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Lessons From Other Disciplines About Communication, Human Performance and Situational Awareness While Wearing Personal Protective Equipment

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Abstract

Introduction: The spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2/COVID-19) has quickly accelerated into a pandemic. As COVID-19 has swept across the globe, health systems have adapted, including the cessation of routine surgery and the re-deployment of staff to critical care settings. Prompt interventions such as endotracheal (ET) intubation, are deemed essential in patients with Acute Respiratory Distress Syndrome. Intubation requires a coordinated approach and effective teamwork, as it is a high-risk procedure not least because it is an aerosol-generating intervention with increased infection risk. As a result, teams responsible for performing ET intubation are required to wear Personal Protective Equipment (PPE), which in turn hinders communication and situational awareness, and can hamper team work.
Method: This review considers the effects of wearing PPE on performance and situational awareness in a healthcare environment. Drawing on literature from the fire service and military, the review will explore approaches to improving communication and situational awareness for teams who, at times, are unfamiliar with one another. The review will consider human factors and, identify approaches that assist teams, including teams that are unfamiliar with one another, to adapt to new ways of working while performing high-risk procedures.
Conclusion: Literature indicates that standardisation, pre-brief and training are important elements of developing improved situational awareness and team working in individuals whose senses may be affected by PPE. In addition, checklists provide a useful way of standardising procedures and can form the basis of a structured pre-brief. Checklists exist for both intubation and patient proning, which, alongside simulation-based team training, provide a useful method of preparing an often unfamiliar workforce for their roles during an epidemic or pandemic. The multi-phase nature of most pandemics provides an opportunity to review processes and implement such procedures, and to develop staff using team-based training during the post-peak period.

Keywords

infectious disease, personal protective equipment, communication, team work, situational awareness

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There are more than 100 infectious disease outbreaks globally per year (World Health Organization [WHO], 2019). Many of these will require staff to wear Personal Protective Equipment (PPE) to reduce the likelihood of them being infected and passing the infection to others. The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2/COVID-19) in December 2019 has resulted in a global pandemic affecting almost every country on the planet (Mahase, 2020). COVID-19

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presents in some patients as a critical life-threatening illness characterised by Acute Respiratory Distress Syndrome (ARDS) and bilateral pneumonia. Many patients with COVID-19 require swift intervention in terms of airway management, resulting in endotracheal (ET) intubation and critical care (WHO, 2020b). The outbreak of COVID-19 has demanded a rapid coordinated response and a re-focus on approaches to team working that need to consider both technical skills and non-technical human factors. Successful ET intubation normally carries a degree of risk as well as requiring technical expertise, alongside situational awareness. Given the highly contagious nature of COVID-19 and the high viral load in the airway, securing an airway poses significant risk for the team performing intubation (Weissman et al., 2020). In order to safely prevent human-to-human transmission of COVID-19 between the healthcare team and the patient during an aerosol generating intervention, it is essential that the team members are appropriately protected by wearing PPE. Typically, PPE includes: a respirator (a Filtering Face Piece - FFP3) mask, visor to completely shield face and mouth, gloves and gown. However, once donned, PPE compromises the ability to communicate and share knowledge easily, or to visually recognise individual team members, some of whom might be unfamiliar from the outset. Furthermore, the ability to communicate effectively through verbal and non-verbal means is impaired. Ordinarily, effective communication supports safety and reliability, but the extreme and high-risk situations presented by COVID-19, compounded by the wearing of PPE and on occasion, unfamiliarity with team members, demand a departure from the usual social norms (Minehart et al., 2012). While respirators protect humans, they can impose other risks and decrease performance (AlGhamri, 2013). Past research highlights how certain types of respirators have the potential to inhibit the user's work performance, impairing physical and psychomotor adeptness, decreasing the ability to respond to facial cues or verbal commands and increasing anxiety (Caretti et al., 2001; Wu et al., 2011). Full-face visors or goggles can also impede 360 degree vision as well as partially blocking eye contact, which plays an important role in verbal and non-verbal communication.

While critical care is a multi-disciplinary endeavour, the nursing workforce often provides the majority of one to one care for patients. In addition, many critical care nurses are in leadership roles within departments and therefore are in a position to influence the actions and behaviours of others. The development of 'surge capacity' as part of pandemic planning is been led by nurses and they are ideally placed to include interventions which can improve team working and situational awareness.

This review aims to consider the effects of wearing PPE on performance and situational awareness in a healthcare environment where teams are operating under such extreme and challenging circumstances. The review will also examine strategies, which can be used to improve team working and situational awareness. Literature from other professions, notably the military and fire service, will be used to explore communication, team performance and situational awareness in high risk and high-pressure environments. Before exploring the literature from other professions, we will examine the key concepts of situational awareness and team performance. The use of mental rehearsal, checklists, pre-brief and simulation will be explored as a way of addressing the issue of situational awareness when working within unfamiliar teams and in PPE.

Key Concepts

The terms situational awareness (SA) and sense-making are often used interchangeably and are defined as essentially having the same meaning (Klein et al., 2006). Approaching the definition in the context of *sense-making* – in contrast to the traditional SA approach – considers underlying goal-directed behaviours, such as the problem-solving context, shared understanding, assumptions, and expectations that affect human performance (United States Department of Energy, 2013). A sense-making SA approach is *"the ability to make sense of an ambiguous situation. It is the process of creating intelligence and understanding to support decision-making under uncertainty—an effort to understand connections among people, places, and events in order to anticipate their trajectories and act effectively"* (Klein et al., 2006, p. 71). Using such an approach in times of uncertainty addresses challenges through prioritisation and provides clarity to support decision making, and understand what matters through meaningful relationships. A sense-making SA approach focuses on awareness, practices, procedures, communication and thought processes. Furthermore, it considers the relationship between the person and their environment and context, and how complex information can be broken down into coherent and manageable steps.

Situation awareness, in a nursing context, relates to perception and awareness of changes in a patient's condition, which may affect their health and well-being. This could include awareness of physical deterioration in the patient's condition where the nurse would be expected to identify changes in vital observations. Analysis of failure to rescue deteriorating patient events (Burke et al., 2020) reveals that nurses may fail to recognise patient deterioration because of workload, fatigue, distractions and cognitive overload. Such failings can be attributed to reduced situational awareness.

Situational awareness is one of a number of clinical human factors. Clinical human factors are defined as organisation, environmental and role characteristics, which can influence behaviour in ways that can influence patient safety (Ives & Hillier, 2015). Examples of individual human factors include cognitive overload, fatigue and information processing. Whereas, Team and group human factors include workload, staffing levels, leadership and team working. Situational awareness applies at both the individual and the team level within a human factors framework.

Endsley (1995) identified a model of situational awareness consisting of three hierarchical levels: perception, comprehension and future decisions. At Level 1 is the perception of the current status and dynamics of various elements in the environment. Once perceived, the decision maker must comprehend the significance of each of these elements (Level 2) then project forward to predict future actions (Level 3). This model is of significance in relation to team functioning because factors such as an individual's goals and expectations can influence where they direct attention. This reinforces the need for a shared understanding of the team's goals and function. Stanton (2016) describes how Distributed Situational Awareness assumes that situational awareness is not an individual endeavour but the result of a complex socio-technical system where individual agents share responsibility. This introduces a range of other factors including those associated with task complexity and workload, team attributes such as team cohesion and attitude, and the team's ability to work collaboratively alongside a host of individual factors such as experience, training and individual goals and role (Salmon, 2009). This suggests that team situational awareness is highly complex and requires a degree of experience, a shared mental model and a mutual understanding of the team's role and the task to be performed.

MacMillan et al. (2002) studied team performance and team structure over a six-year period in the United States Navy. They identified that situational and contextual awareness were important factors in team performance. High performing teams shared information about the situation the team were working in as well as information about each other as team members. Further, the study argued that a shared mental model was important as it reduced the team's need to communicate with each other and, where communication did take place, it was more efficient and targeted. A shared mental model relates to both the task(s) to be performed and the role of each member of the team. The study went on to empirically examine teams that were optimised for their mission (role) and those that were not optimised. They found a reduced need for co-ordination and communication in the optimised team when compared to the non-optimised team. The optimised team also had a higher anticipation rate, suggesting increased situational awareness when on task.

Communication and situational awareness can be impaired by a variety of factors such as background noise, distractions, cognitive load and selective attention to a single task. These factors may be compounded by PPE because of a reduced range of vision from hoods and visors and a reduced ability to hear spoken words and read facial expressions. In a qualitative systematic review, Houghton et al. (2020) reported, with moderate confidence, that a number of healthcare workers reported reduced ability to communicate while wearing PPE and this was one of the reasons cited for poor compliance with PPE in a clinical setting. In addition, situational awareness is of greater significance in an emergency as the speed of information processing and response in heightened. In addition, there is less time to correct errors and to reduce distractions and cognitive overload.

PPE, Communication and Situational Awareness in Other Professions

The fire service uses PPE regularly in high risk and high-pressure situations. Few studies have examined the use of Breathing Apparatus (BA) and team functioning, although one study, conducted in Sweden by Lindgren et al. (2007), examined team performance, shared understanding and communication between pairs of Fire Fighters wearing breathing apparatus. The study involved the collection of verbal radio communications between firefighters and observations at the Fire Departments training facility (14 exercises). Qualitative interviews with 28 firefighters were also conducted after the training exercises. The verbal communication and observations were analysed to identify the nature of communication and team working and the interviews provided insight into how standard operating procedures and shared mental models shaped the rescue operation. The researchers acknowledged that fire fighters wearing BA need a shared understanding of the situation, what colleagues are doing and what might happen next even when spatially separated during BA rescue operations. They identified that in large operations, fire fighters from many different stations may be on site and, as a result the notion of a shared understanding may be impaired. The lack of standardised communication was a factor that impacted on team functioning and safety but the notion of communal common ground helped unfamiliar teams to function even when individuals did not know each other. The research postulated that 'communal common ground' was formed through teams being trained in the same way and having a common

understanding of how fire fighters work and function during emergencies.

Lindgren et al. (2007) noted changes in communication both between fire fighters during search and rescue and with the BA control officer (who monitors staff in a building, location and time). While BA allows communication via a built-in radio set, the physical demands of the task and need for speed result in a significantly changed communication style. Communication was described as 'blunt and to the point', dispensing with any niceties associated with day-to-day communication. Utterances were described as short and concise, and often procedurally related. This finding is interesting as it requires a shared understanding of the task at hand, what communication is appropriate, and how it should be sent and received.

The same study found that the fire fighters used a standardised format for search and rescue, initially developing awareness of a reference room with two fire fighters working together and then moving out to either search as a pair or conducting close search individually. The team established points of reference during search, which were important spatial clues that assisted with the evacuation of the building. The skills associated with establishing common ground and the standardisation of search formed key components of developing situational awareness.

Li et al. (2014) studied situational awareness among fire fighters when arriving at a fire as first responders. The research utilised a desktop simulation, which was used to examine firefighter's information requirements for a given scenario. The researchers went on to conduct semi-structured interviews ($n = 10$) and they then used these interviews to develop a survey which was completed by 283 firefighters from across four boroughs. They found that fire fighters were often faced with chaotic scenes on arrival and that decision making required rapid situational awareness. Some information was often available in advance and that, coupled with memory and experience, allowed people to make judgements and decisions quickly after arrival. The importance of memory and experience in situations has been identified in other disciplines, notably in management (Dreyfus, 1982), where a given situation can be matched with a prototypical situation from memory, allowing for rapid analysis and decision making. The use of memory and experience is noteworthy as it may be possible to provide teams with experience of relatively rare and high-risk events through simulation.

The issues faced by firefighters are similar to the situations faced by health professionals in emergencies both during a pandemic and in normal day-to-day healthcare settings. These include rapidly assembled teams, where team members are unfamiliar with each other, the use of structured communication systems such as structured handoff and the development of shared mental models and structured approaches to care through team training and the use of checklists. The issues are common across healthcare professions, so for example, a cardiac arrest team will be drawn from different departments within a hospital and the team members may be unfamiliar with each other. While situational awareness is relevant to all aspects of practice, the need for rapid processing of information and decision-making makes situational awareness more risky in an emergency.

Given the issues identified amongst firefighters, in terms of team unfamiliarity, shared mental models, standardised approaches and training, the next section will explore approaches to addressing the issues associated with situational awareness and team working amongst nurses and other staff in the critical care environment.

Approaches to Preparation and Practice

Having identified the approaches used by professions outside of healthcare, we will now explore how practice should be improved to accommodate changes to team composition and performance as well as issues around communication when team members are wearing PPE. Clearly, team members need clinical knowledge as well as technical skills to be able to understanding and manage the clinical complexity of COVID-19 patients. At the same time, individual practitioners need to function together as a high performing competent team to carry out interventions and high risk procedures. With the widespread re-deployment of staff to cope with the surge of cases (WHO, 2020a), critical care teams are often made up of individuals with different levels of skill and experience. It is not uncommon for teams to include individuals i.e. outsiders, who are not known to the (usual) core team members. This lack of familiarity poses problems in terms of shared understanding and communication, which in turn is further hampered by the wearing of PPE.

The literature from other disciplines suggests that standardisation of protocols and team training (Lindgren et al., 2007), together with checklists, can be useful in high-risk situations with potentially reduced situational awareness and reduced team familiarity. Such approaches are used in the training of firefighters to help develop a shared mental model of operating on a fire-ground. Within healthcare Standard Operating Procedures have been developed for both intubation (Sherren et al., 2014) and proning the intubated patient (Intensive Care Society & Faculty of Intensive Care Medicine, 2019; Oliveira et al., 2017). Both of these procedures carry considerable risk and effective teamwork is essential so that both procedures can be carried out

quickly and safely thereby minimising risks to both the patient and the health professionals. These checklists promote the sharing of information pre-procedure, the identification of risks and the planning of a standardised approach to the procedure. Such checklists provide a structure for a tailored pre-brief, which in turn leads to the development of a shared mental model. Such structured pre-briefs also allow team members to work at pace within a flattened hierarchy while maintaining both patient and staff safety during high-risk procedures.

Pre-briefings are short team meetings held prior to starting work which are used to familiarise team members with roles, responsibilities and team composition as well as to discuss priorities, risks and safety concerns prior to commencing an interventions (Leonard et al., 2004). Allard et al. (2011) conducted a study to investigate whether pre-surgery briefings altered patient safety attitudes amongst staff. Using three, Patient Safety Attitude Questionnaire over a three-year period they found that those staff who had participated in pre-surgery briefings had a better safety attitude than those who had not.

Team training has been shown to be effective at improving team processes, decision making and patient outcomes. Weaver et al. (2014) conducted a systematic review of the effectiveness of team training in terms of team effectiveness and patient safety. They identified 13 papers published between 2000 and 2012 and of these 10 demonstrated significant improvements in team working and decision-making. Team training can be either classroom scenario based or it can use simulation. Team training needs to be undertaken as soon as possible after a new team is formed or when new team members join an established team.

Alongside the use of checklists and pre-brief, evidence-based team training concepts, such as simulation, are frequently used to educate health professionals, supporting interdisciplinary collaboration, communication and improvements in teamwork (Awad et al., 2005; Torring et al., 2019). Morgan et al. (2015) also recommend team training focusing on human factors, the use of clinical drills to prepare staff for unusual events, and post-event debriefing to evaluate team performance and identify areas for improvement. Systematic, continuous and sustained team training can have positive effects that contribute to improved performance, a safer working environment with fewer errors, and a reduction in mortality and morbidity (Armour Forse et al., 2011). Implementation and sustainability of team training approaches in a hospital setting usually encounters several barriers (Torring et al., 2019), not least the ability to operationalise a training event that has to consider multiple variables in terms of interdisciplinary attendance. Given its speed of transmission between humans and the level of PPE necessary to safely manage the risks of COVID-19 transmission, a rapid response is needed in terms of team training. The nature and complexity of COVID-19, coupled with uncertainty and fear requires a response similar to that of preparing interdisciplinary teams for major trauma events and natural disasters. Interdisciplinary teams that come together to manage such events and disasters are described as 'flash teams', with the expectation that they must form quickly and function effectively, often having never met before (Murphy et al., 2019). With this in mind, a simulation-based 'flash team' training approach has been utilised in some settings to prepare individuals in technical and non-technical skills to develop interdisciplinary collaboration, communication and situational awareness for emergency management. Simulation-based in-situ training enabled rapid deployment of key training scenarios, skills and strategies to support an effective level of competence and safety during ET intubation.

Buljac-Samardzic et al. (2020) conducted a systematic review of interventions to improve team effectiveness in healthcare. They searched databases between 2008 and 2018 and identified 6025 studies of which 297 met the inclusion criteria and were then subject to review. Buljac-Samardzic et al. (2020) identified that studies revealed four types of intervention; training and simulation, the use of tools and checklists, organisational redesign and studies involving a combination of approaches. The researchers found that training and simulation had the strongest evidence of effectiveness in improving team functioning.

It is crucial that emergency situations in healthcare are based on fact and coordinated at pace to respond efficiently to the presenting challenges. To achieve this and avoid chaos, team training needs to include concepts central to effective teamwork, such as shared situational awareness (SSA), respect, fluent communication and critical information sharing, all of which support a common operational overview (Seppänen et al., 2013). In a healthcare team environment, SSA *"is the understanding of elements of the situation that two (or more) individuals have to share in order to achieve their interrelated tasks"* (Prébot et al., 2018, p. 2). Team members must have a shared understanding of what is happening and an opportunity to consider what might happen next.

The goal of in-situ simulation training is to bring together individuals from different clinical backgrounds, who have been identified as having the transferrable technical skills to support, if necessary, safe ET intubation of patients with COVID-19. In-situ simulation training allows for mental rehearsal and task visualisation (Yiasemidou et al., 2018). Through repeated rehearsal, the task becomes increasingly automatic, requiring less cognitive processing, which leaves residual cognitive capacity to process and react to sudden and

unpredicted events (Hearns, 2019). In the case of transferable diseases, this can minimise the consequences of cross contamination and save lives. In terms of pandemic preparedness, the recommended approaches are rapid team training using simulation followed by pre-shift pre-brief and the use of checklists for high-risk procedures.

Conclusion and Importance to the Nursing Profession

While critical care is a multi-disciplinary endeavour, nurses make up a large proportion of the workforce and the nurse-patient ratio means that nurses spend a considerable amount of time at the bedside providing care to patients. The response to the COVID-19 pandemic has resulted in the development of 'surge' capacity within many countries. This surge capacity includes the re-deployment of anaesthetic nurses and others with experience of caring for ventilated patients to COVID-19 wards, providing increased capacity for ventilation of the critically ill. As a result, hospitals are increasingly seeing teams, temporally formed with transient members who are often unfamiliar with their role and with each other. This adds to the stressors on registered nurses and places them and medical colleagues in a difficult position of working as a newly formed team. Rapid pre-brief, using checklists and simulation-based training, can be used to promote safe and effective team working, particularly when performing aerosol generating and other high risk procedures. Reinforcing the use of pre-brief, checklist together with practice via simulation will serve to embed the new approaches and to affect a culture change towards improving patient safety through standardised care and minimising the impact of human factors on errors in care delivery.

Most pandemics consist of more than one wave of infection and the period between the first and any subsequent wave – referred to as the post-peak period (WHO Office for Europe, 2020) – provides an opportunity for a rethink about how to configure services and teams. The post-peak period needs to be more than a period of recovery and reflection; it needs to ensure that lessons from the first peak are learned and that systems and process improve.

Standard Operating Procedure for Intubation

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