Simulation in Limited-Resource Settings

25

Nicole Ann Shilkofski and Peter A. Meaney

Simulation Pearls

1. Key elements for successful implementation of simulation programs in limited-resource settings(LRS) must take into account sustainability and dissemination, collaboration with local health authorities and local stakeholders, appropriate mannequin selection, and impact of culture and language on educational methodology.
2. Priority areas for application of simulation-based education (SBE) in limited resource settings (LRS) include patient safety, clinical decision-making, technical skills, teamwork and communication development, and appropriate allocation of resources.
3. Telesimulation may be a method to share resources and educational expertise between more developed simulation programs and those in LRS, while m-Health technologies may be a way forward for data collection to demonstrate clinical impact after simulation program implementation in LRS.
4. Resuscitation training in both trauma and newborn resuscitation in developing countries has been shown in studies to reduce mortality, but this has not been consistently demonstrated with other types of training programs to date.
5. SBE in the form of widely disseminated programs such as Helping Babies Breathe (HBB) has the potential to impact Millennium Development Goal (MDG) #4, to decrease the neonatal morbidity and mortality rates in LRS. Demonstrating efficacy of these types of programs that are being implemented in global settings will be important in their use as a platform to understand successful and sustainable education and implementation strategies.

N. A. Shilkofski (✉)
Departments of Pediatrics and Anesthesiology/Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA
e-mail: nshilko1@jhmi.edu

P. A. Meaney
Department of Anesthesia and Critical Care, University of Pennsylvania School of Medicine, Children's Hospital of Philadelphia, Philadelphia, PA, USA
e-mail: Meaney@email.chop.edu

Introduction

Uses of Simulation in Limited-Resource Settings

The past few decades have seen major advancements in technology within medicine and nursing, both for clinical care and for educational purposes. As a result, the old adage *see one, do one, teach one* has been largely supplanted by other forms of formative educational strategies that are more in keeping with patient safety priorities. SBE has many uses as a pedagogical strategy in medicine and can enhance the entire spectrum of both care and education, for both novice and expert clinicians. While many of the technological advances in medicine and SBE have had their footholds in the developed world, the idea of *practicing on plastic* has also seen an increase in the developing world, with applications of different types of simulations being implemented in LRS internationally, as part of an encouraging trend toward the globalization of healthcare education.

The need to promote skill development in both medicine and nursing care, in a manner that does not harm patients, has been a primary driver for pedagogical change throughout the world. Development of educational infrastructure and integration of resources (such as simulation) becomes even more salient in the developing world, specifically in LRS. This is due to an epidemiologic mismatch of supply and demand; developing countries often have the highest burden of morbidity and mortality globally, while being under-resourced in the number of practicing clinicians and equipment within the country. Figures 25.1, 25.2, and 25.3 demonstrate this mismatch pictorially in regard to a major worldwide problem, early neonatal mortality, compared to the number of healthcare workers worldwide. SBE programs to address early neonatal mortality on a global scale will be addressed later in this chapter.

V. J. Grant, A. Cheng (eds.), *Comprehensive Healthcare Simulation: Pediatrics,* Comprehensive Healthcare Simulation, DOI 10.1007/978-3-319-24187-6_25

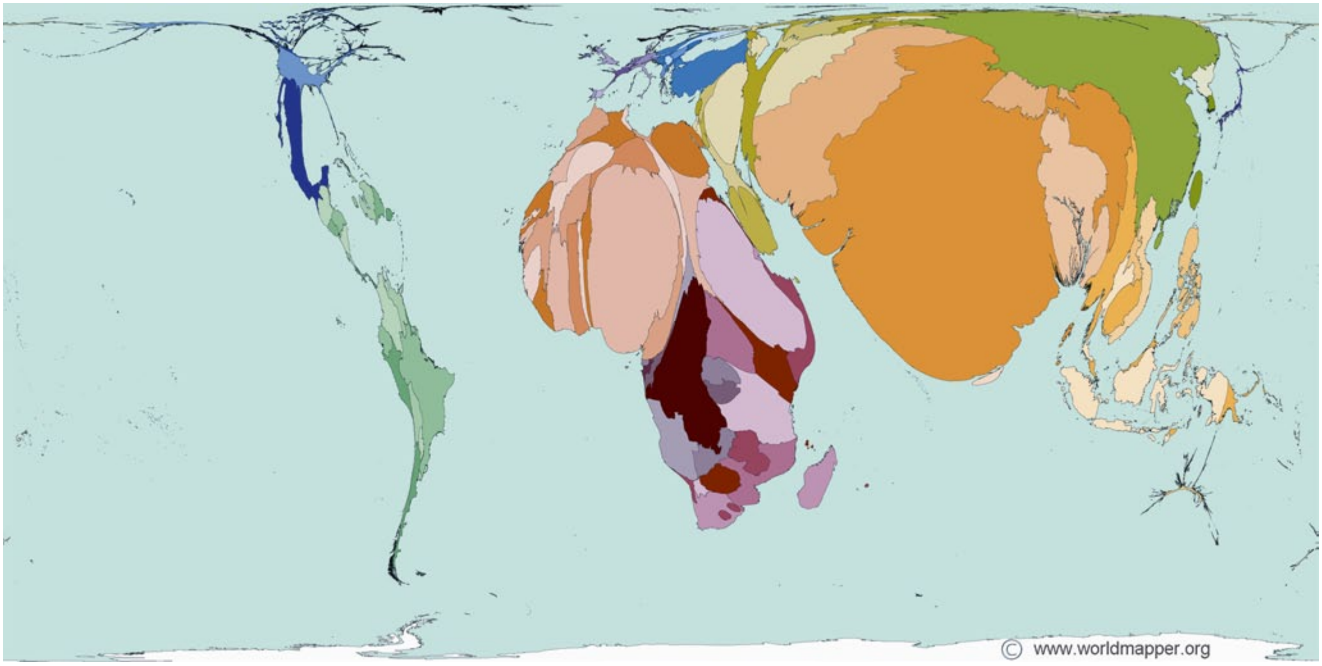

Fig. 25.1 Early neonatal mortality: territory size is proportional to the number of early neonatal deaths in that region, defined as deaths within the first week of life. (Reproduced with permission of www.worldmapper.org)

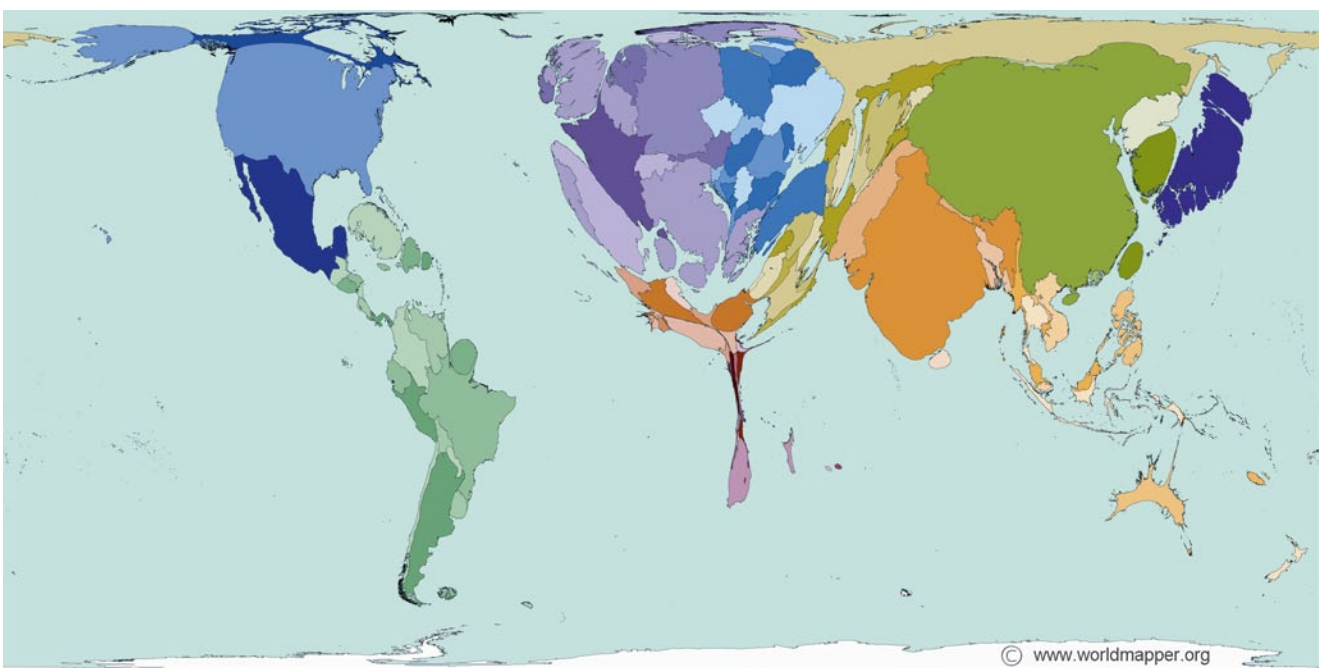

Fig. 25.2 Physicians working worldwide: In 2004, there were 7.7 million physicians working around the world. If physicians were distributed according to population, there would be 124 physicians to every 100,000 people. The most concentrated 50 % of physicians live in territories with less than a fifth of the world population. The worst off fifth are served by only 2 % of the world's physicians. (Reproduced with permission of www.worldmapper.org)

A World Health Organization (WHO) patient safety study identified ten key health areas where industrialized countries have the most to learn from the developing world; low-technology simulation training was one of these key areas [1]. This chapter describes the various types of SBE in use within LRS, including mannequin-based simulation, partial task trainer models, standardized or simulated patients (SPs), virtual reality simulation, and screen-based or computer

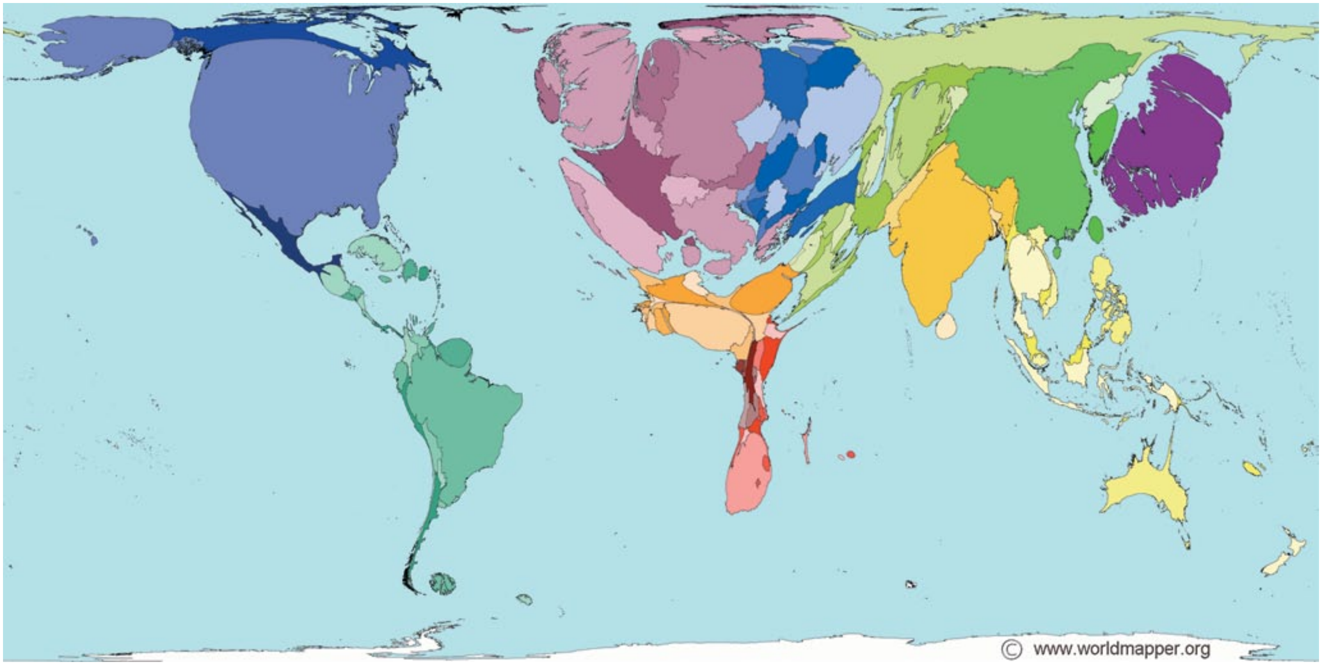

Fig. 25.3 Nurses working worldwide: The USA, China, and the Russian Federation are where the largest number of nurses work. However, the highest numbers of nurses per person can be found in Western European territories such as Finland and Norway. The fewest nurses working per person in the population are in Haiti, Bangladesh, and Bhutan—territories where there is much more need for nurses than is found in many other places. (Reproduced with permission of www.worldmapper.org)

simulation. The chapter will also highlight SBE programs that have been implemented in multiple LRS internationally as an example of attempts to target MDGs established by the United Nations [2].

Pediatric Education for Practitioners and Clinicians in Limited-Resource Settings

Due to a lack of availability of specialist consultants, infants and children in LRS are often cared for by general practitioners. However, many of these practitioners, while often quite skilled and clinically astute, have few formal training opportunities in the care of critically ill or injured children. This can result in a type of *mental paralysis* when confronted with a very sick child. In emergency situations with pediatric patients, *one size does not fit all*. It is well known and recognized that caring for a critically ill child can entail significant cognitive burden when considering clinical elements such as weight-based dosing for fluids and resuscitative medications, age-based consideration of differential diagnoses, and need for different-sized equipment for resuscitation of infants, children, and adolescents [3]. There are a multitude of other physiological, psychological, and psychosocial factors that also impact clinical care for children in these settings [4]. Surveys of practicing clinicians in LRS in parts of Africa and Asia identified significant self-assessed knowledge deficits in caring for critically ill children and identified skills training and education in this area as a major priority. Practitioners cited lack of knowledge in algorithms/protocols, limited opportunity for hands-on practice, and lack of knowledge in functionality of resuscitative equipment (e.g., defibrillators) as major barriers to caring for critically ill children in their settings [5]. This is where pediatric simulation can play a major role in identifying and seeking closure to these gaps in both knowledge and skills.

Overview of Simulation-Based Education Implementation and Interventions in Limited-Resource Settings

Assessment and evaluation methods in medical education that are used in many settings in North America and Europe can often be inaccurate, expensive, and/or infeasible in many LRS. Therefore, innovative approaches are critical when implementing new assessment methods in these settings. Simulation is one of these creative approaches that can be used in the education and assessment of practicing clinicians in urban and rural settings, including community health workers and traditional birth attendants (TBAs) functioning in LRS. In many of these settings, a country's lack of available trained medical and nursing staff is a major obstacle that impedes progress toward improving healthcare outcomes. In developing countries, inadequate initial assessment, inappropriate treatment, and inadequate monitoring contribute to poor outcomes, in part because in-hospital care providers are frequently undertrained in life support techniques [6–11]. The use of simulation in the creation of a sustainable system to manage emergencies can help to negate these obstacles.

A systematic review of the literature on resuscitation training in developing countries concluded that training in trauma and newborn resuscitation in developing countries has been shown to reduce mortality in some studies, but this has not been demonstrated with other training programs [12]. For example, several studies of trauma resuscitation training in developing countries have demonstrated improvement in survival and reductions in mortality from 3 to 33 % after training of both prehospital and hospital-based providers [13–16]. In terms of newborn resuscitation, improvement in operational performance of hospital-based providers was associated in one study with a decrease in asphyxia-related deaths, while improved performance of TBAs in the community was associated with a decrease in overall mortality in another study [17, 18]. Two studies of newborn resuscitation programs examined effect of training on neonatal (28 days) or early neonatal (7 days) mortality and were able to demonstrate a successful improvement in survival [19, 20]. On the other hand, several studies in LRS involving adult life support training were unable to demonstrate an association between training and improved long-term patient survival [21, 22]. Unfortunately, at the time of the systematic review, there were no studies of pediatric life support training that examined subsequent changes in patient outcomes in the clinical setting in LRS.

Simple, community-based interventions have improved mortality in both developed and developing countries [23–28]. Most studies that reported positive outcomes in knowledge acquisition did so by using differences between cognitive assessments at various time intervals in relation to training intervention, but no studies exist which link cognitive knowledge to patient outcome. Many studies reported psychomotor skills post training, but few used validated scoring systems. Incomplete contextualization of SBE designed originally for resource-rich settings often creates a barrier to effective education. Methods for consideration by educators in order to overcome these barriers in LRS are suggested in Table 25.1.

Other studies have assessed models for the design of training programs in fields beyond resuscitation and acute care, such as surgical training programs in rural locations in Romania and Botswana with demonstration of significant improvement in technical skills [29–32]. Many surgical simulation studies have focused on the feasibility and cost-effectiveness of task trainer simulation in LRS and the use of this type of simulation to develop training programs to address the human resources deficit in developing countries [33–36].

Table 25.1 Considerations to overcome barriers to implementation of simulation-based education (SBE) programs in limited resource settings

Collaborate with local experts to maintain overarching themes while adapting to local cultural and clinical contexts
Create simulation scenarios tailored to the local clinical setting
Track operational performance and evaluate patient outcomes after training
Anticipate higher-than-expected requirements to maintain essential functioning equipment for adequate practice
Increase allotted time for the course to incorporate local cultural norms and to consider language comprehension for non-native speakers

Innovative models and simulators for use in LRS must address portability, sustainability, and cost-effectiveness. They must be simplistic while maintaining fidelity. One example, used in Guyana, is a reusable tool to introduce a standard hollow needle for pediatric intraosseous (IO) infusion designed for use in LRS, where standard IO needles are often unavailable for emergency use [37]. Another example is the development of a low-cost simulator for management of postpartum hemorrhage (PPH) in Africa to train TBAs and nurse midwives in the use of bimanual compression to manage PPH [38]. The assessment of this simulator's efficacy included its use to train illiterate learners, since some TBAs living in rural areas may not be literate. Another example within the field of obstetrics is the creation of an inexpensive low-technology birth simulator that has been successfully used in Mexico and other countries for obstetrical emergency training (Fig. 25.4; [39]). Other studies have

Fig. 25.4 PartoPants™: This simulator is made from a modified pair of surgical scrub pants outfitted with a vagina, a urethra, a rectum, and other anatomical landmarks. It is designed to be worn by an actress or standardized patient who simulates a birth, postpartum hemorrhage, or an eclamptic seizure. This low-technology, low-cost simulator has been used as part of a larger program called PRONTO (Programa de Rescate Obstétrico y Neonatal: Tratamiento Óptimo y Oportuno), focusing on improving the quality of care for women and neonates during obstetric emergencies in response to the WHO Millennium Development Goals 4 and 5. More than 2400 providers have been trained in six countries (Mexico, Guatemala, Kenya, Ethiopia, Namibia, and India) through early 2014 using this simulator. (Figure used with permission from PRONTO International; [86])

discussed the use of this type of low-technology simulator in coordination with an SP as a form of hybrid simulation to enhance realism for learners [40]. All of these simulation models represent creative thinking to overcome cost and access limitations in LRS. Diffusion of these innovations has the potential to benefit health care in both the developed and developing worlds.

Challenges and Barriers in Limited-Resource Settings Simulation with Proposed Methods and Solutions to Overcome Them

Cultural Considerations

The examples above show that simulation is feasible and can be effective in global settings. However, conducting simulation and debriefing in LRS requires consideration of the culture and language of the region in order to be maximally effective. Culture can be conceptualized as shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted across generations [41]. There is often a dichotomy between Western and non-Western cultures in ways of learning and conceptualizing entities such as the team construct [42]. This dichotomy can become particularly salient when considering the process of debriefing, discussed further below. With appropriate cultural contextualization, simulation has the potential to improve several areas of team functionality, including membership, role, context, process, and action-taking by focusing intentional learning effort and debriefing on each of these areas [43].

However, in experiential learning, an individual must also engage in reflective practice in the process of debriefing after simulation participation. Most studies of effective debriefing models stem from Western cultures and therefore may not always be generalizable to other cultures and settings. In debriefing, the instructor ideally functions as a facilitator for reflective group discussion by the learners. However, in cultures where *saving face* is important and deference to an instructor or teacher is valued over disclosure of personal viewpoint, a simulation debriefer may find the learner group minimally communicative and seemingly unwilling to engage in reflective practice. This may be due, in part, to the fact that the process of metacommunication (communicating about communication) in non-Western cultures is conceptualized very differently. Participants in a team-based simulation will often be hesitant to reflect on any team performance that seems critical of a team leader, particularly when the team is interprofessional and of mixed gender [43].

Culture also has an impact on conceptualization of different team dynamics, including hierarchy, leadership/followership models, and role delineation within teams. This may be influenced by different cultural interpretation of values, such as the more stereotypically Western *individualism* as compared to the more Eastern *collectivistic* approach to team dynamics and learning [32]. Similarly, there are some cultures that value communal learning and others in which learning is an individual enterprise [41]. In ad hoc teams with members from different cultures and nations, this dichotomy can create barriers to communication and effective patient care and can create problems in SBE ranging from nonacceptance of the *fiction contract* in simulation to unwillingness to engage in an active learning strategy. Simulation itself can often help to improve communication and create a shared mental model that reach beyond cultural bounds for these types of teams [43]. These shared mental models can improve the functionality of medical teams in the care of patients [44].

There is no *one-size-fits-all* solution to these cultural issues that can be barriers to effective implementation of simulation programs. In many ways, broad awareness and recognition of the issues and cultural differences by facilitators can be the first step in overcoming the potential barriers. However, several studies in the literature describe curricular adaptations that have been made for SBE programs in LRS (ranging from virtual patients to computerized patient simulation) to address cultural humility, sociocultural constraints, local epidemiology, and language differences [45–47]. Adaptations of curricula must also consider the influence of culture on assertiveness and leadership styles, uncertainty avoidance, reflective capacity, and individual's degree of introversion/extroversion in order to be successful. Facilitators should incorporate more time than anticipated for teaching and debriefing in order to factor in these considerations.

Impact of Language on Teaching and Comprehension for Learners

Implementation of any new simulation programs internationally will require consideration of cultural sensitivity and linguistic factors if a program is to be successful longitudinally. In a study conducted across medical professionals in different countries in Asia, Africa, and South America, physicians and nurses identified language as a major component for misunderstanding during the conduct of simulation debriefings [43]. Accented speech, methods of pronunciation, differing colloquialisms, or frank language barriers were identified as the origin of misunderstandings and lack of awareness by team members. As a potential solution, the widespread use of skilled interpreters and translation of teaching materials in advance of a planned course or program can be critical to successful implementation of simulation programs in LRS. As mentioned above, facilitators and instructors must also allocate more time than usual for teaching and debriefing when language is a factor, particularly when interpreters are utilized. It can be helpful to use interpreters who have a clinical background, rather than laymen, as this facilitates logical translation of medical terminology in other languages.

Impact of Language on Debriefing Techniques and Strategies

The article *It Is Time to Consider Cultural Differences in Debriefing* discusses the importance for facilitators to understand an individual's frame of reference or mental model in order to optimally structure a debriefing experience [48]. However, this may not be possible when there is a difference in native language between debriefer and learner. In most forms of Western communication, it is the speaker who is expected to communicate ideas without ambiguity, compared with a more *receiver-oriented* culture, in which the listener is responsible to make sense of a communication. Some cultures may value courteous communication over assertive communication and may use mitigated speech when debriefing, so as not to offend the learner or receiver. In the field of medicine, however, this could be a threat to patient safety in the clinical setting, particularly if the mitigated speech does not properly address a knowledge or skill deficiency. These potential barriers make the essential argument for use of interpreters and native speakers as part of the debriefing team. The native speakers should ideally understand the cultural values and linguistic idiosyncrasies in the setting where the debriefing is occurring, thereby serving as a filter and interpreter in order to maximize communication and reflective learning. The barriers discussed above could also potentially be overcome, in part, by wide adoption of the *good judgment* and *advocacy/inquiry* models of debriefing [49, 50]. These models, if taught properly, could appeal to a wide variety of cultures, in that the model acts as a springboard to explore the learner's viewpoints, beliefs, assumptions, and frames of references—all elements that could be a source of cultural misunderstanding between debriefer–learner dyads from different cultures. However, instructors may still find difficulty even when using the *debriefing-with-good-judgment* approach when debriefing learners from cultures in which deference to authority and elders is culturally important since the learners may feel reluctant to express views that seem to contradict the instructor. In this context, the recourse recommended is explicit preparation regarding the goals and norms of the simulation environment, but difficulty may still exist [48].

Other models and techniques of debriefing that promote facilitated discussion, active reflection, and self-discovery may also be helpful in LRS with participants who have language and cultural barriers. When teaching using a train-the-trainer model in LRS, it is crucial for new trainers to explicitly understand and role model the difference between giving *feedback* to learners on their performance and *debriefing* after simulation (see Chap. 3). Some facilitators have anecdotally reported successful use of the structured and supported debriefing *GAS* (Gather–Analyze–Summarize) model with mixed group learners from different linguistic backgrounds, even with clinical bedside teaching and debriefing in international settings [5, 51]. This model, developed in collaboration with the American Heart Association (AHA) for the Advanced Cardiac Life Support (ACLS) and Pediatric Advanced Life Support (PALS) courses, is a learner-centered process that can be rapidly assimilated, is scalable for different levels of learners, and is designed to standardize a debriefing interaction following a simulation scenario, making it ideal for use in LRS and simulation courses utilizing cascade *train the trainer* models. In addition to promoting learner self-reflection and self-discovery, the GAS model promotes closure of performance gaps through discussion and reflection and elicits how learners will change actions in subsequent practice [52]. It can integrate educational objectives for each scenario in the *analysis* phase of the debriefing, thus ensuring that goals for an educational session are achieved and any performance or knowledge gaps are discussed and addressed. The GAS model has already been successfully integrated into debriefing tools for real-time use during PALS to enhance and standardize a scripted debriefing process for PALS instructors [53]. This scripted debriefing process has been shown to be more effective at increasing acquisition of knowledge and team leader behavioral skills than non-scripted debriefing [54]. It is easy to see how these tools could be adapted for use in LRS, both within PALS instruction and other uses of pediatric SBE.

It is also worth considering that there may be a role for both terminal and concurrent debriefing techniques with learners in LRS, depending on the learning goals and objectives. When significant language barriers exist and interpreters are being used, facilitators may find concurrent debriefing to be useful to correct cognitive errors and enhance understanding in real time, particularly when the focus is on skill development. This is an important consideration that should be discussed and agreed upon by facilitators and debriefers in advance when establishing courses and programs in LRS. Some facilitators may also find the incorporation of the *rapid cycle deliberate practice* model to be helpful with learners in LRS when the learning objectives include rapid acquisition of procedural or teamwork skills. This method, which applies concepts of overlearning and automatization to create muscle memory for skill mastery, utilizes more directive feedback and prioritizes opportunities for learners to repeatedly practice skills with *coaching* over lengthy debriefings [55]. This model could be integrated into SBE in LRS when mastery of a skill is a critical learning objective and language differences preclude complex or lengthy debriefings.

Essentially, SBE and debriefing methods that combine opportunities for repetitive practice with reflection and facilitated discussion would be useful when functioning in LRS in order to draw on student's professional experiences and enhance their motivation to assimilate new concepts.

Local Support Considerations

Partnerships with in-country practitioners or stakeholders, ministries of health (MOH), and nongovernmental organizations (NGOs) can help to overcome barriers of competing priorities and potential diversion of resources in LRS. While this is not always an easy task, some groups have found success by partnering with local medical schools, academic institutions, and universities in LRS to establish, develop, and nurture relationships with MOH and ministries of education, but this is of course quite variable from country to country. Some programs such as HBB maintain online lists of country-by-country partnering organizations and academic affiliates working toward program implementation in various LRS. Opportunities for collaborative and cross-disciplinary international projects should be considered in order to promote widespread dissemination of programs and educational interventions. Collaboration with MOH to establish SBE programs is an essential component of program advocacy and realistic potential for widespread acceptance, adoption, and dissemination. When considering implementation and teaching of algorithms in pediatric resuscitation and pediatric acute care, it is critical to ensure that what is taught is consistent with local MOH protocols. These protocols may differ in LRS from traditional algorithms taught in PALS courses due to the types of diseases and comorbidities seen in LRS, such as malnutrition or dengue shock as considerations in fluid resuscitation.

Models for program delivery and dissemination should consider train the trainer paradigms that can also encourage program sustainability and local stakeholder investment. Any individual, team, or organization that endeavors to undertake simulation in LRS should be willing to invest in system strengthening and capacity building within that setting. A plan to demonstrate and measure both short- and long-term impacts is key to obtaining or sustaining funding for educational projects in these settings. The establishment of attainable and realistic educational goals and rigorous research methodology to measure impact are the basis for effecting change. Achievement of pragmatic goals will require interprofessional input from local healthcare providers as partners to incorporate diversity of perspectives and experience.

Program Scalability and Sustainability

It is often the case with pilot education projects that it is initially easier to plan an educational conference or training session outside of the clinical environment. This allows for assurance of quality as well as the ability to teach large numbers of learners rapidly while utilizing the simplest logistics for the intervention. Additionally, the ability to teach at scale allows lowering of direct price per student from the supporting agency. However, these methods often have unanticipated indirect costs on an already limited system. Conference-style educational interventions can require large numbers of personnel to be away from clinical duties, and often there is not enough personnel resource redundancy, leading to significant decrements in clinical staffing during the training. Additionally, large conferences lead to more general and less practical training—leading to a *one size fits none* program. Finally, large group education tends to move toward unidirectional, didactic training and decreases the efficiency of educational transfer associated with SBE. In considering solutions to these potential barriers, it is important in LRS to consider instructor to learner ratios in order to maintain small group learning methodologies that are essential to successful SBE.

Telesimulation and m-Health Technologies

A technological innovation that has advanced the field of international simulation in LRS is the phenomenon of telesimulation. This combines the principles of simulation with remote Internet access to teach procedural skills, conduct simulated resuscitation sessions, or teach other concepts remotely to target learners in LRS. This technology has been used successfully in the field of surgery to teach laparoscopic skills as well as the procedure of IO needle insertion [22, 56]. The utility of telesimulation was also used to conduct pediatric resuscitation training and debriefing sessions between consult and remote hospitals, with a trend toward improved-quality cardiopulmonary resuscitation (CPR) endpoints by practitioners in remote hospitals [57]. Telesimulation may be a way to overcome lack of specialty expertise within LRS, with remote teaching and/or local faculty development by facilitators in developed nations.

Mobile phone messaging applications, such as short message service (SMS) and multimedia message service (MMS), may offer a way to support data collection and reporting in the field of simulation education in LRS. M-Health is the provision of health-related services using mobile communication technology. Many modern information and communication technologies are not yet widely available in LRS. However, the mobile phone is a notable exception that has reached even remote ares in many low- and middle-income countries. M-Health tools have been successfully used as data collection devices, assessment tools, and real-time surveillance techniques and platforms for delivering sustainable interventions [58]. Several investigators have reported on the use of mobile phones to collect data on pregnancy outcomes, PPH rates, and other health outcomes in remote areas of Ghana and Liberia [59–61]. There is great potential for the use of this type of technology to remotely assess both skill retention and actual clinical outcomes after simulation-based training in these settings.

Implementation of Mannequin and Task Trainer Simulation in Limited-Resource Settings

Technology Versus Fidelity and Their Roles in Creating Sustainability in Limited-Resource Settings

The concepts of fidelity and transfer of learning are salient in the developing world when considering sustainability and scalability of a simulation program in LRS. It is often assumed that *high-technology* mannequins or equipments translate to *high-fidelity* environments and transfer of learning to clinical settings. However, this is not always the case, nor is it feasible and sustainable in many LRS, where limitations can range from lack of trained human resources to frequent loss of a consistent electrical power source. The example below of the HBB program demonstrates a large-scale and widespread simulation program initiative in the developing world that utilizes low- to medium-fidelity equipment to create a sustainable educational framework [62].

Mannequin Design Considerations for Limited-Resource Settings

Any health technology or simulator that is developed specifically for LRS must conform to certain considerations that are often unique to these environments. These include:

1. Harsh environmental conditions including temperature extremes, humidity, and dust.
2. Supply chain: Distribution and repair of simulators can be challenging in LRS. Industry support for higher technology simulators in many countries is usually lacking. Therefore, mannequins that require disposables, replacement parts, or frequent servicing are less likely to remain operational.
3. Lack of operator training: Mannequins in LRS generally need to be simple enough that community-level providers with limited training can safely and effectively use them to disseminate teaching programs. Therefore, their design must be relatively simplistic and user-friendly.
4. Cost: Per capita healthcare expenditures in LRS are a small fraction of what they are in the developed world, which results in enormous cost pressures on healthcare products for LRS. Simulation technologies are often unaffordable for both governments and individuals in LRS. This will inevitably result in a lack of supply of healthcare technologies by established manufacturers to LRS markets.
5. Need for quality: Simulation technology for LRS markets need to be of at least as high quality and reliability as those for developed countries to be setting appropriate and achieve impact. A simulator that fails in the developed world can usually be readily replaced or fixed, but that may not be possible in LRS, as discussed above.
6. Paucity of country-specific evidence: Most simulation technology and devices are designed and developed for populations in high-resource countries that typically constitute the primary and most lucrative markets for these products. The vast majority of simulation task trainers have not been evaluated in LRS. This leaves LRS populations vulnerable to suboptimal devices for their educational needs.

MamaNatalie® Birthing Simulator

MamaNatalie® is a simulation device, worn by an SP or facilitator that can simulate PPH, high-risk deliveries, and a wide range of other obstetric complications (see Fig. 25.5a, b).

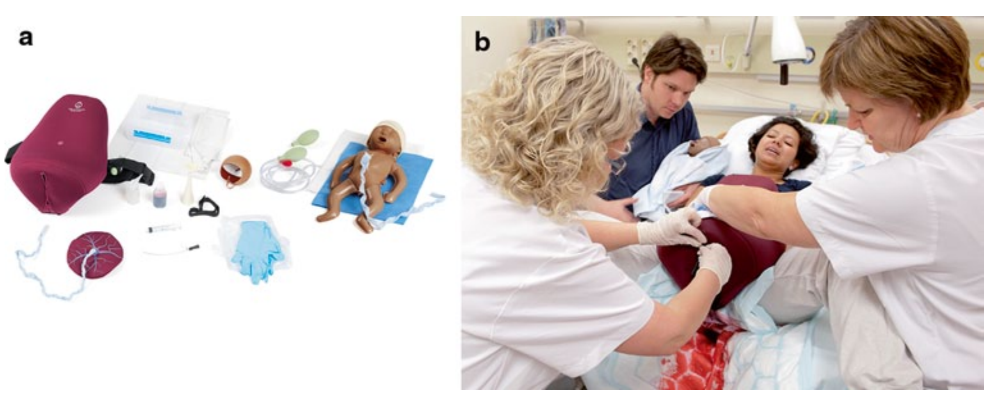

Fig. 25.5 **a** MamaNatalie® Birthing Simulator and **b** its use in situ: This simulator is strapped on to the operator who takes the role of the mother and manually controls the training scenario. The simulator has the following features: bleeding to simulate postpartum hemorrhage, positioning and delivery of the baby, delivery of the placenta, fetal heart sounds, cervix landmark, urinary bladder catheterization, uterine massage, and uterine compression. (Photos used with permission from Laerdal Medical)

Fig. 25.6 **a** NeoNatalie® Newborn Simulator for neonatal resuscitation and its use in situ in Senegal: An inflatable, portable simulator designed to teach basic neonatal resuscitation skills. The simulator has a natural weight when filled with water and includes features such as spontaneous breathing, palpable umbilical pulse, and crying. It can be used for role-play scenarios such as normal post-birth care, standard resuscitation, positive pressure ventilation, and chest compressions. Training materials have been translated into multiple languages for use in LRS around the world, as can be seen in **b**. (Photos used with permission of Laerdal Medical)

The mannequin was designed to be used in collaboration with NeoNatalie® for training of TBAs and midwives in LRS, who may need to manage care of both mother and infant after delivery. The use of this simulator is being increasingly implemented in LRS where emergency obstetric care may be limited to community health workers and TBAs as part of the Helping Mothers Survive: Bleeding After Birth (HMS:BAB) program. This SBE program is aimed at reducing PPH, the leading cause of maternal mortality worldwide and another target of the WHO MDGs [63, 64].

NeoNatalie® Newborn Simulator

NeoNatalie® is a low-technology inflatable neonatal simulator designed to teach basic neonatal resuscitation skills (see Fig. 25.6a and b). The simulator's features include crying, spontaneous breathing, chest wall movement with bag-mask ventilation, and umbilical cord pulsation. It was purpose-built for the HBB program and has been used in LRS for dissemination of the HBB curriculum described below.

Examples of Program Implementation in Limited-Resource Settings Using Mannequin Simulation

Helping Babies Breathe Program

HBB is an initiative of the American Academy of Pediatrics in collaboration with other partners, developed with curricular input from WHO. It is a neonatal resuscitation curriculum using SBE for resource-limited circumstances [62]. Prior curricular programs in Essential Newborn Care (ENC) and Neonatal Resuscitation Programs (NRP) with birth attendants in rural communities demonstrated mixed outcomes [65–67]. Data from observational studies have shown that community health workers can perform basic resuscitation skills that have the potential to substantially reduce intrapartum-related neonatal deaths, but that a major gap existed in terms of strategies to address home births and births in rural and LRS facilities far from referral institutions [68]. The HBB program was developed to address these gaps.

The program was piloted in Kenya and Pakistan, where assessment of participant knowledge and skills pre-/post-program demonstrated significant gains. Bag-valve-mask ventilation was identified as a skill that required more active practice and mentoring in order to be mastered by some participants [69]. The program has subsequently been implemented in several LRS countries, and studies of its efficacy in these settings are ongoing. In India, a train the trainer cascade model was used to train almost 600 birth attendants from rural primary health centers and district and urban hospitals. Investigators examined over 4000 births before and after implementation of training and were able to demonstrate a significant reduction in stillbirths in the area where training had been integrated. However, neonatal mortality rates overall remained unchanged [70].

The HBB strategy was used to train master instructors in Tanzania, who subsequently delivered the program to regional instructors, who in turn trained health providers in smaller facilities. Within the 2 years after intervention, there was a 24 % reduction in the rate of stillbirths and a 47 % reduction in early neonatal mortality, defined as death within the first 24 h. This program focused on grassroots birth attendants practicing in rural facilities rather than on hospital-based physicians [71]. HBB program implementation has also been formally studied in Ethiopia, Rwanda, and Nepal with promising preliminary results toward the objective of addressing MDG #4 to reduce child mortality [72–74]. The preliminary successes of this type of program demonstrate the feasibility of an evidence-based curriculum utilizing SBE in LRS.

Saving Children's Lives Program

Saving Children's Lives (SCL) is an initiative of the AHA in collaboration with the Children's Hospital of Philadelphia that aims to reduce under-five mortality rates (UFMR) through a contextualized resuscitation training program utilizing SBE. It is designed to increase healthcare provider competence to treat pneumonia and diarrhea, improve system-level reporting of resource availability, and increase reporting of quality of provider performance. Begun in late 2013, this program has been piloted in Tanzania and Botswana, with early data showing significant improvement in provider confidence and knowledge of correct management of acute pneumonia and diarrhea [75]. The SCL program is also being piloted in Gujarat, India, to train community health workers to coordinate with local emergency response systems to identify and treat children in the community with pneumonia and diarrhea early in their disease course.

Operation Smile—Simulation-Based Education in Perioperative Pediatric Training

SBE has a role in mission-based healthcare delivery as well. Operation Smile, an NGO focused on cleft lip and palate repair, has endeavored to develop increased local capacity in LRS countries where clefts are epidemiologically common. In collaboration with SBE experts, an educational perioperative pediatrician (POP) training program was developed for Operation Smile pediatric volunteers from LRS countries. Based on the AHA PALS course, POP was tailored to the clinical situations commonly presenting during perioperative emergencies in LRS. The program was implemented with clinicians from different cultures and linguistic backgrounds, being piloted with students from nine different countries [76]. High-fidelity simulators and real-time language interpretation were used to enhance active learning. During the 2-day course, over 50 % of the time was spent in hands-on simulation training. The SP scenarios developed for the POP course are also commonly used as preparatory mock codes during missions, which are implemented with the clinical care team prior to the first surgical case during mission-based surgery. These contextualized simulated emergency scenarios serve as a mechanism to enable ad hoc mission teams to discuss threats to patient safety, reinforce emergency protocols, and allocate team roles during emergency situations arising during the surgical missions.

Emergency Triage Assessment and Treatment

Emergency Triage Assessment and Treatment (ETAT) is a three and a half-day course designed by the WHO based on the UK Advanced Pediatric Life Support Training and tailored to LRS. Its simulated scenarios are designed to teach health workers with limited clinical background to triage sick children as well as initiate treatments for airway and breathing, circulation, and neurologic emergencies in children under 5 years of age. Although simulation mannequins are not mandatory, the course utilizes existing resources and equipment to train participants, which increases the relevance to the participants' work environments [77, 78].

Examples of Simulation-Based Education Programs Using Task Trainer Simulation

There are a multitude of studies on CPR training in LRS, but few of these examine comparative SBE teaching modalities with feedback [79, 80]. One study that did so examined whether task trainer CPR mannequins with feedback and lower instructor to student ratios could train learners as well as traditional instructor-led CPR [81]. Baseline performance data were collected on healthcare providers in Botswana using CPR task training mannequins and then prospectively randomized participants to three training groups: instructor-led, limited instructor with mannequin feedback, or self-directed learning. Subsequently, serial examinations on performance were measured after training up until 6 months post training. Excellent CPR skill acquisition was significant and was retained to 3 and 6 months. Novel training with mannequin feedback was not inferior to traditional instructor training [81]. This is encouraging data to support the use of simple task training mannequins with feedback in LRS. The use of feedback mannequins may be more reliable and equally cost-effective to developing and maintaining a large training infrastructure in LRS.

Use of Simulated or Standardized Patients and Hybrid Simulation in Limited-Resource Settings

Simulated or Standardized Patients (SPs) have been used in LRS for both instruction and assessment [82–84]. In LRS that may be remote from tertiary care facilities and therefore may not have access to specialty care patients, SPs can supplement the learner experience by providing a standardized presentation of specific disease processes for both formative and summative learning. SPs also provide psychological safety within the learning environment for novice learners, particularly in the practice of sensitive examinations, such as pelvic breast or rectal examinations, which may be even more critical in certain sociocultural and religious contexts. In some conservative societies, female patients may refuse certain providers and not be willing to allow students to examine them.

Researchers in Myanmar used SPs playing the role of a patient's mother to assess ability of providers to diagnose and treat pediatric malaria [83]. Another development in SP simulation has been in the use of online *virtual patients* for

Fig. 25.7 Hybrid simulation for sensitive examinations: The photos (**a, b**) depict combined use of partial task trainers (pelvic exam trainer and rectal exam trainer) in conjunction with a standardized patient to assess both clinical examination skills and patient communication skills. In a multicultural or conservative society, it can be difficult to recruit standardized patients willing to allow novices to perform sensitive examinations such as breast, pelvic, or rectal exams. Hybrid simulation provides a way to circumvent these issues while maintaining a standardized educational experience for novice learners. (Photos used with permission of Perdana University Clinical Skills Unit, Kuala Lumpur, Malaysia)

technological skills instruction and capacity building for healthcare educators in Malawi [85]. These *virtual patients* are designed by teams of healthcare professionals to be contextualized for in-country medical education.

SPs provide a degree of fidelity which is not possible when using mannequins alone. However, partial task trainers and mannequins provide students with the ability to practice invasive procedures such as venous cannulation, urinary catheterization, and sensitive examinations to which SPs may not wish to be subjected. When a partial task trainer (such as a pelvic exam model or rectal model) and an SP are combined, as in the case of a *hybrid* simulation, students are able to participate in a realistic human interaction and practice communication skills while performing basic clinical skills (see Fig. 25.7a and b). Hybrid simulation has also been used in medical and nursing school curricula in the Middle East, where gender and religious preference often limit student exposure to opposite-sex, gender-specific examinations [84]. Investigators have been able to demonstrate improved student confidence in sexual history taking and breast/pelvic examination skills after participation in hybrid simulations designed to teach these skills.

The Future of Simulation-Based Education in Limited-Resource Settings

With the ongoing globalization of medical education, LRS are the next frontier in SBE. If the medical community at large is able to address many of the MDGs, it must be with a platform in mind for global educational reform as a priority to accomplish these goals. Simulation can and should play a major role in this platform. It will be crucial to anticipate and address in advance the many challenges that will be inherent in this. The importance of program dissemination, sustainability, and local buy-in cannot be understated. The creation of sustainability can be a difficult process, but involving interprofessional local in-country partners is a critical and key component in the process in order to obtain diversity of perspectives and ensure pragmatic applicability of programs. Other challenges will include competing priorities and potential diversion of resources by MOH, Ministries of Education, and other governmental agencies that often govern these types of programs in LRS countries.

Educators must also consider the global epidemiology of disease burden and ensure that SBE programs address this epidemiology in a country-specific or region-specific manner. Essential to this process is the creation of learning objectives and program goals that align with local needs and protocols in order to address pertinent medical issues that are relevant to a particular country or area. Within the field of pediatrics, many platforms for SBE in LRS have already begun, but further demonstration of both short- and long-term impacts of these programs will be the key to sustain funding and interest. As mentioned above, organizations that undertake simulation in LRS must be willing to invest in system strengthening and capacity building in the settings where they establish these programs. It is now incumbent upon the medical education community to ensure that these programs achieve success through the use of rigorous research methodologies, with the ultimate goal being improvement in current and future health care for children on a global scale.

References

1. Syed SB, Dadwal V, Rutter P, Storr J, Hightower JD, Gooden R, et al. Developed-developing country partnerships: benefits to developed countries? Global Health. 2012;8:17.

2. United Nations Millenium Development Goals. United Nations. [cited 2013 July 10]. http://www.un.org/millenniumgoals/.
3. Luten R, Wears R, Broselow J, Croskerry P, Joseph M, Frush K. Managing the unique size-related issues of pediatric resuscitation: reducing cognitive load with resuscitation aids. Acad Emerg Med. 2002;9(2):840–7.
4. Bishop S. Evaluating teams in extreme environments: from issues to answers. Aviat Space Environ Med. 2004;75(7):C14.
5. Shilkofski N, Jung J, Rice J, Crichlow A. Needs assessment for pediatric and neonatal resuscitation program dissemination in low-resource countries. Pediatr Crit Care Med. 2014;15(4):12.
6. Nolan T, Angos P, Cunha AJ, Muhe L, Qazi S, Simoes EA, et al. Quality of hospital care for seriously ill children in less-developed countries. Lancet. 2001;357(9250):106–10.
7. English M, Esamai F, Wasunna A, Were F, Ogutu B, Wamae A, et al. Assessment of inpatient paediatric care in first referral level hospitals in 13 districts in Kenya. Lancet. 2004;363(9425):1948–53.
8. Kandasami P, Inbasegaran K, Lim WL. Perioperative death in Malaysia: the transition phase from a developing nation to a developed one. Med J Malaysia. 2003;58(3):413–9.
9. Jat AA, Khan MR, Zafar H, Raja AJ, Hoda Q, Rehmani R, et al. Asian J Surg. 2004 Jan;27(1):58–64.
10. Khan AN, Rubin DH. International pediatric emergency care: establishment of a new specialty in a developing country. Pediatr Emerg Care. 2003;19(3):181–4.
11. Kapadia FN. Code 99-an international perspective. Chest. 1999;115(5):1483.
12. Meaney PA, Topjian AA, Chandler HK, Botha M, Soar J, Berg RA, et al. Resuscitation training in developing countries: a systematic review. Resuscitation. 2010;81(11):1462–72.
13. Arreola-Risa C, Vargas J, Contreras I, Mock C. Effect of emergency medical technician certification for all prehospital personnel in a Latin American city. J Trauma. 2007;63:914–9.
14. Ali J, Adam RU, Gana TJ, Williams JI. Trauma patient outcome after the pre-hospital trauma life support program. J Trauma. 1997;42:1018–21.
15. Husum H, Gilbert M, Wisborg T, Van Heng Y, Murad M. Rural pre-hospital trauma systems improve trauma outcome in low-income countries: a prospective study from North Iraq and Cambodia. J Trauma. 2003;54:1188–96.
16. Ali J, Adam R, Butler AK, et al. Trauma outcome improves following the advanced trauma life support program in a developing country. J Trauma. 1993;34:890–8.
17. Deorari AK, Paul VK, Singh M, Vidyasagar D, Medical Colleges Network. Impact of education and training on neonatal resuscitation practices in 14 teaching hospitals in India. Ann Trop Paediatr. 2001;21:29–33.
18. Kumar R. Training traditional birth attendants for resuscitation of newborns. Trop Doct. 1995;25:29–30.
19. Zhu XY, Fang HQ, Zeng SP, Li YM, Lin HL, Shi SZ. The impact of the neonatal resuscitation program guidelines (NRPG) on the neonatal mortality in a hospital in Zhuhai, China. Singapore Med J. 1997;38:485–7.
20. Chomba E, McClure EM, Wright LI, Carlo WA, Chakraborty H, Harris H. Effect of WHO newborn care training on neonatal mortality by education. Ambul Pediatr. 2008;8:300–4.
21. Arreola-Risa C, Mock C, Herrera-Escamilla AJ, Contreras I, Vargas J. Cost-effectiveness and benefit of alternatives to improve training for prehospital trauma care in Mexico. Prehospital Disaster Med. 2004;19:318–25.
22. Moretti MA, Cesar LA, Nusbacher A, Kern KB, Timerman S, Ramires JA. Advanced cardiac life support training and long-term survival from in-hospital cardiac arrest. Resuscitation. 2007;72:458–65.
23. Carcillo JA, Kuch BA, Han YY, Day S, Greenwald BM, McCloskey KA, et al. Mortality and functional morbidity after use of PALS/APLS by community physicians. Pediatrics. 2009;124(2):500–8.
24. Rivers EP, Ahrens T. Improving outcomes for severe sepsis and septic shock: tools for early identification of at-risk patients and treatment protocol implementation. Critical Care Clinics. 2008;24(3 Suppl):S1–47.
25. Carcillo JA, Davis AL, Zaritsky A. Role of early fluid resuscitation in pediatric septic shock. JAMA. 1991;266(9):1242–5.
26. Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, et al. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatrics. 2003;112(4):793–9.
27. Ngo NT, Cao XT, Kneen R, Wills B, Nguyen VM, Nguyen TQ, et al. Acute management of dengue shock syndrome: a randomized double-blind comparison of 4 intravenous fluid regimens in the first hour. Clin Infect Dis. 2001;32(2):204–13.
28. Oliveira CF, Nogueira de Sa FR, Oliveira DS, Gottschald AF, Moura JD, Shibata AR, et al. Time- and fluid-sensitive resuscitation for hemodynamic support of children in septic shock: barriers to the implementation of the American College of Critical Care Medicine/Pediatric Advanced Life Support Guidelines in a pediatric intensive care unit in a developing world. Pediatr Emerg Care. 2008;24(12):810–5.
29. Mutabdzic D, Bedada AG, Bakanisi B, Motsumi J, Azzie G. Designing a contextually appropriate surgical training program in low-resource settings: the Botswana experience. World J Surg. 2013;37(7):1486–91.
30. Moldovanu R, Tarcoveanu E, Lupascu C, Dimofte G, Filip V, Vlad N, et al. Training on a virtual reality simulator–is it really possible a correct evaluation of the surgeons' experience? Rev Med Chir Soc Med Nat Iasi. 2009;113(3):780–7.
31. Okrainec A, Smith L, Azzie G. Surgical simulation in Africa: the feasibility and impact of a 3-day fundamentals of laparoscopic surgery course. Surg Endosc. 2009;23(11):2493–8.
32. Okrainec A, Henao O, Azzie G. Telesimulation: an effective method for teaching the fundamentals of laparoscopic surgery in resource-restricted countries. Surg Endosc. 2010;24(2):417–22.
33. Dorman K, Satterthwaite L, Howard A, Woodrow S, Derhew M, Reznick R, et al. Addressing the severe shortage of health care providers in ethiopia: bench model teaching of technical skills. Med Educ. 2009;43(7):621–7.
34. Kiely DJ, Stephanson K, Ross S. Assessing image quality of low-cost laparoscopic box trainers: options for residents training at home. Simul Healthc. 2011;6(5):292–8.
35. Kigozi G, Nkale J, Wawer M, Anyokorit M, Watya S, Nalugoda F, et al. Designing and usage of a low-cost penile model for male medical circumcision skills training in Rakai, Uganda. Urology. 2011;77(6):1495–7.
36. Waikakul S, Vanadurongwan B, Chumtup W, Assawamongkolgul A, Chotivichit A, Rojanawanich V. A knee model for arthrocentesis simulation. J Med Assoc Thai. 2003;86(3):282–7.
37. Kalechstein S, Permual A, Cameron BM, Pemberton J, Hollaar G, Duffy D, et al. Evaluation of a new pediatric intraosseous needle insertion device for low-resource settings. J Pediatr Surg. 2012;47(5):974–9.
38. Perosky J, Richter R, Rybak O, Gans-Larty F, Mensah MA, Danguah A, et al. A low-cost simulator for learning to manage postpartum hemorrhage in rural Africa. Simul Healthc. 2011;6(1):42–7.
39. Cohen S, Cragin L, Rizk M, Hanbeg A, Walker D. PartoPants: the high-fidelity, low-tech birth simulator. Clin Simul Nurs. 2010;7(1):e11–18.
40. Walker D, Cohen S, Estrada F, Monterroso M, Jenny A, Fritz J, et al. PRONTO training for obstetric and neonatal emergencies in Mexico. Int J Gynecol Obstet. 2012;116(2):128–33.

41. Yamazaki Y. Learning styles and typologies of cultural differences: a theoretical and empirical comparison. Int J Intercult Relat. 2005;29(5):521–48.
42. Joy S, Kolb D. Are there cultural differences in learning style? Int J Intercult Relat. 2009;33(5):69–85.
43. Shilkofski NA, Hunt EA. Identification of barriers to pediatric care in limited-resource settings: A simulation study. Pediatrics. 2015; doi: 10.1542/peds.2015–2677.
44. Hunt EA, Shilkofski NA, Nelson K, Stavroudis L. Simulation: translation to improved team performance. Anesthesiol Clin North America. 2007;25(2):301–19.
45. Fahey JO, Cohen SR, Holme F, Buttrick ES, Dettinger JC, Kestler E, et al. Promoting cultural humility during labor and birth: putting theory into action during PRONTO obstetric and neonatal emergency training. J Perinat Neonatal Nurs. 2013;27(1):36–42.
46. Bediang G, Bagayoko CO, Raetzo MA, Geissbuhler A. Relevance and usability of a computerized patient simulator for continuous medical education of isolated care professionals in sub-saharan Africa. Stud Health Technol Inform. 2011;169:666–70.
47. Muntean V, Calinici T, Tigan S, Fors UG. Language, culture and international exchange of virtual patients. BMC Med Educ. 2013;13:21.
48. Chung HS, Dieckmann P, Issenberg SB. It is time to consider cultural differences in debriefing. Simul Healthc. 2013;8(3):166–70.
49. Rudolph JW, Simon R, Rivard P, Dufresne RL, Raemer DB. Debriefing with good judgment: combining rigorous feedback with genuine inquiry. Anesthesiol Clin. 2007;25(2):361–76.
50. Rudolph JW, Simon R, Dufresne RL, Raemer DB. There's no such thing as "nonjudgmental" debriefing: a theory and method for debriefing with good judgment. Simul Healthc. 2006;1(1):49–55.
51. Phrampus PE. Clinical bedside teaching can benefit from "Simulation Style Debriefing". Pittsburgh: Paul E. Phrampus- Patient safety, quality, simulation and education expertise. 2014 August- [cited 2014 Dec 9]. http;//phrampus.com/Blog.html.
52. Phrampus PE, O'Donnell JM. Debriefing using a structured and supported approach. In: Levine AI, DeMaria S, Schwartz AD, Sim AJ, editors. The comprehensive textbook of healthcare simulation. New York: Springer; 2013. pp. 73–84.
53. Cheng A, Rodgers DL, van der Jagt E, Eppich W, O'Donnell J. Evolution of the Pediatric Advanced Life Support course: enhanced learning with a new debriefing tool and Web-based module for Pediatric Advanced Life Support instructors. Pediatr Crit Care Med. 2012;13:589–95.
54. Cheng A, Hunt E, Donoghue A, et al.; for the EXPRESS pediatric Simulation Collaborative. EXPRESS- Examining Pediatric Resuscitation Education using Simulation and Scripting: the birth of an international pediatric simulation research collaborative- From concept to reality. Simul Healthc. 2011;6:34–41.
55. Hunt EA, Duval-Arnould JM, Nelson-McMillan KL, Bradshaw JH, Perretta JS, Shilkofski NA. Pediatric resident resuscitation skills improve after "Rapid Cycle Deliberate Practice" training. Resuscitation. 2014;85(7):945–51.
56. Mikrogianakis A, Kam A, Silver S, Bakanisi B, Henao O, Okrainec A, et al. Telesimulation: an innovative and effective tool for teaching novel intraosseous insertion techniques in developing countries. Acad Emerg Med. 2011;18(4):420–7.
57. Yang C, Hunt E, Shilkofski N, Dudas R, Schwartz J. Can telemedicine improve adherence to resuscitation guidelines for critically ill children at community hospitals: a randomized controlled trial using high fidelity simulation. Crit Care Med. 2012;40(12):1–328.
58. Krishna S, Boren SA, Balas EA. Healthcare via cell phones: a systematic review. Telemed J E Health. 2009;15(3):231–40.
59. Andreatta P, Debpuur D, Danquah A, Perosky J. Using cell phones to collect postpartum hemorrhage outcome data in rural Ghana. Int J Gynaecol Obstet. 2011;113(2):148–51.
60. Lori JR, Munro ML, Boyd CJ, Andreatta P. Cell phones to collect pregnancy data from remote areas in Liberia. J Nurs Scholarsh. 2012;44(3):294–301.
61. Munro ML, Lori JR, Boyd CJ, Andreatta P. Knowledge and skill retention of a mobile phone data collection protocol in rural Liberia. J Midwifery Womens Health. 2014;59(2):176–83.
62. Helping Babies Breathe Curriculum. The golden hour. 2013. http://www.helpingbabiesbreathe.org.
63. Nelissen E, Ersdal H, Ostergaard D, Mduma E, Broerse J, Evjen-Olsen B, et al. Helping mothers survive bleeding after birth: an evaluation of simulation-based training in a low-resource setting. Acta Obstet Gynecol Scand. 2014;93(3):287–95.
64. Evans CL, Johnson P, Bazant E, Bhatnagar N, Zgambo J, Khamis AR. Competency-based training "Helping Mothers Survive: Bleeding after Birth" for providers from central and remote facilities in three countries. Int J Gynaecol Obstet. 2014;126(3):286–90.
65. Carlo WA, McClure EM, Chomba E, Chakraborty H, Hartwell T, Harris H, et al. Newborn care training of midwives and neonatal and perinatal mortality rates in a developing country. Pediatrics. 2010;126(5):e1064–71.
66. Carlo WA, Goudar SS, Jehan I, Chomba E, Tshefu A, Garces A, Parida S, Althabe F, McClure EM, Derman RJ, Goldenberg RL, Bose C, Hambidge M, Panigrahi P, Buekens P, Chakraborty H, Hartwell TD, Moore J, Wright LL; First Breath Study Group. High mortality rates for very low birth weight infants in developing countries despite training. Pediatrics. 2010;126(5):e1072–80.
67. Bhutta ZA, Soofi S, Cousens S, Mohammad S, Memon ZA, Ali I, et al. Improvement of perinatal and newborn care in rural Pakistan through community-based strategies: a cluster-randomised effectiveness trial. Lancet. 2011;377(9763):403–12.
68. Wall SN, Lee AC, Niermeyer S, English M, Keenan WJ, Carlo W, et al. Neonatal resuscitation in low-resource settings: what, who, and how to overcome challenges to scale up? Int J Gynaecol Obstet. 2009;107:S47–S64.
69. Singhal N, Lockyer J, Fidler H, Keenan W, Little G, Bucher S, et al. Helping babies breathe: global neonatal resuscitation program development and formative educational evaluation. Resuscitation. 2012;83(1):90–6.
70. Goudar SS, Somannavar MS, Clark R, Lockyer JM, Revankar AP, Fidler HM, et al. Stillbirth and newborn mortality in India after helping babies breathe training. Pediatrics. 2013;131(2):e344–52.
71. Msemo G, Massawe A, Mmbando D, Rusibamayila N, Manji K, Kidanto HL, et al. Newborn mortality and fresh stillbirth rates in Tanzania after helping babies breathe training. Pediatrics. 2013;131(2):e353–60.
72. Hoban R, Bucher S, Neuman I, Chen M, Tesfaye N, Spector JM. 'Helping Babies Breathe' training in Sub-Saharan Africa: educational impact and learner impressions. J Trop Pediatr. 2013;59(3):180–6.
73. Musafili A, Essén B, Baribwira C, Rukundo A, Persson LÅ. Evaluating helping babies breathe: training for healthcare workers at hospitals in Rwanda. Acta Paediatr. 2013;102(1):e34–8.
74. Ashish KC, Målqvist M, Wrammert J, Verma S, Aryal DR, Clark R, et al. Implementing a simplified neonatal resuscitation protocol-helping babies breathe at birth (HBB)—at a tertiary level hospital in Nepal for an increased perinatal survival. BMC Pediatr. 2012;12:159.
75. Wright SW, Mazhani L, Ralston M, Steenhoff AP, Nadkarni VM, Meaney PA, et al. Impact of contextualized pediatric critical care training on pediatric healthcare providers in Botswana. Pediatr Crit Care Med. 2014;15(4):194. doi:10.1097/01.pcc.0000449598.26350.c9.
76. Kilbaugh T, Borasino S, Hales R, Nishisaki A, Nadkarni VM, Meaney PA. A multicultural experience with high fidelity simulation. Proceedings of the 17th Pediatric Critical Care Colloquium, February 20–22; British Columbia, Canada; 2008.

77. Gove S, Tamburlini G, Molyneux E, Whitesell P. Campbell; WHO Integrated Management of Childhood Illness (IMCI) Referral Care Project. Development and technical basis of simplified guidelines for emergency triage assessment and treatment in developing countries. Arch Dis Child. 1999;81:473–7.
78. Tamburlini G, Mario S D, Maggi RS, Vilarim JN, Gove S. Evaluation of guidelines for emergency triage assessment and treatment in developing countries. Arch Dis Child. 1999;81:478–82.
79. Urbano J, Matamoros MM, López-Herce J, Carrillo AP, Ordóñez F, Moral R, et al. A paediatric cardiopulmonary resuscitation training project in Honduras. Resuscitation. 2010;81(4):472–6.
80. Young S, Hutchinson A, Nguyen VT, Le TH, Nguyen DV, Vo TK. Teaching paediatric resuscitation skills in a developing country: introduction of the Advanced Paediatric Life Support course into Vietnam. Emerg Med Australas. 2008;20(3):271–5.
81. Meaney PA, Sutton RM, Tsima B, Steenhoff AP, Shilkofski N, Boulet JR, et al. Training hospital providers in basic CPR skills in Botswana: acquisition, retention and impact of novel training techniques. Resuscitation. 2012;83(12):1484–90.
82. Shirazi M, Sadeghi M, Emami A, Kashani AS, Parikh S, Alaeddini F, et al. Training and validation of standardized patients for unannounced assessment of physicians' management of depression. Acad Psychiatry. 2011;35(6):382–7.
83. Aung T, Montagu D, Schlein K, Khine TM, McFarland W. Validation of a new method for testing provider clinical quality in rural settings in low- and middle-income countries: the observed simulated patient. PLoS One. 2012;7(1):e30196.
84. Sole K, Sawan L. Fostering student clinical skills confidence using obstetric and gynecology hybrid simulation. Presented at: 15th Ottawa Conference: Assessment of Competence in Medicine and Healthcare Professions, March 10; Kuala Lumpur, Malaysia; 2012.
85. Dewhurst D, Borgstein E, Grant ME, Begg M. Online virtual patients—a driver for change in medical and healthcare professional education in developing countries? Med Teach. 2009;31(8):721–4.
86. PRONTO (Programa de Rescate Obstetrico y Neonatal: Tratamiento Optimo y Oportuno) International Curriculum. 2014. http://prontointernational.org.