Lessons Learned on Bubble CPAP Implementation in Post-War Iraq

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It is an unfortunate paradox that access to basic, life-saving pediatric emergency and critical care resources is limited globally, particularly in regions with the highest burden of pediatric critical illness (1, 2). While a multitude of respiratory supports exists, from supplemental oxygen to extracorporeal life support, establishing noninvasive ventilatory support is a first step in improving the degree of respiratory care provided in resource-limited settings (RLS) (3). The purpose of this commentary is to use our experience introducing continuous positive airway pressure (CPAP) in unstable RLS as a case study to illustrate the challenges of innovation, particularly when transplanted into novel settings.

Medical education in high-resource settings, aided by political and economic stability in these regions, can be siloed into individual learning experiences. A shift in the framework of medical education is required in global health contexts in which work settings are often inherently unstable. In the face of socioeconomic and political instability, the individual ceases to be a stand-alone unit and becomes subsumed by challenges of the wider context. This shift requires moving from an individual cognitive, constructive lens to a sociomaterial lens.

Several theories have been brought forward to inform learning in inherently unstable work settings. One such theory is ANT (Actor–Network Theory). ANT is a theoretical orientation that describes the heterogeneous relations in which both humans and objects are interconnected actors through a web of networks (4).

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By including objects as actors, ANT theory implies that inanimate things, for instance, technologies in medical innovation and the context in which they are applied, have agency to the extent that they emerge from social interests and have the potential to shape social interactions (5, 6). The ethnographic method of ANT is dynamic and contextual, adapting to a local, rather than universal, complex web of interactions. In Bleakley's correspondence, he argues that ANT theory has a wider purpose beyond its role as a learning theory (7). In short, he suggests its value as a self-reflexive research practice for developing innovation in health care, applying ANT to medical education and innovation, in particular, humans, technologies, protocols, and context form the actors that relate meaningfully through a network of interactions to promote learning and innovation (7).

Introducing bubble CPAP in a neonatal intensive care unit (NICU) in a politically unstable war-destroyed urban area in Iraq highlighted the limitations of conventional frameworks of medical education when introducing innovation in new and complex settings. Iraq has suffered the consequences of long-lasting wars, sanctions, and ongoing instability for decades, resulting in the destruction of medical facilities and the loss of skilled health workers.

Early CPAP is strongly recommended by the WHO (World Health Organization) for the treatment of neonates with respiratory distress syndrome (8). Bubble CPAP is a safe and cost-effective alternative to conventional CPAP machines (9). A systematic review on the efficacy and safety of bubble CPAP in neonatal care in low- and middle-income countries demonstrated that bubble CPAP could reduce the need for mechanical ventilation by 30–50% with no increase in mortality (10). With these considerations in mind, and at the request of the hospital team, we endeavored to implement bubble CPAP to improve the degree of neonatal care delivered at this hospital in a war-destroyed area.

In the introduction of this new technology, our training approach sought to develop knowledge and skills among trainees and a set of guiding protocols. Before training, we evaluated the baseline knowledge and skills of participants, studied the characteristics of the patient population we were serving, and developed context-based protocols and learning tools. Training consisted of both theoretical and practical components to introduce CPAP physiology and the indications and contraindications of its use and to train participants how to set up and care for the CPAP circuit and how to ensure that it is a safe and effective therapy for neonates for whom it is indicated. Once participants completed the training, we implemented CPAP with the goal of providing ongoing practical bedside training over the course of the first 2 months of operation.

Trained team members followed an algorithm to determine which infants were eligible for CPAP. The first two cases that fit eligibility criteria and received CPAP support presented in profound distress for which invasive ventilation was indicated, a higher degree of care that was not possible because of the lack of availability of NICU beds at outside hospitals. Without the ability to further escalate respiratory care, both infants suffered complications, and one infant died. Although likely inevitable outcomes, these were detrimental to team morale and their trust in this new technology.

Cases were reviewed both by experts remotely (telemedicine and incident reporting) and by the team during our weekly case discussions with the goal of exploring concerns and learning from the cases.

Despite months of preparation, we did not anticipate the challenges encountered during our transition from simulation to reality, and we were ill-equipped for the complex interactions that unfolded around the introduction of this innovation. The history of medicine is not short of cases like this, in which the will to save a life surmounts the proper use of technology. The simulation curricula are built with a cognitive constructivist lens in mind, their goal being the competence of providers and their decision-making improved by protocols. If we look at this from that lens, we might analyze it as an inappropriate initiation decision. If we look at it from a sociomaterial theory and specifically ANT, we can see how a nonhuman actor, CPAP, used in a desperate need to save a life, can shake networks among humans and nonhumans, which are already delicate to the point of breaking them. It is with this lens that analysis can help rebuild those networks.

Reflecting on this experience using ANT theory allows us to capture the complex network of interactions between persons, technology, protocols, and context that led to a loss of confidence but also ultimately informed our readaptation. There were several actors interacting in this scenario: The visiting trainers implementing the new technology, the physicians making the medical decisions around its application, the nurses providing the bedside care, the patients receiving the care, the parents being introduced to the new technology, local hospitals aware of the implementation of new technology but without firsthand knowledge of the details, the protocols guiding the patient selection and CPAP use, as well as the bubble CPAP machine itself. All of these actors interact in a complex network that ultimately informs and shapes the acceptance and success of CPAP implementation (Figure 1).

The implementors serve a critical role in the early stages of innovation. If they serve as an intermediary, a static link that connects the various actors to the technology, then they transport information without transforming it, failing to adapt in the exchange of information. This is in stark contrast to their potential role as a mediator, a dynamic link that translates, transforms, and actively innovates contextual information. Analyzing the situation from an ANT framework, Bleakley argues that protocols can also serve as mediators or intermediaries when adapted creatively to local context versus when applied "autocratically and without flexibility" (7). Viewed through an ANT lens, self-reflexive mediation is critical to adapt to local contextual circumstances rather than universal interactions, particularly in novel and inherently unstable work settings.

After the first two challenging cases, we adapted our selection criteria temporarily and actively selected more straightforward subsequent CPAP candidates that helped put the first two cases in context and regain team morale. We held weekly case reviews to facilitate the discussion and address concerns. This ongoing exchange was critical for the collaboration, adaptation, and evolution of ideas among stakeholders. We trained CPAP focal points locally both as CPAP champions and trainers to enhance motivation and a sense of ownership and to facilitate their

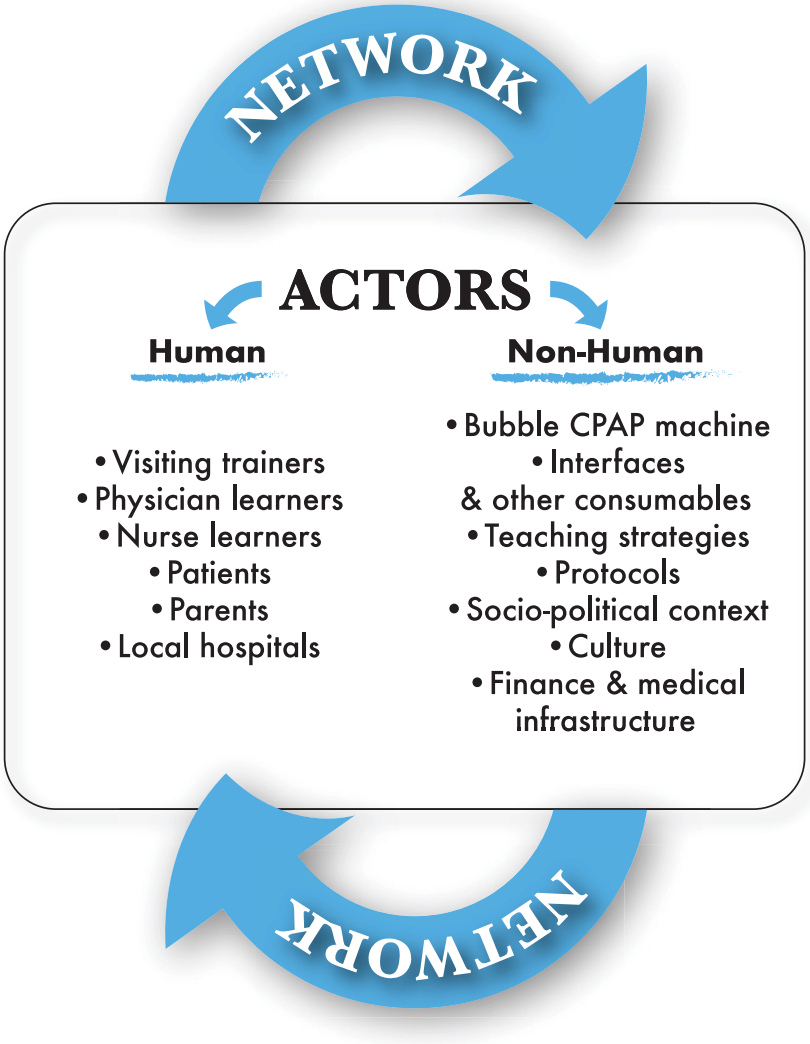

Figure 1. Bubble CPAP implementation viewed from an Actor–Network Theory lens. Figure illustrating networks connecting all actors (human and nonhuman). CPAP = continuous positive airway pressure.

role as mediators in the network. Important networks between relevant actors and strategies used to reestablish those networks are summarized in Table 1. Once the confidence of all actors was regained, we reintroduced challenging cases.

Systematic reviews (9, 10) done in this area provide a list of many factors that can act as barriers or facilitators; however, the factors will change depending on the context in which implementation occurs. We sought to describe a lens through which the stakeholders can explore the multitude of elements and their interactions that can impact the innovation within their own context. The use of theories can help the implementation of educational or quality improvement projects by increasing the understanding of the situations in their full complexity (11).

The implementation was ultimately successful and a lesson in the challenges

Table 1. Strategies to strengthen weak networks and relevant actors

Topic	Strategy	Relevant Actors in Network to Be Reestablished
Selection criteria	Adapt selection criteria to favor the likelihood of success with therapy by applying CPAP to patients with borderline moderate to severe respiratory distress	Visiting trainers, local providers, protocol for patients using a CPAP machine
Discussion opportunities	Hold weekly case conferences and discussions to review cases to date, discuss learning points, and provide an opportunity to discuss and address challenges and concerns	Visiting trainers, local providers, CPAP machine protocol
Local champions	Train local CPAP focal points/champions as trainers, quality improvement champions, bedside support, and point persons for any concerns or suggestions regarding CPAP	Local providers, CPAP machines, patient families
Seek expert guidance	Cases reviewed on telemedicine and by bubble CPAP experts providing external validity	Visiting trainers, local providers, CPAP machine protocol

Definition of abbreviation: CPAP = continuous positive airway pressure.

of innovation in novel settings. It also highlighted the importance of mediators as opposed to intermediaries in reacting and adapting to the dynamic network of actors. ANT, as both a guiding theory and practice, offers an alternative to conventional theories of medical education and innovation, fostering the adaptability, collaboration, and exchange vital to fuel context-appropriate innovation.

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