

## The path to safe and accessible anaesthesia care

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### ABSTRACT

The increasing focus on and importance of surgical care in achieving universal health coverage requires the development of safe and accessible anaesthesia services. Increasing access to care by supporting the necessary inputs to the anaesthesia system, including medications, equipment and personnel, must be accompanied by processes that support high-quality care, including support for education, and guidelines for standards, and training. As safe, high-quality care requires an integrated approach, each element must be supported together, i.e., in an integrated manner to ensure that anaesthesia care reaches those who need it, and in the safest possible manner. Several important efforts have been undertaken globally to address and foster these elements, and resources to guide these processes exist for low- and middle-income countries to improve them. This review highlights both the needs and resources for safe and high-quality care that patients deserve.

**Key words:** Anaesthesia, global health, human resources, quality, safety, workforce

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## INTRODUCTION

Globally, anaesthesia has never before been safer. Much progress has been made in the safety and quality of anaesthesia. Despite this, the gains in anaesthesia safety have not been shared equally across the globe. While rates of anaesthesia-related mortality decreased sharply in high-income countries, low- and middle-income countries (LMIC) continue to face relatively high anaesthesia and perioperative-related mortality rates.<sup>[1,2]</sup> It is clear that performing an anaesthetic is not always the same as delivering safe anaesthesia or perioperative care. Operative volumes, in India and other LMICs, are continuing to increase, as governments increase investment in surgical systems. It is important that the anaesthesia community continues to improve the delivery of safe, high quality and equitable anaesthesia care in an environment of increasing anaesthesia activity.

### What are the elements of safe care in anaesthesia?

Emphasis in the past has been placed on ensuring the inputs to the health system were adequate.

For anaesthesia, these have been investments in human resources and ensuring the baseline adequacy of infrastructure to perform anaesthesia, e.g., medications, equipment and facilities.

Measuring health system inputs has in many cases served as the primary measure of health system capacity. From the perspective of safety, these foundational elements are necessary, but not sufficient; also foundational, and of equal or greater importance, are the processes that enable their utilisation. These processes are a complex web of governance structures, training and practice guidelines.

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This review will focus on three critical elements to providing safe anaesthesia: standards and training as important processes for delivering safe anaesthesia, equipment and human resources as important inputs to anaesthesia safety.

### Standards and training

The delivery of high-quality anaesthesia demands the performance of the right actions at the right time. Given the availability of appropriate minimum resources, the practice of modern anaesthesia can be incredibly safe, with a mortality rate in the range of 2/100,000.<sup>[1,3]</sup> While there are local differences in resource availability and variation in delivery of anaesthetics, the principles of quality care apply regardless: safety, effectiveness, patient-centredness, timeliness, efficiency and equity.<sup>[4]</sup> Yet increasing access alone is not sufficient to improve outcomes—in India, the Janani Suraksha Yojana ('safe motherhood scheme') used cash transfers to incentivise mothers to deliver in hospital instead of at home. The program resulted in a significant increase in number of hospital-births but had no effect on maternal mortality.<sup>[5]</sup> Subsequent analyses suggested that inadequate quality of obstetric care at these hospitals may have played a large role.<sup>[6,7]</sup> Simply increasing medical activity and access alone is not enough; this must be accompanied by delivery of care at an adequate and recognised standard.

The WHO-WFSA International Standards for a Safe Practice of Anesthesia outlines the resources essential for the provision of safe anaesthesia according to hospital facility level and case mix.<sup>[8]</sup> The workgroup for this project was extensively multinational and evenly balanced for low-middle-high income countries. The document uses WHO nomenclature where 'highly recommended' is the equivalent of 'mandatory' and should be interpreted as such. The Standards are structured or layered according to hospital level—Health Centre or small hospital where minor operations may be performed; District Hospital capable of doing 'Bellwether' procedures such as caesarean section, laparotomy, long bone fracture; and Tertiary Specialist hospital doing for example cardiac surgery or neurosurgery. The inclusion of these or similar Safety Standards in national guidelines acts as a tool that can be used for advocacy to governments and administrators, by demonstrating a global and national consensus on minimum requirements for safe care. It allows national and state societies to petition for resources to meet internationally accepted standards and requirements, without which

anaesthesia could be considered 'unsafe'. Furthermore, many national societies of anaesthesia have developed their own minimum professional standards of care which apply to the practice of anaesthesia in their own country (including India), which outline baseline standards of quality care delivery in the local context.<sup>[9]</sup> An increasing number of national anaesthesia societies have asked their ministries of health and/or hospital accreditation agencies to adopt or endorse the WHO-WFSA Standards.

The Standards cover professional aspects, facilities and equipment, medications and intravenous fluids, monitoring, and the conduct of anaesthesia. The Professional Aspects section clearly indicates that WHO endorses 'anesthesiology as a medical practice. Wherever and whenever possible, anesthesia should be provided, led, or overseen by an anesthesiologist'. This section leaves room for local interpretation in the design of the anaesthesia workforce to include non-physician providers working with anaesthesiologist leadership where deemed appropriate and feasible by local and national anaesthesia leadership. In order to allow providers to practise at the specified standard, providers must be trained to a standard. Anaesthesia training differs worldwide, with varied training duration and content.<sup>[10]</sup> As much as possible, training should be standardised to the local practice context, at the national or larger regional level. One way to ensure this is with a common accreditation process—for instance, a single national or regional exam that providers must pass in order to practise, regardless of where they were trained. This gives programmes an incentive to increase education quality, in the interest of having their graduates able to pass the exam (and practice).

Maintenance of competence can be especially challenging in settings with large geographic distances and low provider densities, where anaesthesia providers report going extended periods of time without significant continuing medical education. Helpful in these settings are free high-quality education resources like Anaesthesia Tutorial of the Week (ATOTW), OpenAnesthesia, and the Society for Pediatric Anesthesia (<https://www.wfsahq.org/resources/anaesthesia-tutorial-of-the-week>, <http://www.openanesthesia.org/encyclopedia/>, <https://www.pedsanesthesia.org>). UptoDate is another notable online education platform that often provides free subscriptions to select providers who serve the public sectors in resource-constrained settings (<https://www.globalhealthdelivery.org/uptodate/apply#criteria>).

ATOTW is a free, online extensive library of peer-reviewed educational material and continuing professional development activities with a focus on LMIC relevant topics. There are 17,000 subscribers for this free resource, with the main users from India, UK, US, Australia, Nigeria, South Africa, Malaysia, Brazil, Egypt and Pakistan.

After formal clinical training, options for structured continuing education programmes are often limited to clinical conferences, which may be cost prohibitive, focused on new research with less immediate clinical application, entail significant travel, or impact anaesthesia service delivery in understaffed areas. Short, focused clinical or education courses are one option to address these challenges. Several short courses target the practising anaesthesia provider [e.g., Safer Anaesthesia From Education (SAFE), Essential Pain Management (EPM), and Vital Anesthesia Simulation Training (VAST), all offered by WFSA], or medical educators [e.g., Inspire, Simulation in Medical Education (SMiLe) courses]. Short courses typically involve mixed didactic and practical sessions, and funding is often available to cover expenses for practitioners. A key component of the model is sustainability, and courses include days to ‘train the trainers’, with the aim that each course can be adopted and used by motivated individuals in the host country. Despite the practicality of short courses, their impact on quality of training and clinical performance has yet not been rigorously demonstrated.

In India, SAFE is being piloted in Telangana, and has so far trained 365 anaesthesiologists and 93 nurses as part of a four-year funded collaboration with Masimo Inc. Attendees rate the SAFE experience highly, with delegates consistently rating the experience to be useful, relevant, and likely to change practice, and knowledge improvements persisting up to 12 months.<sup>[11]</sup>

### Equipment and resources

Readily available equipment and medications are necessary for anaesthesia delivery. In many LMICs, there is still a significant lack of the fundamental materials necessary for safe anaesthesia, including even basic infrastructure. A survey of 78 government district hospitals across several continents showed that 32% did not have access to continuous electricity, and 15% did not have access to constant running water.<sup>[12-14]</sup> Access to anaesthetic equipment is often also lacking, as several surveys in low-income countries demonstrate lack of consistent access to

laryngoscopes and other airway equipment.<sup>[15-17]</sup> Access to medicines is similarly inconsistent, and not limited to LMICs; in high-income countries, drug shortages occur frequently and change the anaesthetic plan, possibly resulting in adverse events or postoperative complications.<sup>[18]</sup>

### Medicines

Lack of access to opioids is among the most stark of the medication challenges facing the global anaesthesia community. Opioids are an essential component of the delivery of safe, quality anaesthesia and perioperative care, yet access to opioids outside high-income countries is in many cases severely restricted. It is estimated that 96% of the need for opioids for palliative care in India goes unmet, with only a meagre 40 mg of morphine-equivalent available per patient.<sup>[19]</sup> In contrast, the amount of morphine-equivalent available per palliative care patients in Australia and Canada is more than 40,000 mg and 68,000 mg, respectively.

The barriers to opioid access are several and include limited resources, structural issues in opioid governance, and societal perspectives. While increased resources are necessary, the cost of an essential package of medicines for palliative care could cost as little as \$2.16 (Rupee 150) per capita per year.<sup>[19]</sup> However, the international system of regulation of opioids designed to limit the illicit use of narcotics often has the effect of reducing their availability for legitimate medical uses.<sup>[20]</sup> For instance, multiple licenses were required in India to dispense narcotics (with heavy punishments for violation including up to 20 years in jail), in part to comply with international treaties. Though this law was changed in 2014 to reduce the requirement to one license, the availability of opioids has not yet increased to medically necessary levels.

Efforts such as the WHO Model List of Essential Medicines attempt to outline the drugs which are absolutely essential to healthcare, and contain an important selection of drugs frequently used in anaesthesia.<sup>[21]</sup> Still, this approach is not without problems. As a non-binding document, this list is simply a suggestion, and some Ministries approach the Essential Medicines List as the maximum boundary, instead of the minimum requirement it is intended to be. As a non-mandatory ‘model list’, effectively an ‘optional’ list, it leaves too much room for interpretation by policymakers and puts no pressure on the pharmaceutical industry to make medications available that yield minimal profits.

Mandatory minimum equipment and medicines for anaesthesia should be agreed upon by national societies, to demonstrate to governments that the resources for conducting safe anaesthesia are not optional (e.g., WHO-WFSA International Standards for anaesthesia, discussed above).

### Equipment

In addition to basic infrastructure, specific anaesthesia equipment and monitors are required to deliver optimally safe care. Pulse oximeters are an example of how research, international collaboration and local advocacy have made a difference in equipment availability. A modelling study in 2010 estimated that 77,000 operating theatres worldwide did not have access to pulse oximeters.<sup>[22]</sup> This helped catalyse global efforts to increase pulse oximeter availability, including the creation of an inexpensive, durable device designed specifically for LMICs. The Lifebox Initiative is a charity created by the World Federation of Societies of Anaesthesiologists (WFSA), Brigham and Women's Hospital, Harvard T.H. Chan School of Public Health, and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) with the stated aim of distributing such pulse oximeters to resource-constrained settings in conjunction with provider training on oximeter use. The Lifebox Initiative has increased oximeter utilisation and with evidence of fewer intraoperative desaturation episodes, and likely improved outcomes.<sup>[23]</sup>

In areas with lack of anaesthesia monitoring equipment, providers are often in a difficult position of having to advocate for acquisition of many items at once. Carbon dioxide detection with capnography is another technology that shares many similarities to pulse oximetry. It is included as a highly recommended monitor in international guidelines, yet the 'capnography gap' (the difference between the proportion of total number of operating rooms with and without access to capnography) is probably larger than that for pulse oximetry. In Telangana, >90% of facilities have access to pulse oximetry, an example of the effectiveness of physician advocacy for resources, yet only 60% have access to capnography, with particular deficits in rural areas. (Unpublished data)

Like pulse oximetry, it has several potential critical uses, especially in LMICs where anaesthetic morbidity from airway complications is a relatively frequent event. In addition, pulse oximetry provides relatively late warning of airway complications (hypoxia) from

obstruction or misplaced airway.<sup>[24]</sup> Implementation of capnography has had some early success—introduction of capnographs in Malawi resulted in increased knowledge about capnography, with most providers reporting recognition of oesophageal intubation and belief that capnography had saved lives. The authors estimated that there are approximately 11,000 deaths per year in Sub-Saharan Africa from oesophageal intubations.<sup>[25]</sup> Colorimetric capnography is considered highly recommended by the WFSA-WHO Standards for anaesthesia, but continuous waveform capnography will be automatically highly recommended once appropriately robust and priced devices become available.<sup>[8]</sup>

Each country, state and facility has its own specific and local equipment and resource challenges. The Anesthesia Facility Assessment Tool (AFAT) is a survey instrument based on the WHO-WFSA International Standards for a Safe Practice of Anesthesia developed to enable the characterisation of anaesthesia resources at the facility (hospital) level relative to the Standards. It captures over 200 items with respect to infrastructure, blood product services, information management, workforce, service delivery, medications, equipment, surgical logbook and organisation. In India, the AFAT has been administered in over 100 hospitals in Telangana to map anaesthesia resources in the state in a project funded by Masimo Inc. In Bihar, a similar anaesthesia mapping project is being done by Bhabha Atomic Research Centre (BARC, Mumbai), the federal ministry of health, and WFSA.

This information is an important necessary first step to enable practitioners to advocate for the equipment necessary to provide safe anaesthesia. In many cases, this process has highlighted deficits of even basic equipment and drugs that should have been present, but either were not budgeted for, not ordered, not delivered, or consistently out of stock. This is a tool that anaesthesia department leadership can use to demonstrate to hospital administrators and health ministries that the reality does not match what is needed according to the WHO-WFSA International Standards for a Safe Practice of Anesthesia.

### People

A core requirement for safe anaesthesia delivery is an adequate number of qualified anaesthesia providers. Inherent in this are two questions: how many providers are adequate, and who is qualified? Recommendations on provider numbers come from

observational studies comparing provider densities internationally with patient mortality rates, most commonly maternal mortality rate.<sup>[26]</sup> The currently estimated recommended minimum for combined surgery, anaesthesia, obstetric providers is 20 per 100,000 population.<sup>[27]</sup> While imperfect, these recommendations provide the basis for what is likely a minimum viable anaesthesia workforce. As a practical guideline, recommendations have suggested that 4–5 anaesthesia providers per 100,000 people is a necessary minimum but not sufficient target for safe anaesthesia provision at a population level.<sup>[28]</sup> The WFSA Workforce Survey demonstrated that there is a wide heterogeneity in anaesthesia provider densities in different countries, with some high-income countries like the USA, Sweden, Australia reaching >20 providers per 100,000.<sup>[29]</sup> Based on data provided by the Indian Society of Anaesthesiologists, it is estimated that India's anaesthetic workforce has a density of approximately 1.27 physician anaesthesiologists per 100,000. This is substantially below the recommended minimum for the Indian population. India needs approximately 40,000 more anaesthesia providers to meet the minimum of 4 per 100,000.

In order to reach the recommended provider density, more qualified providers must be trained. However, the question of who are qualified anaesthesia providers and for what type of cases (i.e., scope of practice) is complicated and must be determined together by the national or state anaesthetic society and the relevant ministry of health. At the population level, the anaesthesia services that a health system requires are broad, ranging from the pharmacologic provision of moderate/deep sedation and/or general or neuraxial anaesthesia, to technical skills (e.g., intubation, central line placement), optimisation of systemic diseases, pain management, and critical care. A physician trained in the speciality of anaesthesiology is proficient in all of these areas, so while practitioners in other areas of medicine overlap in some of these skills, proficiency in only certain component parts does not ensure proficiency in the full scope of practice required to provide safe anaesthesia and perioperative care.

Many physician anaesthesia societies take the stance that the provision of anaesthesia is a medical speciality, as endorsed by the WHO, and can only be administered by physicians. Training specialists who can perform the full scope of anaesthesia tasks from the simplest to the most complex is one way that several countries have chosen to provide the scope

of anaesthesia care a health system requires. Many other countries also routinely employ providers other than physician specialists, who are trained to perform some combination of these tasks (with full, partial, or no supervision), in accordance with their level of training and legal regulations. For instance, in Canada, Anesthetic Assistants provide technical help with setting up anaesthetic equipment and monitoring the patient intraoperatively.<sup>[30]</sup> In the UK, the law stipulates that anaesthetic induction requires 'four hands', that is, the presence of either a second anaesthesiologist or an Operating Department Practitioner (a technician knowledgeable in the set-up and use of anaesthesia equipment). Switzerland has a three operator model, including physicians, nurse anaesthetists, and anaesthetic assistants. In some countries, the number of non-physician providers outnumber the physician anaesthesiologists. This is the case in Sweden where there is a 4:1 ratio of nurse anaesthetist to physician anaesthesiologists. Such an arrangement, known as task sharing, can be particularly useful when the deficit in anaesthesia providers is large. These providers, who may come from a nursing background or other clinical background, typically have a shorter training duration, receive lower pay than physicians, and are legislated to work under supervision, i.e., without independent practice. While it is true that in the USA the relationship between nurse anaesthetist and physician anaesthesiologists has become highly politicised at the national level, in many operating theatres relations are mutually supportive. Furthermore, this is not the experience in many countries that have alternate providers working under supervision. The better relationship perhaps reflects that it has often been the physician anaesthesiologists who have led the development and training of the non-physician providers, and have actively participated or led the establishment of an appropriate regulatory framework while also engaging with non-physician stakeholders throughout the process.

It is of paramount importance that if anaesthetic tasks are shared with other non-physician providers, they be performed to the same standard of safety that a physician can provide.<sup>[8]</sup> Several countries have adopted the model of the anaesthesia care team, in which anaesthesia tasks are shared by qualified team members and typically overseen by a physician specialist in anaesthesia. These care teams take several different forms, as determined locally, with different types of providers performing a different suite of tasks, and with appropriate supervision

are able to deliver high-quality care to an expanded group of patients. This substantially expands access to anaesthesia services, increases income to the hospital and/or anaesthesiologist, satisfies ministries of health, and the public. There has been no evaluation to date that demonstrates a difference in outcome according to anaesthesia provider type.

## SUMMARY

The delivery of quality anaesthesia care depends on a reliable foundation of healthcare inputs, including adequate infrastructure, reliable supplies of equipment and medications, and an adequate number of skilled anaesthesia providers. To ensure population coverage, a minimum anaesthesia provider density must be produced and trained to a high standard. There are many models to accomplish this, some of which include non-physicians who are trained to provide certain anaesthesia tasks at a high level of quality under physician anaesthetist direction.

The anaesthesia leadership in any country has the responsibility to ensure that the population as a whole has access to safe, high-quality anaesthesia. This requires local solutions, tailored to local needs and local resources. In all cases, the practice of anaesthesia should be guided by a set of minimum, locally agreed upon practice standards. To support these practices, accurate information regarding available resources is important. Standardised training and examinations will promote a baseline standard of quality, and continuing education courses can assist providers in practising at a high level of skill while maintaining professional development. The WHO-WFSA International Standards for a Safe Practice of Anesthesia has defined a set of minimum equipment and monitoring standards applicable worldwide that local societies can build upon. National anaesthesiology leadership is crucial in setting the standards for care delivery and to advocate for the necessary resources from government and hospital administrations. Monitoring and evaluation of performance is needed on an ongoing basis to assure the public that the highest possible standards and quality are being achieved.

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There are no conflicts of interest.

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