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Video simulation to learn pediatric resuscitation skills tailored to a low resource setting: A pilot program in Iquitos, Peru

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Abstract

Introduction: The Hospital Regional de Loreto in Peru partners with the University of California Los Angeles Global Health Program to enhance educational experiences for US and Peruvian trainees. University of California Los Angeles Pediatric faculty led intermittent in-person code simulation sessions for Peruvian residents, and there is a need for regular education on this topic.

Methods: University of California Los Angeles residents created a video simulation of a patient in respiratory distress. The video was presented to Hospital Regional de Loreto trainees in pediatrics. Stakeholder interviews and reuse of the video after initial presentation assessed acceptability of this mode of education by the site. Pre- and post-surveys using numerical rating scales evaluated the educational utility of this specific simulation video. Paired *t*-tests compared the pre- and post-surveys in the effectiveness of increasing the trainees' comfort of specific resuscitation skills.

Results: Stakeholder interviews revealed the video simulation was integrated into formal intern orientation trainings as well as used for resident and physician trainings multiple times in the year after the introduction. Twenty trainees completed the pre-intervention survey and 19 completed the post-intervention survey. Trainee comfort with code team leadership (2.6 ± 0.9, 3.5 ± 0.09, $p = 0.03$) and arrhythmia recognition/automated external defibrillator (AED) management (2.4 ± 0.9, 3.1 ± 0.9, $p = 0.03$) increased significantly with the video intervention. There was no significant difference in comfort with other skills. Overall, trainees rated the helpfulness of the video as an average of 4.2 (± 1.1) out of 5. The most common positive feedback included the utility of reviewing medication dosing and the skill of performing chest compressions. The most common suggestions for improvement were to review more pathophysiology and simulate available resources at Hospital Regional de Loreto more realistically.

Conclusion: E-learning is an acceptable mode of education in a resource-limited setting when tailored to the local context. This pilot project demonstrated short-term improvement in reported confidence and skills with some aspects of pediatric resuscitation.

Keywords

Global health, Latin America, medical education, resuscitation, simulation training

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Introduction

The Hospital Regional de Loreto (HRL) in Iquitos, based in one of Peru's most resource-limited cities, partners with the University of California Los Angeles (UCLA) Global Health Program to enhance educational experiences for American and Peruvian trainees and faculty. HRL does not have any pediatric subspecialists and relies on general pediatricians to staff the pediatric emergency and critical care units. Formal training and certification in pediatric resuscitation in Peru occurs centrally in Lima and is the responsibility of individual clinicians. Most pediatricians at HRL are not able to travel to Lima for training or refresher courses on pediatric resuscitation due to time and cost-constraints and feel inadequately equipped to teach these skills

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properly to their pediatric trainees. During a programmatic needs assessment, faculty at HRL identified pediatric resuscitation skills as the area of highest educational need for HRL pediatric residents. While pediatric residents are not required to be certified in resuscitation, they do serve as the frontline for the many critically ill children who present to HRL from remote areas of the Amazon. UCLA pediatric faculty have assisted by leading in-person code simulation workshops for Peruvian staff and trainees at HRL, although these sessions are intermittent and time-limited, and thus not conducive to long-term sustainability. Due to the short-term success of these sessions and the desire for a more longitudinal educational tool, UCLA pediatric residents interested in global health set out to explore e-learning as a modality to improve knowledge and skills around pediatric resuscitation.

E-learning can be a vital tool in global health settings by delivering knowledge to lower-resource areas and improving skills of physicians and trainees abroad.[1,2] E-learning modules offer the flexibility of remote creation and implementation, easy transportability, and longevity. Studies of clinicians trained with procedure-based simulations have demonstrated improved clinical outcomes and fewer complications for patients.[3] Systematic reviews of simulated or situated e-learning, where the learner is embedded in a specific clinical scenario, show particular promise for improving novice learners' clinical performance.[4] E-learning can also allow for individuals to be actively involved in a sustainable global health project without necessitating travel abroad. E-learning and simulation have been shown to be effective tools for medical education in resource-rich settings,[2,3,5] and there is growing body of literature on the diverse modalities of e-learning in resource-limited settings.[1] The availability of open-access pediatric e-learning resources in Spanish, however, is limited, and where available, is often tailored to more developed healthcare settings.

UCLA pediatric residents considered the creation of an e-learning tool on respiratory distress, one of the most common causes of pediatric cardiopulmonary arrest in Peru, to provide a potentially sustainable educational resource for pediatric trainees at HRL. National mortality from pneumonia is highest in the Peruvian Amazon, where HRL interns and pediatric residents serve as the front line.[6] The acceptability of video simulation for this setting had never been tested. The primary objectives for this external pilot study were to determine the acceptability of this educational modality by Peruvian trainees and faculty at HRL and the appropriateness of the simulation for the HRL setting, and the secondary outcomes were to assess the utility of the educational content included of this specific video to improve resident comfort with resuscitation knowledge and skills. If successful, future educational videos would be planned to reinforce other areas of pediatric resuscitation.

Methods

Video simulation development

A team of four UCLA pediatric residents interested in supporting HRL developed a pilot project to create a video simulation in Spanish on pediatric respiratory failure. Online literature search revealed no existing open-access resources in Spanish focused on pediatric resuscitation applicable to resource-limited settings at the time of this project in 2019. The simulation was adapted from the pediatric core simulation curriculum at UCLA and modified to focus on interventions that would be locally available at HRL. The knowledge and skills demonstrated in the video included code leadership, recognizing respiratory failure, recognizing arrhythmias, performing chest compressions, performing bag-mask ventilation, and using an AED. The video intentionally did not focus on interventions not available at HRL, such as administration of adenosine or amiodarone for certain arrhythmias. The video was filmed at the UCLA Simulation Center using high-fidelity mannikins. This video was intended to be for open-access use and is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. UCLA Office of Human Research Protection Program provided an IRB exemption for this project (IRB# 19-001321).

The video simulation starts with a case of a 1-year old brought into the hospital with fever and cough for 5 days. The nurse is concerned about the clinical condition of the patient and calls for a physician to assess the patient. The physician notices retractions and adventitious breath sounds and is concerned for bacterial pneumonia. The video periodically focuses on the cardiac monitor to give the viewer insight into the vital signs before the next phase of the video resumes. The patient becomes hypoxic and a rapid response is called. The physician team vocalizes their differential diagnosis and corresponding work up for the patient to keep the viewer in tune with their thought process. The patient develops respiratory failure and the team demonstrates rapid sequence intubation, including the necessary calculations for endotracheal tube placement and medication dosing for induction and neuromuscular blocking agents. After successful intubation, the patient's heartrate drops and cardiopulmonary resuscitation (CPR) is required. The cardiac rhythm is determined to be pulseless electrical activity and epinephrine is given. The cardiac rhythm then becomes shockable and the use of an AED is demonstrated, after which the patient is stabilized. The case simulation lasts 14 min, followed by a 4-min debrief of the simulation. The debrief reviews the diagnosis of pneumonia according to the World Health Organization, signs of respiratory failure and subsequent cardiac arrest. It also reviews the basic tenants of pediatric CPR and effective team dynamics.

Video demonstration

The simulation video was presented in Peru in two sessions to a convenience sample of HRL interns and pediatric

residents assigned to the inpatient pediatric ward in January 2019. Importantly, sessions did not include hands-on training as the video was meant to be an independent self-learning resource. Pre- and post-surveys using numerical rating scales (1–5) were administered to the trainees to evaluate individual confidence with the knowledge and skills demonstrated in the simulation video. Participation in the surveys was voluntary and verbal informed content was obtained in Spanish prior to participation. The survey instrument was adapted from a similar tool used in the UCLA residency program and is not validated. The pre-survey assessment included seven question items: one question asking the participant's level of training and six items asking the participant's level of anxiety or confidence with the demonstrated knowledge and skills from the video. The post-survey included the seven items from the pre-survey and also included three additional items: whether the video aided the learner in recognizing respiratory distress and two open-ended feedback questions (Please see Supplementary Materials for full assessment tool).

Debriefing sessions with key stakeholders, including leadership from the HRL Department of Pediatrics as well as hospital leadership, were conducted after the video demonstration to elicit feedback on the acceptability and appropriateness of this tool for the local setting. The video simulation was made available on desktop computers in the pediatrics ward at HRL as well as online for individual download. Follow-up sessions with stakeholders from the Department of Pediatrics occurred 6 months and 1-year post implementation to assess the use of this video simulation tool.

Statistical analysis

This study employed a mixed-methods approach to determine the acceptability of video simulation by Peruvian trainees and faculty at HRL, the appropriateness of the simulation for the HRL setting, and the utility of the educational content included of this specific video. Qualitative methods were used for the first two objectives and quantitative methods were used for the third objective. Acceptability of the video was assessed by stakeholder interviews as well as follow-up use of the video simulation in the subsequent year. Appropriateness of the video for the HRL setting was evaluated on the post-survey. Utility of the specific educational content of the video was evaluated by pre- and post-surveys.

Anonymized pre- and post-survey data were transferred to Microsoft Excel and analyzed using SPSS. Individual item responses were treated as continuous variables given the numerical representation of each item in the survey and the presence of five categories in the response format. Normality was assessed prior to analysis. Item responses were summarized using means and standard deviations. SPSS programming using paired *t*-tests compared the pre- and post-surveys in the effectiveness of increasing trainee comfort and knowledge of resuscitation skills. A p value of $\leq .05$ was considered significant.

Narrative comments collected on the post-survey feedback questions as well as in stakeholder interview sessions were coded using inductive thematic analysis. Codes were identified and grouped into themes and then compared by author KS and subsequently reviewed by KM.

Results

Stakeholder interviews with the leadership at HRL after initial demonstration of the video simulation yielded positive feedback. HRL leadership commented that the video appropriately reflected the local resources and setting, although it did include a larger physician and nursing team than is usually available for resuscitations. The pediatrics leadership team overall responded optimistically to the intervention and immediately incorporated the video into the orientation training for all new interns hospital-wide at HRL. Subsequent follow-up interviews at 6 and 12 months revealed that the simulation video was utilized multiple times in the subsequent year to train both residents and new physicians in pediatric resuscitation.

Following the initial video simulation sessions, 20 interns and pediatric residents completed the pre-intervention survey and 19 completed the post-intervention survey to assist in evaluating the educational content of this specific video simulation. Trainee comfort with code team leadership (2.6 ± 0.9, 3.5 ± 0.09, $p = 0.03$) and arrhythmia management (2.4 ± 0.9, 3.1 ± 0.9, $p = 0.03$) increased significantly with the video intervention (Figure 1). There was no significant difference in comfort with other skills such as bagging, compressions, and knowledge in identifying respiratory failure. Overall, trainees rated the helpfulness of the video as an average of 4.2 (± 1.1) out of 5. The most common positive qualitative feedback was the utility of reviewing medication dosing and the skill of performing chest compressions. The most common suggestions for improvement were to review more pathophysiology and simulate available resources at HRL even more realistically.

Discussion

To our knowledge, this is the first filmed resuscitation simulation in Spanish used for the purpose of medical education in a global health setting. This project was an external pilot project, with the goal of collecting initial information to assess its acceptability and utility in order to determine if future large-scale projects could be beneficial. This pilot project demonstrated acceptability of video simulation as an e-learning modality in a resource-limited setting in Iquitos, Peru. The video simulation was used multiple times for trainings in the year after introduction at HRL. As this resource was primarily used offline, authors were unable to quantify the exact number of views or shares of this video, but were encouraged by

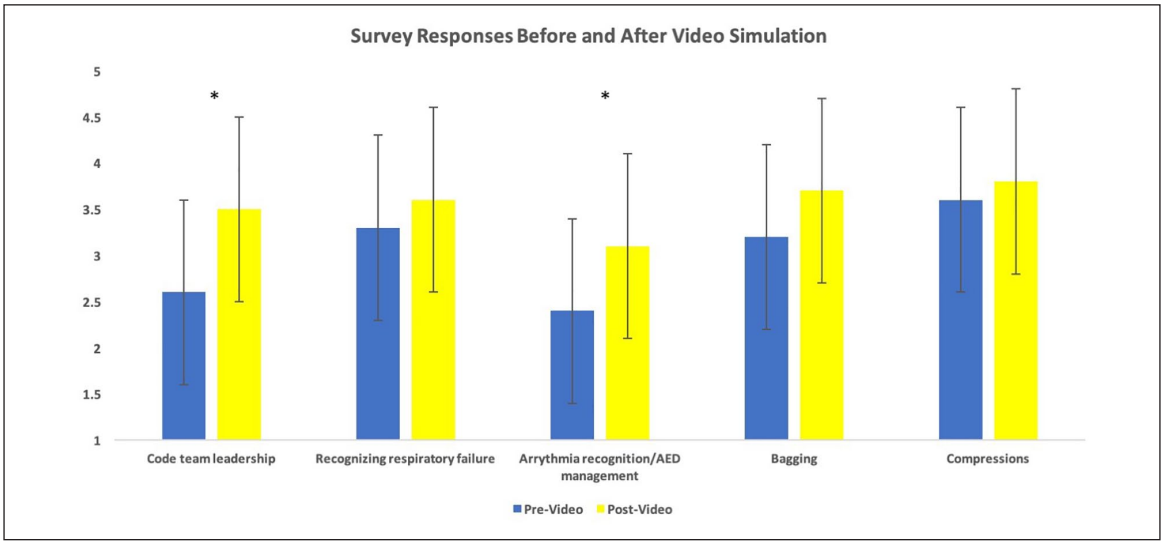

Figure 1. Pre- and post-intervention surveys conducted using a numerical rating scale on comfort level with each skill (1 = *very anxious* and 5 = *very confident*).
Twenty participated in the pre-survey and 19 in the post-survey. Each result represents mean, and error bars represent standard deviation. * Represents statistically significant $p \leq 0.05$.

the formal and informal integration of the video in educational trainings. Initial trainee feedback also rated the helpfulness of the video as a 4.2 out of 5. Short-term improvement in reported confidence and skills related to some aspects of pediatric resuscitation, such as code team leadership and arrhythmia management, suggest educational utility of knowledge and skills demonstrated in this specific video simulation. Importantly, although the creators attempted to realistically demonstrate resources available at HRL, qualitative feedback from trainees and HRL leadership suggest that there is additional room to more accurately depict resuscitation scenarios for this context.

E-learning provides greater accessibility of training content and can be utilized for initial trainings as well as refresher courses. This type of e-learning video can also be reused or adapted to meet the diverse educational and language needs of other similar low-resource settings. Relying on e-learning is particularly useful when there are challenges to in-person learning, common in geographically isolated settings. Studies of e-learning in resource-limited settings suggest efficacy in capacity building especially in rural settings.[1] E-learning is associated with large positive effects when traditional educational interventions are not available,[7] which suggests value in focusing on resuscitation training at HRL as in-person trainings are still challenging. E-learning can also greatly reduce the cost of training,[8] critical in settings with limited resources.

One limitation of our study was the small sample size, limited by the size of the residency program at HRL, which averages five pediatric residents per year. As our primary outcome was acceptability of the training video by HRL leadership, we did not calculate a required sample size for this pilot study. The data were also not disaggregated by type of trainee (intern vs resident) due to the overall small *n*; however, in Peru, these are two distinct teaching populations. Interns have just completed medical school and rotate through different departments in HRL and may plan to practice as general physicians or may be interested in a field other than pediatrics. Residents, on the contrary, have completed 1 year of internship and 1 year of rural service before applying to pediatric residency and are focused on the care of children. We did not also differentiate between trainees who have had previous resuscitation training from those who were learning this information for the first time. Finally, responses may also have been influenced by the desire of HRL trainees to please their international colleagues from UCLA who were administering the survey.

Another limitation in our study was the lack of a comparator module. In future studies, it would be helpful to compare how this type of e-learning compares to either purely didactic e-learning, in-person simulation, or combinations thereof. A study comparing these different modalities could provide some guidance on future educational projects. Prior studies have noted that digital simulation improves knowledge and skills but does not replace hands-on trainings,[5] although in our pilot survey respondents did note some utility in viewing chest compressions demonstrated. Other studies have demonstrated that interactivity and practice exercises play critical roles in e-learning and seem to be associated with improved learning outcomes.[9] Ideally in future iterations, e-learning simulation modules would be paired with in-person practical sessions to complement and reinforce learning. This unfortunately was not feasible with our pilot project due to limited availability of trainers; however, it does accurately reflect the current reality of the limitations on travel during the coronavirus pandemic. Another option,

if technologically and financially feasible, would be to create e-learning modules that are more interactive and allow testing of learners throughout the module, which may enhance learning.[10] Short-term knowledge and skills acquisition does not always translate to a change in clinical outcomes, and measuring clinical outcomes was not within the scope of this pilot. A Cochrane Review of e-learning's impact on clinical outcomes did not show significant benefit on patient outcomes when compared with traditional learning, but this review included studies primarily in high-income countries and may not accurately reflect potential benefits that exist in lower-income settings.[11] Recording real-life resuscitations occurring at HRL for post-resuscitation feedback could be another tool to augment and reinforce learning as well as assess the impact on patient outcomes. Finally, e-learning in medical education is in need of validated tools to assess instrument design and with the advent of a content-validated evaluation tool, comparison between different e-learning paradigms could be facilitated.[12]

An interesting area of need that emerged from trainee comments was the positive feedback on reviewing medication dosing. With the advent of mobile health apps, many have replaced the traditional need for manual pediatric calculations for medication dosing. This is another area of intervention that could reduce the need for specific education on this topic and importantly also improve patient outcomes at HRL. Spanish language availability may limit the apps accessible for this purpose, but this is another area for both future exploration and advocacy to ensure these advances are not confined to English speaking or high-income countries.[13]

Based on the overall positive findings, our group hopes to create a similar resource on neonatal resuscitation in the future. We are also exploring how this project could be expanded to include multiple cohorts of UCLA trainees to allow them to be actively involved in a long-term sustainable e-learning project, even if travel options continue to be restricted. Challenges in continuing this work include the time and effort required for developing site-specific videos as well as the limited number of fluent Spanish speaking trainees who can continue this project.

Conclusion

E-learning video simulation appears to be an acceptable educational tool in a global health setting when tailored to the local resources. This pilot project demonstrated short-term improvement in reported confidence and skills with some aspects of pediatric resuscitation.

Future work will aim to include other areas of pediatric resuscitation and when possible, pair e-learning with hands-on training to complement and reinforce learning.

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Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Ethical approval for this study was obtained from the UCLA Office of Human Research Protection Program and provided an IRB exemption (IRB# 19-001321). This research has been certified as exempt from IRB review per 45 CFR 46.101, Categories 1 and 2 (Research conducted in established or commonly accepted educational settings, involving normal educational practices. Research involving the use of educational tests.)

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Informed consent

Verbal informed consent was obtained from all subjects before the study. The research was minimal risk and did not involve any procedures for which written consent is normally required outside the research setting (e.g. in everyday life written consent is not needed for minimal risk surveys) and was approved by the UCLA IRB committee.

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Supplemental material

Supplemental material for this article is available online.

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