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Human Factors in Patient Safety: Review of Topics and Tools

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Report for Methods and Measures Working Group of WHO Patient Safety. Geneva: World Health Organization.

April 2009

WHO/IER/PSP/2009.05

CONTENTS

EXECUTIVE SUMMARY

This report was prepared for WHO Patient Safety's Methods and Measures for Patient Safety Working Group.

It provides a basic description of major topic areas relating to human factors relevant to patient safety, with some indication of possible tools that can be used in a healthcare workplace for measurement or training of these topics. First an explanation of the human factors approach is provided. An organising framework is presented to provide a structure for the discussion of the topics, by categorising them as follows:

i) Organizational/ Managerial, ii) Team, iii) Individual, iv) Work environment.

Wider social factors and the central role of the patient are also acknowledged but these aspects of the healthcare system are not explicitly covered.

Ten topic areas within these four categories are described: **organizational culture, managerial leadership, communication, teamwork, team leadership, situation awareness, decision making, stress, fatigue, work environment.**

A selection of tools for education, measurement or training these human factors topics is described. Some of these may be suitable for application in developing, as well as developed, countries.

Acknowledgements :

We would like to thank the following for helpful comments on drafts of this report: Lucy Mitchell., Simon-Paterson-Brown, Tom Reader, Bill Runciman, Sarah Parker, George Youngson

Human Factors in Patient Safety:
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INTRODUCTION

This document presents a basic description of ten topic areas relating to organizational and human factors influencing patient safety. It also identifies a selection of tools for the measurement or training of these factors which may be suitable for application in developing, as well as developed, countries. The WHO Patient Safety Methods and Measures Working Group completed a series of reports on methods to measure patient safety in acute (Jeffs et al, 2009) and primary (Dovey et al, 2009) healthcare, as well as position papers on epistemology and ontology of patient safety research (Brown et al, 2008; Runciman et al under review). A number of important lines of investigation emerged from these overview reports, most notably the need to understand not only organizational culture but also a range of human factors, such as managerial, team and individual characteristics that influence the behaviour of healthcare staff in relation to safe patient care. In relation to the new WHO conceptual framework for patient safety, the organizational and human factors covered here would be classed as contributing or mitigating factors (see Sherman et al, 2009). This review gives some details of how a human factors approach has been adopted in industry and then provides a brief explanation of a number of these factors, indicating their relevance to patient safety. It concludes with suggestions for the wider adoption of human factors in patient safety practices. So what are human factors?

What are Human Factors?

The term human factors can be defined in several ways but a widely accepted definition is that of the Health and Safety Executive (HSE: UK industrial safety regulator). *'Human factors refer to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety. A simple way to view human factors is to think about three aspects: the job, the individual and the organisation and how they impact on people's health and safety-related*

behaviour.' (HSE, 1999 p2). Human factors is usually linked closely to Ergonomics which is the application of scientific information concerning humans to the design of objects, systems and environment for human use. In a work context, human factors research examines the environmental, organisational and job factors of humans interacting with systems, as well as the physiological and psychological characteristics which influence behaviour at work. For a more detailed explanation, see: www.hse.gov.uk/humanfactors. See also the Eurocontrol (European air traffic control) human factors website. www.eurocontol.int/humanfactors

Professional Bodies for Human Factors

The largest of the professional human factors organisations is the Human Factors and Ergonomics Society in the USA (www.hfes.org). Members come from various disciplines, such as ergonomics, psychology and engineering, as well as practitioners from industry, military and healthcare organisations. Many other countries have their own Human Factors/ Ergonomics societies, (for example, www.ergonomics.org.uk or www.ergonomics.org.au).

The military and the aviation industry have had the longest history of applying human factors principles to enhance the design of equipment, work environments and human performance, but now many industrial sectors have specialist bodies to advise on human factors. For the UK aviation industry, there is an independent Human Factors Group that is part of the Royal Aeronautical Society (www.raes-hfg.com). Similarly, the Energy Institute (a professional body for the energy sector) has a Human Factors Group (www.energyinst.org.uk/humanfactors/).

In the world of healthcare, very little training in human factors is provided to staff, unlike the other safety-critical industries. In 2007, Martin Bromiley (an airline pilot whose wife died due to an anaesthetic accident which had human factors causes) established in the UK, the first Clinical Human Factors Group, which has both clinical and human factors specialists involved (www.chfg.org). As an airline pilot, coming from an industry that incorporated a human factors approach into all aspects of safety management, including pilot training (see

next page), he was surprised to find that there was little awareness of the role of human factors for patient safety (see Bromiley, 2008).

Training in Human Factors

Human Factors training courses range from University courses (www.ergonomics.org.uk) (www.hfes.org/web/students/grad_programs.html), to very short courses of two or three days, and there are introductory web-based courses (www.hf.faa.gov). Some short courses tend to focus on raising awareness of cognitive and social skills for effective teamwork, for example, versions of the Crew Resource Management (CRM) courses that are taught in airlines and other safety-critical industries (see CAA, 2006; Flin et al, 2008; O'Connor et al, 2008; Wiener et al 1993). These are now being adapted for healthcare practitioners by various organisations and commercial training providers (see Baker et al, 2007). A syllabus for a short course dealing with human performance and teamwork can be found in CAA (2006). The WHO (2009) patient safety course for medical students contains one module on human factors www.who.int.

Aim of this Report

The purpose of this report is to outline the main organizational and human factors that have relevance for patient safety. A basic framework (Figure 1) shows the principal themes. The focus is on the healthcare staff and their working relationships with other staff and how that may affect patient outcomes, rather than on issues to do with interacting with patients or their relatives. When industrial/ organisational psychologists study human factors and safety, they are usually interested in the safety of workers (e.g. Barling & Frone, 2004). This review focuses on human factors concepts that are related to the safety of patients rather than the safety of healthcare workers (although workers can also suffer injuries which can be caused by similar factors to patient injuries).

For the ten topic areas, a definition and basic description of what they are and why they are relevant to patient safety has been produced. These are

presented in short summaries, outlining the relevance of each topic for patient safety, including suggested tools for measurement or interventions such as training, as well as providing easily accessed sources of further information. Where possible, the focus is on what have been called "microtools for safety" (Hudson, 2007). These are readily available and relatively easy to use at the worksite for safety management, without the need for specialist training or on-site advice. The tools have been suggested as potentially applicable for health care organizations and/or research institutions to examine the organizational and human factors related to unsafe care. Their suitability for use in developing countries would need to be assessed and for many of these instruments some degree of cultural customisation could be required. The review concludes by suggesting the directions a subsequent project might take with the aim of identifying or designing human factors tools for patient safety that could be applied in developing or transitional countries.

Background Reading

A full reference list is provided at the end of the report. A reading list of human factors topics related to healthcare can be found on the Clinical Human Factors Group website www.chfg.org/reading.htm

A guide prepared by Dr Jane Carthey on how to implement human factors principles and techniques in healthcare can be found at www.patientsafetyfirst.nhs.uk Further information on human factors concepts and tools that are relevant to patient safety can be found in the following (see reference list for publication details).

Barling, J. & Frone, M. (2004) (Eds.) *The Psychology of Workplace Safety.*

Carayon, P. (2007) (Ed). *Human Factors and Ergonomics for Patient Safety.*

Flin R, et al (2008). *Safety at the Sharp End: A Guide to Non-Technical Skills.*

Flin, R. & Mitchell, L. (2009) (Eds) *Safer Surgery. Analysing Behaviour in the Operating Theatre.*

Reason, J. (2008). *The Human Contribution. Unsafe Acts, Accidents and Heroic Recoveries.*

Runciman, B. et al (2007) *Safety and Ethics in Healthcare.*

St.Pierre, M., et al. (2008) *Crisis Management in Acute Care Settings.*

Stanton, N. et al. (2005) *Human Factors Methods*.

Sanders, J. & Cook, G. (2007) *ABC of Patient Safety.*.

Vincent, C. (2006) *Patient Safety.*

It should be noted that the tools/ references/ websites given in the following sections are not being endorsed or recommended by the authors or by WHO. They are only being suggested as examples to illustrate the type of instruments which are available for human factors research and practice.

FRAMEWORK

The organising framework that we have selected (Figure 1) is based on Moray's (2000) model of the organizational, human and technical components of sociotechnical systems.

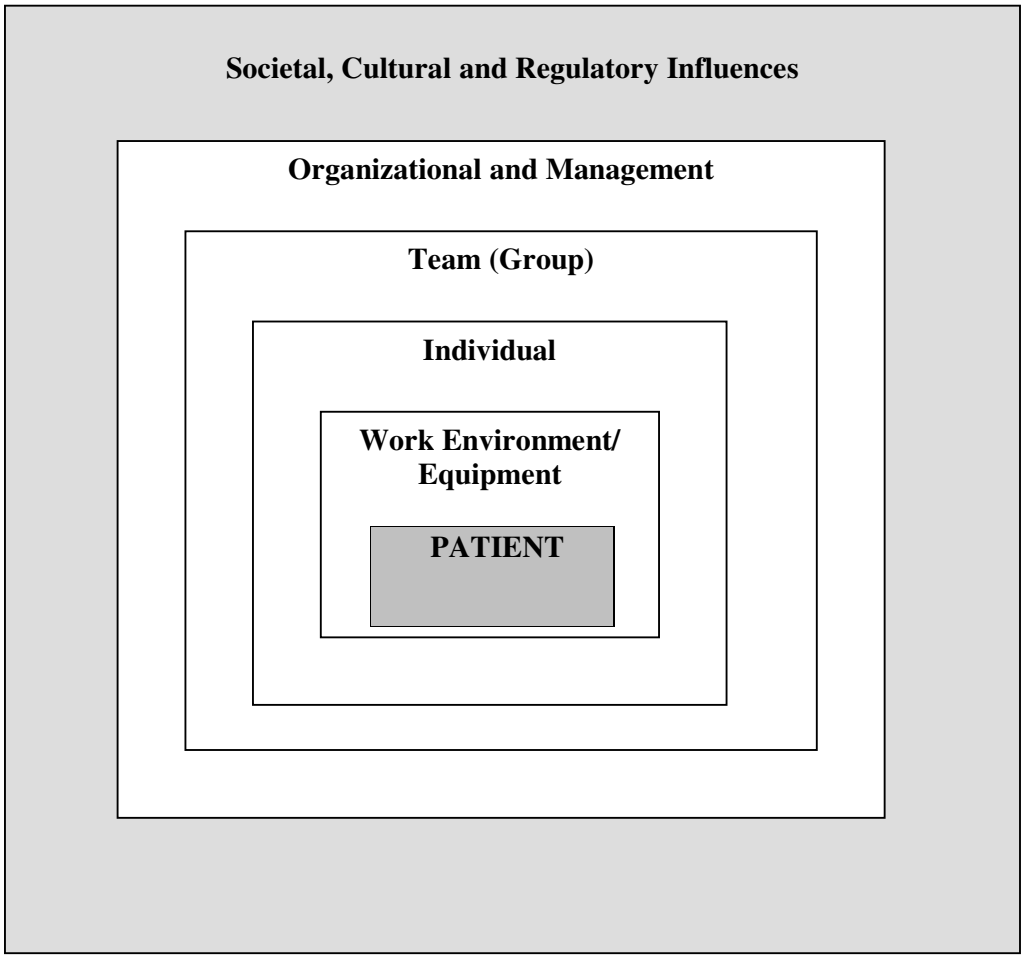

Figure 1. Organisational and human factors in sociotechnical systems (from Moray, 2000)

This model has been adapted by others to demonstrate the role of human factors in patient safety, e.g. by the National Patient Safety Agency in England www.npsa.org or University of Texas Medical School Patient Safety Centre www.uth.tmc.edu . In Figure 1, the patient is portrayed as the central element but patient factors are not covered in this review. The presence of external influences is also acknowledged, for example, from national culture

or government, but the review does not deal with these either. Thus, the report covers only four sets of factors, as shown in the un-shaded boxes above.

There are other frameworks displaying key factors influencing patient safety (e.g. Brown et al, 2008; Runciman et al. 2007; Vincent, 2006). These are often portrayed as systems diagrams indicating postulated relationships between organizational, human factors, errors and safety outcomes. Figure 2 is a simple version of this type of model.

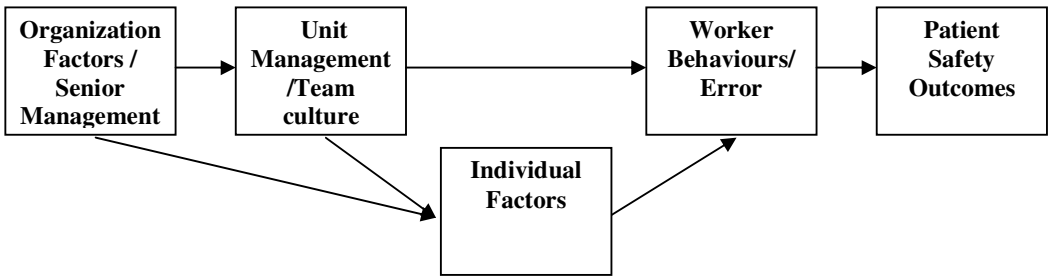

Figure 2. Factors influencing patient safety outcomes (Jackson & Flin, in prep).

In the interest of simplicity, we have not adopted any one of these systems models, nor do we attempt to cover the multitude of human and organizational factors that can be related to human error (Helmreich, 2000; Hurwitz & Sheik, 2009; Reason, 1990). We do not discuss incident/ accident analyses techniques which examine human factors causes, as these are described elsewhere (Straub, 2004; WHO, 2008). The focus of this report is on four main categories of factors listed below. Within these categories, ten key human factors topics for patient safety have been identified as most relevant for patient safety.

Organizational / Managerial	***TOPIC***
	1. Safety Culture
	2. Managers' Leadership
	3. Communication
Workgroup/ Team	
	4. Teamwork - structure/ processes (dynamics)
	5. Team leadership (Supervisors)
Individual Worker	
Cognitive (thinking) skills	*6. Situation awareness* *7. Decision making*
Personal resources	*8. Stress* *9. Fatigue*
Work Environment	
	10. Work environment and hazards

REVIEW OF TOPICS and TOOLS

I. Organizational and Management Factors

There are many organisational and managerial factors that can influence all workers' behaviour (see Landy & Conte 2008) and thus in healthcare, these factors can affect patient safety. The three selected are: i) safety culture, ii) senior/ middle management safety leadership, iii) workplace communication procedures (e.g. briefings, handovers).

1. Safety Culture

Definition: *'The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management.'* (ACSNI, 1993, p.23)

Analysis of major accidents in industry shifted regulatory and research focus from individual factors towards organizational factors such as safety culture. The concept of safety culture (sometimes also called safety climate) gained attention after the Chernobyl nuclear power plant disaster in 1986. Safety culture essentially reflects managerial and worker attitudes and values related to the management of risk and safety. Dimensions of organisational safety culture are: management commitment to safety, work practices relating to safety, relative prioritisation of safety, adherence to safety rules, risk management, reporting of errors and incidents. The safety culture influences what is the normal behaviour of workers in a particular ward or unit in relation to taking risks, following rules, speaking up about safety. Before engaging in interventions designed to achieve a cultural change in an organization, it is important to assess the current state of the safety culture. This is usually achieved with a questionnaire survey asking workers and managers about their attitudes to safety and perceptions of how safety is prioritised and managed in the work unit or across the organization.

Culture and Patient Safety

Safety culture has become a significant issue for healthcare organizations striving to improve patient safety (Kennedy, 2001) and some safety investigations have indicated that organisations need to change their culture to make it 'easy to do the right thing, and hard to do the wrong thing' for patient care. The Institute of Medicine stated, *"The health care organization must develop a culture of safety such that an organization's design processes and workforce are focussed on a clear goal – dramatic improvement in the reliability and safety of the care process"* (Kohn et al, 1999, p.166). Recent studies have begun to assess the safety culture in different types of healthcare organisations and hospital safety culture has been linked to both worker and patient safety (Hofmann & Mark, 2006; Naveh et al 2005; Zohar et al, 2007). There are a number of different questionnaires have been developed to measure dimensions of safety culture in healthcare settings (see Flin et al, 2006 for a review). These tend to be short questionnaires which are easy for staff to complete. They can be used to track the effects of safety interventions on the unit or organizational safety culture. A new review of tools for measuring patient safety culture is being conducted (2009) as part of a European project see www.eunetpas.eu

Safety Culture Tools

Hospital Survey on Patient Safety Culture: (AHRQ, Sorra & Nieva, 2004) 42 item questionnaire measuring 12 dimensions for both clinical and non-clinical staff, at unit and management levels in hospitals. This has been widely used in the USA and European countries with scientific reports beginning to emerge. Versions are available for different settings, e.g. nursing homes. Available from www.ahrq/qual/hospculture

Safety Attitudes Questionnaire: (Sexton et al, 2006) 60 item questionnaire which measures dimensions including teamwork, management, and working conditions. Different versions for intensive care units, operating rooms, wards, clinics, etc. These are available without charge for non-commercial purposes but registration is requested.

www.uth.tmc.edu/schools/med/imed/patient_safety/survey&tools/htm

Instead of questionnaires, another method of assessing safety culture is based on a card sorting and discussion task. The **MaPSaF Manchester Patient Safety Assessment Framework** (Kirk et al, 2007) is designed for work teams to self-reflect on their culture. This is available for pharmacy, primary care, as well as hospital settings.
www.npsa.nhs.uk/nrls/improvingpatientsafety/humanfactors/mapsaf

For **briefing notes** on safety culture, see www.hse.gov.uk/humanfactors or see Eurocontrol's safety culture toolbox www.eurocontrol.int/eec/public

2. Managers' Leadership (Senior and Middle Managers)

> ***Definition:*** "Leadership is the process of influencing people towards achievement of organizational goals" (Naylor, 2004, p.354).

For effective safety management, leadership plays an important role at every level of management, ranging from team leaders to middle managers (e.g. heads of clinical units) at a tactical level to top-level managers (e.g. healthcare organisation senior managers/ Chief Executive Officers) at the strategic level. Research studies have shown that particular styles of leadership are associated with better safety behaviours by workers and more favourable organisational safety performance such as decreased accident rates and increased safety compliance. The appropriateness of a particular style of leadership, and of certain leadership behaviours, may differ across levels of leadership and across different work settings. This section concentrates on leadership for safety at the senior and middle management levels. Supervisors/ team leaders are discussed on page 25.

There are many theories of leadership, focusing on traits, behaviours and styles (see Yukl, 2008 for a review). Most of the research looks at the effects of managers' leadership in relation to business performance and productivity, but there is now an increasing interest in the relationship of particular

leadership styles shown by managers in relation to safety outcomes (e.g. Hofmann & Morgeson, 2004).

The model most often applied to the study of managers' safety leadership is the transactional/ transformational model (Bass 1998) which conceptualises the basis of leadership as a transactional relationship between leader and follower. The leader offers incentives and/ or punishments that are contingent on the subordinate's performance meeting agreed standards. Transactional leaders set agreed goals, monitor performance and administer reinforcement accordingly. Bass argues that this transactional relationship between leader and subordinate will, at best, produce expected performance levels, because it only appeals to individual goals and aspirations. While all leaders use the transactional component, he argues that leaders of the highest performing teams also display transformational behaviours. Transformational leaders are charismatic, inspiring, stimulating, and considerate. They provide followers with a sense of purpose; portray an image of success, self-confidence and self-belief; articulate shared goals and question traditional assumptions, while taking into account the needs of subordinates.

A newer theory of authentic leadership (Avolio & Gardner, 2005) may also be applicable to safety outcomes. In industry, safety leadership is now recognised as an important facet of management and companies have developed special programmes to identify the skills and to train them (Yukl, 2008). One method of assessing managers' commitment to safety and safety behaviours involves the leader completing a self rating questionnaire and asking several of his or her staff to complete an 'upward' rating (Bryden et al, 2006), which means that the staff rate their supervisor or direct boss.

Managers and Patient Safety

Managerial leadership and safety has not been studied as much in the healthcare sector compared to industry, but is just as relevant. *'Only senior leaders can productively direct efforts in their healthcare organisations to foster the culture and commitment required to address the underlying systems causes of medical errors and harm to patients.'* (Botwinick et al, 2006, p1). Katz-Navon et al., (2005) found that when safety was a high managerial

priority, hospital units experienced fewer errors. A UK study revealed that staff perceptions of the effectiveness of senior managers' leadership were linked to lower rates of patient complaints and better clinical governance ratings (Shipton et al, 2008). Senior managers need to demonstrate their commitment to safety in a visible fashion, for instance by visiting the wards, clinics, laboratories etc. These are called 'Executive Walk Rounds' and have been shown to influence the nursing safety culture (Thomas et al, 2005). The upward appraisal approach has also been used with senior managers in healthcare to provide them with feedback on their perceived commitment to safety (Yule et al 2008). With its focus on change, the transformational leadership approach may be the most beneficial style for managers in healthcare (Firth-Cozens & Mowbray, 2001), although, it is not always easy to identify the real leaders, e.g. in a multidisciplinary departments or where clinicians and managers do not have clear authority. Based on the industrial literature, some leadership guidance was offered by Flin and Yule (2004) to healthcare managers see box below.

Middle managers - Emphasise safety over productivity, adopt a decentralised style, become involved in safety initiatives, relay the corporate vision for safety to supervisors.

Senior managers - Ensure compliance with regulatory requirements, demonstrate visible and consistent commitment to safety, provide resources for a comprehensive safety programme, show concern for people, encourage participatory styles in middle managers and supervisors, make time for safety.

Leadership Tools (Managers)

There are many general **leadership questionnaires** for managers available on the web but often limited information is provided on their reliability or validity. Most of them have not been systematically tested in relation to patient safety outcomes. The instruments which have been scientifically developed and have been scientifically studied tend to be sold through test suppliers, some examples are given below.

- **Multifactor Leadership Questionnaire (MLQ)** 45 item questionnaire with four dimensions (Transformational, Transactional, Laissez-Faire Leadership and Outcomes of Leadership, such as Effort, Effectiveness and Satisfaction) (see Bass, 1998). Available in a number of languages at a charge from www.mindgarden.com

- **Authentic Leadership Questionnaire (ALQ)** New model of leadership based on values (Avolio & Gardner, 2005). Available free to researchers in exchange for data. www.mindgarden.com

- **Leadership Practices Inventory (LPI)** measures five key leadership practices (Kouzes & Posner, 2008). Available in a number of languages at a charge from www.leadershipchallenge.com

- The tool for self / upward appraisal of managers' safety leadership **'Seeing Yourself as Others See You'** is available free from www.energyinstit.org.uk/heartsandminds

- **NHS Leadership Qualities Framework (LQF):** is based on 15 qualities which are arranged in three clusters labelled personal, cognitive and social. It also has a 360 degree assessment tool (not free of charge) which can be used for self, upward, peer appraisal. www.nhsleadershipqualities.nhs.uk/

There are also several **guides and checklists** on leadership behaviours and actions to improve patient safety available for healthcare managers.

- **Leadership Guide to Patient Safety** (Botwinick et al., 2006) Describes eight steps for senior healthcare managers e.g. engage strategic priorities, communicate, track performance. Available from Institute for Healthcare Improvement. www.ihi.org

- **Leadership Checklist for NHS Chief Executives** – list of seven recommended actions (eg promote reporting, build a safety culture) with suggested resources www.npsa.nhs.uk/

- **Strategies for Leadership. Hospital Executives and their Role in Patient Safety** Self assessment tool for senior healthcare managers to guide activities for improving safety within their organizations. www.ihi.org

- **Patient Safety Leadership WalkRounds guide** www.patientsafetyfrist.nhs.uk

- **Patient Safety Leadership WalkRounds tool for data collection** www.ihi.org

3. Communication

Definition: *Communication is the transfer of information, ideas or feelings.*

Communication is essential to workplace efficiency and for the delivery of high quality and safe work. It provides knowledge, institutes relationships, establishes predictable behaviour patterns and is vital for leadership and team coordination. The standard model of communication has a sender encoding an idea into a message, transmitting that to one or more receivers who then decode it back into the original idea. Communication in organizations is typically described as one-way (e.g. in written instructions) or two-way (e.g. conversations, phone calls, email exchanges). The main difference between one and two-way communication is that two-way provides feedback which enables the sender and receiver to ensure that the meaning within the information has been understood. It therefore 'closes the communication loop', and is one way of minimising misunderstandings in the receiver's interpretation of the original meaning of the message.

Communication problems can be categorised as system, message and reception failures, see box below. These can lead to errors which can occur as individuals fail to receive or to pass on information or communicate incorrect information (see CAA, 2006).

Categories of communication failures

- **Organisational system failures** in which the necessary channels for communication do not exist, or are not functioning, or are rarely used.
- **Transmission failures** in which the channels exist, but the necessary information is not transmitted. (e.g. sending unclear or ambiguous messages). Difficulties due to the transmission medium (e.g. background noise). Physical problems in sending the message (e.g. when wearing protective equipment).
- **Reception failures**, in which the channels exist, the necessary information is sent, but is either misinterpreted by the recipient (e.g. expectation of another message, misinterpretation or disregard of the message) or timing (e.g. arrives too late). May be caused by physiological problems (e.g. impaired sight or hearing) or equipment problems (e.g. poor radio reception).

- Failures due to **interference between the rational and emotional levels** (e.g. arguments).

For examples of communication failures leading to accidents in the workplace (see Flin et al, 2008, chapter 4); Reason (1997) or in aviation where cockpit voice recordings reveal the final conversations between pilots and air traffic controllers (see Cushing, 1994).

Communication and Patient Safety

Communication failures are the leading causes of inadvertent patient harm (Leonard et al, 2004). Analysis of 2455 sentinel events reported to the Joint Commission for Hospital Accreditation in the USA (JCAHO, 2008) revealed that the primary root cause in over 70% was communication failure. Similar patterns can be found in many areas of healthcare: Reader et al (2006) found that communication featured as a prime cause in many reported incidents in Intensive Care Units. Safe and effective delivery of healthcare requires communication between individuals with different roles, training, experience and perspectives on care. Some of the key problems relate to the following: shift or patient handovers; the quality of information recorded in patient files, case notes and incident reports; status effects inhibiting junior staff from speaking up; and difficulties of transmitting information within and between large organisations (e.g. safety alerts).

In safety-critical industries, pre-task briefing is regarded as extremely important and this is now being introduced more rigorously in healthcare. There are a number of briefing tools for healthcare, such as the WHO Surgical Safety checklist to be used with an operating team prior to a surgical procedure (Haynes et al, 2009). Creating opportunities for all team members to speak up and exchange information is an important element of the briefing. The SBAR (Situation, Background, Assessment, Recommendation) is another communication tool, developed by the military, which provides a common predictable structure to the message (Haig et al, 2006). This can be used for handovers (hand-offs) or for improving the quality of urgent communications (e.g. junior calling a senior person about a patient). The SBAR involves first

clarifying the problem, then giving pertinent background information, followed by an assessment of the situation, and a recommendation. This has the added benefit of allowing professional groups who have been taught to communicate in very different styles, to have a common language.

Task debriefing is the process of an individual or team formally reflecting on their performance after a particular task, a shift or a critical event. It is a technique which can enhance safety by learning lessons from both well managed and poorly managed events (Dismukes & Smith, 2000). Successful debriefing is achieved by identifying aspects of good performance, identifying areas for improvement, and suggesting what should be done differently in future. Recommendations for debriefing in healthcare to improve patient safety can be found in Flanagan (2008) or Rudolph et al (2006).

***Communication Tools**:*

- **Handover (Handoff) Tools** www.dodpatientsafety.usuhs.mil and www.jcrinc.com/Books-and-E-books/HANDOFF-COMMUNICATION-TOOLKIT-FOR-IMPLEMENTING-THE-NPSG/1249/

- **'Do Not Use' List** abbreviations which can cause communication errors

http://www.jointcommission.org/PatientSafety/DoNotUseList/

- **Safety Briefing Tool and SBAR Tool** for Briefing and Handover (IHI) www.ihi.org

- **Safe Handover** (British Medical Association) www.bma.org.uk

- **Surgical Safety Checklist (**WHO, 2008) for pre-operative team briefing

www.who.int/patientsafety/safesurgery/ss_checklist/en/index.html

- **DASH Debriefing Tool** New guidance for structured debriefing

www.harvardmedsim.org.

- **Team Self Review Debriefing**

www.npsa.nhs.uk/nrls/improvingpatientsafety/humanfactors/teamworking/tsr

Communication Websites

Mind Tools provides basic information on communication plus advice on email, listening, assertiveness and other topics www.mindtools.com

Communicating with Others (MIT HR) range of communication information www.mit.edu/hr/oed/learn/comm/resources.html

Safety Critical Communications (HSE) advice with a questionnaire for site assessment www.hse.gov.uk/humanfactors/comah/common3.pdf

II Work Group/ Team

Teams are increasingly a feature of organisational life, as work often involves people with different expertise who have to cooperate on the same tasks. Almost all work in healthcare is carried out by interdisciplinary groups of workers e.g. operating room team, shifts of staff from wards, clinics and other treatment units. A team is usually defined as, '*a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform.'* (Salas et al, 1992, p4). It is known from studies of group behaviour that being a member of a work team can influence individual behaviour. The factors that influence team performance include the size and psychological composition of the group (group structure), what happens when the group work together (group processes or dynamics) and how the group is lead e.g. by the team leader or supervisor.

A basic model of team performance is shown below in Figure 3.

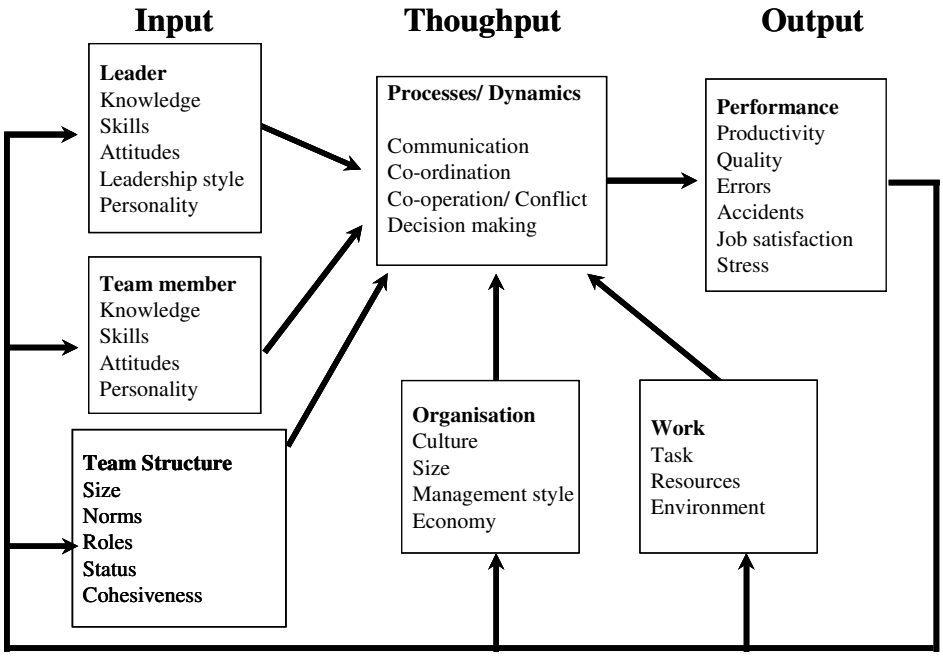

Figure 3. Factors influencing teamwork (from Flin et al, 2008)

Understanding teamwork involves understanding the concepts of team structures and team processes as shown in Figure 3. A definition is given below.

Definition: *Teamwork (or team behaviour) is a dynamic process involving two or more people engaged in the activities necessary to complete a task.*

The factors relating to team structure and team processes are discussed in the following section along with ways to measure them and sources for team training materials.

4. Teamwork

(a) Team Structure

Teamwork is affected by the structural characteristics of a team, which include the number of team members, as well as the status hierarchy, roles and accepted norms for behaviours. These factors will differ depending on the type of team and where that team operates and they can influence group cohesion (West, 2004). In comparison to hospital-based teams which generally have well-defined protocols and procedures, professional hierarchies, and shared organisational goals, teams in community-based primary care practices may work in settings where their roles are blurred. Along with where a healthcare team operates, the structure of teams may vary depending on the needs of the patient. More interdisciplinary collaboration by team members will be needed, the more complex the patient's health issue (CHSRF, 2006).

Many studies in the workplace have described the status differences in teams, especially relating to seniority or professional background. Status is the relative rank or position that a person holds within a small group like a team or a big group like an organization or a society. One's perceived status can impact on behaviours, such as willingness to speak up or to challenge another team member when they may be making an error. The effects can be subtle

such as changes in the way one speaks when addressing a co-worker perceived to be of higher or lower status. There are certainly powerful status hierarchies operating in many sectors of healthcare, especially between doctors and nurses (Edmondson, 2003; Reader et al, 2007). In aviation, special efforts are made to reduce the status 'gradient' on the flightdeck, for example by captains explicitly encouraging co-pilots to speak up if they have concerns during a flight and co-pilots being trained to be more assertive (Jentsch & Smith-Jentsch, 2001). These status differences are more pronounced in some national cultures than others (see Helmreich & Merritt, 1998).

The roles adopted by team members also influence the effectiveness of the team. This not only relates to the formal roles and accountabilities of team members (e.g. nursing assistant, physiotherapist or team leader), but also to the informal roles that people may adopt or be allocated (counsellor, comedian, organiser). Some studies have suggested that a balance of informal roles can aid team functioning. Belbin's (2003) team role self-perception inventory describes team roles at work in terms of those he suggests are required for team effectiveness. He identified nine roles (including Co-ordinator, Implementer, Completer Finisher) that team members need to fulfil if a team is to be successful. Teams do not have to consist of nine people, each team member can fulfil more than one role, but he argued that a balance of roles is necessary. Team members have preferred roles that they can take on, and they need to respect the characteristics and strengths of each team member. This approach emphasises that effective teams require people with different preferences and strengths, and Belbin's questionnaire can be used as part of an exercise to enable teams to talk and about their preferred roles and ways of working together. This may be particularly useful for multidiscipline teams that have different values and expectations of behaviours in relation to work tasks and duties.

If the roles within a work group are not clearly defined, this can create problems (e.g. no-one is leader, or several people believe themselves to be the leader). A pre-task briefing can be used to confirm team roles and responsibilities. West (2004) suggests an exercise in role negotiation which

can be used to address how team members can develop understanding of roles and functions of team members:

Step 1: Team members list objectives and principal activities

Step 2: Team members examine the information for each role

Step 3: Team members note what behaviours each other role should adopt

Step 4: Pairs of team members meet to examine the results and reach agreement about the various requests.

A third structural feature of groups is norms, these are unwritten rules developed by groups that govern the behaviour of group members. They could relate to work rate, whether errors are reported to the supervisor, or what are acceptable topics of conversation. These norms are related to the group culture and may be assessed by questionnaires which ask about typical behaviours in the work group.

(b) Team Processes/ Dynamics

Team dynamics refer to the psychological processes describing the interactions that occur in a group, evidenced by behaviours associated with coordination, communication, cooperation, conflict management, and decision making (see Figure 3). Furnham (1997) argues that understanding team processes can increase the chances of obtaining desirable consequences from groups at work. He states that when managers understand the team dynamics in an organization, they can help their teams to effectively accomplish the organization's and the individual employees' goals. Team dynamics are affected by the organizational culture, which represents a team's shared perceptions of organizational policies, practices and procedures (Bower et al, 2003). Other factors that affect a team's processes are summarized below.

- Goal comprehension- a shared understanding of the goals and how crucial it is that all members commit to the goal.
- Communication- what channels are preferred and how is the group

networked?

- Conflict management- how are conflicts and disagreements handled? Is conflict encouraged or discouraged?
- Decision making- how and by whom
- Performance evaluation- how are members appraised, is it formal or informal?
- Division of labour- how are tasks assigned
- Leadership- how are leaders elected and what functions do they have?
- Process monitoring- how are tasks processed and checked?
- How is feedback provided?

Much of the research in team processes comes from high-risk work settings such as the military, aviation and the energy industry (see Salas et al, 2001). This has often focussed on group decision making, problem solving, coordination, workload management and conflict resolution. One area of current interest is how teams develop a shared understanding (shared mental model) of the task and each team member's particular roles and responsibilities for achieving it. There has been some research on the development of training tools and techniques that can be used to enhance team dynamics by improving processes such as team communication. The SBAR tool mentioned earlier can be used to enhance and standardise team communication during team briefings.

Teamwork and Patient Safety

In healthcare, the definition of teams and teamwork can depend on how different professions view their work arrangements. Makary et al (2006) reported that physicians viewed teamwork in operating theatres as good, and thought effective collaboration was when 'nurses anticipated their needs and followed instructions' (p748). The nurses thought that teamwork was poor, and regarded good collaboration as 'having their input respected'. The importance of teamwork in healthcare has been shown in many different studies (Baker et al. 2007; Manser, 2009). It has been suggested that 70-80%

of healthcare errors are caused by human factors associated with poor team communication and understanding (Schaefer et al, 1994). A review of studies of nursing homes showed that teamwork, communication and leadership were all critical to a safe environment (Scott-Cawiezell & Vogelsmeier, 2006). Good teamwork can help to reduce patient safety problems and it can improve team members' morale and well being, as well as team viability - the degree to which a team will function over time (Bower et al, 2003). It is thus crucial for managers and supervisors to understand how teamwork can be developed to ensure patient safety.

In order to create high-functioning teams, it is necessary to provide opportunities and facilities in which groups of healthcare practitioners can develop their team working practices. There are numerous ways in which this can be done, and the National Patient Safety Agency (NPSA) provides some suggestions on their website http://www.npsa.nhs.uk/nrls/improvingpatientsafety/humanfactors/teamworking/ . Amongst these suggestions, the NPSA proposes that regular team briefings (e.g. at handover) create a good opportunity for all team members to have a shared understanding and knowledge of shared goals.

In healthcare, there are often fluid rather than fixed teams, so the same people do not work together every time they come to work. This means that tools based on industries where teams are not fixed (e.g. civil aviation) are often of most relevance to healthcare teams. The main type of human factors training used for pilots is called Crew Resource Management (CRM) and this focuses on safe and unsafe behaviours for teamwork on the flight deck (see CAA, 2006; Flin et al, 2008; Wiener et al, 1993). This kind of training is now being adapted for use with healthcare teams (Baker et al, 2007; Flin & Maran, 2004).

Teamwork Tools

There are a number of questionnaires that assess aspects of team culture and underlying structural influences, such as norms, roles and status. These

include versions of the *Operating Room Management Attitudes Questionnaire* (ORMAQ, Helmreich & Merritt, 1998; Flin et al, 2006), the *Interdisciplinary Collaboration* questionnaire which measures communication between doctors and nurses (Shortell et al, 1996), or the *Team Climate Assessment Measurement (TCAM)* questionnaire (see below). The associated *Team Self Review* (TSQ) can be used in conjunction with the TCAM, as it offers a collection of techniques that can be used to review and develop team performance. A new measure, the TeamSTEPPS Teamwork Assessment Questionnaire (T-TAQ) developed by the US Agency for Healthcare Research and Quality (AHRQ) assesses attitudes to core components of teamwork (e.g. team structure, mutual support) and is designed for use with a teamwork training programme.

- **Team Climate Assessment Measure** (TCAM) available from www.npsa.nhs.uk/nrls/improvingpatientsafety/teamworking/tcam

- **Team Self Review** (TSQ) available from www.npsa.nhs.uk/nrls/improvingpatientsafety/humanfactors/teamworking/tsr

- **TeamSTEPPS Teamwork Assessment Questionnaire** (T-TAQ) http://teamstepps.ahrq.gov/taq_index.htm

- **TeamSTEPPS** This is a package of tools developed by AHRQ in the USA for assessing team training needs and teamwork problems, plus a package of training materials and advice for healthcare organisations wishing to implement this programme. Available from http://teamstepps.ahrq.gov

Podcasts on Teamwork by Professor Michael West of Aston Business School

www.abs.aston.ac.uk

Behavioural Rating Tools for Teams or Individuals in a Team Setting

There are now a range of tools for rating observations of team members' behaviours, mainly developed for operating theatre teams but versions can be designed for application in other settings. Flin and Mitchell (2009) provide examples of many of these instruments, several of which are mentioned below. Some are for rating individuals, such as an anaesthetist or a surgeon working in a team setting (e.g. ANTS and NOTSS) and others (e.g. OTAS) are for rating a whole team or sub-teams.

ANTS: Anaesthetists' Non-Technical Skills

ANTS (Fletcher, et al, 2003) was designed for anaesthetists to measure anaesthetists' non-technical skills during operations in four categories: teamwork, task management, situation awareness, decision-making. **http://www.abdn.ac.uk/iprc/ants**

The NOTSS system: Non-Technical Skills for Surgeons

NOTSS (Yule et al, 2006) was designed for surgeons to measure an individual surgeon's non-technical skills during surgery. NOTSS uses four categories: communication and teamwork, situation awareness, decision-making, task management. **http://www.abdn.ac.uk/iprc/notss**

Nurses' NOTECHS: Non-Technical Skills for Theatre Nurses (Mitchell & Flin under development). Visit: http://www.abdn.ac.uk/iprc/nursesnotechs/

OTAS: Observational Teamwork Assessment for Surgery (Healey et al, 2004)

Available from: http://www.csru.org.uk

There are several tools adapted from the aviation **NOTECHS** (Flin et al, 2003) designed for rating airline pilots' non-technical skills e.g. **Oxford NOTECHS** (Mishra et al, 2009) or **Revised NOTECHS** (Sevdalis et al, 2008) to measure

non-technical skills of a surgical team or a sub-team, using categories similar to those described above.

6. Team Leadership (Supervisors)

> ***Definition:*** The team leader is *'the person who is appointed, elected or informally chosen to direct and coordinate the work of others in a group.'* (Fiedler, 1995, p7)

Team leaders, also called supervisors or front line managers, are typically responsible for a small group of people working together to achieve a common task. In healthcare, these are leaders of established groups, such as ward charge nurses or leaders of temporary groups, such as operating theatre team. The supervisor generally has responsibilities for task completion and for the safety and well being of the team members. Only a few studies have investigated safety leadership behaviours of supervisors in healthcare, but many studies have been conducted in other industries. Supervisory safety practices have been found to decrease the number of minor accidents and positively influence workers' safety climate perceptions. Transformational leadership behaviours (explained above) of supervisors have been found to be related to fewer occupational injuries (Zohar, 2003). The literature on supervisors and safety emphasises the importance of good communication, the need to build trust and to care about the team members, as well as the need to set and reinforce safety standards, especially when there are strong production or cost reduction goals (Hofmann & Morgenson, 2004).

For supervisors, most leadership theories indicate that the leader has to concentrate on both the task and on the social needs of the team members (see Landy & Conte, 2008). Blake and Mouton's (1964) Managerial Grid provides a questionnaire for leaders to assess how they score of the task and team dimensions. Another popular leadership theory for first level managers is Hersey et al's (2000) situational model. This states that for optimal team performance, the leader needs to assess the level of maturity of the team, in terms of their task competence and commitment. Then the leader has to adapt his or her behaviour accordingly in relation to four styles: a) telling

(autocratic), b) selling (persuading), c) coaching and d) delegating. For example, an inexperienced team will need explicit task instruction and structuring whereas experienced teams with high motivation perform best when the leader takes more of a monitoring role, allowing them get on with their tasks. Salas et al (2004) suggested that team leaders need to define goals and expectations, provide guidance and feedback and adjust their role to match the team's progress.

Team Leaders and Patient Safety

In healthcare, the team leader or supervisor plays a critical role in the maintenance of patient safety for the unit they manage and the models of effective leadership behaviour described earlier are likely to be applicable. Flin and Yule (2004) suggested that supervisors need to monitor and reinforce workers' safe behaviours, emphasise safety over productivity, participate in safety activities, encourage employee involvement in safety initiatives. Edmondson (2003) has shown how the team leader's behaviour influences surgical team members' willingness to speak up.

In acute medicine, there are also leaders of temporary action teams who assume responsibility for coordinating the work during a short but highly consequential event, e.g. resuscitating a patient. Cooper and Wakelam (1999) rated leadership shown by junior doctors during videotaped resuscitations and found that when leaders initiated a structure within the team, the team worked better together and performed resuscitative tasks more quickly and effectively. Marsch et al (2004) studied resuscitation teams in a simulator and found that less successful teams exhibited significantly less leadership behaviour and explicit task distribution. The action leader may need to act in a command role, *"The needs of the individual staff members are [at a] low immediate priority while the key objective of saving the patient's life is paramount. Ability to analyse, think creatively and decisiveness are key attributes'* (McCormick & Wardrope 2003, p72).

Supervisor/ Team Leader Tools:

- **Situational Leadership** (Hersey et al, 2000) measures different leadership styles www.kenblanchard.com

- **Leadership Opinion Questionnaire** (LOQ, Fleishman 1967) measures team-focused and task-focused behaviours in supervisors www.vangent-hcm.com

- **Perceptions of supervisory behaviours for safety** (Zohar & Luria 2005). Questionnaire on supervisors' prioritisation of safety versus work goals.

- **Improving Supervision** training guide with support materials www.energyinstit.org.uk/heartsandminds

III Individual

At the individual level, there are many different psychological and physiological factors which can influence workers' behaviours that contribute to safety outcomes. The human factors that are most frequently addressed at this level are the non-technical skills – these are the 'cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient performance' (Flin et al, 2008 p1).

The concept of non-technical skills (also known as CRM skills) came from the aviation industry, where it has long been appreciated that accidents are not only due to failures in equipment or technical proficiency. Many accidents are caused by problems relating to teamwork, leadership, decision making, or fatigue. As mentioned earlier, airline pilots are given CRM training and assessed in their non-technical skills, as well as their technical skills (see CAA, 2006). The main categories of non-technical skills are cognitive (situation awareness and decision making), social (leadership and teamwork) and managing personal resources (stress and fatigue). Leadership and teamwork have already been covered in the previous sections and this section discusses the other main factors: situation awareness, decision making, stress and fatigue.

6. Situation Awareness

Definition Situation awareness refers to an individual's '*perception of the elements in the environment within the volume of time and space, the comprehension of their meaning, and the projection of their status in the near future'* (Endsley, 1995, p. 36).

Situation awareness (SA) is essentially what psychologists call perception or attention. In essence, SA involves continuously monitoring what is happening in the task environment in order to understand what is going on and what

might happen in the next minutes or hours (see Endsley & Garland, 2000). Driving a car is a good example of a task that requires a high level of situation awareness. Increasing interest in attention skills in the workplace has been partly driven by the rapid development of computer-based monitoring systems and other technological advances that serve to distance humans from the systems they are operating (Stanton et al, 2001). On most jobs, the worker needs to have a good 'mental model' (picture in their head) representing the status of their current task and the risks within the surrounding work environment. It is also a precursor for decision-making in dynamic settings when a specific assessment of the current situation is made in order to judge whether there is a need to take action. Failures in situation awareness have been associated with industrial accidents in aviation and many other work settings, see Flin et al, (2008). Situation awareness extends to the team level and a shared understanding of ongoing tasks is a core factor for good team performance (Wright & Endsley, 2008).

Situation Awareness and Patient Safety

According to Endsley (1995), there are three distinct levels of situation awareness and these can easily be illustrated with examples, from healthcare.

1. **What is going on?** The first level is perception which involves noticing critical cues in the environment: e.g. the patient's vital signs, symptoms, monitor sounds.

2. **So what?** The second level is comprehension – i.e. what do the cues mean in relation to this patient? For example, a nurse has to combine information from the patient about reported symptoms, readings from monitors and charts and other nurses' reports, to understand the status of a patient's current condition.

3. **Now what?** The third level of situation awareness is projection or anticipation. This is a prediction of what will happen on the current task in the near future. The nurse recognises a combination of warning signs and realises that the patient is going to deteriorate in the next few

minutes and so takes action to prevent this. This projection skill is critical in allowing for proactive, rather than reactive response to both expected and unexpected events (Wright & Endsley, 2008).

Good situation awareness is critical in all areas of healthcare, especially in acute medicine when changes to the patient's condition have to be responded to promptly (e.g. anaesthesia, see Gaba et al 1995). Surgeons place great store on situation awareness, especially what they call 'anticipation', thinking ahead of the action about to be taken. Way et al (2003) analysed 252 laparoscopic bile duct injuries and found that the errors stemmed mainly from surgeons' misperception (i.e. poor situation awareness) rather than problems in technical skills. Situation awareness and concentration are diminished by fatigue and stress and can be affected by interruptions and distractions (common in healthcare settings, see Healey et al, 2006).

Situation awareness skills for a given task can be assessed using workplace or simulator observations, often with the use of behavioural rating scales. The Situation Awareness Rating Scales (SARS) are completed by an observer watching an operator perform a task (see Endsley & Garland 2000). As this is a cognitive skill, it is impossible to observe directly, so the observers have to attend to specific task actions and communications that indicate the individual is gathering information or developing an understanding of the situation or thinking ahead. Most of the non-technical skills behavioural rating systems (described earlier) contain a category on situation awareness. For example in the ANTS system (Fletcher et al, 2003) for anaesthetists, some behaviours indicating skill in situation awareness are:

- Conducts frequent scan of the environment
- Increases frequency of monitoring in response to patient condition
- Keeps ahead of the situation by giving fluids/ drugs

Behaviours indicative of poor situation awareness skill in an anaesthetist are:

- Does not respond to changes in patient state
- Responds to individual cues without confirmation
- Does not consider potential problems associated with case

A number of techniques can be used to measure situation awareness: These tend to be applied in studies of task performance in simulators where the proceedings can be stopped without any risk (Stanton et al, 2005). In the Situation Awareness Global Assessment Technique (SAGAT: see Endsley & Garland, 2000), the task is stopped and the workers are asked questions to determine what their current knowledge of the task and related circumstances. For example, in simulated medical emergency management training, the scenario can be halted and team members individually interviewed as to the state of the patient and the current treatment plan (Flin & Maran, 2004). There are also some newer measures that have been designed to assess workers' general levels of situation awareness by self report questionnaires (Wallace & Chen, 2005). Wright et al (2004) discuss situation awareness measures for simulated medical tasks.

Situation Awareness Tools

- **SAGAT (Situation Awareness Global Assessment Technique)**

http://www.satechnologies.com/services/measurement/SAGAT/
This is a SA tool that has been developed for commercial pilot use (may be adapted to suit healthcare professionals).

- http://www.smithsrisca.demon.co.uk/situational-awareness.html

This provides an overview of research on SA and figures to illustrate how SA works.

- http://www.satechnologies.com/Papers/pdf/SATheorychapter.pdf

. Theoretical underpinnings of SA: a critical review chapter by Endsley..

- http://www.satechnologies.com/industry/medical/

  Some information on SA in medical context can be requested.

Video material for training normally has to be purchased from the companies that produce them. Two sources for teaching on **Situation Awareness** are:

Nicholas and Smith produce safety training videos ***'Unclear and Present Danger'*** is their new video (2009) on situation awareness www.nicholasandsmith.com

Visual Cognition has clips of interesting aspects of visual perception, such as inattentional blindness www.viscog.com

Papers from Royal Aeronautical Society conference on situation awareness

www.raes-hfg.com/xsitawar.htm www.raes-hfg.com/xsitass.htm

Situation Awareness Rule of Three This tool is a simple technique that can develop good habits for realising how normal situations can escalate to become serious risks and how this can be prevented. Offers a process for defining problem areas and guidelines for maintaining control. Powerpoint slides and videos.

www.energyinst.org.uk/heartsandminds/situation.cfm

7. Decision Making

Definition: *The process of reaching a judgement or choosing an option, sometimes called a course of action, to meet the needs of a given situation* (Flin et al, 2008, p.41).

On task (or operational) decision making is a critical component of workplace safety in relation to minimising errors. In the last few decades, major accidents in high risk military, aviation and nuclear industries led researchers to develop techniques to study what is called 'naturalistic decision making' (NDM) (Zsambok & Klein, 1997). NDM is decision making in real world, often under conditions of high uncertainty, time pressure and risk, which can often be found in many safety-critical workplaces. A general model of naturalistic decision-making (Orasanu & Fisher, 1997) identifies two stages. The first involves diagnosing the situation (what is the problem, what are the risks, how much time?). The second stage is choosing the course of action and to accomplish this, four different methods of decision making can be used:

Recognition-primed: the type of situation is recognised and a stored course of action is recalled from memory. This can be called intuition or 'gut feel'.

Rule-based: procedures and rules are applied for the identified situation.

Choice through comparison of options: various courses of action are identified and compared to find the one that best fits the situation.
Creative: a new course of action has to be devised.

Many examples of poor decision making leading to accidents can be found. An analysis of aircraft accidents in the USA between 1983 and 1987 revealed that poor crew judgement and decision making were contributory causes in 47% of cases (NTSB, 1991). Across all occupations, there are abundant examples of the importance of decision making skills for safe task performance (see Flin et al, 2008;). Decision making can be affected by fatigue and stress, especially the choice and creative methods (described above) which require more active thinking.

There are various acronyms for the steps recommended to improve decision making, such as DODAR (Diagnose, Options, Decide, Assign, Review) and these sometimes are used as the basis for training. Recent research has also indicated the importance of faster, intuitive decision making, especially in dynamic situations (Klein, 1998).

Decision Making and Patient Safety

Decision making is a key skill for most healthcare professionals and decision errors can occur in all types of patient care environments (Bognor, 1997). Most of the research on decision making in healthcare concerns doctors' diagnoses or treatment decisions (Kostopoulou, 2009) rather than how decisions are made during task execution e.g. in surgery (Flin et al, 2007) or emergency settings (Croskerry et al, 2008; St Pierre et al, 2008). Increasing use is being made of clinical simulators to train individuals and teams in decision making, especially under high pressure conditions (Riley, 2008).

Decision Making Tools

Different measurement techniques have been developed in order to assess decision making skills and processes. The Non-Technical skills rating tools, such as NOTSS and ANTS (see above) have lists of behaviours associated with good and poor decision making that can be rated by observers.

- **Questionnaire for measuring Decision Making Styles** (e.g. Scott & Bruce, 1995).

- **Cognitive Task Analysis:** is a set of methods to understand cognitive skills required for particular tasks. For example, *Critical Decision Method (CDM) Interviews:* involve the interviewee describing in detail a past event involving key decisions from their job and the interviewer analyses this to identify the decision making skills required. (See Crandall et al (2006) *Working Minds).*

- **Tactical Decision Games** Simulators are not available for all work environments and other decision training techniques have been developed for computer-based or paper-based delivery. One particular method suitable for many professional groups is Tactical Decision Games which is a facilitated simulation using brief written scenarios ranging in complexity designed to exercise non-technical skills, especially decision making (see Crichton, Flin & Rattray, 2000 for workplace adaptations).

Decision Making Websites

Cognitive Engineering and Decision Making Technical Group of Human Factors and Ergonomics Society (naturalistic decision making) http://cedm.hfes.org

Society for Judgment and Decision Making (study of normative, descriptive and prescriptive theories of decision making) www.sjdm.org

Society for Medical Decision Making
www.smdm.org

8. Stress

Definition: *Stress is the 'adverse reaction people have to excessive pressure or other types of demand placed upon them'.* (HSE, 2005 p1)

Many people will experience job-related stress at some point during their working life and the main causes and effects are well established (Cooper et al., 2001). Stress is determined by the balance between perceptions of the demands being placed upon the person (e.g. workload) against how she or he judges their available resources to cope with these demands (e.g. experience, skills). When perceived demands outweigh the perceived resources, the

individual may experience unpleasant effects such as anxiety, or feeling unwell, lack of concentration or irritability.

Two types of stress at work can be distinguished: chronic stress and acute stress. Conditions in the workplace and an individual's reactions to these conditions over a period of time can cause chronic stress. For example, lack of support from managers and co-workers, uncertainty about work objectives and lack of clarity about responsibilities or poor relationships with others in the team can all contribute to feelings of strain. These individual reactions to stress can in turn lead to symptoms of stress in the organization, such as high staff turnover or excessive sickness absence. Stress at work has also been linked to workplace safety, such as rates of accidents (Cooper & Clarke, 2003). Questionnaires for measuring individual stress often have to be purchased commercially although there are some published as research tools. Acute stress is sudden, and produces a more intense reaction (e.g. in emergency situations) and it can interfere with decision making and teamwork if not effectively managed (Flin, 1996).

Stress and Patient Safety:

Occupational stress is commonly reported by health care workers, such as nurses (Houtman, 2005). Studies have shown that problems relating to workload, inadequate time off, and restricted autonomy can results in emotional exhaustion and aversion to patients (Biaggi et al., 2003). Work errors, reduced productivity, feelings of discomfort, illness or poor team performance can result when failures to cope with stressors occur. Therefore, managing stress is of high importance and relevance for patient safety.

Managing stress in the workplace requires the understanding of stressors, mediators or resources, as well as symptoms and effects of stress on an individual, team or organization. Stress can be prevented from occurring (primary), symptoms can be detected and managed (secondary) or the effects of stress can be treated (tertiary). In order to prevent stress from occurring, risk management approaches are recommended (e.g. HSE, 1998) and these have been applied in healthcare (Cox et al., 2002). Areas of risk can be discovered by using the HSE Stress Indicator tool listed below. Identified risks

can be managed in various ways, for example by ensuring adequate staffing levels and providing appropriate training. Furthermore, the organization can reduce workplace stressors, for example, by allowing recovery periods after periods of high workload, providing well defined roles or raising awareness of promotional opportunities (Sauter et al., 1990). Secondary stress management takes the general form of stress education and stress management training. Murphy (1996) found that the combination of muscle relaxation and cognitive-behavioural stress management produced the most positive results. Other treatment methods are discussed in Cooper and Cartwright (2001).

To help staff cope with acute stress situations, realistic exercises and simulator sessions can help to ensure effective performance (Hytten & Hasle, 1989). Stress exposure training designed to improve team performance can help in coping with acute stress through practice and feedback using techniques, e.g. STOP (Stand back, Take stock, Overview, Procedures), or STAR (Stop, Think, Act, Review) or breathing exercises (Driskell & Salas, 1996). Critical incident stress management (CISM) is recommended for teams who may be exposed to high stressful situations (Everly & Mitchell, 1999) and proper debriefing after stressful events is recommended (see Hokanson & Wirth, 2000).

Stress Tools:

UK Health and Safety Executive www.hse.gov.uk/stress list of stress sites

HSE Stress Indicator Tool http://www.hse.gov.uk/stress/standards/index.htm

NIOSH Occupational stress information and stress questionnaire www.cdc.gov/niosh/programs/workorg

ILO Information www.ilo.org/public/english/protection/safework/stress/index.htm

9. Fatigue

Definition: Fatigue is *' the state of tiredness that is associated with long hours of work, prolonged periods without sleep, or requirements to work at times that are "out of synch" with the body's biological or circadian rhythm'* (Caldwell & Caldwell, 2003, p15).

Sleep is essential for our wellbeing and lack of sleep is a prime cause of the experience of tiredness or fatigue. Most humans require an average of about eight hours sleep per night to function effectively. For example, two nights with only four hours of sleep each can lead to 'pathological' levels of sleepiness (Carsakadon & Dement, 1981). There are individual differences in the amount of sleep required and also in the 'internal body clock' (circadian rhythm). For example, one in ten people are 'larks' who like to wake up early, whereas two in ten are 'owls' who like to stay up long past midnights, and everyone else is somewhere between those two extremes (Smolensky & Lamberg, 2000).

Fatigue can have consequences for both the safety and productivity of workers. Many industrial accidents have been linked to fatigued workers (see Flin et al., 2008). Fatigue has detrimental effects on cognitive performance which can fall to nearly 40% of baseline after two nights without sleep (Krueger, 1989). A loss of two hours sleep can have detrimental effects on the performance of psychomotor tasks comparable to effects of drinking two or three beers (Dawson & Reid, 1997). In the same way, communication (May & Klein, 1987) and social skills (Horne, 1993) are also affected by sleep deprivation.

Fatigue and Patient Safety:

Especially in health care workers, long shifts and on-call working can result in a state of fatigue and in turn risk patient safety. For example, 41% of junior doctors in the US reported fatigue as the cause of their most serious mistakes. 31% of these reported mistakes even resulted in a fatality (Wu et al., 1991). However, Samkoff and Jacques (1991) showed that after a sleep-deprived period, junior doctors were prone to errors on routine, repetitive

tasks but performed effectively in crisis or novel situations. Likewise, 61% of anaesthetists and anaesthetic nurses reported making errors in administering anaesthetics due to fatigue (Gravenstein et al., 1990). Furthermore, Helmreich and Merritt (1998) found that 60% of a sample of doctors believed that even when fatigued they would perform effectively during critical surgeries. Thus, they did not seem to recognise that their levels of fatigue might lead to an accident.

Continuous (i.e. 24 hour) service is a universal feature of health care organizations, so people need to work in shifts and they adapt differently to shift work. For example, 'larks' and individuals with a history of sleep disorder or gastrointestinal complaints have been shown to have more difficulties in adapting to night shifts (Monk, 1990). Shift work schedules (e.g. rotation patterns, times for changeover) can be designed to improve the performance of workers and decrease the amount of time it takes to adapt to a different shift. Motivation has a large effect on task performance when tired and on coping strategies used to cope with fatigue (Johnson & Naitoh, 1974).

Fatigue Tools

Fatigue can be measured using subjective, behavioural, physiological or cognitive techniques (Flin et al., 2008). Standardised tools, such as the Epworth Sleepiness Scale (Johns, 1991) or the Stanford Sleepiness Scale (Hoddes et al., 1972), provide numerical measures of sleepiness. However, subjective judgements tend to underestimate levels of fatigue. Behavioural indicators of fatigue, such as yawning, microsleeps, dropping eyelids or decreased social interaction, are difficult to quantify. The multiple latency test (MSLT) is used to measure how long it takes to fall asleep, and was used in a study of anesthesiologists (Howard et al, 2002). Fatigue countermeasures are techniques designed to ensure adequate sleep and to optimise circadian adaptation (Horne, 2006). Managers and shift workers can be educated about the effects of fatigue; rest breaks and napping can reduce effects; diet or bright light can facilitate adaption to night shifts. In addition, fatigue should be managed during work planning using fatigue modelling tools eg FAST.

Fatigue Avoidance Scheduling Tool (FAST) software tool for scheduling work/rest schedules for safety critical tasks, developed for the US Airforce www.novasci.com

Fatigue and Risk index developed by HSE, calculates levels of risk relating to fatigue for different work patterns downloadable from www.hse.gov.uk

Eurocontrol Fatigue and Sleep Management Brochure www.eurocontrol.int

Sleep Research Centres: South Australia www.unisa.edu.au/sleep/

Loughborough www.lboro.ac.uk/departments/hu/groups/sleep

III Work Environment

This final category deals mainly with the workplace environment, focussing on tools for the assessment of risks and hazards. Equipment design is also an important area of concern for patient safety, for example readability of medicine packaging and labelling, usability of infusion pumps or laparoscopic tools (see Buckle et al, 2006, Thomas & Galvin, 2008). Factors relating to equipment design and usability are not covered here, as this topic (while a key component of human factors) is beyond our area of expertise and is the domain of the ergonomist rather than the psychologist. Some sources of information on design and ergonomics for patient safety are given below.

For an introduction to human factors relating to equipment design and usability see Noyes (2001) *Designing for Humans*. A useful guide *Design for Patient Safety* was produced by the NPSA (2003) in conjunction with the UK Design Council, available from
www.npsa.nhs.uk/nrls/improvingpatientsafety/design/

There are also a number of research centres specialising in ergonomics and design for patient safety, for example, two located in the UK are:
Robens Centre for Public Health www.surreyergonomics.org.uk
Engineering Design Centre Cambridge www-edc.eng.cam.ac.uk

10. Work Environment (Workplace Hazards)

Definition: Workplace hazards are a set of circumstances or a situation that could harm a person's interest, such as their health or welfare (Croskerry et al, 2008, p409).

Risk modelling and hazard analysis are used extensively in a range of industrial settings, especially those dealing with higher levels of risk e.g. transportation or energy production (Ericson, 2005) In some cases, such as the nuclear power industry, organisations are legally required to conduct

various types of formal risk assessment and provide full documentation of the risks and the measures put in place to control them. This is sometimes known as a safety case for a particular plant or work site (Maguire, 2006).

Workplace Hazards and Patient Safety

In order for healthcare organizations to become safer for patients, they too should identify risks and hazards embedded in their processes and systems and must learn from safety events (Battles et al., 2006). Healthcare delivery consists of a complex series of interactions between the patient and the healthcare worker, but also between the patient and equipment. Those interactions can be systematically examined using analysis methods adapted from industry before or after an adverse event or failure occurred. This can be done in different ways: (1) at the single event level, e.g. root cause analysis (RCA), (2) at the process level, e.g. failure modes effect analysis (FMEA) and (3) at the system level, e.g. probabilistic risk assessment (PRA). Those methods, separate or combined, can help to make sense of the risks and hazards that are a threat to patient safety.

Work Environment Tools

Conducting a RCA of selected events helps determine what happened and why they happened. This provides a systematic analysis of the causal and contributing factors after an adverse event or failure occurred and provides the opportunity to graphically display the causal analysis (Wald & Shojania, 2001).

The Joint Commission in the USA proposed new standards for healthcare organisations that go beyond retrospective analysis of events, to focus on proactive safety engineering of healthcare processes and these require conducting at least one proactive risk assessment annually (JCAHO 2000, 2003). Prospective analysis tools are useful methods for proactively identifying, prioritising and mitigating patient safety risks. There are several methods available, e.g. Healthcare Failure Modes and Effects Analysis, Errors and Omission Assessment, Hazard Analysis, Hazard and Operability Studies and simulation (Jeffs et al, 2009). Those methods tend to be used at a local

level and so discovered information is not always shared with other organizations (Kohn et al, 2000). Moreover, these tools are not designed to identify combinations of events in complex systems that are more likely to lead to incidents (Linerooth-Bayer & Wahlstroem, 1991).

In order to tackle those limitations, quantitative probabilistic risk assessment (PRA) tools were developed that start with modelling the undesirable outcome instead of the process. PRA tools are a mixture of process analysis techniques and decision making processes (Hayns, 1999). Decision making processes in healthcare organizations require balancing and prioritising between competing goals such as safety improvement, cost, timeliness, technical feasibility and other components of organizational behaviour (Macwan & Mosleh, 1994; Safety Factor Associates, 1995). PRA tools allow modelling combinations of equipment failure, human error, at risk behavioural norms, and recovery opportunities using Fault Tree Analyses (Marx & Slonim, 2003). They provide the opportunity for the organizational management to decide on generic organizational level or specific individual level interventions for safety.

Hazard Analysis Tools

Root Cause Analysis Toolkit (for patient safety incidents) NPSA www.npsa.nhs.uk/nrls/improvingpatientsafety/patient-safety-tools-and-guidance/rootcauseanalysis/

Root Cause Analysis Framework (Canadian Patient Safety Institute) http://www.patientsafetyinstitute.ca/uploadedFiles/Resources/RCA_March06.pdf

Healthcare Failure Modes and Effects Analysis
www.va.gov/ncps/safetytopics.html#HFMEA
Failure Modes and Effects Analysis
www.asq.org/learn-about-quality/process-analysis-tools/overview/fmea.html
Failure Mode, Effect, Criticality Analysis Resources

http://www.jointcommission.org/PatientSafety/fmeca.htm

Fault Tree information www.fault-tree.net

Job Hazard Analysis booklet www.osha.gov/Publications/osha3071.pdf

Probabilistic Risk Assessment. (Procedures Guide for NASA Managers) www.hq.nasa.gov/office/codeq/doctree/praguide.pdf

Human Factors Workbench website of the US Federal Aviation Administration has information on a wide range of risk/hazard assessment tools www.hf.faa.gov

CONCLUSION

Managing the safety of patients undergoing medical diagnosis and treatment requires an understanding of the organisational and human factors that contribute to medical error and iatrogenic injury. This report described ten topics related to such factors and suggested a number of tools that could be used for measurement, training or as part of a safety intervention. (There are hundreds of tools and this report only describes a sample of what is available). Many human factors tools can be obtained free of charge from websites, while others have to be purchased from the companies that developed them. A reference list was also provided for sources of further information. These tools are not universally applicable. The choice of particular instrument or training package will depend on the specific project requirements, as well as the level of complexity required, staff time, cost, availability and other considerations.

Almost all the tools listed have been designed in developed countries and are usually only provided in the English language. Their suitability for application in healthcare in other countries would require to be investigated.

It is generally advised that practitioners applying human factors tools for measurement, instruction or safety management interventions should themselves have undertaken a basic introductory course on human factors concepts and applications.

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