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Assessment of Anesthesia Providers' Knowledge and Self-Reported Practices on Safe Handling of Key Anesthetic and Emergency Drugs in Benghazi, Libya

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تقييم معرفة مقدمي خدمات التخدير وممارساتهم المبلغ عنها ذاتيًا بشأن التعامل الآمن مع أدوية التخدير والطوارئ الرئيسية في بنغازي، ليبيا

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Abstract:
Anesthesia safety is a critical field that relies on the precise administration of potent pharmacological agents, where any error can lead to severe patient morbidity or mortality. This descriptive cross-sectional study was conducted to evaluate the knowledge and self-reported practices of 100 anesthesia providers regarding the safe handling of key anesthetic and emergency medications in major hospitals in Benghazi, Libya. Data were collected using a structured and validated questionnaire that focused on five essential drugs: propofol, succinylcholine, rocuronium, atropine, and adrenaline. The assessment covered multiple domains, including therapeutic indications, side effects, contraindications, storage requirements, and safety protocols. The results revealed that the majority of participants were young, aged 20-29 years (48%), and held a diploma qualification (80%). Foundational knowledge was generally strong across the cohort. For instance, 96% of providers correctly identified the use of propofol for induction, and 86% were aware of the strict 6-hour disposal window after opening a vial. Knowledge of neuromuscular blockers was also substantial, with 85-93% correctly identifying their indications and 90-93% recognizing the necessity of refrigerated storage. Regarding emergency drugs, 92% correctly identified bradycardia as the primary indication for atropine, and 98% recognized adrenaline as the first-line treatment for cardiac arrest. Despite these strengths, the study identified critical knowledge gaps, particularly concerning adrenaline concentrations, where only 80% of participants correctly identified the standard 1:1000 concentration. Furthermore, minor misconceptions were noted regarding the

storage of atropine and the use of succinylcholine. In conclusion, while anesthesia providers in Benghazi demonstrate satisfactory foundational knowledge, targeted educational interventions are necessary. It is recommended to implement structured continuous professional development and simulation-based training to address specific gaps, standardize safety protocols, and ultimately optimize patient safety outcomes in clinical practice.

Keywords: anesthesia safety, drug handling, medication errors, knowledge assessment, Libya, propofol, neuromuscular blockers, emergency drugs.

الملخص

تعد سلامة التخدير مجالاً حيوياً يعتمد على الإعطاء الدقيق للعوامل الدوائية القوية، حيث يمكن أن يؤدي أي خطأ إلى امراضية شديدة أو الوفاة للمريض .أجريت هذه الدراسة الوصفية المقطعية لتقييم المعرفة والممارسات المبلغ عنها ذاتياً لـ 100 من مقدمي خدمات التخدير فيما يتعلق بالمناولة الآمنة لأدوية التخدير والطوارئ الرئيسية في المستشفيات الكبرى في بنغازي، ليبيا .تم جمع البيانات باستخدام استبيان منظم وموثق ركز على خمسة أدوية أساسية: البروبوفول، السكسينيل كولين، الروكورونيوم، الأتروبين، والأدرينالين .غطى التقييم مجالات متعددة، بما في ذلك الاستطبابات العلاجية، الآثار الجانبية، مضادات الاستطباب، متطلبات التخزين، وبروتوكولات السلامة .كشفت النتائج أن غالبية المشاركين كانوا من الشباب، الذين تتراوح أعمارهم بين 20-29 سنة (48%)، وحاصلين على مؤهل دبلوم .(80%) كانت المعرفة التأسيسية قوية بشكل عام لدى المجموعة .على سبيل المثال، حدد 96% من مقدمي الخدمة بشكل صحيح استخدام البروبوفول للتحريض، وكان 86% على دراية بفترة التخلص الصارمة التي تبلغ 6 ساعات بعد فتح الأمبولة .كما كانت المعرفة بمرخيات العضلات كبيرة، حيث حدد 85-93% استطباباتها بشكل صحيح وتعرف 90-93% على ضرورة التخزين المبرد .فيما يتعلق بأدوية الطوارئ، حدد 92% بشكل صحيح بطء ضربات القلب كاستطباب رئيسي للأتروبين، وعرف 98% الأدرينالين كعلاج خط أول للسكتة القلبية .على الرغم من نقاط القوة هذه، حددت الدراسة فجوات معرفية حرجة، لا سيما فيما يتعلق بتركيزات الأدرينالين، حيث حدد 80% فقط من المشاركين بشكل صحيح التركيز القياسي 1:1000 .علاوة على ذلك، لوحظت مفاهيم خاطئة طفيفة فيما يتعلق بتخزين الأتروبين واستخدام السكسينيل كولين .في الختام، بينما يظهر مقدمو خدمات التخدير في بنغازي معرفة تأسيسية مرضية، فإن التدخلات التعليمية المستهدفة ضرورية .يوصى بتنفيذ برامج تطوير مهني مستمر ومنظمة وتدريب قائم على المحاكاة لمعالجة فجوات محددة، وتوحيد بروتوكولات السلامة، وتحسين نتائج سلامة المرضى في الممارسة السريرية في نهاية المطاف.

الكلمات المفتاحية: سلامة التخدير، مناولة الأدوية، أخطاء الأدوية، تقييم المعرفة، ليبيا، البروبوفول، مرخيات العضلات، أدوية الطوارئ.

Introduction

The safe conduct of anesthesia is a complex and high-stakes endeavor fundamentally reliant on the precise handling and administration of potent pharmacologic agents (Cai et al., 2025). Anesthesia providers are entrusted with a wide array of drugs, including induction agents, neuromuscular blockers, and emergency medications, each possessing a narrow therapeutic index where errors can lead to severe morbidity or mortality (Esalomi et al., 2025). International guidelines from bodies such as the American Society of Anesthesiologists (ASA) and the World Health Organization (WHO) emphasize rigorous protocols for drug preparation, labeling, storage, and disposal to mitigate these risks (Mackay et al., 2019). However, the translation of these guidelines into consistent practice is influenced by the provider's depth of pharmacological knowledge and the constraints of the clinical environment. This study situates itself within this critical context, aiming to evaluate the knowledge and practices of anesthesia providers in Benghazi, Libya, regarding key anesthetic drugs (AlKhanbashi et al., 2024).

A focused review of the core medications under study highlights the precise knowledge required for their safe use. Propofol, a cornerstone for induction and sedation, acts as a \gamma-aminobutyric acid (GABA_A) receptor agonist (Hudaib et al., 2024). Its formulation as a lipid emulsion necessitates strict aseptic handling and adherence to a short post-opening disposal window (typically 6 hours) to prevent bacterial contamination (Hudaib et al., 2024). Succinylcholine, a depolarizing neuromuscular blocker, is invaluable for rapid-sequence intubation but carries significant risks, including hyperkalemia in patients with conditions like muscle weakness or burns, making knowledge of its contraindication's paramount (Karunarathna et al., 2025; Santiago et al., 2025). Rocuronium, a non-depolarizing alternative, requires proper refrigerated storage to maintain potency (Natanagara et al., 2025). Atropine, an anticholinergic, is first-line for symptomatic bradycardia, with its side effect profile, including dry mouth and tachycardia, being essential knowledge (Amer & Amer, 2025). Finally, adrenaline, the life-saving agent in cardiac arrest and anaphylaxis, presents a unique challenge; providers must be adept at distinguishing between its different concentrations (e.g., 1:1,000 for intramuscular use vs. 1:10,000 for intravenous resuscitation) to avoid life-threatening dosing errors (Lopera-Múnera et al., 2025).

Despite established guidelines, studies globally and regionally indicate that gaps in drug knowledge persist among anesthesia personnel, potentially compromising patient safety (Harfaoui et al., 2024). This evaluation is therefore pressing, as systematic assessment can identify specific areas for targeted educational intervention, ensuring that a strong theoretical foundation underpins daily practice and aligns with international safety standards (Shubayr, 2025).

Method

Study Design and Setting

A descriptive cross-sectional study was conducted across major hospitals in Benghazi, Libya.

Study Population and Sampling

A convenience sample of 100 actively practicing anesthesia providers (technologists and practitioners) was recruited. Inclusion criteria required a minimum of six months of clinical experience. Interns and students were excluded from the study.

Instrumentation and Measures

Data were collected via a structured, self-administered questionnaire. The instrument was developed by the research team based on a review of relevant literature and international safety guidelines (e.g., ASA, WHO). It was reviewed for content validity by a panel of three experts in anesthesiology and clinical pharmacology, and necessary adjustments were made based on their feedback. A pilot test was conducted with 10 anesthesia providers (excluded from the main study) to assess clarity, comprehension, and internal consistency, which yielded an acceptable Cronbach's alpha of 0.78. The final questionnaire consisted of two sections:

1. **Demographic and professional details:** age, level of education, source of knowledge, and duration of work.
2. **Knowledge assessment:** Twenty multiple-choice questions assessing knowledge of five target drugs (propofol, succinylcholine, rocuronium, atropine, adrenaline) across domains of indication, side effects, contraindications, storage, and safety protocols.

Procedure

Questionnaires were distributed to participants during working hours at their respective hospitals. Informed consent was obtained from all participants, and anonymity was maintained throughout the study. Participants were given 20–30 minutes to complete the questionnaire, which was collected immediately upon completion.

Data Analysis

Data were entered and analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies and percentages) were employed for data summarization and presentation.

Limitations

This study assessed self-reported knowledge and intended practices and did not include direct observation of actual clinical handling or administration. This represents a limitation, and observational studies are recommended for future research to validate self-reported practices.

Results

Demographic and Professional Characteristics

The study comprised 100 anesthesia providers. The cohort was predominantly young, with 48% aged 20–29 years and 35% aged 30–39 years. The majority (80%) held a Diploma qualification, while 20% were Specialists. Clinical experience was varied, with nearly half (48%) having 1–3 years of practice. Formal education was the primary knowledge source, cited by 33% of participants, followed by textbooks (25%) and scientific articles (23%). Table 1 presents the complete demographic characteristics.

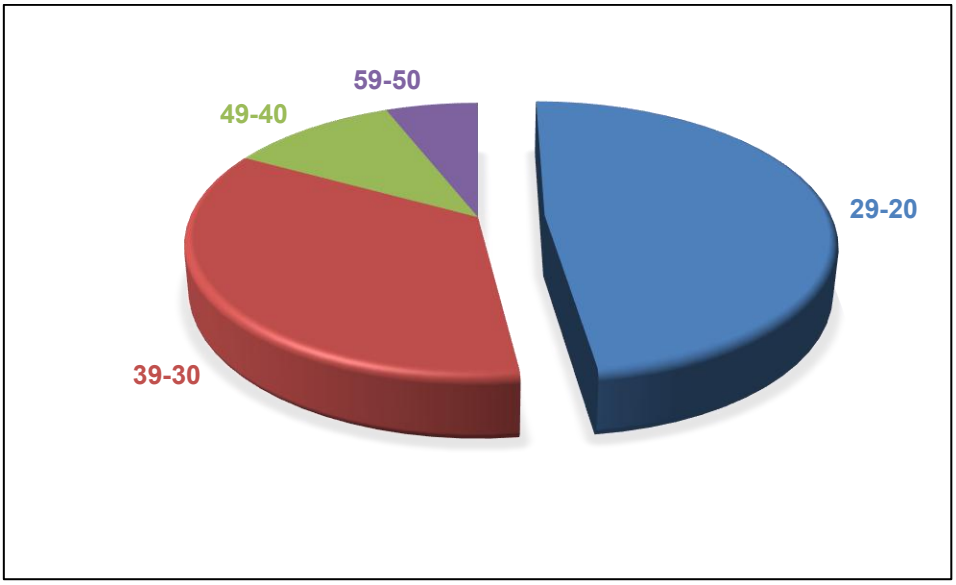

Figure 1: Distribution of Participants According to Age in the Study Sample

Table (1) Demographic Characteristics and Knowledge Sources of the Study Sample (N = 100)

Variable	Category	n	%
Age Group	20-29 years	48	48
	30-39 years	35	35
	40-49 years	11	11
	50-59 years	6	6
Level of Education	Diploma	80	80
	Specialist	20	20
Source of Knowledge	Study Program	33	33
	Books	25	25
	Articles	23	23
	Other	19	19
Duration of Work	1 to 3 years	48	48

	4 to 6 years	29	29
	7 to 9 years	15	15
	More than 9 years	8	8

Knowledge Assessment of Anesthetic and Emergency Drugs

The assessment revealed a generally high level of core knowledge, with specific strengths and gaps as detailed below and summarized in Table 2.

Propofol. Knowledge was excellent regarding its primary indication, with 96% correctly identifying its use for hypnosis/induction. Awareness of its key safety protocol was also strong, as 86% knew an opened vial must be discarded within 6 hours. The recognition of apnea (81%) as a major side effect demonstrated good awareness of its principal risk.

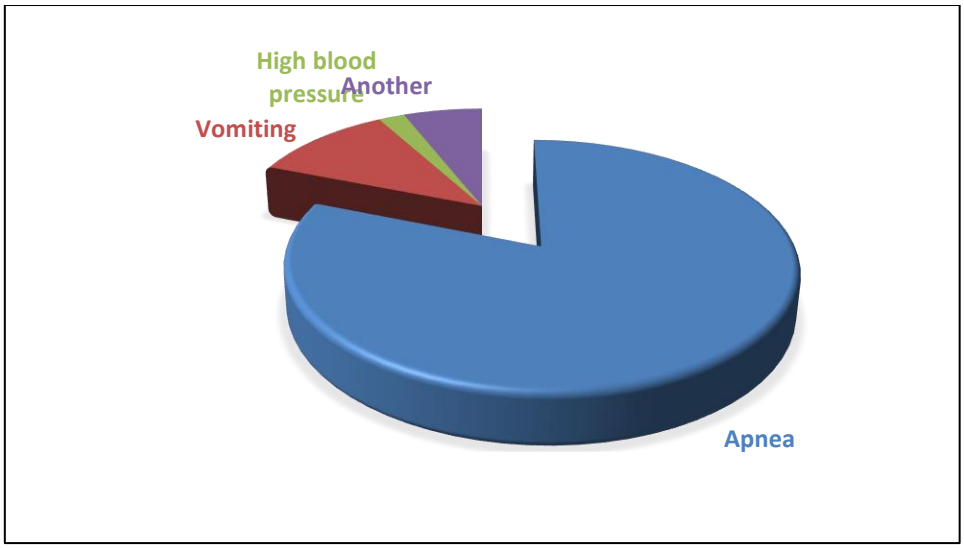

Figure 2: Distribution of Propofol Side Effects as Reported by Participants

Succinylcholine and Rocuronium. Understanding of neuromuscular blockers was substantial. For succinylcholine, 85% correctly identified muscle relaxation as its indication, 88% knew muscle weakness was a key contraindication, and 90% were aware of its refrigerated storage requirement.

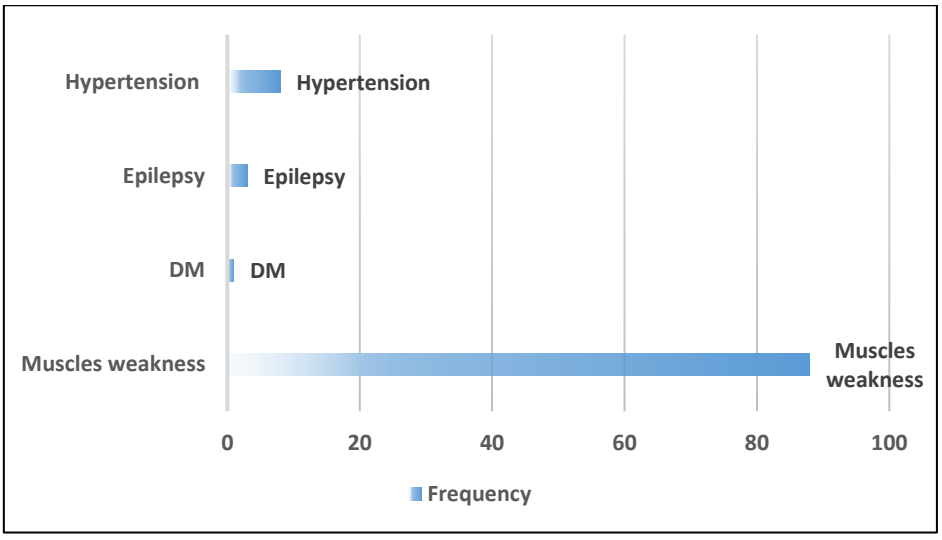

Figure 3: Participants' Knowledge of Suxamethonium Contraindications

Knowledge for rocuronium was even higher, with 93% correctly stating its use for muscle relaxation and the same percentage (93%) indicating correct cold storage.

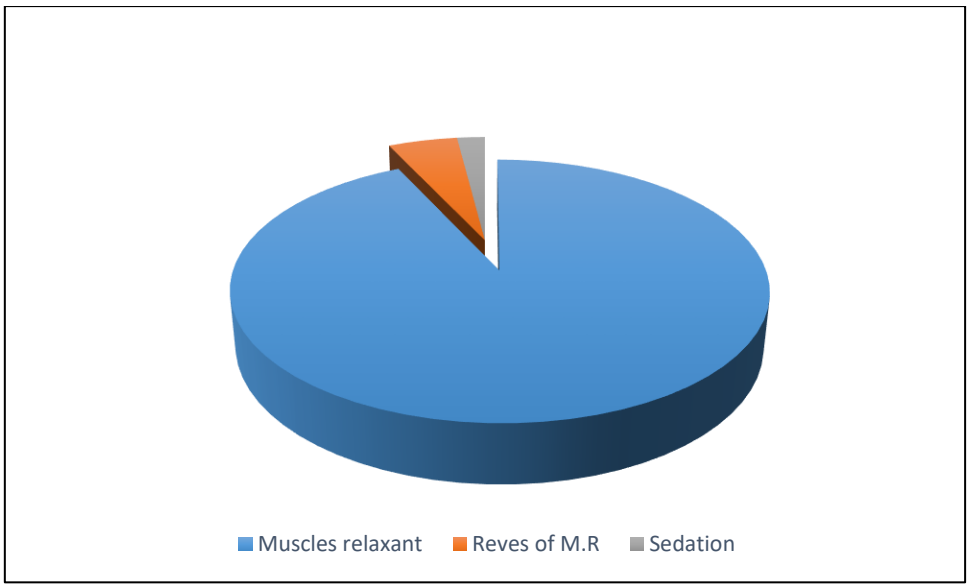

Figure 4: Participants' Knowledge of Rocuronium Indication

Atropine and Adrenaline. For emergency drugs, knowledge was commendable. The primary indication of atropine for bradycardia was correctly identified by 92% of providers, and its most common side effect, mouth dryness, was known by 88%.

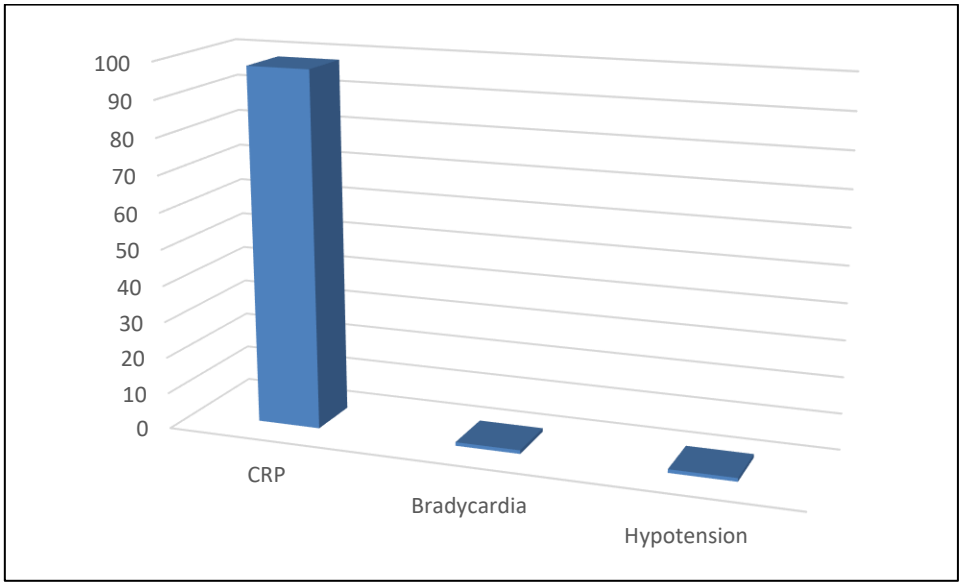

Figure 5: Participants' Knowledge of Adrenaline Indication

For adrenaline, knowledge was near-universal, with 98% correctly citing cardiopulmonary resuscitation as its primary indication, and 97% identifying tachycardia as its main side effect. However, knowledge of its common concentrations showed room for improvement, with 80% correctly identifying the standard 1:1000 concentration.

Table (2) Knowledge Assessment Regarding Drugs Used in Anesthesia and Emergencies (N = 100)

Drug	Aspect	Correct / Most Frequent Response	Frequency (n)	Percentage (%)	Other Reported Responses
Propofol	Indication	Hypnosis	96	96%	Muscle relaxation: 3%; Other: 1%
	Major Side Effect	Apnea	81	81%	Vomiting: 11%; Hypertension: 2%; Other: 6%
Suxamethonium	Indication	Muscle relaxation	85	85%	Hypnotic: 10%; Sedation: 3%; Other: 2%
	Contraindication	Muscle weakness	88	88%	Hypertension: 8%; Epilepsy: 3%; DM: 1%
	Storage	In refrigerators	90	90%	Room temperature: 8%; Hot temperature: 2%
Rocuronium	Indication	Muscle relaxant	93	93%	Reversal of M.R.: 5%; Sedation: 2%
	Storage	In cold temperature	93	93%	Room temperature: 6%; Hot temperature: 1%
Atropine	Indication	Bradycardia	92	92%	Anesthesia: 4%; Hypertension: 3%; Analgesia: 1%
	Side Effect	Mouth dryness	88	88%	Bradycardia: 9%; Vomiting: 3%
	Storage	Room temperature	82	82%	In cold temp: 17%; In hot temp: 1%
Adrenaline	Concentration	1:1,000	80	80%	1:10,000: 8%; 1:50: 7%; 1:500: 5%
	Indication	CPR	98	98%	Bradycardia: 1%; Hypotension: 1%
	Side Effect	Tachycardia	97	97%	Muscle relaxant: 2%; Hypoglycemia: 1%

Discussion

The findings of this study depict a workforce with a strong foundational knowledge of core anesthetic pharmacology, which is credibly linked to their primary reliance on formal academic training (Arefayne et al., 2022). The high correct response rates for primary drug indications (>85% for all drugs), key safety practices (propofol disposal), and storage conditions reflect effective baseline education. This is particularly reassuring for high-alert medications like succinylcholine, where knowledge of its specific contraindication (muscle weakness) was high (88%), a critical factor in preventing life-threatening hyperkalemia (Karunarathna et al., 2025).
Regarding anesthesia medications, the results showed that propofol is known to the vast majority of participants for its correct use (96%). A strong awareness of its safety rules was evident, with 86% stating it must be discarded within 6 hours of opening, consistent with global guidelines for preventing microbial contamination (Adachi et al., 2001; Tabor et al., 2023).
Concerning muscle relaxants, the data showed broad knowledge of succinylcholine's indication (85%) and contraindications (88%). Additionally, 90% correctly identified its refrigerated storage requirement, aligning with global storage instructions (Tabor et al., 2023). The results also demonstrated an excellent understanding of rocuronium use and its storage requirements (93%) (Yuan et al., 2021).
Concerning emergency medications, the data clarified that atropine is used primarily for bradycardia (92%), with clear knowledge of its side effects like dry mouth (88%), which is physiologically expected due to its anticholinergic effect (Chiappini et al., 2022). For adrenaline, the results showed excellent awareness of its primary role in CPR (98%) and its side effects (97%), reflecting a deep understanding of its uses and effects in emergencies (Gough & Nolan, 2018).
However, the study also illuminates specific, actionable gaps. While adrenaline's role in CPR was almost universally known (98%), only 80% correctly identified its most common concentration (1:1,000). This discrepancy highlights a potential risk area for dosing errors in high-stress situations (Lopera-Múnera et al., 2025). Similarly, the persistence of minor misconceptions—such as 10% believing succinylcholine is used for hypnosis or 17% incorrectly stating atropine should be stored in cold temperatures—signals that knowledge, while broadly good, is not uniformly exhaustive. These gaps align with challenges noted in the global literature regarding the translation of theoretical knowledge into nuanced practical application (Harfaoui et al., 2024; Shubayr, 2025).

Conclusion

Anesthesia providers in Benghazi hospitals demonstrate a satisfactory to excellent grasp of fundamental knowledge necessary for the safe handling of critical drugs. Strengths are evident in core pharmacological knowledge and awareness of major safety protocols. The identified gaps, particularly concerning drug concentrations and nuanced contraindications, are not indicative of a widespread deficit but rather point to specific targets for enhanced continuing education. Addressing these through structured professional development is the recommended pathway to further solidify practice, minimize medication error risks, and optimize patient safety outcomes.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Implement Targeted Continuous Professional Development: Design focused training modules addressing the identified gaps, especially on adrenaline concentrations, comprehensive contraindications for high-risk drugs, and proper storage protocols.

2. Promote Simulation-Based Training: Incorporate practical, hands-on scenarios for drug preparation, administration, and management of adverse effects to bridge the gap between theoretical knowledge and clinical application.
3. Standardize and Reinforce Institutional Protocols: Develop clear, accessible visual aids (e.g., posters in anesthesia rooms) and checklists for drug storage, labeling, and disposal to serve as daily reminders.
4. Encourage Access to Contemporary Resources: Facilitate subscriptions to updated pharmacological databases and journals to promote evidence-based practice and lifelong learning beyond initial training.
5. Conduct Future Observational Studies: Perform direct observational studies to validate self-reported practices and assess the actual clinical handling of these critical drugs.

References

[1] Adachi, Y. U., Watanabe, K., Higuchi, H., & Satoh, T. (2001). The determinants of propofol induction of anesthesia dose. *Anesthesia & Analgesia*, *92*(3), 656–661. https://doi.org/10.1097/00000539-200103000-00014

[2] AlKhanbashi, R. O., AlNoamy, Y., Ghandorah, R., Awan, R. M., & AlButi, H. (2024). Assessment of clinical pharmacist interventions using a web-based application in a Saudi Arabian Tertiary Hospital. *SAGE Open Medicine*, *12*, Article 20503121241233217. https://doi.org/10.1177/20503121241233217

[3] Amer, A. M., & Amer, M. M. (2025). Pharmacology of tropane alkaloids. In *Tropane Alkaloids: Sources, Chemistry, Pharmacology and Biotechnology* (pp. 103–132). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-1524-4_5

[4] Arefayne, N. R., Getahun, A. B., Melkie, T. B., Endalew, N. S., & Nigatu, Y. A. (2022). Patients' knowledge and perception of anesthesia and the anesthetists: Cross-sectional study. *Annals of Medicine and Surgery*, *78*, Article 103740. https://doi.org/10.1016/j.amsu.2022.103740

[5] Cai, X., Wang, X., Zhu, Y., Yao, Y., & Chen, J. (2025). Advances in automated anesthesia: A comprehensive review. *Anesthesiology and Perioperative Science*, *3*(1), Article 3. https://doi.org/10.1007/s44254-024-00073-1

[6] Chiappini, S., Mosca, A., Miuli, A., Semeraro, F. M., Mancusi, G., Santovito, M. C., Di Carlo, F., Pettorruso, M., Guirguis, A., Corkery, J. M., Martinotti, G., & Schifano, F. (2022). Misuse of anticholinergic medications: A systematic review. *Biomedicines*, *10*(2), Article 355. https://doi.org/10.3390/biomedicines10020355

[7] Esalomi, T., Lyles, M., & Prochnow, L. (2025). The use of neuromuscular monitoring during standard induction of anesthesia. *Journal of Clinical Anesthesia and Management*

[8] Gough, C. J. R., & Nolan, J. P. (2018). The role of adrenaline in cardiopulmonary resuscitation. *Critical Care*, *22*(1), Article 139. https://doi.org/10.1186/s13054-018-2058-1

[9] Harfaoui, W., El Adib, A. R., Zidouh, S., Zentar, A., Lekehal, B., Belyamani, L., & Obtel, M. (2024). Patient safety in anesthesiology: Progress, challenges, and prospects. *Cureus*, *16*(7), Article e69540. https://doi.org/10.7759/cureus.69540

[10] Hudaib, M., Malik, H., Zakir, S. J., Rabbani, S., Gnanendran, D., Syed, A. R. S., Ahmed, N., Khan, A. A., Ahmed, S., & Varrassi, G. (2024). Efficacy and safety of ciprofol versus propofol for induction and maintenance of general anesthesia: A systematic review and meta-analysis. *Journal of Anesthesia, Analgesia and Critical Care*, *4*(1), Article 25. https://doi.org/10.1186/s44158-024-00159-5

[11] Karunarathna, I., Godage, S., Senadeera, S., Wijepala, J., Rodrigo, P. N., Ranasinghe, S., De Almeida, M., & Bandar, S. (2025). Succinylcholine: Pharmacovigilance in clinical

practice—Adverse reactions, contraindications and drug interactions. *Pharmacology Reports*.
[12] Lopera-Múnera, N., Ortiz, J., Casson, N., Iramain, R., Pavlicich, V., Jaramillo-Bustamante, J. C., Yock-Corrales, A., Meregalli, C., Pirez, M. C., Rodríguez, A., & Jabornisky, R. (2025). Adrenaline for the early resuscitation of children with sepsis—A randomized controlled pilot study (ANDES CHILD): Study protocol and analysis plan. *Intensive Care Medicine – Paediatric and Neonatal*, *3*(1), Article 8. https://doi.org/10.1007/s44253-024-00022-3
[13] Mackay, E., Jennings, J., & Webber, S. (2019). Medicines safety in anaesthetic practice. *BJA Education*, *19*(5), 151–157. https://doi.org/10.1016/j.bjae.2019.01.005
[14] Natanagara, I. G. C. W., Suarjaya, I. P. P., & Sutawan, I. B. K. J. (2025). Navigating frontal lobe arteriovenous malformation resection: A case report on TIVA with propofol-remifentanil TCI for hemodynamic stability and ICP control. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*, *9*(8), 8290–8304. https://doi.org/10.37275/bsm.v9i8.1021
[15] Santiago, R., Gilbert, B., Ray, L., & Reichert, E. (2025). Pharmacotherapy of trauma and the role of the pharmacist. In *The Pharmacist's Expanded Role in Critical Care Medicine: A Comprehensive Guide for Practitioners and Trainees* (pp. 1063–1118). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-62325-1_32
[16] Shubayr, N. (2025). Operating room radiation safety measures: Awareness, compliance, and perceived risks among nurses and other healthcare workers. *International Nursing Review*, *72*(3), Article e13071. https://doi.org/10.1111/inr.13071
[17] Tabor, A., Shalemariam, Z., Alemu, Y., & Gorems, K. (2023). Bacterial contamination of single and multiple-dose parenteral injection vials after opening. *Infection Prevention in Practice*, *5*(3), Article 100290. https://doi.org/10.1016/j.infpip.2023.100290
[18] Yuan, H., Zhang, S., Yin, L., Li, W., Liang, W., Wang, X., & Liu, J. (2021). The safety of high-dose rocuronium bromide in general anesthesia for spinal surgery. *American Journal of Translational Research*, *13*(7), 8110–8117.

