12 consecutive months of maternal deliveries from October 2015 through September 2016. This system allows for the extraction of obstetric and anaesthetic information unlinked to specific patient identifiers. Data extracted for this time period included delivery type, analgesic/anaesthetic procedure performed and whether delivery occurred during a weekday (Monday through Friday 7 AM to 5 PM), weeknight (Monday through Friday 5 PM to 7 AM) or weekend (Saturday 7 AM to Sunday 7 AM; Sunday 7 AM to Monday 7 AM) shift. Data were compiled and analysed in Microsoft Excel 2016 (Microsoft Corp., Seattle, WA, USA). Initial comparison of deliveries per weekday compared to weeknight and weekend shifts were calculated. To control for the increased duration of night (14 hours) and weekend (24 hours) compared to weekday (10 hours) shifts, deliveries were divided by shift hours to calculate deliveries per hour on each shift. The same process was undertaken to compare analgesic/anaesthetic procedures on the weekday versus night and weekend, and we calculated analgesic/anaesthetic procedures per hour on each shift.

In order to estimate workload, we directly observed and timed 25 preprocedure history/focussed physical exam and consents and 25 placements for neuraxial LA during normal clinical practice. The measurements for history/physical and consent included time necessary to review the EMR, discuss history, airway/focussed examination, consent of the patient and document into the EMR. The times for neuraxial LA included time to obtain medication, prepare the patient and equipment, insert and dose the neuraxial catheter and record relevant data in the EMR. The times for CD were taken from a prior study at our institution of 20 scheduled CDs.[11] To calculate obstetric anaesthesiology time-based workload, the analgesic/anaesthetic procedures were classified either LA or CD and then multiplied by a mean observed time, as described above, for LA and CD. The LA and CD times included times for the consent as described above. We controlled for shift time duration differences by dividing total workload per shift by the number of hours in each shift (10, 14 or 24 for day, weeknight or weekend, respectively) to determine this time-based workload ratio. Time-based workload ratio was calculated as time (in hours) spent performing analgesic/anaesthetic procedures and related activities divided by the time (in hours) available on each shift to work. The equation we used is obstetric anaesthesiology time-based workload ratio = ((# of CDs multiplied by CD time) plus (# of LA multiplied by LA time)) divided by (hours per shift). A ratio of 1.0 is equivalent to one person spending all their time in that hour doing analgesic/anaesthetic procedures, and a ratio of 0.5 is equivalent to spending half their time in the hour doing analgesic/anaesthetic procedures.

Graphs were then created in Microsoft Excel 2016 (Microsoft Corp., Seattle, WA, USA) to allow for visual comparison. Data are presented as mean ± standard deviation, percentages and ratios and were calculated using IBM Statistical Package for the Social Sciences (SPSS) version 23 (IBM SPSS Corp.; Armonk, NY, USA).

Main Points

- Asymmetries between patient acuity and/or volume and staffing may affect safety.
- Surgical studies have used caseload to determine workload and staffing needs.
- Obstetric anaesthesia studies have used delivery rate as a surrogate for workload.
- This study analysed anaesthetic interventions and time to evaluate work demands.

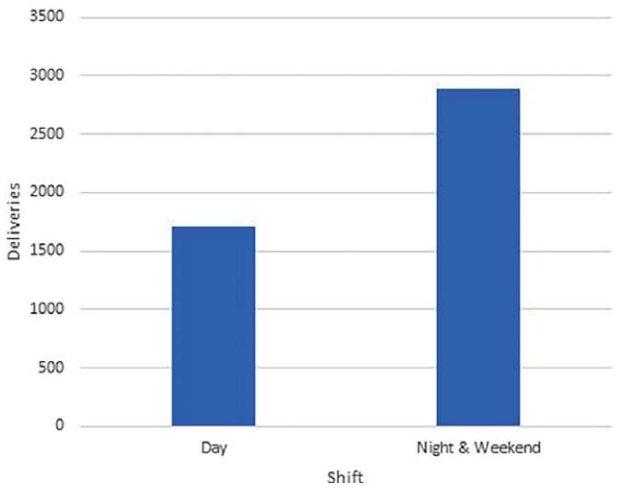

Figure 1. Deliveries occurring on day and night and weekend shifts during the 12-month study period

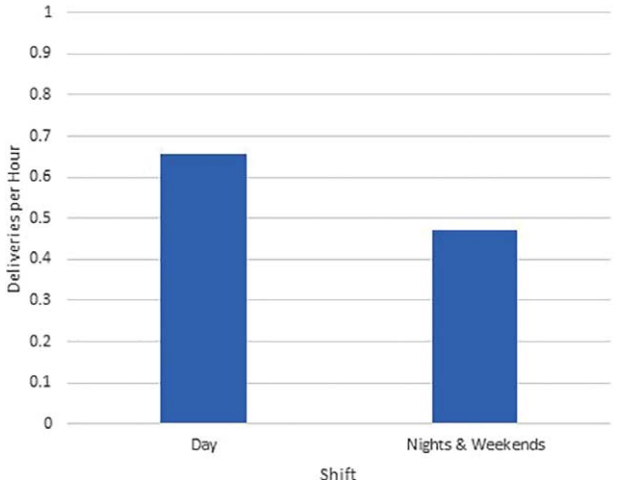

Figure 2. Number of deliveries per hour on day and night and weekend shifts during the 12-month study period

Results

A total of 4,598 deliveries occurred in the 12-month study period, including 1,707 during weekdays and 2,891 during the weeknights and weekends (Figure 1). The CD rate was 32%, and labour epidural rate was 85%. 1,564 anaesthetic/analgesic procedures occurred during weekdays and 2,557 analgesic/anaesthetic procedures occurred during the weeknights and weekends (Figure 2) including 773 caesarean deliveries during weekdays and 684 during weeknights and weekends. A summary of delivery type and analgesic/anaesthetic procedures can be found in Table 1. The mean time necessary for a history/focussed examination and consent was 11 ± 5 minutes. The mean time required for neuraxial

Table 1. Breakdown of Number of Deliveries and Analgesic/Anaesthetic Procedures per Shift Type During the 12-Month Study Period

	Weekdays	Nights and weekends	Total
Deliveries	1,707	2,891	4,598
Vaginal deliveries	794	2,347	3,086
Caesarean deliveries	913	544	1,457
Analgesics and anaesthetics	1,564	2,557	4,121
Neuraxial labour analgesia	791	1,873	2,664
Caesarean anaesthesia	773	684	1,457

LA was 22 ± 4 minutes. Prior work completed by our group showed time for CS was 92 ± 19 minutes. Therefore, the total time, combined history/focussed examination and consent neuraxial LA and CD, was 33 ± 7 minutes and 103 ± 18 minutes, respectively. The number of analgesic/anaesthetic procedures per hour was 0.60 during weekdays compared to 0.42 during weeknights and weekends (Figure 3). After accounting for the duration of each procedure, the weekday time-based workload ratio was 0.68 ± 0.16 versus 0.36 ± 0.09 on weeknights and weekends (Figure 4). Based on delivery volume alone, weekday shifts account for 39% less workload than weeknight and weekend shifts. Based on the number of analgesic/anaesthetic procedures per hour, 44% greater workload occurred during the weekday shifts. Based on time taken for anaesthetic/analgesic procedures, 89% greater workload occurred on weekday shifts than nights and weekends.

Discussion

Our analysis included type of procedure, the time required and the length of each shift, rather than number of deliveries alone. As a result, we can compare the direct obstetric anaesthesia workload associated with various shifts in a functionally relevant way. Our time-base workload estimates (number of anaesthetic procedures per hour and the duration of each procedure and related activity) showed that actual obstetric anaesthesiology time-based workload ratio on weekdays was 0.68 ± 0.16 compared to 0.36 ± 0.09 on weeknights and weekends (ie, weekdays were twice as busy and would require nearly twice the staffing ratios than the weeknights and weekends). In contrast, the workload based on delivery rate alone suggested 41% less workload during the weekday compared to weeknight and weekend shifts.

Estimating obstetric anaesthesia workload is difficult, and the study suggests that just considering number of deliveries likely significantly underestimates workload. Accounting for number of analgesic/anaesthetic procedures per hour did

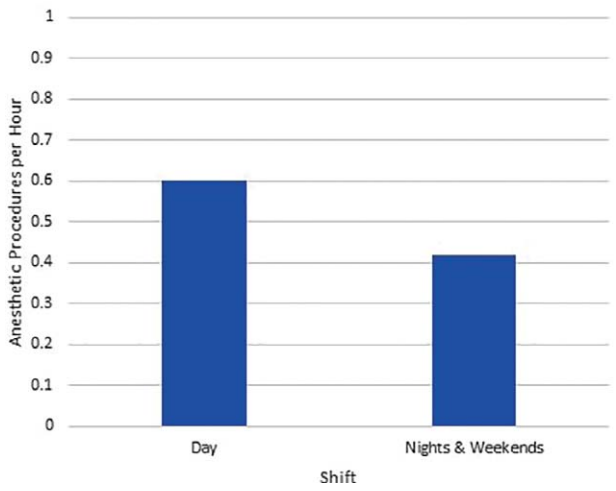

Figure 3. Number of analgesic/anaesthetic procedure per hour on day and night and weekend shifts during the 12-month study period

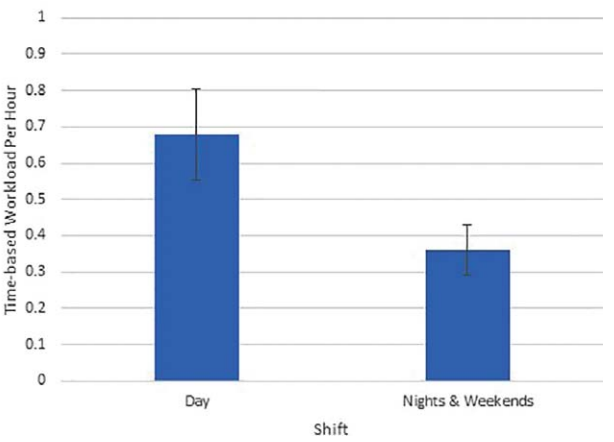

Figure 4. Time-based workload on day and night and weekend shifts during the 12-month study period
Time-based workload was calculated as time (in hours) spent performing analgesic/anaesthetic procedures and related activities per hour. A ratio of 1.0 is equivalent to one person spending all their time in that hour doing analgesic/anaesthetic procedures, a ratio of 0.5 equivalent to spending half their time in the hour doing analgesic/anaesthetic procedures

improve estimates of workload, demonstrating a 44% greater workload during the weekday shifts. Only when factoring in time taken for the analgesic/anaesthetic procedures was the true magnitude of greater workload reflected (ie, 89% greater workload on weekday shifts than nights and weekends). The reason for this discrepancy is that greater numbers of caesarean deliveries occur during the day due to the scheduled CD burden. Both day and night weekend shifts show a dramatic decrease in number of deliveries and anaesthetics at our institution due to decreased rates of scheduled caesarean deliveries and inductions. Prior reports have highlighted that institutional-specific factors may contribute to delivery timing, as seen in this study.[12–14] In this study, CD anaesthesia represents a greater time burden than the provision of vaginal delivery LA for the obstetric anaesthesia provider. Our results demonstrate the importance of considering analgesic/anaesthetic procedures, their relative duration and hours per shift when attempting to devise a rational strategy for staffing of different shifts on labour and delivery. This study also highlights the importance of considering number of deliveries and/or number of analgesic/anaesthetic procedures per hour rather than just total number within shifts, due to the varied length of shifts – in our case, night shifts (14 hours) compared to daytime (10 hours). This can be further amplified by weekend shifts, particularly in the case of institutions with 24-hour shifts.

Prior attempts to quantify obstetric anaesthesiologist workload have focussed on delivery numbers.[9,10] Parsloe et al.[15] demonstrated that workload throughout the day varies with different rates of neuraxial LA and CD. Yentis and Robinson[10] discussed how focussing exclusively on delivery rates poorly estimate anaesthesiologist workload given differing rates of neuraxial labour analgesic at different institutions. The varying rates of CD amongst hospitals have not previously been considered when estimate anaesthesiologist workload. Efforts to quantify clinical and nonclinical time have been undertaken. Wee et al.[16] conducted a survey of 12 hospitals showing that both clinical and nonclinical time was highest during the day shift. Examples of nonclinical activities essential to academic and nonacademic institutions include research, education and training of residents, obstetric and nursing colleagues, education of patients, quality assurance and administrative obligations.

This study was designed to estimate anaesthesiologist workload during weekday compared to nights and weekends in order to guide rational and optimal staffing ratios. The study does not assess patient safety or maternal satisfaction. A study has shown increased dissatisfaction with delays in the provision of neuraxial LA.[17] Neonatal and maternal morbidities outcomes have been evaluated,[1–4] and in studies that evaluated attending obstetrician coverage during the night found no difference in maternal or neonatal outcomes.[18,19] These studies only included hospitals with senior anaesthesiologists providing 24/7, in-house coverage. Given the increasing burden of maternal comorbidities, greater rates of obstetric haemorrhage and continued maternal mortality,[20] anaesthesiologists have the opportunity to improve outcomes,[21] and immediate availability and adequate staffing ratios are essential.[22] In our institution, the evening team is supplemented with potential relief from in-house residents and attendings (that cover other anaesthesia services) or an off-site fellow and attending trained in obstetric anaesthesia. Relief mechanisms like this are particularly important when rationing staffing to allow adequate coverage and safe care during

periods of peak volume or unexpected high-acuity or complicated cases.

We recognise that there are potential limitations to this study. The study was conducted at an academic teaching centre, a busy practice (4,598 deliveries/year), and results may lack generalisability to a private practice or other setting with significantly fewer deliveries. Additionally, the results may differ in centres with different CD and labour epidural rates; our CD and labour epidural rates were 32 and 85%, respectively. However, the study methodology can be applied to other settings to help guide rational staffing ratios during weekday and nights or weekends. Our obstetric anaesthesiology time-based workload calculations and conclusions were drawn from observed cases at our institution (mean time for history/focussed examination and consent of 11 ± 5 minutes, neuraxial LA of 22 ± 4 minutes and CD of 92 ± 19 minutes). Given that we are a tertiary referral centre and university teaching hospital, we are aware these times may be different in other settings, eg, private practices. Varaday and Leighton[23] reported that the average CD time was 98 minutes for a university hospital and 73 minutes for a private hospital that their group covers. Studies looking at workload in the general operating room setting similarly demonstrate time differences in academic versus private practice.[24] Furthermore, our estimate for CD only includes scheduled, nonurgent CD. Nonscheduled, urgent and emergent CD may all have different times and standard deviations affected by a wide variety of factors. Considering this, we have included the equation we utilised to generate our data as variables to allow it to be applied and modified as needed in other settings. In accounting for clinical activities, we have excluded time needed for twin delivery, instrumental delivery, management of patients in a maternal critical care setting and postpartum haemorrhage. While these are certainly important roles of an obstetric anaesthesiologist, they were not accounted for in our data set and likely occur randomly and with a distribution similar to that of the overall workload. We also acknowledge that the workload estimate does not account for nonprocedure time required of the weekday shift anaesthesiologist, including but not limited to research, educational and administrative responsibilities that are not reflected to an equal extent during night and weekend duties. Furthermore, our study does not address the timing or number of specific occurrences when workload outstripped supply of anaesthesiologists due to either volume or acuity. We appreciate that no equation can account for these random events, and that a back-up staff system is required to handle significant workload deviation beyond institutional-specific variations.

Conclusion

Traditional determinants of clinical workload (delivery rate) suggest anaesthesiologist workload is 41% less during weekdays compared to weeknight and weekend. In contrast, our analysis demonstrates an estimate of 89% *greater* workload during weekdays than nights or weekends (0.68 ± 0.16 versus 0.36 ± 0.09 time-based workload ratio on weeknights and weekend). However, these data may under-represent total workload because of superimposed research, education and administrative requirements requirements that occur during weekday shifts. Our current weekday anaesthesiologist staffing is approximately twice that of our night and weekend staffing. Given the results of our analysis, our current staffing model appears to be rational. Data from this study show the potential value of considering analgesic/anaesthetic procedures and their relative estimated duration in order to optimise anaesthesiologist staffing ratios on the labour and delivery unit.

Ethics Committee Approval: Ethics Committe Approval was received from the Stanford University Institutional Review Board Exemption.

Informed Consent: N/A

Peer-review: Externally peer-reviewed.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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