Non-technical skills for emergency incident management teams: A literature review

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Abstract

Every year incident management teams (IMTs) coordinate the response to hundreds of emergency events across Australasia. Larger scale emergencies such as a storms, floods, wildfires, oil spills and chemical explosions can place a lot of pressure on an IMT. Non-technical skills play a central role in the performance of these teams. This article reviewed the broader non-technical skills (NTS) literature before focusing on the NTS required for emergency management. It was found that most NTS frameworks share four to five common skill categories, although there were greater differences at the element and behavioural marker level. A variety of issues were identified in the literature that highlight that emergency management is very different from other domains where NTS systems have been developed. The literature on NTS in conjunction with this set of issues was used to develop a proposed NTS framework for emergency IMTs. This framework comprises 7 skill categories (i.e., communication, coordination, cooperation, decision-making, situation awareness, leadership, and coping, stress and fatigue management). The 7 skills can be further delineated into 16 elements, and 44 behavioural markers. The framework provides a prototype that can form the basis for further research in this area.

Keywords: non-technical skills, emergency management, incident management, teamwork, decision-making, teams.

Introduction

Incident management[1] is defined by the Australasian Fire and Emergency Service Authorities Council (AFAC) as 'those processes, decisions and actions taken to resolve an emergency incident and support recovery that will enable the community to return to normality' (AFAC, 2017, p. 8). Incidents may involve natural hazards such as storms, floods, earthquakes, tsunamis or wildfire; be created by human activities such as oil spills and chemical explosions; or can be intentional, as in the case of terrorism (Owen & Hayes, 2014). Incidents vary significantly in scale, complexity, and duration. The most complex and challenging events may require the services of a 30+ member Incident Management Team (IMT) and take many days, weeks or even months to contain during the response phase. The recovery phase can last much longer.

IMTs are hierarchical workgroups of trained personnel who work together to contain and resolve emergencies (McLennan, Holgate, Omodei, & Wearing, 2006). Most jurisdictions have developed doctrine to guide the operations of IMTs (Bigley & Roberts, 2001; Moynihan, 2009). Occasionally IMTs may be deployed in a support role to a lead agency such as the case following the 9-11 attack on New York when wildland fire IMTs were deployed to support the city (Maynes, 2009). The size and type of IMT deployed depends on the complexity and scale of the emergency. In addition to an incident controller, deputy, and safety officer, IMTs comprise functional officers leading sections such as planning, intelligence, investigation, public information, operations, logistics, finance and administration (AFAC, 2017; US Fire Administration, 2016).

The effectiveness of an IMT is dependent on the ability of team members to interact successfully, make sound decisions, and maintain appropriate awareness of what is going on (Hayes, 2014; McLennan et

[1] In some jurisdictions the word incident refers to everyday small emergencies and in others it refers to major emergency events which is the way the term is used here.

al., 2006; Power, 2018). These types of capabilities, often called non-technical skills (NTS), are especially important for IMTs as they operate in dynamic, high consequence, and uncertain contexts. The NTS required by those working in IMTs to manage the event during the response phase are the focus of this paper.

Review of previous large scale emergencies highlights that the early performance of the IMTs coordinating the response is central to whether the incident continues to escalate or is more quickly contained (Flin, 1996; Lagadec, 1993). Incidents such as Three Mile Island, Chernobyl, Piper Alpha, Channel Tunnel fire, and Deepwater Horizon highlight a range of problems and issues with the NTS performance of people who were managing the incident (Crichton & Flin, 2004; Reader & O'Connor, 2014). At an individual level inadequate situation awareness, poor decision-making, and adverse reactions to stress have been common issues. Crichton and Flin add that at the team level, a lack of role clarity result**ing** ~~ed~~ in tasks not being completed and ~~that~~ ineffective communication were common issues. During the early phases of the Deepwater Horizon response, for example, there was confusion around who was directing the fire-fighting operations and initial progress on the incident was undermined by communication and coordination issues (National Oil Spill Commission, 2011). Similarly, research conducted with IMTs managing bushfires **(wildfires)** underlines this point, highlighting various NTS issues (Bearman & Bremner, 2013; Bearman, Grunwald, Brooks, & Owen, 2015; Brooks, Curnin, Bearman, & Owen, 2018; Brooks & Owen, 2013; Grunwald & Bearman, 2017). Bearman and colleagues have highlighted issues such as breakdowns in communication, disconnects in the understanding between team members, uncoordinated decision-making, and decision errors. Drawing from evidence presented to the 2009 Victorian Bushfires Royal Commission, Brooks and Owen (2012) highlighted that deficits in NTS and the adverse impact of fatigue created significant issues for the management of these bushfires.

In a UK study, Wilkinson, Cohen-Hatton and Honey (2019) illustrated issues related to coordination and decision-making in multi-agency Strategic Coordinating Groups (SCG) during simulated regional exercises and a large scale, multi-day exercise The SCGs use a common multi-agency decision-making model (Joint Emergency Services Interoperability Principles, 2019). The authors found marked differences in the decision making process between SCGs resolving identical incidents. The SCG decision-making reflected more intuitive than analytical processes and paid limited consideration to alternative courses of action and contingencies. In a case study examining the decision-making of an urban search and rescue commander deployed to Fukushima in 2011 following the tsunami and nuclear power plant melt-down (Curnin, Brooks & Owen, 2020) found that when faced with an unprecedented event the commander used both analytical and intuitive skills to detect anomalies.

Given the demanding nature of incident management it should be no surprise that practitioners face various problems with NTS such as situation awareness, communication, decision-making, teamwork, and stress and fatigue management. It is important to recognise that incident management personnel will face significant challenges and need to develop processes to quickly identify and resolve such issues before they impact on operational outcomes (Flin, O'Connor, & Crichton, 2008). This will be particularly important into the future as the effects of climate change mean that we are increasingly experiencing larger and more complex emergencies (Bosomworth, Curnin & Owen, 2017; Mach, Mastrandrea, Bilir, & Field, 2016).

To date limited published research has focused on the NTS required by teams who are coordinating and managing the response to large scale emergency incidents. The purpose of this paper then is to address the question “What are the most important non-technical skills required by IMT members?” by examining the published literature on NTS in emergency management and other high reliability industries. While there is limited research in NTS in large scale incident management (see Brooks, Curnin, Owen & Boldeman, 2019 for an exception) a more extensive literature has been developed from research undertaken in other domains such as aviation, healthcare, maritime, rail, nuclear energy, oil and gas, and military (Flin, O'Connor, & Mearns, 2002; Thomas, 2018). Through this review of the existing broader literature we highlight important insights on the nature of NTS and how they may best be identified, developed, and assessed for emergency IMTs.

The review commences by defining NTS and the related concept of crew resource management (CRM). This provides the foundation for the following sections that focus on NTS in aviation, maritime operations, military, healthcare, organisational research, oil and gas, and nuclear energy. The third section focuses specifically on NTS and CRM in emergency and incident management. The fourth section highlights various issues identified in the literature that affect the development and operationalisation of NTS in this domain. The fifth section draws from the behavioural indicators from four NTS studies to derive a proposed set of NTS for incident management.

1.What are non-technical skills?

NTS are defined as the ‘cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance’ (Flin et al., 2008, p. 1). Although the term NTS is relatively new, the concept has been an important part of professional practice in various work domains for many centuries (Thomas, 2018). For example, in the case of mariners not only is there the requirement for technical skills to successfully pilot a vessel on the correct course and use sails (or propulsion) efficiently, but there is the need for ‘seamanship’ to monitor the changing sea and weather conditions, effectively coordinate crew, and make appropriate decisions to ensure a safe and efficient passage. Thomas observed that the term seamanship in essence captures the NTS required to be a safe and successful mariner.

Similarly in aviation, there is a division between the technical ‘stick-and-rudder’ skills required to pilot the aircraft versus the complementary NTS, also termed crew resource management (CRM). The term CRM is used to describe the NTS used by aircrew but also more generally to describe the training programs used to develop and enhance these skills. NTS such as communication, situational awareness, and decision-making help reduce and capture errors, and enable the crew to more effectively respond to operational problems (Helmreich, Klinect, & Wilhelm, 2003). It is generally recognised that most technical professions have requisite NTS, sometimes labelled as ‘soft’ skills (Bancino & Zevalkink, 2007).

Flin and colleagues have played a leading role in the research translating CRM into domains beyond aviation and in identifying the NTS required in healthcare and incident management settings (e.g., Flin et al., 2008). These authors advocate a standard taxonomy to describe a set of NTS for a particular domain, comprising a hierarchy of NTS categories, elements, and behavioural markers (i.e., positive and negative). The anaesthetists’ non-technical skills (ANTS) system shown in Figure 1 provides a good example of this.

Figure 1. About here

The Flin et al. (2008) guide to NTS identified a generic set of seven NTS categories for higher-risk occupations, namely situation awareness, decision-making, communication, teamwork, leadership, managing stress, and coping with fatigue. As the subsequent discussion illustrates, four or five of these categories generally feature in most published sets of NTS. However, Flin et al. have stated that although broad (generic) categories of NTS can be identified; the elements and behavioural indicators for each category vary widely between different occupations and work settings. Moreover, the differences in the underlying elements and behavioural indicators generally make it inadvisable to apply an NTS taxonomy or behavioural marker system from one work setting to another without carefully examining the similarities and differences between the settings and the proposed use of the taxonomy.

Flin et al. (2008) observed that the development of an NTS taxonomy requires the use of a two-stage process. First, identify the skills and related behaviours required for safe and efficient performance. Second, refine and organise the resulting list into a hierarchical structure or taxonomy. The three techniques generally used to identify NTS are: event-based analysis (e.g., accident and near-hit analyses, confidential reporting systems); questioning techniques (e.g., interviews, focus groups, and surveys); and observational techniques (e.g., direct, participants, and remote (via video)) (Flin et al., 2008). One further technique that can be used to identify NTS is hierarchical task analysis (HTA) (Annett, Cunningham, & Mathias-Jones, 2000). HTA is more of a hybrid approach and may use a combination of event-based, questioning, and observational techniques (see Stanton, 2006 for an overview).

In his review of the assessment of NTS Thomas (2018) highlighted that NTS are more difficult to measure than technical skills. This is especially the case for cognitively-oriented skills such as decision-making and situation awareness (Flin & Martin, 2001). From an incident management perspective, the skills required to work successfully on an IMT can be conceptualised on a continuum from team to task oriented as shown in Figure 2.

2.The genesis of non-technical skills and CRM in high-reliability domains

Over the last 40 or so years there has been growing awareness of the important role that NTS play in managing complex systems and events (Shields & Flin, 2013). Recognition of the central role NTS play in team performance has occurred in a variety of domains. This section briefly outlines NTS and CRM in the aviation, maritime, military, healthcare, and organisational literatures. Some examples of the types of NTS and CRM programs used in these sectors are provided in Table 1. The table also includes the Flin et al. (2008) generic NTS discussed in the previous section as a comparator. As can be seen the types of NTS identified for each sector are similar, although the hierarchy of NTS types and elements does vary between domains. For example, communication is considered an element of cooperation in the maritime sector whereas in health it is an NTS category.

Table 1. *About here*

Aviation

Aviation was one of the first sectors to recognise the important role played by NTS (Kanki, Anca, & Chidester, 2019). Research in the late 1970s highlighted the role that various aspects of human error played in the majority of air crashes (Cooper, White, & Lauber, 1980). Failures of flight crew communication, decision-making, and leadership were identified as particular shortcomings. The concept of cockpit (later crew) resource management was proposed to address this (Helmreich & Foushee, 1993). The idea being that improved training of flight crew could reduce pilot error by enabling better utilisation of the human resources on the flight deck. CRM programs have continued to evolve and become standard training practice across civil aviation (Helmreich, Merritt, & Wilhelm, 1999). The goals of CRM programs is to enable pilots to develop the cognitive and social skills (i.e., non-technical) essential for safe and effective flight operations (Flin et al., 2003; O'Connor et al., 2008). As CRM evolved to become standard practice, researchers developed measures to help airlines assess whether CRM was being translated to improved on-the-job performance and to assess the quality of their flight crews' NTS (Klinect, Murray, Merritt, & Helmreich, 2003). Two examples of the assessment frameworks used to monitor aircrew NTS are the line operations safety audit (LOSA) (Tesmer, 2010), and the pilot's non-technical skills system (NOTECHS) (Flin et al., 2003). A summary of the NTS categories identified in NOTECHS is shown in Table 1.

Maritime operations

During the late 1980s and early 1990s the maritime sector began to recognise the important role human factors were playing in shipping accidents (Haywood & Lowe, 2010). Accident investigations such as the 1992 QE2 grounding off Martha's Vineyard highlighted the need for maritime CRM to better utilise the resources on the bridge of ships. The NTSB (1993) QE2 accident report highlighted that most groundings, rammings, and collisions could be attributed to a core of problems related to the failure of the bridge team to: adequately plan, execute, and monitor the vessels navigation; establish clear lines of communication within the bridge team; effectively utilise all of the resources available; properly prioritise tasks and responsibilities; and respond to unexpected situations. The NTSB report noted that the addition of a local pilot to the bridge created further potential obstacles to effective bridge team coordination and communication.

During the 1990s the International Maritime Organization became increasingly concerned with the 'human element' in maritime accidents and recognised that the study of human factors was important in helping to improve safety (Grech, Horberry, & Koester, 2008). During this period organisations such as the Warsash Maritime Centre in Southampton (UK) were continuing to develop their early maritime versions of CRM as part of their simulator-based officer training (Haywood & Lowe, 2010). This training included topics from aviation and other industries and became known as Bridge Team Management (Barnett, Gatfield, & Pekcan, 2004). During 1992, seven major maritime bodies collaborated with Scandinavian Airlines System Flight Academy to develop a maritime sector training initiative called Bridge Resource Management (BRM) based on aviation CRM principles (Dijkhuizen, de Butter, & Koning, 1996). BRM quite quickly became well established across the global maritime industry (Haywood & Lowe, 2010).

In 1995 the IMO revised the Standards of Training Certification and Watchkeeping (STCW) Code to recognise the need for NTS training and competence. The STCW described this requirement as 'competence in crisis management and human behavior skills for senior officers who have responsibility of passengers in emergency situations' (STCW Code Table A-V/2). However, this initial move towards the adoption of NTS was somewhat limited as it did not outline what human behaviours were required or indicate the required competence level (Hetherington, Flin, & Mearns, 2006). Hetherington et al. (2006) noted that there was a clear gap in the literature regarding the causal factors underlying maritime accidents. Until the time of their research, there had not been a comprehensive review of the literature to aggregate the causal factors leading to shipping accidents. Hetherington et al. reviewed 20 studies from the maritime sector and highlighted the role that fatigue, stress, health, situation awareness, decision making, communication, and teamwork play in maritime safety performance.

In 2010 the Manila amendments were made by the IMO-to the STCW-Seafarers Convention and Code (Wahl & Kongsvik, 2018). From the maritime sector's perspective these were very important changes because they significantly increased the teamwork competency requirements for seafarers. These changes strengthened the training requirements to include bridge or engine-room resource management (BRM/ERM) **or** human element, leadership and management (HELM) principles in the minimum standard of competence for maritime officers and engineers (IMO, 2011). These principles include the NTS of assertiveness and leadership, decision-making, situation awareness, and effective communication.

Orlandi & Brooks (2018) applied the NASA TLX scale to assess mental workload of marine pilots and identified critical indicators of an upper redline of task demands. In addition there has been some work examining communication directives within bridge teams to identify risks (John, Brooks & Schriever, 2019). A summary of the NTS identified for BRM training is shown in Table 1.

The military

Although military research into teamwork stretches back to the 1950s, interest in NTS for military researchers increased following the accidental shooting down of an Iranian Airlines passenger jet by the US Navy (Ilgen, 1999). This event (amongst others) helped spur the development of the Tactical Decision-Making Under Stress (TADMUS) research project (Cannon-Bowers & Salas, 1998). The TADMUS researchers utilised concepts from aviation CRM and worked on improving individual and team decision-making, developing more effective team skills, and enabling the provision of enhanced decision support systems for naval warfare teams (Collyer & Malecki, 1998; Goodwin, Blacksmith, & Coats, 2018). The training programs and strategies developed during the TADMUS project have been found to improve team coordination, adaptation, and performance (Salas et al., 2008; Serfaty, Entin, & Johnston, 1998).

Other military research has sought to understand teamwork breakdowns in communication and coordination leading to friendly fire incidents (Snook, 2000). Research by Wilson and colleagues (2007) focused on the teamwork breakdowns that undermine communication and shared understanding (cognition) central to team performance. Extending the Wilson et al. friendly fire research, Rafferty et al. (2010) reviewed five teamwork models to identify the factors central to teamwork. In addition to recognising the importance of situation awareness from the fratricide literature, the authors identified four further factors central to teamwork. These were communication, cooperation, coordination, and compatible schemata. In subsequent research with military close air support teams, Rafferty et al. (2013) demonstrated that communication was the teamwork factor that distinguished between less and more effective teams. Importantly, the authors found that it was the quality and content of communication that was important rather than the amount. The central role of communication in teamwork is consistent with various other research including work on distributed cognition in command and control teams (Fischer, McDonnell, & Orasanu, 2007; Svensson & Andersson, 2006). A number of military forces have adopted and adapted CRM and BRM/MRM programs for their respective aviation and maritime operations (see O'Connor, Hahn, Nullmeyer, & Montijo, 2019). There has also been the development of NTS for specialist teams such as navy divers (O'Connor, 2005) and to train counter-improvised explosive device specialists (Nixon, Leggatt, & Campbell, 2015).

Healthcare

One of the earliest endeavours to improve teamwork in healthcare through the application of aviation CRM principles was led by anaesthetists Steven Howard and David Gaba in the early 1990s (Davies, 2001). Howard and Gaba recognised that anaesthesiology was complex and dynamic work that required the effective coordination of multiple resources, noting its similarities to other domains such as aviation

(Howard, Gaba, Fish, Yang, & Sarnquist, 1992). These authors developed a training program based on aviation CRM principles initially called anaesthesia crisis resource management (ACRM). Growing evidence for the need for need for better teamwork continued to grow and reports such as the Institute of Medicine's on errors in healthcare (Kohn, Corrigan, & Donaldson, 2000) focused further attention on improving non-technical skills. In the early 2000s UK researchers Fletcher, Flin, and McGeorge started to investigate the NTS checklists and behavioural marker systems for healthcare (Haywood, Lowe, & Thomas, 2019).

The initial healthcare NTS research focused on anaesthesia and surgical teams, before being more widely adopted in other areas of medicine (Shields & Flin, 2013). Patient safety initiatives in healthcare have promoted the training of new and existing staff in NTS (Flin & Patey, 2009; Salas et al., 2013; TeamSTEPPS, 2013). In acute medicine anaesthetists and emergency medicine physicians have developed specific NTS training similar to CRM known as crisis resource management (Carne, Kennedy, & Gray, 2012; Flowerdew, Brown, Vincent, & Woloshynowych, 2012). Examples of the tools developed for assessing NTS include anaesthetists' NTS (ANTS), observational teamwork assessment for surgery (OTAS), the NTS for surgeons (NOTSS), and the scrub practitioners' list of intra-operative NTS (SPLINTS) (Flin, 2010). The OTAS incorporates five (i.e., communication, coordination, cooperation/back up behaviour, leadership, and monitoring/awareness) of the seven teamwork dimensions (i.e., OTAS + feedback and team orientation) identified by Dickinson and McIntrye (1997, see Table 1 and below). Similar to the LOSA used in aviation, the OTAS recognises that operative phases (e.g., pre-Op, Intra-Op, and post-Op) and stages of a surgery mean that the team behaviours required will vary accordingly (Undre, Sevdalis, & Vincent, 2009).

Organisational research

Various strands of organisational scholarship have contributed to NTS research (Paris, Salas, & Cannon-Bowers, 2000). Team and group research has provided insights on team functioning and the team processes central to team effectiveness (Guzzo & Dickson, 1996; Prince & Salas, 1999). Examples of this research include: Fleishman's taxonomy of team performance (Fleishman & Zaccaro, 1992), Dickinson and McIntyre's (1997) model of teamwork, and the Marks, Mathieu, and Zaccaro (2001) temporally-based framework and taxonomy of team processes. In particular, the Dickinson and McIntyre teamwork model and its components (developed from research and previous literature) have played an important role in helping conceptually identify the elements of teamwork and shaped the OTAS used in healthcare (Undre et al., 2009).

A further stream of research that has contributed to our understanding of NTS is the high-reliability organisation (HRO) literature (e.g., Baker, Day, & Salas, 2006; Weick, 1995; Weick & Roberts, 1993). HRO researchers have helped identify the effective practices and behaviours of the teams working in highly complex and dynamic systems with potential for high consequence failure. CRM has emerged from HROs as an effective approach to help train and sustain skills essential to standard work and to enable personnel to adaptively respond to variations outside the norm (Alavosius, Houmanfour, Anbro, Burleigh, & Hebein, 2017). Flin (2018) observed that a further valuable aspect of the HRO literature is that in addition to helping highlight effective behaviours (NTS) it also underlines the importance of attitudes and the role of 'chronic unease' (Reason, 1997) and 'mindfulness' (Weick & Sutcliffe, 2006) in enhancing performance.

Research to help organisations select and train effective team members has identified the competencies required for personnel to successfully perform in teams (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Stevens & Campion, 1994). Researchers have clustered the competencies required to successfully work in teams as taskwork or teamwork oriented. Salas et al. (2005) defined teamwork as 'interrelated behaviours, actions, cognitions and attitudes that facilitate the required taskwork' (p. 187). For a team to operate effectively, team members need not only sound technical skills and knowledge, but the capacity to cooperate and coordinate their actions with their colleagues (Salas, Rosen, Burke, Goodwin, & Fiore, 2006). The development of these multi-level knowledge, skills, and attitudes (also described as NTS) are seen as essential for the effective functioning of a team (Cannon-Bowers et al., 1995).

Offshore oil and gas

Flin and Slaven (1994) were commissioned to investigate the incident management abilities required by offshore oil and gas installation managers (OIM). This initial investigation led to a range of research that identified the key capabilities required for effective offshore platform incident management (Flin, 1995b; Flin & Slaven, 1995) and to the development of CRM for OIM and emergency response teams (Flin, 1995a). The initial CRM training focused on decision-making, communication, assertiveness, and stress management (Flin, 1996). This initial version of CRM training was further developed to expand the focus from four to six NTS and was applied more broadly to offshore production crews. Stress management included under the new category called personal resources and a further category named supervision/leadership was added (Flin & O'Connor, 2001).

Crichton and colleagues undertook further research on incident management for oil and gas by comparing previous research findings from emergency management and military settings (e.g., Flin, 1996; McCann & Pigeau, 2000) with interview data collected from a team called in to manage a major industrial accident on a Gulf of Mexico oil-rig (Crichton, Lauche, & Flin, 2005). The authors identified five command skills for team members shown in Table 2. In the discussion of their findings, Crichton et al. (2005) highlighted two important points. First, the management of the oil-rig incident required the use of a combination of command skills used in conjunction with organisational processes. In the incident management context, these organisational processes would include the incident control system used and a variety of specific agency operating arrangements. The second was that although at the category level these skills may appear to be generic, the underlying behavioural elements are specific to the domain in which they take place.

Following the tragic 2010 Deepwater Horizon explosion the International Association of Oil and Gas Producers commissioned the development of CRM training for well operations teams. The resultant training package is the Well Operations CRM (WOCRM). The WOCRM focuses on six NTS: situation awareness, decision-making, communication, teamwork, leadership, and fatigue and stress (Flin, Wilkinson, & Agnew, 2013).

Nuclear energy emergency response teams

Growing interest in ensuring that the teams leading the response to emergencies in the UK nuclear sector were appropriately trained with the requisite NTS led to Crichton and Flin's (2004) research. The authors used the Critical Decision-Making Method (Klein, Calderwood, & MacGregor, 1989) to interview two representatives from each of the nine incident management roles, a total of 18 interviews. The six NTS identified are shown in Table 2. O'Connor, O'Dea, Flin, and Belton (2008) identified the team skills required by nuclear power plant operations personnel using an adapted form of the Critical Incident Technique (Flanagan, 1954). A total of 38 operations team personnel were interviewed and a NTS taxonomy developed from the interview transcripts based on statements identified as being concerned with team skills necessary to perform effectively in challenging situations. The NTS identified were: shared situation awareness, team-focused decision-making, communication, coordination, and influence.

3.Non-technical skills ~~for~~ in the emergency services

This section outlines the work that has been conducted on CRM and NTS in emergency services. We also consider work from a slightly different perspective that has examined the key *competencies* required in IMTs. As can be seen from Table 2 there are quite a few commonalities in the sets of NTS that have been proposed and a reasonable overlap with the NTS that have been identified in other domains. The research on NTS in the oil and gas and nuclear power industries has also been included in Table 2 because it concerns incident management teams.

Table 2. *About here*

Development of CRM and NTS for fire and emergency response teams

The interest in adopting CRM in emergency services has increased over the last 20 years. Citing the Storm King Mountain tragedy of 1994 as a catalyst, Lubnau and Okray (2001) argued that fire service leaders need to utilise the entire team's skills by adopting the CRM training principles successfully used in aviation and healthcare. Okray and Lubnau (2004) proposed that CRM programs for the fire service should address decision-making, situational awareness, communications, workload management, leadership, followership, and organisational factors. This program is based on evidence from the aviation CRM literature, wildland fire reports and investigations, aviation psychology, TADMUS project, and the authors' experience of developing and teaching CRM to firefighters. More recently LeSage, Dyar and Evans (2011) have offered a similar approach to CRM for the fire service. Some fire and emergency services have built on existing CRM models to develop core NTS such as communication, situational awareness, problem solving, decision-making and teamwork (Hagemann, Kluge, & Greve, 2012). These CRM programs are also referred to as Team Resource Management (TRM) and have the goal of enabling emergency service response teams 'to make the right decisions in the field quickly, safely and collegially' (Griffith, Roberts, & Wakeham, 2015, p. 7).

Researchers have begun to evaluate the effectiveness of CRM programs for emergency and fire response teams. Hagemann and colleagues looked at the TRM/CRM programs in a German fire service (Hagemann & Kluge, 2013; Hagemann et al., 2012), and more recently, Griffith et al. (2015) completed a meta-analysis of four CRM programs undertaken by fire and emergency medicine personnel. The Hagemann et al. study found significant, and in the case of the meta-analytic study, large effect sizes for a positive change in the CRM knowledge of participants following training. However, it is important to note for our purposes that these CRM programs have largely been designed for emergency response teams rather than IMTs.

Shields and Flin (2013) undertook a literature review of the NTS required for ambulance paramedics. Using the seven generic NTS identified by Flin et al. (2008) as a start point, this review used only articles published in English that provided empirical data related to paramedics' NTS. The authors identified five categories of NTS shown in Table 2. The other two generic NTS categories of managing stress and coping with fatigue were excluded as these were considered too difficult to observe and would be likely to influence the other behaviours already included. In Norway a very similar set of NTS have been developed for helicopter emergency medical teams (Rasmussen et al., 2019).

NTS for fire and emergency service incident commanders

Butler, Honey, and Cohen-Hatton (2019) have developed a set of NTS and behavioural markers for UK fire and rescue service incident commanders. Butler et al. (2019) used a combination of survey, semi-structured interviews with incident commanders (i.e., Level 1 and 2), subject matter expert advice drawn from commanders performing at each level of command (i.e., Levels 1 to 4), and evaluated the prototype behavioural marker system's capacity to discriminate between incident commanders of differing capability. The six NTS are shown in Table 2. The authors observed that four of the six NTS are shared with the NOTECHS (aviation, see Table 1) and NOTSS (surgery) behavioural marker systems (i.e., decision-making, leadership, situational awareness and teamwork). While the NTS framework has been developed to cater for all levels of incident command the emphasis is on the individual incident commander rather than the wider IMT.

Incident Management Team (IMT) Competencies and Capabilities

Hayes and Omodei (2011) used semi-structured interviews in conjunction with Flanagan's (1954) Critical Incident Technique to identify the key competencies required for wildfire IMT members. The authors used Kurz and Bartram's (2002) definition of competencies as 'the repertoire of capabilities, activities, processes and response available that enable a range of work demands to be met more effectively by some people than others' (p. 230). This competency definition is consistent with the concept of NTS albeit broader in that some competency frameworks can capture personal qualities (e.g., self-regulation) which may be found in personality taxonomies (Winterton, 2007). The term competency may also be used to describe standards for performance or observable performance (Hoffmann, 1999). In the case of observable performance this view of competency aligns with the behavioural markers used to identify the presence or absence of a NTS or element. Hayes and Omodei identified 12 competencies and a set of positive and negative behavioural markers for each competency. The competencies can be clustered under three types, namely taskwork (2), teamwork (NTS) (6), and personal competencies (4) (Brooks, 2014). The six NTS competencies are shown in Table 2.

More recently Owen et al. (2016, 2018) have developed a set of capabilities for emergency management IMTs. Capabilities are described as 'the cluster of behaviours expected from emergency management personnel to succeed in achieving objectives' (Owen et al., 2018, p. 45). This work was based on a variety of sources including central themes from high reliability organisational and naturalistic decision-making literatures, Bushfire Cooperative Research Centre (BCRC) and Bushfire & Natural Hazards CRC (BNHCRC) research on incident and emergency management (e.g., Ferguson et al., 2015; Hayes & Omodei, 2011; Owen, 2014), and findings from the Victorian IMT Training Project (IMTTP, 2014).

The approach taken is slightly different to that followed by other authors in that Owen et al. (2016, 2018) have focused on the activities undertaken by IMT personnel, in effect more holistically considering the combination of social, cognitive, and task elements required for effective incident management. Each capability is explicated with a set of behavioural indicators. The authors incorporated findings from recent research such as consequence management, the role of leadership in coaching and creating conducive team environments, sensemaking, and the concept 'coping ugly' (Brooks, 2014). Coping ugly is a term used to describe 'a continuum of dynamic control between operational excellence at one end and luck as the other' (Owen et al., 2018, p. 44). Reviewed by 30 experienced incident managers, this set of capabilities has been adopted by AFAC as part of its Emergency Management Professionalisation Scheme (EMPS). A summary of these capabilities is shown in Table 2.

Teamwork in Fire and Emergency Services IMTs

Over the last five years teamwork research has been conducted with Australasian IMTs. Bearman and colleagues (Bearman et al., 2015; Bearman, Rainbird, Brooks, Owen, & Curnin, 2017) have applied and extended the Wilson et al. (2007) teamwork breakdown framework to incident management. This research has highlighted the central role of coordination, communication, and cooperation in incident management and how these NTS tend to be a particular challenge for IMTs. The Team Process Checklist (TPC) developed by Bearman et al. provides behavioural indicators that can be used to diagnose these elements of teamwork that may be problematic. However, this research only partially covers the elements of an NTS framework.

4. Differences between ~~for~~ emergency management IMTs and other industries

This section identifies aspects of emergency management IMTs that are different to other domains where research on NTS has been conducted and the issues that this raises for an NTS framework in emergency management. Taken together the issues for NTS based on these differences are important to consider in any emergency management NTS framework and identify gaps in the current literature on NTS.

Degree of Proceduralisation

One of the key differences between much of the existing literature and the IMTs that we are concerned with is the context in which the operations occur. Much of the NTS and CRM research has been undertaken in aviation and health contexts. This research has tended to focus on smaller units such as flight crews and surgical teams. Crews and teams in these domains tend to operate in a more tightly proceduralised (and coupled) manner (Perrow, 1999) than IMTs. Hayes and Omodei (2011) observed that whilst their competency framework highlighted the value of flexibility, adaptability, and improvisation, two emergency agencies that they compared their framework to emphasised a more systems-oriented approach to incident management. This point is further underlined by Brooks (2014) observation that IMTs may need at times to ‘cope ugly’ when systems become degraded or are no longer effective.

Functional Sub-Teams

IMTs have functional sub-teams (e.g., control, logistics, operations, planning, and public information) and IMTs work in conjunction with regional and state coordination teams (Owen et al., 2013). This means that NTS need to account for the inter-team processes important in incident management. Aviation has some similar but less extensive demands in that pilots need to work with air traffic control and ground crew, and in the case of passenger flights, coordinate their actions with cabin crew.

Team Membership Stability

One of the important differences relevant to IMTs is membership stability. In a comparison of flight crews and air traffic controllers Smith-Jentsch, Baker, Salas, and Cannon-Bowers (2001) noted some important differences between team types. Membership of commercial and military aviation aircrews tend to vary (Hackman, 1993), whereas air traffic controllers tend to work with the same team members for extended periods of time. Smith-Jentsch et al. highlighted that the extended interaction period with the same team members creates ‘teammate specific competencies’ (Cannon-Bowers et al., 1995), which can have a positive or negative effect on teamwork. Knowledge of other members’ expertise and positive attitudes to other members means that members are more likely to ask for or accept assistance from those teammates (Smith-Jentsch, Kraiger, Cannon-Bowers, & Salas, 2009). Like air traffic controllers many people in IMTs will have worked extensively with the other members of the team, although in larger emergencies there may well be people who are new to the team. It is also the case that the IMTs can comprise people from multiple agencies and unpaid volunteers who possess different backgrounds and organisational cultures.

Duration of the Operation

A particular issue for emergency management IMTs is the requirement to operate over an extended period of time. For example, Australian and North American IMTs may work for many weeks managing campaign wildland fires. These longer duration events compound the issues of high workload, stress and fatigue management, and can compromise the effectiveness of individuals and teams (Brooks & Owen, 2013; McLennan, Strickland, Omodei, & Suss, 2014). Longer duration events necessitate the use of multiple IMT shifts and the many associated shift handovers. Elliott, Omodei, and Johnson (2009) reported that the quality of Australian IMTs' situation reports and handover briefings is inconsistent. Moreover, there is good evidence that poor handover briefings and inaccurate documentation have contributed to a number of very adverse incidents in a variety of HRO settings (e.g., Flin et al., 2008; Lardner, 1996). In healthcare communication problems at handover have been identified as a major source of error for patient safety (Arora, Johnson, Lovinger, Humphrey, & Meltzer, 2005; Gordon & Findley, 2011). These demands of sustained high workloads and the requirement to ensure effective handovers between many shifts underline the importance of sound stress and fatigue management and the requirement for very good communication skills in IMTs.

Frequency of Operations

In terms of how often IMTs need to utilise their skills, management of larger scale emergencies can be fairly infrequent for some agencies, whereas teams in aviation and healthcare typically undertake their core work on a daily basis. This means that there is less opportunity to practice both technical and non-technical skills. There is an increasing focus on the issue of the currency of the NTS for incident management personnel and some fire and emergency services are implementing programs to ensure this. Whilst currently under review, the UK national guidance for incident command (2019) advocates that command revalidation provides evidence that commanders have the required command skills (NTS) and knowledge to undertake their role competently. The proposal is for commanders to undergo examinations of their knowledge and command skills every two years, whilst accruing a minimum number of command hours to meet an annual target.

Phases of Operations

Marks et al. (2001) research on team performance highlighted the temporal nature of team processes. The NTS measures developed for aviation and surgery highlight how the importance of NTS may vary across a flight or surgical procedure. The LOSA and OTAS break these activities into different phases indicating that the NTS requirements may vary between phases. In emergency management Bearman and Bremner (2013) have developed a hierarchical task analysis that highlights the changing tasks and NTS demands on incident commanders throughout the phases of an incident. Similarly, a recent hierarchical task analysis of Australian incident management operations highlights five phases, namely: alert, escalation, incident management, de-escalation, and termination (Hayes, Bearman, Thomason, & Bremner, 2020). Analysis of this task analysis shown in Table 3 highlights how the emphasis in the required NTS shifts through these five phases.

Table 3. *About here*

Thinking Ahead

In comparison to other types of HRO teams, emergency IMTs may need to consider significantly longer timeframes and the adverse effects of the incident on multiple aspects of the communities directly affected or under threat. A further observation made by Owen et al. (2013) is that regional and state-level IMTs are required to think further ahead than operational IMTs. The authors observe that one of the important roles played by regional and state teams is that of consequence management. This forward thinking is sometimes referred to as anticipatory thinking (Klein, Snowden, & Pin, 2007; McLennan, Elliott, & Holgate, 2009). That is**,** being able to identify the 'change in circumstances, planned or otherwise, experienced by a community or its members as a result of an event and its subsequent management' (Emergency Management Victoria, 2017, para. 7).

Unit of Analysis

An important question when considering the assessment of team-related phenomena such as NTS is the unit of analysis. Should the individual team members be assessed individually or collectively? The measures that have been developed to assess NTS vary in the unit of analysis. Tools such as the LOSA and OTAS assess the crew or team whereas other measures such as the ANTS or NOTSS assess the individual. In some cases, measures of teamwork may assess a mixture of individual and team level behaviours (e.g., TEAM, Cooper et al., 2010). As a starting point for IMTs, assessing NTS at the team-level is likely to be the most useful approach. A suitable framework and assessment tool could also be used to assess functional areas within an IMT (e.g., planning, operations, public information, and logistics) or larger IMTs smaller sub-units.

Personal capabilities and qualities

An important point to consider in developing capable incident managers are the complimentary personal qualities and capabilities that are not NTS but that are likely to be valuable in these settings. In his discussion of incident manager training, Brooks (2014) highlighted that three types of competency are required for incident management, namely technical or taskwork, NTS or teamwork, and personal competencies. The Owen et al. (2016) capability framework identified the importance of integrity and resilience whilst Hayes and Omodei (2011) identified self-discipline and calmness as key competencies for IMT personnel. These personal capabilities are linked to personality traits, and as Brooks points out, may be hard for some people to develop but much easier for others. It may be the case that these personal competencies evolve as individuals continue to work in incident management and that through natural selection individuals who have these personal qualities tend to survive best in this environment (Brooks, 2014). Although beyond the scope of this article, organisations certainly need to be mindful in ensuring their selection and development practices result in IMT members with the requisite personal qualities.

Taken together these issues raise a number of implications that need to be carefully considered when developing NTS for IMTs. This also means that while the literature on NTS forms a useful starting place for the development of NTS in IMT, it is unlikely that simply mapping across NTS from other domains will be successful.

5. Identifying NTS for emergency IMTs

This section proposes a set of NTS for Australasian emergency IMTs by drawing on the literature on NTS in the context of the very different operational requirements experienced in emergency IMTs discussed in the previous section. The intended unit of analysis is an IMT although functional units such as operations, planning, logistics or public information could be assessed using this framework. IMTs vary in size depending on the complexity and size of the incident. The members of an IMT are usually co-located at a single location although some personnel may spend some time out on the incident ground. A small IMT shift may comprise 4-6 personnel whereas a larger IMT shift may have 45+ members.

Approach taken

Four existing frameworks from the literature were selected to identify a set of NTS for emergency IMTs, namely AFAC's incident management capability framework (Owen et al., 2016), the TPC (Bearman et al., 2017), IMT competencies (Hayes & Omodei, 2011), and a set of incident command skills (Crichton et al., 2005). These published frameworks were selected because they focus on incident management and are broadly consistent with the main categories of NTS identified in Table 1 and Table 2. These frameworks were preferred over other possible NTS frameworks that focus on the more tactical context of emergency response (e.g., paramedics) or are operational in nature (e.g., aviation, medicine or shipping).

Each of the four frameworks vary in the way they have been developed and structured. However, the common element in each of these frameworks is the use of behavioural markers. The behavioural markers are used as the building blocks to identify the elements and categories of NTS required for incident management. In essence this list of behaviours forms the first part of the Flin et al. (2008) method for identifying NTS (see Section 1). The second task was to refine and organise this list into a taxonomy, which is described next.

An initial list of 123 behavioural markers was compiled from these four sources. These markers were carefully reviewed by two of the authors and items that were considered unclear or more difficult to observe in IMTs were excluded (e.g., *can predict future options that reflect the information gathered through sense-making and evaluate those options; assessing the incident and the proposed actions of responders so that decision making and implementation leads to the best possible outcome for those affected by the incident*). The remaining 87 behavioural markers were used to extract an initial set of NTS elements and categories. Seven NTS categories and 16 elements were identified. The behavioural markers were further refined by removing overlapping and two-part items (e.g., *distributes tasks appropriately among team members and detects gaps and inconsistencies*). In some cases the items were carefully re-worded to ensure clarity and consistent language use. The short list of 44 behavioural markers developed is shown in Table 4.

Table 4. *About here*

For a behavioural marker to be effective it needs to be relevant to the NTS, readily observed and evaluated, and to occur reasonably frequently (Gatfield, 2008). As was noted earlier some categories of NTS are more difficult to observe or assess than others (Flin & Martin, 2001; Moffat & Crichton, 2015; Thomas, 2018). In order to ensure that an NTS framework is usable for the assessment of an IMT in real time it is important that it contains a limited number of behavioural markers. Otherwise, an assessment framework may become unwieldy. Behavioural markers were defined by Klampfer, Flin, and Helmreich (2001) as behaviours typically associated with the non-technical skills of a marker system. Gatfield (2008) noted the number of assessment criteria used for crisis management typically varies between 19 for a fire brigade and up to 43 for civil aviation.

The NTS system that we have proposed addresses the issues raised in Section 4 in the following ways. By developing this NTS system directly from the domain of incident management the behavioural markers we have used capture the central features identified in Section 4. Inspection of Table 4 highlights that the system can be used to assess the less proceduralised operational approach that typify IMTs compared to other types of teams. The markers can readily be used to assess either an entire IMT or the sub-units such as a planning, operations, logistics or the public information function. A number of the markers capture features that are important and in some cases unique to incident management. For example, under coordination there is specific assessment of whether teams are capturing each other's errors, an important issue for IMTs. Under decision-making there is assessment of effective communication of decisions. For incident managers, not only do they need to ensure their operational teams have a clear understanding of their plans, but that the affected communities are also kept informed of the current and expected situation. A further central feature of incident decision-making that is assessed is consequence management.

During the development of this NTS system, the high level of interdependence between the seven categories was noted. The identified NTS align closely with the teamwork heuristic developed by Salas et al. (2015) and reflect the various important relationships between NTS shown in the literature such as situation awareness and decision-making (Mosier & Fischer, 2010), leadership and communication (Edmondson, 2003), stress and decision-making (McLennan et al., 2014), communication, cooperation and coordination (Wilson et al., 2007), and communication (quality) and situation awareness (Rafferty et al., 2013). The interdependency between these seven categories highlights the broad repertoire of NTS required and indicates that poorer skills in even one category is likely to be problematic to IMT effectiveness.

In relation to the demands on an IMT as an incident unfurls, at certain phases of an incident particular NTS elements will be particularly important. For example, sensemaking and situation awareness are likely to be critical during the first three phases of an incident (i.e., alert, escalation, and incident management) but less so during the final two phases (i.e., de-escalation and termination).

It should be noted that the framework that we have proposed is really a prototype and further refinement and testing within agencies is required. However, the framework does represent a useful tool to stimulate discussion about NTS within agencies and provides a solid foundation for further research. Many NTS systems (such as LOSA and ANTS) have been developed through an extensive process of discussion, research, and refinement. This paper represents the first stage of that journey for NTS in IMTs.

6. Training non-technical skills

From a training perspective, developing the NTS of prospective IMT personnel will require sound analysis, careful planning, and strong organisational support. Traditional human resource development practice would suggest organisations follow a three-step process of training needs assessment (TNA), developing the training resources, and building assessment and evaluation tools (Goldstein & Ford, 2002; Winterton, 2007). This approach has been used in many organisations to develop various non-technical skills. Researchers and practitioners have also considered of the issue of team training as part of the

TADMUS project (Cannon-Bowers & Salas, 1998) and in conjunction with simulation (e.g., Rosen et al., 2008).

CRM programs in particular provide helpful guidance on how to provide effective NTS training. Flin et al. (2008) note that CRM programs embed the development of NTS through three distinct phases of: awareness, practice and feedback, and continual reinforcement loop. The awareness phase is the classroom-based component that introduces trainees to the key concepts and theory of NTS. Flin et al. observed that this phase focuses on developing a common understanding and language for NTS and uses a variety of teaching methods such as lectures, role play, case studies, and videos of relevant accidents. The practice and feedback phase typically uses some form of simulation-based training to enable trainees to practice using NTS in various situations. This may be role play-based training. The reinforcement loop phase uses ongoing refresher training in combination with organisational practices such as workplace auditing, standard operating procedures, and learning and development systems. The refresher training is important as without regular reinforcement, attitudes and practices tend to atrophy (Helmreich, Merritt, & Wilhelm, 2009).

Flin et al. (2008) drew from the literature to identify five strategies suitable for training NTS, namely team coordination training, cross-training, team self-correction training, event-based training, and team facilitation training. These training approaches have different features which shape their respective suitability for training IMT personnel. These criteria include whether the team has fluid membership (e.g., team coordination training), high degree of interdependence between team members (e.g., cross-training and team self-correction training), lack of knowledge of other team member roles (e.g., cross-training), or limited training resources (e.g., team facilitation training) (Brooks, 2014). In Australasia, team coordination training and event-based training are mainly used for this purpose (Brooks & Owen, 2013). However, cross-training and team self-correction training could also be used effectively to train IMT personnel (Brooks, 2014). The benefits of multi-agency and team-based NTS training are also highlighted by Thomas (2018) who advocates it as a principle of such training.

Flin et al. (2008) noted that the most suitable training strategy will depend on the types of issues that need to be addressed and illustrated this by providing an example of training NTS for offshore drilling teams. The approach taken was to use multiple training strategies to develop these skills such as CRM for initial NTS acquisition and various event-based, tactical decision games, role and responsibility reviews, communication exercises, and command and control training to build specific NTS and clarify roles in the case of unexpected events. Thomas (2018) emphasises the importance of simulation training as a keystone of NTS development as it is capable of incorporating real-world elements within a safe learning environment.

The third step of the TNA for training NTS is developing suitable assessment and evaluation tools. Goldstein and Ford (2002) observe that unfortunately many organisations fail to properly evaluate the effectiveness of their training programs. In terms of suitable evaluation approaches for assessing the effectiveness of NTS training, the Kraiger, Ford and Salas (1993) evaluation model encompassing affective, cognitive and skill-based outcomes neatly captures the types of outcomes effective NTS training should yield for IMT personnel (Hayes, 2015).

We posit that it is important to implement NTS training early in the career of personnel and regularly revisit these skills. This means adoption of NTS into the curricula for recruit training and at key career transition points. Similar to aviation and marine settings, training for incident management needs to include NTS and these skills should assessed as part of the various exercises and team-based activities candidates are required to complete. Okray and Lubnau (2004) emphasised that to successfully embed NTS into an emergency management organisation requires developing an organisational culture that embraces and uses these skills in all aspects of work, not just when a team is managing an incident.

7. Conclusion

This literature review has highlighted the key role NTS play in supporting team performance in high-reliability settings and emergency management. It has also demonstrated that, while there are consistent patterns explicated from studying various sectors that offer insights for emergency management, differences at the elemental and behavioural level evidence the need for tailoring of NTS models for the emergency services. The previous reviews of NTS have tended to either focus on a particular domain or more broadly on HROs. This review has taken a fresh approach to considering the NTS required for emergency IMTs. We have examined the wider literature on NTS and considered this in relation to the specific requirements of emergency management IMTs. Through this process we have identified some of the unique and important features of emergency management IMTs that shape the required NTS. This is an initial step towards improving our understanding of these skills. By continuing to improve our understanding of the NTS requirements for incident management we have the opportunity to train, develop, and better prepare personnel undertaking these challenging roles. The phase one report of the Grenfell Tower Inquiry (Moore-Bick, 2019) serves to tragically illustrate the consequences of poorly prepared and supported personnel. For example, the resultant lack of situation awareness of the initial commanders compromised their ability to make a decision to change their operational strategy from ‘stay put’ to ‘full evacuation’. The ability to better manage the non-technical aspects of emergency management is an important part of preparing ourselves for the future for a future of increasingly challenging events of longer-duration and increasing frequency.

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Table 1. *Examples of the NTS categories identified for six different domains*

Generic HRO (e.g., Flin et al., 2008)	Aviation (e.g., NOTECHS, Flin, 2010)	Maritime (e.g., BRM, Wahl & Kongsvik, 2018)	Military (e.g., NOTEMILS, Tsifetakis & Kontogiannis, 2017)	Health (e.g., OTAS, Undre et al., 2009)	Organisational literature (e.g., Model of teamwork, Dickinson & McIntrye, 1997)
Communication		Communication		Communication	Communication
					Feedback
				Coordination	Coordination
Teamwork	Cooperation	Team coordination	Cooperation	Cooperation/ back up behaviour	Back up behaviour
					Team orientation
Leadership	Leadership and managerial skills	Assertiveness and leadership	Leadership and managerial skills	Leadership	Team leadership
Situation awareness	Situation awareness	Situation awareness	Situation awareness	Monitoring/ awareness	Monitoring
Decision-making	Decision-making	Decision-making	Decision-making		
Managing stress					
Coping with fatigue					

Table 2. *Examples of the types of NTS skills identified for emergency response and incident management*

Oil & gas	Nuclear energy	Emergency response	Incident command	Emergency IMTs		
Crichton et al. (2005) Incident command skills	Crichton & Flin (2004) NTS for emergency response teams	Shields & Flin (2013) NTS for paramedics	(Butler et al., 2019) NTS for incident commanders	Hayes & Omodei (2011) IMT competencies	Bearman (2018) Team process checklist	Owen et al. (2016) IMT capabilities
Situation awareness	Situation awareness	Situation awareness	Situation awareness	Situation awareness		Pursues sensemaking and encourages sensemaking in others
Decision-making	Decision-making	Decision-making	Effective decision-making and planning	Decision-making		Applies effective decision-making
				Analytical & problem-solving skills		Enables consequence management
						Practices planning and strategic thinking
Communication	Communication	Communication	Interpersonal communication	Interpersonal & communication	Communication	
Teamwork	Teamwork	Teamwork	Teamwork and interoperability	Teamwork	Cooperation Coordination	Creates effective background conditions to build confident and capable teams and engaged stake-holders
Leadership	Leadership	Leadership	Assertive, effective and safe leadership	Leadership		Models ethics, inclusiveness and good governance
				Management skills		
	Managing stress					Monitors and manages self for symptoms of stress and fatigue
			Personal resilience			Displays resilience and agility
						Recognises own strengths and limitations

Table 3. *Shifting emphasis of NTS used in five phases of emergency management*

Phase	Alert	Escalation	Incident management	De-escalation	Termination
Main types of NTS used	• Sensemaking/SA • Communication • Coordination • Decision-making	• Sensemaking/SA • Communication • Coordination • Cooperation • Decision-making	• Sensemaking/SA • Coordination • Communication • Cooperation • Decision-making	• Coordination • Communication • Cooperation • Decision-making	• Coordination • Communication

Table 4. *NTS for emergency IMTs*

NTS category	NTS element	Behavioural markers (i.e., the degree to which…)
Communication	*Effective communication*	Information is passed on in a timely manner Information is passed on accurately Team members ensure that information has been received and understood by others Inappropriate communication procedures are used
	Proactive communication	Situation updates are provided Team members are not providing constructive comments to one another
Coordination	*Clear roles, responsibilities, and expectations*	The roles and responsibilities of team members are unclear Actions are always carried out as expected There is a clear and common purpose Everyone has a common understanding relating to the operation
	Adjusting to demands	Everyone is adjusting to meet the demands of the situation Team members are not correcting any mistakes made by others
Cooperation	*Contributes to a positive team environment*	Everyone shows willingness to work as a team Team members do not exhibit confidence and trust in each other Team members are open and approachable
	Alignment of efforts and management of conflict	Everyone is following team objectives without opting for independence Differences of opinion are resolved effectively Individuals are creating unnecessary conflict
Leadership	*Creates a suitable team environment*	Good behaviour is consistently modelled Others are not treated with respect Inclusive behaviours are modelled that enables others to speak up and offer suggestions and constructive comment
	Provides focus, direction, and coordination	There is a focus on the important tasks at hand Appropriate direction and guidance is provided Activities are not well-coordinated within the team
Situation Awareness	*Gathering & analysing information*	Team members ask others about the situation to improve their situational awareness Patterns and trends are identified in a timely manner The consequences of the options available are not identified
	Identifies contingencies, problems, and expectations	Contingencies are discussed and potential future problems identified Expectations are not articulated (i.e., goals and potential event evolution)
	Sharing information and insights	Views are shared of the current situation with others Team members do not effectively participate in team briefings to build and share situational awareness
Decision-making	*Sound, timely decisions*	Decisions are not being made on a timely basis Decisions are being appropriately prioritised
	Appropriate decision-making approach	Plans are not readily adjusted as the situation changes Appropriate decision-making approaches are applied to the situation at hand (e.g., speed vs. thoroughness)
	Engaging others in decision-making	Decisions (and intent) are not clearly communicated Others' ideas and inputs are incorporated into decisions when practicable There is flexible matching of communication style to the audience
Coping, stress & fatigue management	*Manages pressure*	A suitable level of focus is maintained when under pressure Team members do not remain composed when under pressure Team members remain flexible when faced with sub-optimal or novel conditions
	Employs effective coping strategies	The effects of fatigue on oneself and others are recognised and appropriate actions taken to manage this Coping strategies are used to manage under sub-optimal conditions (e.g., takes notes, prioritises tasks, delegates) Team members do not request (and offer) assistance from (to) others, when necessary

Figure 1. Anaesthetists' non-technical skills (ANTS) (Source: Fletcher et al., 2003, p. 583)

Figure 2. Categories of NTS and taskwork for incident management