

A survey of anaesthesia practices at all hospitals performing caesarean sections in Sierra Leone

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Short title:

Anaesthesia for CS in Sierra Leone

Funding:

The study was funded by The study was funded by grants from the Norwegian University of Science and Technology, St Olav's Hospital, Trondheim Norway. The funders had no role in the study design, data collection, data analysis or interpretation, writing, or publication process of this report.

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Abstract

Background: Providing safe anaesthesia is essential when performing caesarean sections, one of the most commonly performed types of surgery. Anaesthesia-related causes of maternal mortality are generally considered preventable. The primary aim of our study was to assess the type of anaesthesia used for caesarean sections in Sierra Leone. Secondary aims were to identify the type and training of anaesthesia providers, availability of equipment and drugs and use of perioperative routines.

Methods: All hospitals in Sierra Leone performing caesarean sections were included. In each facility, one randomly selected anaesthesia provider was interviewed face-to-face using a predefined questionnaire.

Results: In 2016, 36 hospitals performed caesarean sections in Sierra Leone. The most commonly used anaesthesia method for caesarean section was spinal anaesthesia (63%), followed by intravenous ketamine without intubation; however, there was a wide variety between hospitals. Of all anaesthesia providers, 33% were not qualified to provide anaesthesia independently, as stipulated by local regulations. Of those, 50% expressed high confidence in their skills to handle obstetric emergencies. There were discrepancies among hospitals in the availability of essential drugs, the use of post-operative recovery and the presence of a functioning blood bank.

Conclusion: Anaesthesia for caesarean sections in Sierra Leone showed a predominance for spinal anaesthesia. The workforce consisted mainly of non-physicians, of which a third was not trained to provide anaesthesia independently. Both the type of anaesthesia and the presence of qualified anaesthetic providers was widely variable between hospitals. Significant gaps were identified in the availability of equipment, essential drugs and perioperative routines.

Keywords: Anaesthesia, Caesarean section, Global health

Introduction

During the 2015 World Health Assembly, the decision making body of the World Health Organisation (WHO), a resolution was adopted to strengthen emergency and essential surgical care and anaesthesia as a component of universal health coverage.¹ With this, governments worldwide acknowledged that strengthening surgical and anaesthesia capacity and anaesthesia is a highly cost-efficient intervention to the global burden of disease. As part of this, regular monitoring and evaluation of the emergency and essential surgical care and anaesthesia in order to identify unmet needs is required. A previously developed extensive questionnaire-tool for assessment of the state of surgical care in a given hospital was refined into a more clinical approach by assessment of the so-called Bellwether procedures only (2016).^{2,3} Since caesarean section, one of those Bellwether procedures, is one of the most commonly performed types of surgery in Sierra Leone, as well as worldwide, we narrowed down our survey to caesarean section only in order to make later comparison more feasible.⁴

Anaesthesia accounts for 3% of all maternal deaths in low and middle income countries (LMICs), and for 14% of deaths after caesarean section.⁵ In general the majority of anaesthesia-related causes of maternal mortality are considered preventable.^{5,6,7}

Sierra Leone, one of the poorest countries in the world, is located in western Africa and has an estimated population of 7 million, of whom 59% reside in rural areas.⁸ The country has only two skilled healthcare providers per 10,000 population; that is doctors, nurses or midwives. This is less than 10% of what is globally recommended.⁹ In addition to free health care for pregnant women, established in 2010, the Sierra Leone Ministry of Health and Sanitation initiated task-sharing training programs for anaesthesia (in 2008) and surgery (in 2011) in order to further increase access to emergency obstetric services.^{10,11} In 2016, 54% of the 291,000 pregnant women in Sierra Leone delivered in a health facility.¹² Sierra Leone's caesarean section rate, at 2.9%, is among the lowest in the world,¹³ while its maternal mortality ratio (MMR) of 1,360 per 100,000 live births is one of the highest.¹² A total of 706 maternal deaths were reported for 2016; however, a considerable under-reporting rate (76%) is suspected.¹² Eighteen percent of in-hospital maternal deaths occurred during or after caesarean section, and the caesarean section mortality rate was 1.5%.¹³ During the Ebola outbreak, which started July 2014, there was a decrease in the number of in-hospital deliveries and caesarean sections (by over 20%), mainly attributable to the closing of mission/non-governmental organisation (NGO) facilities.¹⁴ Many of these had not, at the time of our

survey, restarted caesarean sections. The WHO declared Sierra Leone Ebola-free on 7 November 2015.¹⁴

The country's health service delivery system includes *public* (government and military), *private non-profit* (mission and NGO) and *private for-profit* providers. The latter operate mainly around the capital, Freetown. In 2014, the *public* sector accounted for 76% of in-hospital deliveries and 67% of caesarean sections, while the *private non-profit* hospitals accounted for 24% and 33% of these deliveries, respectively. Less than 1% of deliveries occurred in the *private for-profit* sector.¹⁴ All three specialist anaesthetists in the country are based in Freetown, and only one covers obstetric anaesthesia, servicing different facilities. One mission hospital, outside the capital, is occasionally staffed by visiting overseas anaesthesia specialists. Locally trained medical officers (MOs), or expatriate MOs employed by some mission/NGO hospitals, may or may not have anaesthesia training. Sierra Leone has several *nurse gradings* involved in providing anaesthesia. Community health officers (CHOs) have undergone a 3-year training. State-registered nurses (SRNs) and State-Enrolled Community Health Nurses (SECHNs) have 3 and 2 years of training, respectively. CHOs and SRNs are offered a 2-year *nurse anaesthetist* training in Freetown.¹⁰ Since 2013, SECHNs can also follow a 1-year training as *anaesthetic technicians*, whose role is to assist the authorised anaesthetic provider. In some hospitals, anaesthesia is provided by personnel *trained "on the job"*. These can be healthcare providers in one of the aforementioned nurse gradings, or even health workers without formal training.

The MOs and the anaesthesia-trained CHOs/SRNs (*nurse anaesthetists*) are **authorised to provide anaesthesia independently**. Both the trained SECHNs (*anaesthetic technicians*) and those *trained "on the job"* are **not authorised** to provide anaesthesia on their own; however, they are often forced to do so due to lack of manpower.

The primary aim of the study was to describe the type of anaesthesia used for caesarean sections in Sierra Leone. Secondary aims were to identify the type and training of anaesthesia providers, equipment used, perioperative routines and essential drugs available.

Methods

All hospitals providing caesarean sections in Sierra Leone were eligible to participate. Facilities to be included were suggested by the Ministry of Health and Sanitation, the Sierra Leone Ethics and Scientific Review Committee (SLESRC) and the authors KSKJ, MAS and AD. All of the facilities in the study were visited after prior notice by telephone and a postal recommendation letter from the Sierra Leonean College of Medicine and Allied Health Sciences. Permission was obtained from the medical superintendent to collect hospital statistics for cases in which caesarean sections were performed in 2016 and to interview one random anaesthesia provider face to face after informed consent was signed.

The questionnaire was a modified and combined version of the WHO's "Tool for Situational Analysis to Assess Emergency and Essential Surgical Care" and the "Anaesthesia 2010 Questionnaire" by the World Federation of Societies of Anaesthesiologists (WFSA),^{2,15} and has already been applied in Zimbabwe.¹⁶ After adjustment to the local context and a pilot interview, the final version consisted of 133 questions (Appendix A). The first part consisted of hospital data from 2016 (e.g. annual number of caesarean sections, total institutional deliveries, live births, maternal deaths, hospital's MMR and number of spinal anaesthesia procedures for caesarean sections). These data were also used in another study.¹³ The second part of the questionnaire covered infrastructure, human resources, equipment and drugs available, perioperative routines and the personal preferences of the interviewed anaesthetic provider when performing caesarean sections. Data were analysed using SPSS version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used. Missing data are indicated. The study was approved by the local ethics committee, SLESRC (date of approval: 16 May 2016). The entire dataset is available from the corresponding author on request.

Results

Data collection.

Face-to-face interviews were conducted at the eligible hospitals between 2 February and 30 March 2017. Of the 64 hospitals visited, 36 were confirmed to provide caesarean sections (Figure 1). The questionnaire response rate was 100% (n=36). As one of the SRNs trained in anaesthesia worked in three different facilities performing caesarean sections, 34 anaesthesia providers were interviewed for the 36 hospitals. The distribution of participating hospitals is displayed in Figure 2. The type of provider interviewed mirrored the distribution of different types of anaesthesia providers in the 36 hospitals in the study. No specialist anaesthetists were interviewed.

Anaesthetic technique used for caesarean sections.

Annual hospital data for 2016 showed that 63% (n=4421) of all caesarean sections (n=7026) were performed using spinal anaesthesia (Figure 3). The numbers vary widely between and partly within the different types of facilities (Figure 2, 3). The personal preference for spinal anaesthesia among the interviewed anaesthesia providers corresponds with the hospital data (Figure 4). The second-most preferred technique (though still uncommon) was ketamine anaesthesia without intubation. A minority were done with anaesthetic gas, either with or without endotracheal tube, or with local infiltration. There was a tendency for trained anaesthesia providers to opt for a spinal technique: 86% in more than 50% of all caesarean sections.

Type of anaesthesia provider

Across the 36 hospitals, there were a total of 115 anaesthesia providers employed, mainly non-physicians. One local specialist anaesthetist covered 3 hospitals, and one mission hospital was frequented by expatriate specialist anaesthetists. In total, 67% of the anaesthesia providers were authorised to provide anaesthesia independently (Figure 5). Eighteen (16%) of the anaesthesia providers were trained “on the job”, 6 in the public hospitals and 11 in the private non-profit hospitals (accounting for 35% and 69% of the unauthorised workforce, respectively). Six of the anaesthesia providers were not trained as a nurse, with all but one working in the mission/NGO hospitals.

Equipment, perioperative routines and drugs.

Pulse oximeters were available in all hospitals, in contrast to ECG, which was available in less than 50% of hospitals. Oxygen was generally provided by oxygen concentrators. Basic amenities like electricity and water were not always available, and only 50% of hospitals had a functioning solar panel at all times (Figure 6). It is also worth mentioning the low availability of a functioning blood bank, an area for recovery, endotracheal tubes, laryngeal masks and spinal needles. Twenty-four hospitals were equipped with an anaesthesia machine, primarily of the draw-over type (Universal Anaesthesia Machine [UAM, 18 hospitals], Glostavent [1], other [1]). The supply of anaesthetic gas was poor (Figure 7).

An anaesthesia provider was available at all times at all facilities (Figure 6). Twenty-eight (78%) of providers reported multiple responsibilities in the operating theatre; in all cases, this included involvement with neonatal resuscitation. In addition, eight providers indicated assisting with the actual surgery as well.

Measures to manage a fall in blood pressure were 100% compliant (wedge/table-tilt and use of vasopressor). Eight hospitals (22%) used laryngeal masks all the time when performing general anaesthesia for caesarean section. All hospitals used dedicated, disposable spinal needles, in contrast to a similar study that reported that intravenous cannulas were also used for this purpose.¹⁶ In the majority of hospitals (67%), the provider used 25G needles most of the time/all the time. In 18 hospitals (50%), the patient predominantly went straight to the ward after surgery (Figure 7). One-third (12) of the hospitals did not have an area designated for recovery. However, six hospitals with a dedicated recovery area did not use it as such. Postoperative pain management in general was lacking in both routines (Figure 7), as was the availability of opioids (Figure 8).

Although benzodiazepines were usually first given only after the baby was delivered, two providers would administer it prior to delivery and one would never use it (all of whom were not authorised providers). Seventy-two percent claimed that they would switch to a general anaesthetic in cases of failure of the spinal anaesthetic. The remaining 10 (9 of whom were authorised anaesthesia providers) would attempt a new spinal. When asked how confident the provider felt managing routine obstetric procedures, 75% of the interviewees replied “very confident”; of those, the majority were trained anaesthesia nurses. Remarkably, 50% of those trained on the job answered similarly.

Indicated reasons for inter-institutional referral of obstetric cases, in the personal experience of the interviewed providers, were unavailability of blood at the blood bank (n=7), and lack of a surgical provider (n=1).

Essential drugs for spinal and general anaesthesia were not always available (Figure 8). However, ketamine was almost always available in 35 hospitals (97%). Oxytocin was generally available, while misoprostol and ergometrin were available to a much lesser degree. The supply of analgesics was poor, with oral paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs) and tramadol always available at 90%, 90% and 94% of hospitals, respectively. The majority of hospitals (97%) used isotonic electrolyte solutions for nearly all caesarean sections. Essential drugs to treat (pre-) eclampsia were not always available (magnesium sulphate [28%], labetalol [50%] and nifedepine [8%] mostly/all the time available).

Discussion

This study on anaesthesia for caesarean sections in Sierra Leone demonstrates the predominance of spinal anaesthesia. The anaesthesia workforce consisted predominantly of non-physicians. On average, 33% of the providers were not trained to provide anaesthesia independently. Both the type of anaesthesia and the presence of qualified anaesthetic providers was widely variable between hospitals. There were also important gaps in the availability of equipment and essential drugs and in the performance of perioperative routines.¹⁷

Although spinal anaesthesia is the most practised and preferred technique for caesarean section, the proportion of caesarean sections using this anaesthesia technique in Sierra Leone is considerably lower than in high-income countries (but similar to Zimbabwe).¹⁶ One possible reason is the proportion of emergency caesarean sections in Sierra Leone (80%–90%),¹⁸ with a high incidence of obstructed labour (42%), (pre)eclampsia (25%) and haemorrhage (22%).¹³ Another reason is lack of competence/knowledge about the technique, which is reflected by the lack of uniformity in use of spinal anaesthesia among facilities. Some mission and NGO hospitals used spinal anaesthesia for nearly all caesarean sections, while others rarely used it. The high incidence of spinal anaesthesia in the private hospitals is most likely due to the predominance of elective caesarean sections. A much-cited meta-analysis published in *The Lancet* in 2016 quoted that nearly 14% of maternal deaths after caesarean section were due to anaesthesia complications, with increased rates of maternal death when exposed to general anaesthesia compared to spinal anaesthesia, and when managed by non-physician anaesthetists compared to physician anaesthetists.⁵ However, these maternal mortality figures are confounded by indication, definition, anaesthesia provider and availability of equipment/drugs.¹⁹ In the hands of a trained provider (specialist or non-physician), along with readily available essential drugs and monitoring in an elective setting, spinal anaesthesia is a safe technique.²⁰ In resource-constrained surroundings, these prerequisites are often lacking, and a simple technique could have catastrophic results.²¹

The health authorities should be commended on their efforts to strengthen the quality of anaesthesia providers by initiating a nurse anaesthesia training program in 2008 and an anaesthesia technician program in 2012. On a specialist level, the country is still far from the minimum standard of specialist anaesthetists of 4 per 100,000 population in LMICs, even though those figures are more LMIC context-sensitive (i.e. lower) than the standards set by Lancet Commission on Global Surgery.^{22,23} Retention of trained anaesthesia providers is a

problem in Sierra Leone, as the attrition rate is high due to staff migrating out of the country and to other medical disciplines. A similar training program in Haiti showed a brain drain of 21% of qualified nurse anaesthetists over a 10-year period.²⁴ In Sierra Leone, like other LMICs, anaesthesia suffers a low status compared to other medical specialities.²⁵ Recent efforts to train medical officers for a master's program in anaesthesia should be supported. Medical officers, both local and trained abroad, are a vulnerable group who are authorised but often inadequately trained for anaesthesia, as pointed out by Farina et al. in South Africa.²¹ One-third of the anaesthesia providers were either not trained to give anaesthesia independently (anaesthesia technician) or trained “on the job”, with the highest portion found in private non-profit/for-profit hospitals. Other unfortunate contributing factors in the LMIC environment, as also illustrated here, are dual responsibilities, often forced upon anaesthesia providers due to lack of other staff, inconsistencies in the use of recovery after surgery, and lack of competence with general and regional anaesthesia.

The management of a failed spinal is difficult, since there are no obvious protocols available. The decision should be balanced between the capabilities of the provider to provide a safe general anaesthetic versus the competence of the provider to manage the complications of a potential high spinal. This is being taught during the anaesthesia nurse training course. This fine balance is illustrated by the “Saving Mothers Report”, which assessed the deaths of 92 patients in South Africa between 2008 and 2010. Of the 73 patients (79%) who died due to spinal anaesthesia, 10 deaths were related to the complications of a subsequent general anaesthesia administered when spinal anaesthesia proved inadequate for surgery. Lack of clinical experience and inappropriate approach to failure were responsible for maternal mortality.²⁶ In our study, ketamine anaesthesia without intubation is the most frequent applied technique after spinal anaesthesia, as in a similar study in Zimbabwe (but less frequent than in the study in Zimbabwe).¹⁶ Although safety records are not established, it may well be a safer option than attempts to control the airway by inexperienced hands.^{27,28}

The dependence of general anaesthesia on a single agent like ketamine under difficult working conditions, like those in many LMICs, demonstrates the potential disastrous effects of imposing a ban on its free distribution, as has been proposed multiple times, most recently in 2015.²⁹ Ours and several other studies have shown that its presence is vital in the majority of LMICs.^{16,29} Pain management in general has a low priority in LMICs, both at the government level and during the care of the individual patient, who may also see pain as an inevitable part of having surgery.³⁰ We documented poor postoperative analgesia, with

shortages of drugs and lack of fixed routines. This was also illustrated by a recent qualitative study in Sierra Leone, which described that severe pain following mostly emergency caesarean sections led to difficulties with mobilisation and breastfeeding.³¹ Moreover, the same study showed a significant prevalence of symptoms suggestive of post-dural-puncture headache. Of the drugs on the WHO essential drug list, only paracetamol and NSAIDs were available, and even these were not available in all formulations. Tramadol, a weak opioid, although widely available in many LMICs, including Sierra Leone, has only recently been reconsidered for inclusion on the WHO essential drug list.³² Unfortunately, due to abuse, it might suffer a similar fate as stronger alternatives, which are not available on the African continent due to widespread opiophobia.^{32,33,34,35} Metamizole, a cheap alternative to expensive intravenous paracetamol, has been discredited in certain countries due to its rare association with bone marrow depression. Risk/benefit assessment should favour its use in the low-resource setting, therefore making it more readily available as a cheap alternative for post-operative pain management.^{36,37}

Maternal mortality numbers collected here were presented in another study.¹³ Ninety-nine maternal deaths (18% of total in-hospital maternal deaths) occurred during or after caesarean sections. The majority of these patients were anaemic prior to surgery, and 75% received blood transfusion. Nearly three-quarters of deaths were caused by haemorrhage. This emphasises the importance of a blood bank. Only 45% of the participating hospitals in our study had a reliable, functioning blood bank (Figure 6); in addition, issues with cross-matching and safe blood transfusion were reported.¹³ Of similar importance is the availability of uterotonic drugs. Although present in most hospitals, the quality of these temperature-labile drugs was not verified. Studies in Ghana and the Democratic Republic of Congo showed that over 75% of all ampoules tested did not meet the specifications for active ingredient.³⁸

Strengths and limitations.

The strength of this study is the inclusion of all hospitals performing caesarean sections nationwide. Another strength is the holistic approach to obstetric anaesthesia and infrastructure at the hospital level by combining the results from the anaesthesia situation assessment, hospital productivity data and questionnaires answered by randomised anaesthesia providers.^{2,15} Despite a 100% response rate, an important limitation of the study was that the second part of the questionnaire covered the interviewee's personal practise for

the previous three months only, and not necessarily the hospital's practise. Furthermore, the questionnaire did not cover whether the anaesthesia machines available were functioning as such; the impression of the interviewers was that most were used for monitoring purposes only.

Recommendations.

The large inter-hospital variability in type of anaesthesia and type of anaesthetic provider for caesarean sections found in this study calls for more uniformity. This could be achieved by a multifactorial approach that includes training focussed on the (contra-) indications and complications of spinal anaesthesia, on the management of a failed spinal, on improving capacities for general anaesthesia both on a competence and utility level (drugs/equipment), and on safe perioperative routines. Strengthening of the authorised workforce is recommended on specialist, medical officer and nurse level, and attention paid to retention of trained staff. In addition, reliable supply chains ensuring sufficient provision of drugs and supplies and functioning blood banks are all essential to provide safe caesarean sections.

Acknowledgements.

The context in which this article was written is purely academic. For clarity, it should be mentioned that words like “authorised/not-authorised” and “on-the-job trained” are purely descriptive and not judgemental. The authors want to give credit and praise to all levels of anaesthesia providers in their efforts to serve the community under difficult and challenging working circumstances.

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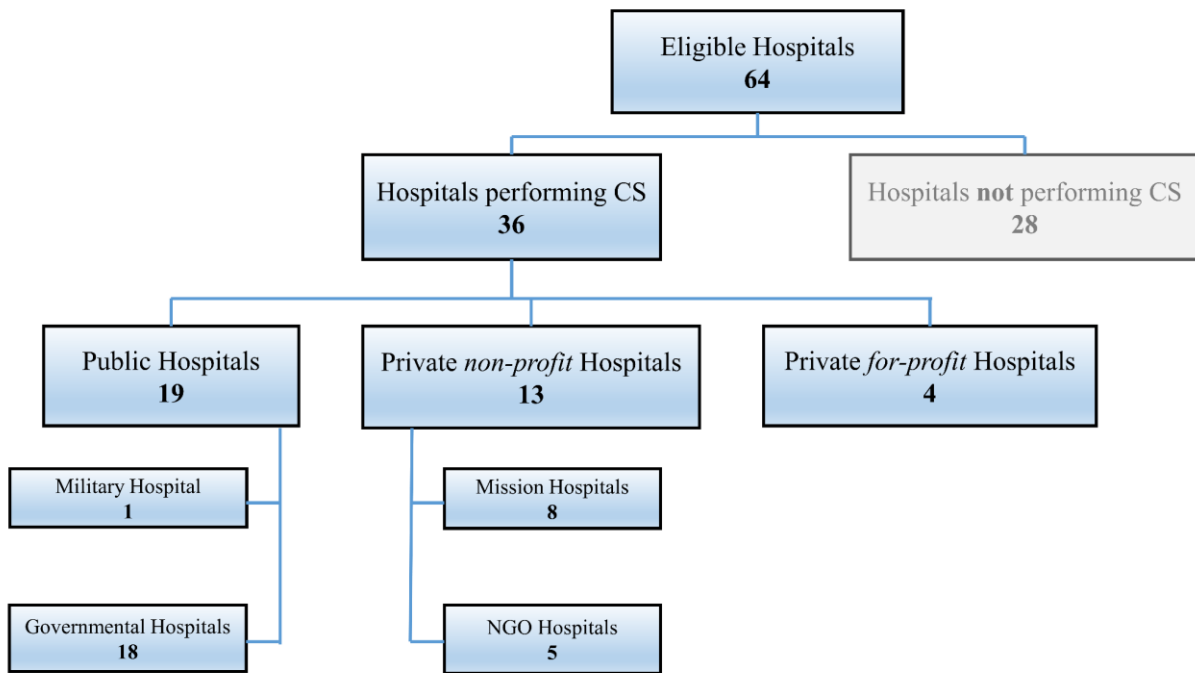


Figure 1: Flow diagram illustrating the selection of hospitals.

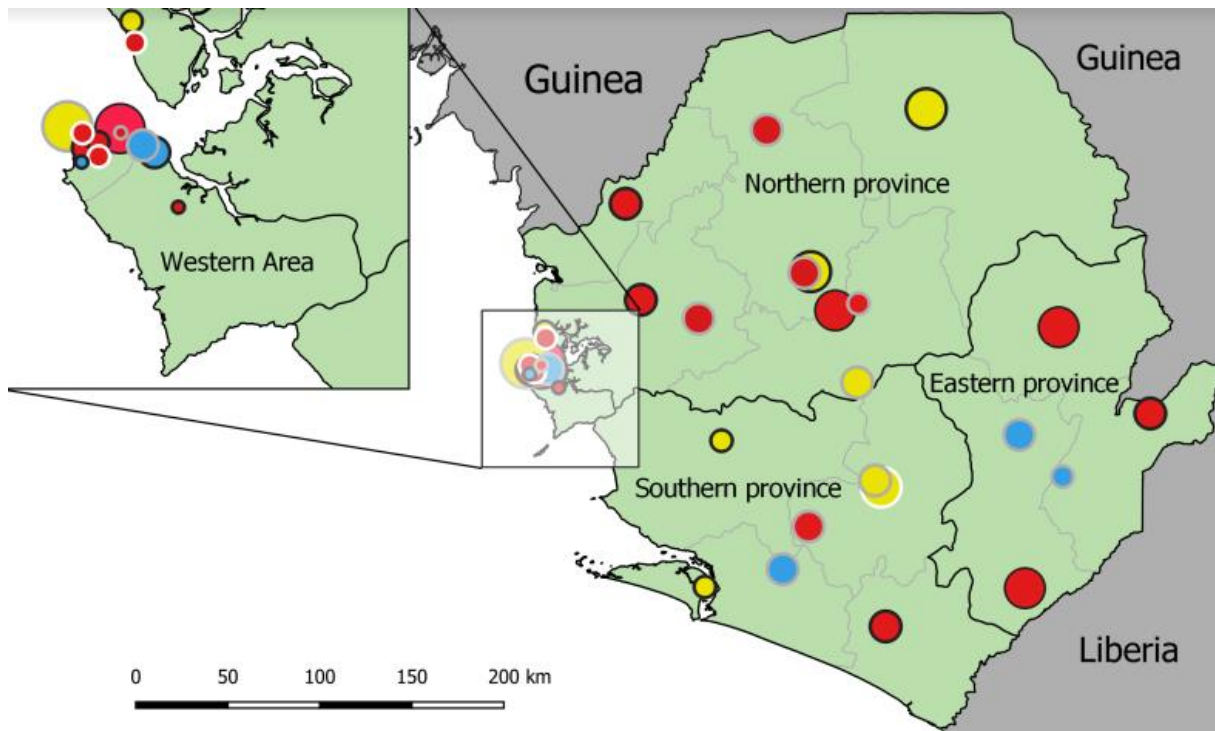


Figure 2: Map of Sierra Leone with geographical distribution of participating hospitals. Western area is the metropolitan province with the capital, Freetown. The size of each circle corresponds to the total number of deliveries in 2016 (smallest, 8; largest, 5718). Colour of the ring indicates the type of institution: black=public, grey=private non-profit (mission/NGO), white=private for-profit. The colour of the centre indicates caesarean section rate; blue<10%, yellow 10-20%, red>20%.

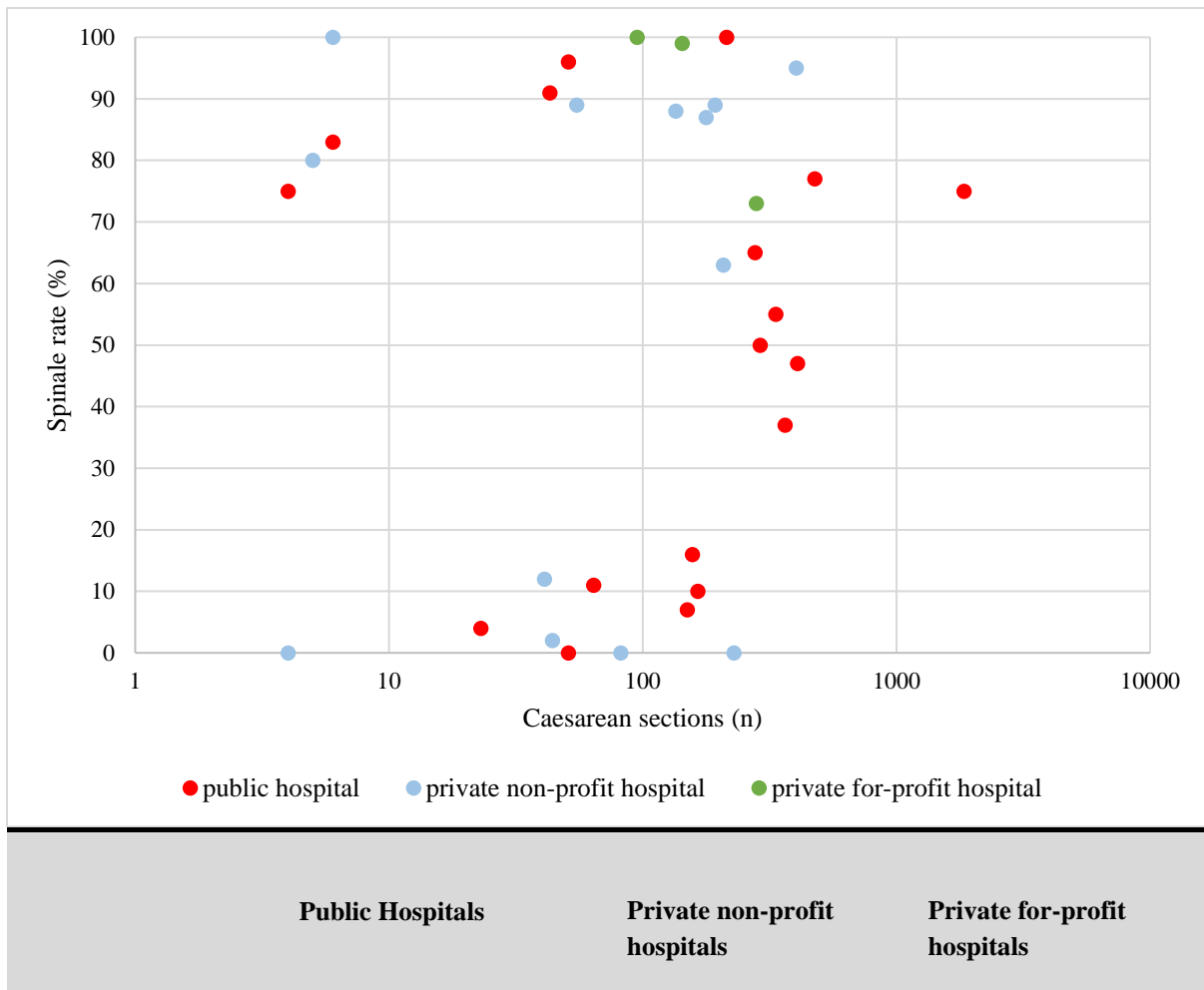


Figure 3: Spinal anaesthesia rate for caesarean sections in public, private non-profit (mission/NGO) and private for-profit hospitals.
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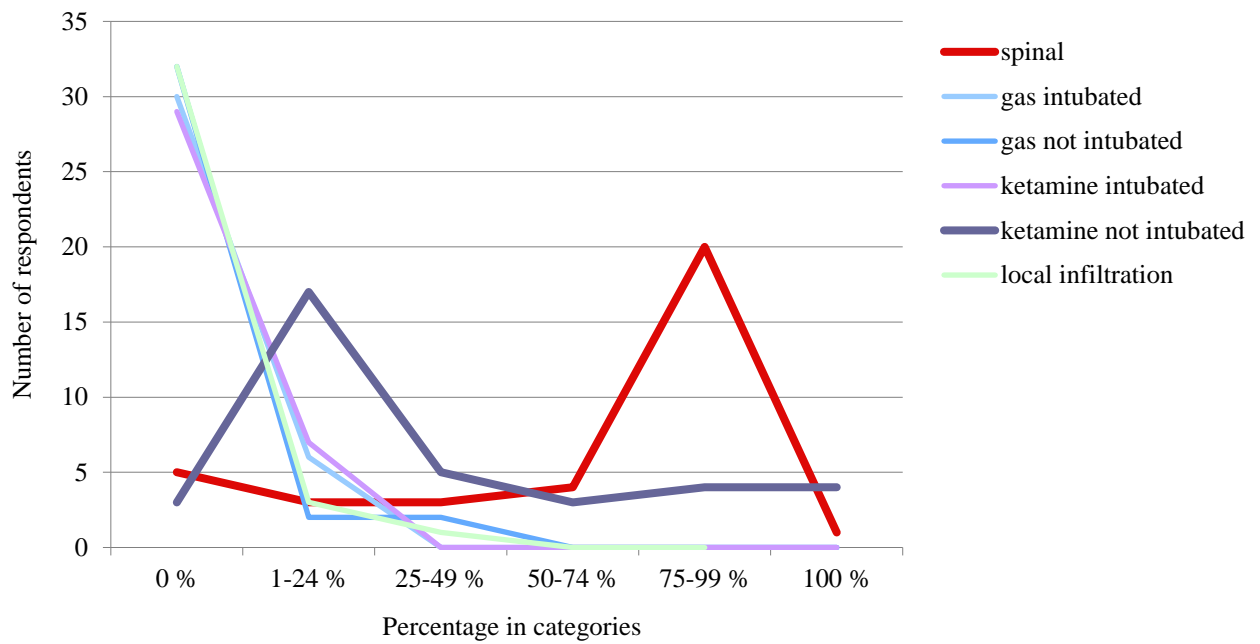


Figure 4: *The respondent's personal experience for type of anaesthesia for caesarean section given in the three months prior to the interview. It shows a clear preference for spinal anaesthesia, followed by ketamine anaesthesia without intubation.*

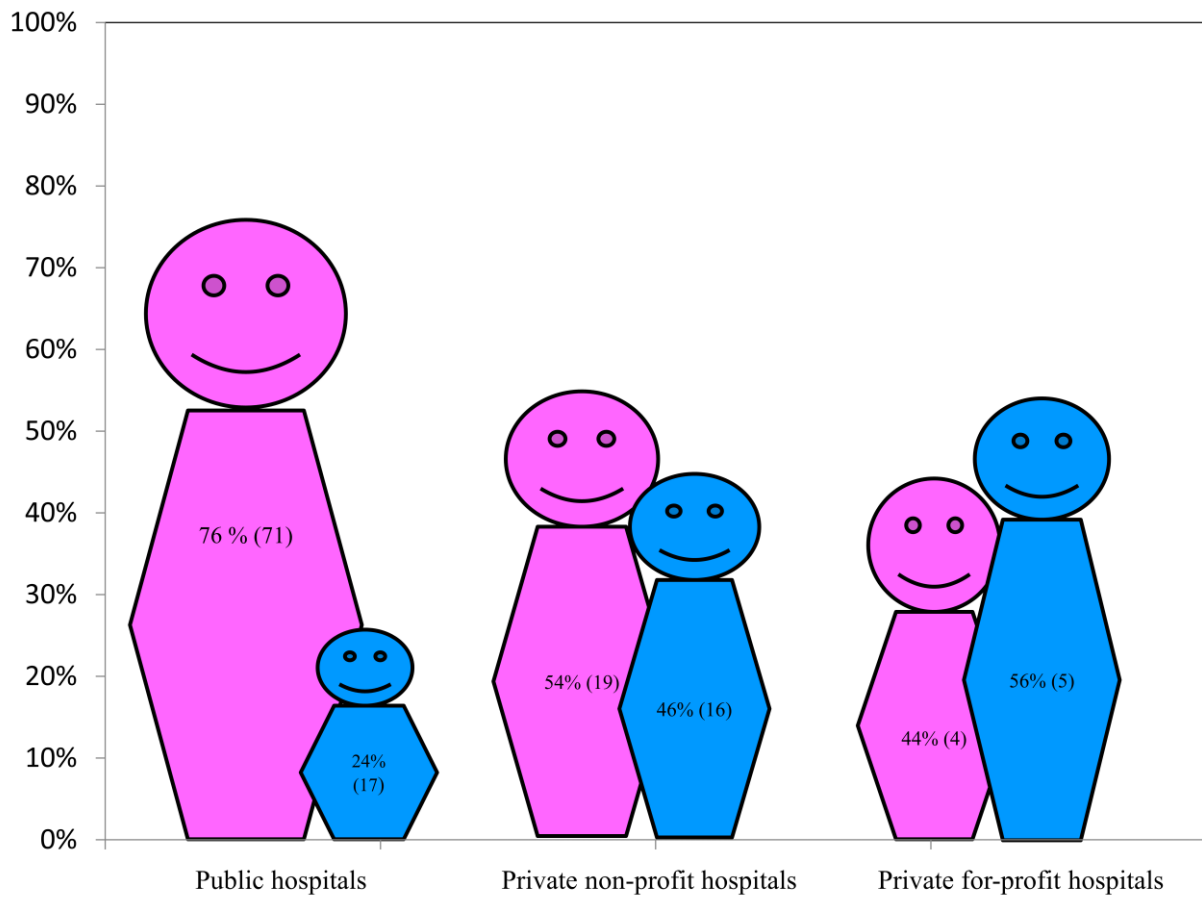


Figure 5: Display of percentage of *authorised (qualified to work independently)*, and *non-authorised (not qualified to work independently)* anaesthesia personnel per type of hospital. Absolute number between brackets.

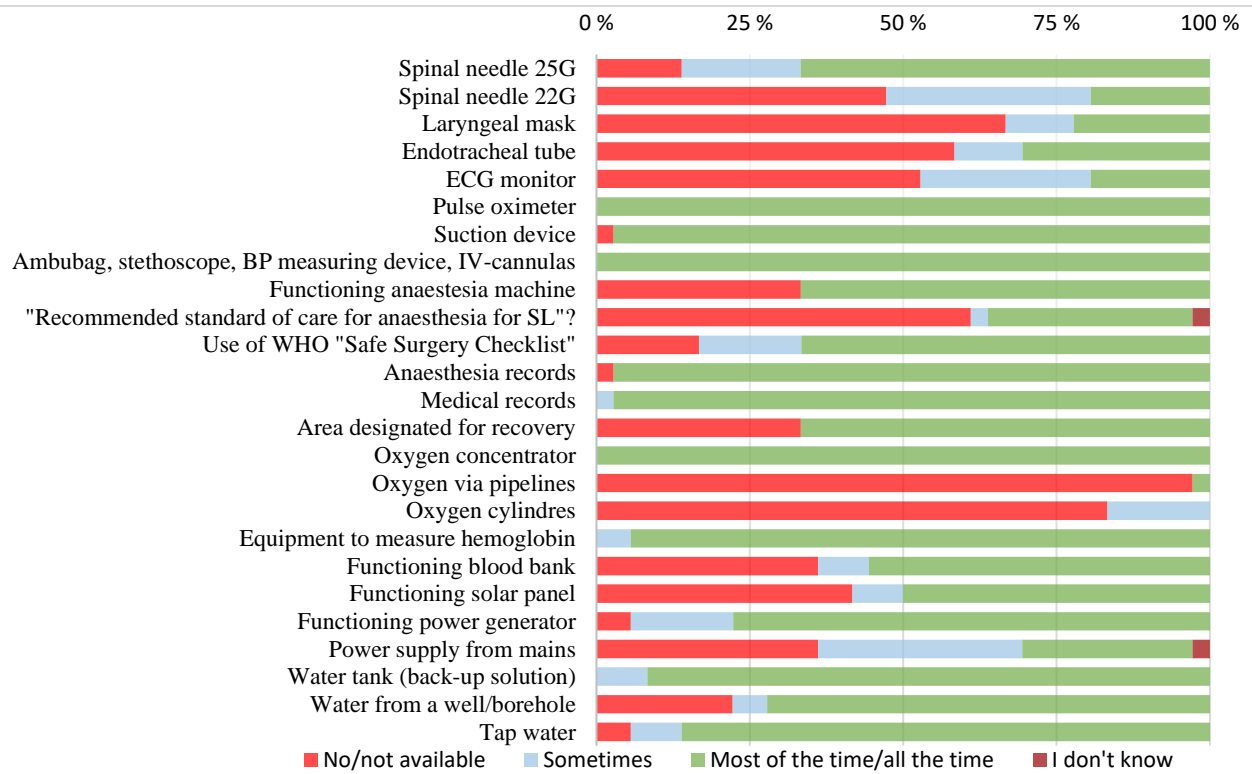


Figure 6: Summary of equipment and other resources for anaesthesia
 (WHO = World Health Organisation. SL = Sierra Leone, IV = intravenous).

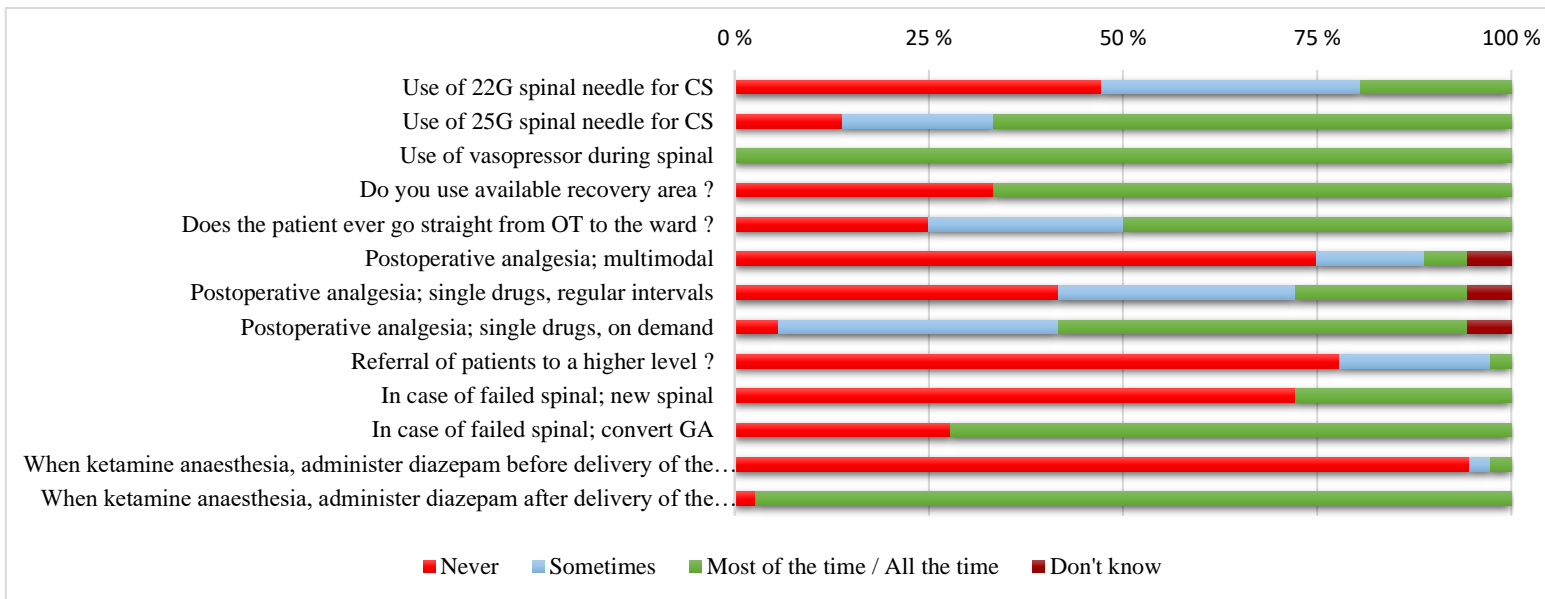


Figure 7: Perioperative routines in all hospitals performing CS in Sierra Leone.
 (CS=caesarean section, OT=operating theatre, GA=general anaesthesia).

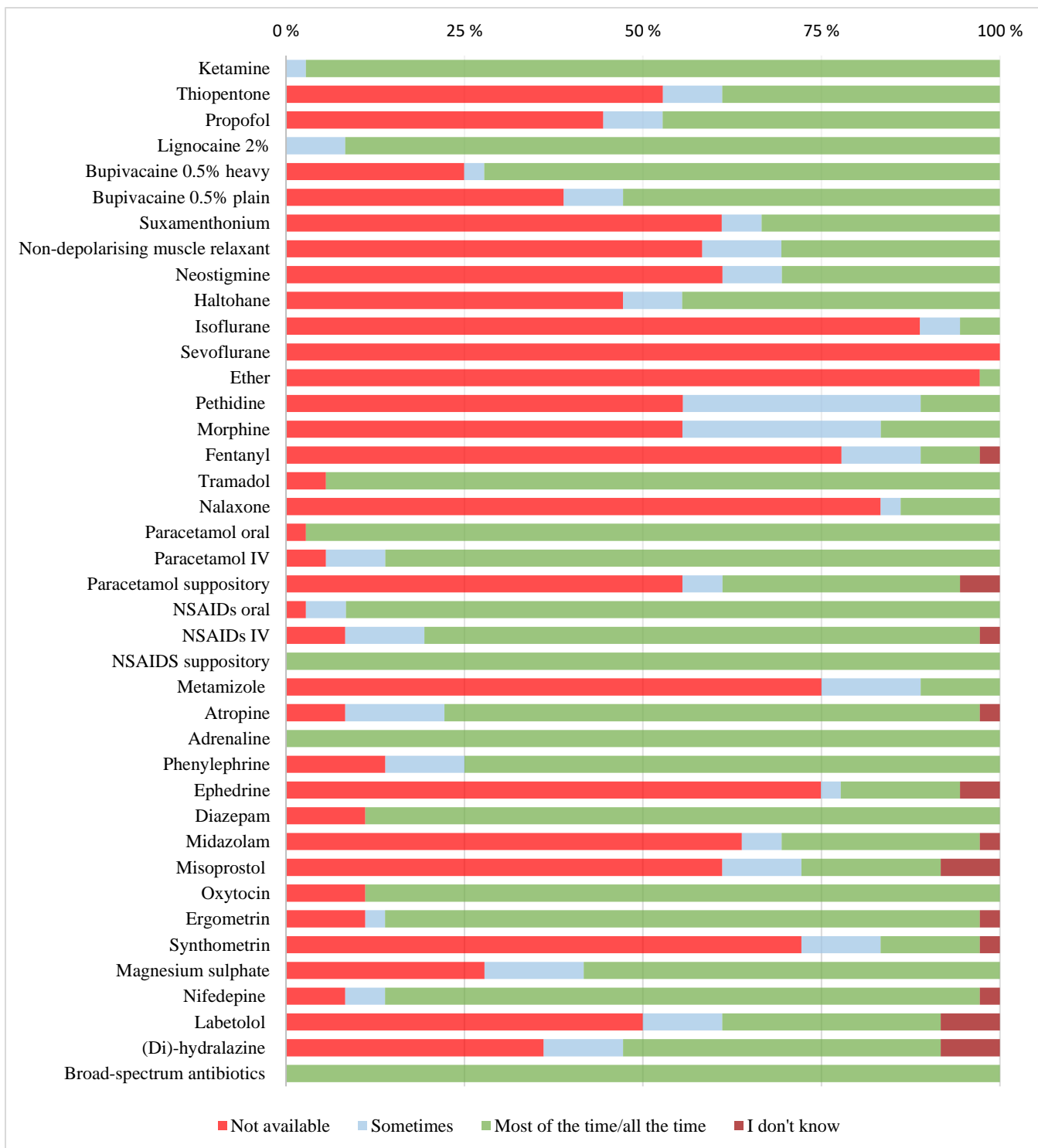


Figure 8: Summary of drug availability for all hospitals combined.
 (NSAIDs = nonsteroidal anti-inflammatory drugs, IV= intravenous).

