

An Examination of Risk Manager's Perceptions of Medical Incidents

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Abstract: Although much research has examined the risk perceptions of 'lay' public to a variety of environmental and public health hazards, little attention has been given to how subjective opinions and value judgements affect those who manage and assess risks as their profession. This paper outlines the results of a psychometric questionnaire administered to 'risk managers' who work as part of a nation-wide risk network, dedicated to improving the quality of Scottish health care. A number of medical incident scenarios were presented and the participants were asked to rate them according to nine pre-determined risk characteristics. The results allow a comparison of the risk perceptions that those who actually compose risk decisions and implement interventions have in regard to hazards resulting from technological, human-machine interaction (HMI) and 'human' error incidents. The analysis concludes that both technology alone and 'human' error incidents are rated much more positively than those involving HMI failures are.

Keywords: risk perception, medical incidents, human machine interaction.

Introduction

Before reviewing research on perceptions of risk, it is instructive to examine the very nature of the risk concept itself. It contains elements of subjectivity that provide insight into the complexities of public perceptions. The Oxford English dictionary defines risk as the chance of suffering harm or loss. In contrast, Vlek and Stallen (1980) believe risk to be comprised of: the *probability* of a potential loss (chances or likelihood), and some *magnitude* of that potential loss (severity of significance). Leveson (1995) relates risk intricately to the hazard concept: a set of conditions of a system that, together with other conditions in the environment of the system, will lead inevitably to an accident. The combination of severity and likelihood of occurrence is often called the hazard level. Risk is therefore the hazard level combined with (1) the likelihood of the hazard leading to an accident and (2) hazard exposure or duration.

Regardless of the definition, however, the probabilities and consequences of adverse events, and hence the "risks," are typically assumed to be objectively quantified by risk assessment. Much social science analysis rejects this notion, arguing instead that such objective characterisation of the distribution of possible outcomes is incomplete at best and misleading at worst. These approaches focus instead on the effects that risky outcome distributions have on the people who experience them. In this tradition, risk is seen as inherently subjective (Pidgeon et al.1992; Weber, 2001) and as including a considerable number of factors, many of them intangible (Slovic, 2001). Large uncertainties and gaps in knowledge still exist, and questions of completeness, the quantification of 'human' error, the wide use of judgement, and the influence of management and organisation, have led to doubt as to the relevance and even usefulness of quantitative risk analysis in risk management decision-making. Risk management is a social and political process and the impact of public risk perception and knowledge is paramount (NAS Report, 1996). This is particularly true of a patient-centred rather than profit-centred industry like healthcare.

A progressive rise in medical incident litigation, added to a genuine desire to improve quality of care to patients, has motivated dramatic advances in safety and the re-evaluation of risk management and communication strategies throughout the British National Health Service (NHS). However, the success of these initiatives relies on the wide integration and support of healthcare workers at all organisational levels. This cannot be achieved without a thorough understanding of the underlying attitudes that these professionals have to the risks and hazards of their daily work (Hale & Glendon, 1987).

This research examines the risk perceptions of those currently spearheading risk management in NHS trusts throughout Britain. To give them their generic name they are 'risk managers', however this group encompasses a number of different job titles, such as medical director, clinical governance manager and nursing and division heads. Despite this variation in titles, they are all appointed by their respective trusts to

oversee the introduction of incident reporting schemes. As a result of this, they share a commitment to learning how to better educate staff on the risks and hazards they face with both the equipment they use and, the procedures they perform on patients.

This paper describes two studies. The first study involves the categorisation of primary causes of medical incidents by risk managers. This is in order to examine the influence that technological and non-technological factors are seen to play in the development of adverse events in hospitals. The second study presents some of the same risk managers with a number of incident scenarios, which they must rate against a number of pre-determined risk characteristics. The outcome provides a measure of their risk perceptions towards three different types of incidents: those caused by technology alone (TA), those caused by non-technology alone (NA) and those incidents which occurred as a result of human-machine interaction (HMI). Therefore the affect that technology, or lack thereof, has on risk perceptions is the main focus of this work.

Risk Perception and Communication: Just as the physical, chemical, and biological processes that contribute to risk can be studied scientifically, so can the processes affecting risk perceptions. The term 'risk perception' is used to describe attitudes and intuitive judgements about risk (Slovic, 1992); in a broader sense, however, risk perception often also includes more general evaluations of and reactions to risk (e.g. regarding the acceptance or mitigation of risk).

The importance of attempting to understand how those *affected* by risk decisions perceive risk is well established. Early psychometric studies (Starr, 1969; Fischhoff et al., 1978) on the 'lay' public found that different groups within society have differing perceptions of the risk from the same hazard. This was explained as a natural consequence of the host of variables, including an individual's background, prior experience, etc., which affect their perception of risk (Slovic et al. 1979).

However, little attention has been given to how those *responsible* for making risk decisions and performing quantitative risk analyses actually perceive risk. If we accept that 'lay' public use subjective opinions and value judgements to assess risk then we must acknowledge that the same process may occur with risk manager's in the NHS. And as their role in managing risk empowers them to control how risk is communicated throughout hospitals, it seems that their perceptions are of considerable importance. Johnson (1993) reported that information provided by risk managers' could directly change public opinion. By controlling how risk information is presented, risk managers therefore have a large role in the formation of the risk judgements and attitudes that their staff hold towards certain hazards and equipment.

Risk Management in Scottish Healthcare: The context of this research is the Clinical Negligence and Other Risks Indemnity Scheme (CNORIS) - a risk management strategy which was introduced in the NHS in Scotland in June 2000. It was developed by the Scottish Executive Health Department (SEHD) in partnership with Willis Limited, the appointed scheme manager, and has two principal aims. Firstly, to provide cost-effective claims management and financial risk pooling arrangements for all of Scotland's NHS Trusts and Health Boards. And secondly, to encourage a rigorous and logical approach to risk management in both the clinical and non-clinical sectors of the NHS in Scotland (NHSiS). The CNORIS scheme provides incentives for organisations to manage their liabilities from negligent acts and omissions by their employees and from other risks (MEL, 2000; HDL, 2000).

The scheme revolves around ten standards, each with three levels and corresponding targets. Progress to date on Level One, involving the setting up of management systems to provide the necessary structure for an effective trust-wide risk initiative, has been encouraging. However, Levels Two and Three, which deal with more advanced requirements involving the wider integration of staff and other stakeholders, present a more difficult challenge. An example of this is at Level Two of the Clinical Risk Management Process Standard which requires that all relevant stakeholders are kept informed and, where appropriate, consulted on the management of significant clinical risks faced by the organisation. Responsibility for this more diffuse risk communication will naturally fall to risk managers. Therefore it seems both appropriate and timely to achieve a heightened appreciation of the underlying perceptions of risk managers towards the technological, human-machine interaction and 'human' error incidents that occur in hospitals.

Technological ‘Stigma’: There is increasing evidence that technology and the impact of technology on public safety is the most difficult of all subjects to communicate accurately and fairly (Garrick, 1998). Generally technical information is poorly presented and as a result, the impact of technological solutions misrepresented. This phenomenon is described as ‘technological stigma’ (Slovic et. al, 1994). Certain technologies are ‘marked’ or perceived as a threat or a risk to society. Gregory et al. (1995) make the important point that “technological stigmatisation is a powerful component of public opposition to many proposed new technologies, products, and facilities.”

This is particularly relevant to this research. Risk managers both compose and impose the majority of internal risk literature and protocols. It would be plausible that they could communicate stigma in regard to new and/or existing technologies to their staff. This may have a detrimental effect on attitudes and subsequent behaviour towards equipment and devices. Even more importantly though, is the effect that risk managers’ personal attitudes toward technology have on their comparative perceptions of incidents involving technical equipment/devices and those which involve ‘human’ error alone.

Study One: The role of technological and non-technological factors in medical incidents

Participants: In total, thirty-three risk professionals (20 male, 13 female) took part in an incident categorisation exercise. They were all members of the Scottish CNORIS risk management syndicate, which is split geographically into an East and West network. The categorisation task aimed to examine the role that risk managers attributed to technology versus ‘human’ error when deciding the primary cause of a number of medical incidents. The main participant group were split into 13 who attended the East network meeting, and 20 who attended the West network meeting. This enabled a comparison between the two groups to see if there was general agreement across Scotland of which risks are more salient in contributing to incidents in NHS hospitals. It also enabled selection of those scenarios which were most consistently selected as belonging to a particular category and therefore were most suitable to be taken forward for use in Study Two: The Risk Perception Questionnaire.

East Group Characteristics: The East group, consisting of 13 participants (8 male, 5 female), were first to carry out the categorisation task. Three of them were Nursing and Midwifery Managers, with an average of 3 years 6 months experience. Three were Clinical Governance Co-ordinators, with an average of 6 months experience. Two were Quality Managers with an average of 2 years experience and there were also three Risk Managers with 8 years 3 months experience. The remaining two participants decided to keep their details anonymous. Although the specific remits of these roles differ, all of these professional groups are responsible for the control and communication of Clinical Risks, within a framework of adherence to the CNORIS standards. Some perform this as part of their existing clinical work (e.g. nursing manager) and some as part of their wider responsibility in assuring the quality of patient care (e.g. quality managers). All are therefore well qualified to make judgements about medical incidents and risks in hospital environments.

Categorisation Exercise: The categorisation exercise required the participants to read 20 short incident scenarios. These were real-life hospital incidents, selected and summarised, from two government reports: An Organisation with a Memory (2000) and Building a Safer NHS (2001). After reading each, participants were asked to attribute the primary cause of the incident to one of four groups: Technology, Non Technology, Mixture and Don’t Know. The definitions for each of the groups were given to the participants prior titles to the categorisation exercise. They were adapted from Hyman’s work on errors in the use of medical equipment (Hyman, 1994) and are shown below in Table 1:

<ul style="list-style-type: none"> - A <i>Technology</i> incident is due to a malfunction of equipment and does not result from interaction by a member of staff or other person. - A <i>Mixture</i> incident involves a Human-machine failure when the user causes or initiates a malfunction of equipment due to the complexity of the interface. - A <i>Non Technology</i> incident involves ‘Human’ Error when there is no interaction with the technology and no technological failure occurred. It also includes those rare incidents where interaction with the technology occurred but was not due to a failure of the interface. - The <i>Don’t Know</i> category is an acceptable answer where you feel you are unable to make a clear judgement about incident causation

Table 1 – Definitions of Incident Types

East Group Results: Out of the 20 original scenarios the East Group (13 participants) categorised 9 of the scenarios as Non Technology. The next highest categorisation was for the Both category, with 7 incidents being assigned. Only 4 incidents were assigned to the Technology category. This was a particularly surprising result as when the original 20 scenarios were selected, there was a conscious attempt to get a good mix of technological and non-technological incidents. These East group results reflect the risk managers' willingness to highlight the contribution of human fallibility to hospital incidents, as demonstrated by the high number of Non Technology category selections. At the same time they demonstrate a reluctance to 'blame' an incident on Technology alone, instead opting for the Both category in the majority of incidents involving technical failures. This is an interesting finding as it may reflect a tendency in NHS risk manager's to emphasize the human element as a contributory factor in incidents as they feel this is the most feasible area for them to affect changes and reduce risks within their respective trusts. Finally, no participants selected the Don't Know category for any of the incident scenarios, which is most likely a reflection on their experience.

Incident Scenarios: In terms of selecting the incidents that most strongly represented each category, and would be taken forward to form the basis of Study Two's risk perception questionnaire, the scenarios with more than 77% agreement (10 Ss out of 13) were chosen. This resulted in three groups of three scenarios being used (9 in total). The three incident groups were those caused by *Technology Alone* (TA), *Non Technology Alone* (NA) and *Human Machine Interaction* (HMI). The HMI group represents the 'Both' category where both technology failure and 'human' error were involved in incident causation. The nine tables below show these nine incident scenarios used in the risk perception study. In the questionnaire the incidents were obviously randomly distributed. However for illustration here in the paper they are divided into the three categories, with Technology Alone first (Tables 2a,b&c), then Non Technology Alone (Tables 2d,e&f) and finally the three Human Machine Interaction incidents (Tables 2g,h&i):

A 23-year-old healthy mother had some difficulty in delivering the placenta, which looked ragged. The uterus had failed to contract and the woman began to bleed. After transfer from the labour ward, a junior doctor examined her. However, the examination procedure was hindered because the button on the bed jammed which prevented the bed being correctly positioned.

Table 2a – The “Button” Incident Scenario

A vaginal probe used to promote continence via electrical muscle stimulation was to be used with the power level of the device set to minimum. However maximum muscle stimulation occurred as soon as it was switched on. Although no injury was caused, the extent of the stimulation was unexpected and distressing for the patient. Investigation showed that a breakdown in the manufacturer's quality system allowed the faulty device to be despatched after it failed inspection.

Table 2b – The “Probe” Incident Scenario

An institution experienced an inadvertent delivery of a vasoactive drug via a computerised infusion device during cardiac anaesthesia. Due to prompt physician intervention, the misadministration had minimal consequences on the patient.

Table 2c – The “Infusion” Incident Scenario

In a three-week period two young children received double the proper dose of medication in a hospital X-ray department, prior to having a scan. In both cases their weight was recorded in pounds, rather than kilograms. The children fortunately suffered minor ill effects.

Table 2d – The “Dose” Incident Scenario

A number of women became pregnant following failure of earlier sterilisation's that had been carried out by laparoscopic surgery. The surgeon had attached the sterilisation clips to the wrong part of the fallopian tube.

Table 2e – The “Clips” Incident Scenario

A hospital patient collapsed after a nurse gave her antibiotic tablets crushed in water via an intravenous drip. Only special fluids can be given via an intravenous drip. Similarly, antibiotics and other drugs can only be given in specially prepared solutions and not through the impromptu crushing of tablets. The patient was rushed to intensive care and subsequently recovered.

Table 2f – The “Tablets” Incident Scenario

A nurse adjusted the high and low alarm limits on a heart rate monitor for a patient with a tracheal tube under respiratory distress, in the absence of direct physician orders. Due to the design of the machine, the limit settings were not continuously displayed. Eventually when the selected 'dangerous' low heart rate alarm limit sounded, the patient's brain was irreversibly damaged. Secretions blocking the tracheal tube had resulted in decreased O₂ and a long period of elevated heart rate. But this increase was not enough to trigger the high limit alarm set by the nurse. The subsequent decrease in heart rate due to O₂ starvation sounded the low limit alarm, but far too late.

Table 2g – The “Alarm” Incident Scenario

When Mrs X went into labour the FHR was monitored by external Doppler. This was then replaced by a scalp electrode, as the midwives were unable to monitor the FHR easily due to maternal size and distress. The trace showed that the FHR was normal up until the time of the scalp electrodes removal as the head was crowning at 12.14 but the delivery did not proceed. The Doppler was re-attached showing a reassuring FHR at 160-170 beats, which led the midwife not to seek assistance until 12.33. At 12.39, the compromised infant was delivered. The misleading CTG trace was a result of a coupling with the maternal heart rate.

Table 2h – The “Doppler” Incident Scenario

Patients were injured when given incorrect doses of Lidocaine, for acute management of ventricular arrhythmias. All involved the erroneous use of two 20% preparations in place of a 2% preparation. The concentrates were either a 5-ml syringe containing 1000mg Lidocaine or a 10-ml syringe containing 2000mg Lidocaine. The 2% preparation was a 5-ml syringe containing 100 mg of Lidocaine. The errors occurred as the syringes were confused. The 5-ml syringes are identical in diameter and length. The 10-ml is the same length with a 40% larger diameter.

Table 2i – The “Needles” Incident Scenario

West Group Characteristics: The West Group (20 participants) then carried out the same categorisation task, but instead of using the original twenty scenarios, they selected from this new set of nine incidents. This was in order to ascertain whether the West group would agree with the East group's categorisations, and therefore whether the risk managers exhibited consistency in their opinions on the causation of different medical incidents.

In total, twenty risk managers (12 male, 8 female) completed this exercise as part of the West group. Seven of these were Nursing and Midwifery Managers, with an average of 2 years 8 months experience. Three were Medical Directors, with an average of 3 years experience, and just one participant had been a Health and Safety Manager for 16 months. The remaining nine participants were all Risk Managers or Co-ordinators, with an average of 2 years 4 months experience. Again although the job titles differ, all of these professionals are responsible for managing Clinical Risks, in accordance with CNORIS standards. The only exception in this group is the Health and Safety Manager whose emphasis is on Non-Clinical Risk.

West Group Results: Much consistency was found between the West Group results and the earlier East Group categorisations. For all three Non Technology Alone incidents, 82% agreement (49 Ss out of 60) with the East Group was achieved. A similarly high 80% agreement (48 Ss out of 60) was found for all three Human Machine Interaction incidents. In the case of Technology Alone incidents, only 38% agreement was found (23 Ss out of 60). However, the 55% majority left over (33 Ss out of 60) categorised that these involved a Human-Machine failure so it is clear that these participants recognised the contributory role of technology to the incident. This result is most noteworthy as it shows that West group risk manager's were as equally reluctant to categorise failures as being caused solely by technology as those belonging to the East Group. Again it appears that the human element is more often identified as the primary cause in medical incidents. It

was decided that this theme required further investigation, which was achieved via the more exploratory risk perception study, outlined in the following sections.

Study Two: Risk manager’s differing perceptions towards three categories of medical incidents

Participants: The same twenty West Network members who carried out the Study One categorisation exercise were used as participants in this postal risk perception study. The aim of this study was to discover whether risk managers had different risk perceptions of medical incidents depending on the role that technology played in the development of the adverse event. The participant’s contact details were obtained via personal contacts within CNORIS. Questionnaires were sent out, with full instructions and a stamp-addressed envelope. Fifty questionnaires were originally sent and twenty received back within a two-week period. Although only a 40% response rate was recorded the sample group that participated were deemed representative and provided enough data for meaningful interpretation of the results.

Risk Characteristics: The Questionnaire presented the West Group participants with the same nine incident scenarios shown in Tables 2a to 2i. This time however they were required, after reading each scenario again, to rate the incidents on nine characteristics of risk similar to those found to be important in prior studies by Slovic, Fischhoff et al. (1985) and Kraus and Slovic (1988). Table 3 below shows these nine characteristics:

<ol style="list-style-type: none"> 1. <i>Anticipatory knowledge</i> of risks by <i>risk managers</i> 2. <i>Anticipatory knowledge</i> by those involved in adverse event i.e. <i>health care workers</i> 3. <i>Severity</i> of the consequences (patient and/or staff present) 4. <i>Dread</i> of the entire range of potential consequences 5. <i>Confidence</i> in future use of the technology (or in performance of the activity) 6. The overall <i>Riskiness</i> of the technology or activity (to both patient and/or other staff) 7. Ability to <i>Control</i> the risks involved with the technology or activity 8. Ability to <i>Observe</i> the risks at the near miss stage prior to development of an incident 9. Future <i>Effort</i> needed for Risk Reduction

Table 3 – The Nine Risk Characteristics

The terms used for the characteristics were not explained explicitly to the participants, which goes against normal construct validity considerations. Construct validity (Child, 1954) refers to the degree to which a test measures the construct, or psychological concept or variable, at which it is aimed (e.g., intelligence, anxiety). In this case, the relevant constructs are the nine risk characteristics and the lack of explicit explanation of their respective meanings was by design. This is true to the nature of traditional psychometric risk studies where despite there being no freedom to choose the characteristics that are used for measurement, subjective interpretation of said characteristics is appropriate (Slovic, 2001). Each of the risk characteristics was rated on 10-point likert scales, with the less serious pole of each scale on the left-hand side and the more serious pole on the right. A partial illustration of the questionnaire is shown in Table 4. It shows a non technology scenario and the first five out of nine risk characteristic questions:

SCENARIO THREE. *A hospital patient collapsed after a nurse gave her antibiotic tablets crushed in water via an intravenous drip. Only special fluids can be given via an intravenous drip. Similarly, antibiotics and other drugs can only be given in specially-prepared solutions and not through the impromptu crushing of tablets. The patient was rushed to intensive care and subsequently recovered.*

i) To what degree should the risks involved in the activity or technology failure that led to the adverse event have been anticipated by risk managers?

Anticipated **1** **2** **3** **4** **5** **6** **7** **8** **9** **10** Unanticipated

ii) To what degree should the risks involved in the activity or technology that led to the adverse event have been anticipated by those present during the event?

Anticipated **1** **2** **3** **4** **5** **6** **7** **8** **9** **10** Unanticipated

iii) When the risk from this activity or the technology is realised in the form of an adverse event, how likely is it that the consequences will be fatal?

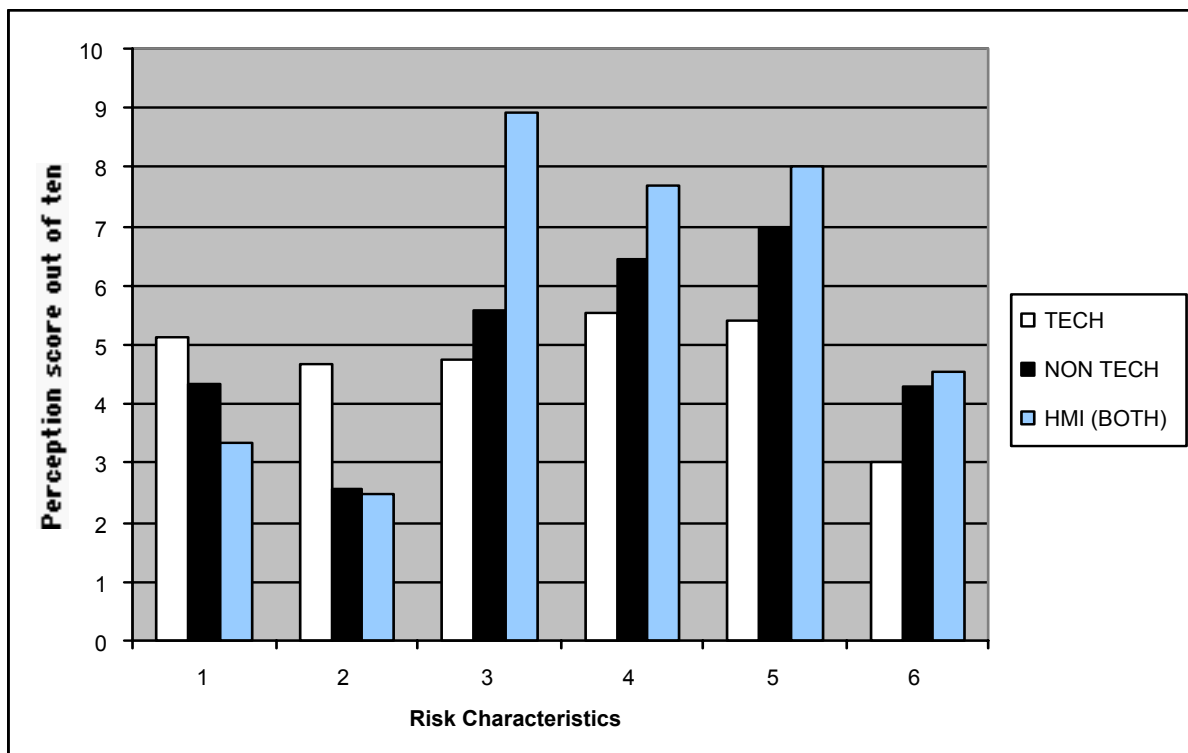
Table 4 – Partial Illustration of the Risk Perception Questionnaire

Results: The mean perceived risk of the three types of incident groups varied greatly, from 2.1 to 9.1 on the 10-point likert scales. The two incident scenarios judged to be most risky were those involving the Doppler Fetal Heart Rate (FHR) monitor and the Lidocaine Needles. Both these scenarios were judged by risk managers as involving Human Machine Interaction (HMI) failures. The two incident scenarios judged to be least risky were the Continence Probe and Bed Button scenarios, both from the Technology Alone (TA) category. Table 5 presents the incidents whose mean ratings were extreme on each of the nine judgment scales. Their corresponding categorisations are also included for each scenario. The three incidents involving Human Machine Interaction (HMI) failures are repeatedly the most negatively rated on all characteristics. The three Non Technology Alone (NA) incidents were consistently rated toward the less serious pole of each scale. This was true also for Technology Alone (TA) incidents, although to a smaller extent.

Risk Scale	Highest Scenarios	Group	Lowest Scenarios	Group
1 Knowledge (Risk Managers)	Probe 6.4	TA	Dose 2.6	NA
	Button 5.8	TA	Needles 2.9	HMI
2 Knowledge (Health Workers)	Probe 6.7	TA	Dose 2.3	NA
	Button 4.4	TA	Tablets 2.3	NA
3 Severity	Alarm 9.1	HMI	Probe 2.7	TA
	Needles 9.0	HMI	Clips 3.4	NA
4 Dread	Doppler 7.9	HMI	Probe 4.6	TA
	Needles 7.8	HMI	Clips 5.1	NA
5 Confidence*	Doppler 5.9	HMI	Dose 4.2	NA
	Probe 6.0	TA	Tablets 4.2	NA
6 Riskiness	Doppler 8.2	HMI	Probe 4.2	TA
	Needles 8.0	HMI	Button 4.9	TA
7 Controllability*	Probe 7.7	TA	Dose 2.6	NA
	Clips 6.0	NA	Needles 2.6	HMI
8 Observability	Doppler 5.7	HMI	Button 2.2	TA
	Alarm 5.5	HMI	Probe 2.6	TA
9 Effort*	Doppler 5.7	HMI	Tablets 3.5	NA
	Needles 5.5	HMI	Dose 4.2	NA

Table 5 (above) - Extreme Scenarios for the Nine Characteristics

Table 6 (below) – Comparing Risk Managers Mean Scores for the Three Incident Categories



Standard deviations across all mean risk scores were calculated. For most of the characteristics these ranged between 1.5 and 3 and so provided a large enough range for comparison between scenarios. Unfortunately though, *the standard deviations for the *Confidence*, *Control* and *Effort* characteristics were all below 1.0 (0.7, 0.6, 0.3 respectively). However, the uniformity with which twenty risk managers rated these characteristics shows us that differences in the areas of *Confidence*, *Control* and *Effort*, regarding technology and causation, appear to be negligible. The following analysis centres around the remaining six risk characteristics, which provide interesting insights about the variations in the risk manager's perceptions toward the three groups of medical incidents. Table 6 represents the mean risk perception scores for each of the three categories of incidents: Technology Alone, Non Technology Alone and Human Machine Interaction.

Referring to Table 6 above, Risk Characteristic number 1 and 2 represent the *Knowledge* characteristic - firstly from the risk manager's own perspective and then from the level of risk knowledge that they hypothesise a healthcare worker directly involved in the incident might have. When comparing the mean perception scores calculated from the three different incident categories we see that risk manager's rated Technology Alone incidents consistently higher than the other two incident categories on both *Knowledge* risk characteristics. This means that Technology Alone incident scenarios were perceived as unanticipated to a greater extent than those involving Human Machine Interaction failure or Non Technology Alone. This suggests that risk manager's have an expectation of the reliability of technology and anticipate incidents only when humans interact with technological equipment or when they make mistakes alone. Although the *Confidence* characteristic result has been discounted, this *Knowledge* result does reflect a form of confidence that risk managers have in technology and its correct and safe functioning.

This finding is echoed on Risk Characteristics 3, 4 and 5, representing *Severity*, *Dread* and *Riskiness*. Technology scores the lowest, making it the most positively rated of all incident categories on these three characteristics. Non Technology is rated slightly higher, and therefore closer to the negative scales, but it is the Human Machine Interaction failures that score very highly and so are rated as both most severe, dreaded, and risky of all incidents. It appears therefore that technology is only perceived as risky when humans are involved, resulting in Human Machine Interaction (HMI) failures. When looking back at Table 5, the two most extreme negatively rated examples for *Riskiness* were the Doppler Fetal Heart Rate (FHR) Monitor and the Lidocaine Needles, with scores as high as 8.2 and 8.0 respectively. Both incidents involved unfortunate breakdowns in the complex interactions between equipment and user/s, with adverse effects to the patient/s.

When turning to the results for *Observability*, the last Risk Characteristic in Table 6, it becomes apparent that a lack of interface visibility may be the problem behind these breakdowns and the subsequent reason for such negative risk perceptions of Human Machine Interaction incidents with equipment and devices. Technology Alone incidents score lowest on *Observability*. This implies that risk managers' perceive incidents that involve devices malfunctioning in hospitals, without direct human input or error, as highly visible and therefore possibly more preventable if they were to occur in their hospital. Although, the difference between the Non Technology and the Human Machine Interaction mean ratings are negligible for *Observability*, it is once again the Human Machine Interactions which scored highest, and therefore are perceived as being the least visible of all incidents. Table 5 supports this as it shows two Human Machine Interaction incidents, the FHR monitor and the Alarm Limit Settings, as the highest scenarios at the negative pole. At the other extreme, the positive pole, are two Technology Alone scenarios – the Bed Button and the Continence Probe. From these *Observability* scores, it appears that risk managers perceive problems with technology as being the most visible. This may account for their low anticipation of the occurrence of technological incidents as problems are easily seen and fixed before an incident develops, that is, at the near-miss stage.

Discussion: These results showed that those incidents viewed as being the result of Human Machine Interaction failure were generally judged to be highly *Dreaded* and *Risky*, and displaying poor *Observability*. Also, risk managers seem well aware of the potential risks that Human Machine Interaction incidents pose, as recorded by their high *Knowledge* results. Conversely, both Technology Alone and Non Technology Alone incidents scored low on *Dread*, *Severity*, and *Riskiness* and high on *Observability*. As such, anticipation (*Knowledge*) of Technology Alone and Non Technology Alone incidents were rated at the less serious pole of the scale as risk managers perceived these problems as occurring less frequently.

A possible limitation of this study is that in order not to tamper with the real-life incidents used, the outcomes of the scenarios were not standardised. Although this variation was only slight, it may have had a confounding effect on the risk managers' responses, that is, more *Dread* was perceived for an incident with a more damaging outcome. However, participants were instructed before beginning the questionnaire to consider the entire range of consequences for each incident and not be limited to what was reported in the scenario. Another drawback was the very short incident summaries, which meant that consideration of contextual factors contributing to risk, such as teamwork and communication issues, were beyond the scope of this study.

Conclusion

This paper has reported on two distinct studies. However, they share common ground and the conclusion of this work is supported by their complementary findings. Study One revealed that risk managers' across the Scottish NHS show consistency with their categorisations of different medical incidents. The most interesting aspect of this categorisation agreement was that they appeared to underestimate the contributions that technological factors have in causing incidents, emphasising non technological and 'human' error causes instead. The results from Study Two directly support this finding. The risk manager's ratings of the medical scenarios revealed that incidents involving Human Machine Interaction failures are perceived as posing the greatest risks, whilst those incidents involving Technology Alone are perceived as relatively innocuous, and on a par with Non technology Alone scenarios. This disproves the earlier hypothesis that the stigmatisation of technology in the NHS may result in the transfer of technophobic attitudes detrimental to the acceptance of both new and existing equipment and devices. On the contrary, the conclusion of this work is that risk managers are only weary of technology when there is human interaction and where errors involving complex interfaces and systems result in potentially dangerous situations for both patients and staff.

Therefore it can be concluded that the thirty- three risk managers that participated in our two studies perceive Human Machine Interaction failures as the biggest current challenge to the task of risk management in the Scottish NHS. This conclusion has a direct impact on the development of CNORIS risk management strategy, highlighting the need for more attention to be given to the relationship between healthcare professionals and the technologies that they use in their daily work. This may include stricter risk protocols for the use of equipment, incorporated within a more open reporting culture of common problems that people encounter using technology. Also a forum to share lessons learnt from near miss situations, that is how Human-machine Interaction (HMI) failures are recovered from before an incident develops, may also be of benefit to the development of the CNORIS Standards.

Finally and most importantly, more attention may be needed in terms of staff training for equipment use. Existing training schemes may be adequate for initial instruction, but refresher workshops and reminder notices given by risk managers may be necessary to help to limit the occurrence of Human Machine Interaction incidents in the future. Whatever course of action, it seems clear that value is added to the process of risk management by a better understanding of stakeholders risk perceptions towards different types of medical incidents. The natural progression of this work is to attempt to uncover some of the perceptual risk variations that exist within and between professional working groups at the frontline of healthcare.

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