Advanced Medical Simulation: Interactive Videos and Rapid Cycle Deliberate Practice to Enhance Teamwork and Event Management

Effective Event Management during Simulated Obstetrical Cases

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Abstract—This article is about an experiential coursework focused on learning and improving teamwork and event management during simulated obstetrical cases. Effective team management during a crisis is a core element of expert practice. Medical simulation can contribute enormously to enhance teamwork during a crisis, fostering situational awareness and contextual intelligence, as well as cognitive retention of essential steps and procedures to be performed during an ongoing crisis. A crisis management organizational approach known as Name-Claim-Aim is being used to facilitate crisis management and decision making. Augmented and virtual reality technology (e-REAL) reproduces a variety of different emergent situations, enabling learners to interact with multimedia scenarios and practice using Name-Claim-Aim in a virtual environment. Subsequently, learners rapidly cycle between deliberate practice and directed feedback within a high-fidelity simulation scenario until mastery is achieved. So far, the early findings show that visualization, if linked in interactive ways to the learners, allows for the better use of the neural processes and for better learning and meaningful behavior change. Non-invasive technologies to monitor patterns of neural activity during the program delivery will be introduced.

Keywords—Teamwork, interactive visualization, contextual intelligence, cognitive retention, advanced medical simulation

1   Introduction

Teamwork and Crisis Resource Management for Labor and Delivery Clinicians (Introductory and Advanced Levels) is experiential coursework focused on learning and improving teamwork and event management during simulated obstetrical cases. It's an interprofessional program based on advanced simulation, delivered many times per year in Boston, Massachusetts, at the Center for Medical Simulation (CMS) in a realistic clinical setting, equipped with all the supplies and devices normally found in Labor and Delivery. Each case is immediately followed by a facilitated debriefing led by experienced instructors and faculty members of CMS. Participants include obstetricians, obstetrical nurses, midwives and obstetrical anesthesiologists, since collaboration and teamwork among these groups is so important during obstetrical events [1].

2   How to Best Organize a Labor and Delivery Team in a Crisis

Effective team management during a crisis is a core element of expert practice. Medical simulation can contribute enormously to enhance teamwork during a crisis, fostering situational awareness and contextual intelligence, as well as cognitive retention of essential steps and procedures to be performed during an ongoing crisis.

A crisis management organizational approach using a mnemonic called Name-Claim-Aim is being used in order to facilitate crisis management and decision making: medical knowledge and skills are essential components of the decisions and actions performed during crises, but they are not enough since what has to be managed is the entire situation—including the environment, the equipment and the patient care team.

After decades' worth of dedicated simulation education for anesthesiologists and labor and delivery teams, teamwork experts at the CMS have found that these teams still struggle to routinely organize in crises during simulation courses, let alone in the clinical environment. Stories from course participants of all professions uphold this notion that there exists a real challenge to both focus on the clinical picture and apply organization principles to the team and, more often than not, the organization is under-prioritized. Part of this may be due to the intense cognitive load experienced by many who are managing a stressful clinical crisis; and it can be difficult to also remember the 11-crisis resource management (CRM) principles introduced by Gaba, Fish and Howard [2] and apply them routinely while actively managing a resuscitation.

Fig. 1. Crisis Resource Management - Key Points

Appreciating the impact of stress on high level thinking [3], faculty at CMS collapsed these 11 key points into five key CRM concepts of role clarity, effective communication, effective use of personnel, effective management of resources and global assessment – see Figure 2.

Fig. 2. CMS – Five Key CRM Concepts

The role of "Event Manager," rather than "Team Leader," is expressly promoted at CMS to facilitate distributed leadership in crises, which has proven to be effective in teams of expert practitioners, and which deliberately seeks to collapse hierarchies which may inhibit speaking-up behavior from team members [4] with the goal of avoiding inattentional blindness and failure of perception. The role of "Event Manager" is one who coordinates the communication and efforts of the team and oversees the organization and application of CRM principles in addition to actively soliciting input and decision-making regarding medical care, if necessary. As role clarity repeatedly is a problem for teams, often manifesting in multiple providers being unsure how to help while critical roles are duplicated or left unfilled, and the "Event Manager" acts to facilitate role designation, orchestrate and coordinate team function. Remembering roles can be challenging as well during a crisis due to high cognitive load, an unnecessary problem for teams.

Based on these challenges, even with a 5 Key CRM concept framework, the mnemonic "Name-Claim-Aim" was developed at CMS to incorporate 10 of the 11 CRM principles in an easy-to-remember, and easily applied, framework – see Figure 3. Cognitive aids were developed to help facilitate learning of this mnemonic and an "Event Manager Checklist" was created to facilitate designating roles effectively – see Figure 4 and Figure 5. Participants have been given this cognitive aid, designed as an ID badge-sized card, to easily access during their simulation course. In addition, the "Name-Claim-Aim" and "Event Manager Checklist" have been adopted by the Massachusetts General Hospital (MGH) (Boston, MA, USA) for inclusion on the latest version of their Emergency Manuals – see Figure 6, which are distributed throughout all anesthetizing locations and offsite healthcare facilities affiliated with MGH.
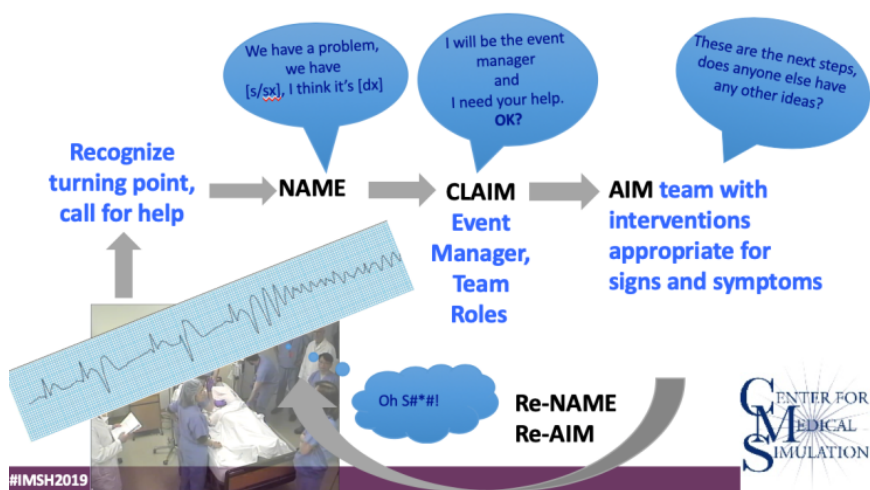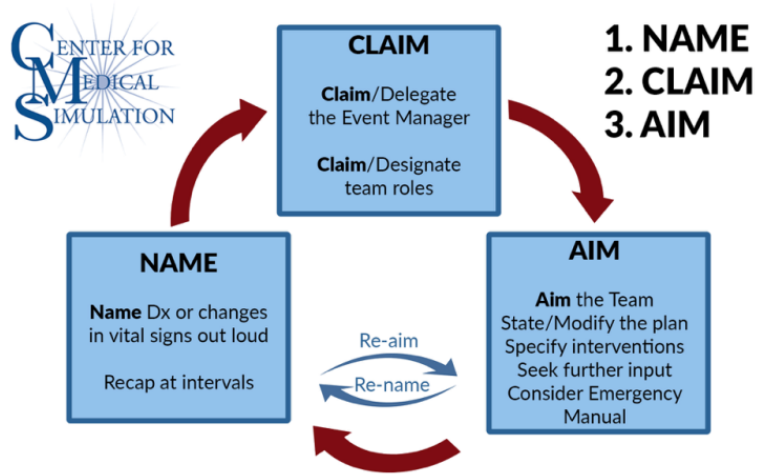

Fig. 3. Application of Name-Claim-Aim

Fig. 4. Name-Claim-Aim Cognitive Aid

BASIC Roles
1. Event Manager
2. Circulation -- CPR
3. Airway
4. Drugs
5. Recorder / Timer
6. Resource Person
Additional Roles
IVs, Fluids, Labs
Hx & Chart Review
Liaison w/ External Services & Phone
Security & Crowd Control
Technical Equipment
Monitor Watcher
Emergency Manual Reader

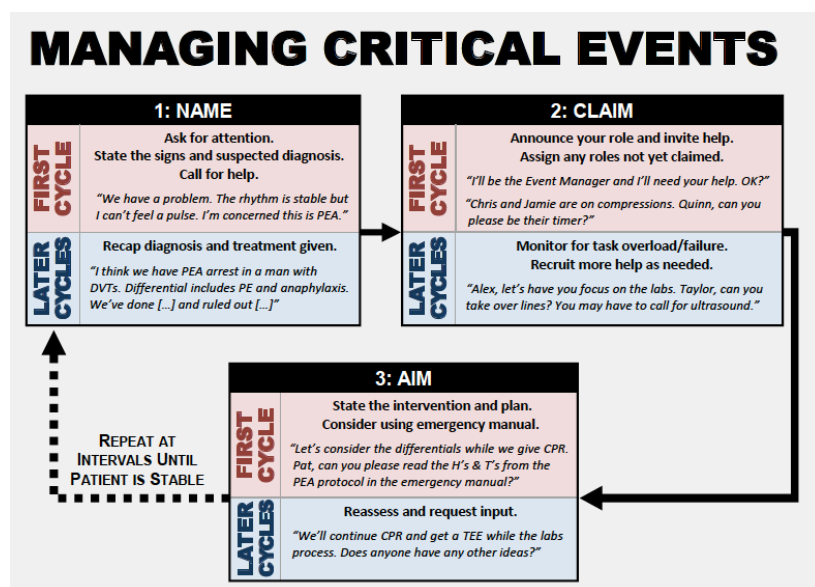**Fig. 5.** Name-Claim-Aim Cognitive Aid

Fig. 6. Massachusetts General Hospital (MGH) (Boston, MA, USA) inclusion of Name-Claim-Aim in the latest version of their Emergency Manuals

3 Interactive Videos and Rapid Cycle Deliberate Practice

Rapid Cycle Deliberate Practice (RCDP) is a novel simulation-based education model that is currently attracting interest, implementation, exploration and research in medical education. In RCDP, learners rapidly cycle between deliberate practice and directed feedback within the simulation scenario until mastery is achieved [5]. Common RCDP implementation strategies include: splitting simulation cases into segments, micro-debriefing in the form of "pause, debrief, rewind and try again" and providing progressively more challenging scenarios. During the Labor & Delivery program, clinicians are shown short dynamic videos: they are challenged to recognize a situation requiring rapid intervention, communication, knowledge sharing, decision-making and management of unforeseen events—taking into consideration critical contextual factors such as a lack of time, scarcity of resources and tools, and a multitude of impactful factors. Augmented and virtual reality technology is being used (e-REAL), enabling learners to interact with multimedia scenarios reproducing very different situations [6]. Learners are requested to be compliant with the Name-Claim-Aim mnemonic in order to manage the crisis by coordinating the team roles and efforts. The interactive videos feature unexpected clinical or non-clinical, emergent scenarios, including extreme, dangerous environmental threats – see figures 7-9.

In 2018, 51 experienced labor and delivery clinicians participated in RCDP within the e-REAL virtual environment, using Name-Claim-Aim for organizing a team to manage the crisis. These learners were highly positive about their experience. Some commented that they "loved the video rehearsals", "will practice the Event Manager

role", "will use Name-Claim-Aim in clinical practice", and "will apply the strategy of Name-Claim-Aim and establish role of the Event Manager". A few learners became so activated by the interactive videos that they performed CPR on an imagined person collapsed on the floor despite the absence of actual mannequins or other real equipment.

Fig. 7. The wall ready to operate as an interactive screen

Fig. 8. Videos' menu within a mixed reality setting

Fig. 9. Sample content: Home Fire Emergency

Fig. 10. Sample content: Clinical Emergency

4 Visual Storytelling, Effective Learning and Open Questions

The learning setting is an e-REAL system that helps create interactive virtual and augmented reality environments for advanced simulation. It is a system that allows a team to be immersed together in a mixed reality environment where they can interact with virtual projections in a natural way, that doesn't require them to wear headsets to be seen. The e-REAL technology, thanks to special projectors and touch-tracking cameras, turns simple walls and empty spaces into interactive environments controlled by the touch of the hand [7].

e-REAL is the output of an applied research project, still ongoing, started and supported by Logosnet in 2011, developed in collaboration with top research and simulation centers: CMS in Boston, Environmental Design and Multisensorial Experience Lab (EDME) from the Polytechnic School of Milan, SIMNOVA Medical Simulation

Center from the University of Eastern Piedmont in Novara, Department for Automation and Informatics (DAUIN) from the Polytechnic School of Turin, Training Center of the Red Cross of Italy in Bologna (CRIBO), National Research Council of Italy (CNR) and others.

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In the e-REAL environment, learners are immersed in different scenarios designed by visual storytelling techniques that allow them to practice handling realistic situations, rather than learning facts or techniques out of context. Much like being immersed within a videogame, people are challenged by facing real cases within complex scenarios that present a more than real wealth of information.

The system enables a multilayer vision: the many levels of the situation are made available simultaneously, by overlaying multisource info—e.g. words, numbers, images, etc.—as within an augmented reality display, but without the need to wear special glasses. Visualizations within e-REAL show relationships between topics, activate involvement, generate questions that learners didn't think of before and facilitate memory retention. So visualizations act like concept maps to help organize and represent knowledge on a subject in an effective way.

Fig. 11. Multilayer visualization

By visualizing relations between topics, contextual factors, cognitive maps and dynamic cognitive aids, e-REAL allows learners for the better use of the neural processes and for storing information into memories based on experiences. At the same time, it helps instructors to immediately identify errors and difficulties of the trainees facilitating an effective debriefing.

The project is ongoing and we are trying to answer two key questions:

- Is visual storytelling enabling more situational awareness, contextual intelligence and cognitive retention translating into a simulated clinical crisis?
- Does the association between visual storytelling and the mnemonic "Name-Claim-Aim" facilitate awareness and teamwork in a simulated clinical crisis?

So far, the early findings show that an interactive learning environment is an effective simulation tool for Labor and Delivery because it offers realistic scenarios that can be easily reconfigured to generate many different situations, including extreme and dangerous ones. Brain activity from thoughts, visualization, evocation of memories and emotions contributes to the learning process, mainly during the early stage of a simulation-based program.

5　More to Explore

We assume that functional changes in neural circuitry, associated with learning, occur best when the learner is actively engaged. We are currently working to introduce non-invasive technologies to monitor patterns of neural activity during the program delivery because the application of computational and quantitative behavioral approaches combined with functional brain imaging can reveal important information about the strategies employed by human brains to acquire, store, and retrieve information in a variety of tasks and settings.

Further questions we're aimed at answering are the following: How does a special class of brain cells, called mirror neurons, reflect the outside world, revealing a new avenue for human understanding, connecting, and learning? [8]. What happens when we learn a new action pattern? Do mirror neurons play a role in this? If so, may we learn just by mirroring? May the mirror system serve as a bridge that allows us to teach and learn new skills? The simpler the pattern, the easier the task? Can pattern recognition be applied to the most complex and even strange situations? Are emotions contagious? When we see someone laugh, cry, show disgust, or experience pain, are we sharing that emotion?

One of the most exciting events in neurosciences over the past few years has been the discovery of a mechanism that unifies action perception and action execution. The essence of this "mirror" mechanism is as follows: whenever individuals observe an action being done by someone else, a set of neurons that code for that action is activated in the observers' motor system. Since the observers are aware of the outcome of their motor acts, they also understand what the other individual is doing without the need for intermediate cognitive mediation [9].

Sets of mirror neurons appear to encode templates for specific actions. This property may allow an individual not only to perform basic motor procedures without thinking about them, but also to comprehend those acts when they are observed—without any need for explicit reasoning about them. Many aspects of imitation have long perplexed neuroscientists, including the basic question of how an individual's brain takes in visual information and translates it to be reproduced in motor terms. If the mirror neuron system serves as a bridge in this process, then in addition to providing an understanding of other people's actions, intentions and emotions, it may have evolved to become an important component in the human capacity for observation-based learning of sophisticated cognitive skills.

We are aimed at reaching a better understanding by performing experiments never done before in medical simulation.

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