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Table of Contents

Edited by: Joan Cahill, H. Diego Estrada-Lugo, Mahnaz Sharafkhani, Anna V. Chatzi, Cora McCaughan, Marie E. Ward
Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

Extended abstracts

Edited by: Joan Cahill, H. Diego Estrada-Lugo, Mahnaz Sharafkhani, Anna V. Chatzi, Cora McCaughan, Marie E. Ward
Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

Applying a Human Factors approach to improve medication safety outcomes in a hospital setting: a systematic review

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Background

Medication errors in healthcare pose a significant global health challenge, with substantial cost associated (WHO, 2017). Using a Human Factors Ergonomics (HFE) approach to improve patient safety may be beneficial in reducing the risk and incidence of error (Institute of Medicine, 2000). It is important to address a current gap in the literature. We set out to determine 1) how HFE methodologies have been utilised in medication safety research in a hospital setting and 2) if these studies have demonstrated any change in medication safety related outcomes.

Methods

The protocol for this systematic review was registered with PROSPERO: CRD42023417909. Four databases were searched in April 2023 and March 2024. These included: EMBASE, PubMed, Web of Science and PsycINFO (EBSCOHOST). Reference and grey literature searching was also undertaken. All interventional studies that used a HFE methodology to improve medication safety were included. A synthesis of study characteristics, focusing on the HFE methodology and medication related outcomes was conducted.

Results

A total of 5534 studies were identified from searches, with 31 papers eligible for inclusion. Human factors methodologies were often utilised in a simulated clinical setting by specialists working in anaesthetics and paediatrics. These studies primarily focused on healthcare technology interventions and redesign of medication storage. Task analysis, workload assessment, system usability scores and failure mode effect analysis were the most frequently reported HFE methodologies. However, the degree to which HFE was embedded in these studies was variable. Observed medication error number/ rate was the most frequently reported medication safety outcome. Most of these studies demonstrated a positive safety outcome.

Conclusion

This review has found that the application of HFE methodology in medication safety research is variable and not reported in the literature consistently. The findings support the need for future research to assess the impact of HFE on medication safety practices and interventions, and to report in detail the application of HFE in the research design and implementation.

References

Institute of Medicine, 2000. *To Err Is Human: Building a Safer Health System*. Washington, DC: *The National Academies Press*. https://doi.org/10.17226/9728.

World Health Organization, 2017. World Health Organization (WHO) *Medication Without Harm - Global Patient Safety Challenge on Medication Safety.*

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

A Human Factors investigation into a fatality during a prisoner restraint

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**This work was done in previous employment for the Health and Safety Executive in the UK. The views expressed here are as part of current employment for the Health and Safety Authority, Ireland, and do not necessarily reflect Health and Safety Executive UK policy.*

Introduction

Human Factors guidance and research regarding the management of the health and safety of work states that Human Factors should be integrated into systems of work to optimise system performance and minimise the potential for workplace accidents or ill-health (Health and Safety Authority 2024; Health and Safety Executive, 1999).

In 2015 a prison escort officer was kicked twice, once in the body and once in the head, at Blackfriars Crown Court in London (UK) during the restraint of a prisoner in custody (Health and Safety Executive, 2024). The prison escort officer died from her brain injuries. Human Factors Specialists from the Health and Safety Executive Science Division in the UK investigated organisational, job and individual factors in relation to the incident.

The aim of this poster abstract is to highlight, using HSE UK accident investigation findings, how a lack of implementation of Human Factors in the design of work led to unsafe practices and a workplace fatality.

Method

Human Factors Specialists reviewed evidence including safety management documentation and witness statements against human factors good practice and relevant HSE and industry guidance and legislation. The review included evidence relating to safety critical communication, staffing levels for prisoner escort activities and fatigue management. An accident investigation technique, known as Events and Conditional Factors Analysis (ECFA+) was also used to produce a timeline of key events and circumstances.

Results and Discussion

Human Factors expert evidence outlined how serious inadequacies in the safety management system led to control measures that were not protective for prison escort officers. Expert evidence also identified that staff were not following safety procedures and considered the reasons underlying this. Key evidence referred to the following elements:

- Human Factors in Risk Assessment - Risk assessment did not identify what could go wrong.
- Safety culture - Over time, a safety culture developed where unsafe practices became a normal way of working.
- Organisational Learning - A failure to change existing processes after an incident meant that it was much more likely that deep rooted organisational problems persisted, making a recurrence

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

of an incident more likely. A separate incident occurred in 2016 where another member of Serco staff was assaulted in Woolwich Court annex.

Conclusions

This case provides support for the integration of Human Factors into safety management systems to optimise system performance and minimise the potential for workplace accidents or ill-health. Future Human Factors tools that enable improvements in how Human Factors are embedded in safety management systems (and in particular, in risk assessments, to ensure control measures are designed based on operational reality -that is, 'work as done'), would be beneficial.

References

Health and Safety Authority 2024, Introduction to Human Factors. https://www.hsa.ie/eng/topics/human_factors/ *Last accessed 18 April 2024.*

Health and Safety Executive. 1999, Reducing error and influencing behaviour (HSG48 Second edition), Health and Safety Executive. ISBN 9780717624522. HSE Books.

Health and Safety Executive. 2024, Annual Science Review: Investigation into a fatality during a prisoner restraint at a Crown Court, *p.7.*
https://www.hse.gov.uk/Research/content/science-review-2024.pdf *Last accessed 18 April 2024.*

Cognitive Ergonomics in action: the impact of psycho-oncology training for staff

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Background

Psycho-oncology plays an important role in patient wellbeing (Faller et al.2013), and psycho-oncology training can help improve oncology staff's confidence and knowledge in this area (Kubota et al., 2016). The purpose of this two-day multidisciplinary training course was to equip staff with knowledge and skills to enhance their practice, thereby improving the care system for patients. A recent review of cognitive ergonomics interventions identified 'supporting good communication and teamwork' as important to reduce cognitive load at work (Li-Wang et al, 2023). Our course covered relevant topics including identifying and managing patient distress, the use of psychotropic medication in cancer, supporting patients discussing cancer with families, effective communication skills, managing difficult situations in healthcare settings, and an introduction to burnout and self-care. The sessions were devised with cognitive ergonomics in mind, focusing on interactive and skills-based learning, reflective processes and peer discussion to maximise learning and retention.

Methods

The course ran over two days in a dedicated classroom setting. Each session had a mixture of didactic and interactive learning (e.g. role play, case-based learning, feedback on skills, reflective discussions) to consolidate learning. Regular breaks were built into the timetable.
A post course questionnaire was completed by all participants. It focused on analysing participants' perspectives of how the course influenced their understanding of psycho-oncology, their practice with oncology patients and managing their own wellbeing. There were fourteen participants including nurses, genetics counsellors and one doctor.

Results

100% of participants voted that the workshop would positively impact their work 'very much' or 'a great deal'.78% reported that engaging in this course would positively affect their wellbeing 'very much' or 'a great deal'.100% of participants found the course 'very' or 'extremely' beneficial. There was a clear increase in the participants' confidence in managing psycho-social issues before and after the workshop.

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

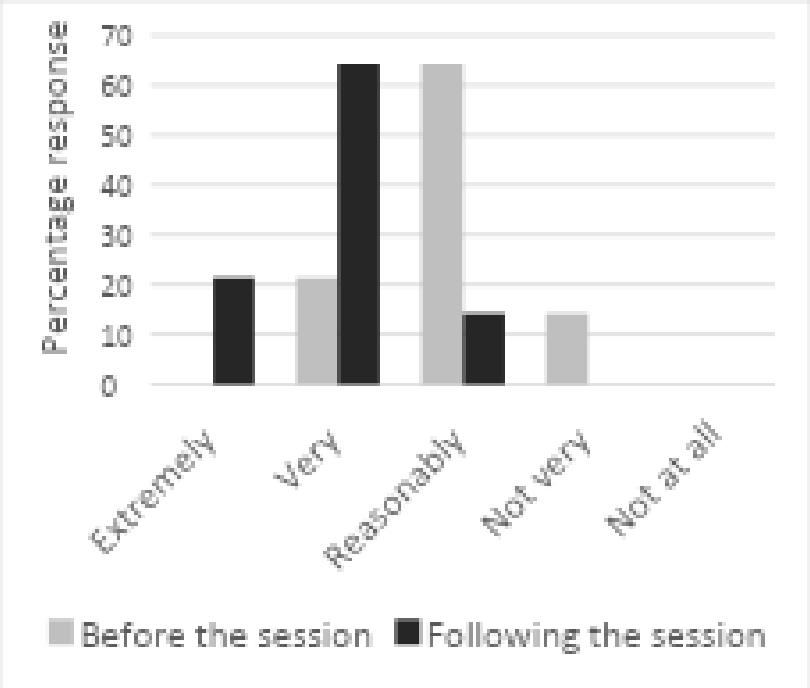

Figure 1: How confident are you at managing the issues discussed?

Conclusion

Participants overwhelmingly reported that the training was beneficial to their practice and to managing their wellbeing. The results of this survey demonstrate the value of dedicated training interventions for staff to improve knowledge and communication skills. This study highlights the importance of patient and staff wellbeing within oncology services. The training will be run again in future, incorporating feedback to guide course content and delivery.

References

Faller, H., Schuler, M., Richard, M., Heckl, U., Weis, J., & Küffner, R. 2013. Effects of psycho-oncologic interventions on emotional distress and quality of life in adult patients with cancer: systematic review and meta-analysis. Journal of clinical oncology: official journal of the American Society of Clinical Oncology, 31(6), 782–793.

Kubota Y, Okuyama T, Uchida M, Umezawa S, Nakaguchi T, Sugano K, Ito Y, Katsuki F, Nakano Y, Nishiyama T, Katayama Y, Akechi T. 2016. *Effectiveness of a psycho-oncology training program for oncology nurses: a randomized controlled trial*, Psycho-Oncology,25(6),712-718

Li-Wang, J., Townsley, A., & Katta, R. 2023. *Cognitive Ergonomics: A Review of Interventions for Outpatient Practice.* Cureus, 15(8), e44258.

A comparison of two quantitative human reliability methods applied to a low dose rate (LDR) brachytherapy healthcare process and the questions arising

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Introduction

Human error related to patient safety has attracted significant attention in the last 25 years with efforts made to transfer methods and lessons from traditional safety related industries (e.g. aviation, nuclear power, or petrochemical industries), to healthcare. Human Error Assessment and Reduction Technique (HEART) and Standardized Plant Analysis Risk Human Reliability Assessment (SPAR-H) are two mature, quantitative human reliability analysis methods developed for the nuclear industry that have been applied in healthcare (Chadwick and Fallon, 2012, Jafari Nodoushan *et al.*, 2022).

Low Dose Rate (LDR) prostate brachytherapy involves the insertion of radioactive seeds into the prostate to treat the cancer from within, supported by real-time ultrasound monitoring. The radiation oncologist determines incrementally whether the treatment plan is being achieved. Depending on the final position of the seeds, the radiation oncologist alters the treatment plan by varying the seed insertion pattern. There are inherent risks to successful patient treatment. However, there is also a significant secondary risk of radioactive poisoning if one or more seeds 'escape' from the prostate gland.

Methods

HEART and SPAR-H were applied to a LDR prostate brachytherapy process by one of the authors. A Hierarchical Task Analysis (HTA) of the tasks of each of the roles in the brachytherapy team was carried out. These HTAs were analysed using HEART and SPAR-H.However, only those of the Radiation Oncologist are presented in this paper. They included; Position the Trans-rectal Ultra Sound (TRUS) for the Patient, Measure Prostate Volume, Insert/Implant the Needles in the Prostate, Measure Prostate Volume Post Needle, Virtual Prostate and Urethra Positioning, Peripheral Seeding and Planning, Central seeding and planning. The purpose of the work was to compare the quantitative results obtained from both methods.

Results and Discussion

HEART and SPAR-H, were applied to the process, however the results were significantly different. It can be argued that the SPAR-H method appeared to be more effective for modelling a healthcare process as it could be argued that the results are more realistic. Nevertheless, a number of questions arise related to the fundamental data in the methods used and the process of mathematically manipulating this data. For example: How is the data for the baseline Human Error Probabilities (HEPs) distributed? How are statistical dependencies modelled in HEART? What is the mathematical rationale for the inclusion of only 3-5 Performance Shaping Factors (PSFs) in a HEART analysis?

Significant judgment is called for in the methods, potentially resulting in great variability. For example: What guidance is available to determine Proportion of Affect (POA)? Is there any interaction between

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

PSFs in SPAR-H? While practitioners refer to the 'utility' of these quantitative approaches which generally give a benchmarked value, purists from both systems reliability and the human sciences may not agree.

References

Chadwick, L. & Fallon, E.F., 2012. Human reliability assessment of a critical nursing task in a radiotherapy treatment process. *Applied Ergonomics,* 43**,** 89-97.

Jafari Nodoushan, R., Taherzadeh Chenani, K., Jahangiri, M., Madadizadeh, F. & Fallah, H., 2022. Quantification of the impact of factors affecting the technical performance of operating room personnel: Expert judgment approach. *Journal of Healthcare Risk Management,* 41**,** 9-16.

Understanding with heart: the intersection of data analytics and empathy in healthcare

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Introduction

Traditional healthcare data analysis often prioritises logistical metrics such as resource allocation and treatment times, sometimes at the expense of patient emotional well-being (Sharmila and Devi, 2023; Batko and Ślęzak, 2022). While patient-reported outcomes (PROMs) and patient-reported experience measures (PREMs) exist, they do not directly address how data can enhance patient-perceived empathy (Anna *et al*., 2023). This research proposes an approach in utilising data analytics to foster a sense of empathy throughout the patient care pathway, aiming to improve patient experience and overall well-being.

Methods

A systematic literature review will be conducted to identify existing practices that incorporate/highlight empathetic factors with healthcare data. Building on those findings, a framework will be developed that integrates qualitative methods, such as interviews and focus groups, with statistical techniques. These narratives will focus on patient experiences and perceptions of care, specifically aimed at identifying critical points within the care pathway where empathy is needed. The goal is to determine how empathy can be effectively integrated into these identified areas to enhance patient care.

Results

This analysis will provide key insights into how data analytics can be harnessed to foster empathy for patients on their pathway. The developed framework will outline specific interventions that can be implemented at critical touchpoints in the care pathway, leading to greater patient empowerment and improved outcomes.

Discussion & Conclusions

This research explores a more holistic view of the care pathway with the potential to transform healthcare by identifying opportunities for greater empathy and understanding. This emphasis on patient experience alongside clinical data can inform process improvements, better patient-provider communication, and empower patients in their decision-making. The anticipated impact of this research is significant, potentially setting new standards for empathy integration in healthcare systems, consequently improving the quality of care and patient satisfaction.

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

This work is supported with the financial support of Lero – SFI Research Centre for Software (www.lero.ie).

References

Batko, K. and Ślęzak, A., 2022, The use of Big Data Analytics in healthcare, *Journal of Big Data*, **9**(3).

Friedel, A., Dehmel, S., Mühlbacher, A. C., and Harpe, N., 2023, Measuring Patient Experience and Patient Satisfaction—How Are We Doing It and Why Does It Matter? A Comparison of European and U.S. American Approaches, *Healthcare (Basel)*, **11**(6), p. 797.

Sharmila, D. and Devi, M., 2023, Data Analytics in Healthcare Industry, *International Journal of Advanced Research in Science, Communication and Technology*, p. 529-532.

Improving operating theatre stock replenishment automation

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Introduction

Scan4Safety is an automated system of stock replenishment and traceability of clinical items used to deliver patient care in the operating room. It has successfully demonstrated improved patient safety, operational efficiency and data intelligence. Stock is set on levels and scanned at the point of opening in theatre. A maximum level and a replenishment point is setup. The challenge is how to capture the stock packaging at point of opening. If it is not scanned, it will never reach the replenishment point for an order to be placed. As stock is coming from different locations/cost centres within theatre, the S4S Cart was designed to meet the challenge of segregating stock at the point of opening - to the origin of stocks or theatre. As there are 11 theatre, inter-theatre movement of stock is the norm.

Methods

Wheeled carts were purchased which could contain a bin at a certain height level to avoid over stooping. Carts were mounted with bespoke plastic document holders to contain barcode catalogues specific to each theatre number (e.g. Theatre 9). These catalogues were needed to allow users to scan a barcode for consumables which didn't have an individual barcode (e.g. a box of sutures). 3D printed spacers were added to the Carts to facilitate unimpeded access to the barcode document holders. Labelling was included on trolleys, bins, and document holders to indicate which theatre the packaging came from, so that it can be "scanned out" of that theatre on the S4S system. Each theatre required a "scanned", "unscanned" and "scrub room" cart/bin for collecting packaging from each case.

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Figure 1: Bespoke Bin Collection System, Fabrication and cart modifications.

Results/Conclusions

Carts have been rolled out to 4 theatres at the hospital, with the remaining to be brought online over the coming months. The system has facilitated an automated system of stock replenishment, traceability, cost savings and waste reduction.

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

Enhancing patient understanding: a pilot study of a patient information video for patients commencing anticoagulant therapy

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Background

Direct Oral Anticoagulants (DOACs) are high-risk medications due to their potential for serious bleeding complications. There is a significant risk of life-limiting or fatal thrombosis in patients who are poorly compliant with their prescribed DOAC. Approximately 30-40% of Irish patients do not adhere to prophylactic pharmacological regimens(IPPOSI, 2013). Patient education ensures that patients understand their medications, why they are taking them, and their associated risks and benefits. Improved understanding of medications may increase adherence. (Winnick et al., 2005) This is particularly relevant for high-risk medications. Patient information videos cater to both visual and auditory learners, providing a multi-sensory experience that can enhance understanding and retention of information when compared to written information alone. (Mayer, 2001) Videos may also offer higher engagement, as well as accessibility for low literacy levels(Wilson & Wolf, 2009).
This pilot study examines the use of a specifically designed Patient Information Video (PIV) versus traditional Patient Information Leaflet (PIL) to educate patients about newly prescribed DOACs.

Methods

Thirty patients were randomised to receive information about their new DOAC either via: (1) PIL or (2) PIV *and* PIL. PIV and PIL were designed specifically for the project, and both contained the same information. PIV and PIL were designed with input from the coagulation team, who are typically involved in patient education in this area. Both PIV and PIL also incorporated information from contemporaneously available PILs. Knowledge of their new medication was tested at 3 points: before, directly after, and 1 week after receiving information. The validated Anticoagulant Knowledge Tool (AKT) was used. Patients gave feedback on each method of information provision.

Results

Mean knowledge score prior to receiving information either by PIL or PIV was 7.66 4.1 (SD), mean knowledge score following intervention was 17.8 2.8 (SD), (maximum possible score = 25). There was no statistically significant difference between knowledge scores pre-, immediately post- or 1 week-post intervention between the PIL and PIV groups. Patient feedback on the PIV was resoundingly positive.

Conclusions

Providing patients with information about their new DOAC through any modality significantly improves their knowledge. Patient reaction to the PIV was positive, suggesting the ability of video to captivate and hold the attention of the viewer. Delivering information in different modalities will likely improve patient understanding of their DOAC and increase compliance, as well as improving patient experience in the healthcare setting. The sample size was limited, preventing conclusions regarding efficacy of PIV in enhancing patient knowledge. Trends demonstrated warrant the pursuit of a larger project.

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

References

Irish Platform for Patients' Organisations, Science and Industry.
A Focus on Patient Compliance and Adherence in 2013. Outcome report http://www.ipposi.ie/index.php/news-a-eventsmainmenu-28/259-ipposi-outcome-report-on-patient-compliance-and-adherence

Winnick S, Lucas DO, Hartman AL, Toll D.
How do you improve compliance? Pediatrics. 2005. Jun 1;115(6):e718-24.

Mayer R.E. *Multimedia Learning*. Cambridge University press. 2001

Wilson E.A., Wolf M.S. *Working memory and the design of health materials: A cognitive factors perspective*. Patient Education and Counselling, 2009. Mar;74(3):318-22. doi: 10.1016/j.pec.2008.11.005.

Optimising the electronic patient record for the early detection of clinical deterioration: a human factors and systems thinking approach

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Background

Recent years have been characterised by a rapid digitalisation of care in Irish hospital settings, with a particular focus on the transition from traditional paper health records to an Electronic Patient Record (EPR). The past decades have also seen increasing clinical implementation of early warning score (EWS) systems, aggregate tools used to identify early signs of patient deterioration. While the integration of EWS systems into the EPR represents a significant opportunity to augment score sensitivity and specificity for the reduction of unnecessary in-hospital mortality, little evidence exists exploring the implications of EPR-embedded EWS system implementation on clinical team workflows. Human Factors psychology — grounded in Sociotechnical Systems Analysis — represents a critical lens through which to view and improve the usability and effectiveness of both the EPR and EWS systems.

Methods

This mixed-methods doctoral research — to be conducted in a large urban teaching hospital — will incorporate a systematic literature review, anonymous online surveys, semi-structured qualitative interviews, and non-participant ward round observations to inform a sociotechnical systems analysis. This will be followed by participatory co-design sessions with information technology professionals and clinician (medical and nursing) end users.

Results

The research will identify areas of improvement for the design of the Electronic Patient Record as well as the implementation of EWS systems in acute care settings, highlighting end user needs, attitudes, preferences, barriers, and facilitators. The primary expected outcome is the design of an implementation road map supporting 1) the augmentation of multidisciplinary communication, 2) the optimisation of clinical workflows, and 3) the improvement of clinician-EPR interactions, for the ultimate maximisation of user satisfaction, care quality, and patient safety.

Discussion

Informed by Human Factors thinking, the research aims to define the individual, social, organisational, and technological challenges to successful implementation of an Early Warning Score system in the Electronic Patient Record. The research also seeks to explore the potential for human-centred design methods to refine both the design and implementation of health information technology.

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Prevention and control of healthcare acquired infection (PCHCAI) in acute hospital setting – what can human factors ergonomics contribute?

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Introduction

Healthcare acquired infections (HCAI) pose a significant threat to patients and healthcare systems in all European countries (ECDC, 2018). This study builds on the Access Risk Knowledge (ARK)-Virus project and explores what Human Factors Ergonomics (HFE) can bring to the management of the risk of HCAI in a large acute teaching hospital.

Methods

The existing risk management frameworks of Enterprise Risk Management (ERM) (HSE, 2023) and NIOSH Hierarchy of Controls (NIOSH, 2024) were studied alongside the HFE socio-technical systems analysis (STSA) framework called the Cube (McDonald et al., 2021) to look at the management of the risk of HCAI in the hospital. Two focus groups were held with healthcare professionals, quality and safety experts and HFE researchers (Nov 2023 n=10 participants; Dec 2023 n=5 participants) to discuss and compare the three frameworks and how they might complement each other. Findings were taken to the project steering group meeting in a third focus group (March 2024 n=16) and further refined following feedback. All participants were given participant information leaflets and completed consent forms. Ethics approval for the study was obtained from the HSE Corporate Ethics Committee (ref RRECB0923MS).

Results

Both the ERM and NIOSH frameworks were considered beneficial for healthcare risk management in terms of moving towards more preventative and design driven controls. The addition of the HFE informed Cube analysis proved to be useful in the following ways (i) to support the analysis of the effectiveness of the existing controls (ii) to support the analysis and improvement of the system of controls and compliance. The Cube high level questions can support understanding the efficacy of existing controls and taking an STSA approach can support understanding vulnerabilities in the overall system of controls at the micro, meso and macro levels. In addition, it can help provide guidance on where to intervene in the system to support improvement. Figure 1 outlines how the three frameworks might interact and complement each

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Irish Human Factors and Ergonomics Society Annual Conference 2024 and 30th Anniversary Celebration.

other. Figure 2 outlines how understanding healthcare as an STS can be used to develop appropriate controls at each level of the system.

Discussion

Despite availability of national and international standards, it is challenging to mount and sustain a fully effective approach to mitigating the risk of HCAI (OECD, 2018). This is a health systems issue and to understand, integrate and analyse all relevant data to inform practice requires the coordination of diverse expertise, including HFE, through the risk management lifecycle.

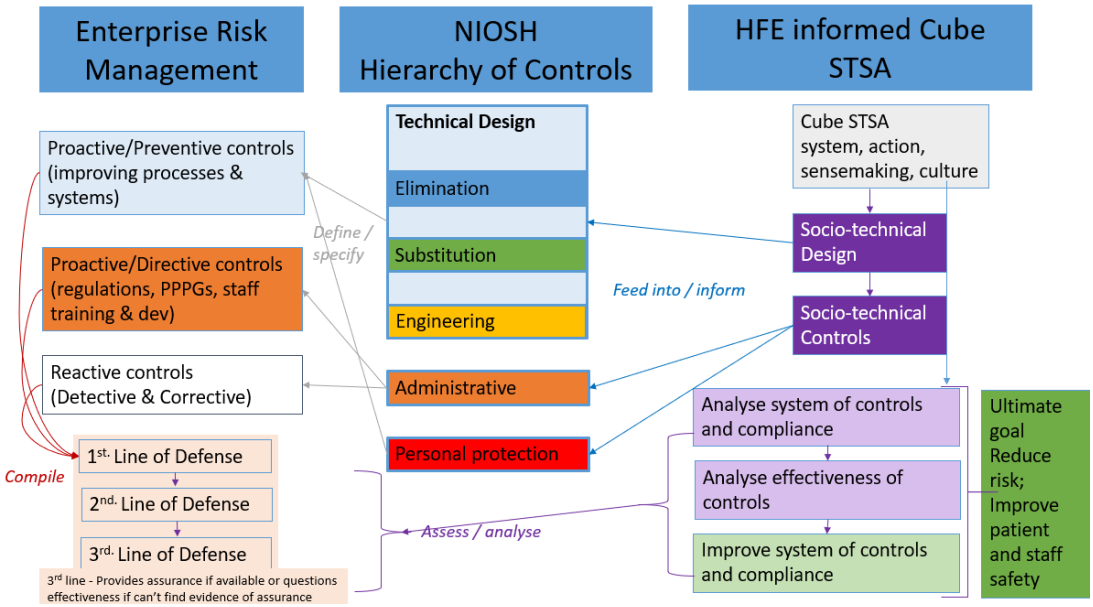

Fig 1. Understanding ERM, NIOSH and HFE informed Cube together

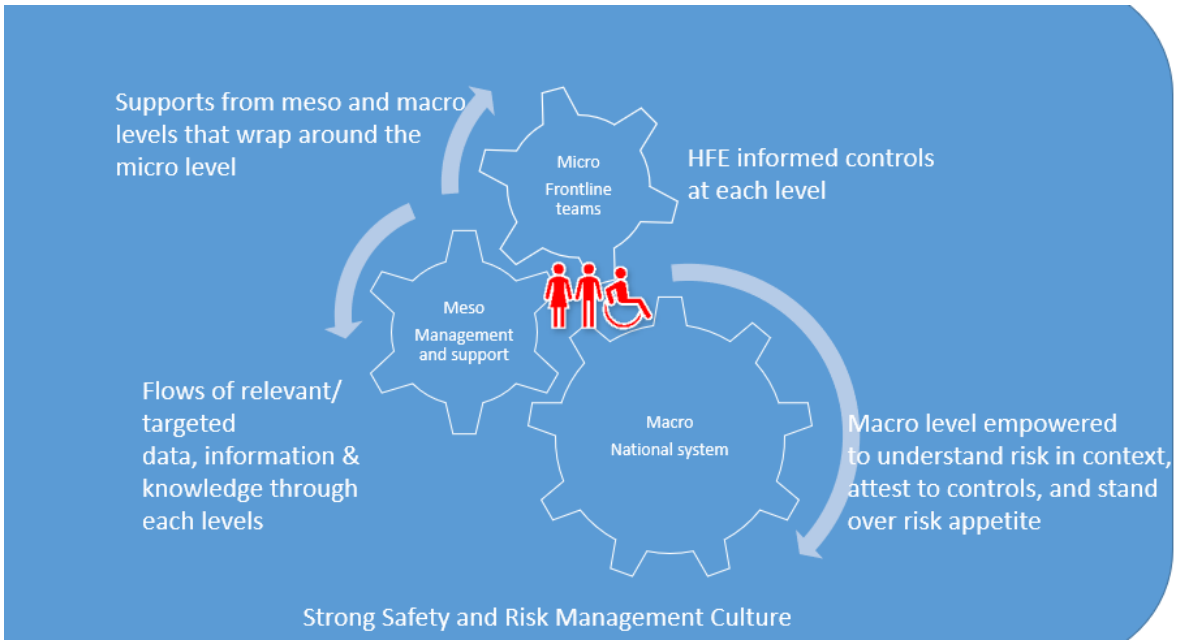

Fig. 2 Understanding healthcare as STS supports risk management

Acknowledgements

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References

ECDC. *Rapid risk assessment: Carbapenem-resistant Enterobacteriaceae - first update*, 2018, Available here: https://www.ecdc.europa.eu/en/publications-data/rapid-risk-assessment-carbapenem resistant-enterobacteriaceae-first-update (Last accessed 22 Oct 24).

HSE, *Enterprise Risk Management Policy*. 2023, Available here: https://www2.healthservice.hse.ie/organisation/national-pppgs/hse-enterprise-risk-management-policy/ (Last accessed 22 Oct 24).

McDonald, N.; McKenna, L.; Vining, R.; Doyle, B.; Liang, J.; Ward, M.E.; Ulfvengren, P.; Geary, U.; Guilfoyle, J.; Shuhaiber, A.; et al., 2021, *Evaluation of an Access-Risk-Knowledge (ARK) Platform for Governance of Risk and Change in Complex Socio-Technical Systems*. Int. J. Environ. Res. Public Health 18, *12572*. https://doi.org/10.3390/ijerph182312572

NIOSH, National Institute for Occupational Safety and Health – About Hierarchy of Controls, 2024, Available here: https://www.cdc.gov/niosh/hierarchy-of-controls/about/?CDC_AAref_Val=https://www.cdc.gov/niosh/topics/hierarchy/default.html (Last accessed 22 Oct 24).

OECD, Stemming the Superbug Tide: Just A Few Dollars More *OECD iLibrary*. 2018, Available here: https://www.oecd-ilibrary.org/social-issues-migration-health/stemming-the-superbug-tide_9789264307599-en (Last accessed 22 Oct 24).

Design thinking in cancer care: a literature review

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Introduction

Design thinking, characterised by its human-centric philosophy, has garnered attention in healthcare for its problem-solving methodology (Altman et al., 2018). Understanding the profound impact that certain conditions, such as cancer, have on individuals and their communities is crucial. The impact of cancer diagnosis and treatment extends beyond patients to include their surrounding communities (Thomas & Porter, 2023). Integrating design thinking into cancer-related approaches holds promise for significantly improving the well-being of both patients and their communities. This review aims to investigate the application and perception of design thinking in cancer care.

Methods

Research articles published up to January 2018 were identified from online databases (PubMed Central, Scopus, and Medline) using keywords such as 'cancer', 'cancer care', 'oncology', 'design thinking', and 'design science'. The inclusion criteria included articles published in peer-reviewed journals, written in English, and addressing the application of design thinking in cancer and/or cancer care. Data collection involved recording the study location, focus (design thinking or cancer care), targeted condition, intervention, and study objectives. Thematic analysis was conducted to discern recurring themes across the studies.

Results and Discussion

A total of twenty studies were included out of one hundred and sixty records identified, with eleven concentrating on cancer care (comprising five patient-facing, five community-facing, and one provider-facing studies), and nine on design thinking (including five patient-facing, one community-facing, and three provider-facing studies). Overall, seven overarching themes were identified, with several subthemes emerging within each.

The findings, alongside the identification of seven themes (user-centred care, digital solutions, cultural sensitivity, operational efficiency, educational approaches, access to care, long-term survivorship and care) (Michalec et al., 2018; Tonetto et al., 2021), indicate that design thinking enables collaborative and innovative approaches vital for tackling the multifaceted challenges of cancer care. However, there remains a gap in design thinking research regarding the long-term evaluation of solutions in cancer care. Additionally, there is a necessity for the adoption of a mixed methods approach in future studies to cultivate more robust evidence.

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References

Altman, M., Huang, T. T. K., & Breland, J. Y. Design thinking in health care. 2018, *Preventing Chronic Disease*, *15*(9). https://doi.org/10.5888/pcd15.180128.

Michalec, S., Dickinson, J. I., Sullivan, K., Machac, K., & Cline, H. Cancer Treatment Facilities: Using Design Thinking to Examine Anxiety and the Patient Experience. 2018, *Journal of Interior Design*, *43*(4), 3–20. https://doi.org/10.1111/joid.12133.

Thomas, A. G., & Porter, A. B. Promoting Inclusive Cancer Care: Beyond Medical Interpreters. 2023, *Oncologist*, *28*(12), e1131–e1133. https://doi.org/10.1093/oncolo/oyad290.

Tonetto, L. M., da Rosa, V. M., Brust-Renck, P., Denham, M., da Rosa, P. M., Zimring, C., Albanti, I., & Lehmann, L. Playful strategies to foster the well-being of paediatric cancer patients in the Brazilian Unified Health System: a design thinking approach. 2021, *BMC Health Services Research*, *21*(1). https://doi.org/10.1186/s12913-021-07018-7.

Optimisation and usability assessment of the venous thromboembolism (VTE) support solution within an electronic patient record (EPR)

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Background

Review of clotting risk, known as Venous Thromboembolism (VTE), is mandatory on admission in an inpatient hospital setting. The doctor has to then make a decision on the requirement for preventative treatment based on the outcome of the risk assessment. Standard configuration within the Electronic Patient Record (EPR) is used to support prescribers which includes alerts to prompt completion of the assessment and a VTE risk review tool for assessing risk. Results of an audit on the various supportive alerts/tools highlighted their limitations which included the high alert burden, misalignment of the alert triggering, and the prescriber's workflow when admitting a patient and poor usability of the risk assessment tool on EPR. Real-world data from the audit directly informed the customisations required to optimise the support provided to prescribers. Assessing usability was identified as a way of comparing the EPR supportive configuration pre and post customisation.

Methods

The configuration was re-designed in collaboration with multiple disciplines using an agile development approach based on user feedback from 20 design workshops. The System Usability Scale (SUS) survey consisting of 10 questions was used to assess usability.

Results

Modifications to the design included redesign of alerts to reduce volume and to present at a more appropriate time in the patient journey and re-design of the risk assessment documentation tool to increase usability and readability. Nineteen intern's pre-update and twenty-six intern's post-update completed the survey, with overall usability scores of 60.4% and 63.3% respectively.

Table 1: Likert Scale Results (1 (strongly disagree) to 5 (strongly agree)) of SUS Survey

Question	Pre	Post
I think that I would like to use the VTE Component of EPR frequently	3.2	3.3
I found the VTE Component of EPR unnecessarily complex	3.4	2.8
I thought the VTE Component of EPR was easy to use	3	3
I think that I would need the support of a technical person to be able to use the VTE Component of EPR	4.3	4.5
I found the various functions of the VTE Component of EPR were well integrated	3	3.4
I thought there was too much inconsistency in the VTE Component of EPR	3.7	3.6
I would imagine that most people would learn to use the VTE Component of EPR very quickly	4	4
I found the VTE Component of EPR very cumbersome to use	2.5	2.6
I felt confident using the VTE Component of EPR	3.2	3.8
I needed to learn a lot of things before I could get going with the VTE Component of EPR	3.8	4

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Conclusion

The results demonstrate only a slight improvement in usability. The minimal difference could be explained by the anecdotal evidence from the survey, and a known limitation of the EPR, that forces users to override the supportive alerts as they cannot view details within the patients record when completing the assessment. This study highlights the need for further exploration into technical workarounds to improve usability.

Acknowledgements

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Personality traits and practitioners' safety attitudes/behaviours: a relationship to be examined under the light of safety in healthcare

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Introduction/Background

Ensuring safety in healthcare remains a paramount global priority, and additional investigation into the role of safety attitudes is necessary (Chatzi & Malliarou, 2023). This scoping review is based on the findings of a study (Kil et al., 2024) , which examined the relationship between personality traits and safety attitudes/behaviours, focusing on the healthcare sector.

Methods

A scoping review was conducted on the following electronic databases: APA PsycINFO, APA PsyARTICLES, CINAHL, Scopus, and Web of Science, with additional searches in reference lists. Articles between 2001 and July 2023, from all industries, were included, as the aim was to identify the relevant articles within healthcare in comparison to other industries. 7,640 articles were initially identified. Following automated and manual duplication removal, articles were screened based on titles, abstracts, and full texts (Figure 1).

Results

This review encompassed 60 studies, with only two focused on the healthcare sector. Studies were divided into two main categories: Driving/Traffic and Industrial safety. The predominant personality traits identified were agreeableness, conscientiousness, extraversion, normlessness, neuroticism, sensation-seeking, and openness, exhibiting both positive and negative relationships between personality traits and safety attitudes/behaviours. Some studies used "Safety attitudes" and "Safety behaviours" interchangeably. Age and gender emerged as the most identified demographic factors associated with safety attitudes/behaviours.

Discussion/Conclusions

Both positive and negative correlations between specific personality traits and workplace and/or road safety were identified, with main issues including inconsistent terminology use regarding attitudes/behaviours and inconclusive results for certain personality traits, potentially hindering the accurate generalisation of findings across various fields of practice/industry. Therefore, further studies should examine and utilise safety attitudes and behaviours separately. Additionally, healthcare should continue to study the relationship between personality traits and safety attitudes by following other highly regulated industry examples to enhance patient safety.

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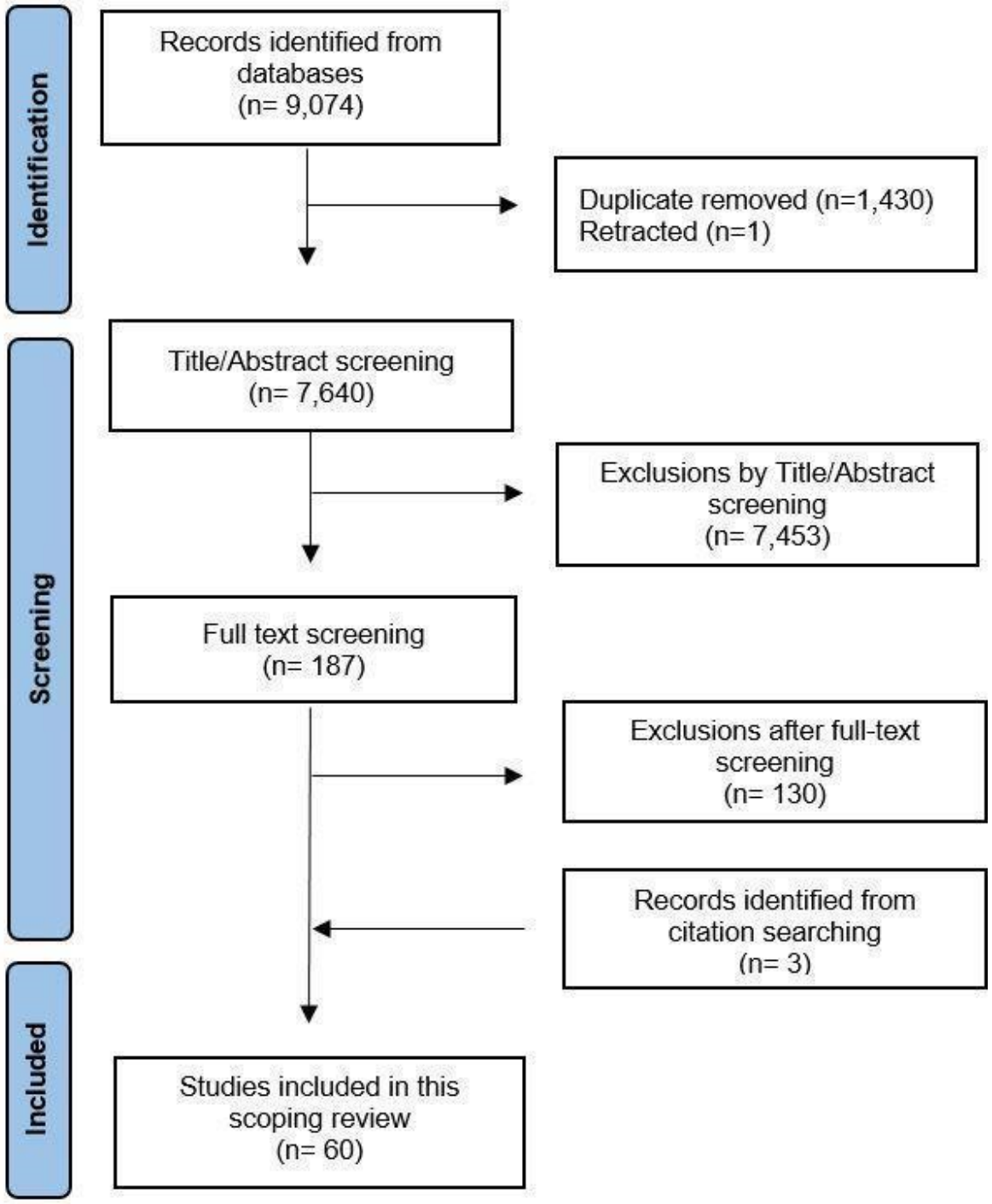

Figure 1. PRISMA-ScR Flowchart (Tricco et al., 2018)

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The authors would like to acknowledge the librarian at the University of Limerick, Liz Dore, for her assistance with the search strategy development.

References

Chatzi, A. V., & Malliarou, M. 2023. The need for a nursing specific patient safety definition, a viewpoint paper. *International journal of health governance.*, ***28***(2), 108-116. https://doi.org/10.1108/IJHG-12-2022-0110

Kil, Y., Graham, M., & Chatzi, A. V. 2024. Examination of personality types as predictors of safety attitudes/behaviours, in support of enhancing safety in healthcare: a scoping review. *International Journal of Health Governance*, ***ahead-of-print***(ahead-of-print). https://doi.org/10.1108/IJHG-06-2024-0075

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D., Horsley, T., & Weeks, L. 2018. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*, ***169***(7), 467-473. https://doi.org/10.1186/s12874-016-0116-4

Understanding user needs for a mobile health record app: enhancing inclusion health services for trauma-informed and integrated care

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Introduction

Social exclusion is connected to healthcare issues in Ireland and globally (O'Donnell et al., 2018). Similarly, the fragmentation of healthcare systems worldwide is related to suboptimal medical care (Siersbaek et al., 2023). This situation particularly impacts persons with lived experiences of social exclusion, like those undergoing Opioid Substitution Treatment (OST) (Delargy et al., 2019). This PhD research seeks to understand the needs of patients, staff, and Inclusion Health Service in a large acute teaching hospital, and in conjunction with community-based services, to develop a set of end-user requirements for a mobile health record app for supporting integrated care continuity across time and space. The OST is used as a case study to demonstrate the complexity and necessity of developing the set of end-user requirements for the mobile health record app. The research intends to take a Human Factors Ergonomics (HFE) and Trauma-Informed Care (TIC) approaches to address the needs of all stakeholders involved.

Method

The research plans to use a concurrent mixed-methods approach in four phases. It commences with a Systematic Literature Review (SLR) with Realist Lens with a focus on mobile health record apps for individuals facing social exclusion. This phase will be enriched by an analysis of de-identified OST-related incidents review reports and engaging with healthcare professionals at a large acute teaching hospital in Ireland. Phase two will map out current practices through semi-structured interviews with healthcare professionals to comprehend the patient journey. This phase will also involve semi-structured interviews with patients to capture their lived experiences to inform further the design of the journey of a patient on OST. This will be followed by Focus Groups with patients and healthcare professionals to refine it. Phase three will involve semi-structured interviews with healthcare professionals to understand their experiences with a mobile health record app. This phase will also involve semi-structured interviews with patients who have subscribed to the app to capture their lived experiences and further inform the development of a set of end-user requirements. Phase four will involve an anonymised online survey with healthcare professionals and semi-structured interviews with patients to gather their insights regarding their end-user needs for a mobile health record app that can be designed to meet the needs for persons experiencing social exclusion. This phase will also involve conducting Focus Groups with patients and healthcare professionals to refine preliminary findings.

Discussion and Conclusions

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The research holds the potential to improve patient and staff safety and wellbeing, and system performance. This study also aims to enhance care coordination and promote integrated care. It is expected that results will aid hospitals in delivering accessible healthcare for persons experiencing social exclusion.

References

Delargy, I., Crowley, D., & Van Hout, M. C. (2019). Twenty years of the methadone treatment protocol in Ireland: reflections on the role of general practice. *Harm Reduct J*, *16*(1), 5. https://doi.org/10.1186/s12954-018-0272-4

O'Donnell, P., O'Donovan, D., & Elmusharaf, K. (2018). Measuring social exclusion in healthcare settings: a scoping review. *Int J Equity Health*, *17*(1), 15. https://doi.org/10.1186/s12939-018-0732-1

Siersbaek, R., Ford, J., Ní Cheallaigh, C., Thomas, S., & Burke, S. (2023). How do health system factors (funding and performance) impact on access to healthcare for populations experiencing homelessness: a realist evaluation. *International Journal for Equity in Health*, *22*(1). https://doi.org/10.1186/s12939-023-02029-8

Perceptions of Human Factors and Patient Safety in undergraduate healthcare education: a multidisciplinary perspective

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Background

Adoption of Human Factors (HF) principles to healthcare can help to jointly optimise work systems performance and human wellbeing. A recent systematic review identified a lack of formal patient safety (PS) and HF education in undergraduate healthcare curricula (Sheehan et al., 2022). This qualitative study aimed to explore staff and student perceptions relating to HF and PS undergraduate education at an Irish university.

Methods

Sampling was purposive and included faculty and undergraduate senior cycle students from the disciplines of medicine and pharmacy. Semi-structured interviews were conducted with faculty members from a school of pharmacy (n=7) and a school of medicine (n=4). Uni-professional focus groups (n=5) were conducted with students (n=10 pharmacy students; n=7 medical students). Data were analysed using reflexive thematic analysis (Braun and Clarke, 2021). Ethical approval was obtained in advance of conducting the study.

Results

The following six overarching themes were identified from the thematic analysis:

1. Conceptualising PS and HF
2. Attitudes to risk and error
3. Culture and professional identity
4. Curriculum factors impacting PS learning
5. Impact of clinical environment on PS learning
6. Connection between the academic and clinical environment

A mind-map illustrating themes and sub-themes is presented in **Figure 1.**

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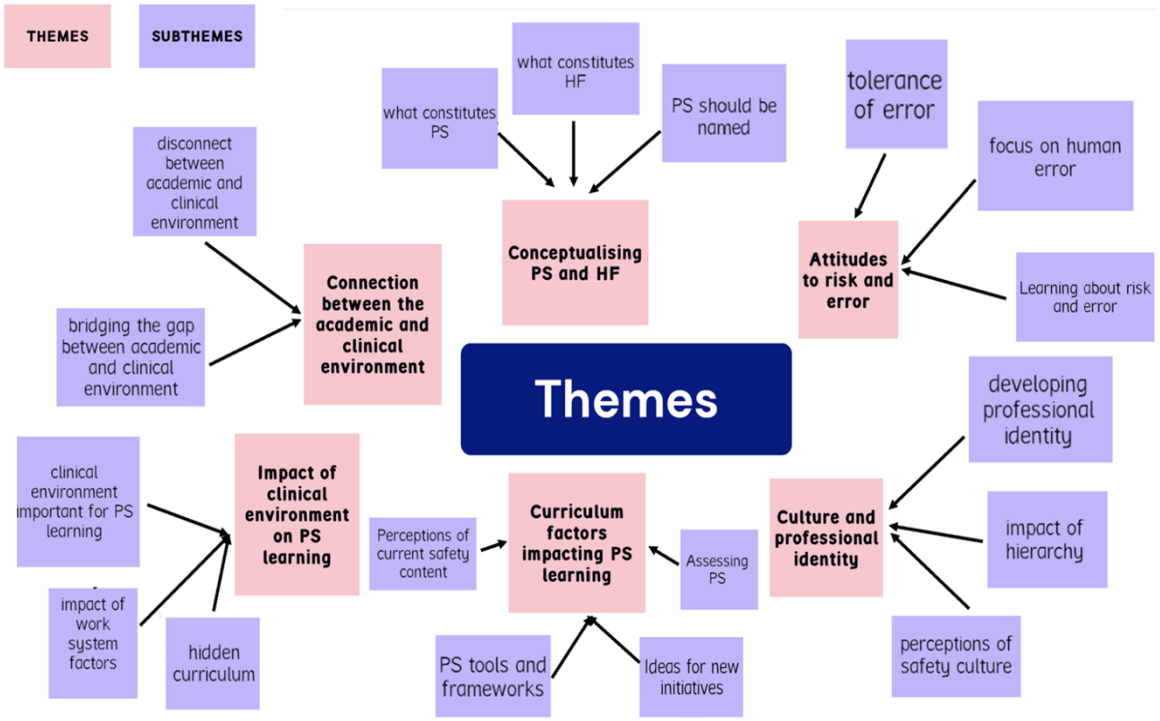

Figure 1. Themes and Sub-themes

Discussion

Participants considered HF to be important for PS education but there was a lack of shared understanding around its meaning. Variation in understanding of what constitutes HF has been well described in the literature (Catchpole et al. 2021). There is a lack of robust competency frameworks underpinning PS and HF content (Sheehan et al., 2022). Findings indicate that much PS learning is implicit and occurs while students are on clinical placement. A perceived disconnect between the academic and clinical environments was a recurring theme. Interprofessional education and simulation were identified as platforms which may help bridge this gap.

Conclusion

This study demonstrates gaps relating to HF/PS teaching in undergraduate medicine and pharmacy education in an Irish context. Increased synergy between the academic and clinical environments may help optimise PS/HF learning.

References

Braun, V. & Clarke, V., 2021, Conceptual and Design Thinking for Thematic Analysis. *Qualitative Psychology* **9**, 3-26. https://doi.org:10.1037/qup0000196

Catchpole, K., Bowie, P., Fouquet, S., Rivera, J. & Hignett, S., 2021, Frontiers in human factors: Embedding specialists in multi-disciplinary efforts to improve healthcare. *International Journal for Quality in Health Care* **33**, 13-18 (2021). https://doi.org:10.1093/intqhc/mzaa108

Sheehan, P., Joy, A., Fleming, A., Vosper, H. & McCarthy, S., 2022, Human factors and patient safety in undergraduate healthcare education: a systematic review. *Human Factors in Healthcare*, 100019. https://doi.org:https://doi.org/10.1016/j.hfh.2022.100019

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Translational simulation for trauma-informed care (TS4TIC): introducing trauma informed care through healthcare simulation

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Abstract

Translational Simulation (TS) for Trauma Informed Care (TIC), (Vallières et al., 2023) is a novel application of translational simulation (Brazil, 2017) that aims to introduce healthcare professionals (HCPs) to the principles of TIC, name existing practice that aligns with those principles and diagnose barriers within the organisation that impede the implementation of TIC. Trauma-informed care (TIC) is an approach that seeks to support healthcare organisations to care that is sensitive to any past trauma and ensure that the process of care delivery does not re-traumatise patients.

Methodology

This study took place in a large acute teaching hospital. HCPs asked to take part in simulation scenarios where volunteers would interact with an actor playing a patient who was experiencing a trauma response. These scenarios were co-designed by socially excluded people, HCPs, and an actor who is a member of the Travelling community and members of the research team. After taking part in/witnessing the scenario, HCPs were asked to discuss the scenario and whether the practice aligned with trauma informed principles.

Results

Seventeen simulations involving 173 HCPs were held in the hospital. De-briefs took place after simulations with all HCPs who took part and HCPs reported finding TS a useful way of learning about TIC, particularly those HCPs who were not often exposed to simulation, and requested that more TIC simulations be held. HCPs noted that simulation was effective in eliciting an emotional reaction from them, and also noted a number of barriers to providing TIC within the hospital.

Discussion

TS4TIC is a promising form of TS that HCPs enjoy taking part in. It is effective in providing a safe and controlled environment for HCPs to learn about and understand TIC. However, without regular simulations, the benefits that HCPs have reaped may decline over time, which HCPs themselves recognise. TS4TIC also provides a forum for HCPs to recognise relationship-building as a clinical skill and to discuss systemic barriers of providing TIC in a large acute hospital.

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We would like to acknowledge the contribution of all the healthcare professionals who participated in the pilot simulations of TS4TIC, the actors who brought life and realism to the simulations, those with lived experience of discrimination and social exclusion who helped us in co-designing the scenarios, and the members of our steering committee who contributed to the conceptualisation of TS4TIC along the way.

References

Brazil, V. Translational simulation: not 'where?'but 'why?'A functional view of in situ simulation. *Advances in Simulation*, 2017. *2*(1), 1-5.

Vallières, F., Ward, M., Shields, D., Geary, U., Gardner, C., King, D., McCarthy, G., Conolly, J., Brown, J., Wiedemann, N., Staunton, P., Halpin, R., McGinty, T., Brazil, V., Ali, A., Buckley, A., Dowds, J., Lambert, S., McGarry, S., . . . Ní Cheallaigh, C. Co-developing, piloting, and evaluating a translational simulation (TS) delivery model for the promotion of psychological trauma-informed care (TIC) to improve service delivery within acute hospital settings: A Research Protocol [version 1; peer review: 1 approved, 1 approved with reservations]. *HRB Open Research*, *2023. 6*(27). https://doi.org/10.12688/hrbopenres.13727.1

Should we escalate? barriers and enablers to deteriorating patient escalation by staff in Ireland: early findings

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Introduction

The Irish National Early Warning System (INEWS) V.2 was launched in 2020. Anecdotal evidence suggests staff 'Fail To Escalate' (FTE) care despite the patient's Early Warning Score indicating they should. This FTE increases the likelihood of Failure To Rescue (FTR): failure to deliver the interventions needed to mitigate patient deterioration (Jones *et al.*, 2011). Contributors to FTE and FTR are often influenced by and related to human factors (Chadwick, 2014). Evidence of inconsistencies exist in how nurses and junior physicians recognise and escalate patient deterioration. In order to address ways of improving patient care, it was considered essential to identify barriers and enablers to deteriorating patient escalation.

Methods

Following a literature review, a focus group protocol was developed to identify factors contributing to FTE and elicit local experiences, while also identifying enablers that improve escalation of care. Three focus groups were replicated in two different hospitals (Site 1 & Site 2) - one each with nurses, junior doctors and registrars – totalling six. Thematic analysis of the focus group discussions was based on the findings from the literature review (Burke and Conway, 2023, O'Neill et al, 2021, Petersen et al, 2017).

Results

Focus group discussions differed significantly by site, predominantly driven by organisational factors, i.e. whether the physician teams were geographically oriented to 'home wards' or not and some process factors. Six main themes emerged as both barriers and enablers to escalating care for deteriorating patients: governance, communication, teamwork, professional boundaries, escalation and clinical experience. Summary early findings are presented in Table 1.

Table 1. Summary early findings

	Site 1	Site 2
Governance - Home based wards	On home based surgical wards, staff come directly to speak, but on the medical wards you don't have a home.	Reduced concerns about escalating care as staff are more familial in home wards.
Communication	Dependence on indirect and inefficient communication processes	Efficient in-person ward based communication

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Using ISBAR communication	Reliance on the INEWS score with little additional context about patient	Informative and efficient ISBAR updates, with patient familiarity and context
Communication using bleeps	Frustration from ward staff that registrars do not carry their pagers/bleeps	Less reliance on pagers/bleeps and staff more consistently carry them
Teamwork	A need for frequent introductions to 'team' members	Familiarity and consistency with colleagues

Discussion and Conclusion

Evidence suggests that geographic colocation of physician teams with their patients could significantly reduce factors contributing to FTE and FTR. The emergence of home wards as an enabler to escalation in this research is considered to be tightly coupled to other enablers such as communication and teamwork. Further research is required to establish the prevalence of the barriers and enablers to escalation within the broader health system.

References

Chadwick, L., 2014. Human factors considerations for the new 'national early warning score' system. *In* E.F. Fallon & L.W. O'Sullivan (eds.) *Irish Ergonomics Society Annual Conference 2014*. NUI Galway: Irish Ergonomics Society.

Jones, D.A., Devita, M.A. & Bellomo, R., 2011. Rapid-Response Teams. *New England Journal of Medicine,* 365**,** 139-146.

Burke, C. & Conway, Y. 2023. Factors that influence hospital nurses' escalation of patient care in response to their early warning score: A qualitative evidence synthesis. *Journal of Clinical Nursing (John Wiley & Sons, Inc.),* 32**,** 1885-1934.

O'Neill S. M., Clyne, B., Bell, M., Casey, A., Leen, B., Smith, S. M., Ryan, M. & O'Neill, M. 2021. Why do healthcare professionals fail to escalate as per the early warning system (EWS) protocol? A qualitative evidence synthesis of the barriers and facilitators of escalation. *BMC Emergency Medicine,* 21**,** 1-19.

Petersen, J. A., Rasmussen, L. S. & Rydahl-Hansen, S. 2017. Barriers and facilitating factors related to use of early warning score among acute care nurses: a qualitative study. *BMC Emerg Med,* 17**,** 36.

Research papers

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A socio-technical systems approach to understand medical device acquisition and inform improvements

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Abstract

Hospitals consume thousands of different individual products, some being medical devices, others being non-medical supplies, and these products are put into use at the end of complex internal chains of management processes. Only medical devices with a Conformité Européenne mark indicating that the device conforms to the appropriate requirements regarding its manufacturing, labelling, performance and safety, are legally allowed to be marketed in the EU. This study involved setting up a project team, conducting interviews with healthcare professionals, and mapping the pathways through which medical devices are acquired in a large hospital. A socio-technical systems (STS) approach was adopted to understand the current end-to-end processes of acquiring medical devices with CE marking. The study found that the acquisition process is complex and involves many healthcare professionals in different roles. Recommendations included the need to provide education and training to healthcare professionals, and to implement a data governance project to collect data fields for each medical device and its storage.

Introduction

In the European Union (EU), there is a precise and detailed legal definition of what constitutes a medical device. Broadly, a medical device can be considered to be a device intended to be used for a diagnostic or therapeutic purpose. In practice, this encompasses a very broad range of products, from large scale equipment (e.g., ventilators, CT machines), to high volume consumables (e.g., catheters, sutures), to implantable devices (e.g., pacemakers, hip replacements).

The placement of medical devices on the market is regulated by the Medical Devices Regulations (MDR). Each EU member state has a designated 'Competent Authority' which acts as the national regulator for medical devices, in Ireland this is the Health Products Regulatory Authority (HPRA). Only medical devices with a Conformité Européenne (CE) mark indicating that the device conforms to the appropriate requirements regarding its manufacturing, labelling, performance and safety, are legally allowed to be marketed in the EU (European Union, 2024). The system is risk based, with CE marking of higher risk devices requiring more intensive oversight, including involvement of independent and regulated 'Notified Bodies'. Other than for some very specific exemptions, no device can be legally used in the EU as a medical device without being CE marked as a medical device. Hospitals consume thousands of different individual products, some being medical devices, others being non-medical supplies, and these products are put into use at the end of complex internal chains of management processes. Given this complexity, there is a least a theoretical risk that a device without a medical device CE mark could be inadvertently placed into use as a medical device. Following the National Patient Safety Alert released by the Health Services Executive (HSE) in 2023, regarding the CE marking of medical devices, it was decided to review processes by which medical devices come into use in a large acute teaching hospital.

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Given the complexity of the system, a socio-technical systems (STS) perspective was adopted to understand the current end-to-end processes of acquiring medical devices with CE marking and to inform improvements. Applying STS theory described by Carayon et al., (2011) as "adopting a systems approach aimed at identifying multiple system elements, their interactions and their impact on the quality of care, as well as understanding the key adaptive role of people in the system" has shown benefits in healthcare (e.g., Hignett et al., 2013). The term STS was coined by Trist and Bamforth in the Tavistock Institute in London in the 1950s and later taken up by Klein and Eason to recognise the interaction between technical and social factors in organisations (Trist and Bamforth, 1951; Klein and Eason, 1991). When trying to change a system STS would stress the need to consider the technical and social factors and the impact of the change on other aspects of the system (Hendrick, 1991). An STS framework called the Cube is used here. The Cube explores four domains of a STS; culture (shared understanding of the STS); system functioning (how the system actually works); action (how people act within the system and measure those actions) and sensemaking (how people make sense of the system) to allow an in-depth analysis of a system at different levels. These dimensions of the Cube are further broken down in terms of four types of relations: goals (linked to objectives and outcomes), process (sequential relations), social relations (reciprocal relations of working with and reporting to, including dimensions such as trust), and information and knowledge (exchanges of meaning that link people and processes) (McDonald et al., 2021). The Cube framework for STSA, has been developed over a number of years in aviation safety and more recently been used in healthcare STSA (Geary et al., 2022; Prescott et al., 2022; Ward et al., 2022; McDonald et al., 2021; Ward et al., 2010).

Methods

Study Context

The study took place in a large acute teaching hospital with over 1,000 beds and over 5,000 full time staff working across a 52-acre campus. The hospital has a Medical Physics and Bioengineering (MPBE) Department which provides scientific and technical support to clinical users and hospital management and looks after all of the hospital's medical and imaging equipment. The hospital has a Quality and Safety Improvement Directorate (QSID) where staff manage quality and patient safety (QPS) and have expertise in Human Factors Ergonomics and Health Systems Research. A small project team was created consisting of the authors who are members of MPBE and QSID, under the guidance of the hospital's Medical Device Management Committee. Medical devices present risks, the management of which require expert input from clinical, scientific, business, QPS and technical domains. The purpose of the Medical Device Management Committee is to bring together this expertise and to drive and oversee the development, implementation and continuous improvement of the structures and processes required to ensure that the risk management of medical device sits within a single oversight framework.

Participation in this study was on a voluntary basis. No personal data was collected from participants. All participants in the study were adults and were in a position to give their own informed consent. The hospital's Research and Innovation (R&I) office approved the study (Ref: 8965). The study was carried out in accordance with the hospital's guidelines and regulations for undertaking service evaluation and improvement projects.

Data Collection

The study involved conducting interviews with key healthcare professionals (HCPs) who were identified by the Medical Device Management Committee members as HCPs who are directly involved in procuring, requisitioning, purchasing, and using medical devices. Thus, initially, the individuals were selected for the study using purposive sampling. However, as the interviews progressed, the study broadened to include HCPs suggested by interviewees as people who could make further contributions to the project, on the basis of their roles and domain knowledge. In total 11 interviews were conducted with HCPs from procurement, pharmacy, theatre nursing staff, surgeons and buyers. The interviews consisted of systematically working through each stage of the process from the participant's perspective. Three authors carried out the interviews in pairs (CZ, MEW, GB).

All known pathways through which medical devices are put into use in the hospital were mapped out using "swim lane" maps to take account of various stakeholders and their roles within the process, with a view to determining where CE marking is, or could be, confirmed. The swim lanes, or rows in the process map, identify the individuals and partners involved and which process steps each would perform (Damelio, 2019). Swim lane diagrams are an effective approach for mapping complex processes in healthcare (O'Leary et al., 2023). Swim lane maps of the processes used to acquire new devices were drafted based on multiple interviews. The draft maps were checked with interviewees before completion where possible.

Socio-technical Systems Analysis

Given the complexity of the pathways studied, the Cube framework was used retrospectively to inform our analysis of the data gathered through the mapping exercise (figure 1). Two authors summarised the findings from the interviews and used the Cube questions shown in table 1 as a first analysis (CZ, MEW). The initial findings from the first analysis were supplemented by information gathered from site visit observations and the review/reading of documents where applicable. Two further authors reviewed the analysis and made further suggestions (GB and UG). Figure 1 below gives an oversight into the areas of the Cube and some high-level questions which inform the Cube analysis are presented in table 1.

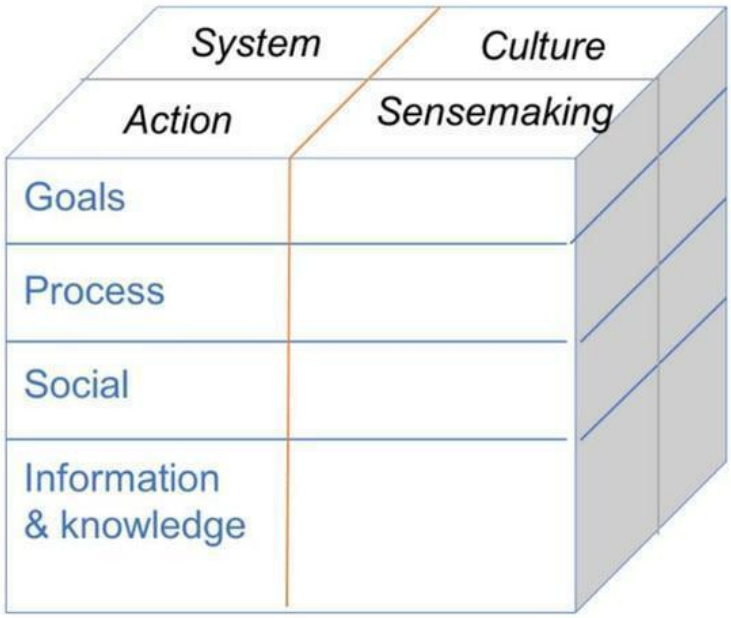

Figure 1: Pictorial representation of the CUBE (McDonald et al., 2021)

Table 1: High level questions to inform the Cube analysis

	Culture	**Functioning System**	**Action**	**Sensemaking**
Goals	What are the cultural values of people working in the organisation?	What are the system goals?	What are the key outcomes of how work is currently done and how are they measured?	What are the goals of key stakeholders and what is people's understanding of these goals?

Process	What are the norms of behaviour and everyday practice?	What are the key tasks and activities, and how effective is the current sequence?	What data and indicators are used to assess performance?	Do people understand the process and know if it is good or not?
Social Relations	Do different professional groups/ subcultures work together and if so which?	What are the key roles and relationships (working with, reporting to)?	Do people collaborate and how are roles and relationships documented and assessed?	How do people perceive the collaboration and relationships at work and what is people's perception of leadership at work?
Information and knowledge	Is there a shared understanding of what to do and how the system works?	Describe the flow of information that links people to their activity.	How is the data, information and knowledge shared in practice and how is that sharing measured?	What do people think of the flow of data, information and knowledge and does the flow inform their actions (i.e. are they getting the right information to inform them to make good decisions)?

Results

The results of the analysis are described here along the four dimensions of culture, functioning system, action and sensemaking.

Culture

There was a strong culture of patient safety evident in interviews with all HCPs who were concerned that patient safety was considered at all stages in the process. The HCPs interviewed were focused ultimately on the goal of obtaining devices that were safe for patient use. It became evident that the system that has evolved around medical device acquisition in the hospital is complex with a large organisational and administrative burden, across many organisational functions in the hospital including clinical staff, procurement, facilities, supply chain, logistics, business and operational managers, buyers etc. who must all work together to acquire medical devices. The HCPs had an understanding of their own role in the process but not all were familiar with the role of others or with all of the regulations and policies related to medical devices.

Functioning system

While health institutions are not explicitly required under the MDR to have processes in place to confirm that devices used as medical devices are in fact CE-marked as medical devices, it is considered good practice. Nine different device pathways to use were identified in this study. In general, the system was found to have explicit and documented checks on CE marking as part of the tender process. In practice, application of the Cube methodology to the specific and narrow question of CE marking resulted in a comprehensive and detailed exposition of 'to use' device pathways, leading to much more general observations than might have been expected. For example, the pathways through which a medical device is first considered, then chosen, then ordered and finally brought in use rely on many HCPs that are based across different units, who have different perspectives on the process. Various

professional groups must work together across the process and it can be difficult to visualise the entire end-to-end pathway. It was found that the main flow of information linking people is via email or phone or different hospital IT systems. Not all data and information, however, flows through the system to all users and the study uncovered a wealth of knowledge about the system from the perspectives of the various HCPs interviewed.

An unexpected outcome of the application of the 'information/knowledge' aspect of the Cube analysis was the identification of additional data fields, unrelated to CE marking, the capture of which would facilitate the overall goals of the process. For example, explicitly recording which devices require patient 'implant cards' was identified as potentially beneficial to the efficient management of implantable medical devices, and was flagged for consideration as a process improvement.

Action

The ultimate outcome of the system is to obtain and safely procure a medical device and place it in use, through one pathway or another. Data, information and knowledge are shared in practice via email or phone or through different hospital IT systems. Sharing is not measured. There were data gathering and analysis barriers at different stages of the process that made it difficult to have end-to-end measurement of how well the various pathways were functioning. We found no data or indicators that can be used to assess and evaluate the performance of the pathways as a whole and thus the effectiveness of the system. HCPs collaborated well during the process however it was evident that in some parts of the process e.g., where approval points were embedded in relation to cost and decisions on release of devices, there was a need for regular updating of the staff involved on the status of each step.

Sensemaking

The medical device regulations have changed recently (European Commission, 2023) and not all HCPs were aware of these changes along with the revised definitions of medical devices (which include but are not limited to the products that do not have a medical purpose and the introduction of unique device identifiers to enhance traceability). It was not widely understood that the definition extends beyond equipment to consumables devices. While all HCPs interviewed were aware of their role in the process not everyone had a full perspective on of the roles of other HCPs in the process particularly in relation to checking for CE marking. Some of the HCPs noted that the flow of data, information and knowledge could be improved in particular in relation to alerts on the status of a newly requested device. The current flow does not inform their actions with regard to CE marking as HCPs require clarity and visibility of various processes and access to relevant guidelines.

Discussion

The process of medical device acquisition is important in a healthcare system as it comprises various phases and serves to protect patient safety. We applied a STS approach to study the complex pathway of medical device acquisition and have shown that the Cube framework is an effective method for analysing this data. This study has allowed us to identify a wide range of HCPs, and key roles, involved in the medical device acquisition process, which was not clear previously. Interestingly, HCPs responsible for specific steps in the process did not have visibility of the entire process, or an appreciation of the roles of others in these steps.

This characteristic of medical device purchasing systems was also identified in a previous study (Hinrichs et al., 2013). Similarly, users had low visibility of the progression of devices along the pathway from initial request to final placement, e.g., if and where a device request was 'stuck' awaiting approval. Process improvements supported by information technology (IT) would likely improve overall visibility of the process and assist HCPs to carry out their daily work more efficiently, e.g., through electronic alerts such as flagging work to review. Having HCPs work together and collaborate in addition to the effective use of resources hastens the process and potentially mitigates risks to patient safety (Hinrichs et al., 2013).

Recommendations arising from this study will inform the work of the Medical Device Management Committee and will inform its policies, protocols and guidelines. These recommendations have mostly arisen out of the 'action' and 'sensemaking' parts dimensions of the Cube including. The first relates to data governance and the second to education and training. Recommendations are (A) to implement a project to agree which data fields along with CE marking are to be collected for each medical device, at which points(s) in the acquisition process this data is to be collected and where this information should be stored and (B) to develop education and training resources for HCPs in relation to medical device regulations covering the definition, the legal requirements placed on the hospital as a 'health institution', knowledge of CE marking etc. The implementation of these recommendations is currently in the planning phases.

While this study adopted a whole system approach with different HCPs of varying backgrounds involved, given the complexity of the system, it still may not have been possible to capture all details. The study opened lines of communication and provided opportunities for staff to meet and discuss the process thus also impacting the 'social' elements of the system. It also provided insights and enabled diagrammatic representation of the process that facilitates stakeholder engagement, management and governance oversight.

Conclusions

This study has shown the benefit of taking a STS approach to understanding the current system in order to inform improvements. This STS informed understanding can feed into the design of systems to ensure patient safety is prioritised at all phases of medical devices acquisition.

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References

Carayon, P., Bass, E. J., Bellandi, T., Gurses, A. P., Hallbeck, M. S., and Mollo, V., 2011, *Sociotechnical systems analysis in health care: A research agenda*, IIE Transactions on Healthcare Systems Engineering, 1(3), 145–160.
Damelio, R., 2019, *The Basics of Process Mapping, Second edition*, Productivity Press, New York.

European Commission, 2023. *Medical Devices Regulation*. Regulation (EU) 2023/607 of the European Parliament and of the Council of 15 March 2023 amending Regulations (EU) 2017/745 and (EU) 2017/746 as regards the transitional provisions for certain medical devices and in vitro diagnostic medical devices.

European Union, 2024, *CE marking – obtaining the certificate, EU requirements*, Your Europe, https://europa.eu/youreurope/business/product-requirements/labels-markings/ce-marking/index_en.htm

Geary, U., Ward, M. E., Callan, V., McDonald, N., and Corrigan, S., 2022, *A socio-technical systems analysis of the application of RFID-enabled technology to the transport of precious laboratory samples in a large acute teaching hospital*, Applied Ergonomics, 102, 103759.

Hendrick H. W., 1991, Ergonomics in Organizational Design and Management, Ergonomics, 34(6):743–756.

Hinrichs, S., Dickerson, T., and Clarkson, J.,2013,, *Stakeholder Challenges in Purchasing Medical Devices for Patient Safety*, Journal of Patient Safety, 9(1), 36–43.
Klein, L. and Eason, K., 1991, *Putting social science to work: the ground between theory and use explored through case studies in organisations*, Cambridge University Press, Cambridge, UK.

McDonald, N., McKenna, L., Vining, R., Doyle, B., Liang, J., Ward, M. E., Ulfvengren, P., Geary, U., Guilfoyle, J., Shuhaiber, A., Hernandez, J., Fogarty, M., Healy, U., Tallon, C., and Brennan, R, 2021, *Evaluation of an Access-Risk-Knowledge (ARK) Platform for Governance of Risk and Change in Complex Socio-Technical Systems*, International Journal of Environmental Research and Public Health, 18(23), 12572.

O'Leary, M. C., Hassmiller Lich, K., Reuland, D. S., Brenner, A. T., Moore, A. A., Ratner, S., Birken, S. A., and Wheeler, S. B., 2023, *Optimizing process flow diagrams to guide implementation of a colorectal cancer screening intervention in new settings*, Cancer Causes & Control, 34(S1), 89–98.

Prescott, E., Reynolds, A., Kennedy, C., Kennedy, B., O'Callagan, S., Geary, U., Byrne, D., Flynn, E., Galvin, Ó., Kielty, H., Hughes, G., and Ward, M. E., 2022, *Ward rounds – A socio-technical system informed analysis of the perceptions of intern and senior house office doctors.* Human Factors in Healthcare, 2, 100027.

Trist, E.L., and Bamforth, K.W., 1951, *Some social and psychological consequences of the longwall method of coal-getting*, Human Relations, 4(1), 3–38.

Ward, M. E., Daly, A., McNamara, M., Garvey, S., and Teeling, S. P., 2022, *A Case Study of a Whole System Approach to Improvement in an Acute Hospital Setting*, International Journal of Environmental Research and Public Health, 19(3), 1246.

Ward, M., McDonald, N., Morrison, R., Gaynor, D., and Nugent, T, 2010, *A performance improvement case study in aircraft maintenance and its implications for hazard identification*, Ergonomics, 53(2), 247–267.

Measuring the organisational trust of artificial intelligence systems in healthcare with socio-technical systems analysis methods: a systematic literature review

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Abstract

Introduction: Implementing artificial intelligence (AI) systems in healthcare has only had limited success to date (Kelly et al., 2019). This is due in part to known implementation gaps and a lack of operationalised AI ethical frameworks, creating deployment concerns in high stakes settings like healthcare. However, the European Commission (EU) has provided guidelines for Trustworthy AI (TAI) with seven key requirements. Additionally, a lack of organisational trust in AI is likely another contributing factor. Organisational trust characterises the expectations individuals hold regarding the networks of relationships and behaviours within an organisation, including trust in AI systems. The research question for this study is: to what extent has organisational trust been measured for Trustworthy AI systems in healthcare? **Methods**: A systematic literature review was conducted according to the PRISMA reporting guidelines (Page et al., 2021). The search string identified 316 articles from four relevant databases (PubMed, IEEE, Web of Science, and PsycInfo). After removing irrelevant articles and duplicates only 11 articles were included in the full review. **Results**: Of the 11 articles reviewed, 6 (54%) of them studied the Fairness of an AI system, 4 (36%) were about data governance, and 3 (27%) about transparency and 3 (27%) technical robustness. These represent 4 of the 7 EC requirements for TAI. Four articles used Socio-Technical System Analysis (STSA) to understand the implications of using AI in healthcare, by a method called Z-inspection. **Conclusion**: Our study identified four articles that measured organisational trust with STSA to understand the implications of AI systems in healthcare. To respond to our research question, organisational trust measurement in healthcare was minimal. Addressing all the TAI requirements could lead to greater AI implementation in healthcare systems. However, some of TAI requirements (for example, accountability) should be given more attention as less attention has been paid to them.

Introduction

Implementing artificial intelligence (AI) systems in healthcare has seen limited success (Kelly et al., 2019), which can be attributed to several factors. One significant reason is the gap between ethical principles and the lack of established methods for implementing these ethical frameworks (Bürger et al., 2024; Wolff et al., 2021). One significant set of ethical guidelines has been established by the European Commission for Trustworthy AI (TAI) with seven key requirements: Technical Robustness and Safety, Privacy and Data Governance, Transparency, Diversity, Non-discrimination and Fairness,

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Accountability, and Human Agency and Oversight (High-Level Expert Group on Artificial Intelligence, Ethics Guidelines for Trustworthy, 2019).

Another contributing factor is the lack of organisational trust in AI (Figueroa-Armijos et al., 2023, Roski et al., 2021). Trust becomes important in different contexts, including, information technologies, and decentralised decision-making. Trust within organisations is essential for forming new associations and networks of trusting relationships necessary as an indicator of an organisation's potential for long-term viability (Shockley-Zalabak et al., 2000).

Socio-Technical System Analysis (STSA) ensures a holistic approach to understanding and optimising the interplay between social and technical components within organisations. This approach encompasses activities regarding system design and human relation with systems, including, identifying and engaging key stakeholders to improve organisational trust (McDonald et al., 2021). With use of STSA we can analyse organisations dynamics including trust. STSA therefore provides insights into how and where trust can be influenced by organisational and technological factors (Mumford, 2006; Vining et al., 2022)

This study aims to understand how organisational trust has been measured for trustworthy AI with socio-technical systems analysis methods. Therefore, the research question for this study is: to what extent has organisational trust been measured for Trustworthy AI systems in healthcare?

The rest of this paper is structured as follows: first the methodology based on the PRISMA checklist, then the synthesis of the 11 paper review, and finally conclusions.

Methods

A systematic literature review was conducted according to the PRISMA reporting guideline (Page et al., 2021). The search string used was: ("Artificial intelligence" OR "AI") AND ("measurement" OR "Evaluation" OR "Intervention" OR "Assessment") AND ("Organization" OR "Socio-technical" OR "Social") AND ("trust" OR "trustworthiness" OR "trustworthy" OR "Data trust" OR "Organisational Trust" OR "Trustworthy Artificial Intelligence" OR "trustworthy AI" OR "TAI") AND ("Healthcare"). Our search string identified 316 articles from four relevant databases (PubMed, Web of Science, IEEE, and Psycinfo). After removing the duplicate number of articles (n=41, 13%), 275 (87%) articles were screened based on the title and abstract. Then, only 43 (15%) articles were included in the full review based on our inclusion and exclusion criteria. We included: English articles, from 2010 to 2024, original paper, case study, mixed methodology, review paper, available paper, studies that evaluate human trust in AI. We excluded: non-English, conference paper without full text, note and news, authorities' opinion, educational materials, books, letters to editor. After the full review only 11 (4%) articles met the inclusion criteria for this study.

Results

We mapped each article to the Trustworthy AI (TAI) key requirements to understand which requirements were addressed (see Table 1). Out of the 11 articles we reviewed, 6 (51%) studied the fairness of AI systems, 4 (36%) focused on data governance and privacy, and 3 (27%) on transparency and 3 (27%) technical robustness. The AI systems described in these articles were primarily implemented in hospitals, where they assist doctors in decision-making. Notably, three of these AI systems were specifically integrated into medical imaging tools to aid doctors in diagnosing patients more accurately. One article (9%) used a ChatBot to aid patients and investigated the patients' perspective about the chatbot accuracy. Four (36%) articles employed Socio-Technical Systems Analysis (STSA) to understand the implications of using AI in healthcare through a method called Z-inspection (Zicari, Ahmed, et al., 2021). The Z-inspection method is a holistic process designed to assist engineers in the early co-design of an AI system that meets Trustworthy AI requirements. A key feature

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of Z-inspection is the collaboration of a multidisciplinary team of experts who work together with AI engineers and their managers to ensure the AI system is trustworthy.

Table 1: Summary of results obtained from screened articles

Author	Reasons for measurement	STSA[1]	Organisational trust[2]	TAI key requirements addressed						
				Privacy and Data Governance	Human Agency and Oversight	Diversity	Transparency	Fairness	Accountability	Technical Robustness
(Nadarzynski et al., 2019)	User Willingness using chatbots	N	N	Y	N	N	N	Y	N	N
(Yang et al., 2022)	Factors for accepting AI systems	N	Y	N	N	N	N	N	N	N
(Allahabadi et al., 2022)	A post-hoc self-assessment to evaluate the trustworthiness of an AI system for predicting COVID lung compromise	Y	Y	N	N	N	N	N	N	Y
(Zicari, Ahmed, et al., 2021)	To create a Trustworthy AI roadmap for the design, implementation,	Y	N	N	N	N	N	N	N	N

Author	Reasons for measurement	STSA[1]	Organisational trust[2]	TAI key requirements addressed						
				Privacy and Data Governance	Human Agency and Oversight	Diversity	Transparency	Fairness	Accountability	Technical Robustness
	and future deployment of AI systems.									
(Hooshafza et al., 2022)	Extract themes for data quality in health	N	N	Y	N	N	N	Y	N	Y
(McInerney et al., 2022)	Evaluate the safety and patient impacts of an AI in comm and center	N	N	Y	N	N	N	Y	N	N
(Baumgartner et al., 2023)	Inequalities	Y	Y	N	N	N	N	Y	N	N
(Wang et al., 2023)	Check user perspective over system acceptance	N	N	N	N	N	N	N	N	N
(Zicari, Brusseau, et al., 2021)	Identify specific challenges and potential ethical trade-offs when consider using AI	Y	Y	Y	N	N	Y	Y	N	Y

Author	Reasons for measurement	STSA[1]	Organisational trust[2]	TAI key requirements addressed						
				Privacy and Data Governance	Human Agency and Oversight	Diversity	Transparency	Fairness	Accountability	Technical Robustness
	in practice									
(Hua et al., 2024)	Key factors influencing the acceptability of AI among medical professionals in healthcare	N	N	N	N	N	N	N	N	N
(Kim et al., 2023)	The requirements for TAI have not yet been clearly established and are discussed inconsistently by different institutions and organisations.	N	N	N	N	N	N	Y	N	N

Notes:
1- Using Socio-Technical Systems Analysis to measure organisational trust.
2- Organisational trust: How the AI system influenced the deployment setting and people inside that organisation.

Conclusions

Despite using a wide set of sources, the study found few articles that measured organisational trust to understand the implications of AI systems in healthcare. This could be due to the limited implementation of AI systems in healthcare. Out of 43 articles reviewed, 32 did not involve AI implementation. These articles only mentioned AI and did not evaluate or measure organisational trust. Another possible limitation could be the lack of consideration for Trustworthy AI (TAI) requirements when designing AI systems, as TAI requirements need to be implemented during AI development. For AI systems in healthcare to be effective, it is essential to incorporate TAI requirements throughout their development and implementation processes (Zicari, Brusseau, et al., 2021). Thus, AI systems developed for healthcare need a more thorough measurement of each TAI key requirement to ensure the necessary requirements transfer into operational/functional systems.

Organisational trust should be evaluated in relation to each TAI key requirement to improve organisational trust. Implementing each TAI key requirement during AI system development is crucial (Kim et al., 2023). However, some TAI requirements, such as accountability, deserve more focused attention due to their relative neglect. To respond to our research question, organisational trust measurement in healthcare was minimal. Therefore, in the future studies, addressing these requirements comprehensively, we will examine if it is possible to foster organisational trust to ensure that AI in healthcare systems are effective and reliable.

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References

Allahabadi, H., Amann, J., Balot, I., Beretta, A., Binkley, C., Bozenhard, J., Bruneault, F., Brusseau, J., Candemir, S., Cappellini, L. A., Chakraborty, S., Cherciu, N., Cociancig, C., Coffee, M., Ek, I., Espinosa-Leal, L., Farina, D., Fieux-Castagnet, G., Frauenfelder, T., … Zicari, R. V. 2022. Assessing Trustworthy AI in Times of COVID-19: Deep Learning for Predicting a Multiregional Score Conveying the Degree of Lung Compromise in COVID-19 Patients. *IEEE Transactions on Technology and Society*, 3, 272–289. https://doi.org/10.1109/TTS.2022.3195114

Baumgartner, R., Arora, P., Bath, C., Burljaev, D., Ciereszko, K., Custers, B., Ding, J., Ernst, W., Fosch-Villaronga, E., Galanos, V., Gremsl, T., Hendl, T., Kropp, C., Lenk, C., Martin, P., Mbelu, S., Morais Dos Santos Bruss, S., Napiwodzka, K., Nowak, E., … Williams, R. 2023. Fair and equitable AI in biomedical research and healthcare: Social science perspectives. *Artificial Intelligence in Medicine*,144,102658. https://doi.org/10.1016/j.artmed.2023.102658

Bürger, V. K., Amann, J., Bui, C. K. T., Fehr, J., & Madai, V. I. 2024. The unmet promise of trustworthy AI in healthcare: Why we fail at clinical translation. *Frontiers in Digital Health*, 6, 1279629. https://doi.org/10.3389/fdgth.2024.1279629

Figueroa-Armijos, M., Clark, B. B., & Da Motta Veiga, S. P. 2023. Ethical Perceptions of AI in Hiring and Organizational Trust: The Role of Performance Expectancy and Social Influence. *Journal of Business Ethics*, 186, 179–197. https://doi.org/10.1007/s10551-022-05166-2

High-Level Expert Group on Artificial Intelligence, Ethics Guidelines for Trustworthy. *European Commission*. https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai.

Hooshafza, S., Mc Quaid, L., Stephens, G., Flynn, R., & O'Connor, L. 2022. Development of a framework to assess the quality of data sources in healthcare settings. *Journal of the American Medical Informatics Association*, 29, 944–952. https://doi.org/10.1093/jamia/ocac017

Hua, D., Petrina, N., Young, N., Cho, J.-G., & Poon, S. K. 2024. Understanding the factors influencing acceptability of AI in medical imaging domains among healthcare professionals: A scoping review. *Artificial Intelligence in Medicine*, 147, 102698. https://doi.org/10.1016/j.artmed.2023.102698

Kelly, C. J., Karthikesalingam, A., Suleyman, M., Corrado, G., & King, D. 2019. Key challenges for delivering clinical impact with artificial intelligence. *BMC Medicine*, 17, 195. https://doi.org/10.1186/s12916-019-1426-2
Kim, M., Sohn, H., Choi, S., & Kim, S. 2023. Requirements for Trustworthy Artificial Intelligence and its Application in Healthcare. *Healthcare Informatics Research*, 29, 315–322. https://doi.org/10.4258/hir.2023.29.4.315

McDonald, N., McKenna, L., Vining, R., Doyle, B., Liang, J., Ward, M. E., Ulfvengren, P., Geary, U., Guilfoyle, J., Shuhaiber, A., Hernandez, J., Fogarty, M., Healy, U., Tallon, C., & Brennan, R. 2021. Evaluation of an Access-Risk-Knowledge (ARK) Platform for Governance of Risk and Change in Complex Socio-Technical Systems. *International Journal of Environmental Research and Public Health*, 18, 12572. https://doi.org/10.3390/ijerph182312572

McInerney, C., McCrorie, C., Benn, J., Habli, I., Lawton, T., Mebrahtu, T. F., Randell, R., Sheikh, N., & Johnson, O. 2022. Evaluating the safety and patient impacts of an artificial intelligence command centre in acute hospital care: A mixed-methods protocol. *BMJ Open*, 12, e054090. https://doi.org/10.1136/bmjopen-2021-054090

Mumford, E. 2006. The story of socio-technical design: Reflections on its successes, failures and potential. *Information Systems Journal*, 16, 317–342. https://doi.org/10.1111/j.1365-2575.2006.00221.x

Nadarzynski, T., Miles, O., Cowie, A., & Ridge, D. 2019. Acceptability of artificial intelligence (AI)-led chatbot services in healthcare: A mixed-methods study. *Digital Health*, 5, 205520761987180. https://doi.org/10.1177/2055207619871808

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. 2021. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Roski, J., Maier, E. J., Vigilante, K., Kane, E. A., & Matheny, M. E. 2021. Enhancing trust in AI through industry self-governance. *Journal of the American Medical Informatics Association*, 28, 1582–1590. https://doi.org/10.1093/jamia/ocab065

Shockley-Zalabak, P., Ellis, K., & Winograd, G. 2000. Organizational trust: What it means, why it matters. Organization Development Journal, 18, 35–48. ABI/INFORM Global; *Social Science Premium Collection*.

Vining, R., McDonald, N., McKenna, L., Ward, M. E., Doyle, B., Liang, J., Hernandez, J., Guilfoyle, J., Shuhaiber, A., Geary, U., Fogarty, M., & Brennan, R. 2022. Developing a Framework for Trustworthy AI-Supported Knowledge Management in the Governance of Risk and Change. In M.

Kurosu, S. Yamamoto, H. Mori, M. M. Soares, E. Rosenzweig, A. Marcus, P.-L. P. Rau, D. Harris, & W.-C. Li (Eds.), HCI International 2022—Late Breaking Papers. Design, User Experience and Interaction (Vol. 13516, pp. 318–333). *Springer International Publishing*. https://doi.org/10.1007/978-3-031-17615-9_22

Wang, L., Zhang, Z., Wang, D., Cao, W., Zhou, X., Zhang, P., Liu, J., Fan, X., & Tian, F. 2023. Human-centered design and evaluation of AI-empowered clinical decision support systems: A systematic review. *Frontiers in Computer Science*, 5, 1187299. https://doi.org/10.3389/fcomp.2023.1187299

Wolff, J., Pauling, J., Keck, A., & Baumbach, J. 2021. Success Factors of Artificial Intelligence Implementation in Healthcare. *Frontiers in Digital Health*, 3, 594971. https://doi.org/10.3389/fdgth.2021.594971

Yang, J., Luo, B., Zhao, C., & Zhang, H. 2022. Artificial intelligence healthcare service resources adoption by medical institutions based on TOE framework. *Digital Health*, 8, 205520762211260. https://doi.org/10.1177/20552076221126034

Zicari, R. V., Ahmed, S., Amann, J., Braun, S. A., Brodersen, J., Bruneault, F., Brusseau, J., Campano, E., Coffee, M., Dengel, A., Düdder, B., Gallucci, A., Gilbert, T. K., Gottfrois, P., Goffi, E., Haase, C. B., Hagendorff, T., Hickman, E., Hildt, E., … Wurth, R. 2021. Co-Design of a Trustworthy AI System in Healthcare: Deep Learning Based Skin Lesion Classifier. *Frontiers in Human Dynamics*, 3, 688152. https://doi.org/10.3389/fhumd.2021.688152

Zicari, R. V., Brusseau, J., Blomberg, S. N., Christensen, H. C., Coffee, M., Ganapini, M. B., Gerke, S., Gilbert, T. K., Hickman, E., Hildt, E., Holm, S., Kühne, U., Madai, V. I., Osika, W., Spezzatti, A., Schnebel, E., Tithi, J. J., Vetter, D., Westerlund, M., … Kararigas, G. 2021. On Assessing Trustworthy AI in Healthcare. Machine Learning as a Supportive Tool to Recognize Cardiac Arrest in Emergency Calls. *Frontiers in Human Dynamics*, 3, 673104. https://doi.org/10.3389/fhumd.2021.673104

Why are interdisciplinary rounds so hard to get right? a sociotechnical systems analysis of SIBR rounds using FRAM

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Abstract

Interdisciplinary bedside rounds (IBRs) are considered the "gold standard" of inpatient review, yet research reports highly variable results due to the variety of models in use and the sociotechnical systems nature of the process and its success. Structured Interdisciplinary Bedside Rounds (SIBR rounds) are a type of IBR that have been implemented and reported in multiple patient populations. This study examined the SIBR rounds process to determine which elements contribute to or reduce process variability, with recommendations for other IBR implementations.

Introduction

Interdisciplinary Bedside Rounds (IBRs) are a type of in-hospital patient review that seek to optimise patient outcomes, efficiency, and collaboration. They typically occur at the patient's bedside (Stein *et al.*, 2015, Cox *et al.*, 2017), though some variations bring the patient to a shared office space (Ågård *et al.*, 2017). IBRs usually include the primary bedside nurse and other key members of the care team. They typically discuss pertinent events, test results, consultant inputs, baseline status & progress, a plan for the day and plan for discharge (Stein *et al.*, 2015, Cox *et al.*, 2017).

The Royal College of Physicians and Royal College of Nurses guidelines on ward rounds updated in 2021 reinforces their commitment to interdisciplinary rounds as the "gold standard" of inpatient review (Royal College of Physicians and Royal College of Nursing, 2021). However, research on the benefits of IBRs remains mixed. A review by Ratelle *et al.* (2019) found limited benefits on patient-centred outcomes. Heip et. al.'s (2021) review concluded that IBRs have the *potential* to influence patient centeredness, quality of care and collaboration but there is a lack of evidence due to the variability in the types implemented and performance consistency.

Reported barriers to IBR success include time constraints, coordination challenges, lack of shared goals, variable responsibilities, and hierarchy (Gonzalo *et al.*, 2014, Walton *et al.*, 2019, Heip *et al.*, 2021). Conversely, research has found stakeholders value IBRs for helping the team be on the same page, for improving communication, collaboration, teamwork, management of patient complexity, satisfaction and supporting holistic care planning (Clay-Williams *et al.*, 2018, Lopez *et al.*, 2019, Walton *et al.*, 2019, Schwartz *et al.*, 2021). Cognisant of the intrapersonal, interpersonal and organization factors involved in IBRs it is clear that their implementation is a complex sociotechnical systems (STS) undertaking that must strive to limit process and performance variability (Vundi *et al.*, 2023).

Pannick *et al.* (2016) have recommended a multi-modal approach to improving patient care: (i) Unit-level physician & nurse co-leadership, (ii) unit-based teams, (iii) structured interdisciplinary rounds, and (iv) ward-level performance feedback to improve ward quality. One specific model that fits these four elements is the Accountable Care Unit care model, with its Structured Interdisciplinary Bedside Rounds (SIBR® rounds) (Stein *et al.*, 2015). Figure 1: provides an example structure for SIBR rounds.

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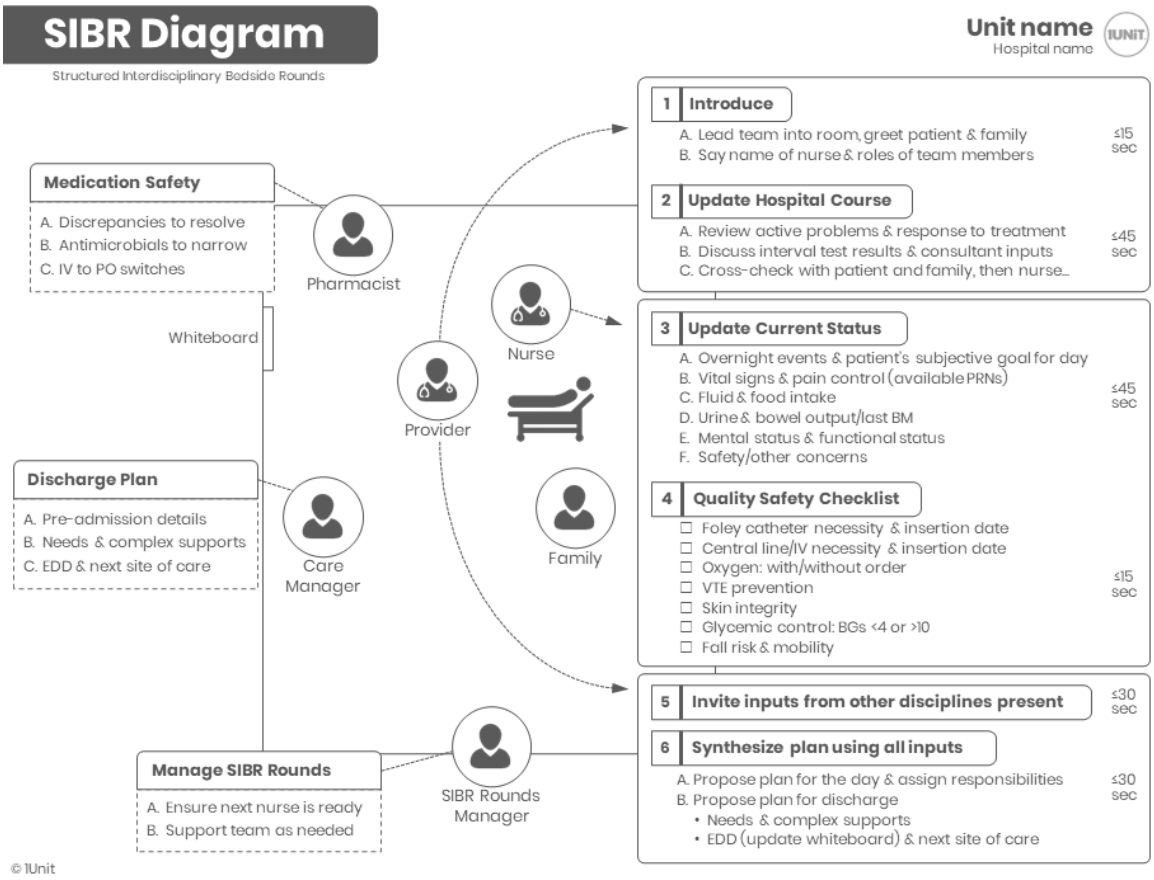

Figure 1. An example SIBR Diagram

SIBR rounds have been implemented widely with outcomes reported across a variety of patient populations. Most studies are positive (Gausvik *et al.*, 2015, Lopez *et al.*, 2019, Basic *et al.*, 2021, Loertscher *et al.*, 2021, Schwartz *et al.*, 2021), but not all (Jala *et al.*, 2019, Sunkara *et al.*, 2020). SIBR rounds are referenced and included as a case study in the Modern Ward Rounds report (Royal College of Physicians and Royal College of Nursing, 2021). Fortunately, this author has directly supported the implementation of the ACU care model and SIBR rounds in over fifty hospitals in three countries.

Objective

The objective was to develop a sociotechnical systems model of SIBR rounds, utilising the Functional Resonance Analysis Method (FRAM) (Hollnagel, 2017) to determine model elements that contribute to or reduce process variability.

Methods

A FRAM model of an individual SIBR interaction was developed using the FRAM Model Visualiser (FMV) (Hill, 2016). This was based on documentary analysis of training materials, best practice guidelines, and job aids developed to support SIBR implementation; an IDEFØ model (IEEE, 1998) of the SIBR process. This was created in 2016 by the author to identify opportunities for improving the implementation methodology at the time, and the author's expert knowledge of the current SIBR process at the chosen hospital. This information was combined with online SIBR training completion data, historical individual SIBR skills assessment data and process Key Performance Indicator (KPI) data from six units currently performing SIBR rounds in a tertiary mid-sized hospital in the North-East

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of America was recorded digitally in SIBR support software (Riberry.health, 2024). The KPI data is typically collected daily by the SIBR rounds manager, usually a charge nurse, who orchestrates the team's movement from patient to patient using a predetermined schedule, called the SIBR Flight Plan. Data collected includes lead provider and allied health in attendance, Lead Provider team census, SIBR quantity and quality data, and free text notes.

FRAM is a commonly used method for modelling variability in STS, analysing system elements that contribute to or dampen process variability, and is a mainstay in Safety II and systems resilience analysis (Salehi *et al.*, 2021, Sujan *et al.*, 2023). The FRAM model was then analysed according to taxonomy of performance variability phenotypes, (i.e. output failure modes such as timing/duration too early, too late, omission; sequence omission, jumping, repetition, reversal, wrong part) (Hollnagel, 2017). The contributions to variability dampening were thematically categorised using the Systems Engineering Initiative for Patient Safety (SEIPS) framework: Work System – person, organisation, environment, technologies and tools; tasks, Processes – care process, other processes (Carayon *et al.*, 2006). The methodology used is summarised in Figure 2.

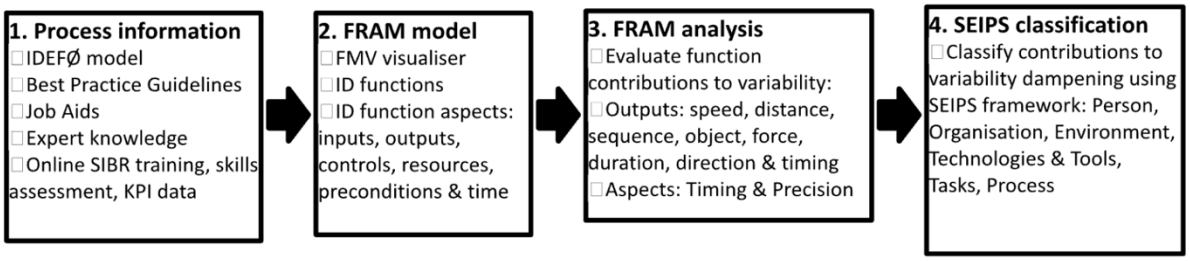


Figure 2. Summary of the methodology used

Results

The original IDEFØ model's Inputs, Controls, Outputs and Means/Resources required additional differentiation to align with the FRAM Aspects (Inputs, Outputs, Controls, Resources, Preconditions & Time). The SIBR FRAM model included thirteen entry functions, twenty-nine foreground functions, nineteen background functions, and five Exit functions. For more on this, please see Appendix 1.

For entry functions, probabilities of success were assigned based on the recorded SIBR performance data from May 1st 2023 to April 30th 2024. In this time, 2222 recordings of SIBR rounds performance were recorded for the 8 Lead Provider teams. These included data for 21,382 individual SIBR interactions (an average of 84% of each team's daily census), with an average of 10.5 SIBR interactions per team per day. The 'SIBR did not occur rate' was 6% (n=131). The most frequent comment about SIBR not occurring was that the SIBR Rounds Manager was absent and no one else took on the role that day, n=50. Average times per patient were within the ground rules determined by the teams: the ICU step-down team targets 8-9 minutes per patient, all other teams target approximately 5.5 minutes per patient.

Due to the interdependent nature of the process, participants, and inputs, 131 unique effects on downstream functions were identified that are likely to increase variability, with 31 unique effects to dampen variability.

Table 1. Example FRAM analysis

Function name	SIBR step 6 (a) completed	**Description**	Lead Provider shares the Plan for Care, assigns tasks and includes contingencies based on test results, consultant inputs etc.		
Aspect	Output	**Description**	Shared & understood team Plan for the Day with contingencies		
Variability Phenotype	Sequence	**Variability**	Omission	**Effect**	Increases
Consequence	If the Plan for the Day is omitted the care team will not have a clear shared mental model of the tasks they need to complete to progress care: inefficiencies will emerge; known risk states will go untreated; further clarity will be needed, requiring additional time and resource utilisation. To optimise independent work, the Lead Provider should provide contingency plans to account for new information that the team is waiting for, e.g. test results or discharge decisions. The contingency plans should address the action(s) to take depending on the outcome of the new information. Failure to provide these will create the need for subsequent discussions and inefficiencies.				

The identified contributions to variability dampening were categorised using the SEIPS framework. This is summarised in **Table 2** below.

Table 2. SEIPS thematic analysis of contributions to dampening process variability

Person	Lead Provider pre-rounding competency	SIBR skilled stakeholders (online & in-person training, coaching & feedback)		
Organisation	SIBR stakeholder specific best practices	Customised SIBR Ground Rules & SIBR Diagram	Optimise for maximum stakeholder participation	Patient Care Pathways, nurse-driven care protocols for common risk states
Technologies & Tools	Accurate & up-to-date patient record	Stakeholder specific SIBR prep sheets	Structured nursing bedside handover report	
Tasks	Moderate/manageable stakeholder-to-patient ratios			
Process	SIBR Rounds Manager (orchestrates the team)	SIBR 'Flight Plan' (patient order for the round)	High-quality & efficient stakeholder inputs	

Discussion

The FRAM model and method resulted in a detailed representation of the SIBR rounds process, with a thorough analysis of the contributions to increasing variability or dampening. The FRAM visualizer was particularly useful in ensuring that no functions or aspects were left orphaned and in prompting the consideration of the multiple elements needed for each function to succeed.

Though the developed FRAM model used average data for the probabilities of occurrence, the recorded data shows considerable variability in individual Lead Provider performance. Strategies to mitigate variation in individual performance have been introduced over time to attempt to reduce individual performance variability: upskilling the individuals prior to their participation, stakeholder specific best practice guidelines and job aids to guide their preparation and inputs. For some simplicity in developing the FRAM model, the stakeholder 'entry' functions were assigned a probability of being 'upskilled' based on data from the online training, certification and SIBR experience.

The developed model could be used to model and consider early-stage IBR implementation variability when staff are less 'upskilled' in the process. It would also be possible to apply a more individualised

approach to the model using stakeholder specific data, which would further highlight the differences in performance variability based on the key roles of the Lead Provider and Bedside Nurse.

Stakeholder patient census is a significant contributor to variability. Over the years of supporting implementation, it has become clear that a Lead Provider patient census of over eighteen patients or seven to eight for nurses is challenging, assuming several new admissions each day. Not only does it become difficult to prepare for SIBR, but it inevitably takes longer to complete. This places additional pressure on the team, who feel excessive demand, resulting in 'shortcuts', (e.g. deferring patient questions until after SIBR that could and should have been addressed in the moment). These 'shortcuts' often just create additional downstream work, (i.e. return visits or additional meetings to address unresolved items).

The utilisation of standardised Patient Care Pathways and nurse-driven care protocols enable the efficient utilisation of resources, but also dampen variability by creating defined inclusion triggers, treatment processes and monitoring requirements. These also create communication efficiencies within the team who have a shared mental model of the care delivery mechanisms as part of these pathways and protocols.

The role of the SIBR Rounds Manager (SRM) had evolved organically to support the efficient ordering and transition from patient-to-patient. The SRM prepares the order of patients to be seen on the 'SIBR Flight Plan', which is then used to guide the team from patient to patient, as not all patients will receive SIBR every day, e.g. patients discharged but awaiting pickup. If the SRM is not available, another team member can use the Flight Plan to direct the team. The SRM also ensures that each subsequent nurse is ready for the team, reducing delays and wait time.

Optimising for maximum team participation is also critical for reducing the variability of the SIBR outputs (i.e. the plan for the day and plan for discharge with contingency plans). It is difficult to plan for care and discharge if, for example, there are uncertainties about medication, therapy needs or the discharge destination. Very few staff have the time for multi-hour team rounds, but many can facilitate 60 minutes. However, this is only feasible if all stakeholders come prepared with their primary data gathering complete, their inputs and critical thinking primed and can deliver these efficiently. Optimising for stakeholder participation is the driving force for the brevity of SIBR rounds. This typically involves 12-15 patients in 60 minutes.

The contributions to variability dampening have been designed, developed, and refined over multiple implementations, to mitigate the variations in performance that had emerged between implementations and hospital environments and support transferability. The current FRAM model needs to be developed further to include other data-driven alerts and governance processes that have been designed to support the continued success of the SIBR process.

Conclusion

Lessons about the 'success' of the SIBR process from this analysis for other IBR rollouts include: standardise the process (i.e. create a shared mental model of participants, inputs, duration, occurrence & frequency); set clear expectations for all stakeholders with best practice guidelines and 'ground rules' (e.g. reduce uncertainty about patient inclusion by stating which patients can be excluded at any given time), create standardised job aids to support preparation and content delivery, allocate time to preparation, upskill stakeholders to efficiently deliver their inputs effectively through training, standardised coaching and feedback, optimise for maximum stakeholder participation; and utilise Patient Care Pathways and nurse-driven care protocols for common risk states to support care progression and collaborative crosschecking.
The FRAM model must be extended to include the data collection, reporting and governance structures that are also elements of the SIBR model that support the long-term success, sustainment, and resilience of SIBR rounds as a value-add process.

References

Ågård, A., Engström, I., Sandén, U. & Erling, V., 2017. The ward round of the future – a person-centred, team-based meeting with the patient. *Lakartidningen.*

Basic, D., Huynh, E.T., Gonzales, R. & Shanley, C.G., 2021. Twice-Weekly Structured Interdisciplinary Bedside Rounds and Falls among Older Adult Inpatients. *Journal of the American Geriatrics Society,* 69**,** 779-784.

Carayon, P., Schoofs Hundt, A., Karsh, B.T., Gurses, A.P., Alvarado, C.J., Smith, M. & Flatley Brennan, P., 2006. Work system design for patient safety: the SEIPS model. *Quality and Safety in Health Care,* 15**,** i50-58.

Clay-Williams, R., Plumb, J., Luscombe, G.M., Hawke, C., Dalton, H., Shannon, G. & Johnson, J., 2018. Improving Teamwork and Patient Outcomes with Daily Structured Interdisciplinary Bedside Rounds: A Multimethod Evaluation. *Journal of Hospital Medicine,* 13**,** 311-317.

Cox, E.D., Jacobsohn, G.C., Rajamanickam, V.P., Carayon, P., Kelly, M.M., Wetterneck, T.B., Rathouz, P.J. & Brown, R.L., 2017. A family-centered rounds checklist, family engagement, and patient safety: a randomized trial. *Pediatrics***,** e20161688.

Gausvik, C., Lautar, A., Miller, L., Pallerla, H. & Schlaudecker, J., 2015. Structured nursing communication on interdisciplinary acute care teams improves perceptions of safety, efficiency, understanding of care plan and teamwork as well as job satisfaction. *Journal of multidisciplinary healthcare,* 8**,** 33.

Gonzalo, J.D., Kuperman, E., Lehman, E. & Haidet, P., 2014. Bedside interprofessional rounds: Perceptions of benefits and barriers by internal medicine nursing staff, attending physicians, and housestaff physicians. *Journal of Hospital Medicine,* 9**,** 646-651.

Heip, T., Van Hecke, A., Malfait, S., Van Biesen, W. & Eeckloo, K., 2021. The effects of interdisciplinary bedside rounds on patient centeredness, quality of care, and team collaboration: a systematic review. *Journal of patient safety*.

Hill, R., 2016. FMV - FRAM Model Visualizer. New Zealand: http://www.zerprize.com.

Hollnagel, E., 2017. *FRAM: the functional resonance analysis method: modelling complex socio-technical systems*: CRC Press.

Ieee, 1998. IEEE standard for functional modeling language - syntax and semantics for IDEF0. IEEE Std 1320.1-1998. New York: IEEE.

Jala, S., Giaccari, S., Passer, M., Bertmar, C., Day, S., Griffith, D. & Krause, M., 2019. "In Safe Hands"–A costly integrated care program with limited benefits in stroke unit care. *Journal of Clinical Neuroscience,* 59**,** 84-88.

Loertscher, L., Wang, L. & Sanders, S.S., 2021. The impact of an accountable care unit on mortality: an observational study. *J Community Hosp Intern Med Perspect,* 11**,** 554-557.

Lopez, M., Vaks, Y., Wilson, M., Mitchell, K., Lee, C., Ejike, J., Oei, G., Kaufman, D., Hambly, J. & Tinsley, C., 2019. Impacting Satisfaction, Learning, and Efficiency Through Structured Interdisciplinary Rounding in a Pediatric Intensive Care Unit: A Quality Improvement Project. *Pediatric Quality & Safety,* 4**,** e176.

Pannick, S., Wachter, R.M., Vincent, C. & Sevdalis, N., 2016. Rethinking medical ward quality. *British Medical Journal,* 355**,** i5417.

Ratelle, J.T., Sawatsky, A.P., Kashiwagi, D.T., Schouten, W.M., Erwin, P.J., Gonzalo, J.D., Beckman, T.J. & West, C.P., 2019. Implementing bedside rounds to improve patient-centred outcomes: a systematic review. *BMJ Quality & Safety,* 28**,** 317-326.

Riberry.Health, 2024. Riberry. Melbourne.

Royal College of Physicians & Royal College of Nursing, 2021. *Modern ward rounds. Good practice for multidisciplinary inpatient review.* London, UK.

Salehi, V., Veitch, B. & Smith, D., 2021. Modeling complex socio-technical systems using the FRAM: A literature review. *Human factors and ergonomics in manufacturing & service industries,* 31**,** 118-142.

Schwartz, J.I., Gonzalez-Colaso, R., Gan, G., Deng, Y., Kaplan, M.H., Vakos, P.-A., Kenyon, K., Ashman, A., Sofair, A.N. & Huot, S.J., 2021. Structured interdisciplinary bedside rounds improve interprofessional communication and workplace efficiency among residents and nurses on an inpatient internal medicine unit. *Journal of Interprofessional Care***,** 1-8.

Stein, J., Payne, C., Methvin, A., Bonsall, J.M., Chadwick, L., Clark, D., Castle, B.W., Tong, D. & Dressler, D.D., 2015. Reorganizing a hospital ward as an accountable care unit. *Journal of Hospital Medicine,* 10**,** 36-40.

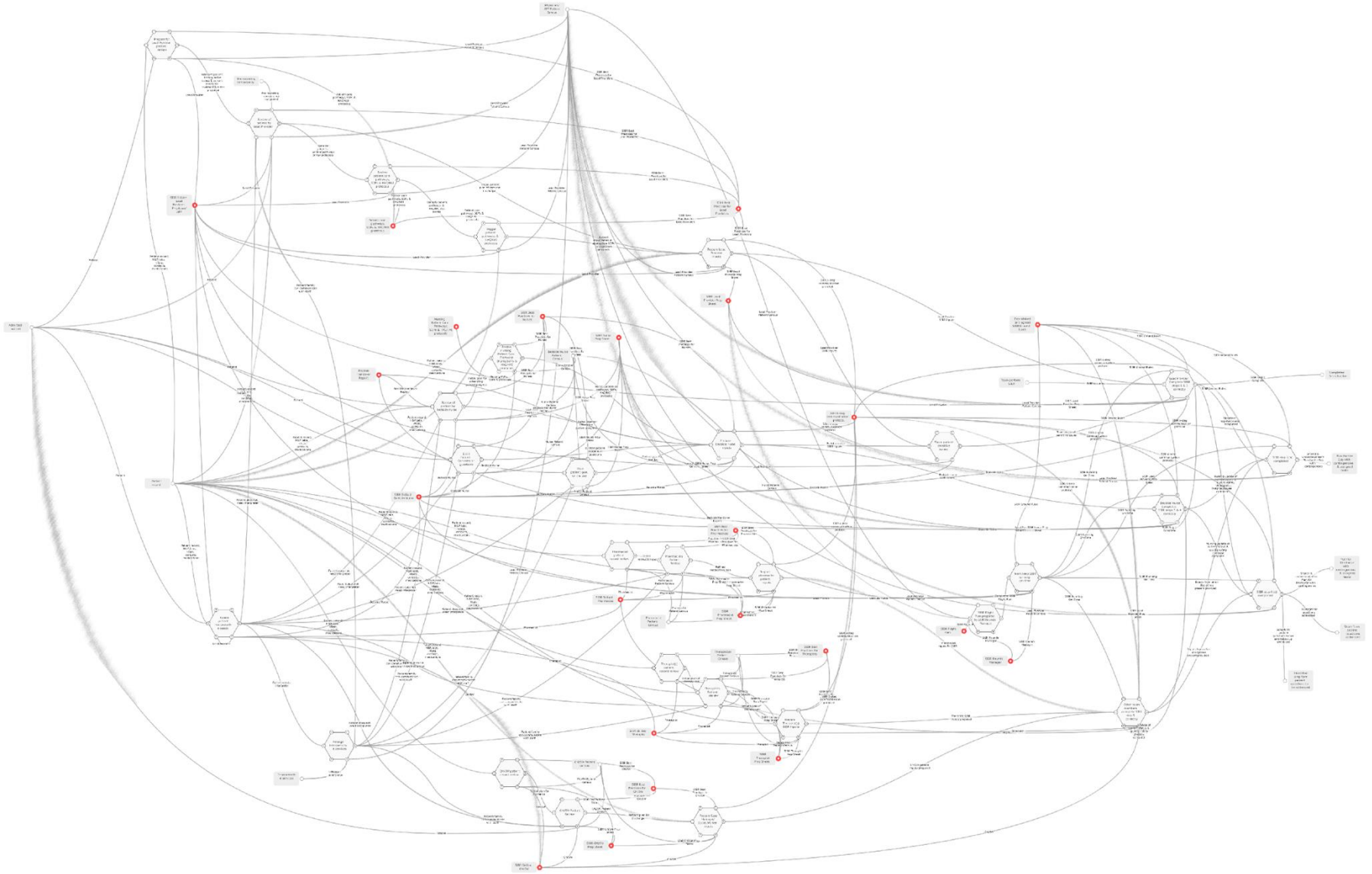
Sujan, M., Pickup, L., De Vos, M.S., Patriarca, R., Konwinski, L., Ross, A. & Mcculloch, P., 2023. Operationalising FRAM in Healthcare: A critical reflection on practice. *Safety Science,* 158**,** 105994.

Sunkara, P.R., Islam, T., Bose, A., Rosenthal, G.E., Chevli, P., Jogu, H., Tk, L.A., Huang, C.-C., Chaudhary, D. & Beekman, D., 2020. Impact of structured interdisciplinary bedside rounding on patient outcomes at a large academic health centre. *BMJ quality & safety,* 29**,** 569-575.

Vundi, N., Clouser, J.M., Adu, A.K. & Li, J., 2023. Implementation and function of interdisciplinary rounds: An observational multisite hospital study from project ACHIEVE. *Journal of Hospital Medicine,* 18**,** 224-233.

Walton, V., Hogden, A., Long, J.C., Johnson, J.K. & Greenfield, D., 2019. How Do Interprofessional Healthcare Teams Perceive the Benefits and Challenges of Interdisciplinary Ward Rounds. *Journal Multidisciplinary Healthcare,* 12**,** 1023-1032.

Appendix 1. THE SIBR rounds FRAM model. Figure 3. FRAM model.



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Examining the impact of sleep on depression and burnout in commercial airline pilots

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Abstract

The mental health of commercial aviation pilots has come into sharp focus over the last decade, largely due to several high-profile fatal accidents in which the mental health of the pilots was demonstrated, or is widely believed, to have been a causal factor. While measures have been put in place to detect and support pilots with existing mental health difficulties, little research has undertaken to identify which factors are negatively impacting on pilot mental health, and how these factors can be addressed. Sleep, in terms of quality, quantity, regularity and timing, has been shown to be one of the foundations of overall health and wellbeing. This research reports on the preliminary analysis of the relationship between Quality, Quantity, Regularity & Timing (QQRT) of sleep, on levels of Depression, Burnout, Emotional Exhaustion and Disengagement in pilots.

Introduction

The mental health of pilots came into sharp focus in the wake of the 2015 tragedy involving Germanwings Flight 9525, which was deliberately crashed by one of the pilots, killing all 150 occupants (BEA, 2016). Recent findings indicate that the mental health of pilots might be under threat from sources of Work-Related Stress (WRS) and unmanaged psychosocial risks. Previous research has examined how sources of work-related stress can impact on the physical, mental, and social health of pilots and how this ultimately impacts on flight safety (Cullen et al., 2021; Cahill et al., 2019; Cahill et al., 2021).

The airline industry is notoriously competitive, and as a result airlines are driven to make full use of their pilot's maximum possible duty hours to reduce staff costs. Commercial airline pilots regularly experience sleep loss and/or disturbed sleep and irregular work-rest cycles, which can lead to disrupted circadian rhythms, and this can be further compounded by trans-meridian flying (Caldwell, 1997). Sleep loss and shiftwork has been linked with fatigue, which negatively impacts most aspects of a pilot's performance, including judgement, decision making, memory, reaction time, concentration, selective attention, fixation and mood (Jackson & Earl, 2006).

Human error has been reported to account for 70-80% of all fatal aviation accidents (Wiegmann & Shappell, 2001), and it has been estimated that over 20% of all aviation accidents have fatigue as a causal factor (Caldwell, 2012). Fatigue has also been reported as the largest identifiable and preventable cause of accidents in transport operations (Akerstedt, 2000). However, fatigue is clearly not the sole cause of human error, and fatigue is not the sole health issue associated with sleep loss and shift work. Both quality and quantity of sleep have been shown to have a profound impact on mental health. Increased duty hours result in less rest time and more fatigue, sleep and depression issues, which may lead to errors that impact flight safety (Aljurf et al., 2018). The quality of sleep is significantly impacted by the number of times we wake up during the night, and a strong correlation between sleep continuity and total sleep time has been reported (Kishi et al., 2017). Adults with chronic or frequent sleep loss report excess mental distress, depressive symptoms, anxiety, and alcohol use (Baldwin & Daugherty, 2004).

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There is evidence that long duties and specifically, those that challenge circadian rhythm have a negative impact on the health and wellbeing of shift workers (Dembe, Erickson, Delbos & Banks, 2005). Long-haul flight crew who regularly cross multiple time zones often report persistent jet lag symptoms, which increase with the number of time zones crossed. Studies have reported that that mood changes, particularly dysphoric mood, are a significant aspect of jet lag (Sack, 2010). Traditionally jet lag has been associated with air travel across time zones, however a much greater proportion of the general population regularly experience 'social jet lag', a phenomenon in which individuals remain in their local geographical time zone, but significantly 'displace their sleep' by shifting their sleep-wake patterns several times per week (Foster et al., 2013).

A 2016 study (Reis et al., 2016) reported that 35% of pilots suffered with clinically relevant sleep problems. This same study reported that 59% of pilots experienced significant daytime sleepiness and 90% experienced extreme fatigue. Similarly, a 2018 study of pilots (n=328) reported that in the previous 12 months 68.3% of pilots experienced severe fatigue, with 34.1% experiencing excessive daytime sleepiness (Aljurf et al., 2017). 67.4% of these pilots reported making mistakes in the cockpit due fatigue and 45.1% reported falling asleep at the controls at least once without previously agreeing with their pilot colleague. 34.5% of participants reported significant symptoms of depression and 29.3% were deemed to be at high risk for Obstructive Sleep Apnea.

Rather than being a medical condition, burnout is defined as an occupational phenomenon, resulting from chronic workplace stress that has not been successfully managed). Burnout is characterised by three dimensions:

1. Feelings of energy depletion or exhaustion,
2. Increased mental distance from ones job, or feelings of negativity or cynicism towards ones job,
3. Reduced professional efficacy.

The links between sleep and burnout have not been reported to the same degree as that with depression. However, there is a significant overlap between the symptoms of depression and burnout (Bianchi et al., 2015), and there is an expanding body of evidence that sleep deprivation, both acute and chronic, plays an immense role in the development of burnout (Abera et al., 2023). Poor sleep quality has been demonstrated to be significantly associated with the emotional exhaustion aspect of burnout (Lu, 2023), and sleep quality has been reported to be a significant mediator in the development of burnout (Vieira, 2023).

Methodology

An anonymous web-based survey was completed by commercial airline pilots, between 7th November 2018 and 24th January 2020. Ethics approval was provided by Trinity College Dublin. Respondents received background information and completed electronic consent, before completing a detailed survey, some results of which have been already reported (Cahill et al., 2020; Cahill et al., 2021). This survey examined the effects of work-related stress (WRS) on pilot wellbeing, and the associated impact on both pilot performance and flight safety. The survey incorporated standardised instruments to measure levels of depression and burnout, both of which have been widely validated and have good psychometric properties. These were the Patient Health Questionnair-9 (PHQ-9) (Kronke et al., 2001), the Oldenburg Burnout (OLBI-8) (Demerouit et al., 2003) and the Oldenburg Burnout (Modified Instrument) (Demerouti et al., 2018).

Results

In total, 1089 participants started the survey. However, analysis showed that 767 participants completed both the PHQ-9 and OLBI, and the sleep section of the survey. Of these, 16.8% met the threshold for moderate depression, 34.7% for moderate burnout, 56.5% for moderate exhaustion and 18.9% for moderate disengagement. Not all 767 participants answered all the questions in the sleep section. 97.5%

of participants reported that they believed 'their job as a pilot negatively influenced their ability to adopt normal sleeping patterns that allow proper rest on a regular basis', with more than 1 in 4 reporting this as occurring 'all the time', and just under half reporting it occurring as either 'several times per week' or 'several times per month'.
Over 3 in 4 pilots reported experiencing sleep difficulties that they attributed to, or believed were worsened by working as a pilot. In this group, the incidence of depression and burnout was more than 330% higher, exhaustion over 100% higher and disengagement in excess of 400% higher, than the other group.

More than 2/3rd of pilots reported that their sleep was disrupted on the night before a duty day, with the most common cited reason being 'trying to sleep outside social norms/against circadian rhythm'. This was cited more than twice has often as the 2nd most common reason. When compared against pilots who did not report disrupted sleep, the incidence of depression, burnout and disengagement was almost 100% higher in the group with disrupted sleep. In this group, the incidence of exhaustion was almost 50% higher. Of those who experienced disruption, approximately 45% reported its frequency as at least once per week, and a similar number at least once per night.
17.5% of pilots reported using sleeping tablets and 22.2% alcohol, with frequencies ranging from 'a few times per month' to 'all the time'. 25.0% of pilots reported no difference in the hours slept before either a free day or duty day. 29.4% and 27.5% reported sleeping one and two hours less respectively. 18.1% reported sleeping three or more hours less, with 5.8% reporting sleeping more before a duty day than a free day. When the level of sleep deficit was plotted against incidence of distress, a positive relationship was observed for burnout and exhaustion, but no clear relationship was observed for depression or disengagement.

Pilots were asked to indicate when they went to bed prior to a duty day, in comparison to before a day free of duty, and separately when they woke up. The options to choose from included 'earlier', 'no change', 'later' or 'a combination of both'. 14.9% reported no change in the bedtime, and 10.9% in their wake-up time. However, prior to a duty day, 40.7% of pilots went to bed earlier, 3.0% later and 41.4% a combination of both. A similar pattern was observed for wake-up time, with 47.5% waking earlier, 4.5% later, and 48.0% a combination of both.Those pilots who had inconsistent bedtimes and waking times all showed higher incidences of burnout and exhaustion than those pilots who maintained consistent bedtimes and waking times. The pattern was not so clear for depression and disengagement.

When asked 'does your work schedule force you to be awake at times that your circadian rhythm dictates that you should be asleep?', 97.9% confirmed it did, with more than 50% reporting this to be the case 'several times per week'. Similarly, when asked 'does your work schedule suggest that you should be resting/asleep at times that your circadian rhythm dictates that you should be awake?' 95.5% confirmed it did, with 43.9% reporting this to be the case 'several times per week'. There was a significantly higher incidence of all forms of distress in those pilots who reported circadian rhythm conflict 'several times per week' than those who indicated 'several times per month' or less.

Normal sleeping patterns were demonstrated to be associated with lower incidences of distress, and the inverse was also strongly observed. Disruption of sleep was seen to be a strong predictor of all 4 forms of distress under consideration. The use of both alcohol and sleeping tablets, which are known to increase disruption, were also observed to coincide with higher incidences of distress among pilots. Sleep duration was seen to be related to incidences of burnout and exhaustion, but not depression and disengagement. It is possible that this non-observance was due to survey design, and relatively small sample size. The impact of regularity on depression and disengagement was not very clear, however, consistent bedtimes and wake times predicted lower incidences of burnout and exhaustion.

A clear relationship between frequency and incidence of distress was not observed, perhaps due to the relatively smaller sample size. However, when examined on a 'yes or no' basis, higher incidences of distress were seen in the groups that reported using sleeping aids compared to those that did not. Pilots who worked and tried to rest against one's body clock were seen to have higher incidences of all 4 forms of distress.

Discussion

The sleep of pilots was examined in terms of Quality, Quantity, Regularity and Timing (QQRT).
As predicted by the literature, a clear and strong relationship was observed when the frequency of inability to adopt normal patterns was plotted against the incidence of moderate levels of depression, burnout, exhaustion and disengagement.

The duty hours and rest periods of airline pilots are governed by Flight Time Limitations (FTLs), the purpose of which are to ensure air safety, by protecting against the negative effects of fatigue. While intended to protect against the risks posed by tired pilots, these scientifically based rules were not designed to protect against other issues that pose a challenge to maintaining the different biopsychosocial dimensions of Pilot Wellbeing which ultimately impact on Flight Safety.

The aviation industry needs to manage psychosocial hazards in the same preventative manner that it manages other hazards. Critically, the identification and management of psychosocial hazards needs to be considered in airline safety management system (SMS), and allied risk assessment processes.

Although, convenience sampling was used, the sample is large and diverse enough that the findings are generalizable to commercial airline pilots in general. The study used standardised measures of burnout and so outcomes are clearly comparable to other studies in the field. This study utilised as cross-sectional survey design. This means that no causal relationships between factors can be inferred. The study used a convenience sample collected with the potential risk of bias among self-selecting candidates. Similarly, the survey was self-reported. The study took place prior to the COVID-19 pandemic and results may not reflect the specific stressors the aviation industry experienced during or since the pandemic.

Conclusions

This study provides a range of highly malleable targets for potential fatigue and sleep management interventions to prevent/reduce Depression, Burnout, Emotional Exhaustion and Disengagement in commercial pilots. Research such as this emphasises the need to move from cross-sectional research identifying the problems to intervention studies looking at preventative and ameliorative strategies to address fatigue and sleep management.

References

Abera, H., Hunt, M. and Levin, J.H, 2023. 'Sleep deprivation, burnout, and Acute Care Surgery', *Current Trauma Reports*, 9(2), pp. 40–46. 2023. doi:10.1007/s40719-023-00253-9.

Akerstedt, T, 2000. 'Consensus statement: Fatigue and accidents in transport operations', *Journal of Sleep Research*, 9(4), pp. 395–395. doi:10.1046/j.1365-2869.2000.00228.x.

Aljurf, T.M., Olaish, A.H. and BaHammam, A.S.. 2017 'Assessment of sleepiness, fatigue, and depression among Gulf Cooperation Council Commercial Airline Pilots', *Sleep and Breathing*, 22(2), pp. 411–419. doi:10.1007/s11325-017-1565-7.

Baldwin, D.C. and Daugherty, S.R, 2004. 'Sleep deprivation and fatigue in residency training: Results of a national survey of first- and second-year residents', *Sleep*, 27(2), pp. 217–223. doi:10.1093/sleep/27.2.217.

BEA, 2016. Final report - Accident on 24 March 2015 at Prads-Haute-Bléone (Alpes-de-Haute-Provence, France) to the Airbus A320-211 registered D-AIPX operated by Germanwings. Available at: https://bea.aero/uploads/tx_elydbrapports/BEA2015-0125.en-LR.pdf (Accessed: 30 May 2024).

Bianchi, R., Schonfeld, I.S. and Laurent, E., 2015. 'Does Burnout help predict depression? A longitudinal investigation', *European Psychiatry*, 30, p. 180. doi:10.1016/s0924-9338(15)30146-2.

Cahill, J. *et al.*, 2021. Pilot work related stress (WRS), effects on wellbeing and Mental Health, and coping methods', *The International Journal of Aerospace Psychology*, 31(2), pp. 87–109. doi:10.1080/24721840.2020.1858714.

Cahill, J., Cullen, P. and Gaynor, K., 2019. 'Interventions to support the management of work-related stress (WRS) and wellbeing/mental health issues for commercial pilots', *Cognition, Technology & Work*, 22(3), pp. 517–547. doi:10.1007/s10111-019-00586-z.

Cullen, P., Cahill, J. and Gaynor, K., 2021. 'A qualitative study exploring well-being and the potential impact of work-related stress among commercial airline pilots', *Aviation Psychology and Applied Human Factors*, 11(1), pp. 1–12. doi:10.1027/2192-0923/a000199.

Caldwell JA, Mallis MM, Caldwell JL, Paul MA, Miller JC, Neri DF, 2009, Aerospace Medical Association Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee [2009]. Fatigue countermeasures in aviation. Aviat Space Environ Med 80(1):29–59.

Caldwell, J.A., 2012. 'Crew schedules, sleep deprivation, and aviation performance', *Current Directions in Psychological Science*, 21(2), pp. 85–89. doi:10.1177/0963721411435842.

Dembe, A.E.*et al.*, 2005. 'The impact of overtime and long work hours on occupational injuries and illnesses: New evidence from the United States', *Occupational and Environmental Medicine*, 62(9), pp. 588–597. doi:10.1136/oem.2004.016667.

Demerouti, E. *et al.*, 2018. 'Burnout among pilots: Psychosocial factors related to happiness and performance at simulator training', *Ergonomics*, 62(2), pp. 233–245. doi:10.1080/00140139.2018.1464667.

Foster, R.G. *et al.*, 2013. 'Sleep and circadian rhythm disruption in social jetlag and mental illness', *Progress in Molecular Biology and Translational Science*, pp. 325–346. doi:10.1016/b978-0-12-396971-2.00011-7.

Jackson, C.A. and Earl, L., 2006. 'Prevalence of fatigue among commercial pilots', *Occupational Medicine*, 56(4), pp. 263–268. doi:10.1093/occmed/kql021.

Kishi, A. *et al.*, 2017. 'Sleep continuity is positively correlated with sleep duration in laboratory nighttime sleep recordings', *PLOS ONE*, 12(4). doi:10.1371/journal.pone.0175504.

Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001 Sep;16(9):606-13. doi: 10.1046/j.1525-1497.2001.016009606.x. PMID: 11556941; PMCID: PMC1495268.

Lu, D.W. 2023. 'Sleep and burnout among health care professionals—the role of the individual', *JAMA Network Open*, 6(11). doi:10.1001/jamanetworkopen.2023.41882.
Reis, C. *et al.*, 2016. 'Sleep complaints and fatigue of airline pilots', *Sleep Science*, 9(2), pp. 73–77. doi:10.1016/j.slsci.2016.05.003.

Sack, R.L. 2010. 'Jet lag', *New England Journal of Medicine*, 362(5), pp. 440–447. doi:10.1056/nejmcp0909838.

Vieira, L.M., Mininel, V.A. and Sato, T. de, 2023. 'Sleep quality as a mediator of burnout, stress and multisite musculoskeletal pain in healthcare workers: A longitudinal study', *Healthcare*, 11(18), p. 2476. doi:10.3390/healthcare11182476.

Wiegmann, D.A. and Shappell, S.A., 2001. 'A human error analysis of commercial aviation accidents using the Human Factors Analysis and classification system (HFACS).', *PsycEXTRA Dataset* [Preprint]. doi:10.1037/e420582004-001.