

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

Update in Anaesthesia

Education for anaesthesia providers worldwide

Volume 33

January 2019

Editor-in-chief: Alan Jay Schwartz

ISSN 1353-4882

Associate editors: Christina Lundgren and Victoria Howell

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Typeset by Prepress Projects Ltd, Perth, UK

Printed by COS Printers Pte Ltd, Singapore

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Update on Update!

This issue of *Update in Anaesthesia* is the first publication facilitated by me as your new editor-in-chief. I am thrilled to bring you, as my first issue of your journal, a collection of safety articles. Safe anaesthesia patient care is our primary goal! Recognising this imperative, the World Federation of Societies of Anaesthesiologists (WFSA), in collaboration with the Anaesthesia Section of the Royal Society of Medicine (anaesthesia@rsm.ac.uk), jointly organised and conducted the SAFE-T (Safe Anaesthesia for Everybody – Today) Summit 2018.

The SAFE-T Summit 2018 provided an opportunity for anaesthetists, surgeons, obstetricians and allied health providers to focus on the principles of safe surgery and all that enables this to be possible, especially safe anaesthesia care. This issue of *Update in Anaesthesia* brings you nine articles that cover some of the important topics considered at the SAFE-T Summit 2018.

To complement the articles from the summit, three previously published safety-focused articles from *Anaesthesia Tutorial of the Week* (ATOTW) have been

reprinted for your review. These tutorials are most pertinent to the topics presented at the SAFE-T Summit 2018. Please join me in thanking ATOTW editor-in-chief, Maytinee Lilaonitkul, for sharing these important safety tutorials.

Completing this issue of *Update in Anaesthesia* are three original manuscripts. The topics discussed in these submissions, that is, utilisation of simulation to teach management of critical events, vascular access techniques and care of a patient with malignant hyperthermia in a low-resource environment, provide important safety considerations.

This issue of *Update in Anaesthesia* launches a new phase of your journal's existence. I look forward to bringing you more themed issues that will focus on important anaesthesia patient care issues. I am eager to bring you more original articles to showcase your scholarly work, be it case reports, review articles or original research. Enjoy and learn from reading this and future issues of *Update in Anaesthesia*. I hope you will share your ideas and manuscripts with me at schwartza@email.chop.edu.

Alan Jay Schwartz, MD MSED

Department of Anesthesiology and Critical Care Medicine
The Children's Hospital of Philadelphia
Philadelphia, PA 19104-4399, USA

Professor of Clinical Anesthesiology and Critical Care
Perelman School of Medicine
University of Pennsylvania

Correspondence: schwartza@email.chop.edu



The WFSA would like to thank Baxter for their financial support of this edition of *Update in Anaesthesia*

Baxter

The global challenge for patient safety: scope and definition

Tore Laerdal

Correspondence: Tore.Laerdal@laerdal.com

Patient safety is normally defined as omission of harm during medical care in hospital. Relative to the global challenge, a wider scope is needed, including the primary care sector and coverage of care, or lack thereof, as well as quality of care. There are no global statistics on deaths caused by medical error. Estimates vary greatly. A review of US-based studies¹ indicates that the number of deaths in US hospitals alone may be between 200,000 and 400,000 per year. Extrapolating these numbers may give a global estimate of 3–5 million deaths per year. However, the death toll is likely to be much larger than this estimate. In low- and middle-income countries (LMICs), where 82% of the global population lives, most medical care takes place in primary care institutions and is delivered by non-physicians. Many deaths that may have a root cause in lack of access to care and poor patient safety end up being classified in other categories. Given the magnitude of the problem, it may appear as a paradox that patient safety is not referred to specifically in any of the 17 sub-goals of the United Nations (UN) Sustainable Development Goal (SDG) 3, to secure health and well-being for all.² One explanation may be the misclassification of patient safety issues and another may be patient safety's vaguely defined nomenclature, measurement indicators and reporting requirements. What is not measured tends to get less attention. In comparison, two other categories of death, death from sudden cardiac arrest (SCA; under 70 years of age) and maternal/newborn death, are more clearly defined and part of SDG3, with goals set for reduction by 2030 of one-third and two-thirds, respectively. These

categories each claim about 5 million lives per year if 1.3 million fresh stillbirths are also included. What lessons can be learned from fighting these categories of death that are relevant to the global challenge of patient safety? (Figure 1).

LESSONS FROM FIGHTING SUDDEN CARDIAC DEATHS

Today, 60 years after the introduction of cardiopulmonary resuscitation (CPR), in-hospital survival from SCA in the USA is about 25%, representing 50,000 survivors among 200,000 patients.³ More recent studies have shown that the quality of CPR delivered greatly impacts patient outcome. Whereas poor CPR has marginal clinical impact, high-quality CPR may enhance the chances of patient survival by three to four times.⁴ Therefore, the American Heart Association (AHA)⁵ recently declared that 'Poor quality CPR should be considered to be a preventable harm'. Evidence now shows that what is increasingly referred to as 'low-dose, high-frequency training'⁶ is significantly more effective for the acquisition and maintenance of CPR skills than traditional 2-yearly certification.

To secure more efficient in-hospital resuscitation practice, the AHA and Laerdal have developed the Resuscitation Quality Improvement (RQI) Program, which enables practitioners to refresh their skills in low doses every month in the workplace. They can do this during a short break and do not need to be absent for up to a day, as is the case with traditional CPR training methods. Since its introduction, approximately 300 hospitals in the USA have adopted the RQI Program, enrolling and improving the competency of over 300,000 healthcare providers. At the 6th World Summit on Patient Safety held in London in February 2018, the AHA presented a 2025 commitment to help save 50,000 more lives each year by widespread adoption of the RQI Program across US hospitals, combined with strategies to prevent cardiac arrest and implementation of practices known to improve survival.

Tore Laerdal MSc
Executive Director
Laerdal Foundation
Stavanger
Norway
and
Chairperson
Laerdal Medical
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UK
and
Chairperson
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Stavanger
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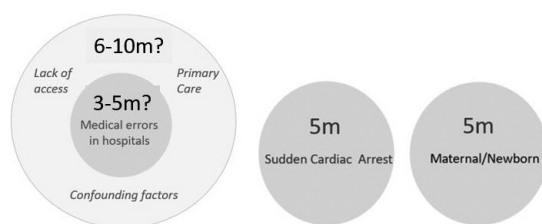


Figure 1. Scope and magnitude of the patient safety challenge relative to sudden cardiac and maternal/newborn deaths.

Out-of-hospital survival from SCA is estimated to average around 10% in high-income countries (HICs) and to be as low as 1% in LMICs. However, there is a 10-fold or more difference in survival from the worst- to the best-performing emergency medical systems (EMSs), even between and within HICs.⁷ What might explain such differences when all systems have access to the same science and use similar education curricula and equipment? This question was first addressed in 1990 at an expert meeting at Utstein Abbey outside Stavanger, Norway. The meeting resulted in widely endorsed recommendations on reporting outcome data. Without good measurement, it is difficult to improve. The Utstein Formula for Survival⁸ stipulates that the chances of survival may be expressed as the product of three factors: medical science, educational efficiency and local implementation (Figure 2). There are strong reasons to believe that the last two factors in this formula are the weakest and where most additional impact could be achieved. Without effective education and implementation, there will be little impact of advances in medical research.

At another Utstein meeting in 2015, experts from around the world made a call to establish a Global Resuscitation Alliance, with an objective of helping increase survival from cardiac arrest by 50% by 2020 by adherence to 10 suggested steps for best practice in the community (Box 1). A report published in 2018, *Acting on the Call*,⁹ details 27 case examples on progress, giving hope that the goal of 50% increased survival may be realistically achievable. This is supported by strong case examples from Japan and Denmark, with both showing an impressive tripling in survival over the past 10 years by leveraging national registries for measuring all out-of-hospital cardiac arrests (OHCAs) as a basis for systematic improvement plans.

A meeting convened in Singapore in August 2017 concluded that the same 10 steps were also relevant for developing EMSs in LMICs, but they needed to be applied in a local context. Factors that the individual EMS service may influence include strong local leadership, efficient training, quality improvement and establishing a culture of excellence. Factors that represent additional challenges in LMICs include restricted healthcare budgets, cultural attitudes to helping strangers, ignorance of lifesaving techniques among bystanders and poorly developed emergency dispatch systems and ambulance services. Addressing such factors may often require a longer term perspective.

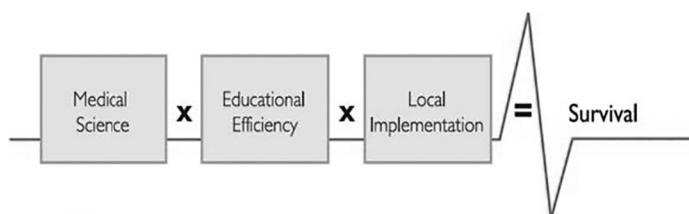


Figure 2. The Utstein Formula for Survival.

Box 1. The 10 best practice steps for increasing survival from out-of-hospital cardiac arrest

1. Cardiac arrest registry
2. Telephone CPR for more and better CPR
3. High-performance EMS CPR
4. Rapid dispatch
5. CPR performance data
6. First-responder automated external defibrillator (AED) programmes
7. Smart technologies to expand CPR and public access defibrillation (PAD)
8. CPR/AED training in schools and the community
9. Accountability
10. Work towards a culture of excellence

LESSONS FROM FIGHTING MATERNAL/NEWBORN DEATHS

In total, 800 babies and 80 mothers die at birth every day, nearly all in LMICs. Over 80% of these deaths could be prevented by well-trained and equipped birth attendants. Asphyxia is the leading cause of early newborn death, officially claiming 700,000 lives every year. In addition, some 1.3 million babies classified as 'fresh stillbirths' have a heartbeat during labour. Many of these could be resuscitated and would likely more correctly be classified as being asphyxiated. On top of this, a million babies survive with brain damage as a result of a compromised oxygen supply during labour.

Some 10 years ago, Laerdal had the privilege of partnering with the American Academy of Pediatrics to develop the Helping Babies Breathe (HBB) programme¹⁰ to address this challenge. Today, more than 500,000 birth attendants in over 80 LMICs have been trained by this programme. Studies in Tanzania, Nepal, Uganda and Ghana¹¹ show that, when well implemented, this programme can reduce early infant mortality by as much as 50% and fresh stillbirths by 25%. The HBB programme makes lifesaving easier to learn and remember through use of a simple action plan, using a traffic light colour-coding system. Ten per cent of babies, in both HICs and LMICs, are born in the yellow colour zone, needing help to start breathing to move to the green zone. The traffic light stays yellow for only 1 minute, the 'golden minute'. If the right help is not given, the light will shift to red and the baby is likely to die. In rich countries, babies get this help; in poor countries, where close to 90% of all babies are born, more than half of the cases do not receive the necessary help.

The course uses scenario-based training in pairs. A low-cost, culturally adapted newborn simulator includes three simple squeeze bulbs enabling realistic training in addressing the three essential questions: Is the baby crying? Is the baby breathing normally? Does the baby have a heartbeat? Thus, the course makes use of two of the main recommendations in the landmark *To Err is Human* report by the

US Institute of Medicine:¹² train in teams those who work in teams and use simulation whenever possible.

Birth attendants must also be prepared to handle mothers at risk: 100,000 mothers are dying on the day of birth. Encouraged by the success of the HBB programme, Jhpiego (<https://www.jhpiego.org>), an affiliate of Johns Hopkins University, Baltimore, USA, and partners have developed with Laerdal the Helping Mothers Survive programme.¹³ These partners include the International Confederation of Midwives, the International Pediatric Association and International Federation of Gynaecology and Obstetrics.

A realistic and affordable simulator has also been developed to facilitate hands-on training in the control of bleeding after birth, the leading cause of maternal death. It is worn by the instructor like an apron and includes a blood tank and a uterus that can be made to contract. Having the facilitator and students in turn act as the delivering mother also facilitates training in *patient communication and respectful care, two important dimensions of patient safety*. The same educational methodology has been used to develop six more educational programmes. Together, these programmes address over 80% of the causes of deaths for both mothers and newborns through the continuum of care, from pregnancy through the first 4 weeks of life.

An Utstein meeting in 2015 established 10 steps for best practice implementation of these programmes¹⁴ (Box 2).

The SAFE (Safer Anaesthesia From Education) (<https://www.aagbi.org/international/safer-anaesthesia-from-education>) programme,¹⁵ introduced by the World Federation of Societies of Anaesthesiologists (WFSA) in collaboration with the Association of Anaesthetists of Great Britain & Ireland (AAGBI) in 2013, utilises many of the same educational principles. This course in obstetric and paediatric anaesthesia has already reached over 3000 anaesthesia providers in 30 low-resource countries.

Box 2. The 10 best practice steps for implementation of the HBB and Helping Mothers Survive programmes

1. Secure Ministry of Health buy-in
2. Form a working group for planning, training and monitoring
3. Develop a national roll-out plan, for pre-service and in-service training, in both the public and the private sectors
4. Provide learning materials and equipment at the time of training
5. Identify and support local leaders and champions
6. Establish low-dose, high-frequency refresher training
7. Establish facility-level quality improvement teams
8. Monitor performance
9. Establish a system for reporting and feedback
10. Engage healthcare professionals, families and the broader community

CONCLUSION

Three lessons that pertain to the global challenge of patient safety can be learned from fighting sudden cardiac arrest and maternal/newborn deaths:

1. more clearly defined nomenclature and criteria for data reporting may help increase awareness of the problems and provide a required basis for measuring and reporting patient safety;
2. strong local leadership, regular refresher training and quality improvement are essential for programme success;
3. partnerships play a key role in implementing and sustaining patient safety programmes.

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A global surgery, obstetrics and anaesthesia metamorphosis

Isabelle Citron and John G Meara

Correspondence: John.Meara@childrens.harvard.edu

NEGLECTED NO MORE

Just 3 years ago it was inconceivable to imagine the trajectory that the ‘Global Surgery’ movement would take. Three years ago, surgery was the ‘neglected stepchild’ of global health, too fragmented and nebulous to take part in the global health discourse and existing almost exclusively as missions or site-to-site partnerships.¹ In 2013, *The Lancet* commissioned an investigation into the state of surgical care worldwide. By the end of 2015, this report, a collaboration including over 110 countries, was published (*Lancet* 2015; 386: 569–624).² The *Disease Control Priorities*, third edition, had dedicated its entire first volume to highlighting the cost-effectiveness of surgery.³ The World Health Assembly had passed resolution 68.15 to include emergency and essential surgery and anaesthesia care as a component of Universal Health Coverage (http://apps.who.int/gb/ebwha/pdf_files/EB135/B135_3-en.pdf).⁴ In addition, the World Bank – through its president Jim Kim – called for time-bound targets for global surgery and by April 2016 the World Bank had accepted four surgical indicators in its World Development Indicators (WDIs) dataset (Table 1).^{5–7} Two years after the launch in 2017, the first National Surgical, Obstetric and Anaesthesia Plans (NSOAPs) were launched by Zambia and Ethiopia.^{8,9} By early 2018, a second worldwide wave of WDI collection had been completed, four countries had completed NSOAPs and many more are in progress.¹⁰ What is needed next for global surgery, obstetrics and anaesthesia is not a simple linear process; rather, it is a

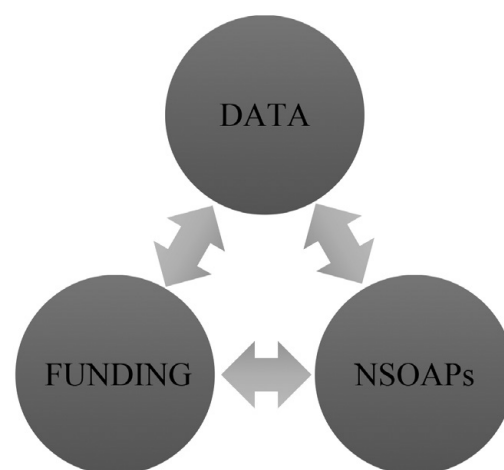


Figure 1. The next steps for the global surgery movement and their relationships.

cycle of three co-dependent elements: data, NSOAPs and funding (Figure 1).

DATA-DRIVEN ADVOCACY

Much of the success of the last 3 years can be attributed to data and, more precisely, data-driven advocacy. The *Lancet* Commission on Global Surgery and its associated publications generated over 50 original articles and over the last 5 years publications in global surgery and anaesthesia have increased fourfold. It

Table 1. World Development Indicators for surgery

No.	Indicator	Definition
1	SAO density	Physician surgery, anaesthesia and obstetric providers per 100,000 population
2	Procedure density	Procedures performed in an operating room per 100,000 population
3	Impoverishing expenditure	Direct out-of-pocket payments for surgical, obstetric and anaesthesia care that drive people below a poverty threshold
4	Catastrophic expenditure	Direct out-of-pocket payments for surgical, obstetric and anaesthesia care exceeding 10% of total income

SAO, surgery, anaesthesia and obstetrics.

Isabelle Citron BmBCh, MPH

Program in Global Surgery and Social Change
Department of Global Health and Social Medicine
Harvard Medical School
Boston, MA
USA

John G Meara MD, DMD, MBA

Department of Plastic and Oral Surgery
Boston Children's Hospital
Boston, MA
USA

is precisely because of this work on consensus building and data generation that the World Bank accepted four surgical/anaesthesia indicators (see Table 1). By endorsing these surgical metrics as WDIs, the World Bank creates a framework for countries to collect and transparently report progress, as Jim Kim challenged the global health community to do in 2014. Once collected, data can be used to advocate for improved access and quality of surgery, obstetric and anaesthesia care by shining a light on the current poor situation of surgery, obstetrics and anaesthesia worldwide, tracking progress made and creating evidence for policies that work to improve surgical outcomes. As the world moves towards results-based financing and impact investing, the goal is clearly to have high-quality data attract funding to improve surgery, obstetric and anaesthesia care and assess what does and does not work.

Despite these benefits, the global surgery community is at risk of losing this great opportunity afforded by the World Bank. To date, although there are data on up to 71 countries for some indicators, this has been achieved through externally driven efforts. No countries are systematically collecting and reporting the WDIs on a national scale.¹¹ The most logical solution is to integrate WDI collection into existing international tools and collection mechanisms. Examples include the integration of surgery-themed questions into some of the world's largest assessment tools such as the Demographic Health Survey or the Harmonized Health Facilities Assessment, developed with the World Health Organization (WHO) and to be launched in the next year.^{12,13}

NSOAPS PREPARE THE PATH

'If you don't know where you are going, any road will get you there'.¹⁴ For decades, national, regional and global health planning ignored surgical care delivery. If global surgery was a 'neglected stepchild', then anaesthesia was its 'invisible friend'. The solution to this lack of data collection involves NSOAPs, uniting all three communities, that are fully integrated into national, regional and global health strategies. Regular reporting of indicators is possible and in fact the norm for many health programmes. Take, for example, maternal and child health, for which 90% of countries report their annual maternal mortality rates.¹⁵ Through the establishment of NSOAPs, a country lays out a comprehensive strategy for improvement of surgery, anaesthesia and obstetric care across all six building blocks of the health system: workforce, infrastructure, service delivery, information management, finance and governance.¹⁶ The creation of the plan itself mobilises the surgery, anaesthesia and obstetric community in a country, brings a new prioritisation of surgery, obstetric and anaesthesia care and incentivises the collection of the indicators to serve as a baseline against which to measure progress and direct activities. Perhaps most importantly, the NSOAP lays out the mechanisms, data flows and governance systems responsible for collecting, collating and escalating data. In isolation, the World Bank request to collect the surgical WDIs, as has been seen, is an insufficient incentive. However, if these form part of a more comprehensive effort to elevate surgery, anaesthesia and obstetric care cohesively on the national agenda, and

there is a clear definition of how these indicators should be collected, surgical indicator collection will be hardwired into each country's monitoring and evaluation strategy. Going forward, countries that have completed their NSOAPs will serve as international leaders and experts to mentor and guide other countries through the process. To facilitate this process, engagement will be required from strong regional advocates such as the WHO Regional Offices, the African Union and the Southern African Development Community. These regional actors can provide technical support, financing, international advocacy and data collection.

FINANCE THE CHANGE

Writing and costing an NSOAP is only the first step; a critical mass of the activities need to be funded concurrently or the co-dependent cogs of the system will not turn. The unreliable drip of location- and disease-specific funding will not achieve the goals of strengthening health systems and Universal Health Coverage, which covers emergency and essential surgery and obstetric and anaesthesia care. Innovative ways of blending diverse sources of funding for NSOAPs will be needed. First, countries will need to mobilise domestic funding for NSOAP implementation and for healthcare more broadly, as, for example, was pledged by the African Union in the Abuja Declaration.¹⁷ Estimates have shown that 85% of funding for Universal Health Coverage can be met with domestic resources.¹⁸ However, this financing will need to be augmented by other sources, especially in the initial stages.¹⁹ Much of the financing required for NSOAP implementation is also needed for the majority of other health interventions, including reliable supply chains, water, electricity, blood banks and oxygen to name but a few. By ensuring that NSOAPs are written to complement, coordinate and not duplicate other funded policies and initiatives, the additional price tag associated with the NSOAP will co-fund other programme and development sectors. Finally, as well as looking to external funding, the coordinated expansion of surgery, anaesthesia and obstetrics creates a unique opportunity to create shared value that will expand markets and create health equity concurrently.²⁰ By creating systems that consistently deliver surgery, anaesthesia and obstetrics, NSOAPs create a consistent market for surgical devices and supplies and therefore a strong business case for industry investment.

No matter what the mechanism, all funders require data. The collection of data, notably the WDIs, will create the data that investors and donors require in order to make a case for investment, calculate the proposed return on investment and measure the real impact that investment is having on population outcomes.

CONCLUSION

Data create evidence to show that improvement is needed. NSOAPs build the roadmap for the process. Funding allows for the metamorphosis from plan to implementation and, coming full circle, data prove the impact of that investment and monitor progress

towards Universal Health Coverage and realisation of the Sustainable Development Goals. None of this will be possible unless all of the communities involved – anaesthesia, surgery and obstetrics – work in partnership, realising that the ‘elephant in the room’ is social change and health equity.

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Surgical capacity indicators in 2018 and beyond

Thomas G Weiser

Correspondence: thomas.weiser@ed.ac.uk

In the early part of the 20th century, Ernest Codman of the Massachusetts General Hospital described his 'end results system' that sought to identify poor outcomes and learn from them. It was the first formal 'morbidity and mortality' programme and for his efforts he was forced from the staff and out of his position. Modern forms of measurement have taken hold despite this early resistance, but realisation of the size and scale of this global undertaking is only just beginning. As we move to an era of Sustainable Development Goals (SDGs), Universal Health Coverage (UHC) and the integration of surgical services as an 'indivisible, indispensable part of health care', the importance of surgical surveillance has taken on increased urgency.¹ The global surgical, anaesthetic and surgical nursing community will not know the effect of care we provide and the advocacy we are engaged in if we neglect to attend to an understanding of capacity and outcomes of that care.

Surgical surveillance should aim to understand some essential components of care: the capacity to deliver surgical services, access to those services, the clinical needs of the population, the biological and functional outcomes of care and, in a nod to the SDGs and UHC, the economic outcomes of care. Although frequently neglected, surveillance should also seek to understand the quality of care and compliance with best practices and current standards of care.

In 2006, Debas and colleagues outlined the importance of surgical care and its cost-effectiveness in the second edition of *Disease Control Priorities*.² This was a remarkable body of work because, for the first time, an effort had been made to make a public health *and* economic argument for the value of surgical care in treating disease. Using disability-adjusted life-years (DALYs), an econometric measure of the value of healthy years of life, the authors noted that there were high-value services such as caesarean delivery, hernia repair, treatment of club foot and other congenital defects, and cataracts. DALYs resulting from diseases amenable to surgical correction or treatment were estimated to account for 12% of all disease burden. By the time the third edition of *Disease Control Priorities* was released, surgical burden was more accurately noted to be responsible for at least 18% of all disease burden, and perhaps as much as 30%;^{3,4} indeed, 6%

of the burden could be averted with a basic package of surgery.

At the same time as Debas was engaged in this work, the World Health Organization (WHO) was launching its Safe Surgery Saves Lives programme.⁵ As part of this effort, surgical surveillance was identified as a priority. The programme developed a working group to focus on surgical metrics, the results of which identified six specific indicators that might help inform surgical capacity, provision and outcomes: number of operating theatres, number of accredited surgeons, number of accredited anaesthesia professionals, number of operations, day of surgery death ratio and postoperative in-hospital death ratio.⁶ These were based on four primary guiding principles: that the proposed measures be simple, widely applicable and relevant to public health imperatives and that unintended negative consequences of measurement were minimised.

Early work from the WHO described the volume of surgery occurring globally. In 2004, 234 million operations were estimated to have taken place; in 2012, that number rose to 313 million, with massive growth noted in the poorest countries.^{7,8} This was followed by estimates of the distribution of operating rooms worldwide, and the resourcing of such infrastructure as a crude measure of safe capacity.⁹ Almost nothing was known about the provider landscape or mortality following surgery.

With the recent *Lancet* Commission on Global Surgery, an updated set of indicators has been identified; it includes measures of timely access, volume of surgical delivery, human resources for surgical and anaesthetic care, postoperative mortality and impoverishing and catastrophic expenditure.¹ However, 3 years following the publication of the Commission report, the global surgical and anaesthesia community is still struggling to deliver information on these basic indicators. A recent assessment by Commission members identified enduring gaps in information, with few countries able to report accurately on surgical access, volume of surgery or postoperative mortality.¹⁰ Definitions were variable, limiting their utility for comparative purposes. There was almost no information on impoverishment as a result of paying for surgical care.

Thomas G Weiser MD, MPH, FACS
Visiting Professor of Surgery
University of Edinburgh
and Royal Infirmary of
Edinburgh
Edinburgh
UK

Of the indicators, only the surgical and anaesthetic workforce density indicator was fairly complete, as recent work has demonstrated.^{11,12}

Although enthusiasm is high amongst the global surgical and anaesthetic community, many threats remain. First, there is a lack of leadership at the highest level, particularly among convening and normalising bodies such as the WHO or the World Bank. The World Bank has expressed interest in the work and has provided a venue for distributing information that has been collected to date, but has not provided further structure or ongoing funding to enable or encourage sustainable data collection. This has led to a lack of collaboration and coordination aside from individual efforts and relationships between like-minded individuals working to fill the knowledge gap. A lack of funding severely impedes the work, as data collection takes effort, time and human resources. Few inroads have been made to engage the public to support, indeed insist on, such efforts. Finally, the potential perverse negative effects of data collection and reporting cannot be underestimated or overstated. Countries that have no incentives to understand what is happening or report truthfully on surgical services likewise have little interest in or appetite for data collection that will undoubtedly tap scant resources with marginal benefit and almost no clear direction for improvement.

Given recent advances in open source data, crowdsourcing of information and connectivity, and enthusiasm by medical students, policymakers, economists and the surgical and anaesthetic community more broadly, a number of opportunities have arisen. The first is the potential for real-time, user-generated, interactive data that can allow for end-user interfaces and exploration.^{13,14} The second is the use of geospatial data, many of which are open access, to explore resources, opportunities and barriers to care.^{15,16} Although the challenges remain substantial, the ability of our community to engage public health professionals, policymakers, economists, ministries, leaders at the highest level and the general public will ensure that surgical and anaesthesia care is no longer ignored as the 'neglected stepchild of public health'.¹⁷

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The SAFE-T Summit 2018: implications for the WFSA Safety and Quality of Practice Committee

Fauzia Anis Khan

Correspondence: fauzia.khan@aku.edu

The inaugural SAFE-T (Safe Anaesthesia for Everybody – Today) Summit took place in London at the Royal Society of Medicine on 13 April 2018. There were presentations by eminent speakers on topics of safe anaesthesia and surgery. Central to the discussion was the patient safety agenda following the *Lancet* Commission on Global Surgery 2015 initiative. The World Health Organization (WHO) defines patient safety as the absence of harm to a patient during the process of healthcare and reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum.¹ Although the *Lancet* Commission has given directions for National Surgical, Obstetric and Anaesthesia Plans (NSOAPs), defined bellwether procedures and provided core indicators, major challenges still exist, especially from the perspective of low- and middle-income countries (LMICs). Safe anaesthesia and surgery is still a distant dream for many.² This commentary will focus on some of the key messages with implications for the World Federation of Societies of Anaesthesiologists (WFSA) Safety and Quality of Practice (SQP) Committee. The function of the WFSA SQP Committee is to provide the highest standards of safety and quality in anaesthesia internationally.

CORE INDICATORS FOR SAFETY

Meara and colleagues³ have recommended five indicators for monitoring universal access to healthcare. These are access to timely essential surgery, specialist surgical workforce density, surgical volume, perioperative mortality rate (POMR) and protection against impoverishing expenditure.

Perioperative mortality

Perioperative mortality has declined over the last few decades but it is still significantly higher in LMICs.⁴ One of the problems seen with the collection of data on this indicator is lack of standard definitions, which have ranged from in-hospital deaths to deaths 30 days postoperatively. As mentioned by presenters at the summit, at present no data have been provided for this indicator from some countries. There is therefore a

need to standardise the definitions used. This requires collaboration and interaction between the WFSA and other stakeholders.

The SQP Committee of the WFSA is also designing a Morbidity and Mortality Tool Kit for LMICs. This toolkit will be aimed at anaesthesiologists working in secondary and non-teaching institutions where there is a lack of systems to analyse such events and bring improvements in patient safety. A needs assessment survey is currently being conducted in five LMICs in this respect. A future goal for the SQP Committee may be to have a web link where anonymous reports of such events can be collected from LMICs to provide information on the nature and magnitude of the problem. At present, publications on major morbidity and mortality are lacking from LMICs.

Specialist workforce density and work assessment tool

Information on infrastructure is one of the building blocks required for NSOAPs. This information is essential to collect data on core indicators. The WFSA's contribution to this has been the World Anaesthesiology Workforce Map. This live interactive map provides information on the physician-based anaesthesia workforce per 100,000 population and is accessible on the WFSA website.⁵ The map is also accompanied by an article on the global anaesthesia workforce.⁶ An Anaesthesia Facility Assessment Tool (AFAT), which is currently undergoing pilot assessment, was also introduced by WFSA secretary Professor Adrian Gelb. The purpose of this tool is to create a dataset that can be modified at a country level to help maintain standards for the safe practice of anaesthesia.

ANAESTHETIC EQUIPMENT

An Ad-Hoc Anaesthetic Equipment Committee was formed by the WFSA in 2017, bringing together global expertise in anaesthetic equipment and varied operating requirements to advance patient safety and access to safe anaesthesia. The Committee is currently being chaired by Dr Philippe Mavoungou.

Fauzia Anis Khan MBBS, FRCA

Chair
Safety and Quality of
Practice Committee
World Federation
of Societies of
Anaesthesiologists
and
Professor of Anaesthesiology
Aga Khan University
Karachi
Pakistan

At the SAFE-T summit he highlighted the issues of affordability and quality of equipment in LMICs. Some of the issues discussed related to poorly organised tenders and on-site maintenance, healthcare budgets not being a priority, short-term guarantees and no policy for disposables. He advocated the reliability of energy sources such as solar energy with use of back-up batteries, the reliability of oxygen sources, modular and non-modular compact monitoring, robust syringe pumps, portable ultrasound systems, cheap and easily reusable devices, local logistic organisation and communication for remote expertise, and long-term warranties.

Pulse oximetry is an example of how concerns about patient safety were married to technology, resulting in the development of robust inexpensive equipment for LMIC settings (<https://www.lifebox.org>). There is a further need to strengthen the WFSA's relationship with industry and to impress on manufacturers the need for such robust, inexpensive and reliable equipment for millions of patients.

The WHO has also published the *WHO Compendium of Innovative Health Technologies for Low-Resource Settings*.⁷ Another piece of equipment described and of interest to anaesthesiologists is an anaesthesia machine with a low-pressure pneumatic ventilator.

The SQP Committee works in close collaboration with the Equipment Committee. Two members of the SQP Committee are also members of the Equipment Committee.

MEDICATION SAFETY

Shortages of anaesthetic medications are an issue for LMICs and have expanded to become a worldwide concern. Some of the European Board of Anaesthesiology recommendations were presented by Dr David Whitaker at the SAFE-T summit. These simple and universally applicable measures relate to drug preparation and administration, proper drug labelling, minimising manipulation of medication in clinical areas and preventing incorrect medication administration scenarios.⁸ The European Board of Anaesthesiology recommendations can be endorsed for universal application worldwide.

Members of the SQP Committee are also currently involved in another WFSA project on anaesthesia medication safety guidelines.

COLLABORATIONS, COORDINATION AND INTERACTIONS BETWEEN SAFETY STAKEHOLDERS

Patient safety is a universal agenda and is a priority for many international organisations. Several of these organisations, that is, the WFSA, WHO, World Bank, Royal College of Surgeons, Royal

College of Obstetricians and Gynaecologists, Anesthesia Patient Safety Foundation, King's Centre for Global Health and Health Partnerships and International Federation of Perioperative Nurses, were represented at this first WFSA SAFE-T summit. Synergistic partnerships between these organisations will benefit patient safety.

One such example of collaboration and strategic partnership is the recently published combined WHO–WFSA International Standards for a Safe Practice of Anaesthesia.⁹

The SQP Committee is also working towards collecting information from all major organisations working on patient safety and to follow up on collaboration between the WFSA with these organisations for the common goal of patient safety.

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Progress and challenges in global surgical and anaesthesia care and safety: proceedings of the SAFE-T Summit 2018

Kerry A Vaughan and Walter D Johnson

Correspondence: johnsonw@who.int

Surgical and anaesthesia care are undeniably critical to strengthening healthcare systems worldwide and they are steadily gaining support from the World Health Organization (WHO). Former Director-General Halfdan Mahler remarked in his address to the World Congress of the International College of Surgeons in 1980 that surgical (and anaesthetic and obstetric) resources should be scrutinised according to social justice principles.¹ His vision of social justice in the realm of surgery and anaesthesia remained in the background of global public health, but began to gain momentum in the 21st century. World Health Assembly (WHA; the decision-making body of WHO) resolution 68.15 on strengthening emergency and essential surgical care and anaesthesia as a component of Universal Health Coverage (UHC), the *Lancet* Commission on Global Surgery (LCoGS)² and *Essential Surgery. Disease Control Priorities*,³ which lay out the health economic case for surgical care and anaesthesia, were all launched in 2015. They serve as key rallying points for advancing surgical, anaesthesia and obstetric (SAO) care.

The scale of the global disease burden of surgical conditions was underestimated prior to the LCoGS, which demonstrated that 5 billion people were lacking timely access to safe and affordable surgery and anaesthesia.⁴ This disparity is aggravated by a severe lack of funding: whereas infectious diseases (HIV/AIDS, tuberculosis and malaria) have a US\$5 billion annual global budget to address 3 million deaths annually, avertable surgical deaths total 16.9 million annually and have a US\$0 global budget.⁵ Furthermore, avertable surgical deaths are expected to increase significantly over the next few years with the projected rise in global deaths due to non-communicable diseases (NCDs); demand for surgical care and anaesthesia increases in parallel with increases in NCDs. Cancer, ischaemic heart disease and cerebrovascular disease are the three most common killers globally and will likely remain so in the coming years.⁶ Deaths from road traffic accidents, among other injuries, are also projected to increase, of which many may be averted by surgery and anaesthesia.

Safety is intimately linked to strengthening SAO care across numerous linked domains, from anaesthesia risks, surgical disease burden, morbidity and mortality to outcomes, SAO workforce and even pain management. Strict adherence to global safety standards for anaesthesia and surgery is critical, as surgical disease accounts for 30% of the global disease burden.⁵ Unsafe perioperative practices in anaesthesia are linked not only to surgical outcomes, but also to maternal mortality worldwide.⁷ Risks associated with anaesthesia are significantly disparate across countries and settings, with the vast majority of risk found in low- and middle-income countries (LMICs). The risk of perioperative mortality from anaesthesia in LMICs remains high at around 5–10%; this compares with 0.0005% (1 in 200,000 cases) in high-income countries as a result of improvements in anaesthesia safety and practice.⁸ Inadequate anaesthesia workforce density, training and support also hinder operative care in LMICs. Whereas in high-income countries such as the UK or USA there is one trained anaesthesia provider per 4000–5000 persons, in LMICs there are much lower ratios, such as one provider per 3.6 million people in Afghanistan.^{8–11} Safety in pain management and administration of pain medications is also critical from an anaesthesia perspective, for acute and chronic pain in all populations.

Safety is inextricably linked to continued global healthcare improvements, as well as strengthening surgical and anaesthesia care. Good health and well-being is one of the pillars of the United Nations (UN) Sustainable Development Goals also launched in 2015 (i.e. SDG3), the successors to the UN Millennium Development Goals.¹² At least nine of the 13 SDG3 targets are directly or indirectly addressed by improving anaesthesia and surgical safety standards and practices worldwide, including SDG3.8 on UHC and a direct link to WHA resolution 68.15.¹³ Furthermore, SAO care is also linked to many of the other 17 SDGs. These strengthening efforts are addressed through all levels of healthcare, from access to essential medicines to health systems integration. Stronger SAO care cannot be accomplished without

Kerry A Vaughan MD
Program in Global Surgery
and Social Change
Harvard Medical School
Boston, MA
USA
and
Department of
Neurosurgery and Penn
Global Surgery Group
University of Pennsylvania
Philadelphia, PA
USA

**Walter D Johnson MD, MPH,
MBA**
Lead
Emergency and Essential
Surgical Care Programme
World Health Organization
Geneva
Switzerland

simultaneously addressing safety concerns and disparity via advocacy, resource development, service access and delivery, data collection and analysis, and workforce training and competence. Baseline data collection on surgical and anaesthesia care is part of the core of WHA resolution 68.15, which directly mentions safety as a focus of these efforts. Although this initial resolution called for a one-time report on implementation progress in 2017, WHA Decision Point 70.22 was adopted in 2017, mandating continued biennial progress reports on implementation from the WHO Secretariat.¹⁴

Progress in SAO care advocacy has occurred, including on the global stage through the WHO. The six major indicators on safety, accessibility and economic burden of surgical and anaesthesia management of disease published by the LCoGS were successfully incorporated into the 2015 WHO 100 Core Health Indicators:¹⁵ postoperative mortality, surgical volume, 2-hour access to services, SAO workforce density and risk of impoverishing and catastrophic health expenditures related to surgical and anaesthesia care. All but one of these, catastrophic health expenditure, was preserved in the 2018 WHO Indicators.¹⁶

Recent safety-focused SAO efforts from the WHO include safety checklists, the creation of collaborative safety standards, international safe anaesthesia guidelines, surgical site infection guidelines and promoting safe essential medicines and their use. Checklists for trauma care, surgical safety and safe childbirth have been developed by the WHO and globally disseminated to help all health systems implement and provide safer services, thus ideally improving SAO outcomes.^{17–19} The WHO and the World Federation of Societies of Anaesthesiologists (WFSA) published *International Standards for a Safe Practice of Anaesthesia* in May 2018 as minimum safety standards for all anaesthesia providers and settings.²⁰ Multiple campaigns on safe administration practices for essential medicines, such as ketamine, narcotics and antibiotics, have been launched, in part with the WHO, to promote the safe and judicious usage of these agents without causing patient harm. The current WHO Patient Safety Campaign is on medication safety. Safety must also be considered for surgical and anaesthesia providers, that is, safety from infectious diseases such as Ebola, as well as harm from local natural and man-made events.

Five academic and medical institutions around the world have become official WHO collaborating centres for surgery and anaesthesia. Centres from all WHO regions have joined efforts to strengthen surgical and anaesthesia care, with the goal of creating not only bidirectional relationships with the WHO, but also international collaborative networks. Resolution 68.15 has been advanced at the country level by the WHO and collaborating centre partnerships with Ministries of Health in the form of National Surgical, Obstetric and Anaesthesia Plans (NSOAPs). Such plans are intended to improve national SAO care and safety by an iterative process of planning, a national surgical forum for feedback, and implementation, with the NSOAP fully embedded within the national health policy, strategy or plan.

NSOAP creation is led by the Ministry of Health, with support from local and international stakeholders and technical assistance from the WHO and international partners. The Republic of Zambia has completed its strategic plan and has begun country-wide implementation, as have Senegal and Tanzania. Ethiopia has also developed a pathway for scaling up SAO care through its SaLTS plan, currently undergoing implementation.²¹ Smaller scale efforts to improve safety in these domains have been launched in Madagascar, Uganda, Vietnam, Brazil and India, among others.

The NSOAP process has garnered international attention, with requests from many Member States, leading to an NSOAP workshop in March 2018 that was developed by the WHO and the Program in Global Surgery and Social Change (PGSSC) from Harvard University. As multiple Member States begin work on this process, collaboration across multiple Ministries of Health and a consortium of partners will be important in improving national and global SAO care.

The planning phase should include special consideration of the safety of vulnerable populations, including obstetric and paediatric patients and those who are injured. Children are particularly susceptible to unsafe practices, as the same challenges facing the surgical and anaesthesia care of the adult patient are even more pronounced, such as fewer paediatric-trained providers, as well as there being additional paediatric-specific challenges. Children under 15 years make up on average 43% of the total population in sub-Saharan Africa (with this figure being as high as 50% in some countries) and 26% of the total world population, which places additional stress on already limited paediatric surgical and anaesthesia resources in LMICs.²² Adult surgeons may choose to not operate on these children because of the higher risks, unfamiliarity with unique pathologies and children's inability to pay for services. Strategic alliances, such as the Global Initiative for Children's Surgery, include all paediatric surgical and anaesthesia services to support care for this vulnerable population.

Patients with traumatic injuries represent another vulnerable population and highlight safety disparities, both in healthcare as well as in prevention. These are often treatable and remain most prevalent and most severe in LMICs. Of the disease burden that could be averted by surgical and anaesthesia system scaling up at first-level LMIC hospitals, 68% would be related to injuries.²³ Safety through injury prevention is also critical, as only 7% of the world's population has adequate legal protection from the five major risk factors for road traffic accidents: speed, drink driving, helmets, seatbelts and child restraints.²⁴

The incoming leadership at the WHO has developed the 13th General Programme of Work, a 5-year strategic plan outlining WHO priorities.²⁵ Its main focus includes promoting health, keeping the world safe and serving the vulnerable. These broad priorities are supported by specific 'triple billion goals' to improve access for an additional 1 billion people to UHC, better protection from health

emergencies and better health. Scaling up safe surgical and anaesthesia care are critical to achieving these priorities and goals, as healthcare safety affects everyone's health.

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Transforming surgical and anaesthesia capacity and safety – the path to success: the European Society of Anaesthesiologists' perspective

Stefan De Hert

Correspondence: stefan.dehert@esahq.org

Following the production of international standards for safe practice of anaesthesia by the World Federation of Societies of Anaesthesiologists (WFSA) in 1992, which were revised in 2008 and 2010,¹ the European Society of Anaesthesiologists (ESA) and European Board of Anaesthesiology (EBA) launched the Helsinki Declaration on Patient Safety in Anaesthesiology (<https://www.esahq.org/patient-safety/patient-safety/helsinki-declaration/full-declaration>).² This declaration emphasises the role of anaesthesiology in promoting safe perioperative care and underscores the fact that perioperative patient safety is a core topic of interest for the society. The ESA promotes this by providing access via the website to the Patient Safety Starter Kit (<https://www.esahq.org/patient-safety/patient-safety/patient-safety-starter-kit>). The ESA Patient Safety and Quality Committee is very active in organising European Patient Safety and Quality Courses and Masterclasses and in promoting the Patient Safety Expert Network. The interest of patient safety extends far beyond Europe as can be observed on the Helsinki Declaration map (<https://www.esahq.org/-/media/ESA/Files/Downloads/Resources-PatientSafety-MapHelsinkiDeclaration/Resources-PatientSafety-Map%20Helsinki%20Declaration.ashx>). Many countries all over the world have signed this Declaration. For instance, Australia and New Zealand have supported the Declaration since 2010; Canada and the USA since 2010 and 2014, respectively; Latin America since 2012; and China and Japan since 2015. Many other countries have followed. In other words, there is a worldwide major interest in the problem of perioperative patient safety.

However, signing a declaration is one thing; another issue is to really implement the principles of that declaration in our daily clinical practice. In 2012, the ESA launched a survey among its council members and national anaesthesiology societies interrogating how three main aspects of the Helsinki Declaration were implemented in their national daily practices. The response rate was impressive, with more than 90% of the member countries providing feedback.

Interestingly, monitoring standards seemed to have been very well implemented in the majority of countries; however, the World Health Organization (WHO) guidelines and organisation of patient safety teaching and training facilities were significantly less well implemented in the various national practices. These data indicated that there is still a huge amount of work to be done to get all different aspects of perioperative patient safety implemented in our daily clinical practice.³⁻⁵

What are the main challenges for Europe in organising similar efficient and effective high-level standards for patient safety in all of its member countries? Although many problems will be similar to those in other places worldwide, Europe faces a major challenge because of its specific political composition of a conglomerate of individual nations with specific languages and healthcare system organisation. Indeed, the European Union consists of 28 member countries in which 24 different languages are spoken. As a mirror of this, the ESA, with its approximately 9000 active members and more than 35,000 associate members, encompasses more than 40 different nationalities.

A 2012 report from the European Commission investigated the topic of Europeans and their languages (http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_386_en.pdf). Some interesting observations were made. First, in accordance with the population, the most widely spoken mother tongue seems to be German (16%), followed by Italian and English (13% each), French (12%) and then Spanish and Polish (8% each). Interestingly, at a national level English is the most widely spoken foreign language in 19 of the 25 Member States where it is not the official language. The five most widely spoken foreign languages are English (38%), French (12%), German (11%), Spanish (7%) and Russian (5%). It is to be underscored that just over half of Europeans (54%) are able to hold a conversation in at least one additional language, one-quarter (25%) are able to speak at least two additional languages and only one in 10 (10%) are conversant in at least three languages. It is obvious that

Stefan De Hert MD, PhD
President
European Society of
Anaesthesiologists
and
Professor of Anaesthesiology
Ghent University Hospital
Ghent
Belgium

the issue of diversity of language creates a huge challenge in terms of implementing common European initiatives such as patient safety directives in individual national daily practices.

Other problems are related to the differences in financial and human resources in the various European countries and the different organisation of the healthcare systems, all of which can influence standard of care. In 2012, the European Surgical Outcomes Study (EuSOS) group published the results of 7-day mortality after surgery in Europe.⁶ Astonishingly, a mean of 4% 7-day mortality was observed, ranging from 1.2% to as much as 21.5% depending on the country. This excess mortality seemed to be related to what the authors referred to as 'failure to rescue'. In other words, patients died because of lack of identification and prompt treatment of adverse perioperative events. This failure to rescue seemed to be related to a lack of adequate resources, suggesting a direct relationship between improved patient outcome, patient safety and available human and financial resources.

This problem deserves further attention. One of the basic principles of the European Union is free movement of students, patients and doctors across borders. If one takes a closer look at the monthly salaries for board-certified anaesthesiologists in Europe, a greater than 10-fold difference can be observed between low-income and high-income countries.⁷ The result is a brain drain of board-certified anaesthesiologists from low-income (mainly Eastern and Southern Europe) to high-income countries (North-western Europe).⁸ The consequence is a lack of trained and skilled professionals in those areas suffering from the brain drain.⁹

How is the ESA dealing with all of these challenges? Several projects are ongoing. Yearly, two or three guidelines are produced on various topics in anaesthesiology and intensive care, critical emergency medicine, pain and perioperative medicine. These guidelines are meant to provide recommendations for standard of care, which should help to bring practices all over Europe to the same level. In addition, they may help local care providers convince hospital administrations and healthcare officials about the specific needs to achieve these European standards of care.

The European Diploma in Anaesthesiology and Intensive Care (EDAIC) undoubtedly contributes to setting a universal high standard with regard to the knowledge and skills of anaesthesiologists worldwide. Programmes such as 'mentor/mentee' and 'train abroad-return home' aim to allow professionals in low-income countries to develop their skills with the help of foreign colleagues/centres with specific expertise.

In line with the Helsinki Declaration Heads of Agreement 7 (need for research), ESA-supported research contributes to provide necessary data to update the situation on current perioperative morbidity and mortality issues and identify potential areas of improvement (e.g. EuSOS, ETPOS, APRICOT, NECTARINE, LAS VEGAS, PROBESE, POPULAR, METREPAIR).

The Helsinki Declaration calls for routine measurement of safety in all anaesthesia departments. Because no generally accepted and sufficiently evidence-based set of anaesthesia quality/safety indicators exists,^{10,11} the ESA Patient Safety and Quality Committee has started the ESA Quality Indicators Project (EQUIP). EQUIP is surveying national anaesthesia societies to establish an overview of anaesthesia quality indices used in Europe. This approach is complementing formal research about quality indices by describing commonly and successfully used indices, the suitability of quality indices in routine practice of different countries in Europe and common obstacles to and requirements needed for implementation of quality indices.

A major challenge is consistent implementation of the Helsinki Declaration principles such as patient safety programmes across Europe. To meet this challenge, the ESA has started the Helsinki Declaration Follow Up (HD-FU) Project. This research project is designed to better understand the local and regional/national differences in anaesthesia departments that help or hinder implementation of the Helsinki Declaration requirements. Based on the results, strategies will be developed that improve implementation and adaptation nationwide.

Patient safety is a concern of every person and society dealing with patient care. The ESA is committed to close cooperation with all anaesthesiology and other specialist societies involved in perioperative patient care. A good example of such cooperation is the International Forum on Perioperative Safety and Quality. This is a meeting jointly organised by the ESA and the American Society of Anaesthesiologists at their yearly scientific meeting. After a successful meeting in Boston last autumn, we organised a new edition of this symposium in Copenhagen on 1 June in conjunction with Euroanaesthesia 2018, which took place on 2–4 June. The Keynote Lecture, delivered by Professor Charles Vincent (Oxford, UK), was entitled 'Safer healthcare: strategies for the real world'. By attending meetings such as this, anaesthesiologists can take the opportunity to meet colleagues and gain new knowledge about fatigue risk management and about the role of simulation for improving patient outcomes.

Finally, caregivers are not the only stakeholders when thinking about perioperative patient safety. Our industry partners and the different patient societies and movements are also important key players. In the end, major advances in patient safety can be achieved only when all stakeholders work together to achieve a safer patient environment.

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The NGO perspective: SAFE operating theatre

Mona Guckian Fisher

Correspondence: mona@guckianfisher.com

Universal access to safe, timely, affordable surgical and anaesthetic care is a basic human right, yet more than 4 million people worldwide lack access to quality health services. This is mostly explained by a human resource shortage compounded by the fact that the skills, competencies and clinical experience of providers are often poorly suited to the health needs of the populations being served.

Nurses play a pivotal role, caring and supporting patients throughout the continuum of life. As a professional group they advocate for health promotion and support and education of patients and the public on the prevention of illness and injury, providing care and assisting in cure and rehabilitation across global communities. No other healthcare professional has such a broad and far-reaching role. Nurses are teachers, advocates, caregivers, critical thinkers and innovators. This honourable profession puts nurses at the heart and soul of the healthcare system in every country.

The Nursing Now campaign (<https://nigelcrisp.com/nursing-now/>), run in collaboration with the World Health Organization (WHO) and International Council of Nurses (ICN), aims to raise the status and profile of nursing, empowering nurses to take their place at the heart of tackling 21st-century health challenges. The campaign launched globally on 27 February 2018 with events worldwide and runs until the end of 2020.

Safety is a challenge inside and outside the operating theatre; recent visits to developing countries provide evidence on additional challenges in infrastructure, where the potential for care in the surgical setting is clearly indicated. There are high-rise buildings with scaffolding made from sticks where construction workers are at serious risk of injury whilst working at height. It is indeed difficult to observe this, in contrast to our first-world regulated safety systems. If the old adage 'prevention is better than cure' still holds good, then there are opportunities for collegiate non-governmental organisations (NGOs) to assist us in the prevention and safety trajectory.

Wherever we are in the world, the basic minimum perioperative team will consist of the anaesthetist, surgeon and registered nurse or, in the UK, registered operating department practitioner.

There are numerous NGOs, charities and individuals involved in delivering support across the globe. In 2010 the first SAFE course (Safer Anaesthesia from Education) was developed in obstetric anaesthesia followed by paediatric anaesthesia by the Association of Anaesthetists of Great Britain & Ireland (AAGBI) and the World Federation of Societies of Anaesthesiologists (WFSA). This has now been successfully delivered in a number of countries: 59 courses have been run and more than 2000 delegates have been trained.

The SAFE OR programme was developed collaboratively, with an initial aim to bring practitioners to a level of practice whereby they could deliver vigilant and competent anaesthesia. This educational programme has been extended to include the other team disciplines of surgery, and more recently nursing, to produce multidisciplinary service delivery teams offering a carefully balanced mix of clinicians to address the full training needs identified.

These courses have shown that, although education can be developed for individual specialties, there is much more to gain from training the whole team working in the operating room. Through this concept, the SAFE OR course was developed, with partners in the Royal College of Surgeons (RCS), Association for Perioperative Practice (AfPP) and now the Royal College of Obstetricians and Gynaecologists (RCOG).

The perioperative setting is a unique practice environment. Provision of safe and effective care in all areas of a surgical services suite requires a complex organisational structure, utilising a diverse skill mix from numerous personnel. In addition, within this multifaceted setting, various members of the surgical team may have conflicting goals and objectives. Because this environment is so complex and intense at times, effective leadership and communication skills are crucial in order to bring these diverse workers together to provide safe care and achieve positive patient outcomes, including prevention of (1) surgical site infections, (2) medication errors, (3) wrong-site surgery and (4) other preventable complications related to surgical intervention.

Nursing skills are essential for the delivery of most healthcare, but are commonly ignored in the various debates about increasing capacity. In surgical nursing,

Mona Guckian Fisher RGN, LLM, BSc (Hons), OHND, DipHSWW, CMIOSH, Dip Perioperative Nursing, Dip Counselling
President
International Federation of Perioperative Nurses (IFPN)
and
Immediate Past President
Association for Perioperative Practice (AfPP)

the small UK-based charity Friends of African Nursing (FoAN), established in 2002, has successfully delivered education and support to 2000 nurses with an unbelievable minimal resource, mostly achieved from coffee mornings and the dedicated altruism of a few perioperative nurses.

In 2017 and 2018 two self-funded perioperative nurses engaged on an educational tour of southern India and provided training sessions on patient safety, staff welfare, nursing leadership and empowerment along with other aspects of clinical practice to over 1000 nurses. During our work we have discovered similar lessons: the perioperative team is the essential ingredient that makes possible the objective of the NGOs working in these settings.

The SAFE OR course is the first time that nurses have been engaged in a team education programme from the start of the writing to joining the courses. When Team 'SAFE OR' travelled to Addis Ababa in Ethiopia in September 2017, nurses were part of a cohesive UK team working with Ethiopian colleagues, a powerful example of what can be achieved if cultural attitudes can be set aside in the name of providing safe and timely perioperative patient care. Of the 35 participants in Ethiopia who attended, 17 were nurses, a clear indication of the investment that is needed for that professional discipline.

We need to see a change in the way that the nursing profession is viewed by surgeons, anaesthetists, community leaders, governments, the WHO and NGOs to create significant change in the perceived value of the profession. The Nursing Now campaign aims to improve the perceptions of nurses, enhance their influence and maximise their contributions to ensure that everyone everywhere has access to health and healthcare.

Collectively, nursing professionals need to ensure that they are visible, have input and value at the forefront of healthcare and are a part of these planned initiatives. There are hierarchical and cultural issues to address and whole-team engagement is the only way to start to tackle this important reality. It will take time and commitment but, if built into every training package as an important part of the overall engagement, then we will begin to see and reap the benefits in terms of team cohesiveness and patient outcomes.

Many of these nurses are well educated but are struggling with limited resources, and many identify the need for support to set standards of practice that can empower them and the entire team. This is where team training cannot be surpassed.

The NGO experience of surgeons, anaesthetists and nurses working collaboratively as an integrated professional group, to educate inform and empower, is a thrilling and worthwhile experience.

Changes that empower the nursing team from the NGO experience are simple to achieve, such as employing the safety checklist, communicating with colleagues, saying thank you, developing suitable standards and protocols, assuring correct patient identification, asking for help, ensuring that consent is signed, assuring scrub nurse responsibility for patient and procedure identification, checking the patient, building capacity for sharing knowledge, implementing a whiteboard count, improving nursing documentation, utilising checklists for instruments, improving the process for preoperative assessment, resolving conflicts within the team, improving teamwork with other professionals for the safety of the patient and generally improving understanding and communication.

VALUE STATEMENT: 'NURSES MAKE A DIFFERENCE'

Managing the perioperative environment is not an easy task, but effective leadership is critical to the success of the department. Effective leaders can create a working environment that promotes staff satisfaction and productivity, thereby contributing to the overall success of the operating theatre. Conversely, ineffective leadership can result in a loss of staff morale and productivity and ultimately have a negative impact on the patient, the department and the organisation.

Success in the perioperative practice setting includes the provision of safe and effective patient care and achieving optimal outcomes. To realise these successes, this work environment requires strong, consistent, knowledgeable nurse leaders who are visible, inspire others and can motivate the multidisciplinary team using effective communication. We are all responsible for contributing to this outcome.

Safe anaesthesia for everybody – today’s initiative: the anaesthesia patient safety perspective

Mark A Warner

Correspondence: warner@apsf.org

Anaesthesia patient safety must be a universal mission. The Anesthesia Patient Safety Foundation (APSF) applauds the World Federation of Societies of Anaesthesiologists (WFSA) for its efforts to improve patient safety through initiatives such as SAFE-T (Safe Anaesthesia For Everybody – Today). The APSF will work closely with the WFSA and its national anaesthesia organisations to provide support through education, research and advocacy.

The APSF’s vision statement is clear: ‘That no patient shall be harmed by anaesthesia’. Its primary mission remains to continually improve the safety of patients during anaesthetic care by encouraging and conducting:

- safety research and education;
- patient safety programmes and campaigns;
- national and international exchanges of information and ideas.

The APSF has primarily been US focused for the past several decades. This focus is changing to meet our founding mission to increase the international exchange of patient safety ideas. For its 32 years of publication, the *APSF Newsletter* has played an important role in providing educational material on anaesthesia patient safety and for sparking discussions through pro/con debates and letters to the editor. It currently is the most widely distributed anaesthesia publication in the world, reaching 125,000 anaesthesia professionals in print and another 50,000 electronically. That’s good – but it also is insufficient.

During 2018 and into the future, the *APSF Newsletter* will be published in an increasing number of languages. These newsletter translations and also translated APSF safety videos will appear on the APSF website (<https://apsf.org>) as they become available during 2018. These will support the exchange of perioperative patient

safety ideas between an increasing proportion of the estimated 350,000 anaesthesia professionals worldwide. The APSF will also use social media opportunities such as Facebook, Twitter, LinkedIn and unique blogs, especially those already well established, to reach international anaesthesia professionals, to lead or participate in discussions of perioperative patient safety issues. These, too, will be provided in multiple languages to support communication between the diverse anaesthesia professionals globally.

The APSF has been a significant source of funding for perioperative patient safety research. More than US\$12 million have been provided to support research on unique clinical safety issues, to develop novel technologies and educational programmes and to support the early career development of future anaesthesia patient safety scientists. Much of that support has been directed at North American-based anaesthesia professionals. We are now seeking opportunities to expand support to aspiring anaesthesia patient safety scientists and clinicians outside North America. This expansion will require significant financial support of the APSF and we are currently working to attain it.

The APSF’s mission has not changed. When applying the mission to today’s expectations of anaesthesia professionals internationally, the APSF needs to ensure that its activities span the extended range of perioperative care and involve collaboration with the full spectrum of colleagues in all fields and industries that impact our patients’ care. As we all move forward, the APSF will increase its focus on the full spectrum of perioperative safety issues and increase its advocacy for patient safety. There are important questions to be answered and issues to be addressed.

It’s the right thing to do for our patients . . . and for our profession.

Mark A Warner MD
President
Anesthesia Patient Safety
Foundation
and
Annenberg Professor
Department of
Anesthesiology and
Perioperative Medicine
Mayo Clinic
Rochester, MN
USA

The WFSA SAFE-T Summit: overview and commentary

Berend Mets and Alan Merry

Correspondence: a.merry@auckland.ac.nz

On launching the SAFE-T (Safe Anaesthesia for Everyone – Today) campaign at the World Congress of Anaesthesiologists in Hong Kong in September 2016, the World Federation of Societies of Anaesthesiologists (WFSA) President and Board of Directors championed the concept of developing a series of SAFE-T Summits that could advance the global patient safety agenda. As the co-conveners of this first SAFE-T Summit we are pleased to provide a brief overview and commentary.

The objectives for the Summit were to update the discussion following the *Lancet* Commission on Global Surgery (2015) (<http://www.lancetglobalsurgery.org/>), with a focus on:

- indicators and metrics of surgical and anaesthesia capacity and safety;
- safety standards for equipment and medications;
- gaining perspectives on the global safety situation from a broad range of stakeholders including anaesthesiologists, surgeons, obstetricians, nurses, governments, the World Health Organization (WHO), industry, patient safety societies and other interested organisations and individuals.

This first SAFE-T Summit was jointly hosted by the WFSA and the Anaesthesia Section of the Royal Society of Medicine at its headquarters in London on Friday, 13 April 2018. There were over 250 participants. Here is our brief report on the entire proceedings.

In his opening keynote lecture, ‘The Global Challenge for Patient Safety’, **Dr Tore Laerdal** reminded us that there will be 80 million deaths by the year 2030, and that every second one of these will be avoidable. He discussed the relative roles of science, education and implementation in generating change. In practice, education and implementation are critical if the benefits of science are to be realised. Tore emphasised the importance of keeping things simple. The Helping Babies Breathe programme and bystander resuscitation (begun by Dr Peter Safar) provided great examples of this, with the graphic comment that ‘the community is the ultimate coronary care unit because the majority of heart attacks occur outside hospital’. In both cases,

the benefit of effective training of people with minimal or no prior qualifications has substantially outweighed any potential for harm. Importantly, in Tanzania, this training was provided under the auspices of, but not necessarily to, or even by, anaesthesiologists.

Dr Andy Leather turned to the messages of the *Lancet* Commission and progress since its report. The poorest one-third of the world’s population receive only 6.3% of its surgical procedures. If global inequity in surgical and anaesthetic care is to be addressed, clinicians will need to embrace the language of public (or population) health and the principles of health economics. Conditions amenable to surgical care contribute to one-third of the global burden of disease. Failures in access to this care, or in the safety of the care once accessed, have substantial, and indeed impoverishing, negative consequences at both individual and national levels. The *Lancet* Commission introduced the notion of three bellwether procedures (surgery for caesarean delivery, laparotomy and open fracture management) as an indicator of the overall capability of a hospital. Importantly, these procedures are the very ones for which safe care is most needed, often urgently, by the patients who currently cannot get it. These procedures can also be very difficult to perform safely, which makes the challenge of providing an adequately trained workforce very imposing.

Professor Justine Davies turned the discussion to the importance of data and why they matter. She asked ‘Whose data are they anyway?’, saying that their impact on the end user was critical. A key objective of measurement is influence, through making problems visible. Professor Davies illustrated this while at the same time introducing the important theme of gender equity, describing the surprising finding that female surgeons are more adversely affected by an unexpected patient death whereas male surgeons receive more benefit from an unexpectedly good result. She discussed the potential for unintended consequences of the use of metrics, using performance-based pay as an example, and introduced the graphic phrase ‘Weapons of math destruction’. The goal should be not so much hitting the target, as hitting the needs of our patients.

**Berend Mets MBChB, PhD,
FRCA**
Chair
Department of
Anesthesiology and
Perioperative Medicine
Pennsylvania State
University
Hershey, PA
USA

**Alan Merry MBChB, FAN-
ZCA, FFPMANZCA, FRCA**
Head
School of Medicine
University of Auckland
Auckland
New Zealand

Characteristics of useful data would include:

- availability;
- comparability;
- utility;
- feasibility.

A review of the availability of the core metrics from the *Lancet* Commission was somewhat sobering. The metrics for affordability are not available from any country and the metric for perioperative mortality is available only for 31 countries. Clearly, more work is needed.

Dr John Meara continued this theme, but with a strong emphasis on the positive. In particular, the World Bank now publishes data on surgery and anaesthesia for the first time. This is a breakthrough of the highest importance, but is vulnerable as a reversal of this decision could readily occur. It is essential that the appropriate data are provided to the World Bank on a regular basis if this is to continue.

Dr Meara introduced three words to capture the process of using data:

- acquire;
- curate;
- disseminate.

Clearly it will be difficult for any one group to manage these processes for all of the data relevant to surgery anaesthesia and obstetrics; hence, organisations will need to work together to this end.

Dr Meara also described the National Surgical, Obstetric and Anaesthesia Plan (NSOAP) of Tanzania, which he estimated has a cost of US\$1.70 per capita per year, representing astonishingly good value for money.

A lasting image from Dr Meara's lecture was that of an elephant: to move the elephant it is necessary to direct the rider, motivate the elephant and shape the path.

Dr Tom Weiser opened with a reminder of the Second Global Challenge of the WHO: 'Safe Surgery Saves Lives'. One of the outputs from this challenge is the definition of five metrics for the measurement of surgery and anaesthesia globally. One of the objectives in developing these metrics is to avoid unintended consequences. Dr Weiser presented a map of surgical volumes that, amongst other things, illustrated an extraordinary range for the highest density areas, from 12,000 to 36,000 operations per 100,000 population. This illustrates the point well that the world faces not only overutilisation of healthcare but also underutilisation. Should the available resource be distributed more equitably, everybody could benefit from the redistribution.

Professor Adrian Gelb defined 'capacity' (which also raises the question of the closely related concept of 'capability') and stressed

that capacity without safety is of little value, adding the often used quotation that 'Safety is not expensive, it is priceless'.

Professor Gelb introduced the third edition of the WHO–WFSA *International Standards for a Safe Practice of Anaesthesia*, which for the first time has been endorsed jointly by both the WHO and the WFSA [Gelb AW, Morriss WW, Johnson W, Merry AF, Abayadeera A, Belil N *et al.* World Health Organization–World Federation of Societies of Anaesthesiologists (WHO-WFSA) International Standards for a Safe Practice of Anaesthesia [published online ahead of print 7 May 2018]. *Can J Anesth* 2018. doi: 10.1007/s12630-018-1111-5].

He also introduced the associated Anaesthesia Facility Assessment Tool, which has been developed by the WFSA and his team at the University of California San Francisco (available at <https://www.wfsahq.org/resources/anaesthesia-facility-assessment-tool>).

Discussion in the subsequent panel included the notions that we are 'bombarded with information', that we need to 'keep it simple', that we should 'target the finance ministers of the world' and that it is essential that data are sent to the World Bank to ensure that this institution will continue including information on anaesthesia and surgery in its databases.

Dr Atul Gawande provided 'A Surgeon's Public Health Perspective'. He started by reviewing classic studies showing that at least half of adverse outcomes in surgery are preventable. The evidence indicates that the most effective approaches to improving surgical and anaesthesia safety lie less in training programmes or regulations than in measures systematising care. A prime example of this is the WHO Safe Surgery Checklist (http://www.who.int/patientsafety/safesurgery/ss_checklist/en/) (also an output from the WHO's Second Global Challenge). This is a process tool 'to get people on the same page'. However, its effectiveness in state and national populations depends on how it is implemented. Top-down mandates alone have been ineffective; when even modest bottom-up organisation and support of implementation teams has been provided, large reductions in mortality have been demonstrated.

Dr Gawande discussed the next generation of system interventions for safer surgery and anaesthesia care, including team training, coaching and the nation-wide simulation-based programme for training entire surgical teams currently being rolled out across New Zealand. Another is the incorporation of patient-reported outcome measures that ensure that the primary outcomes of surgery are actually achieved. For elective surgical patients, 'it is not a sign of success that you didn't die!' Finally, he pointed out a still undeveloped need: interventions to reduce unnecessary surgical interventions. He drew attention to the problem of inappropriate variation in healthcare, noting that rates of the most common operation in the world, caesarean section, vary across the world from 2% to 80% of deliveries, with the optimal rate for the safety of mothers and their babies measured at about 19%. The most unsafe operation is the one that should not have been done at all, he pointed out.

This theme was continued by **Professor Lesley Reagan**. There are 213 million pregnancies a year worldwide, 75 million of which are unplanned, and 303,000 maternal deaths, many of adolescent girls. The ability of a young woman to control whether or not she becomes pregnant impacts her lifetime risk of dying and her chance of secondary school education, amongst many other things. In Chad, where there is little or no ability to do this, the lifetime chance of dying during pregnancy is one in eight. Professor Reagan pointed out that you can't put your pregnancy on hold because your country is having a civil war, noting Iraq as an example. In effect, the determinants of maternal mortality are a matter of political will, and in the words of Professor Mahmoud Fathalla, Secretary General of the United Nations (referring to Millennium Development Goal 5), 'women are dying because societies have yet to make the decision that their lives are worth saving'. The image of elephants returned in the form of the elephants in the room, namely the global lack of access to effective contraception and safe, legal abortion. These are amongst the most important root causes of maternal deaths resulting from the complications of unwanted pregnancy. Gender equity is a precondition to end poverty. The Leading Safe Choices Programme (<https://www.rcog.org.uk/leadingsafechoices>) is a direct response to these challenges.

The ensuing panel discussion included the (much-needed) progress that has been made towards gender equity in medical graduates in high-income countries, but also the continuing dearth of women in senior leadership roles in healthcare and the related need to change long-held hierarchical values in order to embrace the effective use of the Safe Surgery Checklist. In some low-income countries, the Safe Surgery Checklist has opened the way for anaesthesia providers to have the confidence to discuss concerns about patients with surgeons.

Dr Philippe Mavoungou provided a thought-provoking discussion of equipment for use in low-income countries and the need for standards that ensure that such equipment is fit for purpose. Standards for low- and middle-income countries need to be enhanced, not reduced, in comparison with those for high-income countries.

Dr David Whitaker discussed the WHO's Third Global Challenge for Patient Safety, 'Medication Without Harm'. The primary themes of this challenge are:

- high-risk medications;
- polypharmacy;
- transitions of care.

Clearly, medication safety is a central concern in anaesthesia. The importance of labelling, and the concept of 'the Rainbow TrayTM' were noted. A story of the persistent efforts to inject a medication intravenously, when it is intended for oral use, provided a graphic illustration of the point that fools can be both persistent and very ingenious in executing unsafe medication administration.

'The WHO Perspective' was the title of the presentation by **Dr Walter Johnson**, a neurosurgeon who leads the Global Initiative for

Emergency and Essential Surgical Care (GIEESC) at the WHO. Dr Johnson pointed out that all of the WHO Sustainable Development Goals are linked to access to safe surgery and anaesthesia, reiterating that he knew he was 'preaching to the choir' that there is a substantial challenge in getting the message beyond the converted to those who have the capability of changing priorities for investment into global health priorities. Addressing the challenges identified by the *Lancet* Commission will depend on capturing the hearts and minds of those capable of the required investment.

Mona Guckian Fisher, President-Elect of the International Federation of Perioperative Nurses (IFPN), followed with a timely reminder of the importance of registered nurses as part of the team in the care of surgical patients in the operating room and on the wards. She noted that teamwork is key and that the Safe Surgery Checklist had been influential in helping nurses speak up when necessary. Mona highlighted the paradox that, although training and learning often occur in silos, we need to work in teams to ensure patient safety. She finished by noting that nursing is a noble profession and has a key role to play in addressing the challenges identified by the *Lancet* Commission.

Dr Mark Warner, President of the Anesthesia Patient Safety Foundation (APSF), began with the original mission statement of that organisation: that 'no patient shall be harmed from anaesthesia'. Inspirational initiatives by the APSF include a new focus on global health, including the translation of its newsletter (which is distributed to over 150,000 readers) into eight languages, and a proposed grant initiative to develop new patient safety scientists in and beyond the USA.

Professor Alan Merry gave the final presentation of the conference, returning to the point that, in this context, the role of collecting data is to drive improvement in outcomes for patients, globally. He argued that the six core metrics identified by the *Lancet* Commission should form the cornerstone of a wider framework of indicators. Substantial progress on measuring the professional workforce has been made with the WFSA's World Anaesthesiology Workforce Map (<https://www.wfsahq.org/workforce-map>), which has the capacity to support such a framework.

Returning to the ultimate objectives of surgery, he suggested including high-level indicators of outcome, such as life expectancy and patient-reported outcome measures, at the top of the framework to make the ultimate purpose of other indicators explicit. In relation to the 'three delays' identified by the *Lancet* Commission, he showed some measures of access that could potentially be modified to reflect the impact of these delays. Donabedian's triad of structure, process and outcome could be applied across a modification of the Institute for Healthcare Improvement's Triple Aim, such as that adopted in New Zealand, to emphasise equity and also value for money rather than the reduction of expenditure on healthcare. Returning to the core message of inappropriate variation in healthcare, he emphasised the importance of doing 'the right things' in the first place (i.e. treatments that are evidence-based and valued by patients) and then

of 'doing them right' (i.e. safely). He drew attention to the corrosive influence of corruption and advocated including measurements of this into the framework, in effect to shine a light on this important contributor to inequity in health outcomes.

Professors Alan Merry and Berend Mets closed the conference with a summary, concluding remarks and a heartfelt thank you to the Royal Society of Medicine and its anaesthesia section, the WFSA Secretariat, industry sponsors and the speakers and participants for contributing to the first ever WFSA SAFE-T Summit and expressed a commitment to plan for another Summit the following year.

Update in Anaesthesia

World Health Organization Surgical Safety Checklist

Natasha Woodman

Edited by

Dr Isabeau Walker

Correspondence: atotw@wfsahq.org

Originally published as Anaesthesia Tutorial of the Week, 325, 5 February 2016, edited by Dr Isabeau Walker

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QUESTIONS

Before continuing, try to answer the following questions. The answers can be found at the end of the article, together with an explanation. **Please answer True or False:**

1. Regarding implementation of the WHO checklist:

- Anaesthetists are responsible for implementing the checklist in theatre
- Implementation of the checklist is an ideal student project
- It is helpful to collect data, but it is important to only feed this back to the theatre team at the end of the implementation process
- Where an item cannot be completed in your facility due to lack of resources, remove that item from the checklist
- Staff are more likely to use the checklist if they understand how it improves patient safety

2. When conducting the WHO checklist:

- Good communication is important – use clear questions and direct them to an individual using their name
- The WHO checklist is only for elective cases, not emergencies
- It is important to maintain status and hierarchy during the checklist so that everyone knows who is in charge
- Antibiotics are usually given after skin incision
- Retained swabs, needles and instruments are an important recurring adverse event worldwide. Use of standardised packs and lists of instruments helps the counting process

3. When briefing and debriefing:

- These steps are added before and after each surgical case
- The briefing provides an opportunity for everyone to introduce himself or herself and identify their role
- Surgeons are usually very busy so they do not need to attend the pre-list briefing
- The briefing takes too long for it to be used routinely
- There would be no reason to debrief a day that had run smoothly as there is nothing to learn

Natasha Woodman

ST6 Anaesthetic Registrar
Great Ormond Street
Hospital
London
UK

Isabeau Walker

Consultant Anaesthetist
Great Ormond Street
Hospital
London
UK

Key Points

- Adverse events in surgery are an important problem globally. Many are preventable.
- The WHO Surgical Safety Checklist has been shown to reduce surgical complications and improve communication and teamwork in the operating theatre.
- Key components to successful implementation of the checklist include senior administrative support, surgical buy-in, ensuring underlying processes of care are in place and the use of local champions.
- Modification to suit local practice, training, stepwise implementation and real time feedback on performance improves uptake.

INTRODUCTION

In 2008 the World Health Organization (WHO) introduced a surgical safety checklist applicable to all surgical teams to be used for every patient undergoing a surgical procedure. This tool has been implemented around the world, and encourages dialogue within multidisciplinary teams and the use of routine safety checks to minimize harm to our patients.

Example case:

An 18yr old girl, Ms X came to theatre for an urgent appendicectomy. When the operating staff called to the ward for Ms X, her nurse was busy with another patient. Another nurse helpfully gathered the notes and brought Ms X to the operating area. An anaesthetist, Dr A, had assessed Ms X on the previous shift and had given a brief handover to the current anaesthetist, Dr B. Dr B was approaching the end of a busy 12-hour shift, with emergency cases on the priority list. Having anaesthetised Ms X, Dr B was about to give antibiotics and noticed that the allergy box on the anaesthetic chart was left blank. She went to check the drug chart and saw Ms X had a severe penicillin allergy. The nurse was unaware of this allergy, Ms X did not mention it before induction and Dr A had forgotten to hand it over to Dr B. This was a near miss and could have been avoided if the allergies had been checked before induction of anaesthesia during the 'sign in' part of the surgical safety checklist.

ERRORS IN SURGERY: THE SIZE OF THE PROBLEM

The WHO have estimated that 234M operations are performed annually around the globe.¹ A systematic review including over 74,000 patient records found a median incidence of in-hospital adverse events of 9.2% with approximately half of those events being operation or drug-related, and 43% deemed preventable.² In England and Wales, the National Reporting and Learning System (NRLS) reported 10 526 patients died or came to severe harm secondary to

incidents in 2013–2014. Over 3000 of these incidents were related to treatment or procedure, or implementation of care and ongoing monitoring/review.³ These figures, when extrapolated to the global number of surgeries conducted, are alarming and provide clear motivation to make surgery safer.

HISTORY OF THE WHO SURGICAL SAFETY CHECKLIST

In 2002 the World Health Assembly urged countries to improve the safety of health care and monitoring systems. They requested that the WHO set global standards of care and provided support for countries to improve patient safety. As a result, WHO Patient Safety was formed, and focussed its energy on campaigns named Global Patient Safety Challenges. Following their first challenge, 'Clean Care is Safer Care', WHO launched 'Safe Surgery Saves Lives' and led by Professor Atul Gawande, published WHO Guidelines for Safe Surgery.⁴ This set out 10 essential objectives for safe surgery from which the Surgical Safety Checklist was derived (Figure 1)

The aim of this 'WHO checklist' was to give teams a simple, efficient set of priority checks to improve effective teamwork and communication and encourage active consideration of patient safety for every operation performed. WHO also wanted to ensure consistency in patient safety in surgery and introduce (or maintain) a culture that values patient safety.⁵

In a pilot study of the WHO checklist implementation, Professor Gawande's team prospectively observed over 3000 patients prior to the introduction of the checklist and nearly 4000 patients after checklist implementation, and measured the rate of surgical complication or mortality up to 30 days after surgery or until discharge.⁶ The study included four hospitals in low- and middle-income countries and four hospitals in high-income countries and found the overall rate of death prior to introduction of the checklist was 1.5% and after checklist implementation fell to 0.8%. Inpatient complications were also reduced, from 11% pre checklist to 7% after the checklist was introduced. As a measure of adherence to the checklist, they identified 6 safety indicators, such as pre-incision antibiotics, swab counts and routine anaesthetic checks, and saw an increase in performance of these from 34.2% pre checklist to 56.7% post checklist. It is interesting that even with only 56% completing these 6 indicators, significant reductions in complications and death rates were seen. The checklist implementation team used team introductions, briefings and debriefings as part of the safety routine, which has also been formalised as part of the checklist strategy in the UK (see below).

By September 2014, the WHO team had identified 4132 institutions who had expressed an interest in using the checklist and 1790 institutions who were actively using the checklist in at least one operating theatre.⁷ Seven years after introduction of the checklist, numerous studies have shown the benefit of the checklist, but observers, audits and trials have also reported common barriers to successful use of this patient safety tool. Key to successful implementation across all cultures, economies and specialties seems to be engagement of the

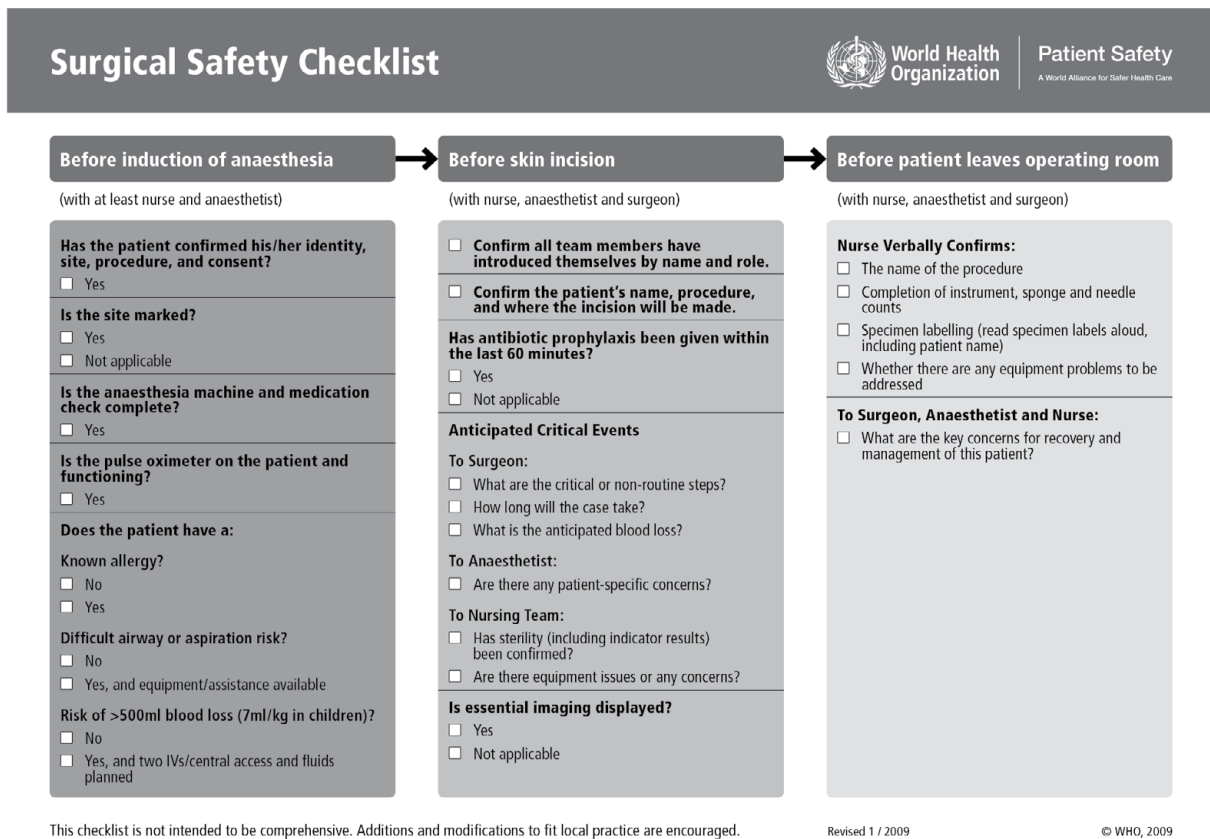


Figure 1. WHO Surgical Safety Checklist. Reproduced with permission of the World Health Organization.

whole team, through understanding the relevance and power of this tool in their setting.

CONSTITUENT PARTS OF THE CHECKLIST

There are three phases to the checklist:

- Sign in** – before induction of anaesthesia, ideally with surgeon present, but not essential
Verbally verify, review with the patient when possible:
 - Patient identity
 - Procedure and site
 - Consent for surgery
 - Operative site is marked if appropriate (involving left or right distinction)
 - Pulse oximeter is on the patient and functioning
Review between anaesthetist and checklist coordinator:
 - Patient's risk of blood loss. If >500ml in adults or >7ml/kg in children, it is recommended to have at least 2 large bore intravenous lines or a central line before surgical incision and fluids or blood available
 - Airway difficulty or aspiration risk. Where a potentially high-risk airway is identified, at a minimum the approach to anaesthesia should be adjusted accordingly, emergency equipment must be accessible and a capable assistant

should be physically present during induction. Symptomatic active reflux or a full stomach should also be handled with a modified plan

- Known allergies - all members of team need to be aware
 - Anaesthesia safety checks complete (equipment, medications, emergency medications, patient's anaesthetic risk)
- Time out** – after induction and before surgical incision, entire team
 - Each team member introduces him/herself by name and role
 - Pause to confirm correct operation for correct patient on correct site. Anaesthetist, nurse and surgeon should all individually confirm agreement, plus the patient if awake
 - Review anticipated critical events
 - Surgical critical/unexpected steps, operative duration, anticipated blood loss
 - Anaesthetic patient specific concerns, for example, intention to use blood products, co-morbidities
 - Nurses confirm sterility of instruments and discuss equipment issues/concerns
 - Confirm prophylactic antibiotics where required, was given within the 60 minutes prior to skin incision. If not given and required, administer prior to incision. If >60 minutes, consider re-dosing the patient
 - Essential imaging displayed as appropriate

3. **Sign out** – during or immediately after wound closure, before moving the patient out of the operating room, whilst surgeon still present
 - a. Confirm operation performed and recorded
 - b. Check instrument, sponge/swab and needle counts are complete. Where numbers do not reconcile the team should be alerted and take steps to investigate
 - c. Check surgical specimens labelled correctly
 - d. Highlight equipment issues
 - e. Verbalize plans or concerns for recovery and postoperatively, especially any specific risks

IMPLEMENTING THE CHECKLIST

The WHO issued an implementation manual in support of the checklist.⁵ This gives detail on how each step should be conducted. The manual highlights the importance of leadership and institutional buy-in, and emphasizes that a department should practice using the checklist before introduction and should modify it so that it can be established within the normal operative workflow. Resources to help with implementation of the checklist are available on the WHO website: http://www.who.int/patientsafety/safesurgery/tools_resources/en/. Example videos from around the world can be seen on the SafeSurg website: <http://www.safesurg.org/videos.html>.

A single person should be responsible for checking the boxes on the list and this can be any healthcare professional in the operating team, often the circulating nurse. That nominated coordinator should prevent the team moving forward before each step has been addressed. Initially this could lead to tensions and resistance within the team, but only through consistently following the safety steps will the most common and avoidable risks be minimized.

Although facilities are encouraged to modify the checklist as needed, they are discouraged from removing safety steps simply because they cannot be accomplished. They also caution facilities from adding too many additional steps and creating an unmanageable, complex checklist. In England and Wales, the National Patient Safety Agency (NPSA) issued a patient safety alert in 2009. They launched a modified checklist for England and Wales with instructions to appoint a clinical lead within each organisation, ensure the checklist was completed for every patient undergoing a surgical procedure and that record of the checklist was entered into the patient notes.⁸ A guide to modification of the checklist is available on the WHO website, as well as examples of modified checklists from around the world: http://www.who.int/patientsafety/safesurgery/local_adaptation/en/

BRIEFING AND DEBRIEFING

The Patient Safety First Campaign was established to support implementation when the NPSA issued their alert informing England

and Wales to use the checklist. Patient Safety First reported that some elements of the checklist could be more effective if incorporated into a briefing before the list starts. This is an opportunity to make a plan for the list, amongst all the team members, to anticipate and plan for any problems that can be foreseen. Any team member can lead the briefing, ensuring that everyone has introduced himself or herself and clarified their role and responsibilities for the list. An overview is taken of the list, highlighting any changes, equipment considerations, special requirements or safety concerns. All theatre team members should be present for the briefing and debriefing.

The debriefing naturally occurs at the end of the list, before any team members have left the theatre or department. The purpose of this debrief is to reflect on the list and share perspective on tasks that went well and tasks that did not go well. This may include discussion of teamwork, the theatre atmosphere, errors or near misses, and a retrospective look at the briefing and use of the surgical safety checklist throughout the day. It is important to register successes, learning points, areas that require change or escalation and for this to be conducted in a non-threatening, open environment. Patient Safety First developed and promoted the ‘Five Steps to Safer Surgery’⁹ (Figure 2)

BARRIERS TO IMPLEMENTATION OF THE WHO CHECKLIST

Common themes that can hinder successful implementation of the checklist are listed in Figure 3. These barriers can be addressed to improve implementation outcomes 9–11.



Figure 2. Five Steps to Safer Surgery.

Pragmatic challenges	Attitudes
<ul style="list-style-type: none"> • Duplication with existing checklists leading to irritation and ‘checklist fatigue’ • Time consuming, inconvenient • Inappropriate timing • Poor communication • Unfamiliarity, confusion, who should prompt the items • Absence of key team members • Using the checklist as a ‘tick box exercise’ 	<ul style="list-style-type: none"> • Denial that routine tasks can be forgotten • Dismissive attitudes, lack of engagement • Hierarchy in the operating theatre discouraging open communication • Embarrassment about introductions • Lack of support from leaders or managers
Resources	Underlying processes of care
<ul style="list-style-type: none"> • Lack of resources such as marker pens, antibiotics and pulse oximeters 	<ul style="list-style-type: none"> • Lack of antibiotic policies, protocols • No routine swab, needle or instrument counts

Figure 3. Table summarising barriers to checklist implementation.

TOP TIPS FOR SUCCESSFUL IMPLEMENTATION OF THE WHO CHECKLIST

Implementation of the checklist can be a challenge, particularly when it is introduced as a new intervention, or top down mandate, or when the benefits are not well understood. After successful implementation, compliance can be one of the greatest challenges, either in terms of use of the checklist or completeness of the checks.¹¹ Below are pointers that may help to introduce the checklist and for it to be used effectively. These points are summarised below in Figure 4.

Leadership

- Leaders in surgery, anaesthesia and nursing are very influential. It is important for leaders to embrace patient safety as a priority and to use the surgical safety checklist for their own cases. Senior members of staff should act as local champions on the 'shop floor', to support junior staff when they want to speak up or challenge an item, or simply to ask a question if they don't understand something. These champions should be approachable, accessible and have skills in negotiation and persuasion. They need to create an honest, transparent culture and a baseline acceptance that

we are all fallible and omissions can occur in any facility under anyone's watch.

- It is important that the checklist is not mandated as a top-down chore for the staff, but that there is enthusiasm and engagement within the workforce, giving them good reason to engage. By using evidence from experience of near misses or adverse incidents, leaders can encourage transparency and honesty, and encourage teams to see the value of these routine checks.
- In addition to leaders and champions, it is important to engage administrative staff. New resources may be needed or simply a supply of paper for checklists in each theatre. Administrative support may also be required to ensure the antibiotic supply chain is established and that the proper equipment is available, including equipment to sterilise surgical instruments.

Implementation of team and staff training

- It is helpful to establish a local implementation team, with representatives from anaesthesia, surgery and nursing. This team should meet on a regular basis to plan introduction of the checklist.
- The implementation team should lead staff training, with in situ demonstrations, videos and coaching when they start to use the

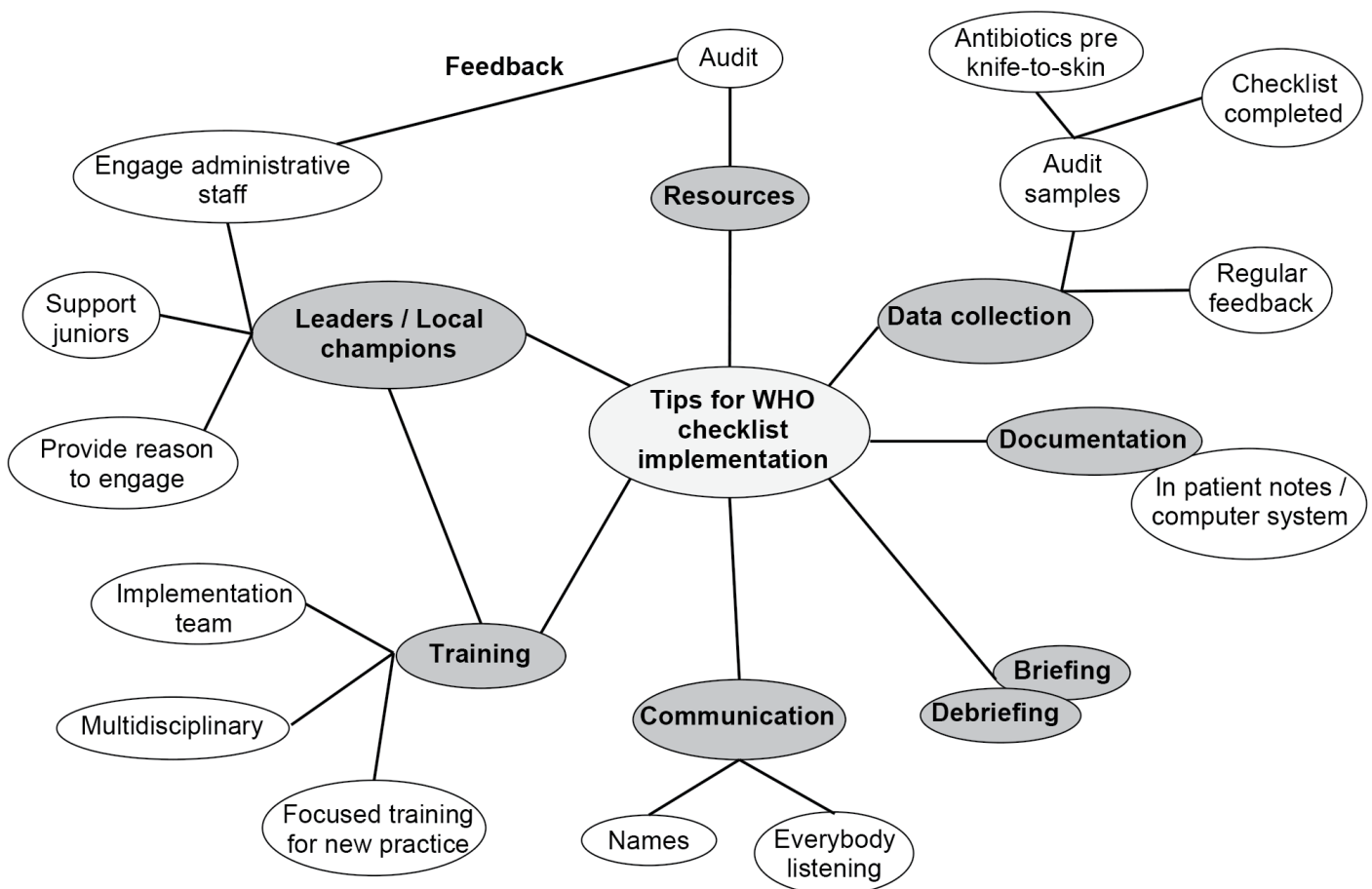


Figure 4. Diagram highlighting important steps in WHO checklist implementation.

checklist. Training should be multi-professional, incorporating the whole team. This helps to flatten the hierarchy in theatre, and for many, it can be very revealing to see the world through the eyes of another.

- In addition to teaching sessions, it is helpful to raise awareness, for instance through posters, newsletters or computer screen savers.
- The implementation team should consider whether to implement the checklist in one area first or to introduce the checklist unit-wide. One example of effective implementation in Washington State described initially piloting the checklist in a small number of operating theatres. Due to the publication in newsletters of 'poster child' success, the other theatres were impatient to wait for official rollout and the checklist spread spontaneously.¹²
- Where an item on the checklist is not a routine practice in your facility, for instance, a team brief or de-brief, or preincision antibiotics or counting surgical instruments, focused training in that area will be needed. These items can be introduced in a stepwise approach, mastering one new item for a period, before adding a second new item.
- Retained swabs, needles or instruments are the most commonly reported serious adverse events in surgery. Training should incorporate the safety impact of such tasks so that staff are given reason to perform them and to recheck the patient if the count is not correct. It will be difficult to complete a surgical instrument count if there is no standardised pack or formal instrument list. Through generation of formal packs and lists, and routine counting out of equipment when it is placed on the surgical trolley, the hazards of retained swabs, needles and instruments can be reduced. All staff groups need to understand the importance of new checks added to practice, to avoid one group finding this a disruptive, time consuming intervention.
- Timely administration of antibiotics at least 15 but not more than 60 minutes before knife to skin (including in caesarean section) is an effective intervention to reduce surgical site infection, and anaesthetists can make an important contribution to reducing this complication. It is important to establish local antibiotic protocols and to make sure that these are adhered to.
- It is useful to encourage teams to communicate clearly. Checks need to be performed out loud for all of the operating team to hear. Avoid leading questions (the antibiotics have been given haven't they?); rather use specific communication to a named individual (Question: Dr X: have you given the antibiotics? Dr X Answer: Yes, the antibiotics have been given).

Timing of briefing and surgical checks

- The 'Five Steps to Safer Surgery' helps to highlight issues at the start of the day and enables early resolution to minimize negative impact on theatre safety and throughput. If your facility is going to adopt this approach, it is helpful to define a fixed time for the pre-list briefing to occur. This will avoid team members arriving casually at different times, and thus inefficiency and resentment whilst waiting for other team members.
- Staff need to free themselves up from distracting tasks when the checks are being completed, ideally asking for 'a surgical pause' or

'a moment of silence' to gather everyone's attention. In addition to being attentive, all members need to be present. It is helpful for the sign out to be completed whilst the surgeon is closing the wound as this integrates the checklist into the surgical process and ensures the surgeon is still present in theatre.

Resources and documentation

- Where an item cannot be completed, for instance due to lack of skin marker pens, pulse oximetry or antibiotics, checklist coordinators should not tick the item dishonestly. Use regular audit to document this need and feed this back to the department on a regular basis. Contact your hospital administrator so that theatre resources can be improved.
- Some facilities have found it useful to record the checklist information on a whiteboard or laminated paper in theatre, to refer to during the case. With operating team members changing frequently, staff names particularly may be easily forgotten and the team may find it helpful to display each staff member's name.
- Where the checklist is not part of the computer system, give each theatre a folder with multiple paper copies. Use of the checklist should be documented in the patient record, for instance, on the anaesthetic chart.
- Routine pre-anaesthesia safety checks and the use of a pulse oximeter are part of the WHO Standards for Safe Surgery, also the WFSA International Standards for the Safe Practice of Anaesthesia 201013. The Lifebox Foundation has been established to facilitate access to pulse oximeters in low- and middle-income countries where these are not available (www.lifebox.org); if you do not have access to a pulse oximeter, please contact Lifebox and make yourself known.

Data collection and feedback

- Data is a powerful way to drive change in practice, and is an essential component of any quality improvement project. This can be an informal or formal process, paper based or electronic, depending on your local situation. The Royal College of Anaesthetists has published a useful introduction to quality improvement,¹⁴ and on-line courses are available through the Institute of Healthcare Improvement (IHI) (<http://www.ihl.org/Pages/default.aspx>).
- Data can be collected in the form of 'process measures' – for instance, audit samples of the patient records on a weekly basis to see if the checklist has been completed or if antibiotics have been given before knife to skin. Ask a member of the team to observe in theatre to see if the checklist is being done, or to check whether all items on the checklist have been completed.
- 'Outcome measures' such as surgical start times, reason for delays, adverse events, near misses, and postoperative infections have been used to support the introduction of the checklist. Patient stories are a powerful way to motivate teams.
- The implementation team should feed this information back to the theatre team on a regular basis, ideally as 'run charts'. A run chart is a simple plot of frequency of event (% patients with

checklist completed, or antibiotics given) against time, so that the theatre team can see how they are performing each week or month. Consider comparing one theatre to another – competition is an effective driver for change. Use these results to stimulate discussion about why things work well, or to discover the barriers that prevent success.

- It is also important to present these data to the hospital administrative team (e.g. managers) so that recurring problems such as lack of resource or system issues can be addressed promptly. On the other hand, making them aware of improvement in patient outcomes will further incentivise management to endorse patient safety projects.

SUMMARY

- Preventable harm occurs daily during surgery across the world. The WHO checklist was introduced as one means of reducing harm and improving patient safety in the operating theatre. With the benefit of hindsight, trials and audit, we have gained experience and identified the key factors that enable successful use of the checklist. These are senior multidisciplinary support, surgical buy-in, ensuring underlying processes of care are in place, and using local champions to enthuse and encourage staff.
- The checklist needs to become part of routine surgical culture, even more so in an emergency or at the end of a long shift when simple tasks are easily forgotten. With consistent use, team members will become familiar with the checks, less embarrassed about using them, more time efficient, and break down the barriers to success. And ultimately, patient harm will be reduced.

ANSWERS

1.
 - a. **False:** Implementation of the checklist is a team effort. The team should represent everyone who works in theatre in order to get buy-in from all theatre personnel.
 - b. **False:** Experienced members of the theatre team who are committed to improving patient safety should lead the implementation process. Senior members of staff are very influential and need to be engaged; students are a very valuable resource and can help support the implementation process if they have support of the leaders in theatre.
 - c. **False:** Real time mentorship in theatre and continual feedback on progress of implementation is a powerful driver to influence change. It is useful to use regular observations and informal discussions on how things could be improved, rather than waiting until the end of an implementation period to evaluate the difficulties.

- d. **False:** Safety steps should not be removed where they cannot be achieved. Examples include using a functioning pulse oximeter and administration of appropriate prophylactic antibiotics. Engage the administrative staff in the hospital so that all the items can be checked. This may also involve support from charities such as Lifebox.
 - e. **True:** Reporting and sharing stories of near misses or adverse incidents helps people to see how the checklist can be useful. Run charts of checklist completion rate can help people to see how they are doing with the 'process'; audits of outcomes such as wound infections are more difficult to do, but can inspire a team to use safety checklists.
2.
 - a. **True**
 - b. **False:** It is even more valuable to use the WHO checklist in an emergency as simple safety checks can easily be forgotten in a pressurised, urgent environment.
 - c. **False:** All staff members should feel able to raise questions and talk without fear or embarrassment. This can be encouraged by creating an open, non-hierarchical environment.
 - d. **False:** Antibiotics should be given 15- 60 minutes prior to the skin incision.
 - e. **True:** 'Counting' surgical swabs and instruments is an important part of modern surgical nursing. It is easier if there are standardised numbers of packs used (for instance, swabs are put on the surgical trolley in packs of 5) and a standard list of instruments so that they can be checked off at the end of the operation.
 3.
 - a. **False:** The briefing is held before the start of the list and debriefing at the end of the list rather than before and after every case.
 - b. **True**
 - c. **False:** A pre-list briefing can be used to pre-empt or trouble shoot equipment or safety issues and anticipate challenges for the list. The whole team should be present for pre-list briefing.
 - d. **False:** The briefing should take around 10 minutes, but will save delays throughout the day.
 - e. **False:** When a list has run safely, efficiently and uneventfully, it is useful to look at the team behaviours during that list that contributed to success. By verbalising what went well the team can actively take those positive strategies into their next list.

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Update in Anaesthesia

Patient Safety Update: Infusion safety, preoperative assessment, bone cement implantation syndrome

Toby Reynolds and Queenie Lo

Edited by:

Isabeau Walker

Correspondence: atotw@wfsahq.org

Originally published as Anaesthesia Tutorial of the Week, 374, 6 March 2018, edited by Isabeau Walker

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KEY POINTS

- Drug infusion errors are preventable. System measures such as the use of a preprogrammed drug library on infusion pumps and a two-person drug checking rule, can provide additional safety barrier.
- Clear, effective communication is essential for patient safety
- Identify patients at risk of bone cement implantation syndrome, ensure all theatre team members are aware and plan accordingly

Patient Safety Updates contain learning from incidents reported to the NHS England and Wales National Reporting and Learning System (NRLS). The aim of SALG is to highlight potential or existing patient safety issues from patient stories, and to encourage incident reporting for the purpose of learning.

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INTRODUCTION

This tutorial is based on the Patient Safety Update (PSU) published by the Safe Anaesthesia Liaison Group (SALG). SALG is a professional group with a core membership including representatives from the Royal College of Anaesthetists (RCoA), the Association of Anaesthetists of Great Britain & Ireland (AAGBI), and National Health Service (NHS) England Patient Safety. SALG's quarterly

The cases reported are reproduced with permission from the Safe Anaesthesia Liaison Group, and were originally published on the RCoA and AAGBI websites. Further information, together with this and previous Patient Safety Updates, is available on the SALG website.² The cases and much of the information contained in this tutorial is taken from the SALG Patient Safety Updates Oct 2016 – March 2017. SALG has not reviewed this publication.

Toby Reynolds

Perioperative Medicine
Fellow
Royal London Hospital
UK

Queenie Lo

Patient Safety Fellow
Royal Marsden Hospital
UK

Isabeau Walker

Consultant Anaesthetist
Great Ormond Street
Hospital
London
UK

INFUSION SAFETY

“A patient remained hypotensive despite maximum dose phenylephrine via peripheral cannula. A central line was inserted by the anaesthetist and noradrenaline (8mg/50mls) commenced by anaesthetist via syringe pump . . . it was noted that around 15mls of 50ml syringe had been given, and that rate had been set wrong and the patient had received 15–17mls bolus. The anaesthetist was informed and the infusion was stopped immediately. The patient became hypertensive and bradycardic, then hypotensive and lost output.”

“A patient underwent elective robotic assisted cystectomy. The patient had pre-existing renal failure and developed metabolic acidosis and hyperkalaemia during the surgery. An IV infusion of lidocaine was used –approximately 1g administered in total. The patient became agitated post extubation, was transferred to ICU, and then had a tonic clonic seizure. The patient became bradycardic and acidotic requiring noradrenaline infusion to maintain blood pressure. LA toxicity was diagnosed and treated with intralipid. The patient improved rapidly within 20 minutes with resolution of the bradycardia and improvement in acidosis, and the noradrenaline infusion was stopped.”

Medication errors are the third most common patient safety incident reported to the NRLS³ and medication-related incidents appear frequently in SALG Patient Safety Updates. The World Health Organization launched its Third Global Patient Safety Challenge, ‘Medication without Harm’ in March 2017 to reduce the level of severe avoidable medication harm related to medications by 50% over 5 years, globally.⁴ The initiative is designed for all healthcare professionals in all care settings. There are useful lessons for anaesthetic practice in the WHO Patient Safety Curriculum Guide,⁵ including an emphasis on clear communication (such as encouragement to “state the obvious”), personal aide-memoires and routine use of careful checks.

The Patient Safety Curriculum also describes the complex systems we work in, and the importance of understanding the multiple system factors that make it possible for error to occur (patient and provider factors; task factors; technology and tool factors; team factors; environmental factors; organizational factors). Human errors such as slips, lapses, mistakes and violations interact with system factors such as inadequate communication, lack of checking procedures and time pressures as well as suboptimal workplace and medication packaging design.

Violation of strict checking rules may be more common than we care to think⁶ (do you check/double check the name and expiry date of every ampoule of every drug that you give?). We need to think about the way that we work as individuals, as well as controlling the environment in which we work (rushed, noisy, multiple tasks undertaken at the same time), to help us to reduce errors.

Vasoactive and analgesic drug infusions

The use of powerful agents or concentrated solutions in anaesthesia such as sedatives, analgesics or inotropes exacerbates the problems associated with infusion errors. Errors associated with infusions include:

- Inadvertent bolus administration
- Siphonage and free flow
- Occlusion, and subsequent post-occlusion bolus delivery⁷

Syringe-driver pumps, the most commonly used pumps for vasoactive drugs in anaesthesia practice, are usually programmed to depress a syringe plunger at a set rate of mm/hr, and thus putting in a syringe with the wrong cross-sectional area will deliver the wrong volume in a given time. Although many pumps have safety systems designed to automatically detect the type of syringe that has been loaded, these are not fool proof. Use of a **pre-programmed drug library**, as opposed to setting a generic administration rate in ml/hr, can help avoid errors in dose calculation, although this requires an institution to keep the pump’s drug library up to date to avoid violation errors. Involving a colleague as a **second person to check** the pump settings and dose calculations provides an additional safety barrier.

Of particular relevance for high potency infusions is the delivery of a bolus dose as a result of a complete or partial occlusion of the infusion line, or other interference with the depression of the syringe plunger. Although the infusion fluid itself is incompressible, air bubbles in the syringe and the elasticity of the infusion line tubing add a small amount of compliance to the system that allows a brief period of continued drug infusion after occlusion of the line, which is then delivered to the patient as a bolus when the occlusion is removed. The more distal the occlusion is to the pump and the higher the pump operating pressure, the greater the magnitude of this post-occlusion bolus. Clinicians investigating an incident of inadvertent hypertension during noradrenaline administration noted accidental boluses of almost 1ml in a simulation study that added additional compliance in the system, such as a piece of infusion tubing accidentally stuck between the plunger and the syringe driver.⁸

Finally, an extremely important source of error in anaesthesia is to forget to **clear the drug line after the infusion** has been completed – for instance an extension used for a remifentanyl or atracurium infusion.

Lidocaine infusions

Perioperative use of intravenous lidocaine infusions for analgesia during and after surgery has gained popularity in recent years. Scientific literature suggests that lidocaine is a useful adjuvant analgesic with predictable pharmacokinetics, but it is nonetheless a drug with a narrow therapeutic range, with central nervous system (CNS) toxicity occurring only slightly above the therapeutic plasma level.

The dose of intravenous lidocaine suitable for analgesia in the perioperative period is 1–2 mg kg⁻¹ as an initial slow bolus followed by a continuous infusion of 0.5–3 mg kg⁻¹h⁻¹. The free plasma

concentration of lidocaine is determined by the total dose and rate of injection, but is also affected by the acid–base status, hypercapnia and hypoxia, low plasma protein levels, and diminished hepatic or renal function. All these factors need to be taken into account when calculating the dose to be given.⁹

A recent review of 45 small randomized controlled trials suggested that systemic perioperative lidocaine infusion was not associated with increased major adverse events, but noted that current data were underpowered to definitively exclude this risk.¹⁰

The authors of one review note that in their experience lidocaine toxicity is almost always a result of an iatrogenic error in dose, delivery, or infusion pump programming.⁹ In the case described here, the rapid response to intralipid therapy suggests that the plasma levels of lidocaine may have been toxic for this patient.

COMMUNICATION AND PREOPERATIVE ASSESSMENT SAFETY

“A patient was undergoing eye examination under a general anaesthetic. He suffered a sudden desaturation, and required transfer to critical care, ventilated and sedated, and later required emergency placement of chest drain which drained large volumes of pleural fluid. A CT scan that was performed and reported prior to the eye examination had demonstrated a large pleural effusion with mediastinal shift.”

The ultimate responsibility for ensuring that a patient has been assessed adequately prior to surgery rests with the anaesthetist who will give the anaesthetic (AAGBI Preoperative Assessment and Patient Preparation 2010)¹¹. However, system factors may contribute to failings in preoperative assessment and preparation. Time is one important factor. Your organisation has a responsibility to make sure that you receive notification about elective lists in good time so that you can assess the patient without undue pressure. Although not specifically mentioned in the AAGBI guideline, it makes intuitive sense that the organisation should also provide space to see the patient, and make sure that you have access to any relevant medical records.

Missing medical records and difficulty accessing relevant test results was a common theme in a 2000 analysis of the Australian Incident Monitoring Study database. That study found that poor communication contributed to 46 of 197 incidents related to preoperative assessment, most commonly through missing records and organisational system factors such as failure to communicate orders.¹² Similarly, a qualitative interview study in the UK found that information transfer between surgeons, anaesthetists and preoperative assessment teams was often poor, particularly regarding the results of specialist assessments.¹³ Another study in surgical outpatient clinics in the UK found that 15% of patients had missing clinical information that the

surgeon looked for but couldn't find, most commonly imaging results, diagnostic test results and recent summaries of recent admissions.¹⁴

While it is hard for any individual clinician to change these system factors, awareness of the problem is important as it can help limit risks. Communication breakdown was found to be the second most common contributing factor in a series of surgical error reports analysed in the United States, after inexperience/ lack of competence. Importantly, miscommunication was reported as a contributing factor twice as often where the surgeon also reported excessive workload.¹⁵

A more detailed study of U.S. malpractice claims identified status asymmetry, ambiguity of roles and handovers as the three most common contributing factors to communication breakdowns that had led to injury to surgical patients.¹⁶

Communication tools can be used to minimise the risk of important information being missed. The most obvious example of this is the WHO checklist, which has been shown to reduce death and complications in both high- and low-resource settings. Despite initial misgivings, the WHO Checklist has now become an accepted part of operating theatre routine in many countries, and probably has had its greatest impact in improving adherence to routine safety checks, and by improving teamwork and communication.^{17,18} However, imposition of checklists and formal communication tools will not eradicate perioperative communication errors without effective implementation – effective use of safety checks requires understanding of the benefits, appropriate training and good surgical leadership.^{5,18,19} Teamwork training, structured reflection using simulated and real clinical episodes and adoption of a systems approach may be useful.²⁰

BONE CEMENT IMPLANTATION SYNDROME

Bone cement implantation syndrome (BCIS) is a poorly understood phenomenon with no agreed standard definition currently. It is characterised by hypoxia and hypotension but has a wide spectrum of clinical features that can occur with any surgical instrumentation of the femoral canal, ranging from transient desaturation and hypotension to pulmonary hypertension and cardiac arrhythmias. A sudden drop in end tidal CO₂ may herald abrupt onset pulmonary hypertension and a precipitous drop in cardiac output resulting in cardiac arrest.²¹ BCIS is described in tutorial 351.²²

“A patient was hypoxic and hypotensive after bone cement was inserted. This resolved to some extent but the patient had to be intubated in recovery and taken to ICU. Following local case review, the department identified and reported some good practice points:

- Identify high risk patients
- Cement implantation syndrome was not discussed within the surgical or anaesthetic consent process. This

should probably be done and documented in patients who are high risk.

- Communication between the surgical and anaesthetic teams was good however the cementing was not discussed at the WHO check
- The cement curfew did not take place formally, we just discussed it around the time of cementing. Guidance should be available in theatre on how exactly this should be done to standardise this."

BCIS is associated with procedures that breach the femoral canal such as intramedullary nailing and cemented and uncemented hip implants. Frail patients undergoing cemented hip replacement surgery following hip fracture are at particularly high risk. Interventions which may reduce the likelihood or severity of bone cement implantation syndrome include medullary lavage, good haemostasis before cement insertion and retrograde application of cement with the cement gun.²¹

The AAGBI published a guideline on bone cement implantation syndrome in 2015, which provides a structured approach to management of patients requiring cemented hemiarthroplasty following a long bone fracture.²³ In the above case, the local review panel noted that some of the recommended steps had not been completed, such as identification of the at-risk patient and shared team understanding of the problem. Clinicians in Coventry recommend a 'Cement Curfew' which teams might like to consider.²⁴

The AAGBI guideline recommends the following steps to minimise the impact of BCIS:

1. Identification of patients at high risk of cardiorespiratory compromise:
 - Increasing age
 - Significant cardiopulmonary disease
 - Diuretics
 - Male sex
2. Preparation of team(s) and identification of roles in case of severe reaction
 - Pre-operative multidisciplinary discussion
 - Pre-list briefing and World Health Organisation (WHO) Safe Surgery checklist 'time-out' (Reference)
3. Specific intra-operative roles:
 - Surgeon
 - Inform the anaesthetist just before insertion of cement
 - Wash and dry the femoral canal
 - Apply cement retrogradely using the cement gun with a suction catheter and intramedullary plug in the femoral shaft
 - Anaesthetist
 - Ensure adequate resuscitation pre-and intra operatively
 - Confirm to the surgeon that you are aware that he/she is about to prepare/apply cement

- Maintain vigilance for signs of cardiorespiratory compromise
- Aim for a systolic blood pressure within 20% of pre-induction value. Invasive blood pressure monitoring is indicated for patients at higher risk
- Prepare vasopressors in case of cardiovascular collapse

The 'Cement Curfew' mentioned above refers to a protocol described by a team in Coventry in the UK, whereby team members are given pre-assigned roles for the period of the operation when BCIS is most likely and attention is focused on readying the patient for this possible event, and monitoring for signs of a problem.

SUMMARY

- Drug infusions are a common source of preventable errors. Users should be familiar with pump programming and the possibility of unintended boluses
- Plasma lidocaine concentrations are related to the total dose and infusion rate, but also to other factors such as acid base status and protein binding
- Communication breakdown is a common source of surgical and anaesthesia error
- Bone cement implantation syndrome is characterised by hypoxia and hypotension around the time of cement implantation in the femoral canal, but can lead to cardiovascular collapse. It is important to identify patients at risk and to plan accordingly, making all the theatre team aware.

This tutorial is estimated to take 1 hour to complete. Please record time spent and report this to your accrediting body if you wish to claim CME points.

To take the online test accompanying this tutorial, please click here.

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Patient Safety Update: Central Neuraxial Blockade, Drug Errors and 'Never Events'

Dr T Reynolds

Edited by

Dr Isabeau Walker

Correspondence: atotw@wfsahq.org

Originally published as Anaesthesia Tutorial of the Week, 357, 11 July 2017, edited by Dr Isabeau Walker

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QUESTIONS

Before continuing, try to answer the following questions. The answers can be found at the end of the article, together with an explanation. Please answer True or False:

1. Regarding safe central neuraxial blockade:

- Meningitis is a rare but well-recognised complication of spinal anaesthesia
- Chlorhexidine in alcohol is the best solution to use for skin antisepsis prior to performing a central neuraxial block
- Barrier precautions for performing an aseptic CNB include hand-washing, wearing a hat, mask, sterile gloves and gown, and using a sterile drape
- There is no need for the operator to wear a face-mask if they are just performing a spinal injection
- Spinal anaesthesia should be avoided in a patient with known bacteraemia

2. Concerning drug errors:

- Rapid bolus administration of vancomycin, magnesium or amiodarone can lead to severe hypotension or cardiac arrest
- Good anaesthetists rarely make a drug error
- Retained anaesthesia drugs in IV lines are only a risk in paediatric practice
- Dangerous drugs such as concentrated potassium should be stored separately in the operating theatre
- Syringe swaps are an important cause of awareness with awake paralysis

3. Concerning 'never events':

- Never events are unfortunate, but have no reflection on the overall safety culture of the organisation
- Surgical events rarely feature in descriptions of never events on a national scale
- A 'never event' usually happens because one person doesn't do their job properly
- The most reliable way to prevent a surgical never event is the time out check immediately prior to skin incision
- All patients should have the surgical site marked if feasible, and the mark should remain visible under the surgical drapes.

T Reynolds

Specialty trainee in anaesthesia
Broomfield Hospital
UK

Dr Isabeau Walker

Consultant Anaesthetist
Great Ormond Street
Hospital
UK

KEY POINTS

- Meningitis is a very rare but recognised complication of central neuraxial blockade, and is minimised by strict aseptic technique
- Drug errors are common in anaesthesia practice. It is our responsibility to adopt safety measures in our daily practice and to comply with standard safety procedures
- 'Surgical' never events - wrong site surgery, retained foreign object, wrong prosthesis- are the most common category of never event in clinical practice, which usually occur as a result of a cascade of errors. Standardisation of operating department procedures may be an effective way to reduce surgical never events.

INTRODUCTION

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CENTRAL NEURAXIAL BLOCKADE

Meningitis is a rare but well-recognised complication of CNB, occurring in <1:200,000 cases. The Royal College of Anaesthetists' third national audit project (NAP3) summarises the risks associated with epidural or spinal central neuraxial blockade (CNB), including the risk of meningitis.²

Nasopharyngeal commensals are the most common causative bacteria for meningitis after spinal anaesthesia, suggesting that the cause is droplet contamination of the spinal needle by the operator. Culture of *Strep. Salivarius* in this case is in keeping with droplet spread from the operator's airway.³ The most common causative agent in epidural anaesthesia is a skin commensal, suggesting suboptimal aseptic technique, also an important cause of epidural abscess.²

Risk factors for development of meningitis after CNB

Patient risk factors:

- Immune compromise
- Prolonged insertion of a catheter.

Endogenous source of infection

- Local skin sepsis
- Systemic sepsis

Exogenous source of infection

- Contaminated equipment
- Contaminated solutions

Case Report

'The patient had a spinal anaesthetic and had a polyp removed in theatre. The patient returned 2 days later for brachytherapy (radiotherapy), and had a repeat spinal anaesthetic... discharged later that day. The patient was rushed to Accident & Emergency in the early hours of the morning and ended up in ITU, intubated with suspected sepsis. Discharged 13 days later.

Reason stated for collapse was cerebromeningoencephalitis with *Strep. Salivarius* bacteraemia from the spinal anaesthetic.'

Full aseptic technique is recommended during preparation and siting of CNB. The Association of Anaesthetists of Great Britain & Ireland (AAGBI) and American Society of Anaesthesiologists (ASA) both recommend the use of a surgical facemask by the operator during spinal anaesthesia.^{4,5}

The evidence-based practice advisory from the ASA highlights the prevention, diagnosis and management of infective complications from CNB. There are few high-level studies, so most evidence is from observational studies and case reports, with recommendations based on expert consensus opinion.⁵ The ASA Practice advisory makes the following recommendations:

- Consider risks and benefits of CNB on a case-by-case basis, and consider an alternative approach in patients at high-risk of an infective complication (for instance, impaired immunity)
- Avoid lumbar puncture in the presence of a known epidural abscess.
- Consider pre-procedure antibiotics in patients with known or suspected to have on-going bacteraemia
- An aseptic technique must be used for all CNB insertions:
 - Sterile equipment must be used (e.g. needles, catheters, ultrasound cover)
 - Operator to wear surgical cap and face-mask to cover mouth and nose
 - Remove jewellery (rings, watches)
 - Wash hands
 - Use sterile gloves
 - Chlorhexidine in alcohol is recommended for skin preparation with adequate drying time
 - Use a sterile occlusive dressing at the catheter insertion site.

Chlorhexidine in alcohol is an effective skin antiseptic, but there are concerns about chemical arachnoiditis if the intrathecal space is contaminated with chlorhexidine, for instance by splashing chlorhexidine on the spinal needle. For this reason, the AAGBI recommends using low concentration chlorhexidine (0.5%) in alcohol for skin antiseptics prior to performing CNB, with meticulous care taken to avoid chlorhexidine from reaching the CSF⁴. Open containers containing chlorhexidine must NOT be placed on the spinal trolley.

Case Reports

'A trainee anaesthetist changed the propofol syringe whilst the Consultant Anaesthetist took a comfort break and forgot to restart the machine. The infusion pump failed to give an audible alarm and the anaesthetic levels were not maintained, which was only discovered when the patient moved on the operating table.'

'Just before knife to skin for insertion of haemodialysis access graft, I gave vancomycin intravenously over one minute instead of over 60 minutes as advised. It had been a year since I had last given vancomycin IV and I simply forgot that it could not be given as a bolus. The patient became red, hypotensive (40/20 initially responding to adrenaline). I knew immediately what I had done, corrected it, and surgery proceeded uneventfully. I explained

everything and apologised to the patient as per duty of candour an hour or two postop. I thought there had been no sequelae as she was fine at the time. Unfortunately the patient developed new neurological symptoms after the operation.'

'A patient was admitted to recovery. The 20G cannula used for induction with remifentanyl and propofol at the start of a case had not been flushed along with the other cannula during the case. We were aware that there was a risk of opioid remaining in the cannula so the cannula was flushed by the anaesthetist. The patient stopped responding and required assisted ventilation for 30 seconds.'

DRUG ERRORS

Drug errors are one of the most common types of error reported to the NRLS and can arise for many reasons, including slips (failure of attention) and lapses (failure of memory), as in the cases described here. The fifth Royal College of Anaesthetists' national audit project (NAP5), 'Accidental Awareness During Anaesthesia in the United Kingdom and Ireland' found that syringe swaps and other drug errors accounted for 1 in 8 of all definite and probable cases of awareness reported to the audit.⁶

Vancomycin, clindamicin and levofloxacin are antibiotic drugs known to lead to hypotension and even cardiac arrest when given as a bolus. Vancomycin is a well-recognised cause of 'red man syndrome' due to histamine release after rapid IV administration. Rapid administration of amiodarone, phenytoin, magnesium, and hypertonic solutions of mannitol and saline may also cause hypotension, which can be severe.⁷ Residual anaesthesia drug in IV lines is another drug error that has recently attracted attention; it is the responsibility of the anaesthetist to flush all IV lines at the end of each case.⁸

Anaesthetists are in the unique position in medicine of prescribing, drawing up and administering multiple different drugs during a case, often in rapid succession, often in situations where there may be many other distractions. Drug errors and near misses are common in anaesthesia, estimated to occur in 1:133 -1:450 anaesthetics. Based in these data, the average anaesthetist could be expected to make up to seven drug errors per year, and possibly two drug errors resulting in serious harm to the patient during a career in anaesthesia. The majority of drug errors are due to human error and preventable, so it is obvious that we all need to put measures into place to reduce our drug errors⁹⁻¹¹.

The **most common** types of drug error in anaesthesia are⁹⁻¹¹:

- Incorrect dose (miscalculation, concentration or infusion rate)
- Substitution (syringe swap)
- Repetition (extra dose)
- Omission (missed dose)

Uncommon potentially lethal drug errors include:

- Wrong route errors (e.g. IV/epidural/intrathecal wrong route errors)
- Miscalculation of dilution (or failure to dilute)
- Mis-programming of infusion pumps
- Administering a drug to a patient with a known allergy
- Failure to flush a line after a drug has been administered

Stabile *et al.* published a very informative article concerning medication safety in a USA Anaesthesia Patient Safety Foundation (APSF) newsletter.¹¹ The APSF is an international campaigning organisation aimed at anaesthesia safety research and education (<http://www.apsf.org>). They have also developed a video to support the APSF advice concerning medication safety (<http://www.apsf.org/resources/med-safety/watch>).

The following practices have been recommended to reduce drug administration errors⁹⁻¹¹:

- Label all syringes, and discard unlabelled syringes
- Read the label on any drug ampoule or syringe before a drug is drawn up or injected
- Standardise syringe labels in your theatres/operating rooms, and use class-specific colour codes according to international ISO standards (or a bar-coding system)
- Organise your workplace - keep your workspace tidy, use standardised drug trays, separate similar or dangerous drugs, and remove dangerous drugs from the operating theatre.
- Double check medications, particularly high-risk medications, prior to administration, ideally with a second person, or using bar-coding technology
- Use pre-filled syringes where possible
- Cover all syringes with caps to maintain sterility
- Use standardised 'smart' syringe pumps in your theatre/operating room, with pre-set alerts and alarms
- Use labelled 'route specific' administration sets (e.g. IV or epidural), with colour codes (yellow epidural, red arterial), and remove injection ports e.g. from epidural lines.
- Include a review of drugs administered in your handover checks
- Discard all unused drugs at the end of each case
- Flush all IV lines at the end of the case, before handing the patient over to recovery

All theatres/operating rooms should have dedicated support from the hospital pharmacy, including support for purchase and restocking of drugs. Purchase of look-alike drugs should be avoided, or if this is unavoidable, the anaesthesia team should be alerted to the existence of look-like drugs, also to any change in appearance or concentration of commonly used drugs. Rarely used drugs and solutions (e.g. glucose, heparin, hypertonic saline, sterile water, epidural solutions) should be stored separately from routinely used IV solutions.

We should all aim to develop a culture of respect and compliance relating to patient safety, with written policies for medication safety,

appropriate induction for new staff, and teaching and supervision of junior staff. Senior leadership is an important factor in achieving this.

SURGICAL NEVER EVENTS

Case Report

'Patient being operated on in the prone position...despite the WHO checklist the patient was shaved and then underwent an incision on the wrong hip... once recognised the wound was closed and surgery was performed on the correct hip.'

There are some things that should never happen in health care, particularly operation on the wrong site.

In the NHS, a 'Never Event' is defined as 'a serious incident that is wholly preventable as guidance or safety recommendations that provide strong systemic protective barriers are available at a national level and should have been implemented by all healthcare providers.'

Never events are unambiguous, serious events, usually preventable, and are thought to be indicative of a problem in the health system.

Mandatory reporting is required, with root cause analysis conducted for each incident in a proscribed time frame and dissemination of learning within the organisation and more widely. There may also be financial implications for the institution or individual clinician in some healthcare settings.

Unfortunately, the most common never events in NHS practice are 'surgical' never events: wrong site surgery, retained foreign object post procedure, wrong implant/prosthesis.

Evidence suggests that never events in surgery generally occur as a result of a 'cascade' of errors, such as:¹²

- Scheduling errors
- Incorrect consent
- Incorrect patient information
- Failure of the time out procedures
- Incorrect marking procedure
- Wrong site anaesthetic block
- Confusion due to prone position or incorrect positioning/application of a tourniquet
- Multiple procedures on the same patient
- Incorrectly labelled specimen

Other contributing factors to surgical never events have been described:^{13,14}

- Failure to follow standard procedures, bending or breaking the rules

- Human factors
- Chaotic workplace, rushing, interruptions
- Complexity of the case, perceived emergency
- Communication failures
- Lack of training
- Confirmation bias
- Channelled attention
- Over confidence
- Lack of vigilance
- Failure to understand barriers
- Inconsistent practices between teams
- Staff unable to speak up

In 2014 NHS England commissioned a Never Events Task Force to address the problem of continuing surgical never events in the NHS (<https://www.england.nhs.uk/patientsafety/never-events/surgical/>). The task force recommended improved education for theatre staff to understand the evolution of never events, the adoption of 'standard operating procedures' for operating practice, and consistent reporting, dissemination and learning from never events. The National Standards for Invasive Procedures (NatSSIPS) were published in 2015 (<https://www.england.nhs.uk/patientsafety/neverevents/natssips/>), with a requirement for all NHS organisations to translate these national standards into local standard operating procedures.

With respect to wrong site surgery, the least reliable safety check is at the time out immediately prior to skin incision as 'confirmation bias' is very common. The most effective way to catch a wrong site error is for the surgeon to assess and mark the patient preoperatively, with repeat checks at multiple points. Relevant to the case described here, the procedural verification NatSSIP recommends:

For procedures during which the patient's position may be changed, marking must be applied such that it is visible at all times. When the patient's position is changed during a procedure, the surgical site should be reverified and the surgical mark checked.

The latest data from NHS Improvement for 2016/17 includes 380 never events, 78% of these surgical, including 156 wrong site surgeries, 95 retained foreign objects post procedure, and 45 wrong implant/prosthesis. This is a slight improvement on the 2015/16 data – rather too soon to say, but maybe indicates that standardisation of our operating procedures could be a way to reduce the incidence of surgical never events.¹⁵

SUMMARY

All anaesthetists should be encouraged to develop a culture of incident reporting and analysis. The anaesthetists involved in the cases reported here are to be commended. In the words of Mackintosh:¹⁶

'It is difficult enough to overcome the inertia natural to most of us to write to the medical journals about our successes. Believe me, it takes considerable effort to prepare a communication about one's failures.'

'A wise man learns from his mistakes, and I hope that we can go a step further and learn from the mistakes of the other man.'

Strict asepsis is important when undertaking CNB. Drug errors are common in anaesthesia practice, and can be reduced by careful arrangement of the workspace, adoption of routine safety procedures such as labelling, checking, and use of prefilled/pre-diluted medications, with separation of 'dangerous' drugs from commonly used drugs. All IV lines should be flushed at the end of surgery prior to transfer to recovery area. Standardisation of operating room procedures and an understanding of why never events occur may be an opportunity to reduce serious incidents in surgical practice.

ANSWERS TO QUESTIONS

1. Regarding safe central neuraxial blockade:

- True: NAP3 estimated the incidence of meningitis as a complication of CNB as fewer than 1:200,000
- True: Chlorhexidine in alcohol is an effective antiseptic. The AAGBI guidelines recommend a 0.5% chlorhexidine solution as sufficient for antiseptics and less likely to cause neurotoxicity
- True: These are the barrier precautions recommended by the AAGBI and the ASA guidelines
- False: Nasopharyngeal commensals are the most common causative bacteria for meningitis after spinal anaesthesia, suggesting that the cause is droplet contamination of the spinal needle by the operator
- True: ASA guidelines recommend that for patients at high risk of infectious complications, alternatives to neuraxial techniques should be considered, but that the decision whether or not to use a neuraxial technique should be made on a case-by-case basis. The guidelines recommend that antibiotics should be given before CNB when the patient has a known or suspected bacteraemia.

2. Concerning drug errors:

- True: Rapid bolus injection of these drugs has been associated with hypotension and cardiovascular collapse
- False: Drug errors are common in anaesthesia and the average anaesthetist is likely to make up to seven errors per year.
- False: IV anaesthetic agents cause harm if not flushed after IV administration in any patient. This is particularly true for potent agents such as remifentanyl.
- True: dangerous drugs such as concentrated potassium should be separated from routine IV drugs, and should be stored separately.

- e. True: Syringe swaps and other drug errors accounted for 1 in 8 of all definite and probable cases of awareness reported to NAP5

3. Regarding 'never events':

- a. False: The occurrence of a never event may reflect an underlying problem in the health system
- b. False: In the NHS, surgical never events are the most common category of never event
- c. False: A never event usually occurs due to a cascade of errors involving multiple individuals
- d. False: the most reliable way to prevent a surgical never event is for the surgeon to assess the patient preoperatively and to mark the patient, and for the surgical site to be rechecked at multiple points.
- e. True: All patients should have the surgical site marked if feasible, and the mark should remain visible under the surgical drapes.

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The Vital Anaesthesia Simulation Training (VAST) course: immersive simulation designed for low-resource settings

Adam Mossenson, Christian Mukwesi and Patricia Livingston

Correspondence: mossenson@gmail.com

KEY WORDS

Simulation, low-resource, non-technical skills

ABSTRACT

There is a global shortage of trained anaesthesia providers, with great disparities between high- and low-resource countries. In low-resource settings, the majority of anaesthesia providers work in relative isolation, under extreme pressure and with few opportunities for continuous professional development. The Vital Anaesthesia Simulation Training (VAST) course was developed for anaesthesia providers in this context and is a collaborative project between partners in Rwanda and Canada. The VAST course aims to maximise learning in a way that is simple, practical and vivid. The main modality used is immersive simulation, with clinical environments replicated through low-cost materials and a focus on a case mix that reflects practice at the district hospital level. The accompanying VAST facilitator course promotes sustainability, mentors future facilitators and is supported by intuitive materials and an opportunity to practise components of course delivery. The VAST course was piloted in early 2018 in Kigali, Rwanda. The pilot course demonstrated feasible course delivery and a participant desire for widespread dissemination in Rwanda. After minor course revisions, the next step is a formal evaluation of the VAST course's ability to strengthen anaesthetists' non-technical skills. The VAST course holds potential as an exciting vehicle for widespread application of simulation-based education in low-resource settings.

INTRODUCTION

Although the volume of surgery performed worldwide is increasing,¹ it is estimated that 143 million additional operations are required to address emergency and essential surgical conditions in low- and middle-income countries (LMICs).² Estimates suggest that

5 billion of the world's 7 billion people do not have access to safe anaesthesia and surgical care.² There is a global shortage of trained anaesthesia providers, with great disparities between high-resource and low-resource countries.³ Non-physician anaesthetists (NPAs), who commonly receive 1–3 years of post-secondary education, provide the majority of anaesthesia in low-resource settings.⁴ NPAs often work independently in challenging environments and have few opportunities for ongoing professional development.^{4,5} Training initiatives that focus on anaesthetic care in low-resource district hospitals are needed.² Although the challenges in this setting are amplified, the potential for impact is dramatic.⁶

Non-technical skills (NTSs), such as communication, team working and task coordination, are vital to anaesthesia safety.⁷ Up to 70–80% of untoward events in healthcare are associated with errors in NTSs.⁸ The Anaesthetists' Non-Technical Skills (ANTS) framework^{9,10} describes behaviour markers for NTSs in anaesthesia. Clinical simulation is often used to teach ANTS.¹⁰

In high-resource settings, simulation is crucial in anaesthesia education and training in NTSs.¹¹ Prohibitive costs have been considered a barrier to simulation-based education in low-resource settings. However, the emotional and conceptual responses to the simulated environment and psychological fidelity, are more essential to learning than the simulator's physical resemblance to real life.¹² Consensus is mounting that relatively low-cost technology paired with thoughtful scenario design can create effective simulation-based experiential learning.^{13,14} Low-cost equipment has been used successfully for simulation-based training of ANTS in a low-resource setting.¹⁵

The VAST course was designed for anaesthesia providers working in district hospitals in low-resource settings. Creation of the VAST course has been made possible through the longstanding relationship amongst the anaesthesia departments at Dalhousie University, the University of Rwanda and

Adam Mossenson, MBBS, MPH

Department of Anaesthesia
Pain Management and
Perioperative Medicine
Dalhousie University
Halifax, NS
Canada

Christian Mukwesi, MD, MMed

Rwanda Military Hospital
Kigali City
Rwanda

Patricia Livingston, MD, FRCPC, MEd

Department of Anaesthesia,
Pain Management and
Perioperative Medicine
Dalhousie University
Halifax, NS
Canada

the Canadian Anaesthesiologists' Society International Education Foundation (CASIEF). Foundational work in Rwanda includes an ethnographic study of ANTS,¹⁶ development of the first simulation centre in East Africa¹⁷ and a feasibility study evaluating ANTS improvement with low-cost simulation.¹⁵ Prior to course development, a needs assessment was conducted amongst Rwandan anaesthesia providers to gauge interest in a new simulation training course, desired content and potential barriers to and facilitators of course success. Insights generated informed course design; anaesthesia providers wanted content to reflect their daily practice and to have a discussion forum for clinical practice challenges and solutions. The following is a description of the VAST course's development, design and pilot in Rwanda.

COLLABORATION

Starting from inception of the idea in mid-2017, the creation process for the VAST course has been consultative and collaborative. Broad goals were first established by the Dalhousie anaesthesia medical director of global health, the Dalhousie anaesthesia global health fellow and the leaders of the Rwanda Society of Anaesthesia. The ongoing development of the VAST course has been the principal project of the Dalhousie anaesthesia global health fellow (AM), supported by co-authors (CM, PL) who have had extensive experience in simulation and NTS training in low-resource settings.¹⁵⁻¹⁷ Input was sought from colleagues at the Scottish Centre for Simulation and Clinical Human Factors (SCSCHF). Simulation principles advocated by the SCSCHF are embedded in the VAST course scenario design and an adapted model of its debriefing framework is a pillar of the VAST facilitator course. A Dalhousie University-based nurse (Michelle Murray RN, Skills Centre Coordinator, Skills Centre for Health Sciences, Halifax, NS, Canada) provided insight into scenario mechanics, logistics and equipment.

The authors wanted content to accurately reflect practice in low-resource settings. Early in development, a course overview and sample scenarios were disseminated widely through the networks of the CASIEF and Dalhousie University's anaesthesia global health unit. This informal 'steering committee' comprised experts in the field of global health and simulation training from a broad range

of high- and low-resource countries. Feedback from the informal steering committee was invaluable in eventual course design and content. The World Federation of Societies of Anaesthesiologists (WFSA) was also engaged during this consultation period, advising on how to maximise VAST's utility alongside existing educational programmes. A preliminary set of scenarios was developed. Pre-pilot testing, first with Canadian and then with Rwandan anaesthesia residents, allowed for iterative refinement of materials and the VAST course's simulation methodology. The University of Rwanda, the Rwanda Society of Anaesthesia and the WFSA were approached for accreditation and endorsement of the VAST course prior to its pilot.

CONTENT

To achieve a balance between breadth of content and feasibility of delivery, the VAST course is limited to 3 days. The caseload, available resources and required clinical performance aim were designed to reflect practice in a district hospital in a low-resource setting. The predominant learning methodology is simulation and, over the course, 15 simulation scenarios and debriefings are conducted. Content includes anaesthesia and resuscitation for obstetrics, paediatrics and trauma as well as safe general surgery and pre- and postoperative care. Targeted case-based discussions and skills stations further explore NTSs, trauma primary survey, difficult airway management, neonatal resuscitation, pain management and complex decision making. Table 1 provides a course overview.

A number of well-established programmes are directed at enhancing core clinical knowledge [i.e. Safer Anaesthesia from Education (SAFE) course, Essential Pain Management, Primary Trauma Course, Helping Babies Breathe]. From the outset, it was the intention for the VAST course to complement these courses. With permission, core resources from these programmes are referenced throughout the VAST course, reinforcing consistent clinical frameworks. Establishment of an immersive simulation environment and a strong emphasis on NTSs is central to the VAST course's value as a parallel training opportunity. All scenarios are followed by debriefing, which involves participant reflection and generation of learning points applicable in the workplace. Participants can deploy deliberate practice – the focused repetitive performance of a cognitive or psychomotor skill

Table 1. Course overview

Day 1	Day 2	Day 3
Introduction to simulation	Obstetric case-based discussion	Paediatric case-based discussion
Facilitator-led scenario ^a	Obstetric preoperative assessment ^a	Paediatric preoperative assessment ^a
Clinical frameworks	Caesarean section (C-section) under spinal anaesthesia ^a	Paediatric laryngospasm ^a
Non-technical skills	General anaesthesia for C-section ^a	Trauma primary survey ^b
Emergency surgery preoperative assessment ^a	Intrapartum haemorrhage ^a	Trauma – paediatric ^a
Pre-anaesthesia preparation ^a	Post-partum haemorrhage ^a	Trauma – adult ^a
Unanticipated difficult intubation ^b	Postoperative sepsis ^a	Trauma – adult reassessment ^a
Rapid sequence induction ^a	Morning handover in recovery ^a	No easy answers
Pain case-based discussion		Commitment to change
Neonatal resuscitation ^b		

^aSimulation scenario; ^bskill station.

– promoting a meaningful exploration and accelerated acquisition of NTSs.¹⁸ Learning is summarised daily through group reflection and the course concludes with a commitment to change workshop.

DESIGN PRINCIPLES

The design of the VAST course seeks to maximise learning and simultaneously promote practical delivery in low-resource settings. Design principles include:

- *Preparation.* A fundamental level of clinical knowledge and skills is required for participants to meaningfully engage in simulation. Participants are sent pre-course preparatory reading materials and guiding questions to help ensure a common understanding of core clinical concepts. During the course, key information is reviewed in case-based discussions and skills stations prior to application in simulation. This allows for greater emphasis during debriefing on behaviours and use of NTSs rather than knowledge gaps. Participants are prepared for simulation through an orientation session that includes principles of simulation, personal safety and use of scenario equipment. Time is given for orientation to the layout of equipment and for practice of basic anaesthesia skills in the simulated environment. Following orientation, participants observe a short demonstration scenario, with role-play by course facilitators. This preparation phase is designed to create a non-judgemental, supportive learning environment and optimise capacity for performance in scenarios.
- *Low cost.* A vivid immersive simulation environment is created with simple props, representative documentation and low-cost technology. The VAST course utilises SimMon software on paired iPads, available at <http://castleandersen.dk/apps/simmon/>. SimMon pairs any two iOS (Apple Inc., Cupertino, CA, USA) devices over Bluetooth to create a simple remotely controlled patient monitor. The facilitator can adjust variables such as oxygen saturation, blood pressure and electrocardiogram on one device, with participants seeing parameter changes on the other, which functions as a patient monitor. Visual and audible cues help to develop realism within a scenario. For example, patient desaturation is associated with a tone change of the pulse oximeter. SimMon is an affordable and intuitive tool that requires only a short period of practice prior to use. Other simulation equipment is simple and robust; basic airway manikins are used in scenarios when airway intervention is required. When airway management is not required, participants role-play as patients and follow pre-scripted instructions. Appendix 1 details the equipment required to conduct a VAST course.
- *Reproducible.* The VAST course aims to be an ‘off-the-shelf’ product. Detailed simulation materials outline predetermined learning objectives, allowing the facilitator to focus on simulation delivery and debriefing. Each simulation scenario is formatted in a consistent fashion including an overview, set-up instructions, briefing guidelines, a copy of participant briefing cards and a scenario run sheet with facilitator notes. The debriefing page includes the debriefing framework as practised in the VAST facilitator course, the scenario’s predetermined learning objectives mapped to ANTS elements and space for note taking. Facilitators are encouraged to record specific actions or behaviours observed during the scenario on a Post-it® note and then use these observations to trigger enquiry and discussion in the debriefing. Appendix 2 provides example scenarios from the course. Additionally, there are extensive course resource materials such as a course manual, presentations with presenter notes, registration and evaluation templates, equipment checklists and participant handbooks.
- *Key themes.* Although the clinical focus changes between scenarios, consistent attention is drawn to the role of NTSs. A systematic approach to core clinical practices such as handover, history taking, examination, pre-anaesthesia preparation and crisis management is reinforced across scenarios. This is supported through printed participant resources, posters and debriefing. The authors have also developed a simplified checklist for pre-anaesthesia preparation and early steps in crisis management. This aide-memoire is incorporated into VAST ID badges and its use is encouraged throughout the course (Figure 1).
- *Immersive.* Psychological fidelity is promoted by creating a simulated environment that reflects clinical practice. Participants wear theatre scrubs and are encouraged to behave as they normally would during clinical work. All scenarios have accompanying documentation with valuable clinical information (i.e. observation charts, anaesthetic charts, consent forms, imaging). Pathology is created through simple moulage and printed photos attached to either manikins or patient actors.
- *Inter-professional.* Dedicated roles are developed for non-anaesthesia participants in the course. Many scenarios, such as trauma and perioperative resuscitation, can accommodate non-anaesthesia providers as the ‘lead participant’. Further, there are active roles for nurses, students, patients and relatives during scenarios. This promotes exploration of a diverse set of themes such as hierarchy, conflict management, consent, complaint resolution and burnout.
- *Scalable.* To provide an appropriate clinical challenge for participants of varied experience, scenarios can be progressed from a ‘fundamental’ level to ‘intermediate’ and ‘advanced’ stages at the discretion of the facilitator. For each level, desired actions are indicated.
- *Accessible.* Equipment and resources are limited to what meaningfully contributes to simulation delivery. As such, the VAST course is readily transportable and can be delivered outside the confines of a dedicated simulation laboratory. This allows the course to be run in district hospitals, reducing transportation costs for participants and increasing accessibility of continuing professional development. Combined discussion sessions create a forum for participants to learn from a broad range of colleagues whereas dividing into two simulation groups maintains individuals’ engagement in scenarios.
- *Local governance.* A local course director is responsible for the selection of participants, course planning and liaison with professional bodies and relevant authorities. External support is provided as required.
- *Sustainable.* The VAST facilitator course is conducted immediately following the VAST course. The facilitator course begins

Pre-anaesthesia check

Patient

History and functional status
Exam and airway assessment
Consent

Equipment

- A** Mask, oral airway, LMA
Laryngoscope, ETT, bougie
Suction
- B** Self-inflating bag
Anaesthesia machine
O₂ (primary and secondary)
Pulse oximeter, stethoscope
- C** BP cuff, ECG
IV cannula, fluid, blood

Medications (labelled)

Routine
Emergency

Staff

Assistant
Additional help



Crisis management

Recognise the crisis

Confirm reading, check equipment

Inform team and call for help

Manage A / B / C

- A** Open airway
Secure with an ETT if required
- B** Support breathing
Give 100% O₂
- C** Assess circulation (HR, BP)
IV access, fluids, blood loss

Find the cause

Avoid fixation error
Ask team for input

Give specific treatment

Reassess

Post-crisis care

Refer if required



training programme, in a low-resource setting. Some revision of course materials will occur, particularly to strengthen the focus on NTSs, improve interactivity in the discussion sessions and expand the scope of facilitator training. Participants expressed a desire for more supporting resources. In the future, this will be addressed through the development of the VAST course website (<http://vastcourse.org>) and review of hard and soft copy materials provided. To simplify delivery and test course mechanics, the pilot courses included only anaesthesia providers. However, the VAST course is designed to accommodate inter-professional participants. Future courses should endeavour to include participants outside anaesthesia, that is, nursing, surgical and medical colleagues. This will ultimately establish a richer and more dynamic learning experience. The VAST facilitator course will be expanded to a 2-day programme. In addition to increasing the opportunity for practice in components of facilitation, trainee facilitators will be tasked with the design and delivery of their own simulation scenarios. This exercise helps build confidence with the internal workings of simulation.

FUTURE DIRECTIONS

After the success of the pilot courses, there is enthusiasm for ongoing delivery of the VAST course in Rwanda. Future delivery will incorporate Rwandan anaesthesia providers who have completed the VAST facilitator course, supported by international facilitators. In addition, planning for broader dissemination of the VAST course is in progress, with the ongoing support of the CASIEF and WFSA. Courses will now aim to have an inter-professional participant group, with each simulation group ideally comprising three or four anaesthesia providers, two nurses and one or two doctors (surgeons or medical officers) from a non-anaesthesia background. A longitudinal study is also underway, formally evaluating the impact of the VAST course on the development and retention of participants' NTS. Additionally, Dalhousie University and the University of Rwanda are extrapolating the VAST course into a 'very VAST' simulation curriculum for first year anaesthesia trainees in Rwanda. Ongoing collaboration and affiliation is being sought with the CASIEF and WFSA to bolster delivery of the VAST course in Rwanda and to consider if the VAST course has a role in other low-resource settings. Although the current materials are in English, translation to other languages is planned.

CONCLUSION

Simulation-based education offers a dynamic and safe forum for practical application of knowledge and skills. In debriefing, there is opportunity to reflect on performance and contemplate meaningful learning outcomes. The successful piloting of the VAST course reinforces the feasibility of offering simulation-based learning outside the simulation laboratory. The next important step is to evaluate programme efficacy for developing NTS. The VAST course holds potential as an exciting vehicle for widespread application of simulation-based education in low-resource settings.

Figure 1. VAST course aide-memoire. The VAST course aide-memoire is printed as a double-sided, 5 × 8.5cm plastic card. The aide-memoire is looped on a ring-pull ID clip that is given to all participants. This ID clip is worn throughout the course and its use encouraged when appropriate. BP, blood pressure; ECG, electrocardiogram; ETT, endotracheal tube; HR, heart rate; IV, intravenous; LMA, laryngeal mask airway.

with an exploration of the theoretical principles of simulation methodology. Trainee facilitators are then familiarised with the practical aspects of the VAST course including equipment, technology and the mechanics of conducting simulated scenarios. Over time, trainee facilitators are mentored towards independent facilitation on subsequent courses. The goal of facilitator training is to develop a local network of simulation leaders both for teaching the VAST course and more broadly to promote simulation-based education.

COURSE PILOT IN RWANDA – JANUARY 2018

The VAST course was piloted three times over 3 consecutive weeks in January 2018 in Kigali, Rwanda. In total, 40 participants completed the VAST course and 12 completed the VAST facilitator course. The pilot courses represented the first time that the VAST course had been conducted in its entirety. This created an opportunity to test feasibility and gather information on the logistics of running a 3-day simulation programme on a modest budget in a low-resource setting. In reviewing course feedback, participants appreciated the simulation format and case mix. They were consistently positive about interactivity, the supportive learning environment, course organisation, central themes and time management. There was a strong desire to see the course disseminated throughout Rwanda and that it be offered to other health professionals.

LESSONS LEARNT

The key outcome from the pilot was demonstrated feasibility of conducting the VAST course, a low-cost immersive simulation

APPENDIX 1: VAST COURSE EQUIPMENT LIST

The equipment list in Table 2 is for **one simulation group**:

- Parallel simulation groups can be run in order to accommodate more participants.

- Other than the laptop and projector, personnel and equipment will need to be multiplied by the number of parallel simulation groups.

Table 2. VAST course equipment list

Category	Detail
Personnel	Simulation group size should be limited to seven participants: <ul style="list-style-type: none"> • two facilitators are required for each simulation group In addition to the facilitators, a simulation coordinator is recommended. Responsibilities include: <ul style="list-style-type: none"> • set-up and changeover between scenarios • checking equipment completeness and function This role can be conducted by an additional facilitator or a simulation technician
General	Laptop Projector and cable for laptop Whiteboard or large paper for debriefing Markers USB loaded with course materials and presentations Printed materials: <ul style="list-style-type: none"> • VAST course manual • VAST course scenario documentation • VAST facilitator course manual • VAST course handbooks (for participants) • VAST facilitator course handbooks (for trainee facilitators) • supplementary resources: <ul style="list-style-type: none"> – equipment checklist – scenario documentation inventory – participant registration template – course timetable – evaluation forms – course certificates Wall posters: <ul style="list-style-type: none"> • SBAR for handover • AMPLE for history • A to E for examination • ANTS framework • WHO Surgical Safety Checklist Blu Tack or tape for hanging posters Post-it® notepad (4 × 6 inches) Masking tape
Manikins	Adult intubation trainer Paediatric intubation trainer (age ≈ 3 years) NeoNatalie
Monitors	SimMon app loaded on two devices (iPad + iPad or iPad + iPhone) (https://itunes.apple.com/ca/app/simmon/id364731597?mt=8)

Table 2. VAST course equipment list continued

Category	Detail
Simulation set-up	<p>Organise equipment into four boxes:</p> <ul style="list-style-type: none"> • boxes 1, 2 and 3 are for use during all scenarios • boxes 1, 2 and 3 should be located near the anaesthetic workstation • box 4 contains extra equipment that is required only for certain scenarios <p>Box 1 – airway equipment:</p> <ul style="list-style-type: none"> • oral airway (3, 4, 5), nasal airway • Yankauer sucker, laryngoscope, laryngoscope blade (Mac 3) • ETT size 4, 5, 6, 7, 8, bougie, stylet • LMA (size 3 – ideally second generation) • tie, 20-ml syringe <p>Box 2 – breathing equipment:</p> <ul style="list-style-type: none"> • self-inflating bag (adult, paediatric, neonate) • Mapleson F circuit (Ayles T-piece) • mask (adult, paediatric, neonate) • nasal prongs, O₂ mask • pulse oximeter probe (does not need to function) <p>Box 3 – circulation equipment and medications:</p> <ul style="list-style-type: none"> • IV cannulae (14, 16, 18, 20, 22G) • IV fluids, tubing • tourniquet, tape • blood pressure cuff, stethoscope, ECG leads • labelled empty syringes – ketamine, thiopentone, propofol, succinylcholine, rocuronium, morphine, fentanyl, midazolam, adrenaline, atropine, ephedrine, ondansetron, antibiotic, oxytocin, ergometrine, carboprost, labetalol, hydralazine, MgSO₄, lignocaine, tetanus immunisation • labelled empty tablet containers – misoprostol, nifedipine, methyldopa <p>Box 4 – extra equipment:</p> <ul style="list-style-type: none"> • surgical drape and clips × 2 • surgical gown × 2, gloves, hats • pre-cut shirt and pants, reassembled with Velcro® • sheets for gravid uterus • wedge or sheets for lateral tilt • 'blood'-soaked pads (see VAST course manual for instructions on how to make fake blood) • clean dressings for paediatric burns • neonatal resuscitation equipment: <ul style="list-style-type: none"> – neonatal self-inflating bag, neonatal mask – suction (bulb or suction device) – cord clamp or tie – scissors – towel <p>Additional large equipment required:</p> <ul style="list-style-type: none"> • stretcher or operating room table • pillow × 2 • sheet × 2 • small table × 2 (for surgical and anaesthesia equipment) • IV pole × 2

AMPLE, Allergies, Medications, Past medical history, Last ate, Events; ECG, electrocardiogram; ETT, endotracheal tube; IV, intravenous; LMA, laryngeal mask airway; SBAR, Situation, Background, Assessment, Recommendation; WHO, World Health Organization.

APPENDIX 2: EXAMPLE SCENARIOS

2.3 – SCENARIO

- C-section under spinal anaesthesia

Learning objectives

Identify the need for left uterine displacement during C-section under spinal anaesthesia

Recognise and treat post-spinal hypotension

Consider the differential diagnosis and management for persistent hypotension post-spinal

Scenario summary

Grace is a 21-year-old G1P0 who is in the operating theatre and has just been given spinal anaesthesia for urgent C-section. She has been in labour for 18hrs, is 5cm dilated with poor progression, signs of foetal distress and the surgeons are concerned regarding cephalopelvic disproportion. The co-facilitator is an anaesthesia provider, wanting to take a quick break. The scenario starts with handover between two anaesthesia providers. Routine care post-spinal anaesthesia is required. Optional progression of the scenario to Int. *hypotension and nausea* or Adv. *persistent hypotension* stages requires management of post spinal hypotension and consideration of the differential diagnosis for persistent hypotension respectively.

SCENARIO SETUP

Location	Operating theatre
Layout	Patient on stretcher, surgical instruments on a small table
Patient	
<i>Type</i>	Human actor, wearing a patient gown
<i>Details</i>	Grace, 21-year-old female
<i>Position</i>	Sitting up, immediately post insertion of spinal
<i>Equipment on</i>	Pulse oximeter, 16G IV line with fluids, BP cuff, ECG leads
<i>Additional</i>	Patient gown, rolled blankets for gravid uterus
Other	
<i>Standard VAST equipment</i>	See VAST Course manual for standard equipment list
<i>Extra equipment</i>	Wedge / sheets for left lateral tilt Surgical equipment on tray for C-section - gowns, drape Antibiotic syringe out on equipment table
<i>Monitors</i>	2 x iPads with SimMon
<i>Documentation</i>	Prefilled pre-anaesthesia, observation, consent and intra-op charts
<i>Cut out briefing notes</i>	Anaesthesia provider (co-facilitator) Simulated patient Scrub nurse Circulating nurse Surgeons, medical students

2.3 – BRIEFING INSTRUCTIONS

Overview of roles	
<i>Lead participant</i>	Anaesthesia provider
<i>Present at start</i>	Anaesthesia provider (co-facilitator) Simulated patient Scrub nurse Circulating nurse Surgeons, medical students
<i>Additional</i>	The co-facilitator will 'leave' the scenario after handover: - Cue the co-facilitator to re-enter if called for by the lead participant or at any stage to help with crisis management following their 'break'

Prepare the scenario
<p>Isolate the lead participant outside the simulation room</p> <p>Prepare the other participants in the simulation room:</p> <ul style="list-style-type: none"> - Allocate roles and briefing cards - Allow time for reading and asking questions - Arrange participants in the scenario according to their roles <p>Provide briefings:</p> <ul style="list-style-type: none"> - In the simulation room for 'other participants' - For the lead participant after the scenario is prepared and other participants briefed

Briefing in the simulation room
<p>This is Grace, a 21-year-old female who is the operating theatre</p> <p>She is having an urgent C-section for failure to progress</p> <p>The spinal anaesthetic has just been placed</p>

Briefing for the lead participant
<p>You are an <u>anaesthesia provider</u></p> <p>You are going into the operating theatre to give a quick coffee break to one of your colleagues who has been working solidly all morning</p>

How to start the scenario
<p>Cue the lead participant to enter the operating theatre to give the colleague a break</p>

2.3 – COPY OF BRIEFING CARDS

2.3– Anaesthesia provider (co-facilitator)

You are an anaesthesia provider and are in desperate need for a coffee break. You have just placed the spinal anaesthetic and the Grace's legs are starting to feel numb. As the lead participant enters, lay Grace down flat, handover with SBAR and then leave the scenario:

S situation:

- This is Grace, a 21-year-old female, G1P0 having an emergency C-section for failure to progress with signs of foetal distress

B background:

- Grace has no allergies, takes no regular medications, has no significant past medical history
- I have just placed the spinal (2.2mls 0.5% heavy bupivacaine)
- **I have just given the antibiotics**

A assessment:

- Grace has told me her legs are numb, so I think the spinal is working well

R recommendation:

- All her documentation is here, the nurses have my number if you need me, I just desperately need to take a quick break

Extra notes:

- Wait to be cued by the facilitator before returning to the scenario

2.3 – Simulated patient

Your name is Grace. You are a 21-year-old female, G1P0 and about to have an urgent C-section:

- You have been in labour for 18hrs with failure to progress and signs of foetal distress
- You are otherwise well, have no past medical history, take no medications and have no allergies
- The spinal anaesthetic has just been placed and your legs are feeling numb

Follow this instruction **only if cued by the facilitator:**

- **One tap on your foot** – complain of having nausea and wanting to vomit
- **Two taps on your foot** – complain of feeling terrible. You now have difficulty talking and breathing, are feeling anxious and your heart is racing

2.3 – Scrub nurse

Act realistically in this role

Follow this instruction **only if cued by the facilitator:**

- **If tapped on the shoulder** – tell anaesthesia the patient has a rash on her abdomen

2.3 – Circulating nurse

Act realistically in this role

Follow this instruction **only if cued by the facilitator:**

- **If tapped on the shoulder** – comment to the anaesthesia provider, “When my sister was pregnant, she was so much more comfortable on her side...will she be ok on her back?”

2.3 – Surgeons, medical student

You should be talking near the surgical equipment:

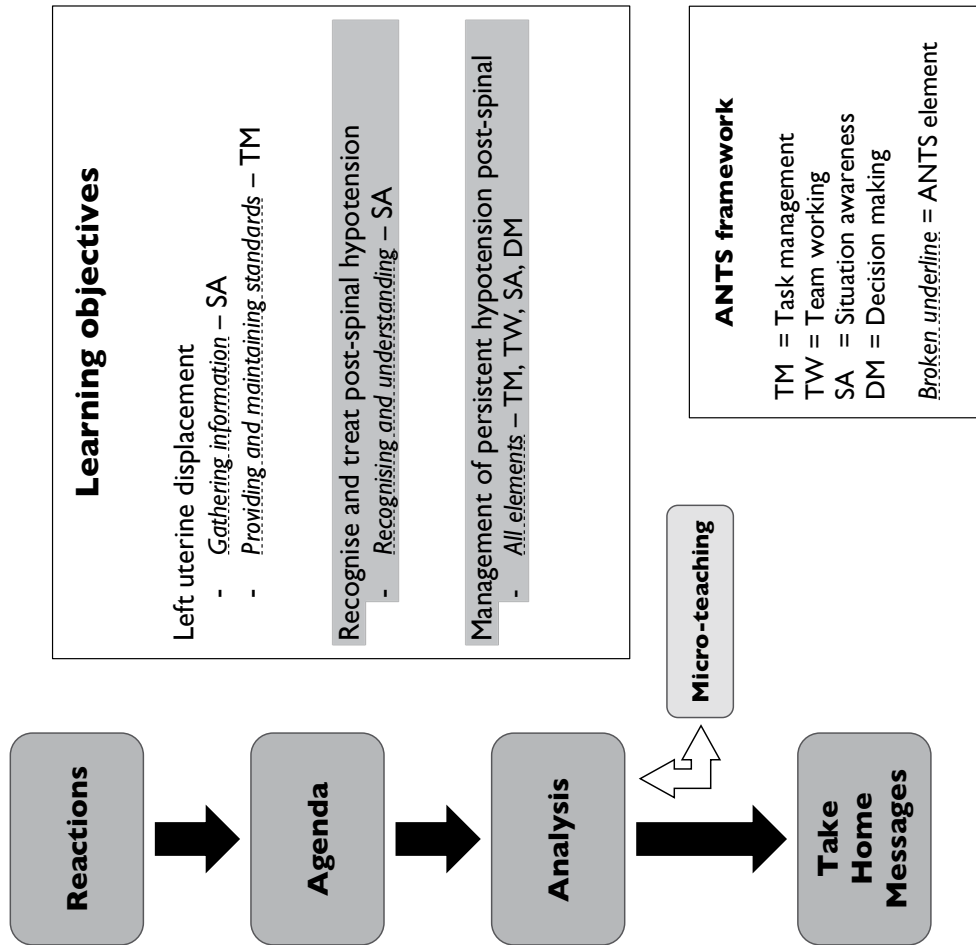
- After the patient is lying down, ask if it is ok to prep and drape
- Start the surgery and deliver the baby if time allows. The operation is going routinely

Give this information **only if asked** - there is a widespread rash over the patient's abdomen

2.3 – SCENARIO SEQUENCE (10 minutes)

Stages	Parameters	Actions	Transition triggers	Additional notes
Fund.	<p><u>Initial vitals:</u></p> <p>A. Alert RR 20, SaO₂ 99% C. HR 90, BP 100/56</p> <p><u>2nd set of vitals:</u></p> <p>A. Alert RR 24, SaO₂ 98% C. HR 98, BP 90/48</p>	<p>Receive handover Lay patient down Position with L uterine displacement Scan monitoring and confirm readings Confirm – IV and running fluids, vasopressor available, antibiotics given Communicate with surgical team Prepare oxytocin for delivery</p>	<p>Uterine displacement or lateral tilt</p> <p><u>Prompts:</u></p> <p>1. 2nd set of vitals 2. One tap circulating nurse – “when my sister was pregnant, she was so much more comfortable on her side... will she be ok on her back?”</p>	<p><u>Post-spinal hypotension possible causes:</u></p> <ul style="list-style-type: none"> - Drug induced vasodilation / neuraxial blockade - Aorto-caval compression - High spinal - Haemorrhage or hypovolaemia - Anaphylaxis - Vasovagal - Drug overdose or toxicity - Amniotic embolism
Int.	<p>A. Alert – nauseated ++ B. RR 25, SaO₂ 97% C. HR 115, BP 82/41</p>	<p>Reassure patient Confirm sufficient uterine displacement Treat hypotension: - Fluid bolus, vasopressor Recycle BP and reassess vital signs</p>	<p>Recognise and treat hypotension</p> <p><u>Prompts:</u></p> <p>1. Change in vital signs 2. One tap patient’s foot – triggers nausea</p>	<p><u>Anaphylaxis grades:</u></p> <p>Grade I – Mild (<i>mucocutaneous signs only</i>) Grade II – Moderate (<i>multi-organ manifestations</i>) Grade III – Life-threatening (<i>severe hypotension or high airway pressure</i>) Grade IV – Cardiac arrest</p>
Adv.	<p>Patient looks awful, sweaty</p> <p>A. Hoarse voice Difficulty talking RR 30, SaO₂ 86% Difficulty breathing Diffuse wheeze</p> <p>C. HR 135, BP 70/32 Responds to voice Extremely anxious Widespread rash</p>	<p>Recognise the crisis, call for help, allocate tasks Support A / B / C: - Assess airway - Give O₂, consider salbutamol - Fluid bolus, vasopressor, adrenaline Consider the differential diagnosis: - Check block height - Assess amount bleeding with surgeons - Assess for signs of anaphylaxis: o Diagnose and treat anaphylaxis Communicate with the team: - Expedite the surgery - Plan for ongoing management of the patient</p>	<p>Consider the differential diagnosis for hypotension</p> <p><u>Prompts:</u></p> <p>1. Two taps patient’s foot – triggers breathing difficulty 2. One tap scrub nurse – comments on the widespread rash 3. Cue original anaesthesia provider to return from break and ask what is happening</p>	<p><u>Adrenaline (epinephrine) dosing in anaphylaxis:</u></p> <ul style="list-style-type: none"> - Initial dose: <ul style="list-style-type: none"> o Grade II – 20mcg IV or 500mcg IM o Grade III – 100mcg IV or 500mcg IM o Grade IV – 1mg IV - Consider IM if no IV access or no monitoring - Repeat adrenaline after 1-2 minutes if needed - Increase dose if no clinical improvement - Prepare an adrenaline infusion, titrate to effect <p><u>Anaphylaxis guideline</u> – www.anzaag.com</p>
End	<p>A. Alert B. RR 22, SaO₂ 96% C. HR 90, BP 110/56</p>	<p>End the scenario when expected actions performed or 10 minutes has elapsed</p>		

2.3 – DEBRIEFING (25 minutes)



Place Post-it® note here

3.6 – SCENARIO

- Trauma – motorbike accident

Learning objectives
Prepare for the arrival of a trauma patient
Co-ordinate the completion of a primary survey
Institute immediate management for a compound fracture

Scenario summary
This scenario is set in the emergency department. Eric, a 27-year-old male motorbike driver has been hit on his R side by a car travelling at low speed. He has extensive rib bruising and an open R femur #. The scenario starts without a patient present. Participants are required to prepare for the ambulance arrival. The ambulance officer (co-facilitator) enters and provides handover. Coordination of primary survey and # management must be completed.

SCENARIO SETUP

Location	Emergency department
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Layout	Patient on a stretcher: - Note – the scenario starts without a patient (Either cover the patient with a sheet, to have them ‘outside’ the scenario <u>or</u> if the stretcher is on wheels, have it outside the room to be wheeled in)
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Patient	
Type	Human actor
Details	Eric, 27-year-old male
Position	Supine on stretcher
Equipment on	C-spine collar, pre-cut shirt and pants closed with Velcro
Additional	Photos of R chest injury, open R femur # under clothes Fake blood on pants

Other	
Standard VAST equipment	See VAST Course manual for standard equipment list
Extra equipment	C-spine collar, photos of chest and leg injuries Pre-cut shirt and pants closed with Velcro Sheet to cover patient at start of scenario Fake blood
Monitors	2 x iPads with SimMon
Documentation	Blank observation, blank pre-anaesthesia chart
Cut out briefing notes	Ambulance officer (co-facilitator) Simulated patient Nurse - A Nurse - B Radiographer

3.6 – BRIEFING INSTRUCTIONS

Overview of roles	
<i>Lead participants</i>	Team approach, consisting of: <ul style="list-style-type: none"> - Nurse - A - Nurse - B - Anaesthesia provider - Surgeon - Medical officer - Radiographer
<i>Present at start</i>	All team members: <ul style="list-style-type: none"> - The ambulance officer (co-facilitator) and patient are initially 'outside' the scenario. Cue them to enter after the first transition trigger.
<i>Additional</i>	None available

Prepare the scenario
<p>Isolate the patient and ambulance officer (co-facilitator) 'outside' the scenario:</p> <ul style="list-style-type: none"> - Allocate them their briefing cards, allow time for reading and asking questions - Achieve this by either covering the patient with a sheet or if the stretcher has wheels, the co-facilitator can wheel the patient in during the scenario <p>Prepare all participants in the simulation room:</p> <ul style="list-style-type: none"> - Inform them to ignore the patient covered by a sheet - Allocate roles and briefing cards - Allow time for reading and asking questions - Confirm participants <p>Provide briefing:</p> <ul style="list-style-type: none"> - In the simulation room for all participants

Team briefing in the simulation room
<p>You have been attending a farewell morning tea for a senior emergency department nurse who is retiring:</p> <ul style="list-style-type: none"> - One of your colleagues received a phone call about a serious car versus motorbike accident near the hospital - The patient is being brought to the hospital by ambulance and will arrive very soon - As a team, you need to go to the resuscitation bay to prepare for the patient's arrival

How to start the scenario
<p>You are about to enter the emergency department resuscitation bay:</p> <ul style="list-style-type: none"> - When you enter, you will have a short amount of time to get ready for the patient's arrival <p><i>(Note - If the patient is in the simulation room covered by a sheet, inform the participants to ignore anything in the room that is covered by a sheet)</i></p>

3.6 – COPY OF BRIEFING CARDS

3.6 – Ambulance officer (co-facilitator)

You and the patient are initially 'outside' the scenario. When cued to enter the scenario, either wheel the patient into the room or remove the sheet covering the patient.

Handover using SBAR:

S situation:

- 27-year-old male, motorbike driver hit by a car. Car travelling at low speed
- The accident occurred near the hospital, around 10 minutes ago

B background:

- No significant allergies, medications, past medical history

A assessment:

- He is in pain. We were so close, so I brought him here without delay for treatment

R recommendation:

- Can you take over his care?

Prompts:

1. **One tap** – you will be cued to give this prompt if there is not a clear team leader. Ask the team “Who is in charge of the patient? I need to leave my paperwork with someone.”
2. **Two taps** – tell the lead participant “I wanted to give antibiotics for his leg, but I didn’t have time to get IV access”

3.6 – Simulated patient

Your name is Eric, A 27-year-old male. You have no significant past medical history, take no medications and have no allergies. You last ate 2 hours ago (rice, beans and vegetables). You were riding your motorbike and were hit on the R side by a car. You were wearing a helmet and did not lose consciousness. You have severe pain in your R chest and R leg.

Follow this instruction **only if cued by the facilitator:**

- **If tapped once on the foot** – complain, “Arrrrggghhhh...my leg hurts so much. Please help me.”

3.6 – Nurse A

You are an experienced and capable nurse. Act realistically in this role

Follow this instruction **only if cued by the facilitator:**

- **If tapped once on the shoulder** – ask the anaesthesia provider “Should I prepare a fluid line for the patient?”

3.6 – Nurse B

You are an experienced and capable nurse. Act realistically in this role

Follow this instruction **only if cued by the facilitator:**

- **If tapped once on the shoulder** – ask loudly “Please can just one person give me instructions? It is very difficult to work with so many people making decisions!”

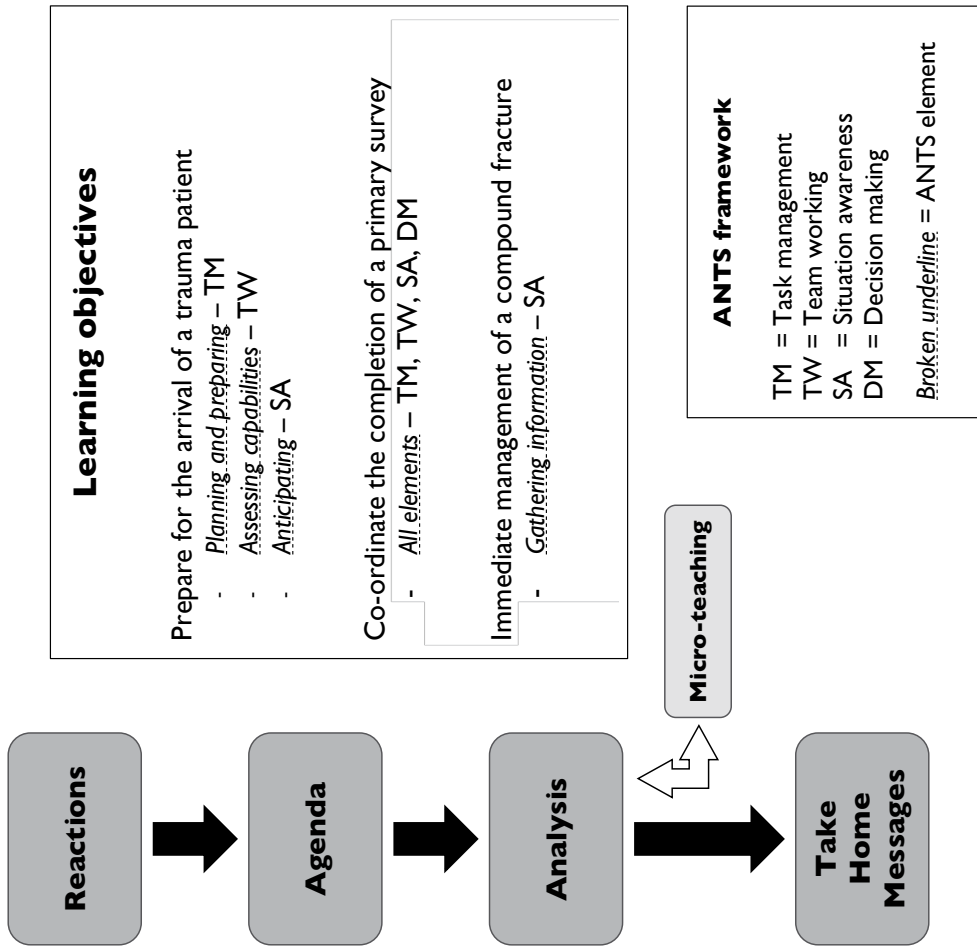
3.6 – Radiographer

You are a radiographer. Simulate conducting X-rays if requested by the team

3.6 – SCENARIO SEQUENCE (10 minutes)

Stages	Parameters	Actions	Transition trigger	Additional notes
Fund.	No patient	<p>Introductions amongst staff Identify roles and capabilities Pre-allocate tasks Prepare equipment and medications Don personal protective equipment: - Gloves, eye wear, gowns</p>	<p>Prepare medications or equipment prior to patient arrival</p> <p><i>Prompts:</i> 1. Briefing to participants 2. One tap nurse A – “Should I prepare a fluid line for the patient?”</p>	
Fund.	<p>A. Alert and in pain ++ B. RR 28, SaO₂ 96% R sided chest bruising Equal breath sounds C. HR 100, BPI00/56 Capillary refill 2 seconds Skin slightly cool D. AVPU - A, pupils equal Moving all 4 limbs E. Open right femur # Temperature 36.1°C Blood sugar 4.5mmol/L</p>	<p>Receive handover Conduct primary survey: - Prioritise A-E assessment - Recognise and treat life threats Co-ordinate activities: - Identify a team leader - Use closed loop communication - Use a systematic approach - Share information Documentation Communicate with patient Maintain patient dignity</p>	<p>Identify a team leader to co-ordinate the primary survey</p> <p><i>Prompts:</i> 1. One tap co-facilitator – “Who is in charge of the patient? I need to leave my paperwork with someone.” 2. One tap nurse B - “Please can just one person give me instructions? It is very difficult to work with so many people making decisions!”</p>	<p><u>Components of the primary survey:</u> A. Assess airway patency, give oxygen Maintain C-spine precautions B. Look, feel, listen Give oxygen, attach pulse oximeter Note rib bruising C. Assess colour, perfusion, pulse Attach BP cuff and check BP Establish IV access, blood for X-match Request a CXR D. Assess AVPU, pupils and glucose E. Expose patient - note open femur # Assess for external haemorrhage Maintain patient dignity and temperature</p>
Fund.	As above	<p>Recognise and manage an open # Begin secondary survey Plan for transfer for surgery</p>	<p>Recognise the open #</p> <p><i>Prompts:</i> 1. One tap on the patient's foot – “Arrgggh, my leg hurts so much...” 2. Two taps co-facilitator – “I wanted to give antibiotics for his leg, but I didn't have time to get IV access”</p>	<p><u>Immediate management for open #:</u> - Tetanus prophylaxis - Antibiotics - Analgesia - # reduction - Splinting and immobilisation</p>
End	As above	<p>End the scenario when expected actions performed or 10 minutes have elapsed</p>		

3.6 – DEBRIEFING (25 minutes)



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DECLARATION

Financial and in-kind support was provided by the Dalhousie University Anesthesia Office of Education and the Canadian Anesthesiologists' Society International Education Foundation for course materials and running costs of the pilot VAST courses, Kigali, Rwanda, 2018.

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Long-term venous access devices and anaesthesiologists

Vibhavari Milind Naik, Keerthi S Rao, Basanth Kumar Rayani, Maddirala Subrahmanyam and Rajeev Subramanyam

Correspondence: vibnaik@gmail.com

KEY WORDS

Vascular access devices, implanted ports, port-a-cath, indwelling catheters, Hickman catheter, complications, catheter-associated infections, catheter obstruction

ABSTRACT

The use of long-term venous access devices is increasing. Anaesthesiologists frequently encounter patients, within and outside the operating room, with long-term venous access. It is important that anaesthesiologists are well informed about these devices, their indications, techniques for implantation and use, and maintenance. In this narrative review, we discuss two commonly used long-term venous access devices: implantable ports and tunnelled catheters. We discuss the indications and contraindications, our technique for placement, maintenance protocols and anticipated complications associated with implanted ports and tunnelled catheters. A goal of this review is to encourage anaesthesiologists to become more involved in placement and maintenance care of these devices.

INTRODUCTION

Long-term venous access is required for many patients who need prolonged intravenous therapy to more reliably provide chemotherapy, parenteral nutrition, antibiotics or fluid replacement therapies. Long-term venous access is also indicated in patients needing high osmolar, irritant or vesicant drugs for an anticipated duration of more than 3 months, those requiring frequent blood draws and patients with poor venous access. Implanted port and tunnelled catheters are very commonly used as long-term venous access devices. Dialysis catheters and peripherally inserted central venous catheters are excluded from this review as the

former is used only in a special patient population and the latter is considered an intermediate-term access technique.¹

As an increasing number of patients are managed with these devices, the anaesthesiologist needs to be well versed in their care. Long-term venous access devices have traditionally been placed by interventional radiologists, surgeons or oncologists. Anaesthesiologists have the prerequisite skill set for placing central lines. Long-term venous access requires some modification of the placement procedures: tunnelling or creating a subcutaneous pocket for ports. Hence, anaesthesiologists can become increasingly involved in establishing these lines and maintaining their use in patient care. Anaesthesiologists can take the lead in forming a hospital-based 'vascular access team'. This review describes the types of long-term venous access devices and associated indications, placement techniques, precautions, anticipated complications and maintenance care.

TYPES OF LONG-TERM VENOUS ACCESS DEVICES

The two broad categories of long-term venous access are ports and tunnelled catheters. Table 1 compares the characteristic features, advantages and disadvantages of both. Use of multi-lumen catheters allows simultaneous administration of non-compatible medications. The material of the catheter determines its longevity and durability. Newer silicone and polyurethane catheters are biocompatible and have a lower thrombogenic potential than polyethylene and polyvinylchloride devices. Recent studies have revealed polyurethane catheters to be more durable but also more thrombogenic and susceptible to infections than silicone catheters.² Antibiotic and antiseptic coatings have been used on catheters in an attempt to reduce catheter-related sepsis but there is not enough evidence to support widespread practice.

Vibhavari Milind Naik
Basavatarakam Indo-American Cancer Hospital and Research Institute
Hyderabad
India

Keerthi S Rao
Rainbow Hospital for Women and Children
Hyderabad
India

Basant Kumar Rayani
Basavatarakam Indo-American Cancer Hospital and Research Institute
Hyderabad
India

Maddirala Subrahmanyam
Rainbow Hospital for Women and Children
Hyderabad
India

Rajeev Subramanyam MD, MS
Children's Hospital of Philadelphia
Philadelphia, PA
USA

Table 1. Basic features of and comparison between implanted ports and tunnelled catheters

Basic feature	Implanted ports	Tunnelled catheters
Characteristic for reducing infections	Implanted into subcutaneous tissue pocket	Tunnelled underneath the skin and has a Dacron cuff
Number of lumens available	Single- and dual-body devices	Single-, double- or triple-lumen catheters
Advantages	Lower infection risk, cosmetically appealing, can perform activities such as showering and swimming	Bigger lumen size allows better flows needed for apheresis
Disadvantages	More expensive, needs more technical expertise to place and remove	Needs more maintenance; home care such as flushing the line is needed

IMPLANTED PORTS

Since the first placement of an implanted port more than 25 years ago,³ there have been many modifications to the device structure and material. The port has a body, a catheter and a connector (Figure 1). The port body has a reservoir with a self-sealing silicone septum on its roof. The silicone septum can withstand more than 1000 punctures with a Huber tip needle. Huber tip needles are special non-coring devices that cause minimal damage to the septum (Figure 2). Port

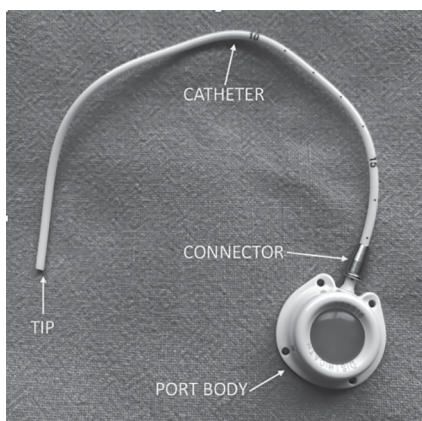


Figure 1. The parts of an implantable port: port body, connector, catheter and tip.

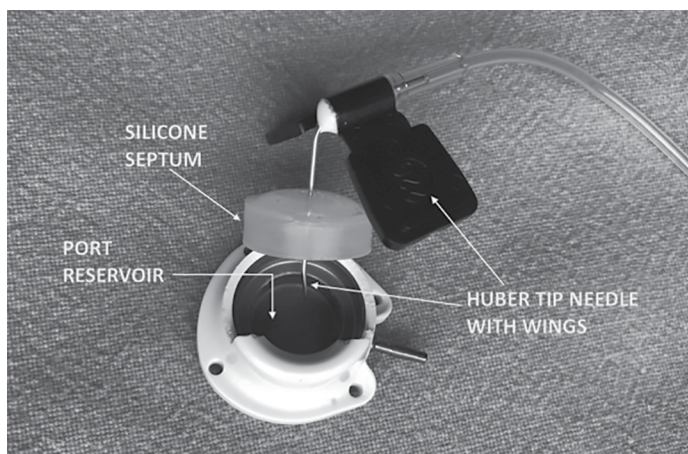


Figure 2. The structure inside the body of a port with a Huber needle inserted. This disassembled port reservoir displays the Huber needle piercing the silicone septum.

catheter tips can be open- or close-ended with a valve. The valve tip catheters were developed with the intention of reducing the incidence of thrombosis, but recent literature does not show that they provide any significant advantage.⁴ Ports are manufactured by multiple companies worldwide and there can be significant variation in the size, shape and material used (Table 2). Selection of the most appropriate port depends on patient factors, treatment requirements and the clinician's familiarity with the port (Table 3). Power-injectable devices and catheters were developed to safely tolerate higher pressures and flows (300 psi or 5 ml/s flow) required for computed tomography (CT) contrast procedures. Power-injectable ports are labelled 'CT', which is visible on chest radiographs, for ease of differentiation from regular ports.

Indications

Implanted ports are preferred for intermittent rather than continuous therapy. They are commonly used in chemotherapy of solid organ malignancies, intestinal failure, cystic fibrosis, sickle cell anaemias, haemophilia and other genetic diseases.

Contraindications

Implanted ports are contraindicated if there is infection at the site of insertion, previous thrombosis of the selected vein or deranged coagulation parameters and in septic or neutropenic patients. Port placement can be considered in patients with a platelet count of $> 50,000/\mu\text{l}$, an international normalised ratio of < 1.7 and a white blood cell count of $> 3000 \text{ cells}/\mu\text{l}$.⁶

Placement technique

Implanted ports are placed in the strict aseptic environment of the operating theatre, with patients sedated or under general anaesthesia. Routine antimicrobial prophylaxis is not recommended.⁷ The most common site of port placement is the infra-clavicular area of the chest wall. The catheter may be placed into the subclavian or internal jugular vein under ultrasound guidance using the modified Seldinger technique. The direction and location of the tip of the catheter should be confirmed by fluoroscopy. The catheter is tunnelled under the skin up to the port pocket. The port is anchored to the pectoral fascia. The port pocket is closed in two layers with absorbable sutures, after securing haemostasis. Video 1 shows the implantable port placement

Table 2. Types and sizes of implanted ports from different manufacturers (in alphabetical order)

Company	Body	Catheter	Tip	Catheter size ^a	Lumen
AngioDynamics	Titanium, plastic	Silicone, polyurethane	Open-ended	5 Fr, 6.9 Fr, 7.5 Fr, 8.4 Fr, 9.6 Fr	Single, dual
Bard	Titanium, plastic	Silicone, polyurethane (attachable/pre-attached)	Open-ended, valved	6 Fr, 6.6 Fr, 7 Fr, 8 Fr, 9.5 Fr	Single, dual
B Braun	Titanium, epoxy, polysulfone	Silicone, polyurethane	Open-ended, valved	4.5 Fr, 5 Fr, 6.5 Fr, 8.5 Fr, 10 Fr	Single, dual
Cook Medical	Titanium, plastic	Silicone (attachable/pre-attached)	Open-ended	6.5 Fr, 7.5 Fr, 9.5 Fr	Single, dual
Districlass Médical	Titanium, polysulfone	Silicone, polyurethane	Open-ended	5 Fr, 6 Fr, 6.6 Fr, 8 Fr, 9.3 Fr	Single, dual
Isomed	Titanium, polyoxymethylene	Silicone	Open-ended	6 Fr, 7 Fr, 7.8 Fr, 9.6 Fr	Single
Lexel	Titanium	Silicone	Open-ended	5.5 Fr, 7 Fr, 9 Fr	Single
Medcomp	Titanium, plastic	Silicone, polyurethane (attachable/pre-attached)	Open-ended	5 Fr, 6.6 Fr, 8 Fr, 9 Fr, 9.6 Fr	Single, dual
Navilyst	Titanium, polysulfone	Polyurethane, silicone (attachable/pre-attached)	Open-ended, valved	6 Fr, 6.6 Fr, 7 Fr, 8 Fr, 9 Fr, 9.6 Fr, 10 Fr	Single, dual
PakuMed	Titanium	Silicone, polyurethane	Open-ended	1.9 Fr (fetal), 3 Fr, 5.1 Fr, 7.5 Fr, 9 Fr	Single
Smiths Medical	Titanium, polysulfone	Silicone, polyurethane (attachable/pre-attached)	Open-ended	6 Fr, 7 Fr, 8.5 Fr, 9 Fr, 11 Fr	Single, dual
Teleflex/Arrow Polysite	Titanium, plastic	Polyurethane	Open-ended	6 Fr, 7 Fr, 8 Fr	Single
Vygon	Titanium	Silicone (attachable/pre-attached)	Open-ended	4 Fr, 5.1 Fr, 6 Fr, 6.6 Fr, 8.4 Fr, 9.6 Fr	Single

Table 3. Components and characteristics of implantable ports

Component	Characteristic
Port body	
Titanium	MRI compatible ^a but can cause artefacts if the desired scanning area is within 40 cm ² range of the port More longevity, less prone to fracture, preferred in treatments lasting for years
Plastic	MRI safe; preferred in patients with breast, chest wall and thoracic malignancies who may need repeated MRI scans Less durable, prone to fracture, posterior wall puncture with Huber needle ⁵
Catheter	
Silicone	Biocompatible, least thrombogenic, lower material strength Smaller inner diameter with the same external diameter as polyurethane catheter
Polyurethane	Slightly higher incidence of thrombosis and infection than with silicone catheter Larger inner diameter allows better flow rate at the same external diameter; useful for apheresis and blood product transfusions
Catheter tip	
Open-ended	Easy backflow and forward-flow Needs heparin for flushing Flushing interval 28 days
Close-ended with valve	Slight resistance in back flow and forward flow causing difficulty transfusing blood Only requires saline flushing; useful in heparin allergy and heparin-induced thrombocytopenia Flushing interval 90 days; helpful in patients with poor visit compliance

MRI, magnetic resonance imaging.

^aMRI compatible up to 3 tesla but could cause MRI-related heating of the port up to 1.9°C.



Video 1. Video showing the technique for implantable port placement.⁸ <https://www.dropbox.com/s/2i3cknssigjzhmk/Video%201.mp4?dl=0>

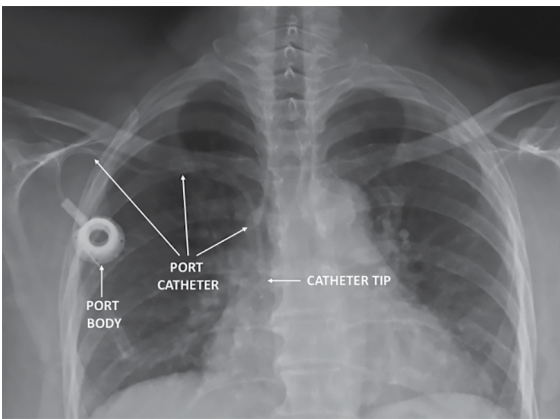


Figure 3. A postoperative chest radiograph obtained after implantable port placement to confirm the final location and rule out pneumothorax.

technique.⁸ Postoperative chest radiography is performed to confirm the final placement and rule out pneumothorax (Figure 3). The ideal position of the tip is the lower one-third of the superior vena cava. This correlates with the lower margin of the third costo-sternal junction or the sixth thoracic vertebral level (Figure 3). The port can be accessed immediately after the procedure if the Huber needle is placed during the procedure. It is advisable to start chemotherapy after a week, to allow for healing of the wound.

Precautions during placement

- A Trendelenburg position of 10–15° and thumb over the open sheath should be practised to avoid air embolism.
- Care should be taken to place a wider loop while tunnelling from the insertion site to the port pocket to minimise kinking of the catheter.
- Good haemostasis is essential to avoid occurrence of port pocket haematoma.

Complications

Complications during placement include arrhythmias, air embolism and inadvertent arterial injury. Early, delayed and late complications

are described in Box 1.⁴ Infection is a common complication that can be intra-luminal or in the port pocket. The incidence of infection is higher in patients with haematological disease than in those with non-haematological disease.⁹ Catheter occlusion can be treated with thrombolytic agents. Catheter-related vein thrombosis requires anticoagulation and may necessitate port removal. Catheter pinch-off syndrome is the pinching or fracture of the part of the catheter between the clavicle and the first rib (Figure 4). Catheter embolisation can be completely asymptomatic or a patient may complain of chest pain, palpitations, dyspnoea and cough.¹⁰ The incidence of catheter pinch-off syndrome is believed to be 1% of subclavian vein port placements.^{11,12} The incidence can be reduced or completely avoided by selecting a more lateral puncture site.

Box 1. Complications of implantable ports⁴

- Early complications (procedure related)
 - haemorrhage
 - haemothorax
 - pneumothorax
- Delayed complications (procedure related)
 - delayed wound healing
 - port pocket haematoma
 - wound infections
- Late complications
 - catheter malposition
 - catheter occlusion
 - catheter pinch-off syndrome
 - catheter-related bloodstream infection (CLABSI)
 - extravasation
 - port fracture
 - vein thrombosis



Figure 4. Fluoroscopic image showing, on dye injection, a catheter break due to catheter pinch-off syndrome.

Maintenance care

- It is recommended that there be a policy with respect to accessing and caring for long-term venous access ports developed by each local hospital and that these protocols be adhered to as well as the manufacturer's instructions.
- The port must be accessed using sterile technique. After cleaning the area over the port body, it is held and the Huber needle is inserted until loss of resistance is encountered. Backflow of blood confirms the correct position of the needle.
- Flushing is carried out with 10–20 ml of normal saline using a pulsatile technique.
- A syringe size of > 10 ml should not be used for flushing as it may generate higher pressures, predisposing to rupture of the catheter.¹³ However, power ports tolerate higher pressures.
- The accessed port is covered with a sterile transparent dressing. The transparent dressing and the Huber needle should be replaced every 7 days.
- Aseptic non-touch technique is essential while using an accessed port. Port hubs should be scrubbed with alcohol or chlorhexidine for at least 15–30 seconds before connecting the medication.
- A port should be flushed with 10–20 ml of saline and locked with 5 ml of heparinised saline when not in use and before de-accessing the port (Table 4). Application of positive pressure during de-accessing the needle reduces the reflux of blood in the catheter tip and may prevent occlusion.¹⁴
- The port should be monitored for erythema, induration and signs

of infection. Any pain while injecting suggests extravasation or port fracture and should be evaluated immediately. The needle should be replaced if in doubt. Injection of dye into the port under fluoroscopy can be used to rule out extravasation.

Device removal

The port is removed after completion of treatment. Premature removal may be needed when the port is infected, occluded or malpositioned. Port removal is commonly performed in the operating theatre under anaesthesia. A fibrous sheath forms around a long-standing implanted port. The sheath should be dissected and removed to prevent the formation of a potential space for serous fluid or haematoma collection. Once the port is removed it is visually inspected for completeness and integrity.

TUNNELLED CUFFED CATHETERS

Tunnelled cuffed catheters were first introduced for prolonged parenteral nutrition in 1973. They were called Broviac catheters. They were made of silicone rubber and had an internal diameter of around 1.00 mm.¹⁵ The Hickman catheter is another tunnelled catheter that was first used in marrow transplant recipients.¹⁶ These catheters were characterised by the presence of a Dacron cuff.¹⁷ The cuff provided a point on the catheter that can be used for anchorage

Table 4. Flushing protocols for long-term venous access

Procedure	Open-ended ports	Groshong tip ports	Tunnelled catheter
After each medication use	10 ml of saline followed by 5 ml of heparinised (10 U/ml) saline	10 ml of saline	3–10 ml of saline before and after medication use
After blood draw or transfusion of blood and viscous products	20 ml of saline followed by 5 ml of heparinised (10 U/ml) saline	20 ml of saline	10 ml of saline followed by 3 ml of heparinised (10 U/ml) saline
When not in use	5 ml of heparinised (100 U/ml) saline once a month	5 ml of saline once every 3 months	3 ml of heparinised (10 U/ml) saline once or twice weekly

Note: a minimum of twice the volume of the reservoir of long-term venous access should be used for flushing.

Table 5. Characteristics of tunnelled catheters

French size, number of lumens	Total catheter length (cm)	Lumen size OD/ID (mm), colour
BROVIAC® 4.2 Fr, single-lumen catheter with peel-apart introducer (paediatric)	71	1.4/0.7
BROVIAC® 6.6 Fr, single-lumen catheter with peel-apart introducer (paediatric)	90	2.2/1.0
HICKMAN® 9.6 Fr, single-lumen catheter with peel-apart introducer	90	3.2/1.6
HICKMAN® 7.0 Fr, dual-lumen catheter with peel-apart introducer	65	2.3/1.0 red; 2.3/0.8 white
HICKMAN® 9.0 Fr, dual-lumen catheter with peel-apart introducer	65	3.0/1.3 red; 3.0/0.7 white
HICKMAN® 9.0 Fr, dual-lumen catheter with peel-apart introducer	90	3.0/1.3 red; 3.0/0.7 white
HICKMAN® 12.0 Fr, dual-lumen catheter with peel-apart introducer	90	4.0/1.6 red; 4.0/1.6 white
HICKMAN® 10.0 Fr, triple-lumen catheter with peel-apart introducer	97	3.3/1.5 red; 3.3/0.8 white; 3.3/0.8 blue
HICKMAN® 12.5 Fr, triple-lumen catheter with peel-apart introducer	90	4.2/1.5 red; 4.2/1.0 white; 4.2/1.0 blue

ID, internal diameter; OD, outer diameter.

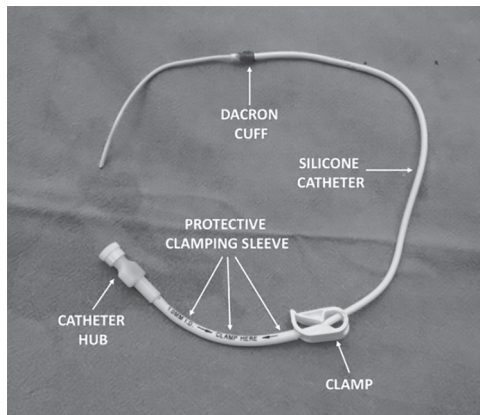


Figure 5. An explanted Broviac catheter showing the different parts: Dacron cuff, silicone catheter, protective clamping sleeve, clamp and catheter hub.

in the subcutaneous plane. It also forms a seal of fibrous tissue around the catheter. The cuff may also act as a microbial barrier, though the evidence for this is unclear.^{18,19} The parts of a Broviac catheter are shown in Figure 5. Tunnelled catheters are available in various lengths and sizes (Table 5).

Indications

Tunnelled catheters are indicated when longer duration intermittent or continuous therapy is anticipated. Typical indications include haematological malignancies, long-term antibiotic therapy, parenteral nutrition, apheresis treatments and repeated blood and blood product transfusions.

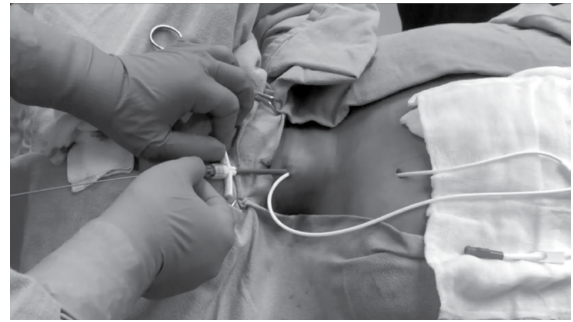
Contraindications

Contraindications of tunnelled catheters are similar to those for implanted ports described earlier.

Placement technique

Maximal barrier precautions and aseptic technique must be followed for placement of tunnelled catheters. The catheters are tunnelled in the subcutaneous plane and are secured at the exit site with sutures, usually on the anterior chest wall. Percutaneous insertion is preferred for the Hickman catheter as it is technically easier than the surgical cut-down technique.²⁰ Sites for cannulation include the internal jugular, subclavian or rarely the femoral vein. Ultrasound guidance and fluoroscopy is recommended for vein cannulation and catheter placement.

The vein is cannulated using the Seldinger technique. A skin incision of 0.5–1 cm is made at the chosen catheter exit site on the chest. Tunnelling is carried out in the subcutaneous tissue and the catheter is brought out just at the vein cannulation site, taking care not to dislodge the guidewire. It is recommended to keep the Dacron cuff around 5 cm from the exit site. The catheter is then cut to the desired length so that the tip lies in the lower one-third of the superior vena



Video 2. Video showing the technique for Hickman catheter placement.²¹ <https://www.dropbox.com/s/uwcv4lrnwq1cws/Video%202.mp4?dl=0>

cava. This cut end of the catheter is pushed into the vein while gently peeling off the sheath. Sterile dressings are applied to the percutaneous venous access and catheter exit sites. Video 2 shows placement of the Hickman catheter.²¹

Precautions during placement

- Arrhythmias should be monitored for while passing the guidewire.
- The angled tip of the tunnelling rod has to be kept upwards at all times to prevent damage to the underlying structures and to ensure the correct direction while tunnelling.
- Wetting the Dacron cuff with normal saline prior to insertion aids fibrosis.
- In women with pendulous breasts, the catheter exit site is made near the sternal edge to avoid catheter displacement in the erect posture.
- A chest radiograph should be obtained after placement to check the catheter position and identify potential complications such as pneumothorax (Figure 6).

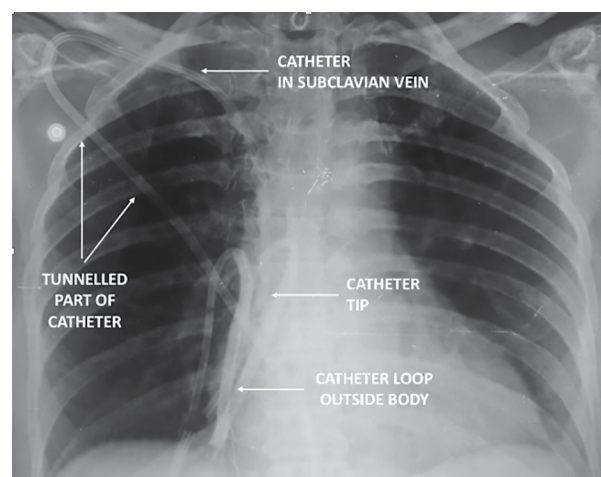


Figure 6. A postoperative chest radiograph taken after placement of a double-lumen Hickman catheter via the right subclavian vein. The tunnelled part of the catheter on the left (two arrows), the catheter loop outside the body at the bottom right (one arrow) and the catheter tip are seen.

Complications

Procedure-related complications include arrhythmias, arterial puncture, kinking of the guidewire, bleeding, sheath or introducer kink/damage and pneumothorax.^{20,22,23} Late complications are similar to those for ports and include infection, occlusion, thrombosis and extravasation. Catheter pinch-off can occur, although this is less common than in implanted ports.¹⁰

Maintenance care

- Catheter access must be carried out using aseptic non-touch technique.
- The hub is scrubbed for at least 15–30 seconds using a 2% chlorhexidine- or 70% isopropyl alcohol-impregnated wipe and allowed to dry.
- The catheter is flushed as per protocol (see Table 4).
- Clamping is performed only over the protective clamping sleeve to avoid damage to the catheter.
- The site is monitored for erythema, tenderness, warmth and purulent discharge.
- The sterile transparent dressing is inspected every day and changed every 7 days or sooner if soiled or wet.
- If found to be damaged, the catheter can be repaired using a repair kit provided by the manufacturer.

Device removal

Indications for removal of tunnelled catheters are similar to those for ports. Recently inserted catheters can be removed with traction alone, but catheters that have been in place for a prolonged time may require a cut-down technique under local or general anaesthesia at the cuff site. Gentle traction on the catheter reveals the cuff by palpation and it is essential to incise the fibrous sheath over the cuff to retrieve the catheter. Pressure needs to be applied over the vein puncture site to stop the bleeding. Skin closure with sutures and a sterile dressing are required.

APPROACH TO A PATIENT WITH A LONG-TERM VENOUS ACCESS DEVICE

With an increase in the use of long-term venous access devices, it is likely that more patients with such devices will be encountered by anaesthesiologists. The devices may be used for administering anaesthesia, with appropriate vascular care during access using aseptic technique. The device patency and integrity can be checked with blood withdraw and flush. Any pain with catheter flushing should raise the suspicion of an infiltrated device, in which case it should be further evaluated prior to use. Additional peripheral intravenous access would be required for major procedures as ports are limited by flow rates. Ports could be used during cardiopulmonary resuscitation but may be inadequate for fluid resuscitation.

SUMMARY

Knowledge of long-term venous access devices is essential as their indications and use are increasing. Familiarity with these devices and their handling protocols will enable anaesthesiologists to safely use long-term venous access. Insertion of these devices should be learnt under supervision. Anaesthesiologists should take the opportunity to lead the 'vascular access team', set protocols and train nurses, to provide safe care of patients with these devices.

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Successful management of malignant hyperthermia without dantrolene in paediatric anaesthesia

Sami Menasri, Rabie Slimani, Nadia Grainat, Nejma Brinis, Haithem Bourenane and Yacine Zerizer

Correspondence: s.menasri@hotmail.fr

KEY WORDS

Malignant hyperthermia, paediatric anaesthesia, dantrolene sodium

ABSTRACT

Malignant hyperthermia is a rare inherited disorder that develops following exposure to volatile anaesthetic agents and depolarising muscle relaxants. The overall incidence of malignant hyperthermia during general anaesthesia is estimated to range from 1 in 5000 to 1 in 50,000–100,000 and the mortality rate is estimated to be < 5% in the presence of standard care.^{1,2} In Algeria, this incidence is even lower because of the absence of the succinylcholine second triggering agent, but there is no centre where an in vitro caffeine–halothane contracture test is performed to confirm the diagnosis in suspected cases. The drug of choice for this condition, dantrolene, is not freely available in Algeria. We hereby report the case of a 7-year-old boy who had previously undergone uneventful general anaesthesia. He developed malignant hyperthermia and survived the condition despite the non-availability of dantrolene, emphasising the role of early detection and aggressive management in these cases. Survival without dantrolene remains exceptional, especially in paediatric cases (there are few cases in the recent literature).^{3,4} This is probably the first case report of this disease from Algeria.

INTRODUCTION

Malignant hyperthermia (MH) is a hypermetabolic response to volatile anaesthetic gases such as sevoflurane and the depolarising muscle relaxant succinylcholine, as a result of a pharmacogenetic disorder of skeletal muscle.³ The incidence and prevalence of MH vary with age and gender. The incidence in adults is 1 in 50,000 and in children is

1 in 15,000.⁴ It occurs more frequently in males than females.^{4,5} The incidence of MH in Algeria may not be as low as expected, especially before the systematic use of capnography. Genetically, MH is an autosomal dominant condition.^{1,4} The pathophysiology of MH involves altered sarcoplasmic reticulum calcium channel-gating kinetics.¹ The high level of calcium in sarcoplasmic reticulum results in aerobic metabolism, glycolysis and neutralisation of hydrogen ions and hydrolysis of high-energy phosphate compounds leading to acidosis, rigidity, altered permeability, hyperkalaemia and a rise in temperature. The first sign of MH under anaesthesia is the increase in end-tidal CO₂ exponentially. Early management of MH, strongly suspected on a clinical basis, could alter a patient's outcomes.^{6,7}

CASE DESCRIPTION

An active, healthy, 7-year-old boy weighing 22 kg was scheduled to undergo laparoscopic surgery for undescended left testicle under general anaesthesia. In the pre-anaesthetic examination, neither the patient nor his family had any history of a neuromuscular disease or a family history of anesthetic complications. The patient received surgery for right ectopic testes at the age of 5 years under general anaesthesia using halothane, propofol and fentanyl and no significant complications occurred. Clinical examination detected a thoracic deformity (globular thorax) and the airway was Mallampati grade II. All routine hematological and biochemical investigations were found to be normal. In the operating room, an intravenous line was secured under inhalation anaesthesia (sevoflurane) and minimum basic monitoring of the patient was carried out [peripheral capillary oxygen saturation, non-invasive blood pressure, electrocardiography and end-tidal carbon dioxide (CO₂)]. Temperature is not routinely monitored for such surgery; the temperature probe was inserted only during crisis management. Anaesthesia was induced using propofol, fentanyl

Sami Menasri

Batna University Hospital
Batna
Algeria

Rabie Slimani

Batna University Hospital
Batna
Algeria

Nadia Grainat

Batna University Hospital
Batna
Algeria

Nejma Brinis

Batna University Hospital
Batna
Algeria

Haithem Bourenane

Batna University Hospital
Batna
Algeria

Yacine Zerizer

Batna University Hospital
Batna
Algeria

and rocuronium and the patient was ventilated with oxygen and sevoflurane; the patient was intubated with a cuffed endotracheal tube and connected to the ventilator. Anaesthesia was maintained with 50% oxygen–50% nitrous oxide and sevoflurane with boluses of rocuronium. After 75 minutes, a rising trend in end-tidal CO₂ was noticed at 54 mmHg, with lack of relaxation signalled by the surgeon; bilateral breath sounds without wheezing were maintained and measured. Temperature was 36.2°C. Initially, adjustment in minute ventilation, circuit check and reinjection of rocuronium was carried out, but the end-tidal CO₂ continued to rise, with the maximum rise of end-tidal CO₂ to 80 mmHg. There was an associated rise in temperature, with a maximum reading of 38.3°C recorded by a nasopharyngeal probe. The surgeons reported that muscle tension was still very high and the lower extremities remained rigid and warm to touch. The patient also had an elevated heart rate and blood pressure, with maximum readings of 130 beats/minute and 135 mmHg, respectively. Suspecting MH, sevoflurane was stopped, propofol infusion was started and the patient was ventilated with 100% oxygen through a new anaesthetic circuit using higher gas flows and higher minute ventilation. The surgeon was informed and asked to expedite surgery. Active cooling was started with ice-cold saline intravenously. A urinary catheter was inserted to check for diuresis. The results of tests carried out intraoperatively were as follows: creatinine kinase 3905 IU/l, sodium 140 mEq/l, potassium 4.4 mEq/l, blood urea 0.3 g/l, creatinine 8 mg/l. A blood gas sample was unavailable at this time. The drug of choice for MH, dantrolene, could not be used as it was not available in our hospital. With active cooling, the temperature decreased significantly and normalised. With high minute ventilation end-tidal CO₂ was also controlled. Surgery was completed without severe haemodynamic changes and pulmonary complications; the patient recovered and was extubated successfully in the operating room once the end-tidal CO₂ and temperature returned to normal and the patient achieved criteria for extubation. The patient was carefully monitored and investigated in the postoperative period and a severe rise in creatine phosphokinase was recorded at 24 hours. The rest of the laboratory work-up was normal. There were no active complaints from the patient except for muscle rigidity and body aches. His creatinine phosphokinase levels are shown in Table 1. To avoid rhabdomyolysis-associated renal injury he received volume loading. The patient was discharged on the eighth day. The patient and his attendants were made aware of the suspected diagnosis of MH and the risks of recurrence in the patient and other family members.

DISCUSSION

We made the diagnosis of MH on the basis of clinical features. As demonstrated in this case, any patient may develop MH during or shortly after an anaesthetic procedure when trigger agents are used, and this may occur even in patients who have had uneventful anaesthesia previously.⁸ It has been estimated that on average three anaesthetics are required before an adverse event is triggered in an MH-susceptible patient.¹ Although a detailed anaesthetic history is an important part of the perioperative assessment, 21% of MH

Table 1. Creatinine phosphokinase (CPK) levels in the patient

Time period	CPK (IU/l)
Operative day	3904
First postoperative day	16,000
Second postoperative day	13,214
Fourth postoperative day	10,100
Sixth postoperative day	1150
Seventh postoperative day	160

patients report previous uneventful anaesthesia and 75% report a negative family history.⁹ The clinical presentations of MH are diverse, ranging from mild to moderate symptoms to life-threatening crises caused by severe rhabdomyolysis.⁸ This was a typical case of MH because of the high level of end-tidal CO₂, increase in temperature and muscle rigidity. In children, sinus tachycardia and hypercapnia have been shown to be the two most reliable early clinical signs.¹⁰ Fever, hyperkalaemia and elevated creatine kinase are late signs and their absence does not exclude the diagnosis.¹¹ The moderate clinical presentation was the result of the early recognition of non-specific clinical signs of MH and the initiation of rapid appropriate treatment.

The severity of MH also depends on the dose of triggering agents given to the patient.¹² Sevoflurane is thought to be a less potent trigger, with there often being a more gradual onset of MH or the occurrence of an incomplete form of MH.¹¹ A clinical grading scale is considered a useful tool for the detection of MH.¹³ This numerical assessment tool, developed by Larach *et al.*,¹⁴ can be used to indicate the likelihood that an adverse anaesthetic event represents MH. Scores of 35–49 suggest that MH is very likely and scores of ≥ 50 indicate an almost certain probability of MH. Our patient had a calculated raw score of 63 (Table 2), placing him in the ‘almost certain’ range for an MH event.¹³

Other causes of the hypermetabolic crisis were ruled out as the patient had a normal thyroid function test, was not on any antipsychotic drugs and had no history suggestive of pheochromocytoma. Overall, the anaesthetist needs to apply good clinical judgement and have a strong suspicion for MH if end-tidal CO₂ continues to rise

Table 2. MH clinical presentation score: likelihood that an adverse anaesthetic event represents MH

Parameter	Score (points)
Rigidity (generalised muscular rigidity)	15
Muscle breakdown (elevated creatine kinase concentration > 10,000 IU/l)	15
Respiratory acidosis (PaCO ₂ > 60 mmHg with appropriately controlled ventilation)	15
Temperature increase (inappropriately rapid increase in temperature, in the anaesthetist’s judgement)	15
Cardiac involvement (inappropriate sinus tachycardia)	3

despite adjusted minute ventilation. This case illustrates the value of capnography monitoring for the timely recognition of the condition, which is key to patient survival. Some cases of MH have probably not been diagnosed because of a lack of this essential monitoring, particularly in some peripheral centres and in private practice in Algeria. The early suspicion of MH and rapid appropriate treatment led to a favourable prognosis of this MH crisis.⁸ In addition to being a specific treatment for MH, dantrolene can decrease the mortality rate;¹ other immediate interventions include stopping the trigger agents, changing to total intravenous anaesthesia and removing the volatile anaesthesia from the anaesthesia machine, Changing the breathing circuits and hyperventilating with 100% oxygen at a maximum fresh gas flow will help remove the triggering agent and accumulated CO₂ as well as compensate for the increased metabolic oxygen requirement. Cooling techniques such as gastric lavage or placing ice internally and externally can help lower the core temperature. Using ice-cold intravenous fluids will also rapidly decrease the core temperature, as in our case.

The successful outcome in this case without administration of dantrolene was the result of the early diagnosis and intervention by multiple trained personnel. Cases of survival without dantrolene have been reported in paediatric practice. Continued monitoring is of particular importance as the recurrence of symptoms has been reported in 14.4% of paediatric patients after the initial treatment.¹⁰ Thus, fluid infusion was employed to prevent acute renal failure in our case.¹¹ For a definitive diagnosis of MH an in vitro caffeine–halothane contracture test is used.¹⁵ This test is not available in Algeria and so we relied on the clinical grading scale.¹³ High MH scores are significantly correlated with the caffeine–halothane contracture test.¹⁶ DNA testing is now used routinely for diagnosis before muscle biopsy when a familial *RYR1* mutation is known.¹⁷ Genetic testing for MH is not available in Algeria.

CONCLUSION

This case highlights the importance of clinical vigilance for this rare condition. It may be encountered only once in an anesthetist's career. We strongly support the monitoring of capnography and temperature during anaesthesia as they are the most common clinical signs of acute MH. Anaesthesia providers should have a high level of suspicion for an MH event; early awareness and proper management including initial and symptomatic treatment is crucially important, and dantrolene, which remains the gold standard for treatment, should be made available.

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In Memory

Paul Clyburn let us know the sad news of the passing of Michael Rosen (<https://www.rcoa.ac.uk/news-and-bulletin/rcoa-news-and-statements/passing-of-professor-michael-rosen>). Many of you will have known Professor Michael Rosen.

Michael was charming, wise, possessed infectious enthusiasm, dedicated to the WFSA and anaesthesia world-wide, and had boundless energy. I will miss him.

John Moyers

The following information about Professor Rosen comes from the WFSA archives:

- Treasurer, WFSA, 1992–2000.
- Chairman, WFSA Obstetric Anaesthesia Committee, 1980–88.
- Member, Committee on Quality of Practice, RSM, London, 1999.
- Past appointments: President, Association of Anaesthetists of Great Britain and Ireland, 1986–88; President, Royal College of Anaesthetists, 1988–91; Treasurer and Founder Member European Academy of Anaesthesiology, 1986–91.
- Member, Confidential Enquiry into Maternal Deaths, 1988–93; Enquiry into Stillbirths and Deaths in Infancy, 1993–93; Member, General Medical Council, 1989–92.
- Honours: Commander of British Empire (CBE) 1989; Doctor of Law (LLD), Dundee; Honorary Member: Australian, French and Japanese Societies.

Julian Gore-Booth, CEO WFSA

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Alan Jay Schwartz MD MSED
Editor-in-chief, *Update in Anaesthesia*

Education Officer
Department of Anesthesiology and Critical Care Medicine
The Children's Hospital of Philadelphia
34th St & Civic Center Blvd
Room 9327
Philadelphia, PA 19104-4399

Professor of Clinical Anesthesiology and Critical Care
Perelman School of Medicine
University of Pennsylvania
215-590-1885 Office
215-590-1415 Fax

schwartz@email.chop.edu

Update in Anaesthesia

Education for anaesthesia providers worldwide

Volume 33

January 2019

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