Medical Simulation as a Vital Adjunct to Identifying Clinical Life-Threatening Gaps in Austere Environments

Adaora M. Chima, M.B.B.S., M.P.H., Rahul Koka, M.D., M.P.H., Benjamin Lee, M.D., M.P.H., Tina Tran, M.D., Onyebuchi U. Ogbuagu, M.B.B.S., M.P.H., Howard Nelson-Williams, M.D, M.P.H., Michael Rosen, Ph.D., Michael Koroma, MBChB, John B. Sampson, M.D.

Abstract: Background: Maternal mortality and morbidity are major causes of death in low-resource countries, especially those in Sub-Saharan Africa. Healthcare workforce scarcities present in these locations result in poor perioperative care access and quality. These scarcities also limit the capacity for progressive development and enhancement of workforce training, and skills through continuing medical education. Newly available low-cost, in-situ simulation systems make it possible for a small cadre of trainers to use simulation to identify areas needing improvement and to rehearse best practice approaches, relevant to the context of target environments.

Methods: Nurse anesthetists were recruited throughout Sierra Leone to participate in simulation-based obstetric anesthesia scenarios at the country's national referral maternity hospital. All subjects participated in a detailed computer assisted training program to familiarize themselves with the Universal Anesthesia Machine (UAM). An expert panel rated the morbidity/mortality risk of pre-identified critical incidents within the scenario via the Delphi process. Participant responses to critical incidents were observed during these scenarios. Participants had an obstetric anesthesia pretest and post-test as well as debrief sessions focused on reviewing the significance of critical incident responses observed during the scenario.

Results: 21 nurse anesthetists, (20% of anesthesia providers nationally) participated. Median age was 41 years and median experience practicing anesthesia was 3.5 years. Most participants (57.1%) were female, two-thirds (66.7%) performed obstetrics anesthesia daily but 57.1% had no experience using the UAM. During the simulation, participants were observed and assessed on critical incident responses for case preparation with a median score of 7 out of 13 points, anesthesia management with a median score of 10 out of 20 points and rapid sequence intubation with a median score of 3 out of 10 points.

Conclusion: This study identified substantial risks to patient care and provides evidence to support the feasibility and value of in-situ simulation-based performance assessment for identifying critical gaps in safe anesthesia care in the low-resource settings. Further investigations may validate the impact and sustainability of simulation based training on skills transfer and retention among anesthesia providers low resource environments.

Keywords: Anesthesia■Africa■Simulation■Training■Sierra Leone■Low-resource environment

Author affiliations: Adaora M. Chima, Department of Anesthesiology and Perioperative Medicine, University of Rochester School of Medicine, Rochester, NY, USA; Rahul Koka, Anesthesiology and Critical Care Medicine-Global Alliance of Perioperative Professionals, Johns Hopkins University School of Medicine, Baltimore, MD, USA; Benjamin Lee, Department of Anesthesiology, Texas Children's Hospital, Houston, TX, USA; Tina Tran, Anesthesiology and Critical Care Medicine-Global Alliance of Perioperative Professionals, Johns Hopkins University School of Medicine, Baltimore, MD, USA; Onyebuchi U. Ogbuagu, Department of General Surgery, University of Maryland, School of Medicine, Baltimore, MD, USA; Howard Nelson-Williams, Anesthesiology and Critical Care Medicine-Global Alliance of Perioperative Professionals, Johns Hopkins University School of Medicine, Baltimore, MD, USA; Michael Rosen, Anesthesiology and Critical Care Medicine-Global Alliance of Perioperative Professionals, Johns Hopkins University School of Medicine, Baltimore, MD, USA; Michael Koroma, Department of Anaesthesiology, Princess Christian Maternity Hospital, Freetown, Sierra Leone; John B. Sampson, Anesthesiology and Critical Care Medicine-Global Alliance of Perioperative Professionals, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Correspondence. John B. Sampson, M.D., Johns Hopkins University, Phipps Building #415 1800 Orleans St., Baltimore, MD, 21287, USA., email: jsampso4@jhmi.edu

INTRODUCTION

The lifetime risk of death during pregnancy is one in six in the poorest parts of the world.[1] Obstetric anesthetic practice has significantly influenced maternal mortality by improving patient safety in the perioperative period. Early awareness of the risks of pulmonary aspiration and the increased risk of a difficult airway in obstetric patients resulted in a preference for regional anesthesia and the widespread acceptance of rapid sequence induction techniques when general anesthesia was necessary, thus increasing safety and survival.[2,3]

Human and physical resources for anesthesia care have been and remain inadequate and represent a major global health care disparity.[4] The paucity of anesthesia providers directly impacts human resources for training, supervision and oversight of anesthesia care, and can result in a degradation of the quality of anesthesia care as well as deviations from recommended practice, leading to unsafe and potentially lethal practice patterns.

Several research studies have demonstrated that many anesthesia related maternal deaths, especially those related to airway problems, are avoidable.[5-8] In low resource environments, unfavorable environmental conditions such as unreliable electrical grids, inadequate biomedical support, scarcity of compressed gas, uncertainty of drug potency and unreliable anesthesia equipment, introduce additional unique challenges that compromise surgical

patient safety.[4,9,10] This situation is all the more dangerous for the maternity patient.[11]

An increasingly popular tool in identifying vulnerabilities and obstacles to delivering safe medical care is medical simulation. The field of medical simulation has grown in popularity over the past decade, especially in technologically developed locations.

Medical simulation offers opportunities to identify systematic, personnel and technical vulnerabilities in the performance of a task or the delivery of service. It is a proven effective training tool and has the advantage of permitting the demonstration of high-risk medical procedures with no risk to living patients. It mitigates the risk of error, decreasing the likelihood of harm to patients when error does occur, because of an increased chance of early detection, and has been shown to improve individual and team performance in different settings such as emergent situations.[12]

In 2015, The Lancet Commission on Global Surgery described the value of low-cost simulation as an effective training tool, however there are perceptions that high fidelity medical simulation is too expensive and impractical to be sustainable in low resource settings.[13] The exact cost of setting up a simulation center varies depending upon how it is equipped but generally runs well over a million dollars.[14] In hospitals with many competing infrastructural needs, this is an improbable priority for resource allocation.

This paper describes the feasibility of conducting a high fidelity obstetric anesthesia simulation training exercise using a portable in-situ simulation system in a low-resource environment. This exercise demonstrated that life-threatening obstetric care healthcare disparities can be identified using affordable simulation systems to evaluate and train anesthesia providers in a low-resource environment on the management of critical decision-making events in a commonly occurring obstetric scenario. Many of these critical decision-making events were rated by the expert group as having a high likelihood of death or disability if handled incorrectly.

MATERIALS AND METHODS

The Johns Hopkins University School of Medicine institutional review board and the Sierra Leone Ethics and Scientific Review committee approved this study.

Setting

We conducted this study over a 2 week period at the Princess Christian Maternity Hospital (PCMH), in Freetown, Sierra Leone in February 2013. PCMH is the sole government operated tertiary hospital for maternal health services in Sierra Leone. It has also served as the home base of a United Nations Population Fund (UNFPA) sponsored anesthesia training program for the past 10 years, aimed at decreasing national maternal mortality rates.

Participants

Inclusion Criteria: We included anesthesia providers in active clinical practice from rural and urban locations in Sierra Leone. Our sample was limited to nurse anesthetists who were trained in Sierra Leone. These nurse anesthetists were recruited by phone with the assistance of the national anesthesia training coordinator (anesthesia consultant to the Ministry of Health), utilizing the registry of nurse anesthetists and a convenience sampling strategy.

Exclusion Criteria: We excluded anesthesia physicians because out of two providers in the public sector, one was a co-investigator on the study. Foreign visiting nurse anesthetists and those trained outside of the country were also excluded to ensure uniform exposure to anesthesia training among all nurse anesthetists in our sample.

The sampling strategy was influenced by phone network disruptions, clinical availability and the ability of the subject to travel to the location of the simulation sessions. Twenty-one practicing nurse anesthetists, recruited from all regions of Sierra Leone, participated in the study. This represents approximately 20% of the nurse anesthetists practicing in Sierra Leone.

Study design

We conducted a cross sectional observation of anesthesia care delivery in a simulated clinical obstetric scenario. It was preceded by an 8-month long observation of surgical and anesthesia procedures at PCMH[15] and the simulation was designed to depict an obstetric scenario that was commonly observed at the hospital. Critical decision making events that would occur during such a scenario were outlined by Johns Hopkins University anesthesiology faculty. Using Delphi Methodology, the panel was asked to rate the risk of injury or death to a patient on the omission of critical tasks in response to the outlined critical decision making events (Table 1) Tasks that had a high risk of injury or death were outlined on a checklist for data collection during the scenario.

Simulation set-up

At any given time, at least two simulation personnel were involved in the execution of the scenario (JBS, OO and AMC), one to record task performance and the other acting as a Confederate (surgeon). Prior to commencing the scenario, participants reviewed an interactive computer based educational curriculum on the features, function and operation of the Universal Anesthesia Machine (UAM). We then oriented the subjects on simulation, with a briefing on the simulated patient's biographical data, clinical condition, and the surgical procedure. Each subject was instructed to commence anesthesia care and given