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ORIGINAL RESEARCH

Anaesthesia drugs preparation and administration in Libyan tertiary hospitals: a multicentre qualitative observational study

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Background: Accidental administration of the wrong medication in anaesthesia can cause serious harm to the patient. To help prevent this issue, anaesthetists must be aware of their responsibility to implement a safe practice of drug preparation and administration. We aimed to assess the anaesthesia drug preparation and administration across Libyan tertiary hospitals.

Method: Three hospitals took part in a pilot study for over two months. Fifteen cases were observed from the start until the end of the operation. We conducted 15 semi-structured interviews immediately after completing the observation with the anaesthetists involved. All the interviews and observations data were transcribed, qualitatively analysed using line-by-line coding and then the codes were synthesised into themes.

Result: We found that there was no 'standard' practice for drug preparation and administration with a significant variation in the timing of medication preparation, the method of medication and syringe checking, and the separation of emergency medications.

Conclusion: We have demonstrated an urgent need for drug preparation and administration practice improvement across the Libyan healthcare system. Further research is required into the existing practices for drug preparation and administration to minimise patient safety risks.

Keywords: drug-checking, drug preparation, drug administration, wrong drug, patient safety

Introduction

Patient safety is fundamental in every healthcare system to facilitate delivery of adequate care. Medication errors stemming from human error, system flaws, poor regulation or other factors, are a recognised risk to patient safety across global healthcare institutions, especially during surgical interventions.[1] The National (United States) Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) described medication errors as 'any preventable event that may cause or lead inappropriate medication use or patient harm while medication is in the control of healthcare professional, patient, or consumer.[2] It is well known that preparation and administration of the intravenous medications in anaesthesia settings are associated with a serious risk of medication errors.[1,3] Such preparation can be technically complex in the operating room due to the requirement of various high potent intravenous medications in a relatively short period of time and sometimes under pressure.[1] Medication errors include the following: wrong doses, wrong labelling, wrong drug, and wrong timing.[4]

Globally, intravenous medication errors have been reported as a number one threat to patient safety costing an estimated 42 billion USA dollars.[5,6] In England, the Department of Health (DoH) reported that more than 12 000 deaths per year occur due to medication errors with an estimated cost ranging between 0.75 to 1.5 billion pounds.[7] Preventable adverse drug events cost 48 287 million US dollars in New Zealand and between 141 588 million US dollars in Japan.[8] Consequently, to curb the rising global medication error rates, the World Health Organization (WHO) initiated a global programme of work aimed at reducing drug error rates by 50% by 2022 and mitigating harm to patients.[9] A recent observational study on medication errors in the last 10 years,[10] observed 1 970 medication-related adverse events from 7 072 reported incidents with 31% of these incidents linked to patient harm.[10] The highest rate was reported during the administration stage in comparison to other medications process stages. Furthermore, various studies have shown risk of high error rates during preparation of intravenous medications.[11-13]

The majority of developed countries have tried to improve the quality of drug preparation and administration related to anaesthesia in order to reduce and avoid medication errors.[14-16] Several interventions have been designed to reduce the risk of medication errors during drug preparation and administration. International colour coding of drug labels confirms that medication labels used by anaesthetists follow a standard colour design, mitigating the risk of selecting the wrong class of drug.[15] A double-checking system by a second person or programmed barcode during preparation, rainbow tray for storage of drug syringes, and pre-filled drug syringes aid to decrease the risk of wrong drug being withdrawn.[17-19]

Currently in Libya, the burden for patient safety from drug errors has not been quantified, and to our knowledge, no studies have been carried out on drug preparation and administration in anaesthesia practice, which is also seen in most developing

countries. Therefore, this observational study was conducted to observe drug preparation and administration practices, standards and procedures in Libyan tertiary hospitals.

Methods

Setting

This multicentre study using practice observations and semi-structured interviews was conducted across three teaching hospitals. The three healthcare facilities employ more than 3 000 healthcare professionals, have around 3 500 beds in various clinical specialities including those which are part of the Libyan Government Libya Health Authority. In Libya, they are considered top medical facilities for trauma, emergency, and critical care that provide high quality services to all patients within the community.

Participants

Participants were identified during weekly group meetings, held at Tripoli University Hospital. Purposive sampling was utilised to confirm a representative sample across the three sites, geographically spread across west Libya. Ethical approval for the study was received from local research governance at all sites. The sample size of the observation was intended to achieve thematic saturation.[20] Fifteen different anaesthetist practitioners contributed to the study. Each participant received a letter of invitation with an information sheet on study details. Written consent was received before participants were enrolled into the study. Participants were informed that all study data collected from the observations and interviews is confidential and anonymous and that they could withdraw from the study at any point without giving a reason. Over a two-month period, two trained researchers observed 15 routine elective cases of drug preparation and administrations at study sites.

For consistency, a standard, pre-tested observation schedule was used to record observations at all sites.[19] Any additional comments provided by anaesthetists, trainees, and technicians were recorded. The researchers observed and recorded their data in real-time, focusing on the drug preparation and administration from the start to the end of each case. Data collected on observation included: medication checking procedures before drawing up the medication and when administering the medication, how medication syringes are labelled to identify their contents after drawing up the medication, and how the syringes with drawn-up medication are stored before full administration (Figure 1). All study observational data was transcribed from detailed notes taken during the observation period immediately afterwards.

Interviews

In addition to observations, semi-structured interviews were conducted with all 15 participants. Each interview lasted 30–45 minutes commencing directly after observation. Appendix 1 summarises the interview guide used as a prompt for each interview session to ensure key questions were asked to all participants. We digitally documented and transcribed all discussions within two days of the interview. During the interviews, researchers supplemented discussions using the observation notes to help elaborate topics that arose. Before starting the interviews, a summary of the format questions was given to participants to ensure that all questions were clear and to reduce any possible anxiety. The final transcripts were independently read through and double-checked against the original recordings for accuracy and data integrity.

Data analysis

The data from observations and interviews were analysed using thematic analysis to identify themes and subthemes. Primarily, one of the investigators read, re-read, and performed line-by-line coding of the transcripts of both interviews and observations as described by Charmaz.[21] After that, a second researcher independently read the transcripts and coded them as described above. Then both investigators met to discuss the coding and to agree or revise the thematic categories before discussing the results with the third investigator. During the analysis, the transcripts were repeatedly revisited for accuracy, consistency and to ensure validity. NVivo-11 (QSR International

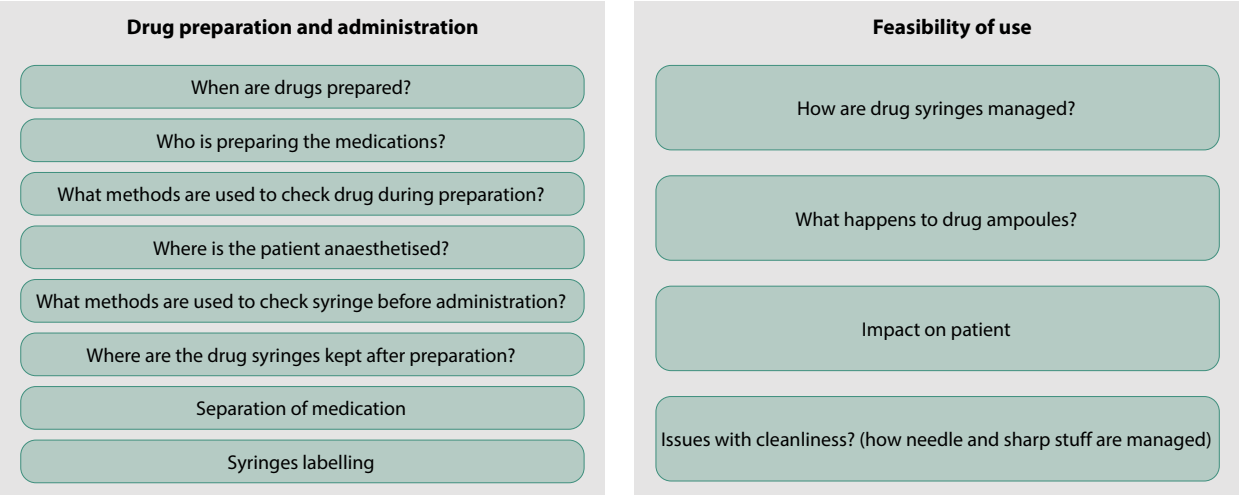

Figure 1: Key themes for the observers

Pvt Ltd.; Melbourne, Australia) was used to organise and manage the data.[22]

Results

We observed the actions of the anaesthetist during routine elective cases, from initial drug preparation to leaving theatre. In each case, there was usually a consultant anaesthetist, one or two trainees, an anaesthesia technician and patient. Among these, 70.06 were male, the median age was 30 to 65; 65.7% had experience of more than five years.

Two thematic categories emerged from the data: (a) practicalities of drug administration, and (b) advantages and disadvantages of the current system.

Practicalities

Across all three sites, key medications in the anaesthesia workspace were: propofol, muscle relaxants, vasopressors, and narcotics. In two sites, medications were prepared before the patient arrived in the operating room. At the third study centre, medications were prepared after the patient arrived in the operating room. None of the sites prepared medication for the whole operation list in advance (Table I). Drawing up medication was observed to be primarily the responsibility of the anaesthesia technician. Only in one site, anaesthetists sometimes drew up the medications for induction to speed up the lists. Nine out of 15 participants discarded empty ampoules directly after drawing up, whereas others used them as a label by putting the needle of the syringe after drug drawing up in the empty ampoules.

Across all three sites, all anaesthetic processes, from after induction, were routinely carried out in the operating room. No cases of anaesthesia induction were observed within the anaesthetic room. Across all three sites, multiple drug syringes were held in hand by the anaesthesia technician at the same time during induction; we did not note any double-checking of medication administration. It was not clear to define how accurately the technician checked each syringe before administration of the contents. Emergency medication (if used) was generally drawn up and given directly without any double-check or label.

Across all three sites, there were no pre-printed drug labels. A plaster and pen were used for labelling the syringes with the drug name and dose. There was uniform acknowledgement that there is a chance of error because of similarity of shape, size and type of the syringe and label. Senior anaesthetists had seen drug errors committed by new trainees and technicians and were concerned about the lack of colour coding. Labels were only used on opioids (fentanyl) and muscle relaxant (rocuronium) and these labels were taken from drug ampoules and placed down the barrel next to the volume marking, mainly to permit the accurate reading of syringe markings.

It was observed that in all three centres, the practice environment offers none or little preventive measures to reduce cross contamination of syringes between patients. Across two sites, we observed poor medication preparation practice where needles are left connected to the drug ampules on the syringe after medication draw up. Prepared drug syringes were stored in an anaesthetic table at all three sites. We observed that anaesthesia providers separated the syringes containing emergency medications from induction medication by preparing and giving emergency medication directly. There was a significant contact between syringes and un-cleaned anaesthesia items in the workspace increasing cross contamination risk.

Table I: Subcategories, key emerging themes, and quotes for current practice

Theme	Subcategory	Quote (s)
Preparation	Before patient enters operating room	*'Obviously, I would like to prepare anticipate medications before patient enters to the operating room to avoid having wrong medication and to decrease risk of errors.'* *'My practice is to prepare my medication before patient enters to the operating room to minimise the anxiety levels of the patient.'*
	After patient enters operating room	*'I like to draw up my drugs after patient enters to the operating room because to avoid any medication errors.'* *'I think once the patient on the operating table means that the chance of cancellation reduce and saving medication as well.'*
Advantages	Feasibility and patient safety	*'Very easy, straightforward, quick.'* *'It is a simple and cheap method of drug preparation as drawn up and giving directly.'* *'In common practice, the same person performs drug preparation and administration; this reduces the risk of drug errors.'* *'It is useful during emergency.'*
Disadvantages	Drug errors	*'Drug errors can be easily happened.'* *'I would like to say the risk of administration is the wrong medication occurs.'*
	Impact on practice	*'Obviously, mistakes! As we did rely on experienced anaesthesia technician and did not do double check after them.'* *'You might suddenly pick up the wrong syringe.'*
	Drug storage	*'Drugs may fall out from the anaesthesia table after being prepared.'* *'Mixed up syringes and drug ampoules.'*

Observed and participant-recognised advantages and disadvantages of the current system

Participants felt that the current practice of preparation and administration was quick and straightforward. The additional benefit was the individual standardisation in the preparation of medications as the same person performs preparation and administration (Table I). However, the potential of making the mistake of picking up the wrong syringe was noted to be high, particularly when ampoules were used as a method of identifying drugs. Most of the anaesthetists' concerns were about the latent risk of syringe swaps and drug mix-ups. If one person prepares and gives more than one drug at a time the potential for drawing up the wrong drug or misadministration would be increased, especially in emergency cases.

Ten out of 15 (75%) of the participants agreed that lack of normal checks along with the use of multiple drugs in stressful working conditions contribute to making the medication error. Across all three locations, anaesthetists stated that they do not perform double-checking of medications either during preparation or administration, as they rely on the expert technician (Table I).

Discussion

This study demonstrates that the existing practices for drug preparation and administration in the participating Libyan hospitals do little if anything to minimise the patient safety risks. This demonstrates and suggests an urgent need for the improvement of drug preparation and administration practice across the Libyan healthcare system. Despite preparation and administration being a fundamental component of safety in anaesthetic practice,[19] we found that there was no 'standard' practice for this with significant variation in the timing of medication preparation and with the method of medication/syringe checking and the separation of emergency medications. This is possibly more unexpected to those outside anaesthesia practice than those within the participating sites. Even though there are valid arguments about the balance between standardisation, clinical variation, and professional autonomy, drug preparation and handling remains a recurrent, low variability, and high-risk task. The literature does, however, describe various factors which could decrease the potential for error.[1,23]

We identified the common practice for the preparation of drug syringes was variable between hospitals and anaesthetists (before each case enters the operating room or after entering the operating room, the syringes labelled or not labelled, and/or drug ampoule double-checked or not by the second person before preparation). We concede that there is little agreement in these areas[14,24] but propose that there is a necessity to standardise these relatively basic tasks to prevent latent error.

Syringe swaps have been regularly quoted as a major factor leading to drug errors.[25] We found that the potential for syringe swaps to occur is high. Many syringes on the anaesthetic table could unintentionally lead to choosing the wrong syringe. Another unexpected result was that some anaesthetists continued to 'cap' syringes with filler needles and placed into empty drug ampoules, despite this practice not being suggested.[26,27] This represents a mismatch between 'work-as-imagined' and 'work-as-done',[28] and highlights an area for further studies.

The pre-existing literature has demonstrated that double-checking medication before administration can reduce medication errors.[24,29,30] The current study found no clear standards mandating double-checking of medication during preparation and administration across participating sites. The requirement of double-checking of medication for preventing drug errors during anaesthesia has been highly emphasised.[14] One study reported that double-checking could prevent an estimated 58% of the drug errors in anaesthesia.[29] However, studies have noted that where it has not been performed properly, this technique is less effective.[31]

The importance of syringe drug labels has been reported as an important factor for drug safety. It helps the identification and administration of correct medications.[32,33] Llewellyn et al. recommended that anaesthesia trainees be educated in ensuring systematically labelled syringes in their daily practice.[32] A further study suggested that medication errors would be decreased if syringes were labelled directly upon drawing up.[26] Yet, there is an argument that if the medications are being administrated directly after drawing up, there is no requirement for labelling the drug syringes.[27] According to the finding of this study, this might be acceptable in some cases, but there is always the opportunity for distraction. This was especially observed when more than one drug is involved and/or when more than one anaesthetist are working together.

Participants reported the direct impact of environmental cleanliness and risk handling on prepared drug syringes. This potentially suggests requirement of further education fundamentals for staff on medication preparation, storage and aseptic environment. In addition to human and organisational aspects, the environment has an important role in the management of drug preparation and administration.[34] Environmental factors reported by observers and participants were noise, interruptions and disorder, similarly to what has been observed in previous studies.[34,35] In two sites, drug preparation was performed on a bedside table in the operating room that was prone to interruptions, while at the other site, preparation was performed in a separate room. To enhance patient safety during drug preparation and administration, interruptions must be kept to a minimum or avoided altogether. This can be enhanced by ensuing availability of designated drug preparation workspace.[36] Box 1 outlines practical examples of strategies that should be employed based on the literature and observations of this multicentre study.

Box 1

Suggested changes to practice
- Identify factors affecting medication errors at local hospital level.
- Provide pre-printed label.
- Drug preparation.
- Avoid any distractions during drug preparation.

Drug label
- Labels on drug ampoules/vials should be checked and read carefully, once before the medication is drawn up and once after labelling.
- Drug should be drawn up and labelled by the anaesthesia provider himself/herself.
- Drug syringes should be labelled, ideally with International Organization for Standardization. ISO 26825:2008.
- Keep prepared syringes to a standard order and in a clean tray.

Drug separation after preparation
- High-risk medications should be stored in a separate tray from routine administered medications.
- Neuromuscular blocking agents should also be stored in a separate tray.

Drug administration
- Only handle one medication at a time.
- Labels should be checked consistently with a second person before and after medication administration.
- Empty syringes should be kept after medication is given.

Build a safety culture
- A culture that is open and fair.
- Reducing the complexity of the system to enhance safety.
- Encourage reporting and reviewing errors or near misses by all anaesthesia providers. Maximisation of the opportunities to investigate, evaluate and educate staff about the hazards associated with work environment.
- Research for evaluation of medication errors.

Study strengths and limitations

This was a multicentre study and built a complete picture of the current practice of drug preparation and administration. It appeared to remind the anaesthesia providers of the potential for medication errors and the need to double-check medication before preparation and administration. However, the sample size was limited; therefore, the findings should be dealt with caution and follow-up studies with larger sample sizes are required.

Conclusion

It has been valuable comparing the methods of medication preparation and administration in three Libyan hospitals. We have found uncontrolled risks in the practice in all three hospitals. Anaesthesia medication must be considered as a high-risk activity where it is used. There is a requirement to enhance better techniques for a safe way to prepare and administer anaesthesia drugs. These techniques can be used to increase staff knowledge and reduce medication errors.

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Conflict of interest

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Ethical approval

This article does not contain any studies involving human participants performed by any of the authors.

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Appendix 1: Interview questions

1. What is your current practice for drug preparation and administration?
2. What are the benefits of current practice?
3. What are the risks of current practice?
4. Do you check the drug with the technician (how)?
5. When do you usually prepare your anaesthetic drugs?
6. Do you label the drug syringes when you prepare drugs?
7. How do you label them?
8. How do you store the medication after being prepared?
9. Do you double-check medication before giving it to the patient (how)?
10. In your opinion, what is the concept of best practice?