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Epidural augmentation for urgent Cesarean Section : a nationwide Israeli survey

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Abstract : *Background :* Epidural augmentation to convert analgesia to emergency cesarean delivery anesthesia is a common practice. In this survey we examined the common augmentation practices in different hospitals in Israel. We investigated whether practices vary by hospital size and if written protocols for conversion correlate with intra-hospital homogeneity.
Methods : A questionnaire containing 39 questions was sent to obstetric anesthesia unit heads and to four additional anesthesiologists (attending and residents) in 24 obstetric anesthesia units nationwide. Answers were received online anonymously using web-based survey site.
Results : 99/120 participants responded to the survey. 80% of large hospitals have a detailed epidural augmentation protocol. The existence of a written protocol does not affect intrahospital management variability. Overall, 18 different drug mixtures for epidural augmentation were reported, and the most used drug combination is lidocaine, fentanyl and bicarbonate. In large hospitals, 72% add epinephrine and 96% initiate augmentation before operating room arrival. Most respondents reported a final administered total volume of 15-20 ml. In most hospitals there is no maternal or fetal monitoring during patient transfer from delivery room to the operating room, lasting 3.68 minutes on average, with a relative low risk of significant complication as a result of augmentation.
Conclusion : We report variations in common practices, depending on hospital size. We recognized low rate of intra-hospital concordance between centers with or without a written protocol of augmentation. Regarding points for improvement, we would recommend adhering to the accepted institutional protocol.

Keywords : Cesarean section ; epidural augmentation ; anesthesia ; survey ; institutional protocols.

Introduction

An emergency or urgent cesarean delivery (CD) is often necessary in the delivery room. Anesthesia for CD must be both expeditious and effective, while ensuring the safety of the mother and her fetus.

According to guidelines from different societies of obstetricians and gynecologists, during an urgent CD in the first degree, there is a 30 minutes timeframe from the moment of decision to perform CD to the fetal delivery (1-3). Therefore, there is usually sufficient time for epidural augmentation-conversion of labor epidural analgesia to the epidural surgical anesthesia. However, in emergencies where there is danger to either the parturient or the fetus (for example amniotic fluid emboli, uterine rapture, abruption of placenta or suspected severe fetal distress) and immediate extraction is needed, general anesthesia will often be favored (4, 5).

General anesthesia for pregnant women is associated with higher morbidity and mortality, increased postoperative pain, postpartum depression and intraoperative awareness (6-9).Therefore, neuraxial anesthesia is the preferred method for CD, and is used in over 70% of urgent and elective CD in the United States (10).

According to the medical team discretion, when a pregnant woman with a preinserted epidural

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catheter is rushed to the operation room for an urgent CD, the *in-situ* catheter can be repurposed to administer drugs for anesthetic augmentation and preparing the woman for operation. This technique for augmentation epidural analgesia to epidural anesthesia was first described by Milne and colleagues in 1973 (11). Numerous studies and surveys on this technique have been published since then, reporting various possible drug combinations (12, 13). A successful epidural augmentation is achieved when the patient feels no pain or discomfort, and the operation can be completed with no disruptions. Different studies reported a failure rate of 0-30% of cases, when the patient required general anesthesia to complete the surgery (14-16), this is in comparison to the guidelines published by The Royal College of Anesthetists, which set the best practice epidural augmentation failure rate at no more than 3% (17). The number of "failed augmentation" may be even higher if we define "failure" as a situation that requires any other type of anesthesia - such as spinal anesthesia or giving drugs for deep sedation during the surgery.

The most common prognostic risk factors associated with failed epidural augmentation are number of patient controlled epidural analgesia boluses or clinician administered boluses for treatment of breakthrough pain during epidural labor analgesia, prolonged duration of analgesia, initiation of neuraxial analgesia using a traditional epidural technique compared with combined spinal-epidural (CSE) labor analgesia, tall compared with short stature, augmentation by a non-obstetric anesthesia specialist, and urgency of CD (14, 16, 18-20).

The wide diversity of epidural augmentation practices, and the many variables affecting its success, call for systematic data collection and evaluation across many practitioners, in order to identify common practices. Therefore, we designed and performed a nationwide survey to assess common epidural augmentation practices in Israel, and their quality. In this survey we specifically addressed scenarios where, in coordination with the obstetric team, there is a sufficient time frame for augmentation.

Methods

Survey

After Ethics Committee approval (0216-18-SZMC, 27.11.2018) we compiled an online questionnaire with 39 questions (Appendix 1). Survey partakers completed the questionnaire online using web-based survey site (google forms), and the results were automatically and anonymously collected and compiled into an Excel spreadsheet.

The questionnaire was sent during March 2019 to a total of 120 anesthesiologists from 24 medical centers in Israel - one head of obstetric anesthesia unit, one attending anesthesiologist, and three residents from each medical center.

The survey comprised four question categories : (1) general obstetric details, such as numbers of deliveries per year, percentage of elective and urgent/emergency CD ; (2) the general practice of epidural augmentation, such as either starting the augmentation in the delivery room or the operating room, and if there is any monitoring while transferring the patient to the operating room ; (3) which medication is used for augmentation and if there exists specific institutional protocol ; and (4) other interventions if woman experience pain or discomfort despite the augmentation, and after the surgery already began.

We measured whether there was intrahospital concordance, meaning did all anesthesiologists from the same hospital have the same response to question. Intrahospital concordance was measured between hospitals with and without written protocols.

Data analysis and statistics

To assess correlation between two variables, both Pearson and Spearman coefficients were computed.

To compare a quantifiable variable between two independent groups, we performed the Mann-Whitney a-parametric test. To compare three or more independent groups, we performed the Kruskal-Wallis test. We used nonparametric test due to the small sample sizes, and the non-normal distribution of a part of the variables.

To assess correlation between two categorical variables, we performed the Chi-square test or Fisher's exact test.

All statistical tests were two-tailed, and a threshold of <5% was considered statistically significant.

Results

Survey participation : Overall 99 anesthesiologists from 24 Israeli hospitals completed the survey, a completion rate of 82.5%. Respondents included 21 heads of obstetric anesthesiology units,

24 attending anesthesiologists, and 54 residents. We stratified hospitals into three size categories, based on annual number of deliveries : ≥9,000 annual deliveries (5 large hospitals, 24%) ; 5,000-8999 (9 medium hospitals, 43%) ; and ≤4999 (7 small hospitals, 33%). Overall, the rate of epidural analgesia is 54%. The overall CD rate is 18%, of which approximately half are non-elective. The rate of neuraxial anesthesia for CD is 80%. In 60% of anesthesiology departments, residents undergo specialized training program in obstetric anesthesia before working in delivery rooms.

Epidural augmentation : In nine of the 24 centers (37.5%), there is written guidelines for epidural augmentation. There is significant correlation between hospital size and presence of the protocol (p = 0.034). In four (80%) of the five large hospitals there is such protocol.

Participants were queried of their preferred mode of action when a patient has to be transferred from delivery room to the operating room for an urgent CD, such that it is possible to deliver drugs via the epidural catheter and avoid general anesthesia. On average, respondents reported that in 97% of cases they encountered over the last two years (2017-2018), they chose to convert a pre-existing epidural rather than perform a one-shot spinal or general anesthesia. The reported main reasons for not performing an epidural augmentation are many previous top-ups in the delivery room or a personal feeling that the epidural is ineffective or malfunctioning.

In terms of location of initiation of augmentation, 62 (62.6%) of respondents reported that they administer a certain amount of lidocaine (a test dose of 60 mg or higher), while still in delivery room or before arriving at the operating room. Conversely, 37 (37.4%) initiate drug delivery only after arriving at the operating room. There is a significant correlation between hospital size and location of augmentation initiation, where the larger the hospital, the more likely anesthesiologists are to initiate augmentation before the operating room arrival (p<0.001 ; Figure 1). However only in nine (37.5%) of the hospitals was there intrahospital concordance. There was no difference in intrahospital concordance between hospitals with and without a written protocol (p=0.52).

Preferred local anesthetics and dosage for epidural augmentation : More than 80% of respondents administer 2% lidocaine. Other responses included varying doses of bupivacaine (0.125%-0.5%), 0.2% ropivacaine, or a combination of lidocaine and bupivacaine (Figure 2).

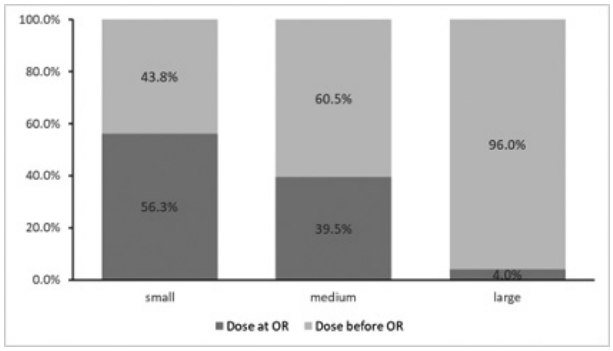

Fig. 1. — Location of augmentation initiation, depending on hospital size. OR : operation room.

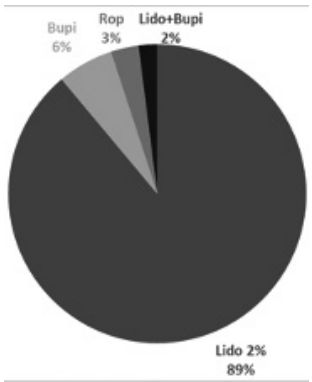

Fig. 2. — Distribution of usage of local anesthesia in epidural augmentation. Lido : Lidocaine, Bupi : Bupivacaine, Rop : Ropivacaine.

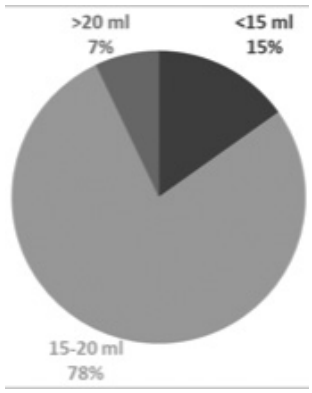

Fig. 3. — Distribution of total volume of loading dose.

Most respondents, 77 (77.8%) reported a final administered total volume of 15-20 milliliters (ml) ; fifteen (15.2%) administered less than 15 ml and seven (7.1%) more than 20 ml (Figure 3). Only in ten (41.6%) of hospitals there was intrahospital concordance regarding choice of local anesthesia and dosage. There was no difference in intrahospital concordance between hospitals with and without a written protocol (p=0.83).

Choice of adjuvants : Opiates : 85 of respondents (85.9%) supplement epidural augmentation with fentanyl. Two (2%) mentioned adding epidural morphine before initiation of surgery.

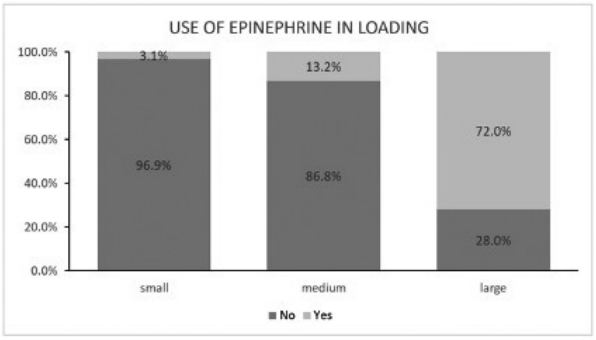

Fig. 4. — Epinephrine supplementation, depending on hospital size.

Twelve (12.1%) do not give any opiates in the augmentation. Only in 14 medical centers (58.3%) was there intrahospital accordance in opioid administration. There was no difference in intrahospital concordance between hospitals with and without a written protocol (p=0.52).

Bicarbonate and epinephrine : 75 (74.7%) of respondents add bicarbonate during augmentation. A quarter of respondents, 24 (24.2%) add epinephrine for augmentation, with a significant correlation between epinephrine supplementation and size of hospital : 18 respondents (72%) from the large hospitals supplement epinephrine, five respondents (13.2%) from the medium hospitals and only one (3.1%) from the small hospitals (p<0.001). (Figure 4) Only in 13 (54.1%) centers there was intrahospital accordance in bicarbonate administration and in 15 (62.5%) centers there was intrahospital accordance in epinephrine administration. We did not recognize any difference in intrahospital concordance between hospitals with and without a written protocol (p=0.92 and p=0.37 respectively). Overall, there were 18 different drug mixtures given for epidural augmentation. (Table 1)

Patient transfer from delivery room to the operating room : The reported average transfer time from delivery room to the operating room is 3.68 minutes, where in 16 (66.7%) of hospitals, respondents reported a transfer time of less than 5 minutes. In 17 (70.8%) of hospitals there is no maternal or fetal monitoring during patient transfer. In hospital where there is monitors during transfer to the operating room - two (8.3%) reported of maternal monitor, included pulse oximeter, non-invasive blood pressure, electrocardiogram (any

Table I.

Summary of all 18 reported combinations for epidural augmentation

Type of LA for loading	Type of Opioids in loading	Use of Bicarbonate in loading	Use of Epinephrine in loading	Number of participants
Lidocaine	Fentanyl	Yes	No	41
Lidocaine	Fentanyl	Yes	Yes	16
Lidocaine	Fentanyl	No	No	10
Bupivacaine	Fentanyl	Yes	No	5
Lidocaine + Bupivacaine	Fentanyl	No	No	3
Lidocaine + Bupivacaine	Fentanyl	Yes	No	3
Lidocaine	None	No	No	3
Lidocaine	None	Yes	Yes	3
Ropivacaine	Fentanyl	No	No	2
Lidocaine + Bupivacaine	None	No	No	2
Lidocaine	None	Yes	No	2
Lidocaine	Fentanyl	No	Yes	2
Lidocaine	Morphine	Yes	No	2
Ropivacaine	Fentanyl	Yes	No	1
Lidocaine + Bupivacaine	None	No	Yes	1
Lidocaine + Bupivacaine	Fentanyl	Yes	Yes	1
Lidocaine	None	No	Yes	1
Bupivacaine	Fentanyl	No	No	1
Total				99

LA : Local Anesthetic.

Table II

Percentages of homogeneity in performing an epidural augmentation

Question	Percentages of homogeneity in performing an epidural augmentation
Do you give the augmentation in the delivery room or in the operation room?	38% **(9/24)**
Which LA do you use for augmentation?	58% **(14/24)**
What is the total volume for augmentation?	42% **(10/24)**
Which monitor while delivery the woman to operation room?	21% **(5/24)**
Do you give opiates in the augmentation and which?	58% **(14/24)**
Do you give bicarbonate in augmentation?	54% **(13/24)**
Do you give Epinephrine in augmentation?	63% **(15/24)**
How do you manage failed epidural augmentation?	0% **(0/24)**
Do you check the epidural height with ice or needle before giving any augmentation dose?	25% **(6/24)**

or all of the above), one (4.2%) reported fetal monitoring, and one (4.2%) reported both maternal and fetal monitoring. There was only five (20.8%) intrahospital concordance in monitoring practices. There was no difference in intrahospital concordance between hospitals with and without a written protocol (p=0.24).

Managing failed epidural augmentations : We asked the participants how they respond when after epidural augmentation and during CD, the patient complains of pain or discomfort, interfering with operation completion. In such a scenario, 52 (52.5%) would give intravenous medication, including benzo-diazepines, ketamine, opiates and propofol. 23 of respondents (23.2%) would immediately switch to general anesthesia, 18 (18.2%) would administer inhaled N2O in addition to intravenous medication. There was 0% intrahospital concordance. There was no difference in intrahospital concordance between hospitals with and without a written protocol (p=0.53).

Complications after epidural augmentation : 70 respondents (70.7%) reported no complications related to epidural augmentation in their hospital during the last two years (2017-2018). Sixteen (16.2%) witnessed high epidural block, 11 (11%) reported "nonsignificant" complications without description, and only two responses included one case of anaphylactic shock and one case of cardiovascular collapse.

Homogeneity per hospital : In addition to the statistics we showed above, we also looked for homogeneity in the answers of the participants per each hospital. We found that even in the same hospital the augmentation procedure is not always homogenous. Table 2 details the questions we compared in each hospital, and the percentages of hospitals in which all participants gave the same answer.

Discussion

Epidural augmentation from labor analgesia to CD anesthesia is commonly practiced in Israel and worldwide. We performed a multi-centered nationwide survey consisting 24 Israeli medical centers and documented the various methodologies practiced in hospitals, specifically assessing whether differences between hospitals may depend on their obstetric volume.

As soon as a patient with a pre-existing epidural catheter is decided to undergo an urgent CD, the practicing anesthesiologist is required to make numerous decisions in a brief time period. The anesthesiologist must determine whether to augment the epidural catheter, whether to initiate drug administration immediately or wait after transfer to the operating room, which drugs and adjuvants to administer, and monitor and prevent any threatening complications that may arise.

In this survey we specifically addressed scenarios where, in coordination with the obstetric team, there is a sufficient time frame for augmentation. Under these circumstances, only 3% of respondents in the survey decide to perform spinal or general anesthesia, rather than augment the pre-existing epidural catheter. When asked why they chose not to perform epidural augmentation, answers included a subjective assessment that the augmentation will fail, or the need for multiple manual boluses, which according to literature can predict failure of augmentation (20).

In many cases, the anesthesiologist initiates the epidural augmentation when the patient is still in the delivery room, and while the medical staff are organizing the paperwork, and preparing the woman for operation. In current survey 62.6% of participants start drug administration at this stage. The advantage of early initiation is that when the patient arrives in the operating room, the drugs are already somewhat effective, and the team can

commence the CD early on. On the other hand, in most hospitals (81%), the patient is not monitored while being transferred to the operating room, raising the risk of unnoticed complications, such as high block or total spinal anesthesia, acute hypotension and inadvertent intravascular injection (21-23). Literature does not specifies guidelines for monitoring during patient transfer.

In this survey there were no reports of maternal mortality, and we did not investigate the correlation between early initiation of augmentation and ensuing complications. However, it is noteworthy that most anesthesiologists in large hospitals (96%) initiate augmentation at the delivery room, while also reporting the highest frequency of epidural related complications (36%), including hemodynamic collapse and high spinal.

Comprehensive surveys conducted in Scandinavia and the United Kingdom described results similar to common practices in Israel : More than 90% prefer epidural augmentation over spinal or general anesthesia, report less than 5 minutes transfer time from delivery room to the operating room, and do not perform maternal or fetal monitoring during transfer (24, 25).

There are no explicit guidelines for the location of the initiation of epidural augmentation, and whether or not to give a test dose. On the one hand, the fact that the anesthesiologist performing epidural augmentations is not necessarily the one who inserted the epidural catheter, combined with the risk for intravenous or intrathecal catheter migration, both support administering a test dose to examine catheter positioning, or delaying the first dose until the patient is monitored in the operating room. On the other hand, early drug administration can shorten the decision to delivery interval (DDI) while maintaining a low risk for unexpected drug response, since the patient already received PCEA for epidural analgesics. While there are no strict guidelines, most recommendations in the literature support giving a certain dose already in the delivery room in order to shorten the DDI (26). In practice, most Scandinavian anesthesiologists (60%) administer the first dose in the the operating room, whereas in the UK, (80.5%) initiation is mostly performed at the delivery room (24, 25). In the current survey, 62.6% of participants mentioned giving a test dose, or prefer to give medication in incremental doses (a part in the delivery room and the rest in the operating room), while continuously examining the patient's condition. In the present survey, we stratified hospitals into three size categories (according to the number of deliveries) and found correlation between the size of the medical center and the management of the epidural augmentation. We have observed that in large hospitals with high volume of deliveries and surgeries, anesthesiologist more often administer augmentation dose in the delivery room, what is more similar to UK practice. A possible explanation is that in hospitals with a large volume of deliveries have a greater readiness for emergencies. Because of large workload, the staff is required to reduce the stay in the operating rooms, so the advantage of early administration of augmentation is early start of the surgery.

The optimal epidural augmentation drug should be both strong and have a fast onset. In the Scandinavian and UK surveys mentioned above, more than 20 drug combinations for epidural augmentation were reported. Respondents in the current survey reported 18 different combinations, where the most dominant combination was lidocaine, fentanyl, and bicarbonate. Lidocaine has a fast onset time, and in combined with adjuvants, can provide a strong and efficient anesthesia (13).

Lidocaine's short duration is not a limitation, since in case of prolonged surgery, additional local anesthetics or adjuvants can be given via the epidural catheter. Moreover, lidocaine is cheaper than other local anesthetics, and its toxic profile is relatively safe (27). There are reports in the literature that a combination of lidocaine, fentanyl, epinephrine and bicarbonate is advantageous in inducing a fast onset and has no reported side effects to the patient and the neonate (28).

In Israel, we found that this four-component combination is mostly used in large hospitals with high volume of obstetric activity and, as we know from our previous study, with anesthetists specialized in Obstetric Anesthesia (29). Bicarbonate as an adjuvant accelerates penetrance of the local anesthetics to the epidural cavity by alkalization of the drug (30, 31). Epinephrine improves block quality by causing constriction of the epidural blood vessels and delaying the systemic absorbance of the drug (32). Hillyard et al. found that addition of epinephrine to lidocaine, with or without fentanyl, exhibit the fastest onset, whereas ropivacaine provides an optimal block strength and quality, and does not require adjuvants (13). Most respondents administer 15-20 ml of local anesthetics and according to literature this dose provides significantly better augmentation than doses lower than 15 ml (26).

It should be mentioned that despite importance of investigating optimal epidural augmentation medications, dosage, and adjuvants, there is still no

consensus in the recommendations, and these issues warrants further studies.

In contrast to previous surveys (24, 25), in the current study representatives were from all levels of expertise, including directors of obstetric anesthesia unit, attending anesthesiologists and residents. We examined intrahospital concordance in the management of the epidural augmentation within the hospital, and whether there is relationship between the consistency of the work and the existence of a written protocol. We found that there is variability between different hospitals and variability in practice within each hospital. In hospitals with written protocol there are still differences in answers of anesthesiologists, what shows the importance in adherence to departmental protocol. The differences in answers may be explained by limited implementation of protocol in daily practice especially among junior residents ; wide and non-specific recommendations in protocol that allows too much freedom of choice ; protocol that is not updated and therefore is not implemented.

Conclusions

Summarizing data from Israeli hospitals, we report preference of using a combination of 15-20 mL of lidocaine, fentanyl, and bicarbonate for epidural augmentation. In large hospitals, epinephrine is also favored in combination with the three mentioned substances. The common practice is initiation of augmentation in delivery room or before arriving in the operating room, transportation to the operating room without monitoring and relative low risk of significant complication as a result of augmentation. We recognized the low rate of intrahospital concordance between centers with or without a writing protocol of augmentation.

This survey demonstrates not only the need for institutional protocols, but also the importance of their implementation in the daily practice.

Ethics approval

The study protocol was approved by the local Institutional Review Board number : 0216-18-SZMC. Ethics Committee, Shaare Zedek Medical Center, Jerusalem, Israel.

Head of the Medical Ethics Department committee : Prof. Avraham Steinberg.

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Appendix
Questionnaire (Translated from Hebrew)

1. Hospital name
2. Position
    a. Resident
    b. Attending anesthesiologist
    c. Head of obstetric anesthesia unit

Questions to head of obstetric anesthesia unit

3. Number of annual deliveries
4. % epidural in delivery room
5. % Cesarean Section (CS)
6. % Urgent CS out of all CS
7. Did the resident have formal training/rotation in obstetric anesthesiology?
    a. Yes
    b. No
8. % General Anesthesia (GA) in urgent CS
9. % regional anesthesia in urgent CS

Questions to all participants

10. Which epidural protocol is commonly used in delivery room?
    a. CEI+PCEA
    b. PIEB+PCEA
11. Which Local Anesthetic (LA) is used in epidural maintenance?
12. Which concentration of LA is used in epidural maintenance?
13. In CEI+PCEA protocol:
    a. Basal Rate (ml/h)
    b. What volume in a single bolus?
    c. What is the usual lockout time?

14. In PIEB+PCEA protocol:
    a. What volume is automatically given by the pump?
    b. What is the PIEB Interval?
    c. What volume can the patient administer to herself in a single bolus (PCEA)?
    d. What is the usual lockout time?
15. Which opiate is given in the solution?
16. What is the opiate dosage (microgram/ml)
17. Does the unit have a written protocol for epidural augmentation for urgent CS?
    a. Yes
    b. No
18. What is the minimal duration in your hospital needed to transfer a parturient from delivery room to Operating Room (OR) once a decision to go into urgent CS is made?
19. Does the patient need to be moved to a stretcher for transfer to OR?
    a. Yes
    b. No
20. When patient is trasnfered to OR for urgent CS, what will you usually do to initiate epidural augmentation?
    a. Give half a dose at delivery room or during transfer to OR.
    b. Give a full dose at delivery room.
    c. Wait with LA until after transfer to OR.
    d. Other
21. In case you decide to give a test dose before augmentation:
    a. Which LA do you usually use?
    b. At what concentration?
    c. What volume?
22. For augmentation bolus:
    a. Which LA do you usually use?
    b. At what concentration?
    c. What is the final volume?
        i. 15ml or less
        ii. 15-20ml
        iii. More than 20ml
23. Before CS augmentation, do you usually check block height (with a needle or ice)?
    a. Yes
    b. No
24. In case you start augmentation already in delivery room, are there available EPHEDRINE or PHENYLEPHRINE in the delivery room?
    a. Yes
    b. No
25. In case you start augmentation already in delivery room, how do you monitor the patient during transfer to OR (choose one or more option):
    a. ECG
    b. Oxygen saturation
    c. Blood pressure
    d. Fetal monitoring
    e. No monitoring
26. Which opiates do you usually give in augmentation bolus?
27. What is the dosage (microgram)?
28. Do you use bicarbonate?
    a. Yes
    b. No
29. If yes, what volume (ml)?
30. Do you use epinephrine?
    a. Yes
    b. No
31. If yes, what dosage (microgram)?
32. Do you use additional drugs?
    a. Yes
    b. No
33. If yes, which and at what dosage?
34. What is the injected solution's temperature?
    a. Room temp.
    b. Reepinefrigerated.
    c. Slightly heated.
35. In the last couple of years (2017-2018), how do you estimate the frequency of failed epidural augmentations?

36. In the last couple of years (2017-2018), how frequently did you remove an epidural catheter and performed spinal anesthesia before CS?
37. What is the main reason in these cases?
    a. I felt the epidural augmentation will fail.
    b. The patient received multiple top-ups in delivery room
    c. Other
38. What do you usually do in case during CS the patient is restless and may interferes with the operation (choose one or more options)?
    a. IV Benzodiazepine
    b. IV Propofol
    c. IV Ketamin
    d. IV opiates
    e. Inhaled N2O
    f. Transform to GA
    g. Other
39. In the years 2017-2018, did any unusual events (anaphylaxis, toxicity, high spinal, inadvertent intravenous injection) occur during epidural augmentation for urgent CS?