Available at: https://resources.wfsahq.org/update-in-anaesthesia

SPECIAL EDITION
SAFETY

Update in Anaesthesia

Education for anaesthesia providers worldwide

Volume 38 **February 2024**

Editor: Christina Lundgren *ISSN 1353-4882*

SAFETY

The Journal of the World Federation of Societies of Anaesthesiologists

The Anaesthesia Patient Safety Foundation

Founded in 1985, The Anaesthesia Patient Safety Foundation (APSF) promotes research of perioperative patient safety issues, supports the development of careers in patient safety, provides patient safety educational materials and communications to all anaesthesia providers, and advocates for changes in clinical practices that improve patient safety. The APSF's goal is that no one shall be harmed by anaesthesia care. For more information on APSF, please visit ***www.apsf.org****.*

Typeset and printed by Sumographics Ltd

Contents

SAFETY

Update in
Anaesthesia

Editorial

This edition of the UIA has been VERY exciting to work on, albeit with some strict timelines.

With the assistance of members of the UIA editorial board, the WFSA CEO and the WFSA Secretariat, contact was established with the Anaesthesia Patient Safety Foundation (APSF). Out of this grew our UIA Safety Edition project, spear-headed by Bala Bhaskar and Mark Warner. Mark has been our mentor and guru for this edition, and for those who do not know Mark, he is an anaesthesiologist extraordinaire, and past president of the APSF. In 2018 he received the ASA Distinguished Service Award in recognition of his contributions spanning all areas of the speciality including patient care, academic leadership, scientific discovery and a remarkable involvement in speciality organisations, including the ASA. The award is the highest honour ASA bestows and is presented annually to a member who has transformed the speciality of anaesthesiology. Mark is currently Professor of Anaesthesiology at the Mayo Clinic in Rochester, Minnesota. Mark, THANK YOU for your guidance, enthusiasm and infinite patience.

Our guest authors hail from all over the globe and volunteered their various articles on Patient Safety topics in Anaesthesia. In addition, Erlinda Oracion and Airton Bagitini are members of the WFSA Safety and Quality of Practice Committee.

I sincerely hope that you, our readers enjoy the various topics, and that you feel inspired to work on various aspects of Safety in Anaesthesia, wherever you practise.

My sincere and warm thanks to Rosa, Kristine, Amal and Francis for their amazing support from the WFSA office.

We welcome your contributions to the journal, and if you have any suggestions about the journal or manuscripts that you would like to be published, please do not hesitate to get in touch. You can find contributor guidelines and submit manuscripts directly through our online submission system. Once again, a huge thank you to all our contributors and reviewers.

Christina Lundgren
Editor-in-Chief
Update in Anaesthesia

Update in
Anaesthesia

Patient Safety: Knowing Where You've Been to Get to Where You Are Going

Mark A. Warner* and Mary E. Warner
*Correspondence email: Warner.mark@mayo.edu

Key words: Anaesthesia patient safety; patient safety; surgical outcomes; global anaesthesia care

Introduction

In this issue of *Update in Anaesthesia* you will find a series of outstanding articles on diverse issues in perioperative patient safety. These issues range from intraoperative management processes to facilities to approaches to reduce the impact of anaesthesia delivery on the environment. Each issue is important, with many addressing perioperative patient safety problems noted in a recent world-focused review of anaesthesia patient safety concerns.[1] The articles *in toto* raise a much larger question as to what we can do to improve anaesthesia patient safety around the globe where there is so much variability in healthcare resources.

We are not experts in global health care. However, we have been to more than 100 countries around the world and visited hospitals and other healthcare facilities in most of them. We have observed anaesthesia in some of the most advanced medical centres in the world, as well as in a number of our very lowest income countries. The disparities in access, resources, and approaches available for the provision of anaesthesia can be shocking to those not previously exposed to surgery performed in countries that have different levels of income, but the primary concerns of the anaesthesia professionals are uniformly and gratefully similar. Simply put, we have found anaesthesia professionals in each of these countries to care about their patients and to wish for them to have safe perioperative outcomes.

The World Federation of Societies of Anaesthesiologists (WFSA) has been a leader in pursuing improvements in perioperative and anaesthetic patient safety in lower resourced countries (Vision and Mission - WFSA (wfsahq.org). The Federation's programmes, often in collaboration with member national societies, have made inroads in increasing expertise in low and low-to-middle income (LMIC) countries.[2] Individual national societies, alone or with others, support their programmes to increase knowledge and resources in these countries. Foundations (e.g., LifeBox) and universities (e.g., Ariadne Labs, unique department relationships with programmes in LMIC countries) contribute, as do military organisations (e.g., the U.S. Navy Mercy and Comfort ships) and non-profit, charitable organisations (e.g., Smile Train). These organisations all help in improving perioperative patient safety around the globe. However, improvement of perioperative patient safety will fall short of its potential until there is better resource distribution as well as enhanced efforts to have more equitable access to healthcare between and within countries.

So what can we do at this time?

(1) We can further improve and expand existing programmes that educate current and new anaesthesia professionals. Already being done by the various organisations within the limits of their resources.

(2) We can continue to advocate for better healthcare access, especially surgical and anaesthetic care access, in LMICs. Already being done through the WFSA's efforts with the World Health Organization and through the advocacy efforts of national societies that are directed towards ministries of health in their country.

(3) We can support research that results in safer anaesthetic medications and their administration. Already being done by various anaesthesia foundations and pharmaceutical companies around the world.

(4) We can provide important physiologic monitors and training with them in LMICs. Already being done by LifeBox and other organisations.

(5) We can improve our collaborations between surgical and anaesthesia organisations. Already being done, albeit with variable success around the globe.

Given these efforts and short of a huge increase in healthcare access and spending in LMICs, what else

Mark A. Warner *MD*
Professor of
Anaesthesiology
Mayo Clinic
Rochester
Minnesota
USA

Mary E. Warner *MD*
Professor of
Anaesthesiology
Mayo Clinic
Rochester
Minnesota
USA

Table 1 – The Top 10 Anaesthesia Patient Safety Issues Worldwide*

•	Implementation of national or international standards of intraoperative care in each country
•	Sustained efforts to support appropriate numbers and distribution of physician anaesthesia providers
•	Support at national levels to provide access to appropriate anaesthesia-related equipment and drugs
•	Development and implementation of databases to track patient and safety outcomes
•	Extension of patient safety initiatives from intraoperative to perioperative care
•	Improvement and use of surgical/anaesthesia safety checklists
•	Initiatives to detect and prevent death from perioperative deterioration
•	Establishment of cultures of safety and teamwork in intraoperative and perioperative care
•	Elimination of punitive outcomes and criminalization of medical errors
•	Allocation of safety research and resources to non-operating room anaesthesia practices

* Based on anaesthesiologist leaders' reports on the current state of anaesthesia patient safety in their countries and highlighted in this article. The issues as shown are not listed in order of importance.

can we do? We found that one of the top 10 anaesthesia patient safety issues worldwide in 2022 was the lack of databases that anaesthesia professionals in LMICs can use to track patient and safety outcomes (Table 1).[1] Therefore, we recommend that the WFSA forms a work group to develop a simple, concise, but useful data collection process that any anaesthesia professional in the world could use to report outcomes of their patients. It would likely be internet-based but simply designed so that anyone could enter the data into an application on a cell phone. Nearly every anaesthesia professional, regardless of country, carries a cell phone. A number of national societies already have excellent, broad-based patient outcome databases. Representatives from these societies could advise the effort.

The data would be uploaded to a cloud database that could be hosted anywhere in the world. The WFSA, perhaps with financial support from APSF, other foundations, national societies, corporations, and other groups, could hire an appropriate number of anaesthesia-oriented analysts or contract with an existing group and provide consistent outcome and quality reports back to anaesthesia professionals and groups in LMICs who may not otherwise have the ability and resources to garner this type of information.

It would be just one of many steps needed to improve perioperative patient safety. Obviously, WFSA, APSF, and many national organisations are doing great things already to help . . . but the need is overwhelming. One important patient safety activity that appears to be missing is a simple, concise, and reliable outcome/quality reporting process for those who have limited resources and even limited internet access. You wouldn't run a manufacturing process without having data regarding production efficiency, defect tracking, and other quality controls. You shouldn't run a crucial healthcare process (i.e., perioperative care) that doesn't have this type of data collection, analysis, and tracking, either. Knowing where you've been with patient safety will make it easier to improve patient safety in the future.

REFERENCES

1. Warner, Mark A. MD*; Arnal, Daniel MD†; Cole, Daniel J. MD‡; Hammoud, Rola MD§; Haylock-Loor, Carolina MD; Ibarra, Pedro Acad, MD, MSc¶; Joshi, Muralidhar MBBS, MD#; Khan, Fauzia A. FRCA**; Lebedinskii, Konstantin M. DSc Med††,‡‡; Mellin-Olsen, Jannicke MD, DPH§§; Miyasaka, Katsuyuki MD, PhD; Morriss, Wayne W. MBChB¶¶; Onajin-Obembe, Bisola FWACS, PhD##; Toukoune, Robinson MMed***; Yazbeck, Patricia MD†††. Anaesthesia Patient Safety: Next Steps to Improve Worldwide Perioperative Safety by 2030. *Anaesthesia & Analgesia* 135(1):p 6-19, July 2022. | DOI: 10.1213/ANE.0000000000006028
2. The World Bank country and lending groups: country classification. Accessed January 1, 2024. World Bank Country and Lending Groups – World Bank Data Help Desk

Update in
Anaesthesia

Review

Human Error – Cognitive Processes and Interventions to Improve Safety. A Global Perspective

Joyce A. Wahr
Correspondence email: jawahr@umn.edu

INTRODUCTION

All humans err. This truth has been self-evident for thousands of years (Sophocles in his Greek tragedy Antigone writes "All men make mistakes") except, perhaps, for healthcare providers whom others, and even the providers themselves, hold as being capable of error-free practice, all evidence to the contrary. Clinicians who make errors have been faced with onerous guilt and shame, with the unproductive result that individuals and institutions involved in preventable adverse events due to human error have hidden these errors, or, worse, placed the blame for the outcome on the patients' condition or on "misadventure." This flawed approach weakened significantly with the publication of "To Err Is Human", with Dr. Leape stating "All humans err frequently. Systems that rely on error-free performance are doomed to fail."[1] This recognition has been bolstered by a much clearer understanding of the inevitability of human error, and the central role the system plays both in errors and in redesigns that can prevent errors, or designs that at least prevent errors from reaching the patient and causing significant harm.

This paper will explore the cognitive foundations of human error, the system vulnerabilities that enable harmful errors, and then explore what options exist to enhance quality and safety in every setting, regardless of national or local resources. It is obvious that the resources available for patient safety differ widely between countries and within a given country. Mid- to low-resource countries often have well-resourced hospitals in the largest cities, while even vital resources (pulse oximetry) can be scarce in rural settings. What is available in Nairobi is different than what is available in rural Kenya: this disparity can exist even in highly resourced countries such as the US. Resources available in a hospital in Minneapolis are greater than those available on the Leech Lake Native American Reservation. Fortunately, there are ways to improve quality and safety in all clinical settings despite these economic realities.

Before delving into the nature of errors, we need to define several terms. Over many years, a wide variety of definitions have been used for the term "error" and similarly much confusion exists around what defines quality and safety.[2,3] While most definitions have a kernel of truth in them, the existing differences make it difficult to compare various studies: for the purpose of this paper the following definitions will be used. Quality refers to the overarching plan for patient management that reduces inter-provider variability and seeks to provide a consistent best practice that is evidence based. Safety refers to failures in either the design of the plan or in the execution of the plan. For instance, quality in elective caesarean section, in well-resourced locations at least, includes use of a bupivacaine spinal with intrathecal morphine, as well as intravenous tranexamic acid for reducing blood loss; a failure of safety is an unintended swap of bupivacaine and tranexamic acid vials such that TXA is administered intrathecally with devastating consequences.[4] The plan was excellent but the execution was flawed. Errors are by definition unintentional, and involve either the use of a flawed plan, or a failure to carry out a planned action as intended.[5] A violation, by contrast, is an intentional, although not necessarily malicious, decision to not follow those practices deemed necessary to prevent harm.[6] The distinction is important because the interventions to prevent violations are very different from those to prevent error; violations, however, are beyond the scope of this chapter but are explored in depth in other resources.[6]

ERRORS

Cognitive-based Errors

All humans use the same cognitive processes to understand and react to the world around them. Although Dr Reason originally approached errors from the types of actions that caused them (skill-based, rule-based, judgement-based)[7], it is more common now to approach errors by what type of

Joyce A. Wahr *MD*
University of Minnesota
Department of
Anaesthesiology

thinking was used. As elaborated by Daniel Kahenman,[8] humans think in basically two ways (Table 1) – either "fast thinking" (System 1), rapid, subconscious, effortless, automatic. This type of thinking is related to subconscious recognition of a familiar pattern followed by an appropriate and typically also subconscious response to it. Conversely, "slow thinking" (System 2), is conscious, laborious, and effortful – the type of thinking needed when the current situation fits no pattern stored in the subconscious. Both System 1 and 2 thinking are accompanied by fast, subconscious, automatic perceptions of the world around us, perceptions which also can be erroneous, but for the purposes of this discussion, we will assume most perceptions in the operating room are correct, albeit coloured by context.

Over millennia of evolution, the ability to subconsciously process our immediate world, assess for threats and opportunities, and then nearly instinctually perform the appropriate actions have enabled the human race to flourish.[6] As James Reason puts it, "humans are furious pattern matchers"[7] – subconsciously assessing the current situation, and "matching" it to a memory of a similar situation and then applying solutions that have worked in the past. For infants and children, each pattern or situation is new, but as they explore and grow, similar situations are encountered again and again, and over time these "patterns" become part of their subconscious, whether it is recognizing a familiar building or street corner or performing a well-known task, such as tying shoelaces or intubating a patient. Without being consciously aware of every step of an induction or placement of an intravenous line, anaesthesia providers effortlessly run sequences that have been learned through many repetitions. Pattern matching with the subsequent patterned response is fast and highly efficient – but subject to failures that often are not obvious (except in retrospect!) As noted above, System 1 or "fast" thinking is used relentlessly in our daily actions and is strongly preferred by humans due to the lower cognitive work and ability to multitask (or rapidly task shift). However, when a new situation appears that does not match a pattern stored in our memory, System 2, or "slow" thinking is required. This involves deliberate and conscious working out of the situation from first principles and making sense by using parts of known patterns, then working out an acceptable response. In daily life, humans rarely work just in one realm or the other but switch from fast to slow thinking and then back again, depending on the situation, all while receiving subconscious input (perceptions) about the situation evolving around them. Both types of thinking are associated with errors, but these errors, once understood, can be defended against. Many external devices and safeguards have been developed to protect against these errors, such as bar code medication administration and pin-indexing for volatile gases, but these safeguards are often beyond the financial resources of many hospitals. However, as these errors involve cognitive processes, there are defences that also involve cognitive processes and thus are available to every clinician regardless of external resources.

Errors associated with fast or subconscious thinking relate either to physical errors (Reason's skill-based errors) or subconscious mismatching of patterns (Reason's rule-based errors).[7] Skill based errors involve stumbles or fumbles and occur more often with distractions, disruptions, fatigue, poor lighting or other environmental issues such as noise. Common skill-based errors involve syringe or vial swap whereby the wrong syringe is picked up and injected, or the wrong vial is drawn up into a syringe. Common system vulnerabilities that increase the risk of these errors are look-

Table 1 – Error Types and Possible Interventions

Error type	Error	Example	Intervention in Low Resource	Intervention in high resourced
System 1 (fast thinking) errors: skill based	Vial/syringe swap	Place dopamine in syringe labelled doxapram; pick up the wrong syringe and administer it	No look alike meds; do not place vials alphabetically in med tray; no concentrated meds in anaesthesia cart	Bar-code preparation and administration; no concentrated meds in anaesthesia cart
	Wrong dilution	Diluting 1 mg epinephrine only once not twice (first dilution = 0.1 mg/ml; second 0.01 mg/mL)	Second person check when preparing; if available, pharmacy prepared or prefilled syringes; no concentrated vasoactive meds on cart	Pharmacy prepared or prefilled syringes; no concentrated meds on cart
System 1 (fast thinking) errors: rule based	Wrong rule	Ventilating during CPR	Education to the correct rule	Decision support embedded into electronic health record and ordering systems
	Right rule, wrong situation	Atropine for bradycardia when electrocautery interference is the cause	Education re best practices; collaboration with other team members; cognitive aids	Decision support embedded into electronic health record and ordering systems
System 2 (slow thinking): knowledge based	Mis-diagnosis	Assume hypotension is vasodilation when it is occult blood loss	Communication with surgeon; cognitive aids	Communication with surgeon; cognitive aids

alike vials or ampoules, placing dangerous solutions (hypertonic saline) on the same shelf as the common ones such as dextrose or normal saline, and the relentless pressure to do more and do it more quickly. A common skill-based error is beginning a sequence of steps, being interrupted, and then returning to the sequence but at the wrong place, such as omitting the second dilution when preparing a syringe of dilute epinephrine or phenylephrine. Failure to recognize a dangerous concentration of heparin, epinephrine or insulin is common and represents an error trap – one which has been made with distressing frequency despite being recognized and guidance provided by many safety agencies such as the recommendations for managing high-risk medicines listed by the WHO, The Joint Commission, or the Institute for Safe Medication Practice.[9] Skill-based errors can also involve a break in the performance of a familiar routine, such as retained wires during central line placement or omitting or repeating a step in a medication administration during a case (omitted or duplicate antibiotic doses). It should be noted that there are some errors that appear to be skill-based, such as inability to place a spinal, or putting a Seldinger needle into the carotid artery instead of the internal jugular vein, but these errors are more accurately termed technical errors. These errors are failures to carry out a plan as intended, but are not related to cognitive processes, but rather represent situations when the patient's anatomic complexity or anomalies exceed the provider's skill or experience. While technical errors can certainly harm patients, prevention efforts are different from those used to reduce skill-based errors (see Interventions and Safeguards below).

Rule-based errors occur when an existing pattern is "matched" erroneously. Daniel Kahneman won a Nobel prize for his work on the behaviour of decision making, particularly when decision making behaviours don't seem to be rational.[8] He postulated that these decisions represent cognitive "shortcuts" that make decision making easier such as the "rule" to give atropine when the heart rate is 20. He termed these shortcuts "heuristics", and they are what Reason called rule-based decisions. Heuristics reduce cognitive work but open the door to Reason's rule-based errors and to cognitive biases[10] which can influence the choice of a diagnosis. Rule-based errors can involve the use of an outdated rule, use of the right rule at the wrong time, or use of the wrong rule for the situation.

Ventilating a patient during cardiopulmonary resuscitation is an example of an outdated rule. Current guidance around resuscitation efforts is focused only on chest compressions – ventilation occurs with chest compression alone making bag-mask or mouth to mouth ventilation unnecessary and possibly detrimental (decreasing the effectiveness of chest compressions). Diagnostic errors are often due to erroneous pattern matching (choosing the wrong rule) such as believing the cause of chest pain to be myocardial infarction, when the real cause is a dissecting aortic aneurysm. Application of a good rule in the wrong situation also is a rule-based error, such as giving atropine to treat extreme bradycardia when the actual cause is electrocautery interference with a pacemaker. Diagnostic or rule-based errors may occur due to inadequate training, experience, or outdated knowledge, but can occur even when the provider is very well trained and experienced – often due to cognitive biases.[10] The availability heuristic refers to the fact that our subconscious will naturally pick the "pattern" that is the most available, whether because it is the one seen most often, or the one seen most recently – chest pain in the emergency room is most often myocardial infarction and much less often is a dissecting thoracic aneurysm. The "pattern" that is most available to our subconscious is the one that comes to mind, and is often complicated by another bias, that of confirmation, where our minds interpret new evidence as confirming our chosen diagnosis. Loss aversion bias refers to the fact that we humans fear loss more than we value gain, and can make it harder to accept that our current diagnosis might be wrong. Cognitive biases can influence either subconscious or conscious thinking and can be difficult to correct even when one is aware of them.

As noted above, errors include a failure to design an appropriate plan, even when the situation is correctly understood. Failure in devising a good plan can result from cognitive biases as noted above, poor application of first principles or logic, inadequate knowledge of best practices, inadequate time to consider alternative plans, and inadequate monitoring as the situation evolves and requires a change in the original plan.

System-based Errors

A frustrating aspect of safety is that the same error seems to be made again and again, despite recognition of the problem and attempts to correct it. Any error made by one provider is likely to be made by other providers - that is, certain common situations make errors more common, such as look-alike vials, or poor equipment design. Reason describes this situation: "The same situation keeps producing the same errors . . . even though quite different people are involved. That surely indicates we are dealing with error prone circumstances rather than error prone people. We are dealing with error traps."[11] Often these "traps" cannot be corrected by individual effort, but require system redesign and changes. Common examples of system vulnerabilities include:

- Production pressure to do more in a shorter time frame can lead to distraction, omission of critical double checks, failure to follow safety guidelines (labelling all syringes)
- Non-standardised concentrations of high-risk medications (e.g., insulin, epinephrine, norepinephrine)
- Non-standardised processes for any aspect of healthcare delivery
- Frequently changing medication suppliers with consequent look-alike vials or ampules
- Stocking of unusual preparations in usual locations (hypertonic saline stored with normal saline)
- Inadequate staffing, leading to working while fatigued or ill, production pressure and chaotic situations
- Failure to deal with disruptive and disrespect between and within hospital disciplines[12]
- Failure to correct providers who habitually violate policies (physicians and hand hygiene)
- Weak safety culture (missing the traits of high-reliability organisations)[13]

- Choosing weak interventions such as retraining over more robust ones such as forcing functions (bar code medication administration and automatic dispensing cabinets)
- Disconnect between leaders view of "work as prescribed" versus the frontline knowledge of "work as done"[14]
- Inadequate tools or systems (central line carts to reduce central line infections)[15]

Communication-based Errors

Communication errors do not strictly fall into either System 1 or 2 thinking, but are likely the most common contributing factor to errors made anywhere in the hospital.[16-19] Communication failures can be due to wrong time (information give too late), result from information directed to the wrong individual or group (wrong audience), be due to wrong or unclear content and wrong purpose (issues not resolved), or to omission of critical facts.[20] Operating room teams often use slang or jargon that can be wrongly interpreted by someone new to the group. Even standard names and numbers can be misunderstood or misheard (hearing fifty instead of fifteen, or eleven instead of seven). ORs also tend to be noisy places, where communication is not only lost in the noise, but muffled by masks. Communication failures occur often in the hand-over of a patient's care from one individual or group to another, both within the operating room and from the OR to the recovery unit and then to the ward.[21] Furthermore, information about a patient degrades across the continuum of care – if an allergy is omitted in the first handover, it will be omitted with each subsequent handover together with the omissions of that latest handover.[22]

These handovers occur frequently in the operating room, as one provider relieves another for a break or lunch, and then at the end of the day, as a night shift relieves the day shift providers. Short mid-case handovers do not seem to carry significantly risk, but still frequently involve omitted information about last narcotic or antibiotic dosing with subsequent duplication by the provider providing relief. Terminal handovers which occur as the primary day team turns care over to a relieving team, may be more dangerous, with several studies showing an increased mortality in patients whose anaesthesia care involved a terminal handover versus those that did not.[23] Relying solely on memory without a checklist to prompt recall results in many more omissions than when a protocol or checklist is used.[24,25]

All of the errors noted above can occur more frequently when a provider is fatigued, a situation that seems inevitable given the need to provide anaesthesia services 24 hours a day, 7 days a week. Simulation studies as well as real-life studies show that fatigue slows reaction time and reduces accuracy.[26,27] One noted study showed that 18 hours of wakefulness slowed reaction time as much as drinking alcohol.[28] Many providers cite situations where they made an error or nearly made an error when fatigued.[29,30] One could argue that adverse events occurring due to provider fatigue represent violations rather than errors:[6] however, if the fatigue is due to a necessity to care for sick patients due to limited resources, the "violation" is both necessary and appropriate. An experienced clinician will, however, recognize fatigue in themselves, and alert their teammates to the danger and ask for double checks during critical periods (coming off bypass) or tasks (measuring out insulin dose).

INTERVENTIONS AND SAFEGUARDS

Local Incident Reporting Systems and Safety Culture

It should be recognized that, because we all think alike, the errors we commit are also alike. These are the "error traps" noted above, and should not be explained by blaming the error-maker as "careless" or "error prone."[31] These error traps represent situations where anyone could easily make this error, and therefore a system redesign is the best way to eliminate a vulnerability. Hazards and vulnerabilities differ considerably between hospitals depending on local culture ("the way we do things here"), equipment (pulse oximeters available everywhere or not), staffing and training of the staff, and so on. Failure to recognize hypoxia is much more likely to happen in a recovery unit that does not have pulse oximeters than in one that does.

Since vulnerabilities are local, the best way to identify and correct these local issues is a local incident reporting system that allows individuals to report their errors or near misses without fear of blame, shame, or punishment.[32,33] Incidents that are reported should be approached with curiosity and compassion and analysed with a view to what system hazard allowed the incident to occur. Interventions proposed to reduce these hazards should be examined to be certain that they can achieve the desired goal, and with an understanding that interventions such as re-education or re-training are very weak, and often are not effective (Table 2).[6] Stronger interventions such as redesigning dangerous processes (requiring a second person check of insulin or heparin concentrations and doses) or using structured communication techniques are more useful. Strongest of all are forcing functions, such as the pin-indexing of gas canisters,

Table 2 – Effectiveness of Interventions to Improve Safety

Weaker Actions	Warnings and labels New procedures, memoranda, policies Training, re-education Additional study or analysis
Intermediate Actions	Checklists or cognitive aids Redundancy Enhanced communication techniques such as speak-back, three-way communication Decision support embedded in computer order entry systems (can over-ride) Improved labelling of medications Elimination of look-alike, sound-alike medications Separation of dangerous medications from routine medications (hypertonic saline) Elimination of concentration medications from anaesthesia carts
Strong Actions	Forcing functions (pin-indexing of gas tanks, unique small-bore connectors for neuraxial route, anaesthesia machines with anti-hypoxic gas mixture function) Standardization of equipment New device usability testing prior to purchase

or computer-based hard stops when a medication is ordered in the face of a pre-existing allergy, or an erroneous dose is entered into a smart pump. Unfortunately, weak interventions are inexpensive and easy to implement, while strong interventions are often costly and may require an extensive change in manufacturing, as exemplified by the new unique small-bore connectors, designed to eliminate wrong route errors. As noted above, resource constrained hospitals may not be able to afford the strongest interventions; this does not mean that they should not employ the weaker ones but that there should be an awareness of the strength of every intervention.

A strong local safety culture is key to reducing errors and requires overt support from top leadership. Although there are inexpensive ways to improve safety, virtually all of them cost something, even if it is simply working at a (slower) pace that allows for double checking, or refusing to be rushed, i.e., resisting production pressure. Without a strong commitment from the top executives of any institution, grassroots efforts are likely to fail. There are nearly always those who resist change, even if it is simple such as implementing the WHO Safe Surgery Saves Lives checklist, and strong leadership is required to establish the expectation that these preop checklists and briefings are an expectation, not a suggestion.[34] Hospital leadership also needs to ensure that reported incidents are met with curiosity and demonstrate a culture of accountability where unintentional errors are met with system and process redesigns, but intentional violations are met with accountability.

Over time, a strong commitment to safety by hospital leadership will change safety culture. This has been demonstrated by entities such as aviation, the military and the nuclear power industries who are known for their ability to perform complicated and dangerous functions without error (high-reliability industries).[35] These entities have characteristics in common, and these traits can be implemented in any hospital at little cost. These habits can also be practiced by individuals in their day-to-day work. The first is a preoccupation with failure, or always being alert to where the next patient is likely to be hurt. This approach can uncover hidden error traps that have become accepted as "how things get done" even if it is a dangerous approach. Another trait is closely related to the first and is sensitivity to operations – the leaders are aware of what goes on at the front lines, so that they can understand what work conditions might make healthcare delivery more dangerous (look alike vials, bar code scanners that do not work, work arounds that are required to get things done but that make it more dangerous.) Leaders need to understand the work as it is really done, not as they imagine it is getting done, or as workers report that it is getting done.[14] This requires leadership rounds in the ORs or on the wards to hear from frontline workers and understand local hazards. A third trait follows the same theme, deference to expertise, i.e., asking front-line workers, who know the job well, what can be done to make it safer.

Policies, Procedures, Standardised Order-Sets

As noted in Table 2, policies and procedures tend to be weak interventions in reducing errors, but by setting a standard way that different processes are done both identifies for all the accepted best practice and allows recognition of an error more quickly. Computerized standardised order sets can include checks such as always including an order for a blood glucose to be done an hour after insulin is ordered. In high resource settings, these safeguards can be built into a computerized provider order entry; in low resource setting, more manual checks can be instituted, such as a process to hang a sign on a patient's bed reminding all that a blood glucose should be checked at such and such a time. Care maps can be written that spell out the evidence based best practice for a given condition. As noted above, in high resource setting, anaesthesia for a caesarean delivery would include a spinal with bupivacaine; in low resource settings with no trained anaesthesia providers, the dose of ketamine can be clearly noted together with what monitors are required.[36]

Technology

In high resource institutions, a multitude of technical safeguards are available, such as bar code medication preparation and administration devices that will scan the label of a vial and print a correct syringe label that can be scanned during administration to provide visual (medication name displayed on computer screen) and audible (name announced) clues that the syringe is the one intended for administration. Scanned medications can then trigger a best practice alert to confirm weight-based dosing or dose adjusted for renal function.[37] Bar coded medication administration (BCMA) is widely adopted in high resource hospitals on the wards, but not yet in all procedural areas: there is clear evidence that BCMA does improve medication safety in anaesthesia and should be implemented everywhere it is affordable.[38,39] Pharmacy prepared or pre-filled medications eliminate the errors associated with provider prepared syringes or infusions, particularly when dilution is required, as well as removing concentrated medications from individual anaesthesia carts. Pre-filled syringes eliminate one possible error category, that of vial swap, which is especially important in the current environment with on-going medication shortages which bring new appearing labels for a given medication. Smart pumps can be pre-programmed with medication "libraries" such that when a pump has the medication name entered only appropriate dose ranges are allowed ("guard rails"). These electronic libraries can be easily updated by the pharmacists as needed.

These technical safeguards may not be available in our low to middle resource institutions, but alternative safeguards are available, albeit somewhat weaker in preventing error. These include a quiet distraction free location to prepare medications for the next case. Perhaps the most important intervention is using a two person check for preparation of a high-risk medication such as verifying with another provider or nurse the concentration of the insulin in the vial and the correct dose drawn up; doing double-dilution of phenylephrine or epinephrine with another provider and doing multiple syringes at one time; quietly stating the name of the medication to oneself while reading the label syringe just prior to administration. In general, mindfully inviting the conscious brain to oversee the unconscious actions will reduce errors.

Cognitive Safeguards

As noted above, unconscious biases play a significant role in cognitive errors, whether those be making a diagnosis or choosing a plan of

action. Although the decisions are often made subconsciously (fast thinking or "intuition")[8], the conscious mind can be trained to "oversee" these subconscious decisions to examine them for possible biases or flaws. In the case of diagnoses, a provider can train themselves to always list at least 3 possible diagnoses other than the one that immediately springs to mind; always consider the diagnosis that would be the most dangerous and consciously work through a process to exclude each diagnosis. Similarly, when choosing a medication to treat a diagnosis, consciously ask if this is the best medication or plan of action. Involving a colleague in the decision-making process brings another point of view and involves someone who will not have the same stored memories, who will have a different "availability heuristic." The saying that "two heads are better than one" refers to the fact that another provider may recognize different elements or view the situation differently. Hearing from all members of the team provides many points of view and may bring to light information known to one but not to others that can help uncover errors. In the OR, announcing a deteriorating situation ("I am having trouble with the patient's pressure) can bring to light new information (surgeon admits that more blood is being lost than expected).

A simple means to prevent skill-based errors is a brief pause before initiating a sequence or to confirm at the end of a sequence that all steps were completed; this allows the conscious mind to verify that the intended action is correct and/or was done correctly. Skill-based errors are more common when the cognitive workload is high (managing multiple issues at the same time) or when distractions are present. Extraneous conversations, phones ringing, staff announcing questions to be decided ("does the next patient require an arterial line?") or problems to be solved ("the blood bank does not have blood available for the next case"). Time pressure and working against the clock can lead to shortcuts that result in steps being skipped or safety checks are not completed.

Communication Safeguards

These safeguards are not costly and can be implemented in even the most resource limited hospitals. Restricting conversation in the OR to that pertaining to the case goes a long way to reducing noise, as does limiting the number of people in the OR. Communication protocols can be implemented without expense other than training or education. The protocols include directed communication,

Figure 1– World Health Organization Safe Surgery Checklist (Available at https://www.who.int/teams/integrated-health-services/patient-safety/research/safe-surgery/tool-and-resources; accessed July 7, 2023)

where the speaker always begins by using the receiver's name (or names) and not going further until the intended recipient is paying attention. Speak-back communication is well recognized to reduce communication errors and is mandatory in many high-risk industries such as the military, commercial aviation, and nuclear power plants. Speak-back is also known as three-way: the speaker states the concern or instruction using the name of the intended receiver, the receiver then repeats back the instructions, and the speaker states "that is correct" or corrects any misunderstanding. Use of the NATO alphabet (Alpha, Bravo, Charlie, Delta, etc) provides clarity for patient names and medications. Other conventions can be used but the NATO alphabet uses names that are each unique in sound as opposed to the common "d as in dog" which could easily be "b as in bog". Numbers that sound alike such as fifteen and fifty should be clarified as "fifteen, that's one-five".

Although not strictly structured communication, preoperative briefings reduce communication failures by making sure that all OR team members have the same information about the case to be done, what equipment will be needed, and what the risks are. The World Health Organization Safe Surgery Checklist (Figure 1, which can be accessed at https://www.who.int/teams/integrated-health-services/patient-safety/research/safe-surgery) has been shown to reduce surgical mortality by 30%. The pre-induction section includes identification of patient, procedure, site of surgery and consent; anaesthesia safety check (machine, suction, etc.), pulse oximeter on patient and functioning, and review of allergies, risk of blood loss, and difficult airway. The time out is the "brief" and includes introduction of the team members by name, once again confirmation of patient, procedure and location of surgery, anticipated critical or risky steps, antibiotic given, and a question about any concerns anyone has. Finally, before leaving the OR at the end of the case, the procedure intended and the one actually done are confirmed, needle and sponge counts are confirmed, specimens removed are appropriately labelled, and any concerns for recovery and postoperative management. Although it seems lengthy, multiple studies have shown that this checklist and briefing can be done in about 2 minutes, a very small time investment to gain a 30% reduction in patient deaths!

Simulation – High- and Low-Fidelity

Many high resource hospitals, especially those that are academic, have sophisticated simulation laboratories with "high-fidelity" that use manikins and sophisticated monitor displays to allow teams to practise the approach to rare but high risk crisis situations. These simulations can improve the speed with which teams manage crises and improve adherence to best practice protocols for many emergencies.[40] These laboratories can be expensive and are typically beyond the resources of many hospitals even in high resource countries. Low fidelity simulation, however, is low cost, and can be implemented by virtually any team. Many labour and delivery units on a regular basis pull a team together when the work-load is low, and draw a crisis situation from a jar such as prolapsed cord. The team then identifies what steps need to be done and in what order they should be completed, practise identifying a leader for the crisis, and work through which roles are required and who should take on that role.

Barriers to Implementation of Safeguards

Cost is one of the greatest barriers to implementing safeguards, as the strongest preventative measures are typically the most expensive. However, even very low-cost interventions are often not implemented (speak-back communication), most often due to human nature and an unwillingness to 1) accept that all of us will make errors; 2) an unwillingness to openly report errors, and then 3) an unwillingness to "be told what to do." We all have our preferred ways of doing things, and strongly resist that another way may be better or safer. Physicians often demand "autonomy" but we need to accept that the "right" to our autonomy should not and cannot be placed above the patient's right to receiving evidence based best practices as well as the safest practices. Safer care of our patients is possible – we simply must do it.

CONCLUSIONS

- Humans are furious pattern matchers and the subconscious processes involved lead to specific errors such as skill and rule based; when no appropriate patterns match, humans must resort to slow, effortful and conscious decision making where errors commonly arise from inadequate information or knowledge, and cognitive biases
- Interventions to improve safety include:
  - Top leader involvement in comprehensive safety programmes (non-punitive incident reporting systems, root cause analyses, unit walk arounds, establishing a just culture).
  - Technology such as electronic health records, with best practice alerts, standardised order sets and decision support, bar code medication administration, smart infusion pumps are strong interventions to improve safety.
  - Non-technical skills such as team training, use of standardised communication protocols and checklists and briefings are also powerful elements of a safety culture.
- Significant barriers to achieving patient safety include lack of transformational leadership, an unwillingness to financially invest in safety teams, adequate staffing and technology, and the personality traits that lead to a hero mentality or a refusal to adopt safety behaviours.

REFERENCES

1. Leape LL. Error in medicine. *Jama* 1994; **272**: 1851-7
2. Lisby M, Nielsen LP, Brock B, Mainz J. How are medication errors defined? A systematic literature review of definitions and characteristics. *Int J Qual Health Care* 2010; **22**: 507-18
3. Lisby M, Nielsen LP, Brock B, Mainz J. How should medication errors be defined? Development and test of a definition. *Scandinavian journal of public health* 2012; **40**: 203-10
4. Patel S, Loveridge R. Obstetric Neuraxial Drug Administration Errors: A Quantitative and Qualitative Analytical Review. *Anaesth Analg* 2015; **121**: 1570-7
5. Donaldson LJ, Kelley ET, Dhingra-Kumar N, Kieny MP, Sheikh A. Medication Without Harm: WHO's Third Global Patient Safety Challenge. *Lancet* 2017; **389:** 1680-1

6. Merry AF, Wahr JA. Medication Safety during Anaesthesia and the Perioperative Period. Cambridge, UK: Cambridge University Press, 2021
7. Reason J. Human error. New York, NY: Cambridge University Press, 1990
8. Kahneman D. A perspective on judgment and choice: mapping bounded rationality. *Am Psychol* 2003; **58**: 697-720
9. Saedder EA, Brock B, Nielsen LP, Bonnerup DK, Lisby M. Identifying high-risk medication: a systematic literature review. *European journal of clinical pharmacology* 2014; **70**: 637-45
10. Stiegler MP, Tung A. Cognitive processes in anesthesiology decision making. *Anesthesiology* 2014; **120**: 204-17
11. Reason J. Managing the Risks of Organization Accidents. Burlington, VT: Ashgate Publishing, 1997
12. Leape LL, Shore MF, Dienstag JL, et al. Perspective: a culture of respect, part 1: the nature and causes of disrespectful behavior by physicians. *Acad Med* 2012; **87**: 845-52
13. Weick KE, Sutcliffe KM. Managing the Unexpected: Resilient Performance in and Age of Uncertainty, Second Edition. San Francisco, CA: Jossey-Bass, 2007
14. Moppett IK, Shorrock ST. Working out wrong-side blocks. *Anaesthesia* 2017; **27:** 1-5
15. Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006; **355:** 2725-32
16. ElBardissi AW, Regenbogen SE, Greenberg CC, et al. Communication practices on 4 Harvard surgical services: a surgical safety collaborative. *Ann Surg* 2009; **250**: 861-5
17. Greenberg CC, Regenbogen SE, Studdert DM, et al. Patterns of communication breakdowns resulting in injury to surgical patients. *Journal of the American College of Surgeons* 2007; **204**: 533-40
18. Greenberg S. Handoff communication: an APSF safety initiative and perioperative provider concern. *APSF Newsletter* 2017; **32**: 29-33
19. Halverson AL, Casey JT, Andersson J, et al. Communication failure in the operating room. *Surgery* 2011; **149**: 305-10
20. Lingard L, Espin S, Whyte S, et al. Communication failures in the operating room: an observational classification of recurrent types and effects. *Qual Saf Health Care* 2004; **13**: 330-4
21. Nagpal K, Abboudi M, Fischler L, et al. Evaluation of postoperative handover using a tool to assess information transfer and teamwork. *Ann Surg* 2011; **253**: 831-7
22. Nagpal K, Vats A, Ahmed K, Vincent C, Moorthy K. An evaluation of information transfer through the continuum of surgical care: a feasibility study. *Ann Surg* 2010; **252**: 402-7
23. Hudson CC, McDonald B, Hudson JK, Tran D, Boodhwani M. Impact of anesthetic handover on mortality and morbidity in cardiac surgery: a cohort study. *J Cardiothorac Vasc Anesth* 2015; **29**: 11-6
24. Catchpole KR, de Leval MR, McEwan A, et al. Patient handover from surgery to intensive care: using Formula 1 pit-stop and aviation models to improve safety and quality. *Paediatr Anaesth* 2007; **17**: 470-8
25. Joy BF, Elliott E, Hardy C, Sullivan C, Backer CL, Kane JM. Standardized multidisciplinary protocol improves handover of cardiac surgery patients to the intensive care unit. ***Pediatr Crit Care Med*** 2011; **12**: 304-8
26. Howard SK, Gaba DM, Smith BE, et al. Simulation study of rested versus sleep-deprived anesthesiologists. Anesthesiology 2003; 98: 1345-55; discussion 5A. doi: 10.097/00000542-200306000-00008.
27. Howard SK, Rosekind MR, Katz JD, Berry AJ. Fatigue in anaesthesia: implications and strategies for patient and provider safety. *Anesthesiology* 2002; **97**: 1281-94
28. Dawson D, Reed K. Fatigue, alcohol, and performance impairment. *Nature Clinical Practice Urology* 1997; **388**: 235
29. Morris GP, Morris RW. Anaesthesia and fatigue: an analysis of the first 10 years of the Australian Incident Monitoring Study 1987-1997. *Anaesth Intensive Care* 2000; **28**: 300-4
30. Trew A, Searles B, Smith T, Darling EM. Fatigue and extended work hours among cardiovascular perfusionists: 2010 Survey. *Perfusion* 2011; **26**: 361-70
31. Reason J. Human error: models and management. *BMJ* 2000; **320**: 768-70.
32. Zoppellari R, Ferri E, Sgarbi A, Vivarelli R, Osti D, Guberti A. Incident reporting in anaesthesia: misidentification of propofol concentrations due to similarities in drug packaging. *Minerva Anestesiol* 2007; **73**: 437-40
33. Westbrook JI, Li L, Lehnbom EC, et al. What are incident reports telling us? A comparative study at two Australian hospitals of medication errors identified at audit, detected by staff and reported to an incident system. *Int J Qual Health Care* 2015; **27**: 1-9
34. van Klei WA, Hoff RG, van Aarnhem EE, et al. Effects of the introduction of the WHO "Surgical Safety Checklist" on in-hospital mortality: a cohort study. *Ann Surg* 2012; **255**: 44-9
35. Sutcliffe KM. High reliability organizations (HROs). *Best Pract Res Clin Anaesthesiol* 2011; **25**: 133-44. doi: 10.1016/j.bpa.2011.03.001.
36. Masaki CO, Makin J, Suarez S, et al. Feasibility of a Ketamine Anaesthesia Package in Support of Obstetric and Gynecologic Procedures in Kenya When No Anesthetist is Available. *Afr J Reprod Health* 2019; **23**: 37-45
37. Nanji KC, Garabedian PM, Langlieb ME, et al. Usability of a perioperative medication-related clinical decision support software application: a randomized controlled trial. *J Am Med Inform Assoc* 2022; **29**: 1416-24
38. Merry AF, Hannam JA, Webster CS, et al. Retesting the Hypothesis of a Clinical Randomized Controlled Trial in a Simulation Environment to Validate Anaesthesia Simulation in Error Research (the VASER Study). *Anesthesiology* 2017; **126**: 472-81
39. Merry AF, Webster CS, Hannam J, et al. Multimodal system designed to reduce errors in recording and administration of drugs in anaesthesia: prospective randomised clinical evaluation. *BMJ* 2011; **343**: d5543
40. Ford DG, Seybert AL, Smithburger PL, Kobulinsky LR, Samosky JT, Kane-Gill SL. Impact of simulation-based learning on medication error rates in critically ill patients. *Intensive Care Med* 2010; **36**: 1526-31

Update in
Anaesthesia

Review

Paediatric anaesthesia safety in low and middle income countries

Osazuwa MO[1]*, Desalu I[2], Aaron O[3], Asiyanbi GK[4]
*Correspondence email: maryroseag@yahoo.com

INTRODUCTION

Low- and middle-income countries (LMICs) make up 63% of the world's 218 countries.[1] Many of these LIMCs are in Africa, Asia, and Latin America. Children constitute almost half of the population in many LMICs;[2] and therefore, present a large proportion of surgical and anaesthesia workload in LMICs.

A prevalence rate of 35% for surgically correctable conditions in children has been extrapolated to suggest that 2.9 million children in LMICs will require surgery and anaesthesia in their lifetime.[3] That prevalence number may be low, however, as there are 1.7 billion children worldwide who do not have access to surgical care. Nearly two-thirds of these children live in LMICs.[4] Many children present late for surgical care due to inadequate perinatal diagnosis; cultural, societal and religious beliefs; long travel distances; impoverishment; and lack of proper health insurance.[5] These disadvantages put them at risk of having poorer health outcomes in general.

Safety in anaesthesia means more than the absence of mortality. It also includes both avoidable and unavoidable morbidity. Outcome measures that determine safety of anaesthesia in children have not been prioritized in many LMIC countries.[6] Safety in children undergoing anaesthesia and surgery in LMICs hinges on timeliness of presentation, adequacy of trained personnel, and availability of appropriate equipment to deliver safe anaesthesia. Besides surgical interventions, sedation services for children are increasingly being provided outside the operating room, especially in specialized teaching hospitals. The safety of these services in children needs to be addressed.

Very few studies focus on outcome of paediatric anaesthesia in LMICs. This may be due to poor data collection, collation and auditing and the lack of safety cultures and fear of reprisals if mistakes are reported. It has been shown that Sub-Saharan Africa has a significantly higher mortality than high income countries (HICs) for many paediatric surgical conditions.[7] Newton et al[5] demonstrated a 7-day mortality 100 times higher in LMICs compared to HICs. This mortality was associated with high ASA classification (>III), not using a surgical safety checklist, and out-of-normal hours surgery. In 2022 the African Surgical Outcomes Study – Paeds (ASOS-Paeds) collected paediatric anaesthesia and surgical data from many countries across Africa. We await the results of this important study at this time.

This review focuses on educational opportunities; the people resources, skills and density of anaesthesia providers; and how these impact perioperative safety in children. It also discusses equipment and medication needs as well as fasting protocols.

Education & Training

Many different groups of health professionals provide anaesthesia care to children in unique hospital settings. The paucity of paediatric anaesthesia sub-speciality training in LMICs makes it imperative that anaesthesia providers undergo standardised training in clinical services, emergencies and recognition of when to refer. In most residency training programmes, trainees rotate through various aspects of paediatric anaesthesia. These rotations provide them with exposure to the anaesthetic care of children but not in-depth experience in the speciality.[8,9]

Paediatric anaesthesia fellowship programmes exist in various LMICs (Table I). These numbers are insufficient to provide the skilled personnel required for the LMIC populations. Fellowship training differs across countries and continents and is not regulated by any one body.

The Paediatric Anaesthesia Training in Africa (PATA), a new post-fellowship training alliance runs programmes simultaneously in 3 countries in Africa. These programmes have 2 local faculty and receive support from international sources. The PATA alliance is expected to produce leaders and future trainers in paediatric anaesthesia.

[1]*Osazuwa MO*
Department of Anaesthesia
National Hospital
Abuja
NIGERIA

[2]*Desalu I*
Department of Anaesthesia
Lagos University
Teaching Hospital
University of Lagos
Lagos
NIGERIA

[3]*Aaron O*
Department of Anaesthesia
Lagos University
Teaching Hospital
University of Lagos
Lagos
NIGERIA

[4]*Asiyanbi GK*
Department of Anaesthesia
Faculty of Clinical Sciences
College of Health Sciences
Obafemi Awolowo
University
Ile-Ife
NIGERIA

Table I – Recognized Paediatric Anaesthesia Post-Residency Training Programmes in LMICs

Body	Country
WFSA*	Asia - 2 Africa -2 Latin America -2 Serbia -1
University of Nairobi	Kenya
PATA**	Nigeria Uganda Zambia
	India (24)8

**World Federation of Societies of Anaesthesiologists; ** Paediatric Anaesthesia Training in Africa*

While physicians trained in the full spectrum of anaesthesia are covered by PATA and WFSA, it is imperative that other physicians and non-physician anaesthetists are also trained in paediatric anaesthesia. For example, Smile Train supports a 6-month training program in basic paediatric anaesthesia and cleft care. It does this in conjunction with the West African College of Surgeons. The program is aimed primarily at physicians who have completed a short, 1-year diploma in anaesthesia training but others may also be included.

Short courses such as SAFE Paeds, Managing Emergencies in Paediatric Anaesthesia (MEPA), and Paediatric Advanced Life Support (PALS) should be provided for all anaesthesia providers. These courses teach safe conduct of paediatric anaesthesia; management of common paediatric emergencies; and recognition and immediate provision of care for sick children. Ultimately, these all have the goal of improving safety during paediatric anaesthesia. However, they require sponsorship to ensure they are within the financial capacity of all who provide anaesthesia to children in LMICs. For example, SAFE Paeds is well established in East Africa and has recently commenced in West Africa but needs additional resources to expand further.

Conference workshops and training sessions provide opportunities for discussion and training. E-learning may be the most effective way to reach many providers who are spread far apart geographically. As an example, SAFE Paeds has a modified 2-day virtual learning platform. Telemedicine may also provide communication between local and advanced level health providers for various stages of patient care.[10] Unfortunately, online resources may be problematic in LMICs because of poor internet connectivity.

PEOPLE RESOURCES

Anaesthesia manpower is progressively dwindling in LMICs. This reduction in workforce has obvious implications for the safe delivery of paediatric anaesthesia.[11]

The physician anaesthesia provider (for adults as well as children) ratio per 100,000 population in most LMICs is extremely low. Few, if any, attain the 20 per 100,000 suggested by The Lancet Commission on Global Surgery or the interim value of 4 per 100,000 suggested by the WFSA.[12-14] In Nigeria the ratio is estimated to be 0.58 per 100,000 population while 1.51 per 100,000 has been calculated for the southwest Pacific Islands.[15] Many reasons beyond the scope of this article are responsible for this. Hence, in many LMICs, anaesthesia is also provided by non-anaesthesiologists. These personnel vary dramatically in their levels of training and have variable skills and knowledge. This issue particularly impacts the anaesthesia care of children. In some communities in LMICs, there are no anaesthesia trained personnel who are comfortable and skilled at caring for children. In extreme instances, some children are subjected to surgery with local anaesthetics only.

The shortage in paediatric anaesthesia workforce increases the burden of children's diseases and also reduces the number of surgeries that can be done in LMICs. In one review, developing countries accounted for only 6% of the total volume of all surgeries done globally in a year.[12] That same low value applies to paediatric surgery, also.

One of the primary determinants of surgical safety is the presence or absence of skilled anaesthesia personnel. Morbidity and mortality is generally high in countries where the anaesthesia workforce is inadequate. The number of trained paediatric anaesthesiologists in Nigeria is as low as 0.028 per 100,000 paediatric density.[9] This value is 0.023 in Uganda, 0.038 in Zambia, and 0.11 in Kenya (personal correspondence). The skills and competencies of anaesthesia personnel vary depending on their training and experience. The dearth of paediatric anaesthesia providers leaves the provision of paediatric anaesthesia mostly in the hands of non-qualified anaesthesia personnel. The absence of well-trained physicians in paediatric anaesthesia results in difficulties with handling complex surgical conditions. Children who require optimization or resuscitation prior to surgery may have little chance of survival.

The lack of standardised paediatric anaesthesia training programmes in LMICs significantly affects the numbers trained. Some countries do not have training programmes in anaesthesia; presently, Liberia is training its anaesthesia residents in Nigeria while Gambia has just started a residency training program. Paediatric anaesthetists across LMICs should actively mentor medical students and junior trainees to help increase interest in paediatric anaesthesia.

In many LMICs, there is progressive workforce migration from rural areas to urban districts as poor work and living conditions in rural areas are bringing more specialists towards regional and tertiary hospitals. This is compounded by local workforce emigrating to developed countries (the "brain drain" phenomenon).

Improvement in paediatric anaesthesia safety requires investment in training and training capacity with assessment of needs in terms of numbers and skill required for the health system. Access to continuing professional development, acceptable working conditions, career progression and adequate remuneration are all essential if paediatric anaesthesia workforce development is to be attained and sustained. It is important to establish appropriate metrics to assess paediatric anaesthesia service at a population level. This should be based on prevalence, backlogs to treatment, and disability incurred by treatment delays.

PREOPERATIVE FASTING

The most commonly used guidelines for preoperative fast recommends intervals of 6, 4, and 2 hours (6–4–2) of fasting for solids, breast milk, and clear fluids. Despite these guidelines, children are often subjected to prolonged fasting before surgery. This predisposes them to avoidable hypoglycaemia and dehydration. As a result, there is often haemodynamic instability, irritability, poor control of pain, postoperative vomiting, and prolonged recovery.[16-18]

A more liberal approach to preoperative fasting in children may enhance favourable postoperative outcomes. That depends, of course, on strong implementation of preoperative fasting guidelines. Sadly, many facilities do not have a good implementation of fasting guidelines for children and prolonged fasts and even dehydration pre-operatively are the norm. More liberal use of clear fluids or carbonated drinks has been recently advocated, right up until the call to surgery. Many factors may lead to a prolonged period of preoperative fast among children in our daily practice (Table II).

There are no well outlined guidelines on what oral intake and quantity should be allowed before surgery in many of the facilities in LMICs.[19] Exactly what constitutes clear fluid may be vague to an uneducated and often anxious mother who will eventually do what she thinks is best for her child.

It is the responsibility of every member of the surgical team to have updated evidence regarding perioperative fasting. Developing local guidelines from contributions from every member will enhance standard practice. Compliance to a standard protocol will not be achieved overnight but with proper education, collaboration, and more local research, achieving an optimum period of preoperative fasting and better outcome in children's surgery is feasible.

EQUIPMENT & MONITORING

The delivery of safe and effective surgical care to children requires appropriate anaesthesia and monitoring equipment. For anaesthesia providers caring for children in LMICs, the lack of appropriate equipment, and deficiencies in postoperative care are especially difficult.[20]

A study in Niger reported a perioperative critical incidence of 11.7%. Over four-fifths of these occurred during induction of anaesthesia and at the postoperative period. A good number were believed to be avoidable with appropriate monitoring.[21]

Perioperative monitoring is an essential component of anaesthetic care regardless of technique being employed. The continuous presence of a trained anaesthesia provider together with regular clinical assessments with the use of monitoring devices is the recommended standard of monitoring.[22] Oxygenation, ventilation, circulation and temperature are essential parameters being monitored by pulse oximetry, capnography, electrocardiography, arterial blood pressure and appropriate thermometers. Sadly, some of these core components of monitoring are absent during paediatric anaesthesia in many LMICs.

Hospital assessments carried out in Ghana demonstrated marked deficiencies in several essential items including basic airway supplies and blood pressure cuffs.[23] This experience may be similar in other LMICs. The wide range of equipment sizes needed to provide safe, high-quality anaesthesia to children is often absent or lacking in the LMICs.[24] Temperature conservation and blood glucose control are also challenging because of lack of active warming and monitoring devices.[25] Many interventions such as the WHO pulse oximetry project have alleviated to some extent the problem of lack of pulse oximeters in many facilities. Furthermore, the KidsOR and the SmileTrain/KidsOR collaborations have equipped many hospitals in LMICs with functional and equipped theatres for surgery and anaesthesia. This has gone a very long way to reduce healthcare worker frustration, improve surgery turnover, reduce wait times and improve safety of paediatric anaesthesia in these hospitals.[24,27]

To improve this situation, better training of staff in paediatric anaesthesia is essential. Ability to understand the peculiarities of the work environment, and skill to maximize the available equipment and devices will enhance safety. The place of government intervention and commitment of various health institutions to the provision of appropriate sizes of equipment and devices for the paediatric age group cannot be overemphasized. Skilled and efficient biomedical engineering staff will also prevent long periods of equipment breakdown and maximize the effectiveness of available equipment.

MEDICATIONS- AVAILABILITY AND ERRORS

Availability of medications vary within LMICs and even within countries there are disparities in the anaesthesia medications available. Hospital leaders often look for ways to reduce costs. This extends to anaesthesia practice. Sevoflurane, a useful inhalational agent in the

Table II – Perceived Factors and Proposed Solutions to Prolonged Preoperative Fasting

Reason	Proposed solutions
Lack of clear fasting protocol	Establish protocols and train all staff involved.
Lack of clarity of Instruction due to language barrier or poor understanding	Print leaflets or posters in different languages, get interpreters to explain.
Unpredictable time of commencement of surgery; Undefined or unachievable	Establishment of institution protocols and sorting of logistics, insurance cover for children, investment in paediatric surgery by government and institutions.
Unduly delayed surgical start time due to Personnel, equipment or patient factors	Establishment of institution protocols and sorting of logistics, insurance cover for children, investment in paediatric surgery by government and institutions.
Negative influence of nursing staff to tailored fasting guidelines	Education of nursing staff, get them to become champions of proper pre-operative fast.

paediatric population is not widely available due to the perceived notion that it is expensive. Halothane is still the most widely used inhalational agent in some LMICs. Its safety in inexperienced hands is questionable.[28]

Various regulations and prioritization of funds makes the supply of opioids erratic. Common opioids employed are morphine, fentanyl, pethidine and the less potent pentazocine and tramadol, as the newer opioids are usually unavailable However, remifentanil is available in countries like Uganda and India. Even when opioids are available, some anaesthetists are wary of administering opioids into the recovery period and thereafter to children, due to fears of respiratory depression especially in a setting of poor monitoring, lack of oxygen and non-availability of naloxone. Sometimes, only paracetamol and an NSAID are administered, which are inadequate for many surgeries.[29]

Suxamethonium is still the muscle relaxant of choice for rapid sequence induction and difficult airway despite its numerous well-known disadvantages. Safer drugs like rocuronium and cis-atracurium, are hardly found in many theatres, while availability of sugammadex is rare.

Medication errors may result in morbidity and even mortality. They are typically underreported in paediatric anaesthesia practice.[30] Reasons include no formal channel for reporting, non-encouragement to report, no action or improvement of systems from those reported, lack of awareness of the importance to report, and fear of punitive action. Medication errors in paediatric anaesthesia vary from 0.04% to 2.6% in LMICs.[31] A survey done in Nigeria revealed that most medication errors were due to incorrect dosing (55%) or incorrect medications given (28%) and 14.8% of anaesthetists reported medication error of at least once a week in children. Medication errors occurred most commonly during a critical event (51.4%) and during an emergency procedure (50%). Top reasons for medication errors were failure to weigh the child (77.9%), haste or insufficient preparation (69%), fatigue (62%), anaesthetist's inexperience (54.2%) and poor team communication (47.9%).[32] Table III suggests opportunities to reduce perioperative medication errors in children.

Reporting of errors or sentinel events needs to be encouraged; unfortunately, reporting is not common in many LMICs. There are no registries and no established protocols for reporting medication errors and therefore, audits of these errors are few. Audits of medication errors will help to determine causes and ways to prevent them, which can lead to better safety in paediatric anaesthesia practice in LMICs.

REGIONAL BLOCKS

Paediatric regional anaesthesia has many advantages; improved post-operative pain management, early ambulation, reduced length of stay in post-anaesthesia care units, reduced opioid administration and their side effects. Despite these advantages, the use of regional anaesthesia for children in the LMICs is still low in many countries.

Safe paediatric regional anaesthesia requires knowledge, expertise and the provision of appropriate equipment and monitoring compliant with the international standards for a safe practice of anaesthesia. Competency varies across regions with many practitioners adept at caudals and spinals while few are competent in epidurals and nerve blocks. All paediatric regional anaesthetists should be adequately trained to monitor and diagnose complications associated with regional blocks and an appropriate level of postoperative monitoring must be ensured to allow for early detection of any complication.

The deployment of inappropriate devices in paediatric regional anaesthesia frequently occurs with anaesthesia providers resorting to the use of hypodermic needles for central neuraxial block and spinal needles when instituting ultrasound guided peripheral nerve blocks. This can lead to local anaesthetic systemic toxicity (LAST). Unfortunately, the earliest sign of LAST may be difficult to recognize because of paucity of ECG monitoring. The lack of availability of intra-lipid in most centres makes the management of LAST difficult. It is therefore imperative that the maximum allowable LA dose is not exceeded, a test dose is given and incremental administration of the LA employed.

In LMICs, landmark-guided regional anaesthesia techniques are usually deployed for regional blocks because of the paucity of ultrasound scans as well as the lack of expertise in its interpretation. This often requires multiple attempts at needle passes, increased dosage of local anaesthetics, and higher incidences of LAST. It is important to expand the use of image guided techniques to reduce these limitations, as well as ensure adequate training. The high cost of imaging machines continues to be a barrier in many LMIC settings.

Anaesthesia personnel must realize that a regional technique should not be seen as an option to deficient airway skills. Anaesthetists caring for children should be adequately trained and prepared in airway management as most children will either require sedation or general anaesthesia, and some may even require resuscitation.

Table III – Suggested ways to Prevent Medication Errors in Paediatric Practice

Medication Error	Suggested Preventions
Overdosing	Weigh patient or use estimated weight, calculate medications carefully
Underdosing	Weigh patient or use estimated weight, calculate medications carefully
Wrong drug	Label correctly, do not place similar drugs side by side
Wrong concentration	Label properly, use pre-formed labels, double check dilution with a colleague.

Table IV – Suggested Ways to Improve Postoperative Pain Control

A plan for postoperative pain management should be decided before the end of every surgery
Adoption of pain management protocols
Education of healthcare personnel to create awareness
Availability of the right analgesic medications
Anaesthetists who administer paediatric anaesthesia should learn basic regional blocks
Anaesthetists who administer paediatric anaesthesia should be conversant with analgesic medications

POSTOPERATIVE PAIN

In many LMICs anaesthesia personnel focus on the immediate postoperative pain management while pain management on the postoperative ward is essentially handled by the surgeons. Reasons for lack of-involvement of anaesthesia personnel in postoperative pain management are inadequate manpower, long surgical lists, disinterest, the lack of availability of devices/ consumables and equipment such as patient controlled analgesia devices, epidural kits, and syringe pumps.

Lack of medications, equipment and consumables, especially specific to children, is a huge deterrent to effective postoperative pain management. Many times the choice of analgesics is limited. Even when medications like opioids are available, they are often under-dosed or not administered at all due to fear of adverse effects like respiratory depression because there are too few ward nurses to do proper observation and to little appropriate monitoring available. In some hospitals, postoperative analgesics are still being administered intramuscularly as many believe the side effects to be less. The incidence of poorly managed postoperative pain in children in LMICs is high.[33]

Poor intraoperative pain management makes postoperative pain management more challenging and can also lead to chronic pain. The detrimental effects in children include brain changes, anxiety, depression, poor academic performance, anti-social behaviour and future risk of opioid dependence.[34] The techniques and medications used to prevent/ control pain intraoperatively are important and can be extended into the postoperative period. Rectal administration of paracetamol and diclofenac should be encouraged instead of the intramuscular route.

Regional anaesthesia has been shown to improve postoperative pain management and reduce postoperative pain scores. Incorporation of regional anaesthesia in paediatric anaesthesia practice is one way to improve postoperative analgesia. Simple techniques like caudal block and some peripheral nerve blocks can be incorporated into the anaesthetic plan and provide long duration of analgesia well beyond the immediate postoperative period.

The importance of good postoperative pain control has to be emphasised to Paediatric anaesthetists and generalists who practice paediatric anaesthesia. Future surgeries may be traumatic for children from bad surgical pain experience, and this should be avoided. Table IV suggests opportunities to improve postoperative pain control in children.

CONCLUSION

Many factors compromise delivery of safe anaesthesia to children in LMICs. While some of these such as education and training can be more readily accomplished, support and advocacy by institutional, political, and governmental agents are essential for long-term sustained goals.

Anaesthesia standards for children should be developed in the LMICs with appropriate outcome measures as safety indices. Safety in children should not only be reflected in mortality figures but all critical incidents and morbidities should be recorded and used as instruments to identify immediate and remote causes, plan and execute appropriate intervention in order to improve paediatric patient safety in anaesthesia.

REFERENCES

1. Lencucha R, Neupane S. The use, misuse and overuse of the 'low-income and middle-income countries' category. *BMJ* Global Health 2022;**7**:e009067.
2. World Bank. https://www.worldbank.org/en/news/press-release/2020/10/20/1-in-6-children-lives-in-extreme-poverty-world-bank-unicef-analysis-shows
3. Ademuyiwa AO, Odugbemi TO, Bode CO, Elebute OA, Alakaloko FM, Alabi EO, Bankole O, Ladipo-Ajayi O, Seyi-Olajide JO, Okusanya B, Abazie O, Ademuyiwa IY, Onwuka A, Tran T, Makanjuola A, Gupta S, Ots R, Harrison EM, Poenaru D, Nwomeh BC. Prevalence of surgically correctable conditions among children in a mixed urban-rural community in Nigeria using the SOSAS survey tool: Implications for paediatric surgical capacity-building. *PLoS One* 2019;**14**(10):e0223423. doi: 10.1371/journal.pone.0223423. PMID: 31600252; PMCID: PMC6786634.
4. Mullapudi B, Grabski D, Ameh E, Ozgediz D, Thangarajah H, Kling K, Alkire B, Meara JG, Bickler S. Estimates of number of children and adolescents without access to surgical care. *Bull World Health Organ*. 2019 Apr 1;**97**(4):254-258. doi: 10.2471/BLT.18.216028. Epub 2019 Jan 28. PMID: 30940982; PMCID: PMC6438256.
5. Newton MW, Hurt SE, McEvoy MD, Shi Y, Shotwell MS, Kamau J, Nabulindo S, Ngumi ZWW, Sandberg WS, Sileshi B; Pediatric Perioperative Mortality in Kenya: A Prospective Cohort Study from 24 Hospitals. *Anesthesiology* 2020; **132**:452–460 doi: https://doi.org/10.1097/ALN.0000000000003070
6. Hansen TG, Engelhardt T, Weiss M. Outcomes after paediatric anaesthesia: which ones should have the priority? *Curr Opin Anaesthesiol* 2019; **32**(3):392-397. DOI: https://doi.org/10.1097/ACO.0000000000000720
7. PaedSurg Africa Research Collaboration. Paediatric surgical outcomes in sub-Saharan Africa: a multicentre, international, prospective cohort study. *BMJ* Global Health 2021;**6**:e004406.
8. Indu S, Nandini D, Neerja B, Chitra J; Shamshad B. Specialised training in paediatric anaesthesia: Need of the hour. *Indian J Anaesth* 2021; **65**(1): 17-22. | DOI: 10.4103/ija.IJA_1445_20
9. Desalu I, Osazuwa MO. Safe surgery for every child, implementation of paediatric anaesthesia training in Nigeria. *Curr Opin Anaesthesiol*. 2022; **35**(3): 343-350. doi: 10.1097/ACO.0000000000001144. PMID: 35671022.

10. Farmer D, Sitkin N, Lofberg K, Donkor P, Ozgediz D. Surgical Interventions for Congenital Anomalies. In: Debas HT, Donkor P, Gawande A, Jamison DT, Kruk ME, Mock CN, editors. Essential Surgery: Disease Control Priorities, Third Edition (Volume 1). Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2015 Apr 2. Chapter 8. PMID: 26741013.
11. Kudsk-Iversen S, Shamambo N, Bould MD. Strengthening the Anesthesia Workforce in Low- and Middle-Income Countries. *Anesth Analg* 2018; **126**(4): 1291-1297. doi: 10.1213/ANE.0000000000002722. PMID: 29547423.
12. Meara JG, Leather AJ, Hagander L, Alkire BC, Alonso N, Ameh EA, Bickler SW, Conteh L, Dare AJ, Davies J, Mérisier ED, El-Halabi S, Farmer PE, Gawande A, Gillies R, Greenberg SL, Grimes CE, Gruen RL, Ismail EA, Kamara TB, Lavy C, Lundeg G, Mkandawire NC, Raykar NP, Riesel JN, Rodas E, Rose J, Roy N, Shrime MG, Sullivan R, Verguet S, Watters D, Weiser TG, Wilson IH, Yamey G, Yip W. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Int J Obstet Anesth* 2016; **25**:75-8. doi:10.1016/j.ijoa.2015.09.006. Epub 2015 Sep 30. PMID: 26597405.
13. Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA Global Anesthesia Workforce Survey. *Anesth Analg* 2017;**125**(3):981-990. doi: 10.1213/ANE.0000000000002258. PMID: 28753173.
14. Davies JI, Vreede E, Onajin-Obembe B, Morriss WW. What is the minimum number of specialist anaesthetists needed in low-income and middle-income countries? *BMJ* Glob Health 2018;**3**(6):e001005. doi: 10.1136/bmjgh-2018-001005. PMID: 30588342; PMCID: PMC6278919
15. Warner MA, Arnal D, Cole DJ, Hammoud R, Haylock-Loor C, Ibarra P, Joshi M, Khan FA, Lebedinskii KM, Mellin-Olsen J, Miyasaka K, Morriss WW, Onajin-Obembe B, Toukoune R, Yazbeck P. Anesthesia Patient Safety: Next Steps to Improve Worldwide Perioperative Safety by 2030. *Anesth Analg*. 2022 Jul 1;**135**(1):6-19 Epub 2022 Apr 07 PMID: 35389378 DOI: 10.1213/ANE.0000000000006028
16. Adenekan AT. Perioperative blood glucose in a paediatric daycase facility: effects of fasting and maintenance fluid. *Afr J Paediatr Surg* 2014; **11**(4):317-22. doi: 10.4103/0189-6725.143140. PMID: 25323181.
17. Mesbah A, Thomas M. Preoperative fasting in children. *BJA* Educ. 2017; **17**(10):346–50. Available from: https://doi.org/10.1093/bjaed/mkx021
18. Thomas M, Engelhardt T. Think drink! Current fasting guidelines are outdated. *BJA* 2017;**118**: 291–3. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0007091217301964
19. Kouvarellis AJ, van der Spuy K, Biccard BM, Wilson G. A prospective study of paediatric preoperative fasting times at Red Cross War Memorial Children's Hospital, Cape Town, South Africa. *S Afr Med J* 2020;**110**(10):1026–1031. https://doi.org/10.7196/SAMJ.2020.v110i10.14814
20. Ndikontar Kwinji R, Evan, F, Gray RM. Challenges with pediatric anesthesia and intraoperative ventilation of the child in the resource-constrained setting. *Pediatric Anesthesia* 2022; **32**(2):372–379. https://doi.org/10.1111/PAN.14353
21. Chaïbou, MS, Daddy H, Mallam MKD, Gagara M, James-Didier L, Sani R, Abarchi H. Prospective, observational study of perioperative critical incidents, anaesthesia, and mortality in elective paediatric surgical patients at a national referral hospital in Niger. *SAJAA* 2022; **28**(1):16–20. https://doi.org/10.36303/SAJAA.2022.28.1.2462
22. Alaa A, Eden N, Rajan S (ed.),'ASA Monitoring Standards', in Alaa Abd-Elsayed (ed.), Advanced Anesthesia Review (New York, 2023; online edn, Oxford Academic, 1 Mar. 2023), https://doi.org/10.1093/med/9780197584521.003.0008, accessed 30 July 2023.
23. Ankomah J, Stewart BT, Oppong-Nketia V, Koranteng A, Gyedu A, Quansah R, Donkor P, Abantanga F, Mock C. Strategic assessment of the availability of pediatric trauma care equipment, technology and supplies in Ghana. *J Pediatr Surg* 2015; **50**(11):1922–1927. https://doi.org/10.1016/j.jpedsurg.2015.03.047
24. Laverde R, Majekodunmi O, Park P, Udeigwe-Okeke CR., Yap A, Klazura G, Ukwu N, Bryce E, Ozgediz D, Ameh EA. Impact of new dedicated pediatric operating rooms on surgical volume in Africa: Evidence from Nigeria. *J Pediatr Surg* 2023; **58**(1):161–166. https://doi.org/10.1016/J.JPEDSURG.2022.09.021
25. Barbour R, Deka P. Paediatric anaesthesia for low-resource settings. *BJA* Education 2017. **17**(11):351–356. https://doi.org/10.1093/bjaed/mkx030
26. Albert V, Mndolo S, Harrison EM, O'Sullivan E, Wilson IH, Walker IA. Lifebox pulse oximeter implementation in Malawi: evaluation of educational outcomes and impact on oxygen desaturation episodes during anaesthesia. *Anaesthesia* 2017; **72**(6): 686–693. https://doi.org/10.1111/anae.13838
27. Ameh EA. Realigning Global Health Realities Towards Children's Surgery: Progress and Possibilities. *J Pediatr Surg* 2023; **58**(6):1039-1047. doi: 10.1016/j.jpedsurg.2023.02.006. Epub 2023 Feb 20. PMID: 36907771.
28. Gyorfi MJ, Kim PY. Halothane Toxicity. [Updated 2023 Apr 10]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK545281/
29. Dejene B, Mesfin M. Practice of Postoperative Pain Management in Under-Five Children in A Tertiary Hospital: A Prospective Cross sectional Study. *Ethiop J Health Sci*. 2022; **32**(6):1117. doi:http:// dx.doi.org/ 10.4314/ejhs.v32i6.8
30. Jones-Oguh S, Elliott EM, McClung Pasqualino H, Harris K, Isserman RS. Medication safety in pediatric anesthesia: An educational review and a call to action. *Paediatr Anaesth* 2023; **33**(1):17-23. doi: 10.1111/pan.14576. Epub 2022 Oct 28. PMID: 36239463.
31. Leahy IC, Lavoie M, Zurakowski D, Baier AW, Brustowicz RM. Medication errors in a pediatric anesthesia setting: Incidence, etiologies, and error reduction strategies. *J Clin Anesth* 2018;**49**:107-111. ISSN 0952-8180. https://doi.org/10.1016/j.jclinane.2018.05.011.
32. A Survey of Medication Errors in Paediatric Anaesthesia Practice in Nigeria. Osazuwa MO, Sonaike M, Aaron O, Desalu I. Unpublished data. Oral presentation at the Annual Scientific Conference of the Nigerian Society of Anaesthetists, Abuja 2022.
33. Gao L, Mu H, Lin Y, Wen Q, Gao P. Review of the Current Situation of Postoperative Pain and Causes of Inadequate Pain Management in Africa. *J Pain Res*. 2023; **29**(16): 1767-1778. doi: 10.2147/JPR.S405574. PMID: 37273275; PMCID: PMC10237197
34. Mathews L. Pain in children: neglected, unaddressed and mismanaged. *Indian J Palliat Care*. 2011;**17**(Suppl):S70-3. doi:10.4103/0973-1075.76247. PMID: 21811376; PMCID: PMC3140088

Update in
Anaesthesia

Review

Anaesthesia Safety in War Zones

Rudi Falovic MG, Martin Graves and Simon Hendel*
*Correspondence email: S.Hendel@alfred.org.au

Abstract

Many countries (and populations) all over the world currently find themselves in armed conflict situations.

The administration of anaesthesia in these situations is difficult, challenging and may be limited, in terms of drugs, equipment and facilities. This review highlights some of these potential difficulties, as well as the effects that working in a conflict zone may have on anaesthetists.

INTRODUCTION

Globally, anaesthetists play a key role within the emergency medical management of humanitarian disasters. This review will focus on anaesthetic safety in areas of conflict. Conflict, like natural disasters inevitably results in disruption of health systems, collapse of essential medical supply chains, breakdown of social and economic systems, an exodus of health care workers, and a concurrent increase in traumatic injuries, epidemics and starvation.[1] The World Health Organisation (WHO) estimates that 1.8 billion people live in conflict-affected areas worldwide.[2] Climate change has and will continue to result in significant natural disasters and with global temperatures increasing faster than predicted[3], the unsurprising scarcity of fresh water and the international push for green energy transition has predictably provided one of the many catalysts for the recent increase in armed conflict, which is likely to accelerate with the rise in global temperature.

This increase in conflict within the 21st century has posed new challenges to the humanitarian surgical response, including changing security requirements; access to patients and communities in need; limited deployable surgical assets; resource constraints; and the requirement to address both traumatic injuries as well as non-injury-related emergency surgical needs of the population.[3] Such conflicts can lead to mass casualty events that potentially overwhelm local medical resources and prevent them from delivering definitive medical care.[3,4]

HOW WAR SURGERY DIFFERS

War wounds differ in the extent of tissue destruction and contamination seen compared with most civilian trauma practice, confounded by the fact that timely patient presentation may be delayed. Working conditions during war are radically different from those in peacetime. Resources are limited and surgeons are often obliged to improvise or make compromises in their management decisions. Their aim should be to bring the best care possible to their patients under these circumstances, not the best care possible in ideal circumstances. War surgery is a surgery of mass casualties. The logic of war triage has little to do with the routine emergency department triage of a major civilian trauma centre. War surgery involves the staged surgical management of the wounded, often at different echelons of care and provided by different surgeons, especially in a military context. Even in a humanitarian context, such as International Committee of the Red Cross (ICRC), several surgeons deployed on short missions may participate in the treatment of a single patient.[4] Patterns of injury encountered are complex and may be foreign to many clinicians yet to work in such circumstances: blast; burn; chemical biological radiological and nuclear (CBRN); penetrating injury with high velocity projectiles of differing natures (MP, API, BALL, Depleted Uranium etc).[5]

PROGRESSION OF MEDICAL CARE IN WAR

From the bombing of Pearl Harbour, Hawaii, to the day Japan's emperor signed the surrender, more than 400,000 U.S. service members were killed during World War II.[6] About 70% of those were combat-related, and the rest were accidents or illnesses. More than 670,000 were wounded. Battlefield medicine improved throughout the course of the war. At the beginning, only plasma was available as a substitute for the loss of blood. By 1945, albumin had been developed, which is saline with serum albumin –

Dr Rudi Falovic
MG BHLTHSC MBBS
Anaesthetic Registrar
Department of Anaesthesia Perioperative and Pain Medicine
The Royal Melbourne Hospital

Dr Simon Hendel
MBBS (HONS) GD JOUR FANZCA AFRACMA GCHPOM
Deputy Director
Alfred Trauma Service

Clinical Lead
Trauma Anaesthesia, Department of Anaesthesiology and Perioperative Medicine
Alfred Health

Adjunct Senior Lecturer, Central Clinical School
Monash University

Research Fellow
National Trauma Research Institute

Anaesthetist
Australian Army

Dr Martin Graves
MBBS FANZCA
Anaesthetist
Australian Army

Consultant Anaesthetist
NSW Health

Guest Lecturer University College
Cork

Figure 1 – Dual-operating tables at a US Forward Surgical Team (FST) in Afghanistan c. 2010

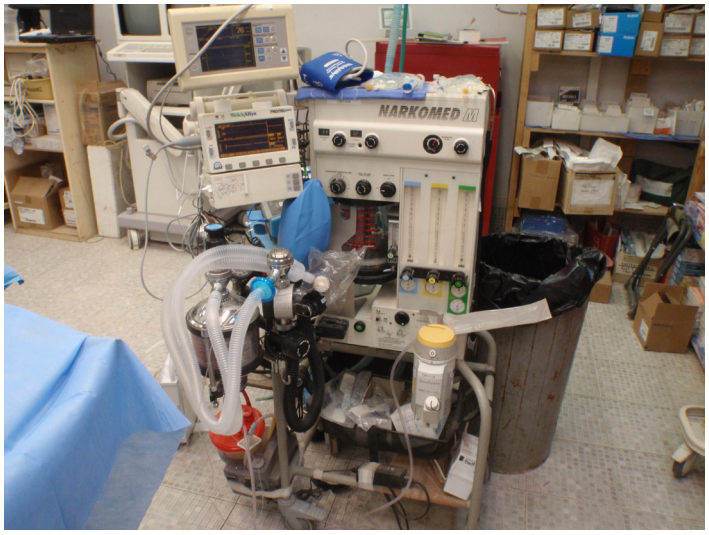

Figure 2 – Narkomed anaesthesia unit at a US FST facility in Afghanistan c. 2010

it was formulated in 4.5% and 25% solutions. Whole blood was also used.

Also, this was the first major war in which air evacuation of the wounded became available. During the war, surgery techniques such as removing dead tissue resulted in fewer amputations than at any time. To treat bacterial infections, penicillin or streptomycin were administered for the first time in large-scale combat. Because of improvements like these and others, the survival rate for the wounded and ill climbed to 50% during World War II from only 4% during World War I.[6] Battlefield medical advances continued after the war. By 2016, a service member wounded in Iraq or Afghanistan had about a 92% chance of making it home alive.[6]

CONTEMPORARY CONTEXT

Middle East:

The wars in Iraq and Afghanistan have helped to shape the modern Defence Medical Services. Many lessons were learnt including the need for rapid haemorrhage control, senior decision-making and the evolution of deployed transfusion support. These changes were implemented simultaneously with a coherent, end-to-end medical plan from point of wounding through to rehabilitation. A relatively new characteristic, further compromising healthcare delivery, is the lack of respect for the sanctity of healthcare structures and the staff working in them (with notable incidents in Kunduz in Afghanistan, Aleppo in Syria, and Saada in Yemen): if in previous armed conflicts the healthcare system was mainly affected due to the absence of human resources and difficult supply lines, nowadays it is more and more a target by itself, and suffers the destruction of facilities and killing of staff.[7]

Russia-Ukrainian War:

Humanitarian NGOs and foreign press alike have reported at least 226 direct and indirect attacks by Russian military on Ukrainian health facilities to date with the maternity hospital in Mariupol being most widely publicised amongst the international media.[8] This demonstrates a specific targeted approach towards health infrastructure, whilst also highlighting the inherent danger for medical professionals working in areas of conflict. No longer is the painted red cross on the rooftop of hospitals a stop sign like it once was but perhaps nowadays it more likely represents a bullseye.

Role of the anaesthetist:

Following disasters such as Haiti the WHO produced the Emergency Medical Team (EMT) Classification Process, which provides the minimum standards for such teams responding to humanitarian disasters.[4] This classification specifies the technical and logistical capabilities that each team must possess. Team classification is as follows: Level 1 – outpatient emergency care; Level 2 – inpatient surgical emergency care; and Level 3 – inpatient referral hospital with an ICU.[3] The majority of anaesthetists will be stationed at a Level 2 field hospital, which must be able to operate fully independently (i.e. structure often tented, generators and provision of its own water and food). And must be capable of providing emergency medical, surgical and obstetric care with an ability to stabilise critically ill patients for transfer to Level 3 facilities. Any Level 2 field hospital must have a medically qualified anaesthetist to avoid the shortfalls in perioperative and critical care management that have previously occurred prior to implementation of the WHO classification system.[4]

Off the floor or in the absence of a floor:

A significant challenge for anaesthetist is working in a range of clinical areas they may have limited or no experience in. Often there is at least one area of medicine that they do not encounter during daily clinical practice. As part of the EMT anaesthetists must be able to manage HDU/ICU care for patients with crush injury, burns, paediatrics and neonatal resuscitation in addition to more common presentations: Obstetric emergencies; perioperative care and pain medicine for trauma patients, including acute and chronic pain from neuropathic pain arising from nerve injuries. In many settings the anaesthetist may be the senior critical care specialist, providing emergency medical services including triage and resuscitation prior to operative intervention. The constraints on all aspects of care extend to those of triage. As surgical needs overwhelm the surgical

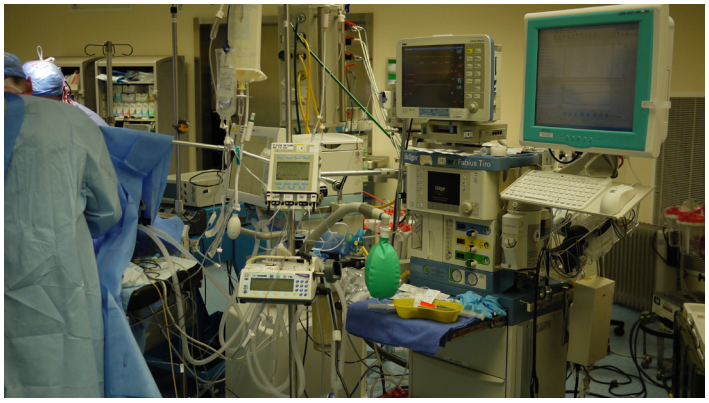

Figure 3 – Operating room with Drager anaesthesia machine at a Role 3 NATO medical facility in Afghanistan

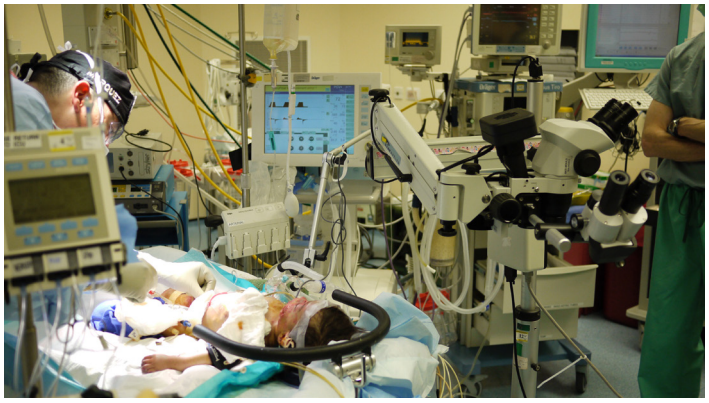

Figure 4 – Paediatric surgery in progress at a Role 3 NATO medical facility in Afghanistan

capacities, triage must be implemented. Triage in armed conflicts and disasters differs considerably from triage used in routine settings: with the main goal being to provide the best possible surgical care to the highest number of casualties, with limited resources. When working in this context it is important to accept there are limits inherent to surgical care, while always upholding the principles of medical ethics.[8] Anaesthetists must be prepared to take on a number of secondary tasks for which they have little or no experience, including but not limited to: pharmacy skills; infection control and sterilisation, and laboratory pathology and interpretation.

PROVISION OF SAFE ANAESTHESIA

Set Up:

Provision of safe anaesthesia presents unique challenges with logistical issues being as significant, if not more so than the clinical presentations. Set up for the conduct of anaesthesia and resuscitation for the operating theatre, emergency, delivery, and recovery rooms including the HDU all fall within the anaesthetists remit. At its core this may include constructing furniture and setting up/fashioning oxygen concentrators, suction devices, airway equipment and anaesthetic delivery systems. They may need to procure and stock anaesthetic consumables, pharmaceuticals, paperwork and protocols for antibiotic, venous thromboembolism prophylaxis and development of acute pain protocols. (BJA/WHO)

CONDUCT

General Anaesthesia

Inhalational Anaesthetic Agents

In the conflict setting there are considerable issues with access to compressed gases, including oxygen, such as the weight of cannisters and the inherent risk of carriage and storage of such gases in an area prone to the use of high and low explosive ordinance. Therefore, oxygen concentrators are preferred. However, these require electricity to function and deliver oxygen at just over one bar (not sufficient for Boyles type anaesthetic machines). Draw-over can be advantages in this context: this continues to work in the absence of electricity, economical oxygen consumption (1L/min-1 = FiO_2 of 0.3), it is not possible to give a hypoxic mixture so inspired O_2 monitor is less vital, and they are non-rebreathing circuits so agent monitoring is not essential.[9] Unfamiliarity with such equipment can be addressed with pre-deployment training.

I.V. Anaesthesia

Total intravenous anaesthesia (TIVA) has logistical and pharmacological benefits over inhalational anaesthetic agents in areas of conflict. Logistically, TIVA requires very little equipment to administer a general anaesthetic. Whether using a bolus technique or a continuous infusion through a pump, TIVA can be employed without the use of an anaesthetic machine.[10] Most anaesthetists from well-resourced health care systems are familiar with running TIVA on a daily basis. Several syringe infusion pumps available on the market are quick to set up, and simple to operate. Most run reliably on batteries for several hours and are easily packed into a backpack. Battlefield trauma patients often require multiple surgical interventions with intermittent intensive care stabilisation. With TIVA the battlefield trauma patients can be maintained on the same intravenous medications, although at decreased doses, throughout the intensive care unit period. Although the majority of resource wealthy clinicians administer propofol TIVA via a target-controlled infusion technique (TCI) or infusion protocols, propofol has many undesirable pharmaceutic and pharmacodynamic properties in these settings. Propofol anaesthetics require quite a large volume of propofol that must be transported to the conflict zone. Limitations on its safe exposure time due to the high lipid content and microbial proliferation may result in iatrogenic infections and waste in resource poor settings. Propofol causes respiratory depression and apnoea is common in contrast to ketamine. This becomes important when the electricity and therefore oxygen supply is unreliable. In addition, owing to the narrow therapeutic index between hypoventilation and apnoea this may pose unnecessary risk to the patient when teams are frequently working alongside local anaesthetic nurses and officers who have a lot of experience monitoring people receiving ketamine anaesthesia but not propofol and do not always have the skills to reliably recognise and manage airway obstruction, hypoventilation and apnoea. The same points apply to the recovery room. In contrast, ketamine comes in high strength ampoules one of which will be sufficient for several anaesthetics. Ketamine remains one of the preferred options for intravenous anaesthesia in undesirable situations[11-15]: it has analgesic effects that avoid the use of opioids

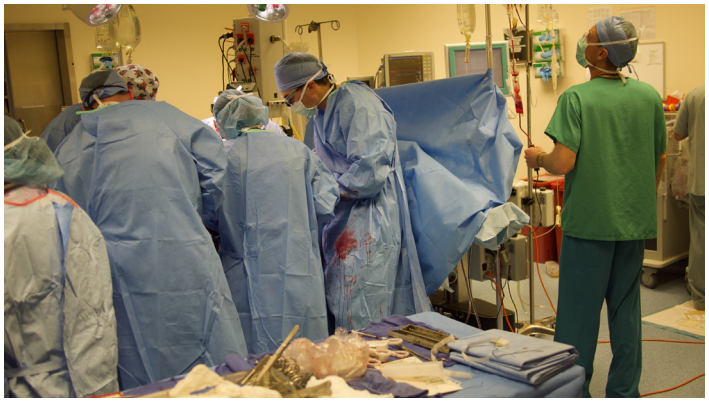

Figure 5 – NATO surgical team in action at a Role 3 medical facility in Afghanistan

during the surgical intervention; it can be used for almost all types of surgery; and as laryngeal reflexes are not totally suppressed, it allows performing some interventions without intubation (e.g. where anaesthesia providers are not highly skilled, TIVA with ketamine and without intubation is used for Caesarean sections). It should be acknowledged that the main concern in disasters and armed conflicts is haemorrhagic shock (from trauma, obstetric or visceral origin), and the effects of ketamine on the cardiovascular and respiratory systems can only be positive in this setting. Finally, ketamine also provides good postoperative analgesia whereas propofol does not. This is important as transport of opioids into conflict zones can be delayed because of customs restrictions. For all these reasons most experienced disaster response teams (such as MSF and the ICRC) rely heavily on ketamine anaesthesia.[11,15] During the MSF response to the Haiti earthquake 90% of general anaesthetics were carried out under ketamine with only 10% of patients receiving inhalational general anaesthesia.[7] Trauma patients often remain intubated following damage control surgery through the resuscitation and may be transferred to higher level care or remain in an ICU setting prior to return to the operating theatre. Continuous infusions of anaesthetic agents, analgesics and relaxants enables safe transfer of these patients with stability and comfort with minimal equipment. The advantages of TIVA over inhalational anaesthesia in the combat setting have been summarised by the "Four S's": simple, safe, scientific, and small logistical footprint. Importantly, most anaesthetists from high resource settings will not have had much experience with ketamine anaesthesia so pre-deployment training is required.

Regional Anaesthesia:

Consent: Given the likelihood of language barriers in areas of conflict it is important that a local speaker is present and reasonably prepared to explain the risks and side effects of regional techniques to avoid patient concern regarding the loss of sensation and function post regional and also equally important throughout the case to ensure the patient is not experiencing pain.

Spinal:

Spinal anaesthesia should be considered for any patient requiring surgery below the umbilicus, who is not shocked. If performed correctly, it is safe and effective and oxygen availability is not an absolute requirement. However appropriate resuscitation equipment and expertise must be available in the event of an adverse outcome.

Epidural:

In Afghanistan where significant numbers of bilateral amputations were seen in military trauma, the use of epidural analgesia allowed anaesthetists the ability to extubate trauma patients in country. This reduced the requirement for ventilation during transport to higher levels of care reducing the risk of pulmonary injury along with the added advantages of post op pain relief and potential benefits in psychological care and reduction of chronic pain.[16]

Regional blocks:

Regional anaesthesia is safe, effective and efficient, and doesn't require oxygen therapy. It is however underused in many settings despite its obvious utility in surgical management of limb trauma. Its increased use has been advocated by several reports and clinician experience,[17,18] access to appropriate needles and ultrasound are likely confounding factors in its scarcity at present. Surgeries may be performed under regional block alone, although the nature of the injuries covering more than one site often means that it needs to be combined with general anaesthesia. It is still very useful in this context however as it reduces the amount of general anaesthesia required with speedier, safer recovery, whilst also improving post operative analgesia.

Postoperative analgesia

Logistical supply chain and customs issues can result in restricted supplies of analgesic medications and inadequate patient monitoring as a result of overwhelming patient numbers in massive casualty events. Regional techniques as previously mentioned are underused, but their efficacy and safety are well established.[16,17,18] The WHO/ICRC recommends such techniques for management of limb injuries and most EMT deploy with ultrasounds. (BJA)

Pre-deployment:

Military anaesthetists have a long pre-deployment training pathway starting with their respective fellowship, and with an emphasis on military skills related to their specific role. Pre-deployment training includes additional skill training and team training. This pathway ensures ongoing and continuing competence on an individual basis, and assurance that team management systems and clinical staff can function effectively as a deploying unit.[19] Training and drills to incorporate CBRN threat should be addressed where a credible threat exists.

Deployment:

Safety of Anaesthesia providers:

Working in these environments is extremely risky not only for the patients but also for those who deploy in order to provide medical assistance. Such risks should be acknowledged and mitigated by deploying organisations. Most western militaries have robust processes to deal with this issue, including but not limited to: pre-deployment training, situational briefings, an understanding of the belligerents (aims, tactics, languages spoken, religious and ideological foundations) and non-combatants customs (those to abide by and those to avoid), security and safety of staff deploying in country and rigorous rehearsal prior to putting boots on the ground. Simple measures can enhance the ability of medical teams to function well whilst also avoiding unnecessary risks. Certain theatres will also

have specific endemic disease which deploying teams should be vaccinated against where possible, have appropriate pharmacological and non-pharmacological prophylaxis when required and the appropriate knowledge of how to manage such disease in the native population. Any clinician deploying should have a list of questions for their respective organisation: is there someone on the team with responsibility for safety and security; what are the identified risks for this context; what has been done to mitigate these risks; what is the plan if one of these risks occurs; and does the benefit of the team being deployed outweigh these risks? If your deploying organisation is unable to answer these questions then you should think carefully before deploying. Potential risks depending on the context include: infectious diseases, transportation accidents, natural disasters, robbery, kidnap, and violence against the team as collateral damage and intentional targeting of the team.

Returning Home:

The psychological impacts of working in such contexts can be significant and although experiences may vary, so do the responses to a specific event between clinicians. It is well documented amongst returning soldiers that there is often a stress reaction to returning to their pre-conflict existence. Many military organisations use a multipronged approach to address this inevitable phenomenon, including decompression time at an intermediary location away from the stress of deployment but not at the home location, psychological health programmes pre, intra and post deployments. The content of these programmes should include specific briefing for the deployment (expectations), education on how to minimise stress and maximise resilience on deployment and management of re-entry, post-deployment debriefing (immediate and delayed), recognition of abnormal stress reactions and routes for getting help.

CONCLUSION

Conflict results in significant logistical challenges for anaesthetists and EMTs alike. Geographical, social, cultural, and local health care infrastructure circumstances are unique to different theatres of war as are the prevailing injury patterns seen for a given conflict. Although the more things change, the more they stay the same and the recognition and immediate management of catastrophic haemorrhage and timely access to life saving surgery remains universal. Preparation for the different contexts that anaesthetists may be utilised in, is vital for an effective response. Well-established programmes such as the WHO EMT initiative and readily deployable Military forward surgical teams have improved the speed, coordination and quality of the international response to humanitarian crises. Clear standards of the logistics, capability of deploying teams and adequate preparation and accreditation enhance the performance of such teams. As anaesthetists have a key role in many aspects of the EMT response in areas of conflict, especially at Level 2 facilities, deploying anaesthetists should receive training for the wider scope of practice when responding to these challenging situations. Ongoing data collection and audit of these processes will help inform improvements in the international medical response to conflict, another role that the deploying anaesthetists will likely fulfil.

REFERENCES

1. Craven RM. Managing anaesthetic provision for global disasters. *Br J Anaesth*. 2017;**119**(suppl_1):i126-i34.
2. Organisation WH. Building peace in fragile and conflict settings through health 2023 [Available from: https://www.who.int/activities/building-peace-in-fragile-and-conflict-settings-through-health.
3. Chu E, Lubis N, Alcock R. Improving mass casualty planning in low resource settings: Médecins Sans Frontières and International Committee of the Red Cross perspective. *Br J Anaesth*. 2022;**128**(2):e92-e6.
4. Giannou CB, M. War Surgery - Working With Limited Resources In Armed Conflict And Other Situations Of Violence 2020. Available from: https://www.icrc.org/en/publication/4105-war-surgery-working-limited-resources-armed-conflict-and-other-situations-violence.
5. Giannou C, Baldan M, Molde Å. War Surgery: Working with limited resources in armed conflict and other situations of violence. Geneva, Switzerland: International Committee of the Red Cross; 2013. Available from: https://www.icrc.org/fr/doc/assets/files/publications/icrc-002-4105.pdf.
6. Vergun D. Medical Improvements Saved Many Lives During World War II 2020 [Available from: https://www.defense.gov/News/Feature-Stories/story/Article/2115192/medical-improvements-saved-many-lives-during-world-war-ii/.
7. Trelles Centurion M, Van Den Bergh R, Gray H. Anesthesia Provision in Disasters and Armed Conflicts. *Curr Anesthesiol Rep*. 2017;**7**(1):1-7.
8. Conflict SHI. Protecting Health Workers, Services and Infrastructure 2015 [Available from: https://www.safeguardinghealth.org/about-coalition.
9. Graves MW, Billings S. Draw-over Anesthesia Bringing the "Dark Art" Back Into the Light. *J Spec Oper Med*. 2018 Fall;**18**(3):125-133. doi: 10.55460/CBVV-A67P. PMID: 30222851.
10. Graves M. Total Intravenous Anesthesia in Disaster Medicine: Essentials of Disaster Anesthesia. June 2020; pp32-41. DOI:10.1017/97813161814454.005.
11. Mulvey J, Qadri A. Maqsood. Earthquake injuries and the use of ketamine for surgical procedures: the Kashmir experience. *Anaesth Intensive Care*. 2006;**34**:489–494.
12. Craven R. Ketamine. Anaesthesia. 2007;62(S1):48. doi: 10.1111/j.1365-2044.2007.05298.x.
13. Svenson J, Abernathy M. Ketamine for prehospital use: new look at an old drug. *Am J Emerg Med*. 2007;**25**:977–980. doi: 10.1016/j.ajem.2007.02.040.
14. Morris C, Perris A, Klein J, et al. Anaesthesia in haemodynamically compromised emergency patients: does ketamine represent the best choice of induction agent? *Anaesthesia*. 2009;**64**:532–539. doi: 10.1111/j.1365-2044.2008.05835.x.
15. Mercer S. The drug of war – a historical review of the use of Ketamine in military conflicts. *J R Nav Med Serv*. 2009; **95**(3): 145–150.
16. Beard DJ, Wood Paul. Pain in complex trauma: lessons from Afghanistan. *BJA Education*. 2015; **15**(4): 207-212. doi: https://doi.org/10.1093/bjaceaccp/mku035.
17. Buckenmaier C, Lee E, Shields C, et al. Regional anesthesia in austere environments. *Reg Anesth Pain Med*. 2003;**28**:321–327.
18. Stojadinovic A, Auton A, Peoples G, et al. Responding to challenges in modern combat casualty care: innovative use of advanced regional anesthesia. *Pain Med*. 2006;**7**(4):330–338. doi: 10.1111/j.1526-4637.2006.00171.x.
19. Wren SM, Wild HB, Gurney J, Amirtharajah M, Brown ZW, Bulger EM, et al. A Consensus Framework for the Humanitarian Surgical Response to Armed Conflict in 21st Century Warfare. *JAMA Surg*. 2020;**155**(2):114-21.

Update in
Anaesthesia

Review

Safety in Non-Operating Room Anaesthesia in Low-and Middle-Income Countries: Challenges and Opportunities

Carolina S. Romero, Vighnesh Ashok, Maria A. Echeto-Cerrato and Markus M. Luedi*
*Correspondence email: markus.luedi@extern.insel.ch

Abstract

Given the increase of minimally invasive procedures in many medical specialties, non-operating room anaesthesia (NORA) is a fast-growing field that presents both challenges and opportunities, particularly in low- and middle-income countries (LMICs). We aim to explore the technical, organisational, economic, and educational dimensions of NORA in LMICs, highlighting the unique hurdles faced and potential avenues for improvement. The challenges NORA faces in LMICs offer opportunities for innovation and improvement. By addressing equipment shortages, strengthening training programmes, optimising workflows, fostering interprofessional collaboration, and exploring funding mechanisms, LMICs can enhance NORA practices and improve patient outcomes.

Key words: low and middle income countries, non-operating room anaesthesia, staffing, education, health-care economics

Carolina S. Romero *MD, PHD, MSTAT*
Department of Anaesthesiology and Critical Care
Hospital General Universitario De Valencia
Valencia
SPAIN

Vighnesh Ashok *MD*
Department of Anaesthesia and Intensive Care
Post Graduate Institute of Medical Education and Research
Chandigarh
INDIA

Maria A. Echeto-Cerrato *MD*
Department of Anaesthesia
Hospital del Valle and Quirúrgica Integral
San Pedro Sula
HONDURAS

Markus M. Luedi *MD, MBA*
Department of Anaesthesiology and Pain Medicine
Inselspital
Bern University Hospital
University of Bern
Bern
SWITZERLAND

INTRODUCTION

Non-operating room anaesthesia (NORA) refers to the administration of anaesthesia outside traditional operating room settings.[1,2] According to some authors, about 25%[3] or 35,9%[4] of the procedures involving anaesthesia provider´s care are performed outside the operating room, and this number is likely to increase.[5] Although anaesthesiologists are located primarily in operating theatres or intensive care units, NORA is becoming progressively more popular, both because of the increase in the number of procedures and because of the improved patient comfort that is now being achieved in procedures that used to be performed without anaesthesia. Due to this fact, the American Society of Anaesthesiology has published a guidance document describing the minimal standards to administer anaesthesia in NORA locations.[6]

Anaesthesiologists, who are in a position of leadership in perioperative medicine, are responsible for providing patient care during all NORA procedures. Although anaesthesiology has been regarded as a less competitive speciality to get into, particularly in LMICs, it is primarily as a result of the work of the anaesthesiologist and technological advances that surgery is increasingly able to offer a wider range of services and that patient safety has improved exponentially.[7]

The NORA environment entails a completely different approach from the Operating Room Anaesthesia (ORA) location since mortality has been reported to be twice the mortality described in the ORA setting.[8] Also, NORA is associated with higher morbidity, a higher rate of claims attributable to inadequate oxygenation, and a higher proportion of side effects related to substandard care.[9]

Healthcare systems in low- and middle-income countries (LMICs) face a unique set of challenges in implementing and optimizing NORA practices due to resource constraints, infrastructure limitations, and socioeconomic factors.[10] Other huge challenges are the often lacking human resources to administer anaesthesia and/or inadequate education and training of the anaesthesia providers at hand.[11] However, these settings may also present opportunities for innovative solutions to improve patient care and healthcare delivery.[12,13]

The anaesthesiologist therefore has a global role and must ensure the same standards of the best medical treatment and maximum safety in any location where a technique or procedure is performed under anaesthesia. However, these proceedings represent a paradigm shift in view of the fact that they involve

a set of variables that need to be considered in addition to those included in the ORA setting. We aim to explore the challenges and opportunities associated with NORA in LMICs, focusing on the technical, organisational, economic and educational dimensions (Figure 1) to provide recommendations for enhancing anaesthesia care outside the operating room, ultimately contributing to improved healthcare outcomes for patients in LMICs.[14]

Technical challenges:

LMICs often face shortages of essential anaesthesia equipment and supplies, including monitoring devices, airway management tools, and drugs.[15,16] Limited availability and inadequate maintenance of equipment may hinder the safe administration of anaesthesia in NORA settings.[17] Innovative approaches, such as portable and low-cost equipment solutions, can address these challenges.[2,12]

The availability of basic requirements such as running water, constant electricity and an adequate supply of oxygen can be highly variable in LMICs.[18] In addition to infrastructural needs, basic monitoring, such as a pulse oximeter, is also necessary. A 2007 survey in Uganda found that 74% of anaesthesia was performed without a pulse oximeter[19] and that almost 35% of healthcare facilities have no access to oxygen.[20] Other Asian countries described a similar situation with lack of resources and trustworthy equipment to perform anaesthesia safely.[21]

NORA environments introduce additional complexity in patient assessment and selection.[22] The absence of sterile conditions, unpredictable patient acuity, and varying procedure types pose challenges for anaesthesia providers. Developing standardised protocols for patient assessment and selection, including risk stratification tools, can enhance patient safety and optimize outcomes.[1,10,23]

Certain anaesthetic techniques, such as regional anaesthesia and sedation, are well-suited for NORA.[24] However, skill gaps and limited training opportunities in these techniques may pose a significant challenge.[25] Strengthening training programmes, promoting knowledge exchange through partnerships, and utilizing simulation-based education can enhance anaesthesia providers' skills and increase the adoption of appropriate techniques.[24]

Figure 1– Critical dimensions to address safety in Non-Operating Room Anesthesia (NORA) in Low-and Middle-Income Countries (LMICs).

Organisational challenges:

Limited availability of suitable infrastructure and suboptimal facilities in LMICs can impede the provision of NORA.[26,27] Inadequate recovery areas, absence of appropriate monitoring systems, and lack of infection control measures are significant concerns.[10] Collaborative efforts involving policymakers, healthcare administrators, and anaesthesia societies are necessary to improve infrastructure and establish minimum standards for NORA settings.[22,26]

Collaboration among healthcare professionals, including anaesthesiologists, surgeons, nurses, and technicians, is crucial for the success of NORA.[1,2] However, poor interdisciplinary communication, hierarchical barriers, and limited teamwork hinder effective collaboration.[28] In addition, NORA environments often lack efficient workflow systems, leading to delays, overcrowding, and suboptimal resource utilization. Additionally, integrating NORA services within existing healthcare structures can facilitate better coordination and resource allocation.[29] These situations are critical in some LMIC where there is significant shortage of anaesthesiologists and the majority of NORA procedures are performed by nurses or by clinical assistants.[20] It is important to urgently address the need for supporting local residency and fellowship programmes in LMICs to promote the continuous growth of local and adequately trained anaesthesia workforce.

Economic challenges:

LMICs face financial limitations, making it challenging to invest in infrastructure development, equipment procurement, and staff training for NORA.[10] Exploring innovative funding mechanisms, such as public-private partnerships, international collaborations, and grants, can help overcome financial barriers and sustain NORA initiatives.[10,22,26] Therefore demonstrating the cost-effectiveness and value of NORA is essential to secure funding and support from policymakers and healthcare institutions. Conducting health economic evaluations, generating local evidence, and highlighting the long-term benefits of NORA, including reduced surgical complications and improved patient outcomes, can strengthen the case for investment.[22]

One of the biggest issues for LMICs is precisely not having adequate data collecting systems or effective incident notification protocols to properly create sufficient and adequate statistical information with enough economic impact. A very important international collaboration or grant would be sharing adequate data collecting platforms or donation of computer-based programmes that may help gather these important findings.

Last but not least, the exact cost of services provided during NORA has not been widely studied. While a cost of approximately $35 United States Dollars (USD) per minute of NORA has been mentioned, other groups have underpinned the cost to be as high as almost $300 USD.[30] Undoubtedly, the economic impact will be one of the limiting factors in whether or not the use of NORA will increase in LMICs.

Educational challenges:

General anaesthesia together with monitored anaesthetic care are the most frequently used techniques in the context of NORA. However, regional anaesthesia may also have a wide applicability in this setting.[31] Regional anaesthesia has clear benefits in the sense that the patient may not require any sedation thereby reducing airway risks.[32] However, regional anaesthesia requires well-trained anaesthesiologists and an organisational system that supports the longer pre-intervention times that are required for the performance of these techniques. This is particularly the case while using regional anaesthesia in children,[30,33] a situation that has not yet been extensively evaluated.

Technical skills require commitment to best practice and continuous objective assessment of the medical practice of all team members involved.[34] It has been found that the percentage of patient complaints was higher in NORA procedures than in conventional operating room procedures.[35] Adherence to clinical practice guidelines and the highest quality standards should be applied without exception, as the unique characteristics of NORA procedures can compromise patient safety, either immediately during the procedure, or in the short term after the intervention.

Free online educational courses, safety and quality workshops, short term anaesthesia training programmes, teacher-mentoring collaborations and anaesthesia residency programmes should be promoted, advertised, and strengthened worldwide.

NORA procedures tend to be shorter so that large numbers of patients with diverse co-morbidities and a variety of clinical presentations, can be treated during a working day. In LMICs, specially in public hospital settings, the number of daily procedures is usually quite large and to avoid cancellations many children and adults are left with long hours of fasting. Many patients travel from long and difficult to access communities, making same day preanesthetic evaluation an unavoidable practice, they are usually placed in distressing or crowded waiting rooms and are occasionally discharged late. Due to the enormous workload, several times, patients feel avoided, ignored or underinformed.

Cultural beliefs make them prone to herbal medications that may be of therapeutical concern, non-compliant to fasting instructions and uncomfortable with same day discharging.

Native languages may cause communication barriers and poor educational background bring about deficient comprehension of the clinical situation and NORA pre and post procedural instructions.

Economic factors make patients from LMICs prone to malnutrition and untreated or undiagnosed illness.

The integration of NORA assessment clinics at all community health centres may help detect several weeks prior to procedure, all possible health derangements that may cause patient discomfort or avoidable surgical-anaesthesia cancellations.

Shortages in qualified human resources:

In addition to the challenges described earlier, LMICs also face a critical shortage of manpower trained in providing safe and robust perioperative care. Limited numbers of physician anaesthesiologists, increased reliance on non-physician anaesthesia providers, and shortage of trained preoperative and postoperative nursing staff

have been described in the literature from LMICs.[36,37] With such constraints of trained human resources affecting capacity and patient flow in the operating theatres, the same is likely to hold true for operating sustainable NORA services in LMICs as well. Continued education and training opportunities for healthcare workers is largely non-existent. High rates of staff attrition due to migrations, redeployment of hospital staff and burnout syndrome are some of the many burdens anaesthesiologists in LMICs must endure.[38,39]

Hospital administrators and managers would need to first address these human resource issues to ensure that NORA services are provided in a manner that it safe and sustainable. Understanding the importance of addressing this issue as soon as possible is the basis of anaesthesia procedural quality and safety improvement and NORA successful implementation in LMICs.

Opportunities for improvement:

Advances in technology, such as portable monitoring devices, telemedicine, and mobile applications, offer opportunities to enhance NORA practices in LMICs.[10] Leveraging these technologies can improve patient monitoring, facilitate remote consultation, and enable real-time data collection for research and quality improvement initiatives.[40,41] Investing in anaesthesia training programmes, workshops, and simulation centres can enhance the skills and knowledge of anaesthesia providers.[1,10] Collaborative partnerships between high-income countries and LMICs, as well as regional knowledge-sharing networks, can contribute to capacity building and knowledge dissemination.[42] Other initiatives already on the agenda propose further research in relation to the discovery of new sedative and analgesic drugs that are safe and allow anaesthesia to be performed outside the operating theatre with fewer adverse events.[43]

Patient selection is another cornerstone of the NORA framework[30] combined with strong policy including guidelines, regulations, and quality assurance mechanisms, are vital for promoting and sustaining NORA practices.[22] Engaging policymakers and advocating for the integration of NORA in national surgical and anaesthesia plans can facilitate the development of supportive policies.[22,44]

CONCLUSION

Non-Operating Room Anaesthesia (NORA) in low- and middle-income countries presents numerous challenges in technical, organisational, workforce and economic dimensions. However, these challenges also offer opportunities for innovation and improvement. By addressing equipment shortages, strengthening training programmes, optimizing workflows, fostering interprofessional collaboration, and exploring funding mechanisms, healthcare systems in LMICs can enhance NORA practices and improve patient outcomes. Continued research, investment, and collaboration are necessary to overcome barriers and unlock the full potential of NORA in LMICs.

ACKNOWLEDGEMENT

The authors gratefully acknowledge Dr. Angela Enright, OC, MB, BCh, FRCPC from the University of British Columbia, Victoria, British Columbia, Canada for her very valuable inputs for the writing of this manuscript.

REFERENCES

1. Boggs SD, Luedi MM. Nonoperating room anaesthesia education: preparing our residents for the future. *Curr Opin Anaesthesiol*. 2019;**32**(4):490-7.
2. Reid C, Meineri M, Riva T, Pilgrim T, Räber L, Luedi MM. Anaesthesia for minimally invasive cardiac procedures in the catheterization lab. *Curr Opin Anaesthesiol.* 2021;**34**(4):437-42.
3. Goudra B, Alvarez A, Singh PM. Practical considerations in the development of a nonoperating room anaesthesia practice. *Curr Opin Anaesthesiol.* 2016;**29**(4):526-30.
4. Nagrebetsky A, Gabriel RA, Dutton RP, Urman RD. Growth of Nonoperating Room Anaesthesia Care in the United States: A Contemporary Trends Analysis. *Anesth Analg*. 2017;**124**(4):1261-7.
5. Boggs SD, Barnett SR, Urman RD. The future of nonoperating room anaesthesia in the 21st century: emphasis on quality and safety. *Curr Opin Anaesthesiol.* 2017;**30**(6):644-51.
6. (CSPP) ASoAACoSaPP. Statement on Nonoperating Room Anesthetizing Locations. https://wwwasahqorg/standards-and-guidelines/statement-on-nonoperating-room-anesthetizing-locations. 2018.
7. Roth R, Frost EA, Gevirtz C, Atcheson CL. The role of anaesthesiology in global health: A comprehensive guide: Springer; 2014.
8. Girshin M, Shapiro V, Rhee A, Ginsberg S, Inchiosa MA, Jr. Increased risk of general anaesthesia for high-risk patients undergoing magnetic resonance imaging. *J Comput Assist Tomogr*. 2009;**33**(2):312-5.
9. Herman AD, Jaruzel CB, Lawton S, Tobin CD, Reves JG, Catchpole KR, et al. Morbidity, mortality, and systems safety in non-operating room anaesthesia: a narrative review. *Br J Anaesth*. 2021;**127**(5):729-44.
10. Luedi MM, Enright A. Instructions for a Highly Relevant Tool in Line With the United Nations Goals for Sustainable Development. *Anesth Analg.* 2021;**133**(5):1129-31.
11. Morriss WW, Milenovic MS, Evans FM. Education: The Heart of the Matter. *Anesth Analg*. 2018;**126**(4):1298-304.
12. Luedi MM. Leadership in 2022: A perspective. *Best Pract Res Clin Anaesthesiol.* 2022;**36**(2):229-35.
13. Mihalj M, Corona A, Andereggen L, Urman RD, Luedi MM, Bello C. Managing bottlenecks in the perioperative setting: Optimizing patient care and reducing costs. *Best Pract Res Clin Anaesthesiol.* 2022;**36**(2):299-310.
14. Beilstein CM, Lehmann LE, Braun M, Urman RD, Luedi MM, Stüber F. Leadership in a time of crisis: Lessons learned from a pandemic. *Best Pract Res Clin Anaesthesiol.* 2021;**35**(3):405-14.
15. Zha Y, Truché P, Izquierdo E, Zimmerman K, de Izquierdo S, Lipnick MS, et al. Assessment of Anaesthesia Capacity in Public Surgical Hospitals in Guatemala. *Anesth Analg*. 2021;**132**(2):536-44.
16. Gajewski J, Pittalis C, Lavy C, Borgstein E, Bijlmakers L, Mwapasa G, et al. Anaesthesia Capacity of District-Level Hospitals in Malawi, Tanzania, and Zambia: A Mixed-Methods Study. *Anesth Analg*. 2020;**130**(4):845-53.
17. Livingston P, Evans F, Nsereko E, Nyirigira G, Ruhato P, Sargeant J, et al. Safer obstetric anaesthesia through education and mentorship: a model for knowledge translation in Rwanda. *Can J Anaesth*. 2014;**61**(11):1028-39.
18. Hsia RY, Mbembati NA, Macfarlane S, Kruk ME. Access to emergency and surgical care in sub-Saharan Africa: the infrastructure gap. *Health Policy Plan*. 2012;**27**(3):234-44.
19. Adams CE, Dobson M. Anaesthetic equipment in low and low-middle income countries. *Anaesthesia & Intensive Care Medicine*. 2019;**20**(9):518-21.
20. Vo D, Cherian MN, Bianchi S, Noël L, Lundeg G, Taqdeer A, et al. Anaesthesia capacity in 22 low and middle income countries. *J Anesth Clin Res.* 2012;**3**(4):207.
21. Shahbaz S, Howard N. Anaesthesia delivery systems in low and lower-middle-income Asian countries: a scoping review of capacity and effectiveness. medRxiv. 2023:2023.05. 03.23289468.
22. Henry JA, Reyes AM, Ameh E, Yip CH, Nthumba P, Mehes M, et al. International consensus recommendations for the optimal prioritisation and distribution of surgical services in low-income and middle-income countries: a modified Delphi process. *BMJ* Open. 2023;**13**(1):e062687.

23. Bello C, Urman RD, Andereggen L, Doll D, Luedi MM. Operational and strategic decision making in the perioperative setting: Meeting budgetary challenges and quality of care goals. *Best Pract Res Clin Anaesthesiol*. 2022;**36**(2):265-73.
24. Dohlman LE, Kwikiriza A, Ehie O. Benefits and Barriers to Increasing Regional Anaesthesia in Resource-Limited Settings. *Local Reg Anesth*. 2020;**13**:147-58.
25. Tabiri S, Russell KW, Gyamfi FE, Jalali A, Price RR, Katz MG. Local anaesthesia underutilized for inguinal hernia repair in northern Ghana. PLoS One. 2018;13(11):e0206465.
26. Qin RX, Velin L, Yates EF, El Omrani O, McLeod E, Tudravu J, et al. Building sustainable and resilient surgical systems: A narrative review of opportunities to integrate climate change into national surgical planning in the Western Pacific region. *Lancet Reg Health West Pac*. 2022;**22**:100407.
27. Meadows JW, Al Imran TMT, LeBrun DG, Mannan MI, Sharraf S, Gaznavee ZZ, et al. Anaesthesia Infrastructure and Resources in Bangladesh. *Anesth Analg*. 2020;**130**(1):233-9.
28. Bello C, Filipovic MG, Andereggen L, Heidegger T, Urman RD, Luedi MM. Building a well-balanced culture in the perioperative setting. *Best Pract Res Clin Anaesthesiol*. 2022;**36**(2):247-56.
29. Tsai MH, Hall MA, Cardinal MS, Breidenstein MW, Abajian MJ, Zubarik RS. Changing Anaesthesia Block Allocations Improves Endoscopy Suite Efficiency. *J Med Syst*. 2019;**44**(1):1.
30. Wong T, Georgiadis PL, Urman RD, Tsai MH. Non-Operating Room Anaesthesia: Patient Selection and Special Considerations. *Local Reg Anesth*. 2020;**13**:1-9.
31. Faddoul A, Bonnet F. Is there a place for regional anaesthesia in nonoperating room anaesthesia? *Curr Opin Anaesthesiol*. 2020;**33**(4):561-5.
32. Yeh T, Beutler SS, Urman RD. What we can learn from nonoperating room anaesthesia registries: analysis of clinical outcomes and closed claims data. *Curr Opin Anaesthesiol.* 2020;**33**(4):527-32.
33. Shih G, Bailey PD, Jr. Nonoperating room anaesthesia for children. *Curr Opin Anaesthesiol*. 2020;**33**(4):584-8.
34. Andereggen L, Andereggen S, Bello C, Urman RD, Luedi MM. Technical skills in the operating room: Implications for perioperative leadership and patient outcomes. *Best Pract Res Clin Anaesthesiol*. 2022;**36**(2):237-45.
35. Woodward ZG, Urman RD, Domino KB. Safety of Non-Operating Room Anaesthesia: A Closed Claims Update. *Anesthesiol Clin*. 2017;**35**(4):569-81.
36. Puri S, Bandyopadhyay A, Ashok V. Improving Anaesthesia Capacity for Ambulatory Surgery in Low- and Middle-Income Countries: Current Scenario and Future Prospects. *Anesth Analg*. 2021;**133**(6):1451-5.
37. Steffner KR, McQueen KA, Gelb AW. Patient safety challenges in low-income and middle-income countries. *Curr Opin Anaesthesiol*. 2014;**27**(6):623-9.
38. Kudsk-Iversen S, Shamambo N, Bould MD. Strengthening the Anaesthesia Workforce in Low- and Middle-Income Countries. *Anesth Analg.* 2018;**126**(4):1291-7.
39. Milenovic MS, Matejic BR, Simic DM, Luedi MM. Burnout in Anaesthesiology Providers: Shedding Light on a Global Problem. *Anesth Analg*. 2020;**130**(2):307-9.
40. Wahezi SE, Kohan LR, Spektor B, Brancolini S, Emerick T, Fronterhouse JM, et al. Telemedicine and current clinical practice trends in the COVID-19 pandemic. *Best Pract Res Clin Anaesthesiol*. 2021;**35**(3):307-19.
41. Enright A. A friend in need: evaluating the impact of Lifebox in Burkina Faso. ***Can J Anaesth***. 2019;**66**(2):139-42.
42. Bacon DR, Enright A. International Connections: The Surprising Outreach of Anaesthesia & Analgesia and the International Anaesthesia Research Society Over the Past 100 Years. *Anesth Analg*. 2022;**135**(2S Suppl 1):S80-s5.
43. Khorsand S, Karamchandani K, Joshi GP. Sedation-analgesia techniques for nonoperating room anaesthesia: an update. *Curr Opin Anaesthesiol.* 2022;**35**(4):450-6.
44. Enright A. The role of the World Federation of Societies of Anaesthesiologists in global anaesthesia. *Int Anesthesiol Clin*. 2010;**48**(2):1-7.

Update in
Anaesthesia

Safety Priorities in the Post-Anaesthesia Care Unit

S. Bala Bhaskar*, Pradeep A Dongare and Zulfiqar Ali
*Correspondence email: sbalabhaskar@gmail.com

Abstract

The Lancet Commission on Global Surgery has identified peri-operative mortality rate as an important quality indicator of access and safety of surgery. Large-scale studies focusing on the availability of post-anaesthesia care units in low and middle-income countries are not available. This article deals with the safety concerns related to the design, staffing patterns, medication error prevention, mandatory equipment and monitoring in the post-anaesthesia care unit and safety concerns related to the patient transfers.

INTRODUCTION

The Lancet Commission on Global Surgery has identified peri-operative mortality rate (POMR) as an important quality indicator of access and safety of surgery.[1] Many studies regarding POMR have been conducted in high-income countries, but data from low-income and middle-income countries is sparse. In a meta-analysis conducted by Bainbridge et al,[2] there was a significant difference in the adjusted mortality rates between the high-income and low-income countries with respect to anaesthesia-related mortality and anaesthetic contributory mortality. Most of these studies continue to impress on the aspect of the scarcity of published data in low and middle-income countries (LMICs). Another meta-analysis highlighted the differences with respect to different surgeries in low and middle-income groups.[3] Large-scale studies focusing on the availability of post-anaesthesia care unit (PACU) facilities in LMICs are not available. One study in Pakistan found that PACUs were not available in 31.1% of the public healthcare facilities at a district level.[4] In a similar survey in Ethiopia, 84% of the hospitals had a PACU, but the availability of monitoring equipment in the PACUs was significantly limited.[5] The presence and adherence to postoperative care protocols was inadequate. In Togo, the anaesthesia-related mortality rate decreased from 25.7 per 1000 in 2002 to 8.9 per 1000 in 2006 with improved numbers of physician providers, the opening of preoperative clinics, the establishment of PACUs and the initiation of locoregional anaesthesia.[6]

For the purposes of this article, a PACU is defined as a unit, located as close to operating theatres as possible in order to avoid unnecessary time loss for the transfer of unstable patients, staffed and equipped for serving for treatment and care of patients during their immediate post-anaesthesia or post-surgery period, regardless of the type of interventions, before they are scheduled to be transferred to general wards, other units of the hospital or discharged home.[7] According to Vimlati et al,[7] the focus of a PACU is to provide:

- Immediate post-operative treatment
- Management of acute pain
- Decision on further care, whether it has to happen in the ward, Intensive care unit (ICU)/ High Dependency Unit (HDU)
- In special situations, pre-operative optimisation of severely ill

The most common events that occur in the PACU are included in Table 1.[8-10] A closed claims analysis found that in 39% of the cases, nurses were primarily responsible for taking care of the patients in the PACU when these events occurred. The top three risk management issues were related to clinical judgement, administration and communication. The other primary responsible parties at the time of events were anaesthesiologists, radiologists, obstetricians and general surgeons. The other issues identified were related to documentation, technical skill, equipment issues and non-compliance from patients.[11] Other researchers have highlighted additional considerations such as identification and visualisation of the patients, alarm fatigue, postoperative analgesia, delirium and staffing as safety issues in the PACU.[11]

S. Bala Bhaskar
Professor of Anaesthesiology
Department of Anaesthesiology and Critical Care
Vijayanagar Institute of Medical Sciences
Ballari
Karnataka
INDIA

Pradeep A Dongare
Department of Anaesthesiology
ESIC Medical College & PGIMSR
Kalaburagi
INDIA

Zulfiqar Ali
Sher-i-Kashmir Institute of Medical Sciences
Srinagar
INDIA

Table I – Common Adverse Events that Occur in the PACU

System Involved	Events
Respiratory System	Bradypnoea Tachypnoea Apnoea Desaturation Airway obstruction Pneumothorax
Cardiovascular System	Bradycardia Tachycardia Cardiac Arrest Hypotension Hypertension Pulmonary oedema
Renal	Oliguria Urinary retention
Central Nervous System	Agitation Confusion Sedation as per the Ramsey Sedation Scale >1
Others	Haemorrhage Pain Death Inadequate reversal of neuromuscular blockade Hypothermia Prolonged stay Postoperative Nausea and / Vomiting Surgical Emphysema

Patient Safety and Design of the PACU

The PACU should be a central facility with ease of access from all the operation theatres. There should be separate access for the transfer of patients to the ward. The operation theatre to the PACU bed ratio should be 1:2 when possible but acknowledging that this is dependent on the type of patients and procedures that they have undergone. It is also advised that these areas should be close to the operating rooms and provide for 12-15m² space for each bed. The number of beds should also depend on the type and duration of the procedure performed.[7,13] The design of the PACU should allow for the visualisation of all the patients throughout their stay from the nursing station. Hence, it is better to have an open room set up. If the design does not allow for visualisation, additional nurses may be required.

Staffing Pattern in the PACU

Guidelines recommend that at least 2 nursing staff are available in the PACU if a patient is admitted. The Association of Anaesthetists of Great Britain and Ireland suggests that only PACU-trained and certified staff are included in the PACU team. These staff should also be trained in advanced life support and, if applicable, paediatric advanced life support.[13] European guidelines suggest that nursing staff trained in resuscitation may serve the purpose.[7] The European guidelines further advise that if the prevailing practice encompasses reversal and tracheal extubation of patients in the PACU, then the presence of an anaesthesiologist should be mandatory. This is an additional requirement to the numbers required to run the operating theatres. If such practice is not possible, then appropriately trained nurses are acceptable to staff the PACU in the absence of critically ill patients.[7] The staffing pattern and workload is also influenced by the type of surgery, the duration of stay and the patient's condition.[11] According to The American Society of PeriAnesthesia Nurses (ASPAN), supervising, experienced nurse should be present to assist in dealing with unexpected complications that may occur after surgery.[12]

Patient Safety During Transfer

Transfer of anaesthetised and recovering patients usually takes place from the operating rooms to the PACU and from the PACU to the wards after complete recovery. The common adverse events during transfer are traumatic injury, pulmonary aspiration of gastric contents, hypoxia, hypothermia and disconnections of the airway, lines and drains. To minimise these, guidelines suggest the usage of properly designed transfer trolleys (provision for head-down tilt and side rails) with the capacity to carry oxygen cylinders, monitoring devices, infusion pumps, fluid infusions and a means to assist ventilation. The patient should be accompanied by a qualified anaesthesiologist

1	Completion of urgent tasks before verbal handoff	
2	Who is in charge of the patient?	
3	Are you ready for report?	
4	General clinical condition:	Stable–unstable
5	Patient	Name and check ID band Allergy Relevant medical history Type of surgery Type of anaesthesia ASA score
6	Procedure	Position Airway management Vascular access Fluid management Intraoperative events or concerns
7	Medications	Analgesia PONV Neuromuscular block Done To do
8	Other	Laboratory results Postoperative concerns
9	Do you have any questions?	
10	Closing the loop by the receiver	

Figure 1 – The PATH checklist for handover. Borrowed from: Jaulin F et al.[14]

or other appropriately trained anaesthesia provider during transfer. Patients should be haemodynamically stable, receive supplemental oxygen and all lines should be flushed to remove anaesthetics and vasoactive medications.[7,13]

A separate, important safety concern is an effective handover of these patients on transfer from the operating rooms to the PACU. Some authors have suggested the Post Anaesthesia Team Handover (PATH) checklist (Figure 1).[14] The use of a checklist such as PATH assists with facilitating effective communication. The complete handover should take place between the anaesthesiologist in charge of the case and the staff supporting the PACU. The handover should provide details of the intraoperative care, the postoperative care required, fluids, blood loss and drugs administered. The staff posted in the PACU should complete the loop by reciting their understanding of this information.[7,13]

In the PATH protocol, there are 10 steps. Proper introduction and completion of the loop by the person receiving the patient is important. Transfer of patients from the PACU to the ward or discharge home is usually done by using the checklists. These checklists should include assessing vital parameters as relevant such as pulse rate, BP, arterial oxygen saturation, train-of-four ratio and end tidal carbon dioxide if the patient is being ventilated. The checklist should also include instructions for supplemental oxygen, fluid replacement, analgesics, anti-emetics, monitoring, physiotherapy and other relevant instructions. A detailed handover using the PATH protocol or similar process is also important when transferring patients from the PACU to postoperative nursing wards.[14]

Medication Errors in the PACU and their Prevention

Medication errors may occur frequently in PACUs and may result in harm to patients and increased costs.[15] Medication errors in PACUs may be due to active failures committed by people who are in direct contact with the patient or latent conditions due to reasons within the system when individuals make decisions that have unintended consequences. Common harmful errors may be in prescribing, transcribing, dispensing, administering, and monitoring which may result in increased morbidity and mortality.[16] Jenson and colleagues[17] have published evidence-based recommendations to minimize errors in drug administration during the perioperative period based on a multi-pronged, 12-point strategy (Table 2).

MANDATORY MONITORING IN THE PACU

Once patients arrive at the PACU, they should be accompanied by a member of the primary team who has knowledge about the preoperative condition, anaesthetic course and surgical details and any intraoperative complications. A detailed handover of patients' present clinical status should be verbally given to the responsible PACU staff and be appropriately documented. Examples of important parameters to assess upon arrival in the PACU setting include level of consciousness, heart rate (HR), electrocardiogram (ECG), blood pressure (BP), airway patency, respiratory rate (RR), oxygen saturation (SpO_2), and temperature, along with the presence of pain, nausea, or vomiting.[18] If patients have received neuromuscular blockers and are planned for tracheal extubation, neuromuscular function should be assessed by physical examination and the use of a peripheral nerve stimulator. Meticulous monitoring

Table II – Recommendations to prevent Medication errors

Recommendation	
(1) The label on any drug ampoule or syringe should be carefully read before a drug is drawn up or injected.	Strongly recommended
(2) Legibility and contents of labels on ampoules and syringes should be optimised according to agreed standards in respect of some or all of font, size, colour and the information included	Strongly recommended
(3) Syringes should be labelled (always or almost always)	Strongly recommended
4) Formal organisation of drug drawers and workspace should be used with attention to: tidiness; position of ampoules and syringes; separation of similar or dangerous drugs; removal of dangerous drugs from the operating theatres	Strongly recommended
5) Labels should be checked specifically with a second person or a device (such as a bar code reader linked to a computer) before a drug is drawn up or administered	Recommended
(6) Errors in intravenous drug administration should be reported and reviewed	Recommended
(7) Management of inventory should focus on minimising the risk of drug error (e.g., a drug safety officer and/or a pharmacist should be appointed for the operating theatres and any changes in presentation should be notified ahead of time)	Recommended
(8) Similar packaging and presentation of drugs contribute to error and should be avoided where possible	Recommended
(9) Drugs should be presented in prefilled syringes (where possible) rather than ampoules (either for emergency drugs or in general)	Possibly recommended
10) Drugs should be drawn up and labelled by the anaesthetist who will administer them	Possibly recommended
(11) Colour coding by class of drug according to an agreed national or international standard should be used – of the syringe, part of the syringe, or of the syringe or ampoule labels	Possibly recommended
(12) Coding by syringe position or size or by the needle on the syringe should be used	Unclear

of fluid administration and urine output, bleeding, and wound drainage should be performed. In patients who have received spinal or epidural anaesthesia, clinical assessment of the return of motor and sensory function should be regularly documented during the PACU stay.

The use of pulse oximetry, non-invasive blood pressure monitoring, heart rate and capnography has been found to reduce cardiovascular, respiratory and neurological complications and should be used for all patients who have received general, neuraxial or regional blocks. Although no practice guidelines exist regarding the frequency at which vital sign monitoring should be done in the PACU, as a matter of practice, vital signs usually should be obtained every five minutes in the first 15 minutes; then after every 15 minutes, in the immediate recovery period(phase I PACU).The heart rate and blood pressure should be maintained within 20% of the patient's baseline values. The respiratory rate and the oxygen saturation should be approximating the patient's baseline levels. In the phase II PACU period (discharge after day-care surgery), the vital signs should be obtained at least every 30 to 60 minutes.[18]

EQUIPMENT TO BE MAINTAINED IN PACU

In order to ensure the safety of the patient in the PACU, adequate drugs and equipment should be available in the PACU. The list of mandatory equipment to be maintained is shown in Table 3.

SPECIAL CONSIDERATIONS

Critically ill patients

Most critically ill patients should be shifted to the intensive care unit and this is usually decided electively. If these patients are being transiently managed in the PACU, the responsibility of monitoring and managing any events often lies with the ICU team, although local staffing models may vary.[8]

Regional anaesthesia

The management of patients who have received regional anaesthesia does not differ much from those who have undergone general anaesthesia in the PACU. The information to be provided during the handover is, however, different. The site of injection, the drug used (concentration and dosage), the approximate duration and management of further pain, relief and the position in which the patient should rest are the important considerations that need to be conveyed.[8] Patients who have received nerve blocks may need to be shifted with support or slings. For those who have received central blocks, the maximum level of sensory and motor blockade achieved, regression times, cardiovascular status, presence, or absence of a urinary catheter and the postoperative pain relief may be the special considerations. If an epidural has been secured, marking and fixing the epidural and continuous infusion equipment may be the most important part of this exercise.

Children

In general, a recovery area for children that is separate from adult patients and with 1:1 staffing is most acceptable. Appropriate paediatric equipment should be available. Bradycardia, nausea and vomiting, and emergence confusion are common in children.[8] In the postoperative period, special attention should be paid to analgesia assessment and management. The presence of a parent or guardian may be permitted depending on the safety aspects of caring for children and considering the socio-cultural aspects of the community.

Documentation in the PACU

Documentation of observations in the PACU should be done at least every 15 minutes by the trained nurse.[8] Prescribed timelines and any tests ordered should be documented.

Table III – Equipment to be maintained in PACU

Standard equipment	Emergency equipment
Multichannel monitor with a Pulse oximeter, electrocardiogram, blood pressure monitor with an automatic blood pressure cuff and a temperature monitor.	Airway = oral/nasal airways
Oxygen ports	Breathing = oxygen cannulae/ Simple face mask./non re-breather face mask (mask with oxygen reservoir bag and one-way valves which aims to prevent/reduce room air entrainment) Endotracheal tubes, Laryngeal mask airways (LMAs) Laryngoscopes
Suction ports	Circulation = intravenous catheters and intravenous fluids
Transducers for monitoring arterial, central, and pulmonary artery pressures	Drugs = emergency cart containing all life support equipment
Forced air warming device	
Other Prerequisites	
Provision for uninterrupted power supply for the PACU (Compatible with the equipment)	

Regular audits

Regular audits should be conducted for quality checks and to examine whether the team is adhering to local and national standards.[8]

SUMMARY

Perioperative mortality rate is an important quality indicator of access and safety of surgery. Low- and Middle-Income Countries often have limited resources with respect to postoperative care of patients. The PACU/ recovery area for anaesthetised patients should be designed for ease of access to the operating rooms and for ease of visualisation of all patients during their stay by the nursing staff. It is imperative to maintain a proper bed to nursing staff ratio. Following the PATH protocol for handover aids in effective care of the patient. Safety of the patients is ensured by following the mandatory monitoring standards within the PACU. Documentation, regular audits and keeping in mind the necessities of patients with special needs (paediatric, critically ill, and those who have received regional anaesthesia) helps in reducing the morbidity and mortality in the PACU.

REFERENCES

1. Meara JG, Leather AJM, Hagander L, Alkire BC, Alonso N, Ameh EA, et al. Global Surgery 2030: Evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;**386**(9993):569–624.
2. Bainbridge D, Martin J, Arango M, Cheng D. Perioperative and anaesthetic-related mortality in developed and developing countries: A systematic review and meta-analysis. *Lancet*.2012;**380** (9847):1075–81
3. Uribe-Leitz T, Jaramillo J, Maurer L, Fu R, Esquivel MM, Gawande AA, et al. Variability in mortality following caesarean delivery, appendectomy, and groin hernia repair in low-income and middle-income countries: A systematic review and analysis of published data. *Lancet Glob Hea***l**. 2016;**4**:e165–74
4. Shahbaz S, Zakar R, Fischer F. Anesthesia Health System Capacities in Public Hospitals of Punjab, Pakistan. Inq (United States). 2021;58:1–8.
5. Kifle F, Belihu KD, Beljege BZ, Dhufera HT, Keno FB, Taye DB, et al. Perioperative care capacity in East Africa: results of an Ethiopian national cross-sectional survey. *Int J Surg Glob Heal*. 2021;**4**:e57–e57.
6. Blaise Pascal FN, Malisawa A, Barratt-Due A, Namboya F, Pollach G. General anaesthesia related mortality in a limited resource settings region: a retrospective study in two teaching hospitals of Butembo. *BMC Anesthesiol*. 2021;**21**:1–13.
7. Vimlati L, Gilsanz F, Goldik Z. Quality and safety guidelines of postanaesthetic care. *Eur J Anaesthesiol*. 2009;**26**:715–21.
8. Membership of the Working Party: Whitaker Chair DK, Booth H, Clyburn P, Harrop-Griffiths W, Hosie H, Kilvington B, Macmahon M, Smedley P, Verma R; Association of Anaesthetists of Great Britain and Ireland. Immediate post-anaesthesia recovery 2013: Association of Anaesthetists of Great Britain and Ireland. Anaesthesia. 2013;68(3):288-97. doi: 10.1111/anae.12146. Erratum in: *Anaesthesia*. 2019 Nov;**74**(11):1471.
9. M Salman J, N Asfarn S. Recovery Room Incidents. *Basrah J Surg*. 2007;**13**(1):1–5.
10. Seglenieks R, Painter TW, Ludbrook GL. Predicting patients at risk of early postoperative adverse. *Anaesth Intensive Care*. 2014;**42**(5):649–56
11. Ross J, Ranum D. Improving patient safety by understanding past experiences in day surgery and PACU. *J Perianesth Nurs*. 2009;;**24**(3):144-51
12. Luckowski A. Safety priorities in the PACU. ***Nursing*** (Lond). 2019;**49**(4):62–5.
13. Whitaker DK, Booth H, Clyburn P, Harrop-Griffiths W, Hosie H, Kilvington B, et al. Immediate post-anaesthesia recovery 2013: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*. 2013;**68**:288–97
14. Jaulin F, Lopes T, Martin F. Standardised handover process with checklist improves quality and safety of care in the postanaesthesia care unit: the Postanaesthesia Team Handover trial. *Br J Anaesth*. 2021;**127**:962–70.
15. Kothari D, Gupta S, Sharma C, Kothari S. Medication error in anaesthesia and critical care: A cause for concern. *Indian J Anaesth*. 2010;**54**(3):187-92
16. Hicks RW, Becker SC, Windle PE, Krenzischek DA. Medication errors in the PACU. *J Perianesth Nurs*. 2007;**22**(6):413-9
17. Jenson LS, Merry AF, Webster CS, Weller J, Larson L. Evidence based strategies for preventing drug administration errors during anaesthesia. *Anaesthesia*. 2004;**59**:493–504
18. Apfelbaum JL, Silverstein JH, Chung FF, et al. Practice guidelines for post anesthetic care: an updated report by the American Society of Anesthesiologists Task Force on Post anesthetic Care. *Anesthesiology* 2013; **118**:291

Review

Update in
Anaesthesia

Anaesthesiologists and the environment

Felipe Favero[1], Airton Bagatini[1,2]
*Correspondence email: baga2010@gmail.com

Abstract

Due to the environmental impact of human activities, the need for sustainable development has become apparent. Increasing consumption of the planet's natural resources, population growth, and waste have resulted in a serious environmental crisis, mainly represented by pollution and global warming. In light of this, many anaesthesiologists have reduced the use of inhalational anaesthetics, which include greenhouse gases. However, focusing only on anaesthetic gas emissions excludes other damaging factors. Sustainable anaesthesiology encompasses all aspects of patient care and ways to provide it with safety, quality, and environmental awareness. The objectives of this article were to understand the concept of environmental sustainability, to describe the environmental impact of medical care, to adopt strategies for sustainable anaesthesia in daily practice, and to raise public awareness about sustainability.

Key words: Anaesthesiology; environment impact; greenhouse gases; green anaesthesia; climate change.

INTRODUCTION

In 2015, the United Nations defined 17 sustainable development goals to end poverty, protect the environment, and ensure that all people can enjoy prosperity. These goals also seek to reduce social inequality and expand access to basic rights and services.[1] This document highlights the importance of an effort between people, governments, and corporations to achieve sustainable development. Environmental sustainability is an attempt to preserve the environment and use natural resources in a balanced way to guarantee their existence for future generations.[2-4]

Airton Bagatini[1,2]
Hospital Ernesto Dornelles
Avenida Ipiranga
1801
90160-092
Porto Alegre
RS
BRAZIL

Felipe Favero[1]
Teaching and Training
Centre of Sociedade de
Anaestesiologia (SANE)
Hospital Ernesto Dornelles
Porto Alegre
RS
BRAZIL

The intense use of natural resources, associated with population growth and waste, has resulted in a serious environmental crisis, represented mainly by pollution and global warming.[5-7] Since our current and future well-being depends on these measures, decreasing the environmental impact of human activity is a choice that must be made by all members of society, with education being the strongest means of disseminating environmental awareness.[8,9]

Health is one of the United Nations' focus areas for sustainability: medical services should be planned, financed, and provided to meet the present and future needs of the general population. This implies not only reducing the environmental impact of health care-related activities, but ensuring that health systems will adapt to climate change, fewer natural resources (water, fuel, etc.), population aging, and environmental disasters.[1,8,10] The World Health Organisation estimates that approximately 250,000 deaths related to climate change will occur each year in the coming decades.[3,7,11]

Health care produces a considerable amount of waste. Operating rooms, for example, produce 20%-30% of all hospital waste, with the U.S. health care sector alone contributing approximately 8% of greenhouse gas emissions.[5,7,10] This article describes the environmental impact of medical activities, mainly those related to anaesthesiology, and the need for sustainable anaesthesiology.

SUSTAINABLE ANAESTHESIOLOGY

Climate change poses a threat to humanity[2,5,12] and has been considered the main concern of the 21st century by the World Health Organisation, since it could contribute to 8.9 million deaths worldwide. Health care systems are facing an increasing number of pathologies linked to climate change. However, these services themselves are also a considerable source of greenhouse gas emissions[5], contributing to the increased demand.

Inhalational anaesthetics account for approximately 3% of hospital greenhouse gas emissions.[3,11,12] Many anaesthesiologists have realized the significance of this fact and have reduced their use. However, focusing only on greenhouse gas emissions overlooks other factors, such as waste management, which can contaminate water, soil, and air, indirectly contributing to global warming.[10,11,13]

In a consensus statement, the World Federation of Societies of Anaesthesiologists' Global Working Group on Environmental Sustainability in Anaesthesia lists three principles of sustainable anaesthesia:

1. patient safety should not be compromised by sustainability practices;
2. all countries must participate in these measures and support each other, and
3. health systems must reduce their contribution to global warming.[11]

In this context, anaesthesiologists must assume leadership roles, defending and encouraging environmental awareness and creating a work environment amenable to sustainable practices. To this end, management programmes have been created to foster more conscious choices about anaesthetic agents, waste disposal, and recycling, which can mitigate the negative environmental effects of anaesthesia practice.[8,11,12]

Achieving sustainable anaesthesiology requires analysis of the following topics, which will be discussed below: sustainable equipment and materials; the environmental impact of inhalational anaesthetics (IAs); fresh gas flow (FGF) management to reduce environmental contamination; conscious use of intravenous anaesthetics and other pharmaceuticals; waste disposal and recycling; conscious donation, and anaesthesiologists as leaders in sustainable change.[6,7,14]

SELECTING MORE SUSTAINABLE EQUIPMENT AND MATERIALS

Anaesthesia, a speciality involving many types of equipment and materials, produces a large amount of disposable or reusable waste.[2,5] Materials are normally selected based on cost, patient safety, effectiveness, and ease of use without considering environmental issues.[5,7,11] Disposable laryngoscope blades are a good example of how complex it can be to decide between disposable and reusable equipment. They are popular because they eliminate the risk of cross-contamination between patients and extinguish the ecological costs of cleaning, which require labour and natural resources, given that reusable items must be cleaned with disinfecting solutions that can be toxic to the environment.[2,4,6] On the other hand, reusable blades are associated with higher quality and reliability. In environmental terms, their manufacture requires fewer natural resources and they produce less waste than disposable units, which end up being incinerated. Generally, the decision to use disposable items does not consider their environmental impact and disposal/waste management costs.[4,11] Hence, there is an urgent need to plan for more sustainable materials.

The cleaning and reselling of single-use devices that are mechanically suitable for reuse is called reprocessing. Single-use devices are only designated as such by the manufacturer; in many countries they are considered reusable equipment. In the USA, reprocessing companies have begun formalizing and certifying this strategy. They accept recently used hospital equipment, such as pulse oximeters, breathing circuits for anaesthesia machines, laryngoscope handles and blades, laryngeal mask airways, sphygmomanometers, and laparoscopic trocars.[4,5,13] They clean, sterilize, and test these items, ensuring they meet U.S. Food and Drug Administration technical standards, and then resell them to hospitals. Resale prices can be 50%-60% below retail.[4,5,7]

Concerns have been raised about sterilization in equipment reprocessing, especially invasive surgical devices. The U.S. Food and Drug Administration currently requires reprocessing companies to comply with a number of rules and regulations, declaring in writing that the reprocessed medical device is "substantially equivalent" to the original. From 65%-75% of reprocessed single-use devices fall into class II (medium risk), which requires filing a report with the U.S. Food and Drug Administration prior to marketing.[3,7,10] Reprocessors must provide evidence of equivalence to the original device in terms of safety, efficacy, and intended use. Some class II devices include pulse oximetry sensors, ultrasound probes, and most laparoscopic equipment. The use of reprocessed single-use devices requires written patient consent, documentation of the reprocessed items used in treatment, and more rigorous systems for monitoring failures and injuries, in addition to attributing legal responsibility for adverse events to reprocessing companies.[5,7,11]

While reprocessing strategies seem sustainable, their costs must be considered. Reprocessing involves cleaning/autoclaving (environmental costs similar to reusable equipment), repairs, and testing (environmental costs similar to new equipment), and additional transportation. Thus, although this strategy reduces costs, it may not be actually more sustainable than others.[7,13,14]

The manufacture of anaesthesia machines and monitors also has a negative environmental impact. They contain metals, plastics, and computer parts that release toxins and heavy metals. Since these devices are manufactured in many locations, government cooperation is needed to reduce toxic emissions.[10,12,13] Improper disposal of monitoring equipment, batteries, computers, and anaesthesia machines harms the environment. This equipment usually includes recyclable metals, such as stainless steel, aluminium, brass, zinc, nickel and copper. The challenge is to separate recyclable from non-reusable material.

Conscious disposal must be achieved through proper medical waste management: independent metal recycling facilities can recover metal parts; old anaesthesia machines and monitors can be renovated and sold to laboratories, health care institutions, or veterinary clinics; medical missions may accept used equipment; contracts with environmentally committed suppliers can stipulate the return, donation, reuse of parts, or recycling of old equipment.[3,5,11,12]

THE ENVIRONMENTAL IMPACT OF INHALATIONAL ANAESTHETICS

Halogenated IAs and nitrous oxide contribute to the greenhouse effect and the depletion of the ozone layer.[6,15,16] Atmospheric emissions

of IAs are unregulated, either because they are considered essential for medicine or because it is believed they contribute little to the greenhouse effect and climate change. However, IA use has increased considerably in the last 30 years, impacting the environment. Desflurane is of special concern due to its high environmental damage. Several studies have demonstrated the environmental impact of IAs and the need to minimize it.[3,17,18]

IAs contribute to the greenhouse effect by absorbing solar radiation and dissipating it as a source of heat; their long atmospheric half-life results in sustained atmospheric warming. Since IAs undergo minimal metabolism in vivo (except halothane), most of these exhaled gases remain intact and are released to the atmosphere through exhaust systems. The agent's effect will continue until the gas is degraded in the atmosphere. The atmospheric half-life of IAs ranges from 1 to 14 years, except for nitrous oxide, which has an atmospheric half-life of 114 years (Table 1).[4,16,19]

Global warming potential (GWP) is a measure of how much a given mass of gas contributes to global warming over a specific period: the Intergovernmental Panel on Climate Change, for example, uses 100 years. The GWP is a relative scale comparing the effect of a gas to that of the same mass of carbon dioxide. Thus, the GWP of CO_2, by definition, is 1. Desflurane has the highest GWP ever described (2,540), followed by isoflurane (510), and sevoflurane (130) (Table 1).[2,5,18]

The environmental impact of IAs depends on 3 factors:

1. total annual consumption (the amount used and released into the atmosphere);
2. higher vs. lower GWP, and
3. atmospheric half-life.

Annual consumption depends on FGF, nitrous oxide use, and the power of the gas. High FGFs increase the effect of volatile agents in the environment, releasing greater amounts of IAs into the atmosphere. Although nitrous oxide decreases the required amount of the volatile agent, this is more than offset by nitrous oxide's long half-life, causing prolonged damage to the ozone layer as a greenhouse gas.[2,11,16,18] Finally, higher minimum alveolar concentration (i.e., lower potency) means that higher amounts of the IA must be used in relation to other gases at similar flows, a key component that is often overlooked. For example, nitrous oxide has a relatively low GWP but is typically used in 40%-60% concentrations, thus increasing its environmental impact. Desflurane, on the other hand, has a high GWP and requires 3-6 times the amount of sevoflurane or isoflurane (assuming similar FGFs) due to its 6% minimum alveolar concentration, compared to 2% for sevoflurane and 1.2 % for isoflurane.[11,16,17,19]

Recently, a complete comparative analysis of the life cycle of IAs and propofol was conducted, with the environmental cost expressed as a carbon footprint[2,5,18] i.e., the degree to which an activity, product, etc. intensifies the greenhouse effect based on all inputs, from manufacturing and delivery to disposal. Atmospheric emission of IAs directly contributes to the greenhouse effect, being the main component of their carbon footprint; other aspects (manufacturing, delivery, and disposal) can be considered secondary.

The carbon footprint of desflurane is 15 times greater than that of isoflurane and 20 times greater than that of sevoflurane. This analysis calculated the FGF for 2L of sevoflurane vs. 1L for desflurane and isoflurane. Using nitrous oxide significantly increases the carbon footprint due to its release into the atmosphere as a residual gas, in addition to the environmental costs of manufacturing.[5,8,11,18]

Current recommendations are to avoid using desflurane and nitrous oxide whenever possible, substituting other IAs, intravenous agents, or regional anaesthesia. The carbon footprint of propofol is, on average, four times smaller than IAs, making it a more sustainable alternative.[11,17]

One way to assess the environmental impact of IAs is to compare their consumption with vehicle greenhouse gas emissions. One hour of desflurane use is equivalent to driving a gasoline-powered car for 640km, which is much higher than sevoflurane (12.8km) or isoflurane (28.8 km) (Table 1).[5,7,15]

To reduce the environmental impact of IAs, low FGFs should be used during the maintenance phase of anaesthesia and IAs should not be released into the atmosphere. Unfortunately, systems for capturing and reusing anaesthetic gases is still under development and are not yet available.[4,6,8,20]

FRESH GAS FLOW MANAGEMENT TO REDUCE ENVIRONMENTAL CONTAMINATION

Whenever the FGF exceeds the patient's needs, gases and vapors enter the exhaust system and contaminate the atmosphere. Thus, by using a minimal fresh gas flow, the environmental impact of IAs can be reduced.[2,5] Although the impact of a single surgery may seem negligible, professionals can make a difference through careful FGF management over time.[15,16.]To implement these strategies, it is important to know how to use anaesthetic agents and oxygen concentration monitors to safely determine the minimal fresh gas flow.[18,19]

Table 1 – Contribution of inhalational anesthetics to the greenhouse effect (adapted from Axelrod et al.[5])

Minimum alveolar concentration/FGF	Atmospheric half-life (years)	GWP in 100 years	Ratio of CO_2 - equivalents produced	1h of IA emissions expressed as km driven
Sevoflurane 2%/2 L	1.1	130	1.0	12.8
Isoflurane 1.2%/2 L	3.2	510	2.2	28.8
Isoflurane 1.2%/2 L	14	2,540	49.2	640
Nitrous oxide 60%/1 L	114	298	-	97.6

FGF: fresh gas flow; GWP: global warming potential; IA: inhalational anesthetics.

Since safe anaesthesia requires continuous measurement of inspired and expired oxygen concentrations and IAs, it is possible to effectively manage FGFs.[3,5] To decrease environmental contamination, FGFs should match the patient's oxygen consumption as closely as possible.[16,17] When the vaporizer settings are adjusted or the FGF is changed, it will require more time for the gas and vapor concentrations in the circuit to change. Hence, there is a risk of inadequate concentrations, especially in the induction phase of anaesthesia, when there is a significant uptake of anaesthetic in the lungs. The concentration of expired IAs shown in the gas analyzer is the closest value to the minimum alveolar concentration and must be used to estimate it, thus ensuring adequate doses of anaesthetic.[5,15] Monitoring the oxygen concentration is essential, since decreasing the FGF below patient oxygen consumption levels will result in a progressive reduction in oxygen concentration, ultimately leading to hypoxemia.[11,15,17]

It is generally necessary to use a high FGF when a rapid change is desired in IA concentration, e.g., during the induction or awakening phases. When the desired concentration of anaesthetic vapor is in the circuit, the FGF can be reduced. Since the maintenance phase is usually the longest part of the procedure and does not require rapid changes in gas concentrations, it is the best opportunity to minimize the FGF.[16,17]

The minimum safe FGF provides enough oxygen to satisfy the patient's consumption, plus additional gas to replace leaks in the circuit and/or losses to a sidestream gas analyzer.[5,12,18] Oxygen consumption during anaesthesia varies: at an estimated 5mL/kg/minute in an adult male weighing 70kg, 350mL of oxygen will be used per minute. Thus, without considering leaks, a, FGF of 350mL/min could be considered adequate.[3,15,18] Higher FGFs will lead to excess gas, which is released into the exhaust system and the environment. If the patient's oxygen consumption is underestimated, oxygen concentration in the circuit will decrease.[2,5,18]

Therefore, measuring the inspired oxygen concentration is important for maintaining a proper FGF, ensuring safe and efficient oxygenation for the patient. If ambient air or nitrous oxide is supplied with the oxygen, environmental contamination will occur, since the nitrogen or nitrous oxide flow that exceeds the oxygen consumption rate will eventually displace a portion of the gases released through the exhaust system.[11,17]

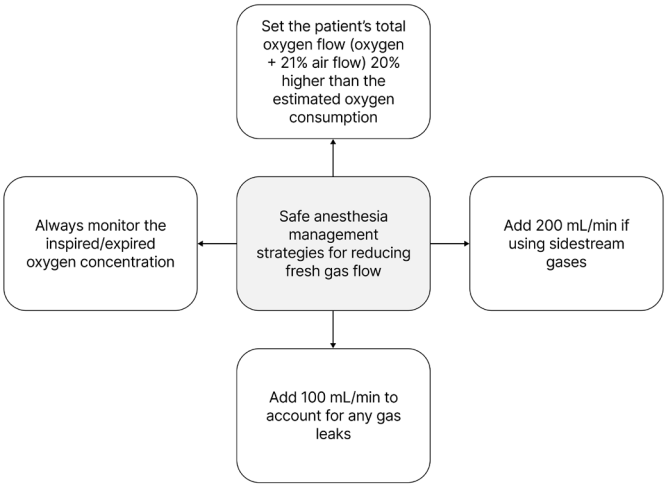

Figure 1 – Safe anaesthesia management strategies for reducing fresh gas flow

Patients with high oxygen consumption (e.g., trauma, pregnancy, or thyrotoxic crisis) require a higher FGF; in those with lower oxygen consumption, the FGF can be reduced during the maintenance phase, although the inspired oxygen concentration must still be monitored.[2,3,5,18,19]

Leakage in the circuit must be considered when determining the minimum safe FGF. It should be minimal if the anaesthesia equipment and breathing circuit have passed a leak check test. If a sidestream gas analyzer (which does not return the aspirated gas) is used, add 200mL/min to the calculated oxygen consumption; another 100mL/min must be added to offset any leaks in the circuit[4,6,19] (Figure 1).

A common practice during the induction phase is to increase the FGF during face mask ventilation and turn off the vaporizer while intubating the patient. The purpose of this is to avoid contaminating the operating theatre with anaesthetic vapor. In fact, anaesthetic vapor that accumulates in the circuit during mask ventilation is released into the room.[8,10,12] Thus, contaminating the room is unavoidable and the vapor in the circuit is wasted. Alternatively, the FGF can be turned off during intubation and the vaporizer left on. With no FGF, the IA is not released and the vapor reservoir that has accumulated in the circuit is preserved. The advantage of this strategy is that the FGF can be set to a minimum after intubation, thus preserving the concentration of anaesthetic vapor in the circuit. When the anaesthetic agent monitor indicates an adequate exhaled vapor concentration and there is a small difference between inspired and expired IA concentrations, it is then reasonable to switch to the minimum FGF.[2,4,5,18,19]

Turning off the FGF but not the vaporizer may not be a good idea in all cases, since for difficult airways the FGF must be turned on and face mask ventilation continued. Thus, anaesthesiologists must choose their own comfort level regarding airway management and FGF changes. In any case, turning off the vaporizer during intubation and leaving the FGF on contaminates the operating theater.[11,16,17]

There are techniques for reducing the concentration of IAs necessary for adequate anaesthetic depth to help reduce environmental contamination. Adjuncts, such as narcotics, regional analgesia, and infusion of local anaesthetic into the surgical field early in the procedure can reduce the required concentration of IAs. Smaller amounts of IA reduce environmental contamination. Another strategy is to use anaesthetic depth monitors to monitor exhaled IA concentrations, ensuring that the patient receives an adequate dose.[5,11,16-8]

CONSCIENTIOUS USE OF INTRAVENOUS ANESTHETICS AND OTHER PHARMACEUTICALS

Historically, anaesthesiologists have been concerned about patient safety but have neglected the effects of IAs and other medications on the environment and, thus, on the long-term health and safety of the population.[5,15] Studies have correlated IAs with the greenhouse

effect, leading some to question whether the best way to reduce environmental impact would be to use intravenous anaesthesia alone. Unfortunately, this is not so simple, since intravenous anaesthesia involves solid waste (syringes, needles, vials, etc.) and the disposal of drugs that can contaminate the environment.[7]

According to pharmacokinetic principles, all administered medication is eliminated by the body, mainly through feces and urine, as active metabolites, other products of biotransformation, and/or unchanged. Thus, a portion of the drug is discarded in sewage systems, which contaminates the water since this type of waste remains untreated.[2,3] Although pharmaceutical contaminants are often below toxicity levels in the water supply, their environmental persistence is a result of a combination of high drug production and utilization rates. The effects of this are both unknown and concerning, especially for pregnant women and children, due to increased susceptibility during growth and development.[8,10]

Anaesthesiologists are trained to dilute drugs according to each case. Managing adverse outcomes is a basic principle of anaesthesia education, and obviously patient safety is paramount. However, this can lead to a staggering amount of waste: 50% of diluted drugs end up being discarded.[10,11] Decreasing medication waste helps curb the environmental impact of anaesthesiology.

In 2003, the city council of Stockholm approved an environmental risk scale for pharmaceutical products. The purpose of this 9-point index, based on persistence, bioaccumulation, and toxicity, is to decrease pharmaceutical residues in water, air, and soil. Drugs are rated according to their environmental threat, which is essentially the relationship between their expected/safe environment concentrations and environmental risk (Table 2).[5,10,15]

Propofol is the most wasted anaesthetic, with 33%-50% of the excess discarded. When used, less than 1% is excreted unchanged and 60% undergoes hepatic glucuronidation. Its improper disposal, whose half-life is >1 year, results in soil and water contamination.[3,4,7]

Antimicrobials have direct ecological effects, such as bacterial resistance, which affect health. In water, they contaminate fish by interacting with intestinal microbiota, inhibiting growth and causing infertility.[2,3,10] They affect soil microorganisms by reducing the enzymatic activity, in addition to plant protein synthesis, which limits the availability of nitrogen and CO_2, necessary for plant life. Microbial resistance is a current concern in the scientific community; a high rate of genetic alterations related to bacterial resistance has been found in environmental samples in recent years, mainly due to incorrect drug disposal in sewage, which can impact animal and human health (Table 2).[2,3,15]

WASTE DISPOSAL AND RECYCLING

Of all hospital waste, 20%-30% is produced in operating rooms. Sterile packaging systems are responsible for a large part of the waste, in addition to disposable items, which exacerbate the problem. Contaminated materials, sharps, and certain medications (dangerous for the environment) must be disposed of in special containers for regulated medical waste.[5,15]

Most operating room waste is solid and can be recycled if it has not been contaminated by body fluids. It has been estimated that anaesthesia procedures produce 25% of all operating room waste, 60% of which is recyclable. The main difficulty in recycling this waste is that infectious and clean waste are not separated.[2,3] Successful recycling programmes involve procedures to reuse materials before the patient even enters the operating room. Much recyclable waste is produced when the instruments are opened and prepared prior to the procedure. Closing containers for recyclable waste before the patient enters the room eliminates the risk of contamination.[11,12]

Recycled objects have value and can be sold to recycling facilities, which lowers the expense of solid waste disposal. Recycling in operating rooms also raises awareness about waste segregation and reduces regulated medical waste, which costs more than solid waste disposal. Several hospitals have reported cost savings after implementing effective recycling procedures in operating rooms.[5,15] According to the U.S. Centers for Disease Control and Prevention, only 2%-3% of medical waste actually requires disposal as contaminants. This is considerably lower than the 50%-70% of waste typically placed in the contaminated waste stream. Regulated medical waste can be reduced through educational programmes for the professionals involved in this process.[2,3]

Table 2 – The persistence, bioaccumulation, and toxicity of drugs used in anaesthesia (adapted from Fang et al.[10])

Medication	Persistence	Bioaccumulation	Toxicity
Propofol	High	Potential	Inhibition of algal growth and acute toxicity in small crustaceans and freshwater fish
Opioids	High	Potential I	Genetic damage to water fleas
Antibiotics (macrolides and quinolones)	High	High	Toxic to fish and amphibians
Lidocaine	High	Low	Possible carcinogen
Bupivacaine	High	Low evidence	No data
Sugammadex	No data in the literature	No data in the literature	Could affect aquatic life by binding to oestrogen and progesterone
Paracetamol	< 15 days	Potential	Highly toxic to bacteria and algae; neurotoxic to crustaceans and planarians in low doses

Responsible donation

Responsible donation involves providing the right equipment to the right facilities and care providers. Matching the supply of equipment to the demand is not merely about need, but the ability to use the donated resources. Therefore, donation plans should include operating manuals, disposable accessories, spare parts, and effective communication to ensure that recipients can operate and maintain the equipment.[4,6]

ANAESTHESIOLOGISTS AS LEADERS IN SUSTAINABLE CHANGE

Awareness is the most important part of an anaesthesiology sustainability program. Anaesthesiologists must actively participate in the selection of sustainable equipment, drugs, and anaesthetic techniques, in addition to the management of hospital waste, recycling, and operating rooms. They must also raise sustainable anaesthesia projects in interdisciplinary meetings, health events, and community events to raise awareness both inside and outside the hospital environment, thus encouraging cultural change and greater sustainability.[4,8,17]

Although most hospitals do not have a sustainability coordinator, many hospital personnel are interested in protecting the environment. Anaesthesiologists must assume leadership roles, becoming "go to" professionals regarding sustainability projects. The goals of such leadership are to identify opportunities, train personnel, monitor progress, collect, report, and analyze statistics, and develop continuing education programmes.[2,11] It is important for all areas of the hospital to participate: the anaesthesiology department, clinical staff, nursing staff, general services and hygiene, as well as the administration and hospital purchasing sectors.[12,17]

CONCLUSIONS

Sustainable anaesthesia goes beyond reducing IA use, since it aims to minimize the environmental impact of health care (Figure 2). Commitment to the environment requires the rational use of resources and a commitment to patient safety. Given that anaesthesiologists have always sought innovative care improvements, making sustainability a reality in anaesthesiology is a chance to make a difference beyond the operating room.

REFERENCES

1. United Nations: Sustainable development. Accessed December 5, 2023. Available from: THE 17 GOALS | Sustainable Development (un.org).
2. Hawkins J, Parrott N. Sustainability: background science [Internet]. London: Churcill House; 2020 [cited 2023 Apr 28]. Available from: https://www.rcoa.ac.uk/events-professional-development/education-professional-development/e-learning-anaesthesia.
3. Schuster M, Richter H, Pecher S, Koch S, Coburn M. Ecological sustainability in anaesthesiology and intensive care medicine. A DGAI and BDA position paper with specific recommendations. *Anästh Intensivmed* 2020; **61**:329-39.
4. Choi BJJ, Chen CL. The triple bottom line and stabilization wedges: a framework for perioperative sustainability. *Anesth Analg* 2022; **134**:475-85.

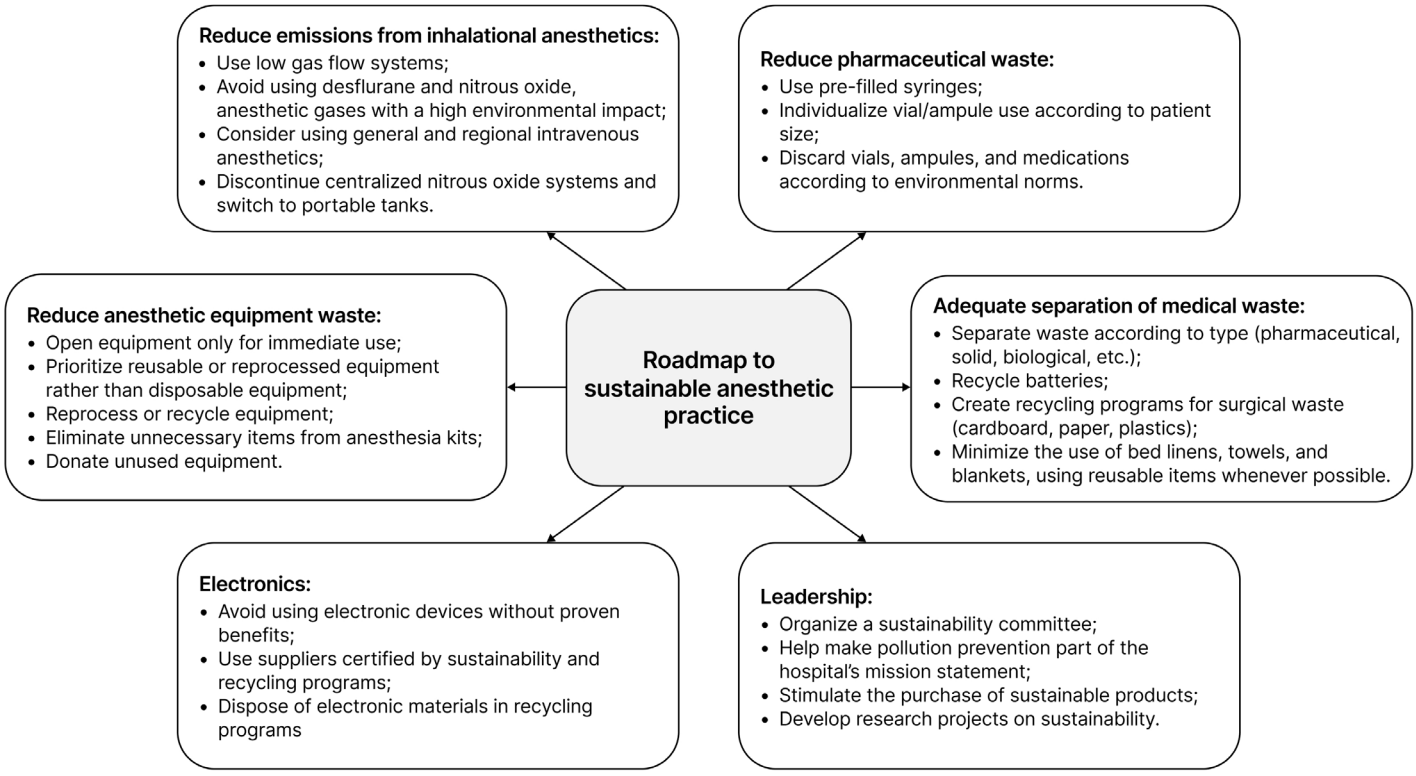

Figure 2 – Roadmap to sustainable anesthetic practice

5. Axelrod D, Bell C, Feldman J, et al. Greening the operating room and perioperative arena: environmental sustainability for anaesthesia practice. Washington: American Society of Anaesthesiologists; 2015 [cited 2023 Apr 28]. Available from: https://www.asahq.org/about-asa/governance-and-committees/asa-committees/environmental-sustainability/greening-the-operating-room#1.

6. Ryan S, Sherman J. Sustainable anaesthesia. *Anesth Analg* 2012; **114**:921-3.

7. Wyssusek KH, Keys MT, van Zundert AAJ. Operating room greening initiatives – the old, the new, and the way forward: a narrative review. *Waste Manag Res* 2019; **37**: 3-19.

8. Petre MA, Malherbe S. Environmentally sustainable perioperative medicine: simple strategies for anaesthetic practice. *Can J Anesth* 2020; **67**:1044-63.

9. Tordjman M, Pernod C, Bouvet L, Lamblin A. Environmentally sustainable practices in the operating room: a French Nationwide Cross-Sectional Survey of Anaesthesiologists and Nurse Anaesthesiologists. *Turk J Anaesthesiol Reanim* 2022; **50**:424-9.

10. Fang L, Hixson, R, Shelton C. Sustainability in anaesthesia and critical care: beyond carbon. *BJA Education* 2022; **22**:456-65.

11. White SM, Shelton CL, Gelb AW, et al. Principles of environmentally-sustainable anaesthesia: a global consensus statement from the World Federation of Societies of Anaesthesiologists. *Anaesthesia*. 2022; **77**:201-12.

12. McGain F, Muret J, Lawson C, Sherman JD. Environmental sustainability in anaesthesia and critical care. *Br J Anaesth* 2020; **125**:680-92.

13. Sherman JD, Raibley LA, Eckelman MJ. Life cycle assessment and costing methods for device procurement: comparing reusable and single-use disposable laryngoscopes. *Anesth Analg* 2018; **127**:434-43.

14. Zaw MWW, Leong KM, Xin X, Lin S, Ho C, Lie SA. The perceptions and adoption of environmentally sustainable practices among anesthesiologists-a qualitative study. *Can J Anaesth* 2023; **70**: 313-26.

15. Wyssusek K, Chan KL, Eames G, Whately Y. Greenhouse gas reduction in anaesthesia practice: a departmental environmental strategy. *BMJ Open Qual* 2022, **11**: e001867.

16. Andersen MPS, Nielsen OJ, Wallington TJ, Karpichev B, Sander SP. Assessing the impact on global climate from general anaesthetic gases. *Anesth Analg* 2012; **114**: 1081-5.

17. Devlin-Hegedus JA, McGain F, Harris RD, Sherman JD. Action guidance for addressing pollution from inhalational anaesthetics. *Anaesthesia* 2022; **77:** 1023-9.

18. Feldman JM. Managing fresh gas flow to reduce environmental contamination. *Anesth Analg* 2012; **114**: 1093-101.

19. Kennedy RR, Hendrickx JF, Feldman JM. There are no dragons: low-flow anaesthesia with sevoflurane is safe. *Anaesth Intensive Care* 2019; **47**: 223-5.

20. Rauchenwald V, Rollins MD, Ryan SM, et al. New method of destroying waste anaesthetic gases using gas-phase photochemistry. *Anesth Analg* 2020; **131**: 288-97.

Update in
Anaesthesia

Worldwide incident reporting

Erlinda C. Oracion and Yasmin Endlich
*Correspondence email: ecoracionmd@gmail.com

Introduction

Worldwide incident reporting in anaesthesia is a system that allows healthcare providers to report adverse events, hazards or near misses which might occur during anaesthesia administration. The overall aim is to enhance patient safety by learning from these events and preventing potential incidents by providing insight into human factors and highlighting opportunities for improvement in anaesthetic techniques and procedures.

The reporting system typically involves collecting data on incidents,[1] some examples being medication errors, equipment failures, and adverse reactions to anaesthesia.[2,3] These data are then analysed to identify trends and patterns and in an ideal world the findings are then reported back to the anaesthetic community, providing system insights and learnings to increase patient safety.[1]

Many nations have created anaesthesia-specific national or regional incident reporting systems, and a few international organisations also gather and evaluate data on such events.[1] These mechanisms are crucial for enhancing patient safety and ensuring anaesthesia providers are responsible for their conduct.

The World Federation of Societies of Anaesthesiologists (WFSA) strives to improve anaesthesia patient safety. Many nations lack a uniform protocol or reporting format for anaesthetic incidents. A consistent reporting procedure and a centralized data analytics workgroup would produce reliable data for local and national quality improvements.

HISTORY

As a profession, anaesthesia has a long history of advocating for patient safety measures. Incident reporting systems have been established a long time ago to learn from adverse events and improve patient safety and outcomes.

Sir Robert Macintosh, a New Zealander based in Britain and the first professor of anaesthesia outside the United States, was one of the pioneers of anaesthetic management. He first drew attention to fundamental failures in anaesthetic practice in the 1940s.[4] In an open letter published in the British Journal of Anaesthesia, he recommended that an independent anaesthetist with suitable qualifications analyse every anaesthetic death immediately after its occurrence. Macintosh recognized that knowledge and investigations of such events would create valuable information. He compared the benefits of incident analyses and the information the anaesthetist would gain to the information provided to the sailor by lighthouses at dangerous locations.

Flannagan first described the critical incident reporting technique in 1954 to enhance military aviation performance and safety.[5] Since then, incident reporting and analysis have been well established in multiple high-risk industries, including aviation, nuclear power plants, scuba diving, and anaesthesia.

Cooper et al.[6] Modified Flannagan's critical incident analysis to examine preventable anaesthetic mishaps in 1978. They collected information about preventable incidents by interviewing 47 healthcare providers and identifying and categorizing 359 incidents. An anaesthesia-related critical incident was defined as "an occurrence that could have led or did lead to an undesirable outcome, ranging from increased length of hospital stay to death or permanent disability."[7] They only focused on preventable incidents. The overall aim of their study was to uncover patterns of frequently occurring adverse events.

Runciman et al[8] founded the Australian Incident Monitoring Study (AIMS) in 1987, which was the first national anaesthetic critical incident analysis program worldwide. Participating anaesthetists in Australia voluntarily and anonymously reported any preventable or non-preventable incident, ranging from near misses to major harm, via a standardised aims form. Data were collected via narratives, where the reporter could describe the incident, contributing factors, and alleviating factors via free text. Quantitative information, including patient demographics, the time of day of the events, and incident outcomes, was reported via pre-defined drop-down lists, where the reporters ticked the appropriate box. Incident reporting in anaesthesia gained further

Erlinda C. Oracion
Department of Anesthesiology and Pain Medicine
Cardinal Santos Medical Center
San Juan City
Metro Manila
PHILIPPINES

Department of Anesthesiology and Perioperative Medicine
Rizal Medical Center
Pasig City
Metro Manila
PHILIPPINES

Safety and Quality of Practice Committee, World Federation of Societies of Anaesthesiologists (WFSA)
Patient Safety Interest Group
Asian Society of Paediatric Anaesthesiologists (ASPA)
Commission on Patient Safety and Quality Assurance
Philippine Society of Anesthesiologists (PSA)

Yasmin Endlich
Department of Anaesthesia
Royal Adelaide Hospital
Adelaide
AUSTRALIA

School of Medicine
The University of Adelaide
Adelaide
AUSTRALIA

traction, with Switzerland adopting the principle next. Nowadays, there are a number of national incident reporting schemes in Europe, the United States and Asia.[9,10]

WHO GUIDELINES FOR INCIDENT REPORTING

The World Health Organization (WHO) has reviewed incident reporting in healthcare and has provided guidance to further increase patient safety.[1] The aim is not only to encourage healthcare professionals to report incidents, but also to identify systemic flaws and prevent future patient harm, via detailed incident analyses, quality improvement projects and healthcare system advancements. The ultimate goal is to reduce the number of adverse events .

The WHO defines an incident as any unforeseen event or circumstance that has the potential to injure a patient, a healthcare professional, or any other person. Additionally the WHO promotes reporting, and encourages healthcare organisation's to create a culture that supports and encourages this in a confidential non-punitive approach. Reporting systems are required to be easily accessible, user-friendly, and de-identified. These systems can be electronic or paper-based, but need to facilitate timely reporting and analysis of incidents.[1]

Information regarding the details of the event, such as the patient demographics, anaesthetic provider, surgical procedure, daytime, location, and a description of what happened, including any contributing variables should be collected. Ideally, the procedure should allow for any additional follow-up data that could be required, however, this might be difficult when considering de-identified and anonymous data collection.

Investigating reported incidents to determine their underlying causes and contributing elements is essential. These analyses might identify system weaknesses, and findings might improve healthcare practices and methodologies. It is crucial to share the lessons discovered from incidents with the relevant stakeholders to promote learning and prevent similar events in the future. Transparent communication regarding incident reporting and its outcomes will further support a culture of reporting and patient safety.

It is important to note that these recommendations need to be adapted and implemented according to each healthcare organisation's specific context and needs.

COMMON ELEMENTS OF INCIDENT REPORTING SYSTEMS

Anaesthesia incident reporting systems typically include several common elements to ensure comprehensive reporting and analysis of incidents. Depending on the particular design or organisation, these components may differ slightly. The following are some typical ones:

Confidentiality: encouraging healthcare professionals to report incidents without worrying about potential legal repercussions requires confidentiality and protection of the data. Systems for reporting anaesthesia incidents need to ensure that the data provided are kept de-identified and are handled by expert analysts.

Non-punitive strategy: a non-punitive strategy ensures that medical personnel who disclose situations do not face negative consequences for reporting. Focus is maintained on improving patient safety and learning from adverse events.

Reporting mechanisms: anaesthesia incident reporting systems may collect incident reports in various ways, including computerized reporting tools or paper-based forms. The objective is to make the reporting procedure simple and available to healthcare professionals.

Analysis and investigation: investigations of reported incidents are necessary to determine their underlying causes and contributory variables and to identify strategies to reduce the occurrence of adverse events. Analyses may identify system weaknesses and improve anaesthesia practices and protocols.

Feedback and learning: anaesthesia incident reporting systems need to provide feedback on findings to the anaesthetic community. It is crucial to share the lessons discovered from incidents to promote learning and prevent similar events in the future.[11]

Incident reporting form: systems reporting anaesthesia incidents often use a standard format to gather pertinent data. These data help to capture essential information about anaesthesia incidents, contributing factors, and patient outcomes. They facilitate comprehensive analyses of incidents, the identification of system weaknesses, and the implementation of corrective actions to improve patient safety in anaesthesia care. The form equally should allow easy access for review by the analysers.[12]

Common elements found in anaesthesia incident reporting forms include demographic data, including patient, surgical and anaesthetic factors. Narrative boxes describing the incident in the reporters own words provide the opportunity to 'paint the picture' of the event and to also reflect on contributing, alleviating and additional factors leading to the event. Data boxes ensuring the collection of information regarding the patient outcomes, the severity of the incident and suggested follow up actions are required for a complete picture of the incident.

These shared components help ensure that anaesthesia incident reporting systems facilitate the identification of safety issues, promote a culture of continuous quality improvement, and ultimately enhance patient safety in anaesthesia care.[1,12]

DIFFERENCES BETWEEN HIGH INCOME COUNTRIES (HIC) & LOW-MIDDLE INCOME COUNTRIES (LMIC)

In 2010, nearly one-third of global deaths were caused by conditions requiring surgical care, surpassing the combined number of deaths from HIV, tuberculosis, and malaria. A report published in 2015 by the Lancet Commission on Global Surgery[13] emphasized the importance of universal access to safe and affordable surgical and anaesthetic care. Perioperative mortality reflects surgical and anaesthetic safety. While global perioperative mortality rates have decreased over the past 50 years, low and middle-income countries (LMICs) still face a two-to-four times higher risk. Improving anaesthesia services has been identified as a priority in global health. There is a wide range of conditions in which anaesthetic providers with varying training backgrounds provide anaesthesia in LMICs. According to the WFSA workforce survey, there is a shortage of physician anaesthesia providers, with a significant discrepancy between HICs and LMICs.[14] In countries with advanced resources, anaesthesia incident reporting systems are commonly more established and comprehensive compared to low resource

countries. Some key differences include infrastructure, availability of technology, reporting culture, training and education, and outcome data analyses and feedback mechanisms.

HEALTHCARE INFRASTRUCTURE AND TECHNOLOGY

Healthcare infrastructure and technology play a crucial role in critical incident reporting, and there are significant differences between high-income countries (HICs) and low-middle income countries (LMICs) in this regard. HICs generally have well-developed healthcare infrastructure, including advanced hospitals and medical facilities, which allows for improved data collection and implementation of reporting systems. They also have reliable communication networks, enabling seamless information sharing among healthcare providers and institutions. Furthermore, HICs commonly leverage advanced technology such as Electronic Health Records (EHRs) and mobile applications designed for incident reporting purposes within anaesthesia practice settings.[15]

In contrast, LMICs may struggle with procuring essential resources and setting up incident reporting systems and allocating funds for it support and management. They often rely on manual or paper-based systems, making data collection and distribution more labour-intensive and prone to error. LMICs may also face challenges with internet connectivity, further complicating the use of technology for incident reporting purposes.

To facilitate comprehensive analyses at a national level and identify trends, patterns, and areas for improvement in anaesthesia care delivery practices, established databases or registries designed explicitly for collecting critical incident data are required. Sophisticated data analysis tools may be available in HICs, but LMICs may need more centralized databases due to resource limitations, it and internet structure improvements, availability of advanced technology, and resources for data analyses. HIC anaesthesia training programmes benefit from well-established educational institutions with experienced faculty members specialising in patient safety practices and critical incident reporting protocols. These programmes provide comprehensive training opportunities emphasizing the importance of accurate incident documentation and reporting procedures throughout a provider's career development.[15]

High-income country systems often include robust mechanisms for analysing reported incidents at both local and national levels. Regular feedback loops are established between anaesthesia providers, hospitals/clinics, regulatory bodies, and professional societies to disseminate lessons learned from incidents with the aim of improving patient safety practices overall. HICs may have well-established infrastructure for data analysis, including dedicated teams or departments responsible for analysing critical incident data. These teams utilise advanced analytical tools and methodologies to identify trends, patterns, and potential areas for improvement in anaesthesia care delivery practices.[16] In contrast, LMICs may have limited resources or expertise dedicated to comprehensive data analysis due to financial constraints.

Improving healthcare infrastructure and technology is an ongoing effort globally, with organisations such as the World Health Organization (WHO) and other international bodies working towards supporting LMICs in strengthening their healthcare systems, including critical incident reporting capabilities. Efforts are being made globally to bridge the technology gap between HICs and LMICs by promoting initiatives that support the adoption of cost-effective technologies and innovative solutions tailored to the specific needs of healthcare systems in resource-limited settings.

REPORTING CULTURE AND EDUCATION RESOURCES

HICs typically have established cultures for reporting critical incidents within the healthcare system. Healthcare professionals are encouraged to report adverse events or near misses without fear of retribution or blame.[1]

Openness and transparency: HICs often have a more robust culture of openness and transparency when reporting critical incidents. Healthcare providers are encouraged to report adverse events or near misses without fear of retribution or blame. There is an understanding that reporting incidents is essential for learning, improving patient safety, and preventing future occurrences. In contrast, LMICs face cultural barriers that discourage open reporting due to concerns about professional reputation, legal consequences, or a lack of trust in the system.[17]

Legal and regulatory frameworks: HICs usually have well-established legal and regulatory frameworks that protect healthcare providers who report critical incidents in good faith from legal repercussions or disciplinary actions. These protections help create an environment where healthcare professionals feel safe to report incidents without fear of negative career consequences. LMICs often need better legal protections for healthcare providers who report incidents and encourage individuals to come forth with their experiences.

Professional support systems: in HICs, professional societies and organisations promote a positive reporting culture by providing support systems for anaesthesia providers who experience critical incidents. These support systems offer guidance, counselling services, peer-to-peer discussions, and educational resources for incident reporting best practices.[17] LMICs need more resources to establish similar support systems for healthcare professionals.

Training and education on reporting practices: training and education on reporting practices is an important aspect of anaesthesia care delivery.[11] The following are examples of resources that many HIC anaesthesia training programmes have available but that are not as prevalent in LMIC training programmes.

- **Incident reporting**. HIC anaesthesia training programmes generally include education on incident reporting protocols as part of their curriculum. Anaesthesia providers receive training on accurately documenting critical incidents and understanding the importance of timely reporting for patient safety improvement efforts.[11]
- **Critical incident reporting protocols and implementation of patient safety practices**. In HICs, there is generally more investment in training programmes for anaesthesia providers regarding critical incident reporting protocols and patient safety practices. These programmes help create a culture of continuous learning and improvement in anaesthesia care delivery.[17]

- **Patient safety-trained faculty in anaesthesia training programmes**. HIC educational institutions often have experienced faculty members who specialize in patient safety practices, including critical incident reporting protocols. These faculty members can provide guidance, mentorship, and practical examples related to effective incident documentation techniques during the training process.
- **Simulation in training programmes**: HICs frequently utilise simulation-based training methods as part of their anaesthesia education curriculum. Simulations allow trainees to practise responding to critical incidents in controlled environments before encountering them in real-life situations. This includes practicing proper documentation techniques during simulated incidents for later analysis or debriefing sessions focused on improving communication skills related to incident reporting processes.
- **Investment in continuing professional development opportunities (CPD)**: HIC healthcare systems also often invest in CPD opportunities for anaesthesia providers that include workshops or conferences focused on patient safety practices and critical incident reporting strategies. These CPD activities allow providers to stay updated on best practices, learn from real-life case studies, and network with peers to share experiences.

Organisational culture: the organisational culture within healthcare institutions can significantly influence the reporting culture. In HICs, there is often a strong emphasis on a "culture of safety" that encourages reporting and learning from incidents. Institutions prioritise creating an environment where healthcare providers feel comfortable reporting incidents and are supported in their efforts to improve patient safety. In LMICs, resource constraints and other challenges may result in less focus on fostering such a culture.[13]

Quality improvement initiatives: HICs often implement quality improvement initiatives based on insights gained from critical incident data analysis. These initiatives aim to address identified areas for improvement through changes in policies, procedures, training programmes, or equipment upgrades that enhance patient safety practices within anaesthesia care settings. LMICs have fewer resources available for implementing such comprehensive quality improvement initiatives.

Research opportunities: HICs with well-established critical incident reporting infrastructures provide opportunities for research studies focused on patient safety and anaesthesia care. Researchers can access anonymised incident data to conduct studies that contribute to the understanding of factors contributing to critical incidents and the development of evidence-based interventions. LMICs have limited research opportunities due to challenges in data collection, analysis, and resource allocation for research purposes.

BENEFITS OF IMPROVING WORLDWIDE ANAESTHESIA CRITICAL INCIDENT REPORTING

Enhancing the global reporting of critical incidents in anaesthesia would yield a multitude of advantages that would contribute to the improvement of patient safety and the provision of high-quality healthcare. Several notable benefits encompass as follows: the practice of reporting critical incidents in anaesthesia fosters a culture that values openness and responsibility.[18] Through the process of reporting incidents, healthcare personnel can gain a deeper understanding of the various elements that contribute to these occurrences. This enhanced understanding subsequently leads to increased awareness and knowledge of potential dangers and the measures that may be taken to prevent them.[19] The act of globally reporting occurrences enables the identification of repeating trends or systemic issues that impact patient safety. These data can be utilised to enact focused interventions and create procedural modifications to address these concerns and mitigate similar situations effectively.[20]

Reporting critical incidents enables healthcare practitioners to effectively communicate their experiences and impart valuable knowledge gained from these events. Sharing information facilitates the widespread distribution of exemplary practices and pioneering methodologies, ultimately resulting in enhanced patient outcomes and the establishment of standardised treatment across diverse healthcare environments.[19] The process of critical event reporting catalyses quality improvement activities. By examining documented occurrences, healthcare institutions can identify specific domains that require enhancement and then employ evidence-based approaches to augment patient safety and maximise the utilisation of anaesthesia techniques.

Participating in critical incident reporting promotes a culture that prioritises ongoing learning and advancing professional skills. Healthcare practitioners can self-reflect on their practices, discern areas that require improvement, and actively pursue more education or training opportunities to augment their proficiency and understanding of anaesthetic treatment.[11] Enhancing global anaesthesia critical incident reporting will ultimately lead to advancing patient safety through identifying and mitigating possible hazards and system breakdowns. Healthcare organisations can enact preventive measures, optimise protocols, and establish a safer environment for patients who are undergoing anaesthesia.[20]

In brief, enhancing the global reporting of significant incidents in anaesthesia contributes to heightened consciousness, detection of systemic concerns, dissemination of exemplary approaches, endeavours for quality enhancement, professional growth, and enhanced patient safety and treatment quality.[11]

LIMITATIONS OF INCIDENT REPORTING SYSTEMS

Incident reports can provide valuable information for research and practice improvement, but there are limitations associated with this type of data. These limitations can be divided into two categories: data input and data analysis.

Limitations related to data input

The World Health Organization (WHO) has reported that underreporting of incidents is a significant issue.[1] It is believed that only a small percentage, between 7-15%, of incidents are ever reported. This underreporting is often due to a fear of punishment or retribution, which is a consequence of the so-called blame culture."[21] Other factors contributing to underreporting include a lack of user-

friendly reporting infrastructure, poor perceptions of the usefulness of incident reporting systems within the medical community, and time pressures in high-stress working environments.[22]

In addition, incident reports are subjective in nature and the views and experiences of the reporter can influence them. This can lead to selective recall bias or under-reporting of the incident. Additionally, medical professionals may not report near-miss events or incidents that did not cause harm to the patient, despite these occurring more frequently than significant adverse events. Analysing near-miss events is just as crucial as analysing significant adverse events.

Limitations related to data analysis

Data analysts face the challenge of having to work with large volumes of reports, often with limited time, resources, and expertise. In healthcare, interpreting and summarizing the findings of incident reports may come at the expense of implementing changes to improve patient care and safety. Although there are many published articles related to incident reports and their findings, far less attention has been paid to processing, learning from, and responding to these findings. Most incident reporting systems collect de-identified data, which means that the analyses are dependent on the information provided.[19] If information is unclear or missing, it is not possible to collect missing data or clarifications. Additionally, denominator data is commonly not available, making it impossible to calculate the true risks associated with many adverse events.[3]

STRATEGIES TO IMPROVE WORLDWIDE ANAESTHESIA INCIDENT REPORTING

We offer the following recommendations to improve incident reporting and patient safety globally.

- Develop and implement a standardised, anonymous reporting system worldwide.
- Encourage all healthcare facilities to regularly audit and verify the reporting of incidents and assess the efficiency of the reporting system.[23]
- Advocate and create cultures of safety in clinical practices. [11,21,22,24]
- Encourage the use of feedback mechanisms in healthcare facilities that effectively communicate the outcomes of healthcare experts' reports.[24]
- Establish collaborative efforts among diverse nations and healthcare institutions can facilitate the exchange of exemplary methodologies and enhance the efficacy of the reporting system.[23]
- Utilise technology such as mobile applications, web-based platforms, and digital health records to enhance the ease and efficiency of the reporting process.
- Pursue legal safeguards for all healthcare professionals who disclose critical incidents.[23]

SUMMARY

By working together, healthcare providers can help to improve patient safety and reduce the risk of critical incidents in anaesthesia care. There are a number of barriers to the optimal development and implementation of incident reporting processes.[25] These barriers are often more pronounced in LMICs but a number of them are also present in HICs. A global approach to improving incident reporting and reducing these barriers is possible and necessary if we are to continue to advance anaesthesia patient safety worldwide.[23]

References

1. Organization WH. Patient safety incident reporting and learning systems: technical report and guidance. 2020.
2. Gibbs NM, Culwick M, Merry AF. A cross-sectional overview of the first 4,000 incidents reported to webAIRS, a de-identified web-based anaesthesia incident reporting system in Australia and New Zealand. *Anaesth Intensive Care*. 2017;**45**(1):28-35.
3. Gibbs NM, Culwick MD, Endlich Y, Merry AF. A cross-sectional overview of the second 4000 incidents reported to webAIRS, a de-identified web-based anaesthesia incident reporting system in Australia and New Zealand. *Anaesth Intensive Care*. 2021;**49**(6):422-9.
4. Macintosh R. Deaths under anaesthetics. *British Journal of Anaesthesia*. 1949;**21**(3):107-36.
5. Flanagan JC. The critical incident technique. *Psychological bulletin*. 1954;**51**(4):327.
6. Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anaesthesia mishaps: a study of human factors. *Anesthesiology*. 1978;**49**(6):399-406.
7. Munting KE, van Zaane B, Schouten AN, van Wolfswinkel L, de Graaff JC. Déclaration des incidents critiques dans un hôpital de soins tertiaires: une étude de cohorte historique de 110 310 interventions. *Canadian Journal of Anaesthesia/Journal canadien d'anesthésie*. 2015;**62:**1248-58.
8. Runciman W. The Australian patient safety foundation. SAGE Publications Sage UK: London, England; 1988.
9. Staender S. Incident reporting in anaesthesiology. Best practice & research *Clinical anaesthesiology*. 2011;**25**(2):207-14.
10. Staender S, Davies J, Helmreich B, Sexton B, Kaufmann M. The anaesthesia critical incident reporting system: an experience based database. *International Journal of Medical Informatics*. 1997;**47**(1-2):87-90.
11. Mellin-Olsen J, Staender S, Whitaker DK, Smith AF. The Helsinki declaration on patient safety in anaesthesiology. European Journal of Anaesthesiology| *EJA*. 2010;**27**(7):592-7.
12. Fukami T, Uemura M, Nagao Y. Significance of incident reports by medical doctors for organizational transparency and driving forces for patient safety. *Patient Safety in Surgery*. 2020;**14**(1):1-7.
13. Mukhopadhyay S, Ojomo K, Nyberger K, Meara JG. Lancet commission on global surgery. *Iranian Journal of Pediatrics*. 2017;**27**(4).
14. Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA global anaesthesia workforce survey. *Anaesthesia & Analgesia*. 2017;**125**(3):981-90.
15. Liu E, Koh K. A prospective audit of critical incidents in anaesthesia in a university teaching hospital. *Annals of the Academy of Medicine*, Singapore. 2003;**32**(6):814-20.
16. Mahajan RP. Critical incident reporting and learning. *Br J Anaesth*. 2010;**105**(1):69-75.
17. Milch CE, Salem DN, Pauker SG, Lundquist TG, Kumar S, Chen J. Voluntary electronic reporting of medical errors and adverse events: an analysis of 92,547 reports from 26 acute care hospitals. *Journal of General Internal Medicine*. 2006;**21**:165-70.
18. Guffey PJ, Culwick M, Merry AF. Incident reporting at the local and national level. International Anesthesiology Clinics. 2014;52(1):69-83.
19. Gibbs NM. Clinical incident reporting: Extending the learning opportunities through webAIRS. SAGE Publications Sage UK: London, England; 2023. p.372-4.

20. Evans SM, Berry JG, Smith BJ, Esterman A, Selim P, O'Shaughnessy J, et al. Attitudes and barriers to incident reporting: a collaborative hospital study. *BMJ* Quality & Safety. 2006;**15**(1):39-43.
21. Howell A-M, Burns EM, Bouras G, Donaldson LJ, Athanasiou T, Darzi A. Can patient safety incident reports be used to compare hospital safety? Results from a quantitative analysis of the English national reporting and learning system data. PloS one. 2015;10(12):e0144107.
22. Saito T, Wong Z, Thinn K, Poon K, Liu E. Review of critical incidents in a university department of anaesthesia. *Anaesthesia and intensive care*. 2015;**43**(2):238-43.
23. Warner MA, Arnal D, Cole DJ, Hammoud R, Haylock-Loor C, Ibarra P, et al. Anaesthesia patient safety: next steps to improve worldwide perioperative safety by 2030. *Anaesthesia & Analgesia*. 2022;**135**(1):6-19.
24. Blais R, Sears NA, Doran D, Baker GR, Macdonald M, Mitchell L, et al. Assessing adverse events among home care clients in three Canadian provinces using chart review. *BMJ* quality & safety. 2013.
25. Macrae C. The problem with incident reporting. *BMJ* quality & safety. 2016;**25**(2):71-5.

9TH AAAC

DATE: 13th - 19th September 2024
VENUE: Sandton Convention Centre
Johannesburg, South Africa

ALL Africa ANAESTHESIA CONGRESS

SAFETY & INNOVATION ARTIFICIAL INTELLIGENCE

Inviting the world back home

INVITED SPEAKERS

Prof Stanton Shernan
Boston, United States

Dr Angela Muhozya
Dar es Salaam, Tanzania

Dr Ibironke Desalu
Lagos, Nigeria

Dr Bhiken Naik
Virginia, United States

PLENARY HIGHLIGHTS

- Artificial Intelligence
- Diversity, Equity & Inclusivity
- Global Surgery
- Innovation
- Workforce Wellbeing
- Education

TO REGISTER & PAY

SCAN ME

SASA SOUTH AFRICAN SOCIETY OF ANAESTHESIOLOGISTS

ARS

WFSA WORLD FEDERATION OF SOCIETIES OF ANAESTHESIOLOGISTS

Update in Anaesthesia

Guide for Contributors

MISSION OF UIA

Update in Anaesthesia (UIA) is an official journal of the World Federation of Societies of Anaesthesiologists (WFSA). UIA's primary goal is to provide high-quality, peer-reviewed, clinically-relevant educational articles aimed at improving the quality and safety of anaesthesia care around the world.

UIA welcomes manuscripts focused on, and not limited to, anaesthesia that is relevant to resource-limited settings. UIA also serves to share knowledge from affiliated associations such as the World Health Organization (WHO) and surgical societies and educators that recognise safe anaesthesia as an essential part of safe surgery.

Over 16,000 anaesthetists around the world access UIA on the internet at http://www.wfsahq.org/resources/update-in-anaesthesia UIA is read by many others including anaesthesia trainees, nurses, surgeons and medical students.

Manuscripts should be submitted to:

https://www.editorialmanager.com/wfsa/default.aspx

GENERAL CONSIDERATIONS FOR PREPARATION AND SUBMISSION OF A MANUSCRIPT

A major focus of UIA is to provide educational materials for those working with limited resources. The types of manuscripts that are published in the journal reflect this. If you have an idea for an article and would like to discuss this further, please email the Editor-in-Chief with a proposed title and a brief (200 word) summary of the scope and content.

Manuscripts are screened by the editorial staff and are sent to independent reviewers who are not informed of the identity of the author(s). The reviewers' comments and suggested revisions will be forwarded to the corresponding author. Manuscripts will be reviewed with plagiarism detection software. Manuscripts may not have been published in whole or any part in another journal.

Some readers of UIA may not use English as their first language. It is therefore important to keep text straightforward and to avoid long sentences and complex terminology. Explain words and abbreviations that may not be universally standardised.

Aim to include the full range of therapies available worldwide. Provide detailed descriptions of therapies available in resource-limited settings. When appropriate, discuss older medications, such as Halothane and Thiopentone that may still be used around the world.

Authors must acknowledge any financial support received or conflict of interest related to the contents of a submitted manuscript.

Contributions to the, 1) clinical care or research described in a manuscript or 2) preparation of a manuscript made by persons other than the authors may be acknowledged.

Upon acceptance for publication copyright becomes vested with the journal.

Manuscripts based on clinical investigation of human subjects must adhere to the ethical principles of the Declaration of Helsinki developed by the World Medical Association. **https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/**

Manuscripts based on clinical investigation of human subjects must include the consent of the patients or study participants or appropriate person (parent/guardian) and a statement of approval from an appropriate Institutional Review Board (IRB)/Ethics Committee. The IRB/Ethics Committee must review and provide oversight or grant exemption from requiring patients' or study participants' consent for the performance of audits and this should be referred to in the text.

Manuscripts must protect patients and study participants from being identified. UIA adheres to the USA HIPAA Privacy Rule that defines 18 identifiers that must be removed to assure the protection of personal health information. **https://privacyruleandresearch.nih.gov/pdf/HIPAA_Privacy_Rule_Booklet.pdf (Specifically refer to page 10)**

Manuscripts should adhere to Uniform Requirements for Manuscripts Submitted to Biomedical Journals prepared by the International Committee of Medical Journal Editors. **http://www.icmje.org/recommendations/browse/manuscript-preparation/preparing-for-submission.html**

Manuscript Types

As an official journal of the WFSA, UIA is the appropriate forum for publication of articles describing anaesthesia patient care, original research and audit conducted in, and specifically relevant to, low and middle income resource settings.

Manuscripts describing clinical care, research, procedures, techniques or equipment adapted by anaesthetists to the limited resource setting in which they care for patients are welcome in any of the following formats:

- Review article - Basic Science or Clinical (3000 words maximum)
- Original Research (3000 words maximum)
- Case Report/Clinical Overview (1500 words maximum)
- UIA Short Reports (750 words maximum)
- Editorials (1200 words maximum) - Editorials are usually by invitation of the Editor-in-Chief. Proposals for Editorials may be sent to the Editor-in-Chief for consideration and potential invitation.
- Review of Books or other Educational Materials (eg web app) (750 words maximum)

- Letters to the Editor (1000 words maximum) - Correspondence is welcome on any topic, article or editorial that has appeared in UIA or is of interest to individuals providing anaesthesia patient care.

COMPONENTS OF THE MANUSCRIPT

Title page that includes:

- Title of the article
- Name and affiliation of each author
- Email, postal address and telephone contact details of the corresponding author
- Key words using terms from the Medical Subject Headings (MeSH) of Index Medicus https://www.nim.nih.gov/mesh
- Abstract that includes no more than 200 words

For research manuscripts note Background, Methods, Results, and Conclusions

ILLUSTRATIONS / FIGURES

Tables, figures, graphs and illustrations should be submitted as electronic versions of drawings (black on white) or as black and white or colour picture files in JPEG format. If computer or internet access is unavailable, print versions may be submitted. If facilities to produce drawings are unavailable, contact the Editor-in-Chief for assistance. Text accompanying tables, figures, graphs and illustrations should be supplied on a page separate from the image.

Tables, figures, graphs and illustrations copied from other publications must be accompanied by a statement that permission for reproduction has been obtained from the publisher. A footnote acknowledging permission to reproduce must accompany the copied table, figure, graph or illustration and the full reference of the original source included in the reference list.

If patients appear in an identifiable photo, a copy of their consent to the use of their image must be submitted.

REFERENCES

A minority of UIA readers have extensive access to journals. References, therefore, should in general be limited to those that are considered 'desirable supplemental reading', and should not exceed 25 references. Number the references in the order they appear in the text, using the reference number as a superscript at the relevant point in the text.

Reference style should adhere to the format set forth in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals prepared by the International Committee of Medical Journal Editors http://www.icmje.org

Abbreviations for journal titles should follow Index Medicus format https://www.ncbi.nlm.nih.gov/nlmcatalog/journals

Examples of the recommended format for references are noted below and can be found at https://www.nlm.nih.gov/bsd/uniform_requirements.html

1. Reynolds F, O 'Sullivan G. Lumbar puncture and headache. 'Atraumatic needle' is a better term than 'blunt needle'. Br Med J 1998; 316: 1018.
2. Costigan SN, Sprigge JS. Dural puncture: the patients' perspective. A patient survey of cases at a DGH maternity unit 1983–1993. Acta Anaesthesiol Scand 1996; 40: 710–14.
3. Spriggs DA, Burn DJ, French J, Cartlidge NE, Bates D. Is bedrest useful after diagnostic lumbar puncture? Postgrad Med J 1992; 68: 581–3.

References to textbooks should give book title, place of publication, publisher and year; those of multiple authorship should also include chapter title, first and last page numbers, and names and initials of editors. For example:

1. Roberts F. Chapter 22: Ear, nose and throat surgery. In: Allman KG, Wilson IH, eds. Oxford handbook of Anaesthesia (1st edition) Oxford: Oxford University Press, 2001: 506-39.

Unpublished manuscripts in preparation or submitted yet not accepted for publication and personal communications and unpublished observations should be referred to as such in the text.

Articles accepted and not yet published should be included in the references, with the abbreviated journal name, followed by '(in press).

MEDICATIONS

Use international units, e.g. mg.kg -1 rather than mg/kg. Use SI notation for g, mg, mcg etc. Use internationally accepted non-proprietary generic medication names, e.g. furosemide, epinephrine and avoid trade names.

Manuscripts should be submitted to:

https://www.editorialmanager.com/wfsa/default.aspx

UIA's Editorial Team will be delighted to help with the preparation of articles. Please contact the Editors-in-Chief for any assistance.

- Christina Lundgren
  Chris.Lundgren@wits.ac.za
- Victoria Howell
  updateinanaesthesia@gmail.com

If you are unable to upload your manuscript to the online submission system, please email them directly to the editors.

Alternatively manuscripts may be sent to:

World Federation of Societies of Anaesthesiologists (WFSA)
Dean Bradley House,
52 Horseferry Rd,
London
SW1P 2AF
England

Update in
Anaesthesia
Education for anaesthesia providers worldwide

Volume 38 February 2024

Design and printing: sumographics ltd. e: info@sumocreative.co.uk