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Benefits of CRM education and simulation in intensive care and emergency medicine

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First developed in aviation, CRM education facilitates prevention of accidents in medicine. Beyond the improvement of technical skills, the simulation can provide to learners the capacity to work with other team members, to pay attention to the work environment and to manage physiological or psychological constraints in critical situations.

Activity in intensive care and emergency medicine

Intensive care and emergency medicine are high risk departments where critical decisions and procedures are performed by multidisciplinary teams on vulnerable patients. Patients in the intensive care unit frequently suffer from multiple organ dysfunction that requires invasive support and multiple intravenous medications with rapid response rates required. Errors in such frail patients have a major impact on morbidity and mortality with an estimated 100,000 deaths each year in the U.S. due to medical errors (Kohn et al. 2000). Emergency and intensive care units teams have irregular working patterns, with long working hours and night shifts at irregular intervals. They are therefore frequently exposed to stress and fatigue. The skills required to deliver quality of care can be differentiated into technical and non-technical skills (NTS), both playing a crucial role in patient safety (Flin et al. 2008).

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Technical skills are generally taught and assessed properly in physicians' training with overall good performance. Nontechnical (social and cognitive) skills, on the other hand, suffer from lack of recognition and training in most countries. Deficiency in non-technical skills is often implicated in the occurrence of medical errors and serious adverse events (Catchpole et al. 2006). The development of simulation with high-fidelity human mannequins has transformed evaluation and training of non-technical skills with dedicated scales and specific simulation-based training programmes. Such programmes, derived from the aviation industry, are called crew resource management (CRM) training.

CRM education

CRM (Crew Resource Management [1]) training was first used by civil aviation after many deadly accidents in the 1970s (e.g. Tenerife airport disaster that killed 583 people). Lauber (1984) defines CRM as "using all the available resources (information, equipment and other people), to achieve safe and efficient flight operation". The main objective of CRM is to reduce accidents derived from human errors. To explain the increase of accidents in the aviation industry, we can enumerate the introduction of technology in the human activity (e.g. augmentation of complexity; Hollnagel 1991), and also the impact of human collaboration (e.g. communication between the exterior and interior of the cockpit or within the crew). In the literature, two concepts were identified to illustrate the human skills during their activities, namely technical skills (also named hard skills) and non-technical skills (also named soft skills). For Flin and colleagues (2003), the concept of non-technical skills includes cognitive skills (cooperation, leadership and managerial skills) and social skills (situation awareness and decision making), as being a complement of workers' technical skills. In medicine, medical errors are the third leading cause of death in the U.S. (Makary and Daniel 2016). The notion of error is quite complex (Reason 1990; Amalberti 2013), but we can consider that it contributes to accidents. For St Pierre, Hofinger and Buerschaper (2008), critical situations provoke errors, which can even lead to accidents. Flin and colleagues (2003) created a taxonomy, named NOTECHS (NOn-TECHnical Skills) to evaluate the good and bad practices of NTS in aviation. This work has been translated to surgery to design an evaluation scale of NTS in the teamwork operating theatre (Sevdalis et al. 2008). Many methods emerge from the medical domain to evaluate NTS in different specialities like anaesthesia (Fletcher et al. 2003). The objective of these methods is to evaluate the capacity of practitioners: (1) to work with the other membership or colleagues (e.g. communication or leadership), (2) to pay attention to the work environment (e.g. situation awareness) and (3) to manage physiological or psychological constraints (e.g. stress or fatigue). In their book Safety at the sharp end, Flin, O'Connor and Crichton (2008) formulated NTS into seven skills: situation awareness, decision making, communication, teamwork, leadership,

managing stress and coping with fatigue. For them, NTS represent cognitive, social and personal resources skills that complement technical skills and contribute to safe and efficient task performance. Indeed, the deficiency of technical knowledge is not enough to explain the occurrence of accidents. For example, the analysis of the case of Elaine Bromiley (Reid and Bromiley 2012) revealed a deficit in situation awareness and some wrong communication between the membership of the medical team, which led to bad decisions and the death of the patient. At the beginning of the 1990s, the crew resource management of aviation became crisis resource management for healthcare professionals, especially through the work of Gaba in anaesthesia (Gaba et al. 2001).

Advantages of simulation

In the medical domain, simulation is defined as the

use of a device, such as a mannequin, a task trainer, virtual reality, or a standardized patient, to emulate a real device, patient, or patient care situation or environment to teach therapeutic and diagnostic procedures, processes, medical concepts, and decision making to a health care professional.

Alinier (2007) classified different types of simulation. He delimited 6 levels of simulation teaching, from basic knowledge/no technology (pen and paper simulation; Level 0) to high knowledge and practice/advanced technology (high-fidelity simulation; Level 5, see **Figure 1**). High-fidelity simulation remains the most comprehensive to train non-technical skills, but learners need to have enough theoretical and procedural background knowledge to be effective. So, these different kinds of simulation should not be seen as opposed but complementary. Some bring knowledge (e.g. low-fidelity mannequin, software), others provide procedural know-how (e.g. high-fidelity simulation).

Figure 1. Classification of simulation (adapted from Alinier 2007), including examples of study focused on CRM Education in intensive care, emergency medicine and anaesthesia

At the end of the 1980s, Gaba and DeAnda (1988) developed a simulator in a real operating room to investigate decision making and human performance during critical situations in anaesthesia. This kind of simulation challenges technical skills but also non-technical skills (e.g. I stay calm in crises, I focus on priorities, I assume the role of team leader, etc.;) (Holzman et al. 1995). Among many advantages (see Cook et al. 2011), the simulation reduces errors and improves patient safety (Salas et al. 2005). Learners increase autonomy and self-confidence when delivering patient care after practising first with high-fidelity patient simulators (Peteani 2004). Recent technological advances allow learners to carry out interventions on high-fidelity mannequins (Maran and Glavin 2003; Cooper and Taqueti 2008), especially in intensive care (Campbell et al. 2009) or emergency medicine (Small et al. 1999). CRM courses facilitate improvement of NTS such as team working, leadership, communication or managing stress (Coker and Kass 2006; Naik and Brien 2013). CRM learning should be designed for each activity with multiple working supports, including theoretical courses and simulations. Professions such as intensive care or emergency medicine include some critical situations that generate stress and challenges. Physicians must be prepared in order to anticipate problems and complications with adequate communication (e.g. accurate, cordial), leadership/ team working (e.g. role distribution), situation awareness/decision making (e.g. avoid the tunnel effect) and to be preserved from emotional disorders. Apart from mannequin training (parts, low or high fidelity), we can mention the importance of advanced software in medicine. Computer-based applications are increasingly used to support learning in medicine. The technological improvement of virtual environments, virtual reality, and augmented reality creates an expansion of use in the medical domain (Barsom et al. 2016). For example, serious games have emerged in health professional training (Drummond et al. 2017), as in cardiopulmonary resuscitation thematic applications like CPR simulator or Staying Alive (see Wattanasoontorn et al. 2013). Some serious games can be used in CRM education (Barré et al. 2017). In this last study (ongoing project), the authors are improving NTS physicians' learning in postpartum haemorrhage (PPH) situation with PerinatSims software.

Perspectives

In this paper, we highlighted that education and teaching of CRM in medicine, mainly in critical situations, helps to reduce errors and accidents. Simulation is a virtuous circle for CRM; it provides evaluation of the skills of professionals (Kim et al. 2006) and at the same time improvement by training (at the end of evaluation a debriefing with the learners capitalises on the knowledge and the know-how). Simulation may improve specific NTS, such as communication (e.g. role playing), situation awareness or decision- making (e.g. serious game), but can also simulate situations that challenge all NTS (e.g. high-fidelity).

1. The first denomination was cockpit resource management used in 1979 in the NASA conference (Cooper et al. 1980).

Conflict of interest

Jessy Barré declares that he has no conflict of interest. Arthur Neuschwander declares that he has no conflict of interest. Antoine Tesniere declares that he has no conflict of interest.

Abbreviations

CRM crew/crisis resource management
NTS non-technical skills

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