Error Management combining people and systems

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Abstract *A significant amount of attention has focused on enhancing understanding of Human Error, both as a potential cause of incidents and for managing incident response effectively. Solutions often comprise of ergonomics, user centred design and workforce training. Some industries, including Aviation and Healthcare are adopting a more novel approach to Human Error Management, training their workforce in psychological techniques that support error identification and effective incident response. Such techniques include a heightened awareness of cognitive biases such as 'groupthink' and 'tunnel vision'; the way in which heuristics (mental shortcuts) can influence the decision making process; and refinement of non-technical skills. Organisations, such as the NHS, recognise the frequency of error occurrence, whether the result of organisational factors, or individual behaviour. Subsequently, all individuals, directly or indirectly involved in frontline operations, are encouraged to identify the potential for human error by critically reviewing the thoughts and actions of themselves, peers and superiors, to enable error prevention and error correction through taught techniques. This paper looks at examples of Error Management Training being applied across high hazard industries and how psychological techniques and non-technical skills overlap to effectively manage Human Error.*

1 Introduction

When applied in earnest, a systems approach tries to optimise human performance to prevent error by (for example) ergonomic equipment and technical training and to make safety systems tolerant to residual errors that cannot be engineered out. The systems approach focuses on ensuring suitable support is provided to people and that error is not inadvertently caused by, for example, unclear procedures or excessive workloads. Error can also occur due to our cognitive behaviours, how we think, and their interaction with social group dynamics. This paper looks at the contribution that Non-Technical Skills (NTS) and psychological techniques make in delivering a holistic and truly effective approach to error management, with examples drawn from across industries.

2 Safe systems for error management

Traditional error management has focused on a systems approach to incident prevention, via, for example, ergonomics, user centred design, safe systems of work, defined processes and procedures and assuring the technical competence of personnel. Table 1 presents some typical system level tools to support error management.

Table 1. Example system level tools

System level tools
Prospective error analysis
Error prevention tools (e.g. pre & post task briefing, self & peer checking, task observation and coaching, communication Techniques)
Competence management and assurance
Creating a fair and just safety culture
Root cause analysis and lessons learnt processes
Procedures assessment and design
Equipment and workspace assessment and design
Fatigue and workload management

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These examples illustrate how the systems approach can help ensure safety throughout different stages of the product lifecycle (from design and development through to installation, use and maintenance) where it is critical that a system level approach be taken. Despite such systems level tools being in place, errors and incidents remain recurrent across high hazard and safety critical industries (e.g. HSE, 2016; Rail Accident Investigation Branch, 2017; NHS, 2017). So, what role does individual level behaviour and cognition play with respect to their effectiveness? A simple analogy can be made with reference to error management when driving car:

- Seat belt use;
- ABS breaks;
- Speed limits on roads.

The three examples above require different levels of input from people to manage the various hazards involved in driving a car. The seat belt requires direct and repeated involvement from the driver to fasten this correctly each journey, without which it serves no safety purpose. ABS brakes need to be installed and maintained correctly by a competent professional and the brake pedal applied by the driver firmly in order for them to activate and effectively stop the car with minimal skidding. A defined speed limit on a road will only be effective if drivers are compliant with the law enforcing it. So, what are the factors that influence someone's awareness and decision making behaviours with respect to managing the hazards around them?

3 Psycho-social sources of error

Whilst there are many system level influences on human performance, there are also many influences at the individual level. These include social, psychological and cultural factors, as follows:
Social - the way in which other people and the social context influence people's behaviour, such as:

- Peer pressure – changing one's values, attitudes and behaviours to align with those encouraged by peers;
- Group/social norms – following the rules/behaviours considered acceptable and expected within a given group or social setting.

Psychological – the way in which heuristics (mental shortcuts) and cognitive biases, be they conscious or unconscious, influence our judgement and subsequent behaviour, such as those cited within Table 2.

Table 2. Heuristics and cognitive biases

Heuristic/cognitive bias	Description	Impact
Familiarity	Applying the same rule (wrongly) to a similar situation	Failure to take account of all available information and judgments are based on incorrect assumptions (poor decision making).
Overconfidence Bias	Overestimation of self/others performance or strategy impact	Assumed success results in failure to monitor or contingency plan.
Premature Closure/Anchoring	Tendency to decide that the current problem is related to the first thing we recognize rather than multiple issues.	Failure to take account of all available information and judgments are based on incorrect assumptions (poor decision making).
Recall (primacy/ recency)	Remembering select information (e.g. the first or last piece of information)	Failure to take account of all available information and judgments are based on incorrect assumptions (poor decision making).
Groupthink	Desire for harmony or conformity amongst a group of people.	Irrational or dysfunctional decision making
Tunnel vision	Concentrating on achieving a single aim or explanation for an event	Poor situational awareness and hence poor decision making
Commission bias	Tendency to want to do something rather than be inactive	Poor decision making (not grounded in understanding of risk/impacts), misdirection of resources, premature action initiated.
Confirmation bias	Seeking to support rather than challenge one's assumptions.	Consideration of information is restricted, causing important details to be ignored and/or wrongly discounted.
Escalation of commitment	Justifying increased investment in a decision due to the level of effort already invested	Important information discounted, resource misdirected, decisions not underpinned by understanding of risk and impact.

These heuristics and cognitive biases serve to help people perform quickly and well in what can be a complex and information rich environment. A highly practiced procedure can be carried out quickly and reliably. Focusing on a single issue can allow people to avoid information overload. However, they can also lead to inadvertent errors.

These above sources of error are not mutually exclusive, but rather they interact with the culture (i.e. ‘the way we do things around here’) of an organisation or group to influence people’s thoughts and subsequent behaviour. For example, in an overly hierarchical organisation, junior staff may be unwilling to challenge biased judgements made by more senior staff. Similarly, excessive workloads and fatigue can contribute to error by making people more reliant on cognitive heuristics.

Hence, to draw upon the analogy of safety systems within a vehicle, despite these being designed, installed and operated by competent people (ABS), and their use mandated as a legal requirement (in the case of seat belts and speed limits), such systems are still susceptible to fail in their objective of keeping people safe, as a result of the human interaction and individual factors such as those mentioned above. So, what can be done to enhance the human element?

4 Preventing error through NTS and Psychological techniques

Within high hazard/safety critical industries social, psychological and cultural factors can be particularly detrimental to people’s behaviours and their effectiveness in respect to identifying, preventing and responding to error. By enhancing organisational awareness of psycho-social sources of error, and training the workforce to proactively implement NTS and psychological techniques, people working in safety critical and high hazard organisations will be better able to prevent, detect and respond to precursor signals of human error before these manifest into an incident or accident.

4.1 Recognising and responding to precursor signals

Within safety critical and high hazard organisations, individuals can be trained to identify and respond to ‘precursor signals’, such as those identified within Table 3. Such training encourages people to take a step back and reflect upon their situation and the visible behaviours that they themselves, and others, may be displaying. A considered and timely response can then be applied to challenge these error precursors. To refer back to the analogy of driving a car, it is training the driver to:

- Maintain awareness of the speed they are traveling at;
- Not allowing the estimated time of arrival on the satellite navigation screen, nor speed of other drivers around you to influence your behaviour;
- Effective communication with any passengers and those at the target destination to enable an informed decision making regarding a change in route or meeting time.

Table 3. 'Precursor signals' of error and examples of how NTS and psychological techniques can shape thinking and action in response.

Precursor signals detected	Trained cognition or response t
People becoming withdrawn or closing down with respect to communication.	Prompt to liaise with their wider team, use of open/probing questions to stimulate discussion with colleagues.
Safe practices starting to slip beyond the agreed protocol without challenge.	Independent review of action relative to information available and constructive challenge of behaviour.
Recognition that important information appears to have been missed/overlooked is missing information. Feeling of pressure to conform with the attitudes and behaviours of colleagues when this seems to contradict your judgement of the situation.	Questioning to understand and prompt review of decision making, constructive challenge of 'group think' and resistance to conforming with peer pressure. Objective communication of information to independent individual(s) encouraging fresh review and impartial judgement.
Decision making that fails to objectively consider all response options and information available.	Ability to take a step back and re-communicate information that appears to be omitted, or retracing a sequence of events to ensure decision making has taken account of all available information. Seeking to challenge, rather than support one's own assumptions. Identify information gaps and how these may be filled, clear delegation to others as necessary.
Consideration of information from sources likely to support assumptions (confirmatory bias).	Seeking to challenge, rather than support one's own assumptions and identifying information sources/indicators to provide such information.
Ambiguity surrounding poorly defined roles and responsibilities.	Demonstration of effective leadership, collaboration and communication to assert and confirm responsibilities proactively and ensure that these have been accurately understood.
Hierarchical chains of command presenting a visible barrier to open communication and constructive peer challenge, whereby junior staff are reluctant to challenge/question the senior and more experienced.	Use of hierarchical structures to support effective communication cascade. Foster a culture supportive of peer-to-peer challenge that responds positively to constructive challenge.

5. Crew resource management

It has long been recognised that individual factors influence human performance. The approach of Crew Resource Management (CRM) is long established within aviation, having first been recommended in 1978 (NASA, Unknown). CRM aims to enhance situational awareness, self-awareness, leadership, assertiveness, decision making, flexibility, adaptability, event and mission analysis, and communication. As part of this it aims to foster a culture where authority can be challenged in a non-threatening way within a hierarchical organisation, particularly challenging potential errors and oversights.

CRM is now a well-established part of flight crew training delivered through classroom teaching and simulator real-time based flight training involving emergencies and difficult tasks (termed Line Oriented Flight Training – LOFT). LOFT is now a common part of commercial airline training, aimed at developing skills and, through the review of performance, identifying any issues with flight procedures and equipment.

Recent developments have sought to build upon and extend the ideas underpinning CRM and apply these ideas in other sectors. A number of approaches have emerged with the aim of giving people the individual skills they need to prevent, detect and correct error in their day-to-day work. These approaches complement systems level approaches by developing individuals' error prevention skills, and some go beyond team/crew resource management by also focusing on individual error and their self-management. Person level error prevention tends to involve training front line staff at all levels and the provision of associated support. Examples of these approaches are noted below.

6. Recent developments in error management: Non-technical supervisory skills

6.1 Supervisory skills within oil and gas and nuclear defence

Two examples are given below of translating the principles of CRM from aviation into bespoke training for oil and gas and nuclear safety operations.

National Grid sought to improve compliance with procedures, and general working practices amongst their direct staff and alliance partners and the pivotal role of the supervisor/front line leader was rightly recognised as a catalyst to drive forward change. Greenstreet Berman (GSB) formed Supervisor Development Centres to enhance leadership and supervisory skills to ensure they can effectively identify, challenge and rectify team procedural non-compliance (Leach, 2009). Self-reflective pre-work was coupled with classroom discussion, individual/small group activities, and picture-based and live mock-up scenarios to enable skills practice within a safe and supportive learning environment. Personalised development needs reports facilitated trainer feedback on individual strengths and areas to target continued/ongoing development. The training provided supervisors with the competence and confidence to consistently challenge non-compliance and stop unsafe jobs; and drive through compliant attitudes and behaviours to achieve sustainable improvements.

A similar approach was implemented within a high hazard facility operated by a nuclear licensee, demonstrating the broad applicability and benefits of training leaders and supervisors in NTS and cascading these throughout the workforce. The Supervision+ programme was developed and delivered as part of a procedural compliance improvement programme for a nuclear licensee. This programme aimed to provide supervisors with the relevant NTS for effective performance and management of (procedural) compliance. The role of the supervisor was explored across functions, identifying a set of common NTS competencies required for effective performance (illustrated in Figure 1). A matrix of NTS was mapped to cross function feedback, with clear positive and negative behavioural markers articulated. These behavioural markers subsequently shaped the structure and content of a two-day NTS training programme, following which delegates reported improvements in understanding, skill application and confidence.

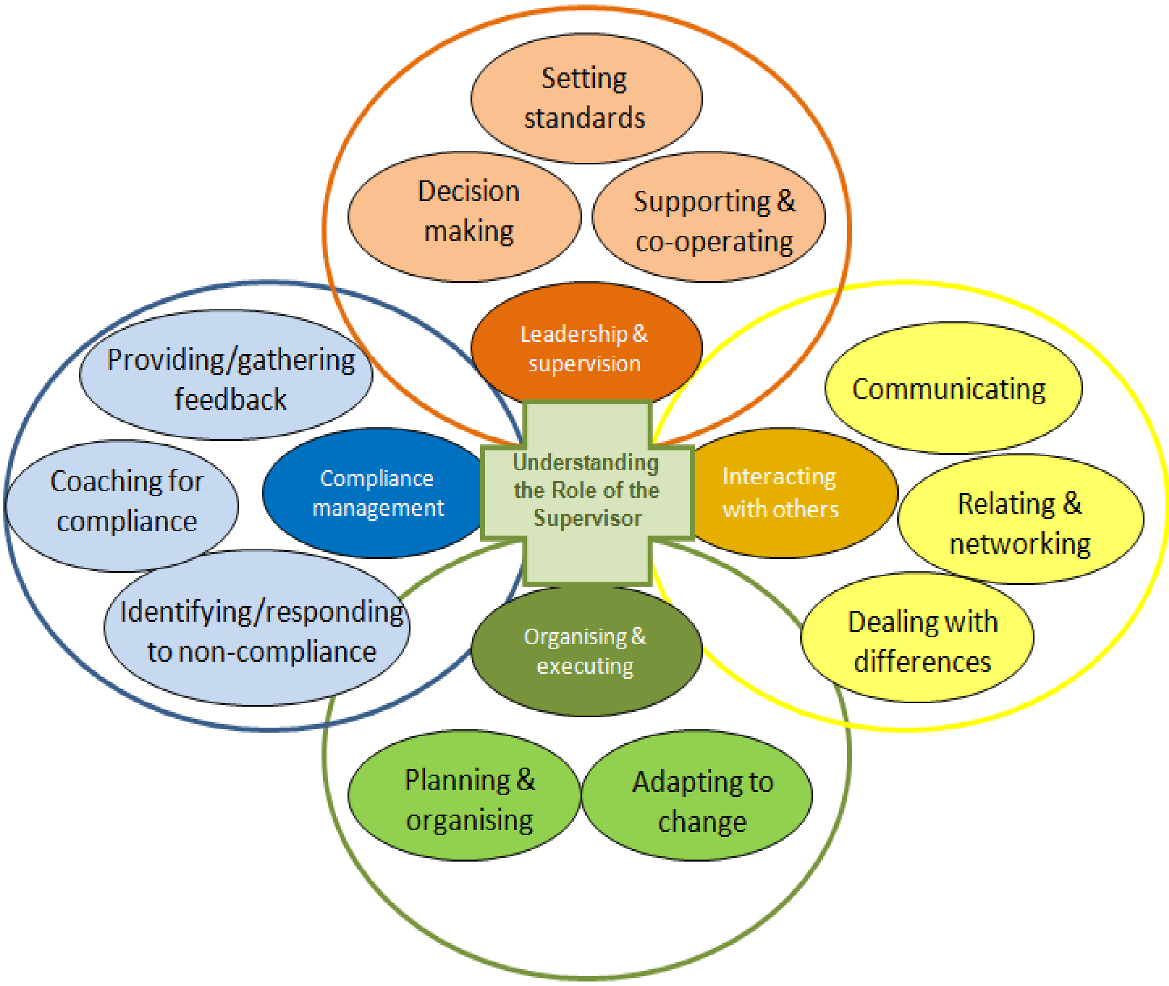

Figure 1: Supervision+ non-technical skills competencies (Watson, Argent, Canham, Selfe, 2015)

With respect to developing a NTS programme to support those conducting safety critical operations, the above two examples share a handful of similarities which contributed to their successful deployment, namely:

- Senior endorsement from the top of the organisation, such that delegates are released from operational duties to attend and credibility of the course content and value is apparent;

- Management awareness to support implementation. Whilst both of the above NTS courses focused on training the supervisor as a pivotal influence. A condensed version of the course was also delivered to those who manage individuals occupying supervisory roles, such that they had insight of the content coverage and key messages and were in a position to support implementation of NTS following course completion;
- Clear, objective behavioural markers through which to enhance consistency of application, transparency of expectations and monitoring of performance;
- The inclusion of scenario-based skills practice to support consolidation of learning and build individuals confidence in the skills learned, as well as fostering self and peer reflections to facilitate further learning.

7 Recent development in error prevention: Individual training

7.1 Error management training (EMT)

Within the NHS, the ‘Recognising Risk and Improving Patient Safety’ course (R²IPS) educates front line staff in the attitudes, skills and behaviours needed to identify and prevent the behaviours that contribute to adverse patient outcomes, including how to constructively challenge colleagues (Bawa & Carlin, 2011). This approach drew on lessons learnt from high hazard sectors, building on these to develop practical training for front line staff within a healthcare setting.

The one-day training programme comprises presentations and lectures supported with peer discussion and directed workshops, and takes a novel approach to educating healthcare professionals about the importance of non-clinical skills, behaviours and attitudes in assuring patient safety (Bawa & Carlin, 2011). Drawing upon real patient experiences, to create reconstructions of the sequence of events which has led to negative patient outcomes presents a powerful and memorable context through which to frame course content.

The course covers what is defined as ‘person’ and ‘system’ level Human Factors issues, as noted by the NHS Institute for Innovation and Improvement, incorporating knowledge and skill based training and behavioural markers to support objective identification and consistency of expectation. The content is underpinned by the eight ‘R²IPS beacons’, defined as those factors whose presence or lack are considered most prominent hospital errors, namely:

1. Communication;
2. Fixation;
3. Confusion;
4. Leadership;
5. Trepidation;
6. Policies and procedures;
7. Time pressures;
8. Humanity.

Content is therefore structured around these ‘R²IPS beacons’ with content encompassing situational awareness, communication, leadership, team working, and empowerment (team resource management collectively); how to design, observe and assess simulated operations; identification of risky situations/decisions; how to manage stress and fatigue, and intervention (i.e. feeling empowered and able to challenge and question others in their behaviours and decisions).

A similar approach is cited by Morgenstern (2015), with the aim of promoting and enabling what may be termed ‘metacognition’ or ‘mindfulness’. These terms refer to enabling people to think about what they are thinking and how they are thinking, and thereby detect potential errors or risky forms of cognition. This has been described as training for a ‘reflective approach to problem-solving: stepping back from the immediate problem to examine and reflect on the thinking and affective process’ (Croskerry, 2005). As with R²IPS the suggestion is to first alert people to the forms of cognitive error they may incur, such that people can self-detect cognitive errors, and then offer psychological techniques to detect and avoid such error. The training would include self-questioning techniques, termed ‘cognitive forcing strategies’ (Croskerry, 2005), such as:

- Asking ‘What else can this be?’ when diagnosing a problem - to counter premature conclusions, anchoring and availability bias;
- Asking ‘Does anything not fit?’ – to counter confirmation bias;
- Asking ‘Is there more than one thing going on?’;
- Write out alternative explanations – as a way of prompting consideration of alternatives;

- Cognitive stop points – stopping and reconsidering conclusions before critical decisions are made.

This includes developing specific operational scenarios that allow cognitive error to occur and then debriefing participants on their errors and how cognitive bias may have contributed to them. The combination of awareness of cognitive error, cognitive forcing techniques and simulated training aims to help people counter their cognitive bias, termed 'debiasing'.

7.2 Utilities Emergency Management Training

An example of translating EMT from the healthcare sector to a high hazard sector is found in the emergency management training for a UK utility business. Inconsistencies were evident in the response to abnormal and emergency operating situations: management decisions often focused on the 'technical fix', as opposed to minimising the impact arising from a dynamic incident; and front line staff failed to consider the importance of timely, accurate and objective communication of information. GSB developed and delivered a three-tiered training programme focused on the requisite NTS and competencies at each level of the response team, namely:

1. **Incident Response Managers** – It was essential that those coordinating the response maintain situational awareness at a strategic level relative to a rapidly changing situation. Seeking to validate and verify information provided from a diverse range of information sources (staff, customers, monitoring systems and indicators, images, etc.) and challenge their own assumptions, inevitably influenced by technical expertise and personal experience. Ensuring risk-based decisions take account of new information available in a timely and documented manner, to support the proactive review of strategy effectiveness and monitoring of secondary impacts. Furthermore, it was essential for the response managers to define indicators for escalation, to ensure that the response remains proportionate to the unfolding risks (along with vigilance to scale back resource so as not to detract otherwise necessary resource from normal operations).
2. **Incident Responders** – Ensuring accurate and objective cascade of information between staff on the ground and those co-ordinating the response required a number of NTS. Maintaining focus on identifying both actual and potential risks for active monitoring and management. Avoiding fixation on repairing the asset, rather than maintaining consideration for the wider impacts (e.g. health and safety, environmental and stakeholder impacts). Monitoring the response to ensure safety and quality of actions remain uninfluenced by time pressures, threat of litigation, stakeholder involvement, media interest, and other such factors largely outside of the responders' control (and providing constructive intervention where necessary). Furthermore, essential to the role of a responder was the periodic review and contribution of the strategic plan, such that cognitive biases are detected and challenged constructively (e.g. Should this be escalated to a higher level within the business based on the information presented?).
3. **Incident Spotters** – Training the wider business in taking three critical steps in mobilising an effective business response to what might be a series of precursor signals or an obvious indicator of abnormal operations. These steps being: a) *Recognise* a situation out of the ordinary and potential impacts to the business; b) *Record* information accurately and objectively; and c) *Respond* with respect to verifying information (e.g. An indicator light has signalled asset failure, what other sources of information would disprove this assumption?), communicating through clear chains of command in a timely manner and/or taking immediate action (e.g. particularly with respect to an imminent health and safety risk).

The above training sessions lasted two-days, a half-day and one hour respectively and served to clarify role expectations and enhance understanding with respect to; chains of command and fostering skills and confidence to implement NTS to enhance situational outcomes. The courses helped to educate individuals in the different heuristics and cognitive biases that may contribute to human error. Through self-reflective techniques and scenario based skills practice, common situations where human error is likely to occur were simulated to challenge individual's recognition of such biases and facilitate skill application.

7.3 Railway non-technical skills

The Rail Safety and Standards Board (RSSB, 2016) have invested considerable resource into researching and the role of NTS in safety critical performance within the rail industry. RSSB identified seven core skills, applicable across breadth of rail industry operations, that can be enhanced through education, training and development opportunities, and contribute to both safe and efficient task performance. Their (RSSB, 2016, p1) NTS framework covered both team level and individual level error management, these being:

1. Situational awareness;
    a. Attention to detail,
    b. Overall awareness,
    c. Maintain concentration,
    d. Retain information,
    e. Anticipation of risk,
2. Conscientiousness;
    a. Systematic and thorough approach,
    b. Checking,
    c. Positive attitude towards rules and procedures,
3. Communication;
    a. Listening,
    b. Clarity,
    c. Assertiveness,
    d. Sharing information,
4. Decision making and action;
    a. Effective decisions,
    b. Timely decisions,
    c. Diagnosing and solving problems,
5. Co-operation/working with others;
    a. Considering others' needs,
    b. Supporting others,
    c. Treating others with respect,
    d. Dealing with conflict or aggressive behaviour,
6. Workload management;
    a. Multi-tasking and selective attention,
    b. Prioritising,
    c. Calm under pressure,
7. Self-management;
    a. Motivation,
    b. Confidence and initiative,
    c. Maintain and develop skills and knowledge,
    d. Prepared and organised.

In addition to an industry-wide guidance documents that seek to educate rail operating companies on the safety and efficiency benefits of NTS, the good practice guide provides practical tips, guidance and case studies to support the effective integration of NTS into their front-line operations through leadership, training and staff selection. GSB further supported RSSB and the wider rail industry to understand and implement the value of NTS by identifying those relevant to non-driver roles (e.g. Train dispatchers, Guards, Fitters, Engineers). Having identified the relative non-technical knowledge, skills and attitudes for each role through industry consultation and review of role descriptors, the most effective training methods could then be determined.

8 Does it work?

A large number of studies evaluating the effectiveness of CRM training in aviation (military and civilian), healthcare, and other domains have been carried out. These tend to focus on behavioural changes and report that CRM and similar training does help improve behaviour and error awareness (for example see O'Connor et al., 2008 and Salas et al., 2001). For example, Morgan and colleagues (2014) assessed a three-month intervention. Teamwork training using CRM was provided and supported by standardised operating procedures. NTS were assessed using a non-technical skill scoring scheme (NOTECHS II), technical performance was assessed using glitch rate (deviations from the recognised process with the potential to reduce quality or speed), and compliance with a World Health Organization checklist. Statistically significant improvements in NTS ($p=0.002$) and compliance ($p<0.001$) were recorded amongst those trained.

There is far less evidence regarding the effectiveness of metacognition training. For example, in a review of clinician training Trowbridge and colleagues (2013) report 'there is little evidence that explicitly teaching the mechanics of the clinical reasoning process can improve diagnostic performance'. Keith and Frese (2008) completed a meta review of Error Management Training (EMT) and found from 24 studies that there was a positive and significant benefit, particularly for post training transfer for other tasks. They noted that encouraging error in training and exploring these errors was more effective than error avoidant training methods (e.g. procedure based training), especially for enabling people to transfer skills to novel tasks.

9 Conclusions

The work on CRM and EMT offers an alternative view to traditional procedure or skill based training. Rather than solely instructing people in the correct method of performing a task and aiming for reliable skill based performance through repetition, one intentionally encourages errors in a safe simulated environment. As part of this self-awareness of cognitive bias and group behaviours that contribute to error can be increased and communication techniques for challenging risky decisions in others provided along with and cognitive techniques for detecting and preventing error in oneself. As stated by King and colleagues (2012) in the context of healthcare, 'encouraging errors in low-risk settings like simulation can allow teams to have better emotional control and foresight to manage the situation if it occurs again with live patients'. Combining this with a) an open, challenging culture that encourages team and communication, and with b) well designed systems and procedures should address the organizational, system and individual level factors that contribute to error.

References

Bawa, M. & Carlin, K. (2011). Recognising risk and improving patient safety (R²IPS). Retrieved 6th October 2017 from http://careers.bmj.com/careers/advice/view-article.html?id=20005722

Croskerry, J. (2005). Diagnostic Failure: A Cognitive and Affective Approach. In: Advances in Patient Safety: From Research to Implementation (Volume 2: Concepts and Methodology). Henriksen K, Battles JB, Marks ES, et al., editors. Rockville (MD)

Health and Safety Executive. (2016). Alton Towers' owners fined £5million over Smiler crash. HSE Media Centre. http://press.hse.gov.uk/2016/alton-towers-owners-fined-over-smiler-crash/

Human Factors Training in the National Health Service: A Scoping Study. For NHS Institute for Innovation and Improvement. June 2010. https://pdfs.semanticscholar.org/a24d/5fa287253e9fa03139bb80251961fd9f004c.pdf

Janis, Irving. (1972). Victims of Groupthink. New York: Houghton Mifflin.

Keith, N., & Frese, M. (2008). Effectiveness of error management training: A meta-analysis. Journal of Applied Psychology, 93(1), 59-69.

King, A., Holder, M. and Ahmed, R. (2012) Errors as allies: error management training in health professions education. Vol 22, Issue 6, British Medical Journal Quality and Safety.

Leach (2009). Achieving Compliance through people: The National Grid Supervisor Development Centre. Conference paper presented to the Institute of Gas Engineers and Managers.

Morgan, L., Pickering, S.P., Hadi, M., Robertson, E., New, S., Griffin, D., Collins, G., Rivero-Arias, O., Catchpole, K., McCulloch, P. (July 2014). A combined teamwork training and work standardisation intervention in operating theatres: controlled interrupted time series study. http://qualitysafety.bmj.com/content/early/2014/07/22/bmjqs-2014-003204.short

Morgenstern J. (2015). Cognitive errors in medicine: Mitigation of cognitive errors. https://first10em.com/2015/09/21/mitigation-of-errors/

NASA. (Unknown) Airline Crew Training. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020087647.pdf

National Transportation Safety Board (NTSB). (1978). Aircraft accident report. United Airlines McDonnel Douglas. DC-8-61. http://libraryonline.erau.edu/online-full-text/ntsb/aircraft-accident-reports/AAR79-07.pdf

NHS. (2017). Provisional publication of Never Events reported as occurring between 1 April and 31 August 2017. https://improvement.nhs.uk/uploads/documents/Never_Events_1_April_2017_-_31_August_2017_.pdf

O'Connor, P., Campbell, J., Newon, J., Melton, J., Salas, E., & Wilson, K. (2008). Crew resource management training effectiveness: A meta-analysis and some critical needs. International Journal of Aviation Psychology, 18(4), 353-368.

Rail Accident Investigation Branch. (2017). Report 13/2017: Fatal collision at Woodbourn Road, Sheffield. https://www.gov.uk/government/news/report-132017-fatal-collision-at-woodbourn-road-sheffield

Rail Safety and Standards Board. (2016). A Good Practice Guide to Integrating Non-Technical Skills into Rail Safety Critical Roles. https://www.rssb.co.uk/Library/improving-industry-performance/2016-07-non-technical-skills-integration-good-practice-guide.pdf

Salas, E., Burke, C. S., Bowers, C. A., & Wilson, K. A. (2001). Team training in the skies: Does crew resource management (CRM) training work? Human Factors, 4, 161-172.

Trowbridge, R., Dhaliwal, G., Cosby, K.S. (2013). Educational agenda for diagnostic error reduction. BMJ quality and safety. http://qualitysafety.bmj.com/content/early/2013/08/07/bmjqs-2012-001622

Watson, S., Argent, M., Canham, R., & Selfe, R (2015). Supervision+ – scoring high marks for compliance through supervisor non-technical skills. Conference paper presented at Hazards 25: UK on 13-15 May 2015.