Pediatric Resuscitation Education in Low-Middle-Income Countries: Effective Strategies for Successful Program Development

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Abstract

Keywords

- education
- resuscitation
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- simulation

Despite established international guidelines, there is considerable variability in the quality of resuscitative care received by critically ill children in low-middle-income countries. While this problem is certainly multifactorial, education of health care workers is an important determinant of care quality. This article will discuss approaches to health care worker education in pediatric resuscitation in low-middle-income countries, with emphasis on aspects of educational programs that may contribute to positive educational and clinical outcomes.

Introduction

Worldwide, 6.3 million children under 5 died in 2013, many from conditions like pneumonia, diarrhea, sepsis, and neonatal asphyxia,¹ all of which are often reversible with appropriate resuscitation. Through the Integrated Management of Childhood Illness (IMCI) initiative, the World Health Organization (WHO) has defined management guidelines for all common life-threatening pediatric diseases.² Despite studies in low-middle-income countries (LMICs) demonstrating feasibility of these strategies, adherence to IMCI guidelines by health care workers is highly variable and often suboptimal. In a study of community health workers in Kenya, for example, only 35 to 58% of severely ill children were treated according to IMCI guidelines.³ Another study in Benin found that clinic workers provided appropriate assessment for only a small minority of patients and that quality of management varied substantially by diagnosis.⁴

While this problem is certainly multifactorial, education of health care workers is an important determinant of care quality. A meta-analysis examined the impact of IMCI training on health care worker performance, demonstrating that compared with providers without training, IMCI-trained providers

were twice as likely to adequately assess patients, and three times as likely to prescribe correct treatment.⁵ This finding underscores the importance of education for improving the quality of care provided to children in LMICs. However, it should be noted that this study found variable performance even among IMCI-trained providers, with correct diagnosis and treatment ranging from 33 to 94%. This variability demonstrates that some IMCI training programs were more effective than others, and suggests that use of optimal educational methods could potentially yield superior outcomes.

A systematic review of the literature on resuscitation training programs in LMICs revealed that participants almost universally enjoy and value these programs, but educational and clinical outcomes are mixed.⁶ The authors note that the literature to date is limited by inconsistency in the rigor with which training environments and trainees are described, and in the manner in which outcomes are measured and reported. This inconsistency makes it impossible to determine if findings from one study are applicable in another setting, and prevents researchers in this area from building upon one another's successes. It also presents significant challenges in identifying features of resuscitation training programs that are associated

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with success, and establishing evidence-based recommendations for best practice. Nonetheless, there are lessons to be learned from this body of literature, and this article will review programmatic and pedagogical elements of resuscitation education initiatives in LMICs with an attempt to identify factors that influence outcomes. The ultimate goal is to aid educators in developing future training programs in a manner that will maximize educational impact and ultimately improve clinical outcomes for target patient populations.

Simulation

There is an ever-growing body of literature from the developed world demonstrating the value of simulation-based medical education (SBME) for teaching emergency care and resuscitation skills. Compared with traditional methods, SBME has been shown to yield superior educational outcomes both in simulated settings and in actual clinical practice.^{7,8} SBME has also been associated with improved clinical outcomes for patients, including reductions in procedural complications and decreases in morbidity.^{9–12}

The success of SBME in the developed world suggests that it will be beneficial in the developing world as well. To this end, many educational programs in LMICs have incorporated some form of simulation, with encouraging results. One example is Helping Babies Breathe (HBB), an initiative of the American Association of Pediatrics designed to improve the quality of neonatal resuscitation and reduce neonatal mortality in LMICs. HBB training, which relies heavily on low-fidelity simulation, has been shown to improve learner performance in simulated neonatal resuscitations,¹³ and it has been associated with improvements in neonatal mortality outcomes. Following national implementation of HBB in Tanzania, neonatal deaths dropped by 47% compared with the preimplementation period.¹⁴ HBB implementation in India was not associated with overall neonatal mortality reduction, but it was associated with a significant reduction in stillbirth rates.¹⁵ However, a large multinational study on essential newborn care (ENC) and Neonatal Resuscitation Program (NRP), both of which incorporate elements of SBME, failed to demonstrate any reduction in rates of neonatal mortality or stillbirth.¹⁶ This result directly contradicts the results seen in large-scale studies of HBB, and again raises the question of why one educational program succeeds when another one fails, especially when both incorporate a highly effective method such as simulation. Of note, the details of how the ENC and NRP programs were adapted and implemented in this study were not described, nor were the educational outcomes of participants. Education can change clinical outcomes only inasmuch as it is effective, and it is possible that pedagogical issues may have affected the outcomes seen in this study.

Trainer Factors

Language and Culture

There are a variety of factors that may influence the effectiveness of one educator compared with another, none of which have been systematically studied. While many trainer

factors are beyond the control of program developers, some merit special consideration. For example, it is intuitively obvious that it is preferable to conduct instruction in the learners' native language. However, many international training initiatives involve trainers who are not fluent in local languages, and there are no studies explicitly addressing impact of language barriers on educational outcomes. Several international education studies discuss strategies for overcoming these barriers, including translation of course materials, speaking slowly, and allowing extra time for translation.^{17,18} In settings where trainers and learners do not share a common language, special effort should be made to ensure comprehension of material by learners.

Cultural differences between learners and educators may also influence educational outcomes. A recent review on the role of culture in simulation debriefing notes that accepted best practices emanate largely from Western cultures, and may not be applicable in other settings.¹⁹ Western medical education places great emphasis on engaging learners as active participants in their own instruction, and Western educators teaching in a foreign country may feel distressed about their learners' reluctance to speak out and share their perspectives. Learners whose cultures emphasize passivity and deference to authority may feel equally distressed by being asked to do so. There is no definitive answer to the question of culture, but it is clear that it influences the experiences of both educators and learners, and it must be considered in international education initiatives. The aforementioned review questions whether it is appropriate or desirable to push learners out of their cultural comfort zones in debriefing. The authors recommend cultivating common language with learners, acknowledging cultural differences, and modifying the debriefing process to account for these. Though focused specifically on simulation debriefing, this is likely excellent advice for all forms of education in a multicultural context.

Clinical Experience

The clinical experience of trainers is another important but unstudied variable. To ensure quality of instruction, trainers themselves must be competent in their subject matter, and should ideally be licensed practitioners. Trainees, particularly senior residents and fellows who are advanced in their postgraduate education, can make great contributions to educational initiatives, but they must receive adequate guidance and supervision. Practitioners based in the developed world can certainly be effective instructors, but should ideally have clinical experience working in the LMIC in which they plan to teach. If this is not the case, then particular care should be taken to ensure that all instructors understand the epidemiology, practice standards, available resources, and potential barriers to care in the local setting.

Preparation for Teaching

It is widely accepted that talented clinicians are not universally talented teachers, and that specific preparation for teaching is essential. However, the optimal amount and type of preparation is unknown, and there is a paucity of literature examining the impact of instructor preparation on learning.²⁰ In the simulation arena, much is written about the

importance of faculty development for scenario development and debriefing, but there is no data demonstrating that faculty development changes educational outcomes.^{21,22} That said, it is prudent to ensure that trainers are both comfortable and competent in using the educational methods employed by their training programs. The optimal duration and format of trainer preparation is an important area for future study.

Train-the-Trainer Programs

The “train-the-trainer” (TTT) approach is a widely advocated dissemination strategy in international education programs, though little is known about its effectiveness from the standpoint of learning outcomes such as knowledge acquisition and skill mastery. Many TTT studies focus on process outcomes, such as number of learners trained or number of patients treated, and the TTT approach is clearly effective for extending the reach of training programs.^{23,24} There is a paucity of data regarding the competence of “trained trainers” themselves, or the educational outcomes of their learners. Several studies document knowledge gains from TTT programs,^{25,26} but very few examine psychomotor skill or operational performance outcomes.

There are a few studies supporting the value of TTT strategies in resuscitation education. In one study of physicians in Sri Lanka, a TTT program improved performance in simulation-based testing of resuscitation skills.²⁷ A study on the ENC program used a TTT model for dissemination to 18 clinics in Zambia, and demonstrated a reduction in neonatal mortality.²⁸ While educational outcomes were not reported, the observed mortality reduction certainly suggests successful skill acquisition by participants. The previously described HBB projects in Tanzania and India^{13,14} also utilized TTT approaches to improve knowledge and skills of participants and ultimately to improve neonatal mortality.

However, some TTT results are less encouraging. As noted previously, the largest multinational study to date on the clinical impact of neonatal resuscitation training, which incorporated a TTT dissemination model, failed to demonstrate survival benefit.¹⁵ A Tanzania-based study of Helping Mothers Survive (HMS), an obstetric emergency training initiative similar to HBB, found that only 29% of trained facilitators passed a simulation-based skills test, and only 3% of learners trained by these facilitators passed the test.²⁹ This finding demonstrates that simply completing a training program does not necessarily ensure mastery of the material, much less competence to teach this material to others. The success of TTT programs depends on the ability of “trained trainers” to serve as effective educators, and it is therefore essential to ensure that they receive adequate instructional time, support, and mentorship to succeed in this role. Rigorous assessment of future trainers must be conducted to ensure their competence, and remediation should be available to those who need it—*before* they assume their roles as educators. Future research is needed to evaluate the educational outcomes produced by TTT programs, and to identify strategies that contribute to their effectiveness.

Curricular Factors

Traditional versus Self-Directed Learning

One study in Botswana evaluated the impact of various instructional methods on cardiopulmonary resuscitation (CPR) performance, and found no difference in cognitive or skills outcomes between traditional instruction (6:1 learner:teacher ratio), limited instruction (18:1), and self-directed education groups.³⁰ For psychomotor skill development, this study incorporated manikins with automated feedback, and the findings suggest that this type of feedback may be as effective as in-person instruction, at least for relatively straightforward skills like CPR. Similar results have been observed in the United States, where “self-regulated” learning has been shown to produce equivalent immediate results and superior retention compared with “instructor-regulated” learning for development of lumbar puncture skills and CPR.^{31,32} In neonatal resuscitation, self-directed learning (including independent practice with low-fidelity manikins) has been found to yield comparable cognitive and skills outcomes compared with traditional instruction.³³ All these findings suggest that in settings with limited personnel resources, in-person instruction time may potentially be reduced without compromising the quality of education for participants. It should be emphasized that these studies focused on relatively basic content, and may not apply to more complex skills or scenarios.

In-Person Instruction versus Tele-Education

Recent technological advances have enabled the development of tele-education, in which learners and instructors interact through an online remote connection. This method has great potential implications for international education, as it permits training to occur without the physical presence of instructors, thereby improving access to education for learners in remote areas, and potentially decreasing costs. Tele-education techniques have been successfully applied to simulation and procedural skills training both domestically and internationally. “Telesimulation” has produced excellent educational outcomes for both laparoscopic skills and intraosseous insertion training in LMICs.^{34,35} When compared with in-person instruction, tele-education has been shown to produce results that are equivalent to in-person training for ultrasound skills,³⁶ advanced trauma life support,³⁷ and neonatal resuscitation.³⁸ In the neonatal resuscitation study, participants were also given low-fidelity manikins for independent skills practice, thus combining self-directed learning with tele-education, and both knowledge and skills were equivalent between tele-education and traditional instruction groups. Of course, there are limitations to this type of instruction. It is unsuitable for locations lacking stable Internet access, it requires a significant start-up investment, and capable technicians are needed at both ends for maintenance and troubleshooting. That said, tele-education may permit learners to access educational opportunities independent of geography, and well-designed programs may yield positive results.

Simulation Fidelity

Much of the research on SBME conducted in the developed world utilizes high-fidelity human patient simulators, which enhance realism by simulating a myriad of physiologic functions that are controlled using computers. The complexity and high cost of these simulators are prohibitive in many LMIC settings, where educators must consider not only acquisition cost, but also maintenance and repair, which can be significant for these intricate devices. Infrastructure is also lacking in many LMIC settings, where climate control and consistent power sources are often unavailable. For this reason, there has been considerable interest in durable, low-fidelity, low-cost simulation models for use in LMICs.

Despite their popularity, there is virtually no evidence that high-fidelity simulators yield superior educational outcomes compared with lower fidelity alternatives. A systematic review found that low- and high-fidelity simulation produced equivalent outcomes for teaching auscultation skills, procedural skills, and resuscitation.³⁹ One study examining different methods for advanced cardiovascular life support (ACLS) training found that *any* form of simulation improved educational outcomes compared with traditional instruction, but there was no difference between low- and high-fidelity groups.⁴⁰ Another study examining simulation fidelity in neonatal resuscitation also found that cognitive and skills performance were identical between low- and high-fidelity groups, though the high-fidelity group had greater satisfaction and self-efficacy scores.⁴¹

Many low-cost, low-fidelity simulators designed for use in LMICs have been described and used successfully.^{42–47} HBB, which uses a low-cost inflatable manikin manufactured by Laerdal Medical, is an example of a widespread and successful program that incorporates low-fidelity simulation. In cases where higher fidelity is desirable, there are several software applications that simulate monitor tracings for display on tablets or laptops, providing high-fidelity functionality to a simple CPR manikin. Standardized patients also provide a low-technology solution to the problem of fidelity, as they add realism and interpersonal dimensions to simulation scenarios. In hybrid simulation, standardized patients are combined with task trainers or simulated monitors to permit learners to perform procedures or address physiologic needs in the context of a clinical scenario. In short, using high-technology, high-cost simulators may not be appropriate or feasible in LMICs, and there is no evidence that they yield superior educational outcomes compared with lower cost alternatives.

Needs Assessment

A systematic approach to needs assessment is essential to ensure that resuscitation education programs for use in LMICs offer recommendations that are relevant and feasible in the local context. This requires a clear understanding of local epidemiology, available infrastructure and equipment, and training/experience deficits of target learners. The WHO Global Initiative for Emergency and Essential Surgical care has created a standardized and validated situational analysis tool for use at the hospital level.⁴⁸ Although developed to measure surgical capacity, this tool contains many elements

relevant to resuscitation, such as the availability of emergency care areas, access to equipment like oxygen cylinders and bag-valve-mask devices, and educational needs of personnel in resuscitative procedures. Many researchers have also published surveys used to assess resuscitation and critical care capacity in LMICs,^{49–52} one of which is specific to pediatrics.⁵³ Of note, all these studies identified education and training of personnel as a major need for improving resuscitation capacity and quality. Program developers may use these tools as a starting point for gathering needs assessment data, and should be sure to seek the input of local experts to ensure adequate understanding of the practice environment in which target learners operate.

Adaptation of Standard Protocols and Training Materials

A recent comprehensive review of global pediatric advanced life support (PALS) initiatives published in *Lancet* emphasized that resuscitation protocols used in the developed world are often not feasible or clinically inappropriate in LMIC settings, necessitating modifications when used in this context.⁵⁴ The authors emphasize the need for standard resuscitation protocols that are optimized for use in LMICs, and reference the successes of existing programs such as the WHO's Emergency Triage and Treatment (ETAT).^{55,56} Existing international guidelines such as IMCI and ETAT provide a starting point for resuscitation protocol development, but it is also essential to consult local experts. As the authors of the *Lancet* review note, there are many important epidemiologic differences between patient populations in various regions, and these differences often impact clinical care. For example, aggressive administration of IV fluids is widely recommended for children with septic shock, but a multinational trial in Africa found increased mortality for children with febrile illness and hypotension who were given fluid boluses.⁵⁷ This finding necessitates reconsideration of the role of fluids in these patients, and requires that resuscitation protocols be adjusted accordingly. This underscores the importance of rigorous needs assessment to ensure that program planners possess detailed knowledge about local epidemiology and standards of care. Collaboration with local experts is also essential to ensure quality and relevance of protocols and teaching materials.

In addition, it must be stressed that standard resuscitation protocols such as those recommended by the American Heart Association (AHA) are designed for health care facilities with full resources, but infrastructure and equipment are often extremely limited in LMIC settings. This reality necessitates further modification to existing protocols, sometimes even those that are specifically developed for resource-limited settings. The *Lancet* review suggests substitutes for many resuscitation interventions that may be used when standard resources are unavailable, as well as low-resource management recommendations for a variety of common pediatric life threats.⁵⁴ Again, proper needs assessment will include a thorough inventory of infrastructure and equipment availability, enabling program planners to address these limitations in their curricula.

An excellent example of a thoughtful and systematic approach to protocol adaptation is provided by a recent study from Botswana. In this project, the authors contextualized the AHA Pediatric Emergency Assessment, Recognition and Stabilization (PEARS) course for use in the local setting.⁵⁸ They ensured that adequate time was provided to meet cultural norms, enable language translation, and permit remediation. While standard AHA protocols were preserved, specific AHA recommendations were replaced with the most appropriate locally feasible alternative, procedures were taught using available equipment, and simulation scenarios were developed to address common pathology seen at the host hospital. Local experts were engaged in the contextualization process, and the chair of pediatrics at the host hospital approved all final course materials. While the precise process of protocol adaptation may vary considerably across sites, this study explicitly incorporates the key elements of addressing relevant pathology, engaging local experts, and understanding resource limitations.

Programmatic Factors

Course Duration

International education programs are often designed for intensive delivery over a short period of time. This decision is usually made for reasons of logistics rather than pedagogy, as instructors visiting from other countries typically have time constraints, and longer courses are costly. Additionally, removing practitioners from their clinical duties to participate in training may be problematic, particularly in areas with critical shortages of health care workers. Inadequate instructional time has been cited as a barrier to effective education in resuscitation programs implemented in LMICs.⁶ Additional time may be required for foreign language translation, or to accommodate cultural norms regarding lateness, breaks, and duration of the workday. In addition, some studies note poor learner performance and need for remediation, particularly for novice learners,^{29,30} both of which require extra time and must be considered in course planning. There are no studies regarding the impact of course duration on educational outcomes, but common sense dictates that excessively ambitious course schedules should be avoided and that flexibility is needed to ensure that participants have adequate time to master core concepts and skills.

Frequency of Instruction

Knowledge and skill decay is an inevitable part of education, and “refresher” courses are necessary to ensure ongoing mastery of important material. The optimal interval for repeat instruction is unknown, though many studies demonstrate some degree of decay in resuscitation skills at 6 to 12 months.^{59,60} Deliberate practice (DP) has been advocated as a helpful technique for enhancing acquisition and retention of resuscitation knowledge and skills.^{61,62} DP consists of structured sessions wherein learners work toward achieving specific defined goals through repetitive practice with feedback. This method has been found to be superior to traditional instruction for teaching neonatal resuscitation preparation⁶³ and performance,⁶⁴ as well as pediatric

resuscitation skills.⁶⁵ It should be emphasized that DP programs do not have to be time-intensive. In one study on CPR training, monthly independent practice sessions with automated manikin feedback lasting only 6 minutes were shown to significantly improve both acquisition and retention of skills.⁶⁶ Two additional studies demonstrated CPR skill improvements with 2-minute practice sessions, though interestingly, the latter of these studies also found that instructor-led sessions were more effective than independent practice with automated feedback.^{67,68}

There is no consensus on how to optimally structure DP programs, though many studies (including the CPR examples described above) employ “low-dose, high-frequency” practice sessions over an extended period of time. This method is also termed distributed practice, and it refers to dispersing instruction over a longer period rather than delivering it in a shorter block. There is evidence that this approach yields superior educational outcomes compared with more intensive instruction. One study compared standard PALS with “PALS Reconstructed,” wherein the content was broken down into modules that were delivered over a 6-month period, and found that the “reconstructed” group performed significantly better on posttesting.⁶⁹

Compared with intensive instruction, distributed practice may prove logistically challenging to implement in LMICs, where both learner and instructor time are potentially scarce resources, and longitudinal availability of instructors may be impossible. Nonetheless, “low-dose, high-frequency” simulation has been used successfully in this setting. For example, the HBB program in Tanzania included regular refreshers for providers, and required that all providers practice independently with a simulator and document successful completion of key skills prior to beginning work in the hospital or clinic.¹⁴ While there were many elements of this program that may have contributed to its success, incorporation of a distributed practice model of training likely enhanced skill acquisition and retention by participants.

Summary and Lessons Learned

Quality resuscitation education initiatives in LMICs may have the potential to save the lives of many children worldwide. To optimize their effectiveness, educators should consider these factors when developing resuscitation programs for use in LMICs:

- Simulation should be incorporated as an educational method, with emphasis on low-cost, low-fidelity approaches to enhance dissemination potential and sustainability.
- Linguistic and cultural barriers should be explicitly addressed in program development and implementation.
- TTT programs may be used for dissemination of knowledge and skills, but the competence of newly trained personnel should be assessed before they assume their roles as trainers.
- Self-directed learning and tele-education, when logistically and technologically feasible, may be considered for use in settings where traditional in-person instruction is impractical or costly.

- Rigorous needs assessment should be undertaken before developing new programs.
- Adaptation of standard courses and protocols should be guided by needs assessment data and input of local experts and stakeholders.
- Course duration should be adequate to permit attainment of learning objectives, including time for remediation.
- DP and distributed practice should be considered to enhance acquisition and retention of knowledge and skills by participants.

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