# Non-Technical Skills (NTS) for Enhancing Patient Safety:

## Achievements and Future Directions

N Kodate[1] KODATE, Naonori　　AJ Ross[2] ROSS, Alastair
JE Anderson[3] ANDERSON, Janet　　R Flin[4] FLIN, Rhona

1) Lecturer, School of Applied Social Science, University College Dublin (UCD); Research Fellow, UCD Geary Institute, Ireland
Senior Fellow, Todai Policy Alternatives Research Institute (PARI), University of Tokyo, Japan.
2) Senior Research Fellow, Simulation and Interactive Learning Centre (SaIL), St. Thomas' Hospital, London, UK.
3) Senior Lecturer, Florence Nightingale School of Nursing and Midwifery, King's College London (KCL), UK.
4) Professor of Applied Psychology, School of Psychology, University of Aberdeen, UK.

## Introduction

Problems in team communication and decision making have been implicated in accidents in high risk industries such as aviation, off shore oil processing, and nuclear power generation. Recognition of the role that breakdowns in communication and teamwork play in patient safety incidents has led to a plethora of studies in the area of what has come to be widely known as non-technical skills (NTS); a term initially used in European aviation [1]. This has led to increasing interest in identifying, assessing, training and measuring non-technical skills. Technical skills are the procedural and clinical skills that healthcare professionals apply when diagnosing, monitoring and treating patients[1]. Non-technical skills refer to the general cognitive and social skills that allow them to, among other things, monitor the situation, make decisions, take a leadership role, communicate and co-ordinate their actions within a team, in order to achieve high levels of safety and efficiency.

There is growing awareness that non-technical skills are essential for competent practice and NTS have been incorporated into medical education and training programmes [2]. Internationally, a module on human factors is one component of the World Health Organization (WHO)'s curriculum on patient safety for medical students [3, 4]. In the UK, serious deficiencies in the undergraduate medical curriculum were highlighted by Parliament's Health Committee Report [5]. Now the Royal Colleges of Surgeons in Great Britain and Ireland all provide training in NTS although to varying degrees of extent, coverage and financial support for medical students and trainees. One notable example is that the Royal College of Surgeons of Edinburgh began to offer a course called NOTSS (Non-technical Skills for Surgeons)[6] in conjunction with the University of Aberdeen in 2006 [7]. This has now developed into two courses. One is a multidisciplinary course called Safer Operative Surgery, which encompasses wider safety issues surrounding surgical teams (Yule et al., 2009; The Royal College of Surgeons of Edinburgh website). The other is a NOTSS Masterclass for surgeons who want to train and assess these skills using the NOTSS system. Although the examples in this article deal primarily with the National Health Services in the UK, NTS are being applied by healthcare practitioners and research groups worldwide, and Japan is no exception [8-12].

In this paper we aim to give an overview of the development and application of NTS in healthcare and offer some thoughts about its future directions.

We start by outlining the importance of non-technical skills (NTS) in healthcare, with a focus on patient safety and quality of care, and then provide an overview of how NTS are identified, trained and assessed before considering future directions for NTS theory and practice. We conclude that the future of NTS in healthcare is likely to: a) pay more attention to skills such as inter-professional teamwork and communication with patients (e.g. care and compassion), providing scientific rigour and replicability can be brought to bear on this area; and b) incorporate an appropriate context from systems-theories, in line with recent developments in cognitive science and resilience engineering.

## What are non-technical skills

NTS theory and practice has its roots in Crew Resource Management (CRM) techniques developed in aviation [13] and later applied in other domains [14, 15]. It also has been influenced by cognitive engineering approaches that investigate the key role of cognitive skills in many work tasks, using methods such as Cognitive Task Analysis to identify them [16].

Definitional aspects remain a contentious issue. Both 'non-technical'[17] and 'skills'[18] have been criticised as misleading and imprecise terms. Further, there is a debate around whether the term 'soft skills' is synonymous [19] or compatible [20] with NTS ('there is nothing soft about non-technical skills') [21: p455].

These ongoing debates notwithstanding, it seems beyond question that a) NTS is a term in common usage and b) there is broadly a shared understanding of the cognitive and behavioural factors covered [22]. It can be noted that terminology around 'human error' and 'human factors' has been similarly debated in recent years [23] but the contribution towards patient safety made by behavioural, cognitive and organizational science is generally recognised [24, 25].

Although the NTS that are most relevant to effective performance may vary according to work demands, it is possible to identify the core NTS that are commonly required in high risk industries. Most training courses for NTS are concentrated around a

**Table 1: Core non-technical skills (21: p454)**

| NTS | Skill components |
|---|---|
| Situation awareness | ・gathering information |
| | ・recognising and understanding |
| | ・anticipating future states |
| Decision Making | ・defining the problem |
| | ・identifying options |
| | ・balancing risks and selecting options |
| | ・reassessing/reviewing outcomes |
| Communication skills | ・giving information clearly and concisely |
| | ・including context and intent |
| | ・receiving information |
| | ・identifying and tackling barriers to communication |
| Team working | ・supporting others |
| | ・solving conflicts |
| | ・exchanging information |
| | ・coordinating activities |
| Leadership | ・using authority and assertiveness |
| | ・maintaining standards |
| | ・planning and prioritizing |
| | ・managing workload and resources |
| Stress management | ・identifying symptoms of stress |
| | ・recognising effects of stress |
| | ・implementing coping strategies |
| Fatigue management | ・identifying symptoms of fatigue |
| | ・recognising effects of fatigue |
| | ・implementing coping strategies |

set of core components originally derived from CRM work in aviation and these have been outlined by Flin, O'Connor and Crichton [1), 8)], Their list of NTS skill categories and component elements has been applied to healthcare by Engle et al [21)] (see Table 1).

## Identifying NTS

One of the underlying assumptions in this area is that NTS can be trained and assessed. This means that in order to develop training programmes, the relevant NTS for a particular clinical area or occupational group have to be identified. Identification of NTS has to be systematic and objective. This is challenging because non-technical skills are not always directly observable and particularly in the case of cognitive skills, must be inferred from people's behaviour. There can also be ambiguity in the interpretation of observations meaning that some degree of subjectivity is inevitable. The identification of relevant NTS is therefore more challenging than the identification of technical skills. Different researchers have approached the identification of NTS in different ways, but in general all the methods are underpinned by human factors approaches to the analysis of work, such as task analysis methods.

Identification of the NTS required for a given job can be based on existing taxonomies for other occupations but will need to be augmented with data gathered from the relevant domain. Some of the generic NTS categories (e.g. situation awareness and teamwork) are likely to be applicable but not all roles in a work team require leadership or decision making as key facets of their responsibilities. Moreover, the specific behaviours and the level of skill required can be very different for particular occupations. The use of several methods to gather data is recommended and can include questionnaires, interviews, focus groups, analysis of adverse events and observations. Flin et al (2008) [1), 8)] recommend data triangulation,

**Table 2: NTS identification vignette [26)]**

| **Developing behavioural markers for Emergency Physicians' non-technical skills** | |
|---|---|
| Clinical area | Emergency Medicine |
| Participants | Physicians and nurses |
| Site | UK, large urban city, two Emergency Departments in teaching hospitals |
| Purpose | Identifying NTS to develop behavioural marker system for the observational assessment of emergency physicians' non-technical skills in the workplace |
| | Tool designed for use in formative assessment: to promote reflection, guide future learning, and monitor progress |
| NTS definition | "the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance" |
| Key NTS categories | Leadership; decision making; communication skills; situation awareness; team working |
| Key NTS components | Maintaining standards; managing workload; resolving conflict; team building;supporting others; teaching and providing feedback; using authority and assertiveness; co-ordinating team members; supervising/assessing capabilities |
| Methods | Triangulation of data from a number of sources |
| | Phase 1: a provisional assessment tool was developed according to published literature and curricula |
| | Phase 2: analysis of staff interviews and field observations to determine whether the skill list contained any significant omissions; identify behavioural markers linked to nontechnical skills in the context of the emergency department (ED); establish whether skills included in the tool were observable |
| | Phase 3: evaluating the content validity index of exemplary behaviours, using a survey of experts |
| Outcomes | Behavioural marker system for NTS of emergency physicians |
| Learning points | 20hrs of observation were sufficient to identify key NTS |
| Limitations | Limited to two EDs; self-selecting group of participant clinicians with attendance at patient safety meetings may not be fully representative |

the development of a preliminary taxonomy and then further development and validation, especially if a behavioural rating scale is being developed as well as a training programme.

Table 2 shows an example of a recent study of NTS in Emergency Medicine in which a behavioural marker system for formative assessment was developed.

## Training NTS

NTS can be trained using a wide range of training techniques, including didactic lectures, demonstrations, and practice based methods such as role play, and simulated exercises with varying degrees of fidelity. Many NTS courses, based on CRM techniques from aviation, are now used widely in many high risk industries, including healthcare. Application has been extended to a range of clinical domains including anaesthesia, surgery, emergency medicine and primary care [19), 27), 28)].

There are typically three phases to CRM training:

- Raising awareness of NTS and their importance; this is usually accomplished by introducing NTS in an educational session such as a lecture. Specific lectures then follow on individual NTS categories. Pre- course reading introducing the topics can also be provided
- Skill practice using exercises and simulations; this is usually followed by feedback and discussion of performance to enable participants to understand how NTS contributed to the outcome of the exercise, and to reflect on their experience.
- Reinforcement of NTS in the workplace or involving refresher courses.

Recent years have seen a steady growth in the application of medical simulation modalities to the study of, for example, teamwork [29)], leadership [30)], empathy [31)] and staff-patient communication [32)].

**Table 3: NTS training vignette [32), 37), 38)]**

| **Simulation training for improving the quality of care for older people** | |
|---|---|
| Clinical area | Care of the older person |
| Participants | Inter professional including Nurses, Healthcare Assistants, Doctors, Physiotherapists, Nutritionists |
| Site | UK, large urban NHS teaching hospital, three geriatric wards |
| Purpose | Inter-professional team training aimed at enhanced patient experiences |
| NTS definition | Broad, including teamwork (e.g. shared mental models) and compassionate communication with patients (including awareness of voice, posture etc.) |
| Key NTS categories | Leadership; team working; communication skills; decision making; situation awareness |
| Key NTS components | Trust; team orientation; backup; shared mental model |
| Methods | Hi and Lo fidelity simulation; classroom exercises |
| | Mixed-methods independent evaluation including validated questionnaires, observation, interview |
| Outcomes | Learners' self-confidence on clinical competencies increased post-training |
| | Knowledge for achieving better care was learned and retained at follow up 7-9 weeks post-training |
| Learning points | The study is important because high quality communication goes beyond the transmission and reception of information and becomes 'real dialogue' [39)] |
| | Compassionate care is at the core of the NHS constitution [40)] and championed by the Nursing and Midwifery Council and the General Medical Council, yet it has been argued that nursing training has become increasingly academic [41)] with a loss of core values such as compassionate care [42)] |
| | Study conclusions are that NTS training can be defined broadly to include team communication, patient interaction and empathy, in addition to traditional conceptualisations which emphasise cognitive skills such as situation awareness and decision making |
| Limitations | Limited involvement from student nurses and agency (bank) staff |

Ward-based simulations [33], exercises in high fidelity simulation suites [34), 35] and in situ or mobile simulations [36] have all been applied to the training of non-technical skills to positive effect. Table 3 shows an example of a recent study of combined ward-based and high fidelity suite- based simulation for the training of non-technical skills in a multidisciplinary team for the care of older people.

## Assessing NTS

Formal methods for assessing NTS are required for the following purposes:

1. To give training programme participants feedback about their level of skill
2. To test skills for a licensing programme
3. To evaluate the effectiveness of a training programme and to assess whether skills have transferred to the work environment
4. To audit skill levels in a team or department for ongoing training and development needs [1), 8]

Behavioural marker systems have been developed to define the different components of the skills and to give positive and negative examples of practice relating to the skill. These are usually combined with a rating scale that allows observers to rate how effectively the skill is being practised. Rating scales can have varying formats but should adhere to the principle of having good psychometric properties, including reliability, validity and sensitivity. Observers usually require extensive training. Using video for recording performance and later analysis

**Table 4: NTS assessment vignette [52]**

| Assessing Scrub Practitioners' Intraoperative Non-Technical Skills using the SPLINTS system | |
|---|---|
| Clinical area | Operating theatre team |
| Participants | Scrub practitioners (nurse, operating department practitioner, or instrument technician) |
| Site | Northern UK, off site - based on video simulation |
| Purpose | Validate (reliability, validity, usability) the SPLINTS tool for assessing scrub practitioners' NTS |
| NTS definition | "the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance" |
| Key NTS categories | Situation awareness, communication and teamwork, task management |
| Key NTS components | Gathering information; recognising and understanding information;anticipating; acting assertively; exchanging information; coordinating with others; planning; providing and maintaining standards; coping with pressure |
| Methods | Introduction to human factors concepts (3 h) and trained in the use of the SPLINTS system (2 h) |
| | Practice with using the tool to rate behaviours seen in a simulated video scenario (1 h) |
| | Used SPLINTS to rate the performance of scrub practitioners seen in seven standardized simulated, surgical video scenarios (1 h). |
| Outcomes | Non-technical skills of scrub practitioners can be identified (from behaviours seen in realistic scenarios showing scrub practitioner performance in the intraoperative phase of surgery) using the SPLINTS system |
| | The results indicate that the SPLINTS system has a consistent internal structure, and can be used with a reasonable level of accuracy to rate performance in simulated scenarios, when compared with subject matter expert ratings |
| | Participants indicated that the SPLINTS system is usable and contains the most important non-technical skills for the scrub practitioner to perform effectively |
| | Even with minimal training, scrub practitioners can use the SPLINTS behavioural rating system to reliably rate the non-technical skills performance of scrub practitioners seen in simulated, standardized video scenarios |
| Learning points | Providing a common language and a structured method for rating and training non-technical skills could take scrub practitioners one step closer to reducing the still unacceptably high adverse event rate seen in the operating theatre |
| Limitations | Fairly small number of participants (n= 34); The use of semi-scripted recorded scenarios rather than live or recorded operating theatre situations meant that some of the scenarios may have seemed more realistic than others |

of performance allows multiple raters to observe the same scenarios and compare their interpretations, increasing the reliability of the ratings.

A number of behavior rating systems have been designed and developed for specific specialties, including the operating theatre teams (Oxford NOTECHS) [43] and associated professional groups such as anaesthetists (ANTS) [44, 45], surgeons (NOTSS) [6, 46, 47] and scrub practitioners (SPLINTS) [48, 49]. Parker et al. (2012) describe a specific inventory for surgical leadership [50]. Hull et al. (2012) also outline the use of a number of global performance rating scales applied to non-technical performance [51].

Table 4 shows an example of a recent study assessing the psychometric properties of a new NTS behavioural rating system .

## Future Directions

### Definition

As more healthcare practitioners and health sciences researchers become familiar with the broad area of NTS, the definition of NTS is being reconsidered, especially in relation to interactions with patients. In the operating theatre where most NTS research in healthcare has taken place, patients are normally anaesthetised. A fundamental question is whether interpersonal and listening skills that are essential for good patient care should be considered as a category of NTS. Ross et al. argue that compassionate and empathetic communication with patients, for example, are important not just for patient experiences but for safety and quality and thus should be considered key NTS [38]. However most researchers continue to focus on NTS as applied to co-ordination and communication between team members but not between healthcare professionals and their patients.

### Clinical areas

Although NTS is a general term, its application in healthcare has tended to focus on acute specialities such as anaethesia [53] and surgery [54]. In cognitive terms, the thrust of much work has been towards features of individual cognitive performance such as situation awareness, planning and decision making [33]. Nevertheless, an important strand in surgical work has been the cross-disciplinary nature of study in this area [55]. Applications concerned specifically with nurses' teamwork and cognitive skills are becoming more visible in the literature (e.g. resuscitation teams [56]; scrub practitioners [48, 52]; midwives [57]) but this is an area that has room to develop [58].

### System perspective and resilience

Researchers have approached NTS mostly at the level of individual behaviours, as in most healthcare domains practitioners do not always work with the same team. Hence each worker requires portable NTS that they can apply in any team and accordingly NTS are assessed on an individual basis. Saurin et al. (2012) argue that traditional categories (e.g. situation awareness) derived from CRM have been applied via methods that 'adopt, implicitly, paradigms that are based on cognition in the mind, rather than cognition in the wild' [15]. This refers to the emerging areas of distributed cognition [59] and situated cognition [60] wherein cognition is interpreted as bound in situ within social, cultural and physical contexts. Without a better understanding of interactions between individual professionals and these contextual factors, post-training teams will not be able to fully utilize their newly acquired NTS in a sustained manner. There also needs to be organizational support, such as senior management commitment to institutional resources, development of official policies and creation of 'champions' [27]. The main implication for developing NTS applications is that NTS should be approached from a systems-level perspective if they are to be ultimately successful in increasing flexibility and adaptation in organizations. Important consideration should be given to the context in which skills are performed: newly trained NTS can only be applied if the organizational culture is supportive and facilitates the expression of these skills [61].

Saurin et al. (2012) suggest that applying Resilience Engineering principles to NTS could be fruitful [15]. Resilience Engineering is 'an emerging discipline

which 'emphasizes the capacity of a system to adapt safely to changing conditions'[62] even when unexpected conditions are encountered[63]. Resilience is viewed as an emergent feature of the work system[64] and the focus moves beyond human error[65, 66] towards understanding the adaptive capacity of the system and how people anticipate, deal with and recover from difficult demands and challenging conditions[66, 67]. This perspective suggests an additional application of NTS work; it will be important to develop ideas about how the core skills and components (see Table 1) reflect organizational or systems level adaptations to fluctuations and pressures in the work system. Training would focus less on rating individual behaviour and more holistically on interactions between NTS categories, and the relationship between NTS and technology, resources and work systems including documents, procedures and policies.

### NTS achievements to date

There is general acceptance that the introduction of NTS concepts into healthcare via training, development and research has had an impact on medical outcomes. Hull et al. (2012) conclude in a review of surgery that 'Although the available literature is somewhat heterogeneous, this review provides evidence that [NTS] skills can and do have an effect on surgeons' technical performance'[51]. Similarly, another simulation study found a strong correlation between technical and non-technical skills[68]. Moreover, recent prospective observational studies demonstrate that surgeons' NTS can be reliably measured using various work-based assessment methods[69, 70].

## Conclusions

In this paper we have outlined the importance of NTS in healthcare and some of its contributions to patient safety and quality of care. Examples have been provided of how they are identified, trained and assessed. It can be concluded that future directions for NTS theory and practice involve: increasing applications in nursing and interprofessional environments; focus on skills for interacting with patients ; approaches that consider cognition in complex systems. Amalberti et al. (2001) describe a 'plateau' reached by tools derived from CRM in 'ultra-safe' industries that already have high safety records[71]. These are levels of safety that healthcare strives to emulate and CRM approaches may help to play a part in that endeavour. It is thus important that the field of NTS in healthcare continues to evolve. The future of NTS in healthcare is likely to: a) attend to skills such as teamwork, leadership and communication skills, providing scientific rigour and replicability can be brought to bear on this area; and b) incorporate systems-theoretical extensions, in line with recent developments in cognitive science and resilience engineering.

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