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Short Report

Noise levels during cesarean delivery: a prospective observational study

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A R T I C L E I N F O

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A B S T R A C T

Background: Excessive noise has negative implications for both clinicians and patients. Emergency cesarean deliveries require rapid co-ordination and communication, possibly increasing noise pollution. We aimed to determine if noise levels in the Labor and Delivery operating room were higher during emergency cesarean deliveries than during non-emergency cesarean deliveries.
Methods: We conducted a prospective observational study measuring noise levels in Labor and Delivery operating rooms at a single academic medical center. Sound meters placed on anesthesia machines and events charted in the electronic medical record were used to correlate noise levels to clinical activity. Noise levels in all cesarean deliveries were recorded for one year. Deliveries were classified into two groups: non-emergency (routine or urgent) and emergency. We compared noise levels of the groups at eight time points of interest: anesthesia provider enters operating room (T1), induction (T2), five minutes before incision (T3), three minutes before incision (T4), one minute before incision (T5), time of incision (T6), delivery (T7), and five minutes before initiating emergence (T8).
Results: Noise levels were measured for 440 cesarean deliveries. Forty were classified emergency and 400 non-emergency (304 routine, 96 urgent) procedures. Emergency cesarean deliveries were noisier at all eight time points, although the absolute difference in decibels between the two groups was modest. The difference in noise level reached statistical significance at five time points (T1, T2, T5, T6, and T7).
Conclusion: Noise levels were higher during emergency than during non-emergency cesarean deliveries.

Introduction

Excess hospital noise carries implications for clinical providers and patients. Operating rooms (ORs) can be particularly noisy. Background noises like air handlers, forced-air warmers, and patient monitors combine with conversation and surgical equipment to create significant levels of sound. Noise levels of 55–77 dB in ORs have been reported across multiple surgical specialties[1,2] with transient increases to levels above 100 dB.[2,3] Specifically, a noise simulation showed a baseline level of 54 dB in an obstetric OR, with the loudest measurement being 85 dB.[4]

Operating room noise pollution can impede effective verbal communication, which is critical to patient safety, between staff. Failed communication is frequently implicated in poor patient outcomes.[5] In a simulation study of auditory processing, surgeons exposed to noise showed reduced performance, with a greater effect when simultaneously completing a task.[6] Similarly, high noise levels impaired the performance of obstetric teams managing postpartum hemorrhage.[7]

In obstetric anesthesia, emergency deliveries may be necessary for fetal or maternal health. Emergency cesarean deliveries require rapid completion of multiple steps to anesthetize and prepare the woman for operative delivery; these tasks may increase OR noise. One study found increasing noise levels in cesarean deliveries during the establishment of neuraxial anesthesia, testing of the block, and at delivery, with the loudest phase being immediately following delivery.[8] However, evidence is lacking as to whether and how noise levels differ between routine and emergency cesarean deliveries. We aimed to determine if noise levels in the OR were higher during emergency compared with non-emergency cesarean deliveries.

Methods

This single-center, prospective observational study took place in the Labor and Delivery unit ORs at a large academic medical center from March 2018 to February 2019. The study was approved by our

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Institutional Review Board. There was no physical risk to the patient, therefore written consent was not required.

Study design

All consecutive cesarean deliveries performed on women age ≥18 years during the study interval were included. The primary outcome was noise level. An industrial-grade sound meter, validated from 30-130 dB with a resolution of 0.1 dB per manufacturer specifications (Class 1 Sound Level Meter, model DSM403SD with Excel-formatted Data Logging SD Card, General Tools & Instruments, Secaucus, NJ, USA), was used to measure noise levels. The meter was set to "A" frequency weighting, slow time weighting, and auto-range mode. Sampling time was set at 60 s. A single measurement was recorded every 60 s.

The electronic medical record was used to determine if the cesarean delivery was elective or urgent (non-emergency) or an emergency. Non-emergency deliveries were compared with emergency cesarean deliveries. Noise levels were correlated to specific clinical time points marked in the anesthesia record, including: T1. Start of data collection (anesthesia provider enters the OR); T2. Neuraxial block placement or induction of general anesthesia; T3. Five minutes before skin incision; T4. Three minutes before incision; T5. One minute before incision; T6. Skin incision; T7. Delivery; T8. Five minutes before end of data collection (initiation of emergence). Of note, T3-T5 always occurred at the same time relative to skin incision, but T2 varied depending on the type of anesthesia.

Data collection

Sound meters were secured in identical locations on top of the anesthesia machine in two Labor and Delivery ORs to capture noise experienced by anesthesia personnel (Supplementary Material 1). Meters were placed without notifying OR personnel and remained in place for one year to avoid behavior change. The authors only discussed the study amongst themselves. Noise levels were saved with a time/date stamp to a secure spreadsheet. To ensure the sound meters were maintaining time correctly and similarly to the computers used for the electronic medical record, the meters were examined weekly, then monthly and at the study conclusion. No issues arose.

Our institution's intra-operative anesthesia record has specific event time stamps that anesthesia personnel mark during cesarean delivery, which include our study's time points. Other data points were deduced using the time stamps. For patients with labor epidural analgesia who required cesarean delivery, the time of the first vital sign noted in the anesthetic record was used for T2.

Statistical analysis

To determine a sample size and establish decibel ranges for emergency cesarean deliveries, a three-month pilot test was completed. Based on the data, our institution has a 10:1 ratio of non-emergency to emergency cesarean deliveries. Data were analyzed with a mixed-effects ANOVA, then follow-up t-tests at each time point controlling for an overall family-wise error rate of 0.05. Because there are eight time points, the critical P-value was determined to be 0.006 (0.05/8). A sample size of 440 with a 10:1 ratio of non-emergency to emergency deliveries with repeated measures at eight time points in a mixed effects ANOVA gave 96% power based on our pilot data (effect size = 0.47) at a type-1 error rate of 0.05. Secondary exploratory analysis was also conducted to delineate noise levels among routine, urgent, and emergency deliveries. Data were analyzed using R Core Team (2020, R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 440 consecutive cesarean deliveries were included, of which 400 were non-emergency (304 routine, 96 urgent), and 40 were emergency deliveries. Average noise level across all time points in the non-emergency group and emergency group were 66 dB and 70 dB, respectively. Mixed-effects ANOVA showed that the group effect was significant ($F = -14.11$, $P < 0.0001$). Post hoc t-tests showed a significant difference between the non-emergency and emergency group at T1, T2, T5, T6, and T7 after adjusting for multiple testing (Fig. 1).

A mixed-effects ANOVA showed that the group effect was significant (emergency vs. routine $P < 0.0001$; emergency vs. urgent $P < 0.0001$). Average noise level in the routine group was 66.0 dB and 66.6 dB in the urgent group. Post hoc ANOVA results comparing all three groups after adjusting for multiple testing showed a significant difference between noise level at T1, T2, T5, T6, and T7 (Fig. 2). Pair-wise tests comparing emergency to elective deliveries as well as urgent to emergency deliveries found significant differences at T1, T2, T5, T6, and T7 for each comparison. There was no difference in noise level at any time point between urgent and elective deliveries.

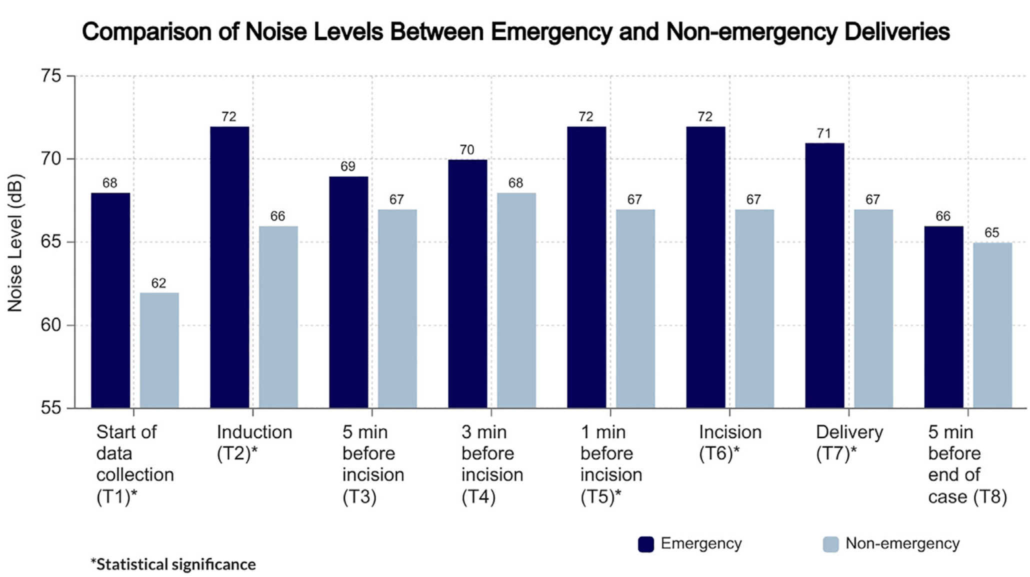

Fig. 1. Graph of mean noise levels (dB) across time points between non-emergency and emergency deliveries. *Indicates significance (all $P < 0.0001$).

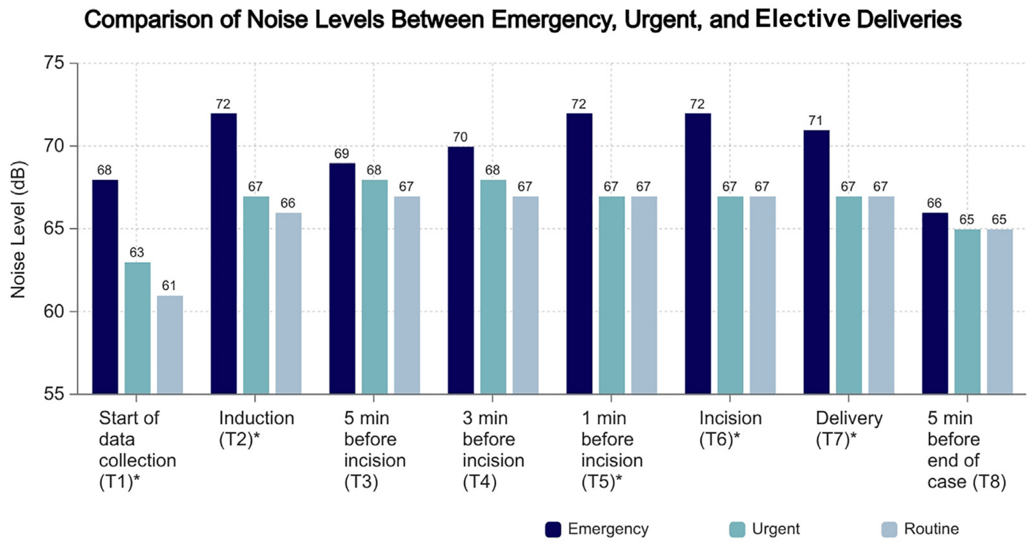

Fig. 2. Graph of mean noise levels (dB) at each time point between elective, urgent, and emergency deliveries. *Indicates significance (all $P < 0.0001$).

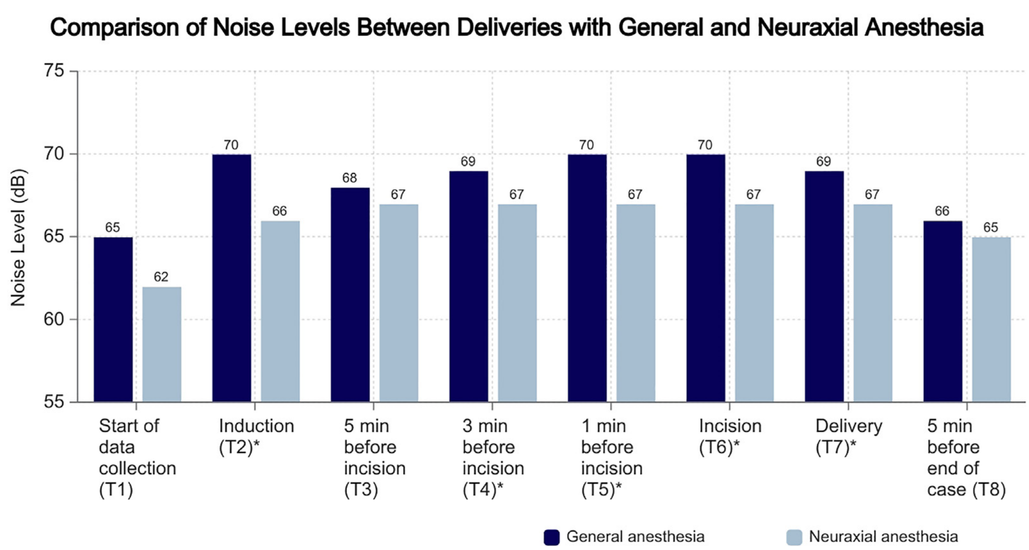

Fig. 3. Graph of mean noise levels (dB) between general and neuraxial anesthesia. *Indicates significance (all $P < 0.0002$).

An exploratory analysis based on anesthetic type was completed. In the emergency group, 35/40 (88%) patients had general anesthesia, a significantly greater percentage than the routine (19/304, 6.3%) and urgent (11/96, 11.5%) groups. Deliveries with significantly higher percentage than the elective general anesthesia were significantly noisier than neuraxial anesthesia at T2, T4, T5, T6, and T7 (Fig. 3).

Discussion

Our study confirmed an increase in noise during emergency compared with non-emergency cesarean deliveries. Excess noise can induce distractions and potentially lead to human errors, thus impacting patient safety.[9] Compared with non-emergency cesarean deliveries, emergency deliveries were significantly noisier at the start of the procedure and induction, in addition to one minute before and at incision through to delivery. Unlike previous studies, we did not demonstrate elevated noise levels during emergence. This could be due to the decibel meter's location or additional personnel leaving the OR before emergence.

Unlike most ORs, obstetric ORs commonly have additional people arriving for delivery, including neonatal intensive care and anesthesia personnel. This could explain the increased noise. Additional anesthesia personnel during an emergency cesarean section include an anesthesia staff member and resident to assist with a quick transition to the OR and conversion to a general anesthetic, if needed. In deliveries using neuraxial anesthesia, a support person is brought into the OR immediately before skin incision. While conversations and shared excitement following a birth are variable, we found delivery was significantly noisier in emergency compared with routine or urgent deliveries, at which the presence of a support person was more likely.

General anesthetics were generally noisier than neuraxial anesthetics. The difference in noise levels between the neuraxial and general groups mirror the differences observed between the non-emergency and emergency groups. It is possible that the general anesthetic is responsible, in part, for the increased noise pollution, in addition to the clinical emergency. We are unable to determine if anesthetic choice alone was responsible for increased noise, as this was not an original aim of our study.

While the absolute difference in noise between the emergency and non-emergency groups appears modest, an increase of 3 dB doubles the sound intensity and an increase of 10 dB is perceived to be twice as loud. Excessive noise has been correlated with mental inefficiency[1] and average background noise levels of 67–70 dB can delay response time and decrease accuracy and communication.[6,10] In an emergency situation, it is reasonable to suggest that relatively modest differences in sound may have a clinical impact.

This study is limited as it was performed at a single institution. While sound was intended to be recorded without the knowledge of individuals in the OR, it is possible that personnel noticed the sound meters and modified their noise levels, introducing a Hawthorne effect. Recordings occurred once per minute and may not have captured transient increases in noise, nor the loudest moment of each minute. The number of patients who had a cesarean delivery under a general anesthetic complicated our analysis, making it difficult to determine whether noise differences in emergency and non-emergency deliveries were related to anesthetic type, clinical urgency, or both. Future work should investigate potential noise reduction interventions as well as determining whether type of anesthesia affects OR noise.

In summary, noise levels are higher during emergency than non-emergency cesarean delivery. Noise pollution is of importance, as eliminating unnecessary noise may play a role in decreasing critical events and patient care distractions.

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None.

Declaration of interests

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijoa.2021.103211.

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