

CRJ R&D: Safe surgery innovation in crisis zones

New technologies have been designed to combat the ubiquitous inaccessibility of safe surgery, which is a major global health issue, especially in resource-poor areas prone to disaster, write **Sarah Ayton, Carly Esteves and Ian Portelli**



Relief responders in crisis zones are faced with limited resources and chaotic situations that affect the medical treatment available for those who have sustained traumatic injuries. In the wake of multiple global crises, resource-poor medical facilities are increasingly incapable of providing urgent care such as safe surgery.

Surgical intervention may be required in a number of circumstances, including injuries from trauma, as well as chronic conditions such as cancer, and in the case of childbirth complications. While resources are often limited in crisis areas and resource-poor settings, the need for safe surgical care is not.

Globally, nearly five billion people lack access to adequate and safe surgical care, with a disproportionate burden falling upon the most vulnerable. Collectively, the world's poorest countries comprise only six per cent of surgeries around the world every year.

Safe surgery requires, at a minimum, the availability of medical care providers, and anaesthetic and sterile equipment.

Limited medical resources and health crises often appear to be inseparable and this co-occurrence influences each level of an emergency medical response. Underdeveloped regions that are vulnerable to crises or disasters are especially likely to have minimal capacity for anaesthesia or the sterile equipment required for safe surgery.

Traumatic injury is a common reality in developing regions and in crisis response efforts the needs of patients cannot be met if a response lacks the infrastructure and resources to provide safe surgery. For example, if a patient is caught in the blast of an explosion or an improvised explosive device, amputation is one

Midwives examine a new mother by torchlight at a maternity ward in South Sudan. Unreliable, intermittent or sparse power supplies limit the availability of anaesthesia and sterilisation in hospitals

Albert Gonzales Ferran | ICRC

surgical option that may be unavailable or unsafe, owing to the inaccessibility of anaesthetic and sterile instruments. Anaesthesia is critical in preventing pain and preventing reflexes during the amputation procedure, while sterile equipment is critical to the patient's long-term health and recovery. Without sterile equipment, a patient has a significantly increased risk for post-operative infection and sepsis. If untreated, sepsis can cause the failure of multiple organ systems and may progress to septic shock, which is often fatal.

It is evident, therefore, that any limitations on safe surgery caused by the absence of anaesthetic or sterile equipment, are detrimental to crisis response and can impede urgent medical care.

Conventional anaesthesia machines rely upon dependable sources of electricity and compressed gas to power ventilators, vaporisers, and pressure gauges, as well as other integral components.

Currently, medical facilities in the poorest countries and regions deemed to be in crisis experience over a dozen power outages every month, making continuous and reliable electricity and compressed gas supplies unavailable or inconsistent. This compromises the functionality and accessibility of conventional anaesthesia machines, leaving them without a reliable source of anaesthesia, meaning patients are unable to receive safe surgical care.

Gradian Health Systems has designed a Universal Anaesthesia Machine, which can reliably deliver safe anaesthetic in medical

Helping immediate responders to save lives

With response times for trained responders increasing and research highlighting the critical need for prompt haemorrhage control and airway management, the spotlight is being focused on the need for bystanders to take action, writes Seth Goldstein of Mobilize Rescue.

To achieve this, 'immediate responders' need training and access to medical supplies. A number of models have emerged that are designed to empower bystanders to take action before professional responders arrive on the scene. Traditional first aid training has been available for decades, but the inability to retain the knowledge imparted in such courses has been well documented.

Simplifications of the traditional first aid class are becoming available. First Care Provider takes the concepts of Tactical Combat Casualty Care (TCCC) and its civilian counterpart, Tactical Emergency Casualty Care (TECC), and distils them into a course easily assimilated by the public, even with no prior medical training. First Care Provider focuses on the recognition and management of the most treatable preventable causes of death: Massive haemorrhage; airway compromise; and respiratory compromise. While simplified and focused, the training still requires the bystander to remember what they have been taught

environments that do not have consistent access to electricity or compressed gas. The device consists of a ventilator, a patient vital signs monitor, an oxygen monitor, a vaporiser, manual bellows (which do not require compressed gas), a balloon valve, and an integrated oxygen concentrator (which functions by filtering air in the room). Each component has been designed to work on rechargeable batteries (giving six to ten hours' power) in the absence of electricity. In short, the machine enables safe and reliable anaesthetic for patients in crisis situations.

Developed regions typically employ an intensive sterilisation process for surgical equipment, involving multiple levels of training and infrastructural support, as well as expensive sterilisation equipment. This process requires devices such as an autoclave, which are not always available or functional in low-resource settings. Medical facilities in disaster-prone or developing regions often lack critical sterilisation resources and infrastructure, inhibiting access to safe surgery because of the risk of post-operative infection.

Resource-poor medical facilities have an infection rate of approximately one in three surgical patients and these patients have a 900 per cent higher risk of infection than those in resource-rich medical facilities. This discrepancy is a consequence of the limited manpower, financing, and the equipment required to create elaborate sterilisation procedures.

Companies such as Eniware Portable Sterilisation have developed devices and equipment to maximise sterilisation capabilities in these low resource settings. The Eniware Portable Sterilizer EPS-25, requires no electricity or fuel to operate, and is lightweight and durable. The device consists of an ampule that produces NO₂ and a scrubber, which absorbs NO₂. The EPS-25 is designed with

protective pouches that protect instruments to ensure sterility before use. This device utilises novel NO₂ sterilisation technology, which is effective thanks to the compound's low boiling point, a characteristic ideal for diffusion around heat-sensitive instruments.

Engineers and researchers at Rice University have developed the Rice Sterilisation Box, a mobile sterilisation room based on a shipping container, designed to enable safe and sterile surgery in regions with limited or no electricity and contaminated water. The room consists of a solar powered autoclave, which provides steam-based sterilisation, a four-station system for sterile processing, and a water filtration system used to provide clean water for decontaminating equipment.

Reducing pain

These recent advances have served to ameliorate two major barriers to global safe surgery. Designed for low resource settings, these anaesthetic administration devices and sterilisation facilities promise to improve the availability of safe surgical care, reducing the risk of infection and pain, as well as enabling more widespread access to surgical care.

These advances could also provide a platform to streamline existing technologies in other hospital systems and make improvements in surgical practice in all areas of the world.

Developments towards more cost-effective and efficient devices may change the practice of surgical medicine in high resource hospitals, as well as in low resource settings. Meanwhile, these innovative devices will improve surgical conditions and outcomes in under-resourced areas, disaster zones and crisis relief efforts around the world.



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weeks, months or years after they received their training. A collection of real-time training aids has become available, most of which provide some type of audio prompting. Intelligent First Aid is offering a first aid kit that includes 'talking cards'. The rescuer will need to choose the right card – bleeding for example – and listen to the instructions that are read aloud.

Another audio-based option is the First Voice Emergency Instruction Device (EID), which allows the rescuer to select the type of emergency, then listen to instructions that are simultaneously displayed on a small LCD screen.

While both of these aids are an improvement on a traditional first aid kit, neither account for the background noise surrounding most emergencies, nor do they include modern bleeding control tools. They also rely on the rescuer to choose the correct emergency.

Another option is the Mobilize Rescue System (pictured), which allows an untrained rescuer to provide appropriate, assessment-based interventions. These systems integrate the inventory of a modern first aid kit, including TCCC/TECC compliant items like haemostatic

gauze, tourniquets and chest seals, with a custom-designed application running on a touchscreen device included in the kit.

Through a series of interactions with the screen, the rescuer can identify life threats, locate the appropriate item of medical equipment and receive just-in-time training on how to use it. In testing, it took less than 15 seconds for rescuers to open the kit, determine they had a wound requiring a tourniquet, and locate the instructions to apply it.

Mobilize Rescue Systems also help untrained rescuers to assess and manage more common emergencies like allergic reactions, seizures and cardiac events.

The ability of a first aid kit not only to organise medical supplies, but also to help the rescuer choose and use the right piece of medical equipment correctly, is a new concept. Modern technology affords the medical community the opportunity to create effective, real-time training systems that vastly improve the ability of a willing, but untrained bystander to intervene when minutes or seconds count.

▶ www.mobilizerescue.com