

## Part 3: The ‘outside-in’ surgical resources model

### Capacitating a hospital and staff for surgery

The lack of surgical capacity resulted in the young pregnant lady with a thoracic injury requiring a six-hour ride on a motorbike to Kinshasa for surgery. Supporting a healthcare system to deliver ‘neglected’ surgeries requires local hospital resources and educational ‘stepping-stones’ to provide these surgeries. This is the ‘outside-in’ surgical model.

Clinicians providing surgery in Africa have previously identified the minimum resources and education necessary for delivering quality surgery in Africa as the top two priorities.<sup>1</sup> The ‘outside-in’ surgical model has two components. Firstly, governments must work through the National Surgery Obstetrics Anaesthesia Plan (NSOAP) to address the resource shortages (physical infrastructure and the human workforce) to provide the scope and volume of surgical care required for population health. The second is to ensure the skills and knowledge of a surgical team are adequate to deliver the necessary surgeries at the district hospital level.

### Resources

#### *The impact of limited resources on patient outcomes*

Dr Isabella Epiu began her presentation at the closed Bill and Melinda Gates Foundation meeting on maternal outcomes in New York in December 2019 with a slide of a state-of-the-art anaesthesia machine, covered with a tablecloth and teacups. This beautiful anaesthesia machine (I am biased being an anaesthesiologist) was redundant in her home environment of Makerere University, Uganda. It has been the gift of an international donor, but was useless without the physical, resource and financial support needed to ensure its operation. Indeed, Isabella’s work conducted across five referral hospitals in Uganda, Kenya, Tanzania, Rwanda, and Burundi demonstrated that based on the WFSA international guidelines for safe anaesthesia, none (!) of the respondents had all the necessary requirements available to provide safe obstetric anaesthesia. Only 7% reported adequate anaesthesia staffing. There were limited anaesthesia monitors available, and when available, they were often non-functional,<sup>2</sup> similar to the beautiful anaesthesia machine in her opening slide. These findings confirm why we identified the ‘*development of minimum provision of care standards for peri-operative healthcare providers (surgical, anaesthesia and nursing)*’ as the second highest ranked perioperative research priority in Africa.<sup>1</sup> Basically, we do not have the resources to deliver the care that we are expected to deliver, with the resources currently available. So, what strategies can one adapt to address this challenge?

With the incredibly low volume of surgery in Africa, and the limited resources to provide anaesthesia, one strategy has been to provide sedation alone (without resorting to general anaesthesia) to increase the volume of essential surgeries where no formal anaesthesia services are available. Ketamine is a low cost sedative which is commonly available in low-resource environments, and has a perceived safe risk profile.<sup>3-5</sup> Formal protocols have been proposed to standardize the administration of ketamine in these environments.<sup>3</sup> The ‘Every Second Matters for Emergency and Essential Surgery-Ketamine’ (ESM-Ketamine) package is a protocol to aid

inexperienced physicians and non-physicians in the administration of ketamine to enable surgery without anaesthesia, and it has been reported as a safe alternative when there is no anaesthetist.<sup>3</sup> However, the ESM-Ketamine protocol proposal remains controversial, and is not universally accepted.<sup>6</sup> Despite these concerns, it has been included in the recommendations for doctors and midwives managing complications in pregnancy and childbirth.<sup>7</sup>

In Africa, sedation has also been used to increase access to surgery.<sup>8</sup> But patients receiving procedural sedation by non-physicians in Africa has an 8-fold increase in the odds of severe complications or death compared to physicians.<sup>8</sup> This finding is even more important when one considers, that nearly a 1/3 of all procedural sedations for surgery in Africa were provided by non-physicians. This is naturally an extremely sensitive issue, and on submitting the data to a peer-reviewed journal we worked hard with the statistical editor to ensure that the signal of harm associated with the provision of sedation for surgery by non-physicians was real and robust. This is important, as it is easy to jump to the conclusion that it is the non-physicians alone that are responsible for these poor outcomes. What we found however, was that the non-physicians were working in an environment which was significantly more resource constrained than that of the physicians. It was as if their hands had been tied, and they were forced to ‘do something’ to enable surgery, which in these cases was to provide sedation to enable surgery, where general anaesthesia was not available. These ‘resource-limited’ environments almost certainly were driving the bad outcomes, and not the non-physicians themselves.

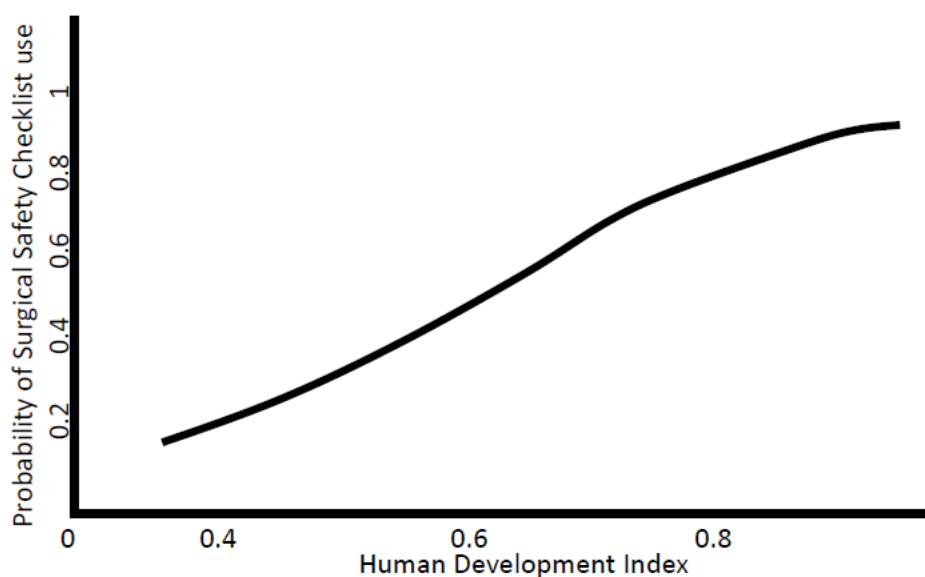
The inability to completely match the environments in which the non-physician and physician groups were working suggests that there are fundamental differences in health systems in which the non-physicians and physicians in Africa are providing sedation for surgery. This is crucial for interpretation of our findings. The fact that non-physicians are required to provide sedation is more likely a marker of a poorly resourced facility. Furthermore, this environment may result in an inability to recognize and manage the complications of procedural sedation by non-physician providers due to limited resources to identify complications, limited education to identify the deteriorating patient, and/or a working environment that is inadequately resourced to manage procedural sedation and complications. The overall result is ‘failure to rescue’ when complications arise in the perioperative period in these low-resource environments, contributing to the high number of severe complications and death.<sup>8</sup> Ultimately it is the environment with a lack of resources and education that have forced the non-physicians into this invidious position, and not the non-physicians themselves. Through multiple analyses, the very clear signal was that patients who received sedation by non-physician providers were significantly more likely to die or suffer severe postoperative complications, but our understanding was so much clearer now, and these outcomes were associated with the environment in which the non-physician providers had to work.

*‘A fundamental problem in providing surgical care in a low resource environment is the inability to concentrate on the quality of care, when one is struggling with the absolute basics’* says Isabeau Walker, a British anaesthesiologist who has spent her life in developing the SAFE (Safer Anaesthesia From Education) educational programmes for low resource environments. These include paediatric and obstetric anaesthesia and theatre management programmes (personal communication). This is what we see when we consider the need for non-physicians to provide sedation for surgery in Africa. It is the absence of these absolute basics which is compromising the quality of care. These ‘basics’ are the resources necessary to provide care, and the education to ensure that this care is delivered safely. It is therefore inappropriate to think that the ESM-Ketamine programme will safely increase the volume of surgery in Africa. This is because it will be required in the very environments where the resources are limited,

the monitors are insufficient, the skills and education are limited, and the ability to treat the complications are inadequate, which ultimately results in excess mortality. These working conditions are certainly not the same conditions in which the ESM-Ketamine programme was developed, in a more capacitated environment with a safety net of resources.

We have seen other examples of where limited resources compromise the quality of care. Although we know that the SSC is a great example of improving outcomes through a simple intervention, it falls apart when the resources to support the processes of the checklist are insufficient, as evident by the decreased use of the SSC in countries with a lower HDI (Figure 7).<sup>9</sup>

**Figure 7. The relationship between the use of the Surgical Safety Checklist and the Human Development Index of a country**



Even more worryingly, the SSC is used less frequently in urgent compared to elective operations in low HDI countries, while this is not the case in very high HDI countries.<sup>9</sup> Why is this? Are the surgical providers not concerned about care in lower HDI countries, or is there something else going on? When the wheels come off, the structure that the checklist provides saves lives. That is why it is distressing to see less use of the surgical safety checklist in less resourced countries, and less use in urgent and emergent surgery.

Now imagine working in a low-resource environment without the resources needed to respond in the affirmative to some of the checklist questions, for example the ability to provide preoperative antibiotics, or have blood available for big surgery. I suspect that the tolerance for the SSC falls in these resource limited environments (and especially in the emergency situation), as these questions have become redundant and irritating, especially when one is trying to do one's best with the limited resources. This opinion is supported by a programme in Uganda which attempted to implement the SSC. It showed that over 80% of the barriers to implementation of the checklist were associated with a lack of adequate staffing, malfunctioning equipment, and a lack of essential equipment,<sup>10</sup> which are essentially the same factors which would push non-physicians to provide sedation to patients to 'get surgery done'.<sup>8</sup> The key observation from the Ugandan surgical SSC study was the following; '*Using a checklist is an effective tool to improve surgical outcomes, but assumes that standard safety*

*practices are already in place, which may not be the case in resource-poor settings.*<sup>10</sup> What we see is that once resources are constrained, healthcare workers are forced to compromise in order to allow surgery, and the simple safety nets (such as the SSC) are removed because of limited resources. This is why the checklist on its own may not be an effective intervention in these environments.

What is needed is a stepwise approach to strengthening a health system through ensuring sufficient resources and education to provide the necessary surgical care.<sup>10</sup> So, if you look at the conduct of the SSC, or the outcomes of a non-physician providing sedation for surgery, you may interpret the poor compliance with the checklist as low-quality care, or the excess deaths associated with the non-physician providing sedation as poor care, but in reality part of the problem lies in a poor healthcare system, which does not provide the necessary cradling support through adequate resources and education for these activities. The result is the clinicians are put in an undesirable position to provide care.

We have seen how limited resources result in physicians and non-physicians been forced into providing care in a potentially unsafe manner. But how much does the availability of resources contribute to poor outcomes? If we can improve the resources supporting surgery, can we improve outcomes? The work by the NIHR Unit for Global Surgery gives us an idea of the proportional contribution of hospital resources and patient risk factors for mortality following cancer surgery. This allows us to estimate the proportion of the quality of care which is attributable to resources, and the proportion of quality of care which is attributable to patient risk factors (which is where the healthcare providers and the processes and interventions employed will impact on the quality of care, as described in the ‘inside-out’ surgical model). In this study, the country HDI and hospital resources contributed about 40% to mortality following cancer surgery globally, while the patient and disease factors contributed the remaining 60% to the mortality following surgery.<sup>11</sup> This makes a strong case for investing in adequate resources for surgical care. It demonstrates that despite the substantial role that clinicians and healthcare providers play in determining safe surgery for all, there is a necessity for adequate resources to deliver quality care, and these resources are responsible for nearly half of the deaths following surgery.

### *The National Surgery Obstetrics Anaesthesia Plan (NSOAP)*

Emmanuel Makasa is the epitome of an advocate for surgical care and universal health. He was part of the famous World Health Assembly (WHA) resolution 68.15 where governments signed an agreement to ensure safe and affordable surgery for all.<sup>12</sup> He had followed a circuitous route to sit at this table. Emmanuel is a hustler, with a strong moral compass. At the time I met him, his Twitter profile picture accurately captured his personality: a black and white portfolio pic, a suave, bearded man donning a Stetson hat. Emmanuel is the middle child of 11, with five brothers and five sisters. He was involved in student leadership from a young age. Not on the frontline, but rather strategising and organising in the background. It is not surprising then, that with the early death of his father when he was 21, he used his strategic, organisational skills, and his ‘numbers’ affinity to first ensure the financial security of his siblings. He describes how in Zambia, an intergenerational loss of wealth is almost ubiquitous, as the siblings split the wealth between numerous family members, leaving everyone with too little money to do anything meaningful. Instead, Emmanuel advocated for using his father’s wealth for the education of his siblings to ensure they could be financially independent.

With his strong moral values, he had flirted with the possibility of becoming a priest. However, his first love was numbers and engineering. But being locked down in a mine somewhere in Zambia was not Emmanuel's idea of a life well lived. So, he reached out to his third career choice, medicine. Medicine however, was not for a 'numbers man'. The rote learning was relentless, but for young Emmanuel with a clear idea of his future he moved through medicine comfortably. As a young doctor, he tried paediatrics but 'there were too many children' and then obstetrics but the unpredictable nature of delivery and the awkwardness of naked women, led him to his true love, orthopaedics. A perfect combination of mechanics with compassion. It seemed like a match made in heaven, an effortless caring for Emmanuel.

He completed a master's in public health (MPH) in Alabama, and then returned to Zambia to work as a specialist who would 'fly in' to remote locations to provide surgical care. With his public health background, and working on the ground in remote locations, he could not only see the problem of too little skilled surgery, but also what was required to change the situation. To effect changes through policy he moved to the WHO in Geneva. When WHA 68.15 was signed, it galvanised a self-belief within Emmanuel. At that time he was not in the health ministry of Zambia, but his take on the situation was "*Well, I sat at the table (to sign the WHA 68.15 resolution), and I wasn't even in the ministry, yet I helped convince 194 countries to sign a resolution, so everything else seemed easy.*" His strategy to promote surgical health advocacy is clear and simple. We need a hierarchy of priorities which include global health diplomacy and advocacy, regional health policy improvement, policy implementation for surgical health service delivery, and policy implementation research.

The global health diplomacy and advocacy for safe surgery is well on the road with WHA 68.15 resolution, and the regional policy improvement and implementation is described in the NSOAP manual.<sup>13</sup> However, despite resolution WHA68.15 little has changed, which essentially makes a mockery of the commitments of many governments to the process of ensuring safe and affordable surgery. This is a social injustice. The very people who represent their citizens whom they profess to care about, have not led the change. It is clear that no country will reach the SDGs without safe surgical care for all, as surgery is a core component of health, with a third of all hospital admissions requiring a surgical component to care,<sup>14</sup> and 30% of diseases requiring surgical care.<sup>15</sup> Fortunately, there is a solution and a template for governments to respond to the surgical needs of their populations. This is in the form of the National Surgical, Obstetric and Anaesthesia Planning (NSOAP) manual which has been published to help governments create a local environment which can deliver surgical care,<sup>13</sup> in order to fulfil their mandate to WHA resolution 68.15. The NSOAP is a policy framework which helps to evaluate, strengthen and establish a health system able to provide quality and sustainable surgical care for all.

At this point, only four African countries have responded to resolution WHA 68.15, and developed NSOAPs (Ethiopia, Zambia, Tanzania, and Rwanda).<sup>16</sup> In typical Emmanuel style, he left the WHA meeting where resolution 68.15 was taken, and like a true leader and pioneer returned to Zambia to start the NSOAP process there. Zambia was the first country in the world to have a NSOAP, driven by the conviction of Emmanuel. There are other countries that have also started NSOAPs including Senegal, Nigeria, Madagascar,<sup>17</sup> and South Africa. In South Africa, we had a stuttered start to a NSOAP in 2015, which stalled, and now we are on our second attempt at an NSOAP started in 2020. NSOAPs are important to support adequate surgical provision in a country and ultimately health equity, but for a NSOAP to thrive it needs the support of a national health department.<sup>16</sup> Governments must take ownership, and clinicians and citizens must push governments to deliver it. NSOAPs allow us to plan for a healthcare

system that can deliver safe and affordable surgical care necessary for health equity, and it tracks the quality of the surgical service we are providing. Just as we expect to see the budget and expenditure of our countries, so too, we should demand to see how our surgical system is planned and how it is delivering. It has been suggested that the key components necessary to ensure a successful NSOAP implementation include;<sup>16</sup> government ownership and support, agreed upon target timelines, broad stakeholder involvement which includes frontline workers, with integration of the indicators into health management systems to track progress, and ensuring that the implementers and financing bodies are involved in the entire process.

While we have seen improvements in the number of facilities and patient outcomes, these indicators also show us how far we still must go. For example, in Ethiopia, maternal mortality has halved since 2000, and there has been an increase in surgical facilities from 108 in 2013 to 289 in 2019 (Dr Bezaye Zemed, personal communication). However, despite these successes, the shortfall in achieving the minimum volume of surgery is enormous. In Ethiopia there are about 112 surgical procedures per 100 000 population, nearly 50-fold short of the recommended 5000 per 100 000 needed for an adequate surgical provision in a country.<sup>18</sup> The inability to provide an adequate volume of surgical procedures, means that the resources to support surgery are insufficient, and therefore the ability to support other disciplines, such as critical care and acute care are also compromised. In an Ethiopian survey, the surgical facilities could only perform a median of seven surgical procedures per day, approximately 30% of the facilities had no specialist surgical workforce members, or specialist obstetric workforce members. Remember, being able to provide a caesarean section is a Bellwether procedure standard for a surgical facility. Over 60% of the surgical facilities did not have a physician anaesthesiologist (Dr Bezaye Zemed, personal communication). Therefore, despite advances made in healthcare provision, these remain too slow in low resource environments, and we therefore need to embrace and push for the NSOAP process in every country if we want to provide safe and affordable surgery.

This is my experience of the impact of a lack of NSOAP engagement at a governmental level. Occasionally when working in the operating theatre, I meet a South African junior doctor (intern) who has studied medicine outside of South Africa: commonly China, or Mauritius. They had studied abroad, often because they were passionate about medicine, but could not secure a local undergraduate training post. I ask them how difficult it has been to enter the South African medical system, with the required regulatory approvals, and intern placements. The stories are distressing, remembering that South Africa is still short of the minimum workforce number defined for safe and affordable surgery.<sup>19 20</sup> Typically, the response is that there is an inefficiency in obtaining registration, which takes a couple of years, which they feel is driven by the fact that there is no will to facilitate this process, because there are actually few to no job positions in which to place doctors coming into the system, and no money to support further doctors entering the profession. This is despite the fact, that there is a need for more healthcare providers. One of the results of not engaging in the NSOAP process, is this perpetuation of the workforce crisis in low resource environments. A NSOAP demands that a country must actively engage in a response to the surgical indicators and develop strategies on how it will increase and capacitate its surgical workforce to provide universal healthcare. This is why it is so important.

A contrasting story is Tanzania. It is an illuminating example of the power of a NSOAP programme. The return on investment for the implementation of an NSOAP is potentially massive. In Tanzania the cost to implement the NSOAP was an additional 3% of healthcare budget.<sup>21</sup> However, for this small additional cost to the health budget, the scale up in

anaesthesia providers would be 25-fold for the country over a five-year period. This is a powerful outcome, and mind bogglingly massive, but it is only one component of the many benefits in providing an improved health system structure to upscale surgical care. The principle is that implementation of NSOAPs can result in big wins, as demonstrated in Tanzania. This builds capacity and will build the ‘cross-cutting’ benefits on health by strengthening a surgical system. And the cost for these benefits? US\$600 million over 7 years, or \$2 per person per year which at the time was 3% of the individual healthcare expenditure per year.<sup>21</sup> Considering the proportional contribution of surgical services to population health (estimated at about 30%),<sup>15</sup> this is a tiny investment in the proportional increase in health capacity.

In Ethiopia with the implementation of their NSOAP programme, we have seen the surgical facilities increase from approximately 80 in 2011 to over 290 in 2019, and access to surgery from 43 operations per 100 000 population to 465 operations per 100 000 population.<sup>22</sup> The increase in surgical facilities in Ethiopia was based on an upgrading of facilities, and increasing staff with the necessary surgical skills (Desalegn Bekele, personal communication 1 May 2022). These results are astounding. Increasing personnel 25-fold, and facilities able to provide surgery over 10-fold, both within a period of under 10 years. Political will increases surgical capacity. These are compelling cases for the first part of the ‘outside-in’ strategy in addressing the resources shortage through the governmental work of NSOAPs.

Remember the example of appendicitis in Africa. The current limited access to surgery in Africa is resulting in approximately 6500 to 8300 excess deaths per 100 000 patients due to inadequate surgical management of appendicitis alone, and at an additional 4.5 and 6.3 billion dollars this shortfall can be addressed.<sup>23</sup> Suddenly, the \$2 per person per year seems totally inconsequential, if it was extended across Africa, and it would capacitate health systems to manage appendicitis and many other unmet surgical needs. This is the power of a NSOAP. It has recently been appreciated by the WHO that the uptake and implementation of the NSOAP has been disappointing. The recent passing of the WHA resolution 76.2 commits to the integration of emergency, critical and operative care into universal health coverage, with a specific declaration that emergency, critical and operative care are part of comprehensive primary health care.<sup>24</sup> This is an extremely important resolution providing more support for WHA 68.15. We need to ensure now, that governments fulfil on their NSOAP mandate.

### *Do more resources improve the quality of care?*

A fundamental question is the following, ‘If we improve the volume and scope of resources available, will we improve the quality of care?’ A phenomenal study examined over 4000 healthcare facilities across eight low- and middle-income countries. It assessed WHO recommended amenities, equipment, and medications necessary for various healthcare services. The investigators then conducted over 30 000 observations of clinical practice to identify whether it conformed with evidence-based recommendations. In this way it was possible to determine the correlation between the recommended infrastructure for healthcare delivery and quality of care delivered (i.e., providing evidence-based practice). While most sites had a moderate degree of infrastructure (at least 60% of recommended resources), the quality of care delivered was generally low, averaging 37% for sick-child care, and up to 60% for labour and delivery. The reality is that even when controlling for the resources necessary to deliver surgery for all, it does not guarantee quality surgical care. For example, when the outcomes of hospitals with similar levels of birth attendants were compared across middle-income countries, the maternal mortality still varied between six and 12 fold across these



countries, and neonatal mortality varied between three and fourfold.<sup>25</sup> Essentially, the correlation between resources and quality of care is low.<sup>26</sup>

So, should we even try to improve the resources available for surgery? Absolutely! There appears to be a low inflection point for resources below which the quality of care at a healthcare facility in the most resource limited environments will be challenged, even in teams that are willing and able to provide good quality of care normally. Essentially, when you start from a low resource base, there is a potentially large return in the quality of care. For example, implementation of the surgical safety checklist will require a minimum resource level. These include staffing, and functional essential equipment. In a Ugandan study, staffing and a lack of functional equipment accounted for over 80% of the barriers to implementing the surgical checklist.<sup>10</sup> A NSOAP could potentially have a large impact on these barriers as a result.

This same principle holds for making sedation safer in Africa.<sup>8</sup> Again, staffing would be key here, and other equipment resources necessary to provide general anaesthesia and monitor patients. In summary, increasing resources alone will not guarantee an improvement in the quality of care, but a certain minimum number of resources is necessary to provide a minimum safe level of surgical care. Above this minimum resource level, any subsequent improvement in the quality of care with additional resources becomes unpredictable. Once we have crossed the minimum resources threshold, then other factors impact on the quality of care delivered, as discussed in the ‘inside-out’ model.

### *Novel resource solutions*

Besides ensuring NSOAPs are implemented in every country, Africa presents a unique opportunity for novel strategies to resource provision for safe surgery. This is what Emmanuel Makasa, Alex Torborg and I were discussing on a balmy evening in Pretoria, South Africa in March 2020. We were there for the annual South African Society of Anaesthesiologist’s conference. Little did we know that we would not have another face-to-face meeting for more than two years because of COVID-19. It was a fascinating evening discussing global surgical health, and in particular novel strategies to address resource limitations which compromise surgical delivery, especially with Emmanuel’s extensive knowledge and Alex Torborg’s understanding of the challenges in providing safe paediatric care in Africa through leading the African Paediatric Surgical Outcomes Study (ASOS-Paeds). The key discussions revolved around their understanding of the infrastructure limitations necessary to provide surgery, and the novel strategies that people have tried to circumvent these barriers in resource limited environments. In particular, we discussed strategies for equipping and maintaining operating theatres, and effective theatre management.

Emmanuel’s approach to novel strategies is simple. *‘Stop showing countries how poorly they are performing. Rather, do something positive, and the money will follow.’* Although, the strategies are separate, they are potentially linkable for scaling access to operating theatres and the equipment necessary to support surgery. The first principle to equip and maintain a theatre effectively at a low cost is to build and stock identical theatres, to leverage financial incentives from bulk buying. A country’s most powerful moment for financial negotiation for operating theatre resources, is when it is preparing to implement an NSOAP. Emmanuel sees NSOAPs as ‘stimulus package for Africa’. *‘Don’t provide us with the crumbs of small incentives, but rather bring industry to the table when a whole country is negotiating to strengthen a surgical system through a NSOAP. Then you have real power to negotiate, and financial leverage’.*



Providing identical theatres allows us to realise the second principle of ensuring that all anaesthesia machines and surgical machinery are maintained. Technical support for operating theatre maintenance in low resource environments is difficult and costly, especially when using a relatively low commercial volume in remote locations. If we don't get this right, we will see more of Isabella's tea tables, instead of operations. To circumvent this problem, the classic case study is the model developed by Gareth Wood and 'Kids OR'. The model is simple, but brilliant. They build identical operating theatres across the globe, and then when technical support is needed, it is delivered remotely by a technician in an identical model operating theatre in Scotland, to the site needing support. It is possible to communicate where the problem lies, and then provide the support for a remote repair of the theatre. This model has been highly effective. There are now over 50 Kids OR operating rooms in Africa and Latin America, and it is estimated that they have provided the infrastructure for more than 80 000 operations since the inception of the charity in 2018 (<https://www.kidsor.org/our-work/>). This is a great model for sustainable operating theatres in Africa.

The third principle it to then ensure that operating theatres are managed effectively. Many operating theatres currently do not run 24 hours a day. Any theatre down time could be used for private surgical patients and billed for. This model provides a place to conduct surgery and an incentive to operate 'out of hours' for fee paying patients. This exploits the financial potential of having a functional operating theatre. CURE International has leveraged this principle successfully.

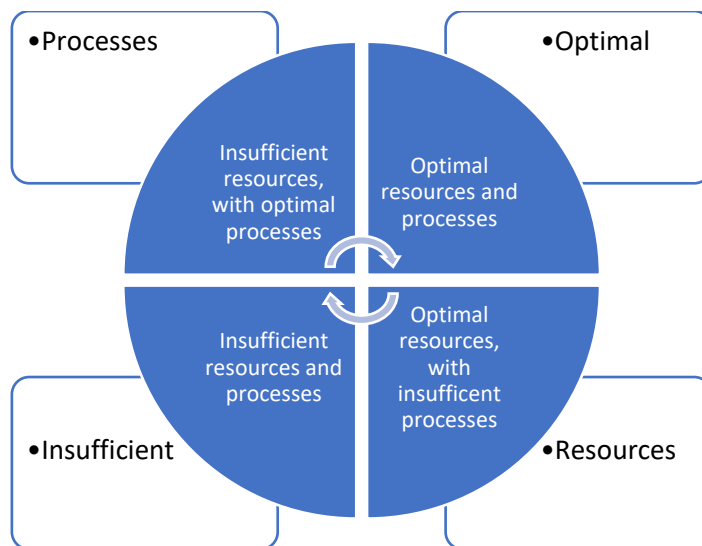
It could be argued that the current resource requirements for surgery in low- and middle-income countries should not be seen as a barrier, but rather an opportunity for thinking differently to resourcing surgery. It is important to remember that setting up operating theatres are not prohibitively expensive (construction costs and equipment account for about 20% of the cost), but rather it is the ongoing staffing of the operating theatres which is the main expense (about 30%).<sup>27 28</sup> It is possible that these novel strategies could further drive down the costs of establishing and maintaining operating theatres in Africa.

### *Making sense of the relationship between resources and processes*

The 'outside-in' surgical model is about *resource capacitation* and the 'inside-out' surgical care model is about *process capacitation*. These two models work in tandem. Neither model can work effectively in isolation.

The relationship between resources and processes on the quality of care is shown in the figure 8.

***Figure 8. The relationship between resources and processes in delivering quality care***



The figure represents a simple, yet appropriate hierarchical strategy to ‘quick wins’ in improving the quality of surgical care in low resource environments. In the bottom left corner, when both resources and processes are inadequate, a strategy targeting resources should be adopted first. When resources are so limited, it sets up even the most committed healthcare providers for failure. We have seen this in ASOS when non-physicians have been forced to provide sedation to allow for surgical care when the necessary resources for other anaesthesia techniques and expertise are unavailable, and its negative impact on morbidity and mortality.<sup>8</sup> These data suggest that there is a minimum resource level that should never be accepted in healthcare delivery. This is similar to the observation that most of the barriers to implement the surgical safety checklist, are related to insufficient resources (both human and equipment).<sup>10</sup>

Only once this minimum resource threshold is reached, can processes then contribute to increasing quality of care. The ultimate quality of care will be limited by the ceiling effect of the available resources (the top left corner). This is what I believe we are starting to experience at Groote Schuur Hospital.

When resources are optimal, which is closer to the situation in the EPOCH<sup>29</sup> study in the NHS (bottom right corner), then it is the processes which become more important. We have seen from EPOCH, that implementation of these processes in a relatively well-resourced environment are certainly not easy. The top right corner of sufficient resources, with optimal processes appears to almost be a unicorn. However, it is possible provided that the delivery of care is based on the principles of the ‘inside-out’ surgical model to ensure process capacitation.

The Confidential Enquiry into Maternal Deaths (CEMD) in South Africa led to 10 recommendations to decrease maternal mortality in South Africa in 1998.<sup>30</sup> Sue Fawcus told me how excited the group was about the 10 recommendations. They felt that once these recommendations were out in the public domain, that maternal mortality would tumble in South Africa. These recommendations were robust and based on good data, and expert interpretation of what was contributing to maternal mortality in South Africa. However, the expected decrease in maternal mortality was not nearly as spectacular as was expected. Sue relates how deflating this was for the group.<sup>31</sup> However, to realise the true impact of the CEMD recommendations, what was really needed was an implementation strategy for the CEMD recommendations. Unfortunately, the majority of CEMDs globally do not have implementation

strategies linked to the recommendations made by their committees. In fact, South Africa does have an implementation strategy<sup>32</sup> and so the disappointment due to a lack of implementation of CEMD recommendations in South Africa was likely to be more than most other resource-constrained environments without an implementation strategy. This suggests that the process capacitation of the ‘inside-out’ quality surgical model is needed to ensure optimal implementation of these recommendations.

To achieve a functional surgical health system, we must work inside the organisation with the ‘inside-out’ model to optimise processes and implementation, and outside the organisation to provide the resources necessary for surgical care.

## Education

### *The scope and challenge of the education needed for quality surgical care*

To determine the role of education in increasing the quality of care, we could conduct an experiment where we control for the resources available and determine the impact of education or supervision on patient outcomes. This is what the Service Provision Assessment in Sub-Saharan Africa investigators did, to assess the impact of in-service training or supervision on the quality of sick-child care and antenatal care. What they found was that the quality of care was generally poor, with only about 40% of evidence-based interventions applied in sick-child and antenatal care. The improvement in the quality of care following the educational or supervision interventions was small, amounting to one additional evidence-based intervention administered out of 18 sick-child interventions (a 6% improvement) and one additional intervention of 40 antenatal evidence-based interventions (or a 2.5% improvement).<sup>33</sup> The effect of training was small. Granted, it is difficult to assess the quality of the educational training and supervision from this study, but other studies have suggested that supervision or training alone has provided about 10 to 20% increase in health care worker performance.<sup>34</sup>

In South Africa, in an attempt to improve maternal outcomes, a ‘skills and drills’ two-day course built on the Kirkpatrick training model, was held for obstetric teams from the 12 worst performing healthcare districts. The objective was to deliver the Essential Steps in Managing Obstetric Emergencies (ESMOE) course to the maternity care providers in the district teams with the worst maternal mortality. The result was a significant decrease in direct maternal deaths, driven predominantly by a decrease in haemorrhagic deaths, and indirect maternal deaths, driven predominantly by a reduction in non-pregnancy related infections.<sup>35</sup> These sites had started from a really low base with an institutional maternal mortality ratio of 206. When one considers the surgical component, the case fatality rate for caesarean section dropped by just under 15% which was not significant in the study, but there was a clinically significant decrease in haemorrhagic deaths at a RRR of 36%. Education had decreased maternal mortality. While the data presented in these examples suggest that education is not a panacea, it is possible that the more decisive action needed to prevent death in the rapidly fatal complications, such as acute haemorrhage, may be positively impacted by education. Although, an adequate volume of education with an extensive coverage to include most of the healthcare providers is important in delivering safer maternal and caesarean section care, it is apparent that not all outcomes are going to be improved by education alone.<sup>35</sup>

Here is a summary of our understanding of factors affecting quality surgical care. Resources are needed to provide a minimum acceptable environment to deliver safe surgery and

anaesthesia and will ultimately determine a ‘ceiling effect’ on local site performance. With similar resources, the quality of care still varies tremendously between similar surgical sites, which could be improved by process capacitation and implementation. Education alone is not going to improve the quality of a surgical system in Sub-Saharan Africa, but it is essential to fully realise the benefit of adequate resources, and processes and implementation. There is probably a dose and volume training effect to education that is needed, and the impact of the educational intervention will only be evident on some patient outcomes. At this point, we do not know which outcomes, although it is likely that education is important in improving the success in managing maternal haemorrhage, which is important, as it is the leading cause of maternal mortality in Africa.<sup>36</sup> Educational interventions may be more impactful for acute complications which deteriorate rapidly, having the knowledge at your fingertips allows more decisive action. It is these predominantly rapidly progressing complications, such as haemorrhage and anaesthesia related complications which are most important in maternal mortality<sup>36</sup> and unnecessary deaths associated with anaesthesia complications in children<sup>37</sup> following surgery in Africa.

The scope of education required to provide a safe surgical service is mind-boggling. My own path has been instructive. When I started my medical training, I aspired to be a ‘super general practitioner (GP)’. At the time they were prevalent in South Africa. A vast country with small one-horse towns where the population was cared for by the single town GP. This was the omnipresent doctor who was all-seeing and all-knowing. He or she knew everyone in the town, their personalities, their secrets and their frailties, both physical and psychological. Yet, at the drop of a hat, they could leap in and wield a surgical scalpel competently and swiftly to save a life. They were skilled and confident. I had prepared myself through my varsity career for this. I had collected obscure textbooks with the names like ‘Primary surgery’ with step-by-step guides on how to do an appendicectomy and the like. My texts were full of practical annotations on how to manage everyday surgical problems, resourcefully transcribed during training through intense listening to my consultants who spoke from practical skill. Groote Schuur Hospital and the University of Cape Town had a proud tradition of pioneering surgery, and it was evident in the training I received.

Towards the end of my undergraduate medical training, I had undertaken a road trip around Zimbabwe. It was there that I found where I wanted to be. I had driven east from Masvingo, to the Eastern Highlands which run off the plateau towards Mozambique and the Indian Ocean. In this verdant forest, moist and misty, I drove through Chimanimani. There was a small medical clinic, unpainted with a red cross on the wall just off the dusty jeep track. It looked like the place that one doctor could hold the fort, and make a difference. It felt like a calling. The perfect place for me to be a ‘super GP’. It was Africa at its most beautiful, and most wild. I was on track to complete my training and return as soon as I was ready. I literally had to navigate two more years, my final year and internship, and I would be able to return.

While I was enjoying Zimbabwe, and imagining my future, Sue Fawcus was working down the road in Masvingo and contributing to the first documentation of maternal mortality for the region. Our paths would cross more than 25 years later in Cape Town. At the time, I was unaware that in Masvingo, the maternal mortality rate was about 168 per 100 000.<sup>38</sup>

Aspiring to work in Chimanimani, I worked hard to get my fifth-year elective placement at the hospital of my choice, Victoria Hospital in Wynberg, Cape Town. This hospital was the ‘school of the all-rounder’ and the ‘super GP’. It was a small family of competent career doctors who had dedicated their lives to teaching safe principles of medical practice for the non-specialist.

It was unbelievable that this gem of a hospital was basically in Cape Town. Here one learnt how to treat heart attacks, do essential surgical operations such as appendicectomies, cholecystectomies and fix fractures, give a safe anaesthetic and resus a tiny baby that was severely dehydrated from diarrhoea. Essentially a year in this environment with the great mentors would set me up nicely to become a great GP. If I impressed the local doctors during my elective, there was a chance that I may get my internship placement there. It would be great. Things were on track. I got my elective in fifth year and spent 4 weeks doing paediatrics. Fortunately, I managed to pull the wool over their eyes, and was offered an internship placing at Victoria. I would be joining the family of docs who did their work diligently in the morning, down tools to connect in the small tearoom with the veranda overlooking the parking lot with its beautiful palm trees, and then after connecting and discussing problem patients would return to the wards, operating theatres, and outpatient clinics to continue the work. It was a happy place.

But as I neared the end of my undergrad training, I started to realise the enormity of the task of being a competent ‘super GP’. There was a slow realisation that a ‘super GP’ was not part of a specific training programme but rather a generalist who maintained and augmented the many and varying skills and knowledge of medicine and surgery. Indeed a ‘super GP’ may well be one of the hardest jobs in all of medicine. One had to be skilled enough across the range of medicine and surgery, that you could practically bail yourself out of trouble, and competent enough that you can ensure the safe passage of a sick patient over a far distance to a larger centre if necessary. This reality started to hit home, while doing my internship at Victoria. I pivoted towards anaesthesia, a more controlled environment, with clear speciality boundaries. My mentors were super understanding at Victoria. Often when I was meant to be on the ‘blood’ side of the ‘blood-brain barrier’ during surgery, they would allow me to sneak back onto the ‘brain’ side and sit and learn with the anaesthetist. I felt more secure in the ‘corralled’ space of the aspiring specialist anaesthetist, behind the green sheet that was the ‘blood-brain barrier’ separating me from the surgeon and the bloody surgical field. Following the advice of Margie Lavelle, my anaesthesia mentor at Victoria, I moved to KwaZulu-Natal to continue to pursue my anaesthesia training. I moved to Edendale in KwaZulu-Natal, South Africa after my internship to continue a diploma in anaesthesia under the peerless, motherly teaching of Jenny King, instead of the planned Chimanmani adventure.

Edendale was wild. It was shortly after the first democratic elections in 1994 in South Africa, and was marred by the continued Inkatha-ANC violence in KwaZulu-Natal where the stronghold of the Inkatha (Zulu) dominated party in KwaZulu-Natal tried to maintain political and tribal relevance in a fast-moving political environment. The anaesthesia training was solid, and the exposure was unbelievable. As a mere medical officer, I managed three stabbed hearts on New Year’s Eve in a row. It was mind boggling. This was straight from the pedagogy of ‘see one, do one, teach one’. Edendale was a five-storey hospital, with old red brick floors. I wasn’t sure if that was an intentional plan in the building to hide the blood on the floor. Edendale, and especially in the surgical wards and theatre had that sweet smell of dry blood and alcohol. It felt that the floors were always awash with blood. If it wasn’t a knife in the heart, it was a knife in the abdomen, or a mother frothing and fitting with eclampsia on a hard metal stretcher which always looked like it should have been washed before that patient was placed on it.

Outside of the crazy anaesthesia training, and the brutality of the trauma and the filth and blood of the hospital, my colleagues and I tried to earn some extra cash by moonlighting when we could. We straddled the harsh world of the massive tertiary Edendale hospital filled with dirt

and horror, with the neat, clean and sterile world of private medicine in South Africa. There were a few locum opportunities doing the rounds in our small community; a small GP practice locum in a town outside of Pietermaritzburg, and a 'city slicker' alternative locum 50 kilometres down the road in the city of Durban. I had been lined up for the small-town GP locum, but for some reason, (which evades me now), I did not go. Thank goodness as it turned out! A colleague of mine went instead. He had the courage to leave Pietermaritzburg for the weekend and drive maybe 50 or 60 kilometres to the small town to locum for the only GP in the town, who had taken the weekend off to go fishing. My colleague was doing the Saturday morning ward round in the small 'hospital', when he got to the bedside of a lady who had been recently admitted with a complicated term pregnancy. He read through the patient's notes and talked confidently about the patient's obstetric problems with the nurse who was rounding with him. Eventually (and appropriately proud of his diagnostic skills) he announced that she would need to go to theatre for a caesarean section. The nurse did not turn, to call a surgeon, but instead stood still and looked at him. That's when he broke out in a sweat. It suddenly dawned on him, that it was he who was to be the surgeon. When he recounted the story to me, he told me how he had only assisted at a caesarean section as a student, and now he would need to do one on his own (without an assistant). That took plenty of courage and stupidity. As he recounted the story, my dreams of being a 'super GP' died. Instead I kept doing my 'city-slicker' locums down the drag in Durban, during my time at Edendale. I provided night cover for patients with anxiety, and kids with sore throats. Sadly, I would sneak into the procedure room during the consults to flick through my textbooks to find diagnoses, treatments, and drug doses. I was anything but a 'super GP'. Sadly, I was an incompetent generalist.

I had had these grandiose visions of being this knight in shining armour who could arrive at any medical condition, and then both know what to do, and then more importantly, know how to do it. It was clear now that I was not a knight, but rather a wimp. It was only then that I realised the challenge of being a true 'all-rounder', and the reality that it is a very select group of individuals who will be able to rise to this level of medical and surgical skill. Despite my own personal revelation, my perspective was also limited. I only saw the challenge from my own personal context and individual competence. At the time, I had started to understand the immense and broad competence needed, I had not even considered the environment in which these 'super GPs' had to work, and how these environments may further contribute to the challenge and risk of failure when trying to deliver quality medical and surgical care.

What education is needed to provide quality surgical care in these environments? And how do we disseminate knowledge and education into these low-resource environments? Atul Gawande discusses the complexity of modern medicine in his book, 'The Checklist Manifesto',<sup>39</sup> and how medicine has responded with the emergence of numerous specialities and super specialists across the spectrum of medicine. While this transformation of modern medicine has resulted in improved outcomes through the advantages of an amazing understanding of the many subspecialities of medicine and honing a unique skillset to respond to all its challenges, the fallout has been the massive gulf that has arisen between the medical aspirations of high-income countries and the real-world reality of rest of the under resourced world. With an insufficient number of healthcare workers, there is a need for the generalist to provide competent care across a broad range of conditions in low-resource environments. The need for a 'super GP' has never been more important than now where the demand for the competent 'all-rounder' is increasing exponentially globally, due to the population growth in low resource environments, yet it is arguably the hardest 'discipline' in medicine. It is predicted that the global population by 2100<sup>40</sup> will be 10.9 billion people, with only 1.3 billion residing in high-income countries. The remaining 9.6 billion will be in low and middle-income



countries, with 4.7 in Asia and 4.3 in Africa. The skill and scope of work of the ‘super GP’ who is a ‘rural doctor’ and ‘rural surgeon’ has been largely ignored and lost, as society has continued to hurtle towards the aspirations of super-speciality medicine in high-income countries, yet close on 90% of the world’s population is going to need care by these ‘super GPs’ by 2100.

In the provision of healthcare in resource limited environments, we find ourselves at a fork in the road. Many now see medicine and medical education as a ‘high-complexity, high-cost’ model in high-income countries, and an alternative ‘low-complexity, low-cost’ model in low and middle-income countries. This model is flawed, and does not consider the alternative, which has been summed up beautifully by two of my colleagues. Allan Taylor, a neurosurgeon in Cape Town states; *‘It is not how can we dumb down modern health care for low-income countries, but rather, how do we provide excellent care associated with good outcomes despite limited resources.’* Silke Dyer, an obstetrician and gynaecologist in Cape Town asks; *“How can we provide rational excellent care, at a reasonable cost which is appropriate for all?”*

Reforming education is a key component of responding to this challenge. Understanding the needs of healthcare worker in Africa may provide some direction for educational initiatives needed to improve surgical care: African researchers consider the top two research priorities for perioperative care to be to *‘develop training standards for perioperative healthcare providers (surgical, anaesthesia and nursing) in Africa’* and *‘develop minimum provision of care standards for peri-operative healthcare providers (surgical, anaesthesia and nursing) in Africa’*.<sup>1</sup> This is crazy, right? Surely, we have training standards for healthcare providers, and surely medicine has minimum monitoring standards for perioperative care? And yes, we obviously do. But they are all developed in the high-complexity, well-resourced environments of high-income countries. They are not ‘fit for purpose’. These top two priorities tell us so much about the current situation in Africa, and providing care in low-resource environment. Dolly Munlemvo, an anaesthetic colleague in the DRC bemoans the fact that the patient outcomes vary so much across institutions, when comparing similar procedures of similar complexity, reflecting the variance in quality of care.<sup>25</sup> Dolly speaks passionately of a desire to “harmonise” practice, through the standardisation of care and practice protocols. *“In the same country, the gap is huge among hospitals. In the DRC, in the very same country, you can find people who are doing a great job, but others are just doing badly.”* He believes that training is a big contributor to the variance in quality of care, as did most of the clinicians across Africa who participated in our priorities’ consensus process.

We need to consider the three provider categories of surgical care when considering education: anaesthesia, surgery, and critical care providers. In anaesthesia, the ability to respond to the current training standards is difficult when the number of physician anaesthesia providers in the DRC is 0.13 per 100 000,<sup>41 42</sup> which is a mere 3% of the required number of anaesthesia providers for a minimum safe service,<sup>43</sup> or conversely, for every current provider another 32 are needed to reach the recommended minimum to provide a safe level of surgical care<sup>20</sup> in the DRC. Achieving this objective is both daunting and debilitating in expectation. Furthermore, as a 33-fold jump to physician providers is not possible, the need for task shifting becomes real. However, the recommendations for training, and scope of practice to respond to this challenge do not exist.<sup>44</sup> Isabeau Walker comments that; *“In these low resource environments, anaesthesia providers may be very skilled, but with a knowledge which is extremely limited, as they are essentially ‘trained on the job’, and their knowledge is based on what their mentors taught them years ago.”* Now add a work environment characterised by few resources, where the crucial resources necessary to provide safe care (many of which our high-income country

colleagues would take for granted) are absent, hampering the delivery of safe surgical care in Africa. In low- and middle-income district hospitals, a study showed that a quarter of hospitals did not have a reliable oxygen source, a third did not have reliable electricity, 70% did not have a pulse oximeter, and 47% do not have dedicated postoperative care.<sup>45</sup> In the ASOS-Paed study of surgical outcomes in Africa, a third of anaesthetists and surgeons across Africa considered their operating theatres unsafe for surgery for children less than a year of age.<sup>46</sup> So published standards of practice which consider carbon dioxide detectors and pulse oximeters as ‘highly recommended’ set up providers to fail in these low resource environments as they cannot fulfil these recommendations,<sup>47</sup> just like the Ugandan study which showed that it was impossible to complete the SSC because the resources to complete the SSC were unavailable in many cases.<sup>10</sup> Indeed, when we were looking at risk factors associated with COVID-19 critical care survival and mortality in Africa, we found that it was impossible to measure the oxygen saturation in every patient in the intensive care unit could have their oxygen saturation measured, a most basic requirement for a sick patient.<sup>48</sup> In this light, the priorities for set by African clinicians for training and monitoring now make sense.<sup>1</sup> We have to provide training and monitoring standards which are ‘context-sensitive’ to low-resource environments. These observations are totally consistent with Nicky’s evaluation of the CanMEDS training model, which found that the whole model was encapsulated in a ‘context awareness’ framework in the South African context.<sup>49</sup>

In summary, healthcare providers in Africa are aware of their working environment and its limitations. They are also acutely aware of where education and recommendations need to be addressed to ensure the delivery of safer surgical and anaesthesia care. The challenge now is to plan, design and deliver these adapted educational programmes in Africa, and other possibly other resource poor environments.

### *Educational ‘stepping-stones’ to improve care*

To respond to this educational challenge, we need to firstly provide ‘stepping-stones’ to help bridge the divide from the current under-resourced reality to the prescribed minimum training and monitoring standards. The priorities of training and monitoring are asking for a bridge, or a holding hand, or ‘stepping-stones’ to get to accepted international standards of practice, from the current under-resourced reality. By setting these priorities in Africa, the healthcare providers are asking not to be berated because they don’t have an oximeter, or a carbon dioxide detector, but rather they are asking us to accept their current practice context and circumstance, and rather help in providing a safe framework within which to work to minimise the risk of harm. The response needs to be done in a realistic timeframe to reach the prescribed training and monitoring goals. The Tanzanian National Surgery Obstetric and Anaesthesia Plan (NSOAP) is a classic example of how a country has responded to the challenge. At the time of the development of the NSOAP, Tanzania had 0.46 surgery, obstetric and anaesthesia (SOA) physician providers per 100 000 population.<sup>21</sup> This is well short of the recommended minimum of 20 SOA physicians per 100 000, and so a decision was made to target 2.27 per 100 000 by 2025, which remains a massive fivefold increase in workforce. This target was based on the calculation, that they would then have enough physicians to supervise non-physician staff to further increase capacity and bridge to safer care through task-shifting. Anaesthesia providers were particularly sparse at 0.09 (physicians and non-physicians) per 100 000 at the beginning of the NSOAP development, but would increase substantially to 2.23 per 100 000 requiring the training of 567 anaesthesiologists, and 1100 nurse anaesthetists by 2025.<sup>21</sup> This is against a backdrop of less than 20 physician anaesthesiologists at the time of the NSOAP development.<sup>21</sup> This is a scale up of nearly 25 fold from the current state. Clearly, early funding must be

earmarked for human resources. The strategy was to provide an opportunity to phase out non-certified practitioners, and replace them with 3-year trained practitioners, ensuring an appropriate educational platform sensitive to the 'context' in which surgical and anaesthesia care is to be delivered. What is truly incredible however, that through appropriate planning and management, this massive scale up comes at a projected increase in healthcare expenditure of \$2 per capita per year over a seven-year period, which was calculated at 3% of the current per capita health expenditure.<sup>21</sup> What a wonderful return on investment.

As the Tanzanian NSOAP model shows, a 'stepping-stone' response requires a mix of physician and non-physician providers, which necessitates 'task-shifting'. It is this realisation that resulted in the approach of the SAFE courses, as described by Isabeau, where the objective was to support the anaesthesia providers with the knowledge and skills to provide safe anaesthesia even in low resource environments. Safer Anaesthesia From Education or SAFE is a joint project developed by the Association of Anaesthetists and the World Federation of Societies of Anaesthesiologists (WFSA). The realisation was that the local physicians were the experts, and outstanding trainers (partly because they also understood the 'context'), but needed support to provide education for the non-physicians, and non-specialists. The SAFE courses provide a 'training of trainers' strategy to create a sustainable training model. This is also a 'stepping-stone' approach to bridging a 'context-sensitive' educational programme.

The SAFE model works.<sup>50</sup> A 3-day SAFE Paediatrics anaesthesia programme conducted in Ethiopia, Kenya, Malawi, Uganda, and Zambia, with six lectures, 10 modules of low-fidelity simulation and over 95% of the participants being non-physicians, demonstrated that pre to post course knowledge and skills increased significantly, but more importantly that it was retained at six months. Preparation, peri-operative care, resuscitation, communication and teaching were all assessed as having positive behaviour change over six months through face-to-face interviews.<sup>50</sup> This has important implications for rapid improvement of the quality of care, through simple educational interventions.

As there are no standardised educational programmes for non-specialist anaesthesia providers across Africa, the SAFE programmes provide an important step forward in providing educational standards for safe anaesthesia for obstetrics, paediatrics and theatre management.

A critical care nurse was telling me about his experience in the Eastern Cape, South Africa. A poor province with a health system that is collapsing. Diabetic comas are a medical emergency driven by uncontrollable high blood sugar levels. It is life-threatening. This is core emergency care in any environment. As a critical care nurse, he was commonly involved in treating these emergencies.

*'Bruce, it was really difficult to treat these patients.'*

*'But why?'* I asked, *'This is common medical emergency, and you are working in an intensive care.'*

*'Well, we didn't have glucometers to measure the blood surgery level,'* he declared somewhat ashamedly. He had no reason to be ashamed. He cared, but he was providing care in a difficult environment. How could he make the step from education and knowledge to delivery of care in this resource limited environment. It is quite incomprehensible that to treat a diabetic emergency, he could not measure the glucose level. This is obviously an extreme example, but it highlights the importance that the education and knowledge must be transferable to the clinical environment in which the healthcare workers are delivering care. Otherwise, the education is meaningless. This is the key step which is often compromising the ability to deliver quality care on the ground in low-resource environments, as the education is not deliverable.

A strategy to cross the education to the ‘local delivery of care’ divide is group problem solving. Education or training is important, but on its own does not improve the performance of healthcare workers much more than 10%,<sup>34</sup> especially when the working environment is unable to support the all the interventions needed to deliver the care.<sup>51</sup> Group problem solving substantially increases healthcare provider performance to over 40%.<sup>34</sup> This is because the team then engages with the unique challenges of the local environment, to determine ‘work arounds’ to provide as much of the required interventions based on the education as possible within the resource constraints of the local working environment. Group problem solving helps translate educational theory into clinical practice.

The quality of surgical care varies tremendously, and even across Europe postoperative mortality differs nearly 16-fold between countries even after adjustment for confounding variables.<sup>52</sup> We know that merely providing resources or education alone will not adequately or reliably address the quality of surgical care. Furthermore, we also know that the provision of care is intricately linked with processes necessary to deliver the surgical care. So how do we maximise the success of many wonderful educational activities (such as SAFE courses and ESMOE) which are happening across Africa to improve surgical outcomes? SAFE courses, ESMOE and others have all shown improved knowledge about how to manage critically ill mothers and surgical patients, yet the data doesn’t demonstrate the massive improvements in the surgical outcomes that we would like to see. I think the fundamental issue is that the health care providers rarely return to their work environment and ask; ‘*How do I implement what I have just learnt on that course in my environment?*’ Without asking that question, they will never develop the ‘work arounds’ needed to deliver the care that they have learnt about.

For example, it is too late when you find yourself in an emergency, and you ask for the defibrillator, and you find it is a ward away. Time matters and that valuable minute or two of problem solving to find the defibrillator, could be the difference between life and death. More importantly, sometimes the resources necessary for the treatment taught on a course do not even exist in one’s environment, leaving the health care worker stumped. On returning to one’s place of work, it is necessary to check in, and work out how to apply the knowledge.

*‘So we need to do A, B, C.’*

*‘But we don’t have B.’*

*‘Yes, you are correct. Okay, so how do we do deliver this treatment without B? I think we should look at doing D, and then C. What do you think?’*

*‘That is reasonable, but D takes time. This is an acute problem, so if we ensure that C is immediately available, then maybe it will be okay without B. That may mean moving the treatment cart to the nurses’ station, instead of being between the two wards. What do you think?’*

*‘Yes, that may be a solution.’*

This is the type of group problem solving that is needed by health care workers in low-resource environments following a training course. It transforms the theory into site specific practice. This is the reality of working in Africa and other low-resource environments where all the tools and resources do not exist to provide the expected care. This is exactly what Elliott Taylor showed when he attempted to identify which interventions are both efficacious and feasible for treating maternal haemorrhage in Africa.<sup>51</sup> Nine interventions which were considered efficacious in preventing or treating maternal haemorrhage were not feasible in Africa. So if you are on a course on how to manage obstetric haemorrhage, and one of these interventions

is part of the management algorithm, such as ensuring that a repeat caesarean delivery is only performed by an experienced provider, or the availability of a specialist obstetrician or anaesthesiologist, then following the algorithm it is not going to happen as it is not just feasible.<sup>51</sup> We have to take the educational package, and then group problem solve it, to ensure that it is a ‘context-specific’, which is cognisant of the missing interventions available in the local environment.

Proposed medical and surgical guidelines are often inappropriate for more resource-limited environments. This is a potentially massive barrier to the delivery of quality care. ‘Stepping-stones’ is not only bridge education across different levels of health care providers, but also provide treatment algorithms and guidelines which are ‘context-specific’ for the environment within which the providers work. These are not the ‘gold standard’ care or guidelines of high-income countries which cannot be achieved currently in a resource limited environment. A great example of ‘context-relevant’ educational materials, and treatment guidelines are evident in the work of Professor Johan Fagan. He is Professor and Head of Ear, Nose and Throat (ENT) surgery at the University of Cape Town, South Africa. He is an avid biker, and it is not uncommon to see him in his leathers after work as he heads home. Johan has a three-pronged approach to creating ‘context-specific’ ENT surgical care. Firstly he hosts international fellowships within his department for surgeons from other parts of Africa.<sup>53</sup> This is hugely important as many countries do not have ENT training programmes. To ensure ‘home country’ retention and sustainable change of the trained fellows, he provides continual support through virtual meetings for case discussions with past and present fellows. The drive and commitment of Johan cannot be underestimated. He chairs a monthly educational meeting with the fellowship network, in addition to two one-hour meetings per week, where fellows from across the continent can discuss difficult cases and challenges with all on the virtual meeting. They are essentially ‘group problem solving’ surgical treatment and management options for the patients in their own environments. This ongoing mentorship and collaborative learning are key to the success of the programme. This strategy has allowed fellows to establish their own fellowship programmes (Melesse Geneyehu, personal communication 1 May 2022).

The second approach is the delivery of open access educational resources, to overcome the limited access to educational and training resources, which are often both unaffordable, and inappropriate for the environment. Johan started an open access ENT textbook, which documents all the known ENT surgical approaches. In a way it has led to a revival of the ‘old’, where surgeries which are considered obsolete are documented, and practiced in environments, where they are still fundamentally relevant due to either limited equipment, skills, or therapeutic options. The textbook has now had over a million downloads, and ironically is heavily downloaded in high-income countries too, and recently recognised as the open access book of the year at the University of Cape Town. Johan’s work has relevance, as his commitment is to the training for ENT specialists for Africa, and those surgical operations that were disappearing, remain relevant in an environment where access to all chemotherapy and other therapies are not available. This strategy exploits smart phones, and internet access for educational support across Africa.

Finally, the third approach is the provision of resource appropriate ENT surgical practice guidelines developed by local experts, which provide treatment guidelines according to the availability or unavailability of diagnostic and therapeutic resources.<sup>54</sup> These guidelines have taken the concept of ‘group problem solving’ to the highest level, by including African and global leaders in the development of these ‘context-sensitive’ guidelines. One can simply click on a diagnosis category, and based on what is available at a site, and an agreed upon consensus

practice guideline will be displayed which documents the path to the best care that can be provided based on the resources available at that site. This is the ultimate ‘stepping-stone’ which provides the ideal guidelines for the resources available, and does not leave the health care provider at the coalface stranded and helpless trying to navigate what they can provide with the resources they have available (<https://developingworldheadandneckcancerguidelines.com/>). One could consider these as ‘fit for purpose’ guidelines. Developing guideline such as these, should be an aspiration for all disciplines for surgical and anaesthesia care in Africa.

Johan’s educational approach is simple; mentor local leaders and experts, ensure access to appropriate educational material, and finally ensure that treatment guidelines are ‘context-sensitive’ and deliverable.

### *Improving competency*

In a low-resource environment, the question of the number of surgeries needed to ensure proficiency in a procedure becomes hugely important. Indeed, we know from earlier discussions, that the surgical volume in these low resource environments is severely limited, and this hampers the quality of care delivered. Furthermore, the environment requires task-sharing due to the limited human resources, and task-sharing requires collective responsibility for the care of the patient across all the levels of participating healthcare providers. In task-sharing this is important. The most common approach to learning is intuitive or tacit knowledge, characterised by pattern recognition. Yet, in low resource environments, it is the complications associated with care which may not have enough cases to ensure the necessary pattern recognition for safe management. For example, a spinal anaesthetic is frequently used for caesarean section because it is simple, and generally safe, and removes the need to secure the airway with an endotracheal tube, which of itself, is potentially difficult and dangerous because of the swelling of the airway associated with pregnancy. However, sometimes the height of the local anaesthetic block on the spinal cord reaches the nerves which supply the diaphragm necessary for breathing, resulting in the early signs of difficulty in coughing, and a soft voice and if allowed to progress will result in the inability to breathe and a respiratory arrest if the airway is not secured with an endotracheal tube. In these more complex or unusual situations, there is a need for factual knowledge and theories to ensure an explicit analysis of the situation, to allow appropriate management. The common theory of learning in high income countries is through reading and knowledge, which is then exposed to practical experience to create a theoretical knowledge. The common theory of learning in low resource environments is often the inverse. That is, the clinician often gets experiential learning first (the ‘see one, do one, teach one’ model), and then later supplements it with reading.<sup>55</sup> This is exactly how my early anaesthesia training in Edendale Hospital was conducted.

The challenge in low-resource environments is linking the experiential learning to theory, such as linking the mother with the spinal and a soft voice, to the theory of a ‘high spinal’ and how to manage it. Ideally in education theory, reflection is important to provide the knowledge, but there is little time for reflection or people to mentor the reflection in an understaffed resource-limited environment. Nicky Kalafatis considers competence to be the biggest challenge to safe surgical care in low resource environments.<sup>56</sup> While there is a need for training to produce ‘fit for purpose’ surgical and anaesthesia providers in this resource limited environments, ‘collective competency’ becomes extremely important. The surgical team needs to provide collective oversight to ensure patient safety. Nicky makes the point that the WHO Safe Surgical Checklist is partly based on ‘collective competency’, where we share our understanding of the



surgical case, and our insights into potential problems which may arise. By sharing the potential problems, the surgical team are ensuring that they can share the different competencies across the team in the operating theatre should they need to manage that complication. The results from the ASOS-2 trial suggest that we must ensure that ‘collective competency’ extends across the entire healthcare team. A nurse needs to understand what the deteriorating patient looks like, and then needs to know how to communicate the deterioration with the doctor on the ward, so that the doctor understands the gravity of the situation, and responds appropriately, and swiftly. The SAFE courses have gone a long way towards developing ‘collective competency’, which can certainly be augmented with stepwise plans and cognitive aids.<sup>55</sup> Nicky is adamant when she states that, “*The bottom line for me is that we have to move away from individual competence into the realm of ‘fitness for purpose’ and collective competence.*” We must strive for ‘collective competence’ in delivering safe surgery and anaesthesia in Africa.

In the United Kingdom, it is normal for anaesthetists to work with an ‘operating department assistant’ or ODA. An ODA is the ‘right-hand man’ of any anaesthetist. As a junior anaesthetist in the beginning of my training, I was anaesthetising a patient, and as soon as the patient lost consciousness, I lost the airway and I was unable to intubate the patient. The time between life and death is extremely short, as the patient cannot breathe, and desaturates. I could feel my vision narrowing, as I felt the anxiety growing. Suddenly, I felt a bougie placed in my hand by the ODA. The ODA had clearly been watching, and understanding the situation, and provided support through his knowledge and experience. Fortunately, the bougie was the answer, and I managed to introduce it into the airway, and then railroad the endotracheal tube to secure the airway, and oxygenate the patient, with no harm to the patient. This was ‘collective competence’ at the bedside. ‘Collective competence’ is powerful for quality of care. For example, if you have an anaesthesia nurse who is assisting an anaesthetist, then 30-day mortality was halved compared to an anaesthetist working without assistance.<sup>57</sup> Indeed, I could have been part of this grim statistic, without the assistance of that ODA.

The Lancet Commission for Global Surgery suggests that the ability to deliver the three Bellwether surgical procedures: a caesarean section, a laparotomy and an open reduction of a fracture<sup>20</sup> will ensure that a hospital has sufficient resources to provide safe surgical care. Zane Farina believes that the ability to perform the Bellwether procedures has additional value in “*cross training*” through learning the unique requirements for each procedure. The skills learnt from the each of different procedures, are transferable to the management of the complications across the procedures. He is correct to suggest that a hospital that is only able to provide caesarean sections (and maybe some other minor surgical procedures), is dysfunctional, and to improve must address the absence of the other two surgical procedures. If you can perform a caesarean section, you may be able to manage massive haemorrhage, but the anaesthesia provider may not be comfortable managing the airway. If you are also conducting laparotomies, then the anaesthesia provider will be comfortable managing an airway as these procedures require endotracheal intubation routinely, and this will ensure increased safety when a pregnant woman requires an endotracheal tube or a general anaesthetic, as opposed to a spinal anaesthetic. Sadly, if there is no ‘cross training’, it is likely because the environment does not support ‘cross training’ through insufficient resources. A study in Uganda showed that due to shortages of personnel, drugs, equipment and training, only 23% of anaesthetists have the facilities to deliver safe anaesthesia to an adult, 13% to deliver safe anaesthesia to a child and 6% to deliver safe anaesthesia for a Caesarean section.<sup>58</sup> Therefore, if you are can only able to provide anaesthesia for caesarean delivery, it is certain that your ability to provide safe anaesthesia for other adults and children will be compromised due to limited resources *and* limited ‘cross training’ compromising the ability to develops the skills and proficiencies needed

to provide safe surgery for all. Zane clearly states that to address the fundamental problem of maternal mortality, the mother needs to arrive at a district hospital that has been upskilled through the ‘cross training’ through performing the non-caesarean section operations such as ordinary laparotomies or fracture fixation. The reason he gives is that it prevents obstetric care being delivered by a provider with a limited arsenal of anaesthesia skills. So instead of only been able to provide a spinal anaesthetic for a caesarean section, or an evacuation of a retained placenta under sedation (uncomfortably), rather a broader skillset is developed through the need to develop the other skills necessary to perform the other two Bellwether operations, such as general anaesthesia for laparotomies. It is these skills which are life-saving for mothers, in times of trouble, and a general anaesthetic is needed, or a mother obstructs her airway with sedation, and the airway needs to be rapidly established to ensure the ability to breathe and oxygenate. This is what was missing at the sites we studied where non-physicians had to provide sedation for surgery, because these hospitals only had the resources to deliver sedation, and did not have the resources or the ‘cross-training’ to manage the complications.

Zane is adamant that, *‘We will not make a difference until we are doing SAFE courses and the district hospitals are also doing their Bellwether procedures. These true generalists are actually ‘multi-specialists’ and allow care provision for many rural communities that would otherwise go without care. However, to work as a ‘multi-specialist’ in a rural setting is taxing, both personally and professionally.’*<sup>20</sup> This was my problem when I realised that I was not up to the task of being a ‘super-GP’. A ‘super GP’ is a specialist, and as Zane correctly says, in reality a ‘multi-specialist’. Half the problem is that these ‘multi-specialists’ are not recognised as specialists by professional medical colleges, and the ability to ‘cross train’ and provide adequate care in resource limited environments will not change, until these ‘multi-specialists’ are recognised as specialists.

While we have focussed on the three Bellwether surgical procedures, the World Bank has identified 44 procedures that these ‘multi-specialists’ must provide at the district (or first level) hospital.<sup>59 60</sup> Essential trauma services, including the expeditious management of pneumothoraces and haemothoraces (air and blood in the chest cavity), with a tube thoracoscopy is considered an essential procedure.<sup>60</sup> The inability to provide this procedure, is what nearly killed the young pregnant lady in Bandundu, DRC. ‘Neglected surgeries’ are these missing surgeries or surgical skills at district level hospitals, but are needed for provide the 44 essential surgical procedures for the ‘super-GP’..

The Western Cape in South Africa could be considered a desirable and well-resourced environment in an African context. South Africa is an upper middle-income country, and the Western Cape has traditionally been viewed as functionally good, and medically desirable with a strong history of landmark medical achievements from the first heart transplant to the centre of HIV and AIDS advocacy and world class scientists. Yet, examination of the district hospitals in the Western Cape show that 1/3 have no budget for surgery, and a 1/5 have no functional operating theatre.<sup>61</sup> This puts the challenge facing lower resource environments trying to provide surgery at a district hospital level in context, especially if we cannot even reliably provide appropriate district level surgery universally in a comparatively well-resourced African environment. We know that in Africa, the predominant Bellwether procedure performed is the caesarean section.<sup>36</sup> In the district hospitals of KwaZulu-Natal in 2015, 96% of Bellwether procedures were caesarean sections, and 2% were laparotomies and 2% were for managing open reductions of fractures.<sup>62</sup> Even to provide just the Bellwether procedures, demonstrates a huge vacuum for the provision of laparotomies and fixation of open fractures. The remaining two-thirds of surgeries other than caesarean sections which are conducted in Africa are likely

to be severely compromised in quality due to insufficient resources necessary for delivery, and a failure of ‘cross-training’ necessary for the development of a skill set necessary for safe practice.

This brings us to the competencies for surgeons in these district hospitals. There is no standard training programme for these competencies. This impacts on what surgery can be delivered in these environments. The challenge is to roll the competencies of surgeons from 20 different specialities into a single ‘multi-specialist’ surgeon, which is needed in the district hospital. Kat Chu, a general surgeon and head of global surgery at the University of Stellenbosch has worked extensively in humanitarian surgical programmes. At a meeting, she puts up a slide from the very textbook I once owned “Primary Surgery, Volume 1” when I still aspired to the great heights of the ‘super GP’. It is a picture of some of the common procedures in a rural hospital. These included a caesarean section (obstetrics), a laparotomy (general surgery), a fracture reduction (orthopaedics), packing a bleeding nose (ENT), draining a pericardial effusion (cardiothoracics), draining a subdural haematoma (neurosurgery), inserting a suprapubic catheter (urology), managing an infected hand (orthopaedics), doing a skin graft (plastics), repairing a severed artery (vascular), and the list goes on. The challenge we must address is the creation of a ‘multi-specialist’ surgical and anaesthesia course which is accessible and achievable in low-resource environments, both in training, and the maintenance of the clinical service while training. Kat speaks passionately about the need to provide surgical support from a central ‘hub’ hospital to the isolated rural surgeon at the district ‘spoke’ hospital. The central ‘hub’ surgeons and hospital need to consider themselves responsible for all patients within their catchment. This is like the role that Zane plays in anaesthesia care in KwaZulu-Natal, South Africa, and Johan Fagan plays in his weekly virtual African ENT surgical management meetings. The benefit of the ‘hub and spoke’ model is creation of an understanding of the surgical needs in the district hospital, and the challenges and support needed for delivery of appropriate surgical care, and when up referral is required. Until we reform ‘surgical and anaesthesia education’ to address the many procedures required at the district level, and enable ‘cross training’ by enabling the delivery of all these surgeries, we will not be able to provide safe care in low-resource environments.

We need to capacitate the surgical team at the district hospital level so that they can provide the necessary surgeries in this environment. This includes working towards a personnel structure that is sustainable for surgical provision, that these providers have functional communication networks for external mentorship, the knowledge and educational materials opportunities at hand for self-development, and ‘context-specific’ guidelines. Human resource capacitation can be done locally and externally.

The personnel at a district hospital must be able to make and deliver on the brave decisions expected of a ‘super-GP’ across many medical and surgical disciplines. To be able to make these brave decisions, the medical officer needs to be trained to make decisions which are acceptable in terms of potentially successful management, outcomes and complications, across many disciplines. These include, for example, the baby with diarrhoea in the clinic, to the mother bleeding with a preterm fetus, to the surgical patient with an open fracture from a road traffic accident. This is the reality that faces doctors providing care in the district hospital. Education and training for a ‘package of care’ will not guarantee a functional and sustainable district hospital until it has the necessary human resources to support it. Modelling suggests that a functional district hospital requires at least eight medical officers to provide a sustainable model for a district hospital, of which one needs to be a family physician (Steve Reid, personal communication). If you have adequate human resources, you then need to retain them within

the district hospital environment which is difficult. Steve Reid's group's work in KwaZulu-Natal in South Africa, and supported by the literature, suggests that the work environment needs to develop the characteristics of a 'learning system' within the hospital. This 'learning system' has six components which are important of the hospital to continue to function and improve. These include leadership, teamwork, a culture of change, resources for learning, formal education (the factual knowledge component) and reflective practice (which is considered informal learning). The interesting observation is that these six components are almost the same concepts needed and identified to support quality improvement and implementation. Reflective practice could be considered equivalent to the regular meetings to ensure the compliance and adherence to the implementation of quality improvement interventions, or group problem solving.

Communication has been shown to be critical to hold the 'inside-out' quality surgical model' together, and this extends to the 'learning system' of the district hospital. The functional communication networks need to extend outside of the hospital too, to an environment of external mentorship. The external mentor may be a local expert in a specific discipline working at a central hospital or 'hub' and may support or mentor several district hospitals or 'spokes' across many countries as demonstrated by Johan Fagan. These can be provided on a number of social media platforms, including WhatsApp.

The external component of human resource capacitation through education is probably best personified by Johan Fagan's work earlier described. This model could be adopted by all disciplines across Africa who do not have dedicated training programmes in various countries. What is beautiful about his strategy is how his educational strategy acknowledges the contextual challenges facing surgeons in low resource environments. It provides comprehensive open access educational material through the online textbook including procedures which are disappearing in high-income countries, but may still be relevant in an environment where access to all chemotherapies and other treatment regimens are not available. The second component supports the clinical surgical decision making which is cognisant of the environment and resources available to the surgeon in that environment, through the context-specific guidelines. Finally, the third component is the provision and ongoing mentorship through fellowship and virtually management meetings.<sup>53</sup> These fellowships have resulted in sustainable change, with nearly a 100% retention of trainees in their base countries. The impact of these educational interventions, with the upskilling a single surgeon can increase head and neck surgeries more than 3 fold per annum, without increasing the number of healthcare workers.<sup>53</sup> Furthermore, this strategy provides evidence for the ability of these fellowships to be provided by middle-income countries within Africa (such as South Africa), as opposed to high-income countries.<sup>63</sup> This is a good example of South-South mentorship, as opposed to the North-South learning.

It would be fair to say that the experts and skills needed for training in low resource environments are on the ground in Africa and other low-resource environments, Johan's educational strategy has overcome the limited access to education and training which in mostly unaffordable, often inappropriate and inaccessible in low resource environments. He has then exploited the power of smart phones, and internet access for accessing educational materials, and virtual platforms for sustaining groups for educational support and mentorship. This is certainly a model which could and should be replicated for other surgical disciplines in low resource environments. If one was to be critical of these fellowships, it is that they are fundamentally focused on individual (procedural) competence. Really, we need to consider adding quality improvement implementation science to any fellowship, which addresses the

importance of leadership, the development and maintenance of multidisciplinary teams and an appreciation of ‘collective competency’ strategies.

In summary, we need to do the following to strengthen district hospital surgical services. We need to ensure that the healthcare providers receive education in the package of emergency and essential surgical procedures described for district hospitals. We need to ensure that there is appropriate equipment and resources available to deliver these procedures, over and above the three Bellwether procedures. We need to ensure that there is a ‘collective competency’ and clinical leadership and teams characterised by a flat hierarchy. Finally, the ‘collective competency’ needs to extend externally to support from surgeons and anaesthetists at hubs at regional and tertiary hospitals.<sup>64</sup> The role of a multidisciplinary team is probably best summarised by Kat Chu and colleagues who state that “*successful surgery should be defined by the patient and is best achieved by a co-ordinated, multidisciplinary team, embedded in a culture of collaboration and safety.*”<sup>65</sup>

### *Scaling education and care*

The Utstein Abbey is a beautiful Norwegian medieval monastery which lies about 30 kilometres north of the port town of Stavanger. It is a small monastery, with imposing high white walls and steep roofs standing on the southern bank of Klosterøy Island, overlooking the marshes and fjord across to the Fjøløy Island. Founded in the 1100s, placed in its current location by King Magnus VI of Norway in the 1200s it was the home of the Augustinian Canons.<sup>66</sup> It has a small central courtyard, with rooms running on the perimeter. It housed about 12 monks, and many other people who worked to maintain the building, cook and work the lands. This little monastery supported many people by virtue of its extensive lands. The highly prized sheep feed on the very salty grass which runs down to the marshes on the coast, are considered a local delicacy. It is a particularly satisfying meal, which has you coming back for more. One can imagine the monks sitting in the beautiful dining hall, with its low entrance and ceilings, been sooted up by large candles bellowing smoke, while looking through the hazy windows over the waters below. This existence came to an end in 1537 with the Reformation, passing through the hands of various noblemen, until the Abbey was returned to the state in 1899. It now is a museum and a site for music recitals in the high arched church, where the acoustics are something to behold.

However, over the last 50 years the Utstein Abbey has become synonymous with resuscitation innovation and practice globally. This is because of Åsmund Laerdal, and his toy and doll company which started in Stavanger in 1940, and an unfortunate event with his child, Tore. Tore was two years old when he fell in the cold waters of a Norwegian fjord, and it was his father who fished him out.<sup>67</sup> Hypothermia is protective for near drownings, and fortunately Tore was fine. Although, this traumatic experience showed Åsmund that he had to clear the mouth of his own baby boy to ensure that he could breathe, and that very few people knew what to do to resuscitate a child. Åsmund was acutely aware of the need for training in resuscitation. Probably what contributed to his awareness was the extraordinary number of near drownings in the cold Nordic waters, and the opportunities for survival due to the protective effects of profound hypothermia.

By a strange twist of fate, the world leader in early research on resuscitation, an anaesthesiologist Dr Peter Safar from Boston would meet Dr Bjørn Lind from the Stavanger Hospital (not far from Åsmund Laerdal’s offices) at a Scandinavian anaesthesiology congress in Norway. Peter Safar had demonstrated that expired air and mouth-to-mouth or mouth-to-

mask resuscitation was possible and potentially lifesaving. But to do this, what was needed were mannikins for training. Dr Bjørn Lind's local knowledge of both Åsmund Laerdal's experience and his successful toy doll business would prove pivotal in the quest for global resuscitation training. Åsmund Laerdal was naturally receptive to the need for mannikins for resuscitation training following his traumatic experience, and he had the skills and knowledge of plastics to enable the development of working resuscitation mannikins, which would respond to the mechanical needs of resuscitation manoeuvres including head tilts, responsive airways and chests. The rest is history. Laerdal is now an industry leader in resuscitation equipment, and 'Resusci Anne' is the most well-known resuscitation mannikin around. *Resusci Anne*, which is the face of Laerdal's resuscitation mannikins was fittingly taken from the death mask of a young, unknown woman who drowned in the River Seine in the 1880s. Her face is calm, youthful and innocent, yet poignant enough to remind us of unnecessary avoidable deaths.<sup>67</sup>

The work and friendships of Peter Safar, Bjørn Lind and Åsmund Laerdal resulted in the pivotal moment of the first International Symposium on Emergency Resuscitation held in Stavanger in August 1961. It had global attendance, and the recommendations were published in a special edition of the *Acta Anaesthesiologica Scandinavica*, with a recommendation that mouth-to-mouth should be taught in all schools.<sup>67</sup>

Laerdal has gone on to provide many simple, low fidelity mannikins that can be found across Africa. It is these mannikins which are key to resuscitation training across Africa. Why are simple mannikins so important? Firstly, they are accessible and functional in low-resource environments. Secondly, we know that they have similar educational impact to high-fidelity mannikins, as demonstrated data for simulations for education from the SAFE courses. It is the realism of the simulation used in training that is important for the educational response (and not the need for realistic mannikins). The data suggests that simulations using simple mannikins is not inferior to that delivered using high-fidelity mannikins for retention of skills performance at a year after training.<sup>68</sup> Data also demonstrates that a similar stress response can be achieved during the simulation training, with a low-fidelity mannikin when compared to a high-fidelity mannikin, supporting the delivery of a realistic simulation.<sup>69</sup> Finally, education including low versus high-fidelity mannikins have shown no difference in knowledge acquisition.<sup>70</sup> The importance of ubiquitous mannikins across Africa therefore cannot be overstated. And where mannikins are not available, improvised low fidelity mannikins could be used, such as the example of Rowan Duys's low fidelity improvised mannikins in the Eastern Cape in South Africa which have used pillows, linen and gloves (Figure 9). Christian Kampik, a German anaesthesiologist who has spent his professional career in South Africa conducts simulation training across Africa. He stares at me over his reading glasses, and intensely educates me, emphasising every point as his ponytail swings behind him. He speaks about the simple things that one can do to increase the realism of simple simulations. These include doing the simulation in an operation room, dressing up in theatre clothes, using apps which provide patient monitor readings of heart rate, blood pressure and saturation, and then doing simple work around jobs on low fidelity mannikins to make the mannikin more 'responsive', so that the simulation instructor can then manipulate the mannikin look like it is breathing. He inserts a simple tube through the neck of the Laerdal mannikin, which runs under the doll's clothes and over to the instructor in the corner of the room, who then can breathe for the mannikin through the tube into the trachea or obstruct breathing. With a bit of ingenuity and imagination, Christian can get all the low fidelity mannikins, with a few work arounds into a single suitcase, and an app for a bit more feedback in the simulation, and then he can essentially travel anywhere to provide a fairly realistic simulation.



The reality is good educational courses, and simple low fidelity mannikins used in realistic simulations can result in knowledge retention and skills retention for 6 to 12 months. This is all accessible in a low-resource environment. First-prize would be to ensure that the teaching is ‘context-sensitive’ and the simulation is adapted to the resources that are available. This would then not require group problem solving to ensure implementation of the training on returning to one’s work environment.

**Figure 9. Rowan Duy’s low fidelity mannikins in the Eastern Cape, South Africa**



### *Conclusion*

The Donabedian perspective<sup>71</sup> on quality of care considers the relationship between structures (e.g. resources, adequate staffing), processes (e.g. adequate ward routines for monitoring patients) and outcomes.

When considering the resources for safe surgery we know the following. Surgical healthcare providers need education and training which is ‘context-sensitive’, with management plans which are also ‘context-appropriate’ and mentorship to support their decision making and delivery of care. All training should focus on ‘collective competency’ which allows everyone in the team to contribute to better outcomes, while simultaneously supporting the delivery of care to the patient. An emphasis on ensuring the capacity to ‘cross-train’ is necessary if we don’t want to end up with unwanted complications and deaths.

We must acknowledge the importance of tracking processes which are key to ensuring the implementation of evidence-based care. We have shown, that studies of complex interventions from high-income settings, e.g.<sup>72</sup> and low- and middle-income settings e.g.<sup>73</sup> cannot improve the quality of care through process improvement alone. Improving outcomes (the quality of care) requires triangulating resources (which include the infrastructure, the equipment, and the people needed) with evidence-based interventions and the processes needed to implement and

track the success of the interventions.<sup>10</sup> To improve surgical outcomes, we need to marry clinician researchers (who have the expertise to provide the evidence) with implementation scientists (who have the expertise to ascertain that the interventions are implemented). While clinician researchers focus on the science and the evidence, implementation scientists consider the people and the processes. We need these two groups to meet, so that the evidence, people, and processes work in unison to improve outcomes.

Finally, we need to track outcomes, and meet and reflect on the performance of the quality of care that we are delivering. Feedback on processes, and outcome data completeness is then necessary to drive quality improvement through implementation. One needs to develop a culture of quality care. We need to be able to review our performance on the implementation of these evidence-based interventions if we want to improve care. We need to embrace the process of group problem solving, if we are to ultimately make surgical care better.

In the resource-limited environment of Africa, we need to accept that there are ‘ceilings’ to any quality care initiative. Low ‘ceilings’ are imposed by the limitations of ineffective stakeholder and leadership engagement. These are soft ‘ceilings’. The hard ‘ceiling’ is that of severe infrastructural and resource limitations, which cannot be bypassed without more resources.

In conclusion, the challenge to improving quality of care is that it is more often than not, a complex intervention in a complex environment.<sup>74</sup> Unlike simple interventions such as a medication being evaluated in a drug trial, complex interventions are commonly designed to change institutional processes and systems and / or human behaviour or interactions. The number and adaptability of interacting components and people involved affect the level of complexity of the intervention, making it hard to define exactly what is delivered, and which of these are the “active ingredients” that are most influential on the target outcomes.<sup>75</sup> Finally, this is also complicated by the negative impact of sequential or multiple processes problem on fidelity. We must therefore do everything possible to take ‘complex’ interventions, and try and simplify them, if we are to successfully improve the quality of surgical care.

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