Appendix 1: Healthcare Human Factors Ergonomics - Academic publications by Irish Authors 2018-2023

This appendix is part of the ***Human Factors in Irish Healthcare 2018-2023*** document. It is a summary of publications relating to human factors ergonomics in healthcare by Irish authors over the last 5 years along with details on how to access them. The publications are and are categorised along the themes of:

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Article Title	Authors	Date of Publication	Abstract	Publication Source
General Patient Safety Research				
A scoping review of patient safety research carried out in the Republic of Ireland	O'Connor, P., O'Malley, R., Kaud, Y. et al	2023	Maintaining the highest levels of patient safety is a priority of healthcare organisations. However, although considerable resources are invested in improving safety, patients still suffer avoidable harm. The aims of this study are: (1) to examine the extent, range, and nature of patient safety research activities carried out in the Republic of Ireland (RoI); (2) make recommendations for future research; and (3) consider how these recommendations align with the Health Service Executive's (HSE) patient safety strategy. A five-stage scoping review methodology was used to synthesise the published research literature on patient safety carried out in the RoI: (1) identify the research question; (2) identify relevant studies; (3) study selection; (4) chart the data; and (5) collate, summarise, and report the results. Electronic searches were conducted across five electronic databases. A total of 31 papers met the inclusion criteria. Of the 24 papers concerned with measuring and monitoring safety, 12 (50%) assessed past harm, 4 (16.7%) the reliability of safety systems, 4 (16.7%) sensitivity to operations, 9 (37.5%) anticipation and preparedness, and 2 (8.3%) integration and learning. Of the six intervention papers, three (50%) were concerned with education and training, two (33.3%) with simplification and standardisation, and one (16.7%) with checklists. One paper was concerned with identifying potential safety interventions. There is a modest, but growing, body of patient safety research conducted in the RoI. It is hoped that this review will provide direction to researchers, healthcare practitioners, and health service managers, in how to build upon existing research in order to improve patient safety.	Irish Journal of Medical Science https://doi.org/10.1007/s11845-022-02930-1
Handbook of Patient Safety	Lachman, L.F.Q.I.P.P., Lachman, P., Runnacles, J., Jayadev, A., Jayadev, C.R.P.A., Brennan, J.	2022	Explains patient safety theory in simple terms to help clinicians practice safely. Provide day-to-day practical approaches to improve care. Provides summaries with key take home points Written by clinical specialists with international expertise in patient safety issues. Content applies patient safety theory to clinical practice with real world examples. Reflects the WHO Patient Safety Curriculum	Handbook of Patient Safety. [online] Google Books. Oxford University Press. https://books.google.com.au/books?hl=en&lr=&id=vptjEAAAQBAJ&oi=fnd&pg=PP1&ots=EfRyqT-iVU&sig=a2eV_0CvTwDQ0-

	and Fitzsimons, J.			27xVYHQNugrtY#v=onepage&q&f=false
Translating HFE into Action – Lessons from the Frontline.	Albolino, S., Lachman, P., Krause, C.M. and Muniak, A.	2021	Human Factors and Ergonomics (HFE) theory and methodology is well established in many industries. In healthcare it is still in its infancy and not well established, despite increasing evidence of the need to implement a HFE approach in day to day operations. The COVID-19 pandemic demonstrated the need to implement HFE theories with clinical teams to ensure safety, be it for patients in clinical care or design of healthcare worker safety, or the procurement of supplies. The examples of three different settings illustrate the key point of service design, development of situation awareness in clinical teams and the development of a culture of safety.	Proceeding of the 21st Congress of the international Ergonomics Association (IEA 2021) https://doi.org/10.1007/978-3-030-74611-7_31
COVID-19: Patient Safety and Quality Improvement Skills to Deploy during the Surge	Staines, A., Amalberti, R., Berwick, D.M., Braithwaite, J., Lachman, P. and Vincent, C.A.	2020	The COVID-19 pandemic has suddenly challenged many healthcare systems. To respond to the crisis, these systems have had to reorganize instantly, with little time to reflect on the roles to assign to their patient safety (PS) and quality improvement (QI) experts. In many cases, staff who had a background in clinical care was called to support wards and critical care. Others were deemed "non-essential" and sent back to work from home, while their programmes were placed in hibernation mode. This has meant that many QI and PS experts with skills to offer in their field have ended up carrying out tasks unrelated to the current crisis. We believe that the skillset of patient safety and quality improvement personnel is essential for the successful implementation of the changes required to achieve the desired outcomes. An understanding of systems theory and the complexity of healthcare systems, human factors and reliability theories, and change methodologies is key to the success of any transformation programme. Here, we suggest a five-step strategy and actions through which PS and QI staff can meaningfully contribute during a pandemic by employing their core skills to support patients, staff and organizations: 1. Strengthen the system by assessing readiness, gathering evidence, setting up training, promoting staff safety and bolstering peer support. 2. Engage with citizens, patients and their families so that the solutions are jointly achieved and owned by both the healthcare providers and the people	International Journal for Quality in Health Care https://doi.org/10.1093/intqhc/mzaa050

			who receive care and in particular the citizens who are required to undertake preventive interventions. 3. Work to improve care, through actions such as the separation of flows, flash workshops on teamwork and the development of clinical decision support. 4. Reduce harm by proactively managing risk to both COVID-19 and non-COVID-19 patients. 5. Boost and expand the learning system, to capture improvement opportunities, adjust very rapidly and develop resilience. This is crucial as little is known about COVID-19 and its impacts on patients, staff and institutions.	
Medication errors in anesthesiology: Is it time to train by example? Vignettes can assess error awareness, assessment of harm, disclosure, and reporting practices.	Duffy, C. C., Bass, G. A., Duncan, J., Lyons, B. & O'Dea, A.	2020	Background: Perioperative medication errors (MEs) are complex, multifactorial, and a significant source of in-hospital patient morbidity. Anesthesiologists' awareness of error and the potential for harm is not well understood, nor is their attitude to reporting and disclosure. Anesthesiologists are not routinely exposed to medication safety training. Methods: Ten clinical vignettes, describing an ME or a near miss, were developed using eDelphi consensus. An online survey instrument presented these vignettes to anesthesiologists along with a series of questions assessing error awareness, potential harm severity, the likelihood of reporting, and the likelihood of open disclosure to the patient. The study also explored the influence of prior medication safety training. Results: Eighty-nine anesthesiologists from 14 hospitals across Ireland (53.9% were residents, and 46.1% were attendings) completed the survey. Just 35.6% of anesthesiologists recalled having had medication safety training, more commonly among residents than attendings, although this failed to reach significance ($P < 0.081$). Medication error awareness varied with the vignette presented. Harm severity assessment was positively associated with error awareness. The likelihood of patient disclosure and incident reporting was both low and independent of harm severity assessment. Conclusions: Perioperative ME awareness and assessment of potential harm by anesthesiologists is variable. Self-reported rates of incident reporting and error disclosure fall short of the standards that might apply in an environment focused on candor and safety. An extensive education program is required to raise awareness of error and embed appropriate reporting and disclosure behaviors.	*Journal of Patient Safety.* *DOI:* 10.1097/PTS.0000000000000785 https://journals.lww.com/journalpatientsafety/abstract/2022/01000/medication_errors_in_anesthesiology__is_it_time_to.3.aspx

			Vignettes, designed by consensus, may be valuable in the delivery of such a curriculum.	
Patient Experience Feedback and Safety				
Using a stakeholder co-design approach to develop interventions for quality improvement based on patient complaints	O'Dowd E, Lydon S, Rudland C, Gillespie A, Ahern E, Ward ME, Kane M, Reader T, O'Connor P.	2023	Background While research into complaints made about hospitals is increasing, this has yet to be translated into interventions to improve quality and safety. Incorporating the views of stakeholders into learning from complaints can be an effective means of bridging the gap between research and implementation in patient safety research. Aims The aim of the study is to assess whether a co-design approach involving stakeholders is feasible and effective for identifying interventions to address issues from patient complaints. Methods A series of online workshops and surveys were utilized to collate the views of stakeholders including patients, healthcare providers, health system researchers, and healthcare managers on how to improve quality and safety in care. Findings of previous analyses of patient complaints were used to identify the focus of this study and guide participants. The strength and feasibility of the interventions outlined by participants was subsequently assessed. Results Thirty-two interventions were outlined across the two workshops. These were ranked by participants using the APEASE model. Participants considered the co-design approach an appropriate and effective way to identify interventions for quality and safety improvement. Conclusions Stakeholder co-design demonstrated excellent potential for suggesting interventions to improve patient safety based on the findings of complaints analyses.	International Journal of Healthcare Management https://doi.org/10.1080/20479700.2023.2188717
The impact of the COVID-19 pandemic on patient complaints	O'Dowd, E., Lydon, S., Ward, M.E. et al.	2023	Background The coronavirus disease 2019 (COVID-19) pandemic dramatically impacted the delivery of hospital care in terms of quality and safety. Objectives	Irish Journal of Medical Science https://doi.org/10.1007/s11845-023-03282-0

within one Irish teaching hospital			To examine complaints from two time points, quarter 4 (Q4) 2019 (pre-pandemic) and Q4 2020 (second wave), and explore whether there was a difference in the frequency and/or content of complaints. Methods A retrospective analysis of complaints from one Irish hospital was conducted using the Healthcare Complaints Analysis Tool (HCAT). Within each complaint, the content, severity, harm reported by the patient, and stage of care were categorised. The complaints were analysed using descriptive statistics and chi-square tests of independence. Results There were 146 complaints received in Q4 2019 and 114 in Q4 2020. Complaint severity was significantly higher in Q4 2019 as compared to Q4 2020. However, there were no other significant differences. Institutional processes (e.g. staffing, resources) were the most common reason for complaints (30% in Q4 2019 and 36% in Q4 2020). The majority of complaints were concerned with care on the ward (23% in Q4 2019 and 31% in Q4 2020). Conclusions The severity of complaints was significantly higher in Q4 2019 than in Q4 2020, which requires further exploration as the reasons for this are unclear. The lack of a difference in the frequency and content of complaints during the two time periods was unexpected. However, this may be linked to a number of factors, including public support for the healthcare system, existing system-level issues in the hospital, or indeed increased staff collaboration in the context of the COVID-19 crisis.	
An Analysis of Complaints about Hospital Care in the Republic of Ireland. International Journal for Quality in Health Care	O'Dowd, E., Lydon, S., Lambe, K., Vellinga, A., Rudland, C., Ahern, E., Hilton, A., Ward, M.E., Kane, M., Reader, T.,	2022	Background Patients and family members make complaints about their hospital care in order to express their dissatisfaction with the care received and prompt quality improvement. Increasingly, it is being understood that these complaints could serve as important data on how to improve care if analysed using a standardized tool. The use of the Healthcare Complaints Analysis Tool (HCAT) for this purpose has emerged internationally for quality and safety improvement. Previous work has identified hot spots (areas in care where harm occurs frequently) and blind spots (areas in care that are difficult for staff members to observe) from complaints analysis. This study aimed to (i) apply the HCAT to a sample of	International Journal for quality in Healthcare https://doi.org/10.1093/intqhc/mzac037

	Gillespie, A., Vaughan, D., Slattery, D. and O'Connor, P.		complaints about hospital care in the Republic of Ireland (RoI) to identify hot spots and blind spots in care and (ii) compare the findings of this analysis to a previously published study on hospital complaints in the UK. Methods A sample of complaints was taken from 16 hospitals in the RoI in Quarter 4 of 2019 (*n* = 641). These complaints were coded using the HCAT to classify complaints by domain, category, severity, stage of care and harm. Chi-squared tests were used to identify hot spots, and logistic regression was used to identify blind spots. The findings of this study were compared to a previously published UK study that used HCAT to identify hot spots and blind spots. Results Hot spots were identified in Irish hospital complaints while patients were receiving care on the ward, during initial examination and diagnosis, and while they were undergoing operations or procedures. This aligned with hot spots identified in the UK study. Blind spots were found for systemic problems, where patients experience multiple issues across their care. Conclusions Hot spots and blind spots for patient harm can be identified in hospital care using the HCAT analysis. These in turn could be used to inform improvement interventions, and direct stakeholders to areas that require urgent attention. This study also highlights the promise of the HCAT for use across different healthcare systems, with similar results emerging from the RoI and the UK.	
The patient's "story": an examination of patient-reported safety incidents in general practice	Madden, C. et al	2022	Background Patient safety incidents (PSIs) are typically studied through engagement with healthcare providers, without input from patients despite their privileged viewpoint of care experiences. Objectives To examine the potential of the patient viewpoint as a lens for future safety improvement initiatives, by: (i) collecting and analysing patients' accounts of PSIs; and (ii) comparing patient and clinician perceptions of PSIs. Methods Firstly, Critical Incident Technique (CIT) interviews were used to obtain rich descriptions of PSIs, which were then condensed into patient stories. Deductive content analysis was used to code the safety deficiencies described in patient	*Family Practice* https://doi.org/10.1093/fampra/cmac033

			stories using patient-derived safety categories. Secondly, General Practitioners (GPs) and patients individually rated the perceived severity and likelihood of each story. Results A total of 32 eligible patient stories were obtained from 25 interviews. Stories commonly described deficiencies related to communication, staff performance, and compassion/dignity/respect. There were significant differences in GP (*n* = 14) and patient (*n* = 11) severity and likelihood ratings. GPs were significantly more likely to consider stories to be a lower severity, and occurring with a lower frequency than patients. Conclusion Elicitation of the patient perspective using the CIT allowed for the rich description of safety deficiencies that occur in general practice. Given that patients bring a unique and important viewpoint on safety, there is a need to make greater efforts to include the patient perspective of safety in healthcare.	
Simulation in Healthcare				
An assessment of the simulated performance of basic clinical procedures by junior doctors during the first year of clinical practice	O'Connor, P., Reid, A., Mongan, O. *et al.*	2023	Background Upon entering the healthcare system, junior doctors may lack the skills required to care for patients, and feel unprepared for their role, with considerable variation in the level of proficiency in the performance of particular clinical procedures. Objective To compare the performance and proficiency (self-report and observed) of the performance of nine basic clinical procedures. Methods Seventeen interns were observed performing nine clinical procedures in a simulated setting in June 2021 (Assessment 1) and January 2022 (Assessment 2). The observers identified whether each step in the procedure was performed correctly, and provided an overall assessment of proficiency. The participants also rated their own level proficiency. Results At Assessment 1 the number of steps performed correctly ranged from a mean of 41.9–83.5%. At Assessment 2 the number of steps performed correctly ranged from a mean of 41.9–97.8%. The most common median proficiency rating for	*BMC Med Education* https://doi.org/10.1186/s12909-023-04545-1

			Assessment 1 was 'close supervision', and was 'indirect supervision' at Assessment 2. There was a significant and large effect size in the improvement in performance from Assessment 1 to Assessment 2. Low correlations were found between observer and self-reported proficiency in performance of the procedures. Conclusions The large improvement in performance across the two assessments is encouraging. However, there is a need to address the variability in performance on graduation from medical school, and to ensure that any assessment of proficiency is not only reliant on self-report.	
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	Vallières F, Ward ME, Shields D *et al.*	2023	Background: Over 70% of the general population have experienced at least one psychologically traumatic event in their lifetime, with 30.5% experiencing four or more events. Recognising the prevalence and potentially injurious effects of psychological trauma among healthcare workers and patients alike is considered important to ensure patient engagement, quality of care, positive health outcomes, as well as improved staff wellness, and more resilient health systems. Aim: The current project aims to improve the experience of both patients and staff in two acute hospital settings in St James' Hospital (SJH): the Emergency Department (ED) and Acute Medical Assessment Unit (AMAU). This will be achieved through the development of a translational simulation improvement programme for trauma-informed care (TS4TIC). The objective of trauma-informed care (TIC) in the acute hospital setting is to reduce the impact of previous trauma on the care experience. Methods: Underpinned the Institute for Healthcare Improvement (IHI) Model for Improvement we will (i) co-design a TIC improvement programme for use in acute hospital settings using translational simulation (TS) approaches, (ii) implement TS4TIC in two acute hospital settings, and (iii) co-evaluate the effectiveness and acceptability of TS4TIC using co-defined outcome, process, and balancing indicators measured across iterative Plan, Do, Study, Act (PDSA) cycles. Expected Outcome: The project's completion will result in a co-designed, open access *TS4TIC Toolkit*, consisting of a suite of TS scenarios and accompanying monitoring and training resources to guide the adaptation of this approach for use in other acute healthcare settings nationally and internationally.	[version 1; peer review: awaiting peer review]. *HRB Open Research* https://doi.org/10.12688/hrbopenres.13727.1

Experiential training for situation awareness in the operating room: Teaching novice surgical residents to anticipate and plan	O'Dea, A., Morris, M., & O'Keeffe, D.	2022	The fast-paced perioperative environment calls not only for expert clinical knowledge and technical skill but also the ability of the surgical team to gather and share information in real time. This ensures that an accurate understanding of all patient and environmental factors is developed and maintained throughout the operative procedure. This understanding is termed situation awareness (SA) and it is crucially important for surgical teams because it underpins accurate decision making, timely communication and appropriate leadership. The Royal College of Surgeons Ireland (RCSI) has developed a one-day training program to support the development of SA in junior surgeons. The program utilizes the educational principles of experiential learning following Kolb's Learning Cycle. The training program has 3 components: knowledge acquisition, simulation and debriefing. **The knowledge component** introduces situation awareness as a cognitive skill that places demands on surgeons' working, short term and long term memory and is highly susceptible to cognitive bias. Learners are introduced to the behaviors involved in developing and maintaining SA and the types of errors that can arise. Strategies to develop, maintain and regain SA are explored. **The simulation component** has three parts: the pre-operative huddle, the clinical event and the after action review. In the *pre-operative huddle* multiple cases which constitute an operative list are presented and discussed. The team must co-ordinate, delegate and communicate with individuals across the hospital, in order to complete the tasks required to ensure smooth running of the planned list. The second part of the simulation component is *the operative case*. How well SA has been managed in the pre-operative phase will determine how the case unfolds. This phase reinforces learning of procedural knowledge and skills relating to specific complications. Cases also provide a platform for learners to develop behavioral repertoires such as, surgical time out, using cognitive aids, monitoring performance and speaking up, that are context fluid. The third part of the simulated event is *the after action review*. A learner facilitates the discussion which is structured around four questions: 1. What did we expect to happen? 2. What actually happened? 3. Why was there a difference? 4. What have we learned? The outcome of this discussion enables the individuals involved in the event to understand what went well and why and what didn't go well and why. **The debriefing component** aims to enhance experiential learning by applying conversational techniques to support the learner to analyze action and reflect on	JAMA Surgery. Surgical Innovation. doi:10.1001/jamasurg.2021.4886. https://jamanetwork.com/journals/jamasurgery/article-abstract/2786064

			thoughts that drive actions. Advocacy inquiry is the tool used to explore frames. Through this method, cognitive biases, flawed or faulty mental models or inaccurate knowledge schema that underpinned the decision or action can be explored.	
SafePsych: Improving patient safety by delivering high-impact simulation training on rare and complex scenarios in psychiatry	Tong, K., McMahon, E., Reid-McDermott, B., Byrne, D., & Doherty, A.	2021	Abstract Introduction: Despite an evidence base demonstrating simulation to be an effective medical education tool, it is not commonly used in postgraduate psychiatry training as it is in other medical specialties. Objective: This paper outlines the development and effectiveness of a hybrid-virtual simulation-based workshop designed to improve patient care by improving clinical skills of non-consultant hospital doctors (NCHDs) in detecting and managing rare and complex psychiatric emergencies. Methods: Three clinical vignettes based on near-miss psychiatric cases were developed by a multidisciplinary team of physicians and nurses in psychiatry and experts in simulation-based medical education. The workshop, 'SafePsych' was delivered in a simulation laboratory while and broadcast via Zoom video-conferencing platform to observers. Debriefing followed each clinical scenario. Participants completed preworkshop and postworkshop questionnaires to evaluate clinical knowledge. Results: The workshop was attended by consultants (n=12) and NCHDs in psychiatry and emergency medicine (n=19), and psychiatric nurses (n=5). In the psychiatry NCHD group, test scores significantly improved following the workshop ($p<0.001$). There were significant improvements in the test scores with a mean difference of 2.56 (SD 1.58, $p<0.001$). Feedback from participants and observers was positive, with constructive appraisals to improve the virtual element of the workshop. Conclusion: Simulation-based training is effective in teaching high risk, rare complex psychiatric cases to psychiatry NCHDs. Further exploration of the learning needs of nursing staff is required. Future workshop delivery is feasible in the COVID-19 environment and beyond, using a virtual element to meet social distancing requirements while enhancing the reach of the training.	BMJ Open Quality https://doi.org/10.1136/bmjoq-2021-001533
Objective assessment of surgical	DA O'Keeffe et al.	2020	Background Non-technical skills (NTS) encompass personal skills such as communication, situational awareness, decision making, teamwork and leadership. Poor	The American Journal of Surgery

trainees' non-technical skills: Improved performance following a two-year program of instruction			performance of these skills has been shown to contribute to medical error. The Royal College of Surgeons in Ireland (RCSI) has delivered a mandatory program of instruction in NTS to all surgical trainees since 2005. We investigated whether the NTS of surgical trainees improved after the first two years of this program. Methods Baseline data was collected in a three-station OSCE assessment of NTS at the beginning of Year one and again at end of Year two of surgical training. Results Trainees' mean percentage NTS scores improved significantly over the two-year period for the NTS assessment ($P < .001$). A significant difference was demonstrated using within-subject (paired) t-tests between the Year one and two time points for all three OSCE stations: Consent (-5.39; $P < .001$); Colleague Conflict (-8.63; $P < .001$); and Disclosure of Error (-7.56; $P < .001$). Conclusions RCSI offers a unique mandatory program of instruction in NTS. There was a statistically and practically significant improvement in the NTS scores of surgical trainees over the two-year period of the program.	https://doi.org/10.1016/j.amjsurg.2020.04.039
Effect of a proficiency-based progression simulation programme on clinical communication for the deteriorating patient: a randomised controlled trial	Breen, D., O'Brien, S., McCarthy, N., Gallagher, A. and Walshe, N	2019	Objective This study aimed to determine the effectiveness of a proficiency-based progression (PBP) training approach to clinical communication in the context of a clinically deteriorating patient. Design This is a randomised controlled trial with three parallel arms. Setting This study was conducted in a university in Ireland. Participants This study included 45 third year nursing and 45 final year medical undergraduates scheduled to undertake interdisciplinary National Early Warning Score (NEWS) training over a 3-day period in September 2016. Interventions Participants were prospectively randomised to one of three groups before undertaking a performance assessment of the ISBAR (Identification, Situation, Background, Assessment, Recommendation) communication tool relevant to a deteriorating patient in a high-fidelity simulation facility. The groups were as follows: (i) E, the Irish Health Service national NEWS e-learning programme only; (ii) E+S, the national e-learning programme plus standard simulation; and (iii) E+PBP, the national e-learning programme plus PBP simulation.	BMJ Open Journal https://doi.org/10.1136/bmjopen-2018-025992

			Main outcome measures The primary outcome was the proportion in each group reaching a predefined proficiency benchmark comprising a series of predefined steps, errors and critical errors during the performance of a standardised, high-fidelity simulation assessment case which was recorded and scored by two independent blinded assessors. Results 6.9% (2/29) of the E group and 13% (3/23) of the E+S group demonstrated proficiency in comparison to 60% (15/25) of the E+PBP group. The difference between the E and the E+S groups was not statistically significant (χ^2=0.55, 99% CI 0.63 to 0.66, p=0.63) but was significant for the difference between the E and the E+PBP groups (χ^2=22.25, CI 0.00 to 0.00, p<0.000) and between the E+S and the E+PBP groups (χ^2=11.04, CI 0.00 to 0.00, p=0.001). Conclusions PBP is a more effective way to teach clinical communication in the context of the deteriorating patient than e-learning either alone or in combination with standard simulation.	
Measurement & Monitoring of Safety				
Measuring and monitoring patient safety in hospitals in the Republic of Ireland	Kaud, Y., McKeon, D., Lydon, S. *et al*	2023	Background Measuring and monitoring safety (MMS) is critical to the success of safety improvement efforts in healthcare. However, a major challenge to improving safety is the lack of high quality information to support performance evaluation. Aims The aim of this study was to use Vincent et al.'s MMS framework to evaluate the methods used to MMS in Irish hospitals and make recommendations for improvement. Methods The first phase of this qualitative study used document analysis to review national guidance on MMS in Ireland. The second phase consisted of semi-structured interviews with key stakeholders on their understanding of MMS. The MMS framework was used to classify the methods identified. Results Six documents were included for analysis, and 24 semi-structured interviews were conducted with key stakeholders working in the Irish healthcare system. A total of 162 methods of MMS were identified, with one method of MMS addressing two dimensions. Of these MMS methods, 30 (18.4%) were concerned with past harm, 40 (24.5%) were concerned with the reliability of safety critical	Irish Journal of Medical Science https://doi.org/10.1007/s11845-023-03336-3

			processes, 16 (9.8%) were concerned with sensitivity to operations, 28 (17.2%) were concerned with anticipation and preparedness, and 49 (30%) were concerned with integration and learning. Conclusions There are a wide range of methods of MMS in Irish hospitals. It is suggested that there is a need to identify those methods of MMS that are particularly useful in reducing harm and supporting action and improvement and do not place a large burden on healthcare staff to either use or interpret.	
Progressing patient safety in the Emergency Medical Services	Lydon S, Masterson S, Deasy C, et al.	2023	Patients are vulnerable during emergency episodes outside the formal care sector, for example, care provided by paramedics responding to a stroke or heart attack at home. Yet much less is known about the safety of Emergency Medical Services (EMS) as compared with primary or secondary healthcare.1 This relative lack of information is important given there are aspects of EMS care that create unique patient safety challenges. EMS staff are not surrounded by the usual safety infrastructure one finds in hospitals or community facilities. The episodic nature of each interaction means EMS staff lack the information one finds in more predictable care contexts. Even in highly developed EMS systems, patient history will be unavailable. This results in an almost complete reliance on the patient, family/carer or bystander to describe pertinent clinical history such as 'do not resuscitate' plans for the patient, or how the current emergency is connected to previous care… lack of attention to the issue of patient safety in the EMS that is detrimental for both patients and EMS care providers. It is now time for attention to how we can, and must, provide guidance for improving patient safety in the EMS.	BMJ Quality and safety *http://dx.doi.org/10.1136/bmjqs-2023-016184*
A meta-review of methods of measuring and monitoring safety in primary care	O'Connor, P., Madden, C., O'Dowd, E., Byrne, D., & Lydon, S.	2021	Background A major barrier to safety improvement in primary care is a lack of safety data. The aims of this systematic meta-review (registration: CRD42021224367) were to identify systematic reviews of studies that examine methods of measuring and monitoring safety in primary care; classify the methods of measuring and monitoring safety in the included systematic reviews using the five safety domains of Vincent *et al.*'s framework and use this information to make recommendations for improving the measurement and monitoring of safety in primary care. Methods	International journal for quality in health care https://doi.org/10.1093/intqhc/mzab117

			Four databases (Medline, Academic Search Complete, Web of Science and CINAHL) and the grey literature were screened in November 2020, with searches updated in January 2021. Systematic reviews were included if they addressed the measurement of patient safety in primary care and were published in English. Studies were assessed using the Critical Appraisal Skills Programme for systematic reviews. Results A total of 6904 papers were screened, with 13 systematic reviews included. A commonly reported method of measuring 'past harm' was through patient record review. The most frequent methods for assessing the 'reliability of safety critical processes' were checklists, observations and surveys of staff. Methods used to assess 'sensitivity to operations' included observation, staff surveys, interviews, focus groups, active monitoring and simulated patients. Safety climate surveys were a commonly used as an approach to assess 'anticipation and preparedness'. A number of the reviews concluded that safety data could, and should, be used for 'integration and learning'. The main limitation of the meta-review was that it was of systematic reviews only. Conclusions Many of the methods for measuring and monitoring safety are readily available, quick to administer, do not require external involvement and are inexpensive. However, there is still a need to improve the psychometric properties of many measures. Researchers must support the development of psychometrically sound safety measures that do not over burden primary care practitioners. Policymakers must consider how primary care practitioners can be supported to implement these measures.	
Systems Analysis / Systems Improvement				
Making a Sustainable Difference to People, Processes and Systems: Whole-Systems Approaches to	McNamara, M., Ward, M., & Teeling, S. P.	2023	Introduction The eighteen papers in this Special Issue, 'Whole-Systems Approaches to Process Improvement in Health Systems', address an enduring challenge in healthcare: to improve efficiency with existing or reduced resources, while maintaining safe and effective care. Process improvement methodologies such as Lean, Six Sigma and Lean Six Sigma are increasingly being deployed to address inefficiencies in healthcare. However, a systems perspective is now considered to be the key to sustainable healthcare improvement and results in statistically significant	International Journal of Environmental Research and Public Health http://dx.doi.org/10.3390/ijerph20075232

Process Improvement in Health Systems			improvement of both patient and service outcomes. It is important, therefore, to pay close attention to the impact of the wider healthcare system on the design and implementation of process improvement methodologies. In the wake of the COVID-19 pandemic, it is clearer than ever that person-centred approaches to change are essential if we are to improve staff and patient experiences. Such approaches help staff to find joy and meaning in their work and to remain working in healthcare, enabling patients to be cared for in an environment that supports their wellbeing in a genuinely holistic sense. This Special Issue focuses on how and to what extent process improvement initiatives across a range of clinical contexts can enhance staff and patient experiences of providing and receiving care and clinical outcomes. These eighteen papers fall into three broad areas: (1)Lean, Six Sigma and Lean Six Sigma studies embedded within a system-wide improvement programme. (2)Person-centredness and system improvement. (3)Systems approaches to change and improvement.	
A Case Study of a Whole System Approach to Improvement in an Acute Hospital Setting	Ward, M.E., Daly, A., McNamara, M., Garvey, S. and Teeling, S.P.	2022	Changes in healthcare tend to be project-based with whole system change, which acknowledges the interconnectedness of socio-technical factors, not the norm. This paper attempts to address the question of whole system change posed by the special issue and brings together other research presented in this special issue. A case study approach was adopted to understand the deployment of a whole system change in the acute hospital setting along four dimensions of a socio-technical systems framework: culture, system functioning, action, and sense-making. The case study demonstrates evidence of whole system improvement. The approach to change was co-designed by staff and management, projects involving staff from all specialities and levels of seniority were linked to each other and to the strategic objectives of the organisation, and learnings from first-generation projects have been passed to second and third-generation process improvements. The socio-technical systems framework was used retrospectively to assess the system change but could also be used prospectively to help healthcare organisations develop approaches to whole system improvement.	International Journal of Environmental Research and Public Health https://doi.org/10.3390/ijerph19031246
A socio-technical	Geary, U., Ward, M.E.,	2022	The scale and pace of improvement in patient safety in healthcare has been unacceptably slow. A paucity of research into the application of systems-thinking	Applied Ergonomics

systems analysis of the application of RFID-enabled technology to the transport of precious laboratory samples in a large acute teaching hospital	Callan, V., McDonald, N. and Corrigan, S.		concepts and a failure to appreciate health systems complexity are cited as barriers to sustainable health systems improvement. This study reports on a socio-technical systems analysis, called the CUBE, of the characteristics of a large acute teaching hospital's system for the transport of precious specimens, a system enabled by radio-frequency identification tracking technology. The CUBE proved itself to be an effective analytic tool. The analysis provided a constructive framework to link diverse data and documentation; explicitly inviting consideration of the roles and understandings of different stakeholders; as well as broader cultural factors that could influence current or future activity. The analysis also supported recommendations to improve and extend operations. This study supports the argument for systems understanding and systems thinking being at the core of new approaches to patient safety.	https://doi.org/10.1016/j.apergo.2022.103759
Ward rounds – A socio-technical system informed analysis of the perceptions of intern and senior house office doctors	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	Background Ward rounds (WRs) are a daily organisational process in hospitals. Studies have found variation however in the definition and objectives of WRs, where they take place, who partakes in them and how they impact patient care. Objectives This study was undertaken as part of a longitudinal improvement project in relation to WRs taking a socio-technical systems approach. The objective of this study was to explore junior doctors understanding of the goals, process sequence, social relations particularly understanding of roles and responsibilities, and information and knowledge in relation to WRs. We also wished to hear junior doctors' perceptions of how WRs may be improved. Methods Our study took place in a large 1000 bed acute teaching hospital. A survey was developed by the improvement project team and administered to junior doctors at the hospital (n=148). Results A response rate of 30.4% was achieved (n=45 completing the survey). Junior doctors perceive the primary goals of WRs to be reviewing patient history and current status (39%) and progressing care plans (38%). They believe their main role on WRs to be writing notes (46.5%). 75% of participants reported that they fully understood their responsibilities on WR, while 67% fully understood the	Human Factors in Healthcare https://doi.org/10.1016/j.hfh.2022.100027

			responsibilities of others. 80% reported learning on WRs lower than all other forms of learning. Conclusions The findings of this study will help inform our current 'AS IS' understanding of WR practice and co-design of improvements. We would argue that further systems level research is needed to examine the impact of lack of agreed goals; clarity in relation to roles and responsibilities; involvement of nursing and health and social care professionals in the WR, and perceived educational value of WRs on staff and patient outcomes.	
A STS analysis of an effective bio-security responder in Trinidad during COVID-19 pandemic in Irish Human Factors & Ergonomics Society Review	Daniel, D.K. & Ward, M.E.	2021	Background Computer use has been associated with the development of musculoskeletal symptoms (MSS). Previous research on working populations has demonstrated associations between computer-related MSS and age (Shuval and Donchin, 2005), female gender (Madeleine et al., 2013), longer computing time (Shuval and Donchin, 2005) (Madeleine et al., 2013), poor posture (Eltayeb et al., 2009) and poor workstation design (Ye et al., 2017). However, the factors associated with remote working have not been adequately addressed, despite the fact that many employees, including university staff, frequently conduct some or all of their work remotely (Crawford et al., 2011; James et al., 2018). With restrictions imposed by the COVID-19 pandemic, workers from many sectors, including the higher education sector, have been required to work from home and it was likely they were required to have greater screen time than they would when working onsite (Crawford et al., 2011). A recent questionnaire survey of employees in Ireland investigated aspects concerning remote working during the COVID-19 pandemic (McCarthy et al 2020). The study identified that 'physical workspace' was one of the top three challenges for the respondents when working remotely, although the specific aspects were not explored. This current study investigated the pattern of computer use, physical characteristics of onsite and remote computer workstations, and the prevalence and impact of computer-related MSS among university staff in an Irish university during the COVID-19 pandemic.	Proceedings of the Irish Human Factors & Ergonomics Society Annual Conference http://www.tara.tcd.ie/bitstream/handle/2262/98222/Irish%20Ergonomics%20Review%202021.pdf?sequence=1#page=28
A study of how to effectively leverage incident	Mc Caughan, C.	2020	Purpose: The purpose of this thesis was to explore how to effectively leverage incident investigations to better inform system safety. Method: Four studies were conducted to achieve the purpose of this research. Study 1 used an iterative action research approach to develop and test an Investigation Quality	Thesis submitted for the degree of Doctor of Philosophy to Trinity college Dublin

investigations to better inform system safety.			Evaluation Tool (IQET) to rigorously and reliably evaluate the quality of serious incident investigation reports, including evaluating what Dekker (2006) referred to as the analytic trace for investigation findings. Study 2 applied the IQET to evaluate the quality of serious incident investigation reports assigning Investigation Quality Scores (IQS) and identifying what was done well and what needed to improve. Study 3 used data from (i) the evaluation of investigation quality, and (ii) attendance at investigation training - to empirically test hypothesis about the determinants of investigation quality. Study 4 conducted a thematic analysis of further details of contributory factors identified in investigation reports to identify patterns in causal factors. Results: Study 1 showed reasonable IQET inter-rater reliability whereby this was excellent in 55.5% (n=5) of cases (kappa value ranging from .756 – .859), and fair to good in the remaining 44.44% of cases (n=4) (kappa value ranging from .418 - .587). Study 2 found that IQSs ranged from 13.79% - 78.13% with a mean of 45.17%. Elements satisfactorily done most frequently included placing events in chronological order in the chronology, and evidence of review of records. Elements not satisfactorily done related to generalizing from investigations, and not using the hierarchy of controls to develop recommendations. Study 3 revealed that there was a positive statistically significant correlation between IQS and (i) attendance at NIMLT2 training; (ii) having investigation expertise on the investigation team; (iii) having a team of not less than 2 and not more than 3 investigators; (iv) conducting individual interviews; and (v) adherence to the definition of Key Causal Factor (KCF) in investigation guidelines. Study 4 identified nine main 2 NIMLT: National Incident Management and Learning Team 7 themes in causal factors including (i) Care pathways, PPPGs and other tools that support care delivery (ii) education, training and supervision; and (iii) Governance and risk management. Conclusions: This thesis shows that it is possible to develop a reliable tool to comprehensively evaluate the quality of investigation reports and that data from this can be used to empirically test hypotheses about the determinants of investigation quality. It reflects analysis at a deeper level of causal factors to identify patterns in causal factors in a larger batch of investigations from a wider span of the health system than done in previous research. It reveals that the outcome of this analysis identifies emergent system features which (i) add to information about existing risks, (ii) identify newly	http://www.tara.tcd.ie/bitstream/handle/2262/91307/13.01.2020%20Final%20Version%20PhD%20Thesis%20for%20eSubmission%20and%20Hardbound%20Printing.pdf?sequence=1

			emerging risks, and (iii) are important for informing safety improvement across the organisation. It achieves a resolution of the contradiction between the complexity of the system and the need to identify sufficient cause to implement prevention. Above all, the findings of this thesis supports a change in the concept of how to generalize from investigations for system wide learning, and presents a model of how to continuously improve how to do this.	
A Socio-Technical Exploration for Reducing & Mitigating the Risk of Retained Foreign Objects	Corrigan, S., Kay, A., O'Byrne, K., Slattery, D., Sheehan, S., McDonald, N., Smyth, D., Mealy, K. and Cromie, S.	2018	A Retained Foreign Object (RFO) is a fairly infrequent but serious adverse event. An accurate rate of RFOs is difficult to establish due to underreporting but it has been estimated that incidences range between 1/1000 and 1/19,000 procedures. The cost of a RFO incident may be substantial and three-fold: (i) the cost to the patient of physical and/or psychological harm; (ii) the reputational cost to an institution and/or healthcare provider; and (iii) the financial cost to the taxpayer in the event of a legal claim. This Health Research Board-funded project aims to analyse and understand the problem of RFOs in surgical and maternity settings in Ireland and develop hospital-specific foreign object management processes and implementation roadmaps. This project will deploy an integrated evidence-based assessment methodology for social-technical modelling (Supply, Context, Organising, Process & Effects/ SCOPE Analysis Cube) and bow tie methodologies that focuses on managing the risks in effectively implementing and sustaining change. It comprises a multi-phase research approach that involves active and ongoing collaboration with clinical and other healthcare staff through each phase of the research. The specific objective of this paper is to present the methodological approach and outline the potential to produce generalisable results which could be applied to other health-related issues.	International Journal of Environmental Research and Public Health https://doi.org/10.3390/ijerph15040714
HFE Tools and approaches in healthcare				
The medication self-management work system of patients and informal carers from a human factors & ergonomics	Negoescu E, Marcilly R, Cromie S *et al.*	2023	Background: Healthcare is increasingly delivered closer to the patients' homes, which increases the level of responsibility that patients and informal carers take for managing their medication-taking, although this is associated with hazards. Medication self-management has been conceptualised as work taking place in non-formal settings (*e.g.*, households), which are complex systems. Human factors and ergonomics (HFE) models provide a framework for studying such systems. The Systems Engineering Initiative for Patient Safety (SEIPS) is one framework that considers work system elements and how they interact with each other to shape processes that lead to outcomes (*e.g.*, safety). Given the	HRB Open Research https://doi.org/10.12688/hrbopenres.13674.1

perspective: A scoping review protocol			increasing amount of diverse research on patient and carer work and on system-shaping factors, the objectives of this review are to: (i) identify available evidence in a structured and systems-oriented way, (ii) explore approaches that have been applied and (iii) highlight research gaps. Methods: An evidence-informed patient, public and carer involvement (PPCI) approach will be implemented at all post-protocol stages to ensure the relevance, uptake and translation of the scoping review. The review will systematically search MEDLINE, Embase, PsycInfo, CINAHL and Web of Science to identify relevant qualitative studies. The methodological approach will be guided by Johanna Briggs Institute methodology and will be reported according to the PRISMA-ScR standards. Data charting and qualitative content analysis directed by SEIPS will explore how the work system and its constituting elements have been described in the literature and identify specific gaps and opportunities for future research. Borrowing from realist approaches, included studies will be assessed in terms of richness and relevance to our review question. Discussion: Strengths of this scoping review include PPCI and a converging focus on medication safety, medication self-management and HFE. Ultimately, this approach will advance our understanding of this complex system and guide opportunities to broaden and strengthen the evidence base.	
Employee silence in health care: Charting new avenues for leadership and management.	Montgomery A., Lainidi O., Johnson J., Creese J., Baathe F., Baban A., Bhattacharje e A,, Carter M., Dellve L., Doherty, E., Jendeby, MK., Morgan K., Srivastava M., Thompson	2023	Health care management is faced with a basic conundrum about organizational behavior; why do professionals who are highly dedicated to their work choose to remain silent on critical issues that they recognize as being professionally and organizationally significant? Speaking-up interventions in health care achieve disappointing outcomes because of a professional and organizational culture that is not supportive. Critical Theoretical Analysis Our understanding of the different types of employee silence is in its infancy, and more ethnographic and qualitative work is needed to reveal the complex nature of silence in health care. We use the sensemaking theory to elucidate how the difficulties to overcoming silence in health care are interwoven in health care culture. Insight/Advance The relationship between withholding information and patient safety is complex, highlighting the need for differentiated conceptualizations of silence in health	Health Care Management Review Employee silence in health care: Charting new avenues for leadership and management - PubMed (nih.gov)

	N., Tyssen R., Vohra V		care. We present three Critical Challenge points to advance our understanding of silence and its roots by (1) challenging the predominance of psychological safety, (2) explaining how we operationalize sensemaking, and (3) transforming the role of clinical leaders as sensemakers who can recognize and reshape employee silence. These challenges also point to how employee silence can also result in a form of dysfunctional professionalism that supports maladaptive health care structures in practice. Practice Implications Delineating the contextual factors that prompt employee silence and encourage speaking up among health care workers is crucial to addressing this issue in health care organizations. For clinical leaders, the challenge is to valorize behaviors that enhance adaptive and deep psychological safety among teams and within professions while modeling the sharing of information that leads to improvements in patient safety and quality of care.	
Acknowledging and nurturing complementary leadership contributions	Ward M.E. & Vaughan D (2021)	2021	Distributing leadership practices, while not new, are certainly a challenging idea in healthcare given the current dominance of traditional hierarchical medical-led models. The chapter lays out some lessons that have been learned in the field of patient safety that can help support the development of distributed leadership in other areas of healthcare. The examples given focus in particular on what we believe is the area that has been most neglected in healthcare patient safety – safety culture.	In Distributed Leadership in Nursing and Healthcare: Theory, Evidence and Development https://books.google.co.uk/books?hl=en&lr=&id=9MgvEAAAQBAJ&oi=fnd&pg=PA29&dq=Acknowledging+and+nurturing+complementary+leadership+contributions&ots=T4bzfqM0At&sig=6Xfx7qv_VExXPFof4i05fvxjoN0#v=onepage&q=Acknowledging%20and%20nurturing%20complementary%20leadership%20contributions&f=false
The Surgical Safety Huddle: A	Cullinane C, Healy C,	2021	Background: Acutely deteriorating patients are entitled to the best possible care, which includes early recognition and timely appropriate intervention to reduce	Patient Safety

Novel Quality Improvement Patient Safety Initiative	Doyle M, McCarthy H, Costigan C, Breen D		adverse events, unnecessary admissions to intensive care, and/or cardiac arrest. Aim: To reduce the number of poor outcomes for surgical patients with a National Early Warning Score (NEWS) score ≥7 in our institution by 50%. A poor outcome was defined as: 1. Cardiac arrest 2. NEWS >7 not improving after 72 hours 3. Transfer to intensive care unit >6 hours Methods: Surgical inpatients from a variety of surgical specialties (general, vascular, breast, colorectal, hepatobiliary, and plastic surgery) in a large university teaching hospital were included. Quality improvement tools were used to generate regular dialogue with the clinical teams, resulting in the concept of the surgical safety huddle being proposed. Deteriorating patients were highlighted at the daily huddle and a plan of early intervention was implemented. An incremental approach with continuous PDSA [Plan-Do-Study-Act] cycles and subsequent feedback was adopted on the surgical ward to develop the huddle. Poor patient outcomes were analysed prospectively via chart reviews. Results: Prior to the introduction of the "surgical huddle" 110 patients with NEWS >7 were audited. Twenty-eight of these patients had a poor outcome at 72 hours (25%). Following the introduction of the surgical huddle supported by the deteriorating patient team, 64 patients with NEWS >7 were reviewed. Three of these patients had a poor outcome at 72 hours (4.7%). The introduction of the surgical huddle increased the interval between cardiac arrests more than six fold on the surgical ward. Discussion: The introduction of the surgical safety huddle supported by the deteriorating patient response team reduced the number of cardiac arrests and poor outcomes in a surgical inpatient cohort.	https://doi.org/10.33940/data/2021.6.5
Medication Errors in Anesthesiology: Is It Time to Train by Example? Vignettes Can Assess Error Awareness, Assessment of Harm,	Duffy, C.C., Bass, G.A., Duncan, J., Lyons, B. and O'Dea, A.	2020	Background Perioperative medication errors (MEs) are complex, multifactorial, and a significant source of in-hospital patient morbidity. Anesthesiologists' awareness of error and the potential for harm is not well understood, nor is their attitude to reporting and disclosure. Anesthesiologists are not routinely exposed to medication safety training. Methods Ten clinical vignettes, describing an ME or a near miss, were developed using eDelphi consensus. An online survey instrument presented these vignettes to anesthesiologists along with a series of questions assessing error awareness, potential harm severity, the likelihood of reporting, and the likelihood of open	Journal of Patient Safety Employee silence in health care: Charting new avenues for leadership and management - PubMed (nih.gov)

Disclosure, and Reporting Practices			disclosure to the patient. The study also explored the influence of prior medication safety training. Results Eighty-nine anesthesiologists from 14 hospitals across Ireland (53.9% were residents, and 46.1% were attendings) completed the survey. Just 35.6% of anesthesiologists recalled having had medication safety training, more commonly among residents than attendings, although this failed to reach significance ($P <$ 0.081). Medication error awareness varied with the vignette presented. Harm severity assessment was positively associated with error awareness. The likelihood of patient disclosure and incident reporting was both low and independent of harm severity assessment. Conclusions Perioperative ME awareness and assessment of potential harm by anesthesiologists is variable. Self-reported rates of incident reporting and error disclosure fall short of the standards that might apply in an environment focused on candor and safety. An extensive education program is required to raise awareness of error and embed appropriate reporting and disclosure behaviors. Vignettes, designed by consensus, may be valuable in the delivery of such a curriculum.	
Safety culture in health care teams: A narrative review of the literature	O'Donovan, R., Ward, M., De Brún, A. and McAuliffe, E.	2019	Aim Explore the recent literature to examine the factors that affect safety culture within health care teams. Background Health care organisations must understand and improve their safety culture. However, safety culture is a complex phenomenon which interacts with a myriad of factors, making it difficult to define, measure and improve. Evaluation A comprehensive search strategy was used to search four major databases. Peer-reviewed which were published in English between 2006 and 2017 and presented research studies related to safety culture in health care teams were included. A narrative analysis was undertaken. Key issues	Journal of Nursing Management https://doi.org/10.1111/jonm.12740

			Issues relevant to the definition, measurement and improvement of safety culture, the impact of teamwork and communication on safety culture, the role of leaders and accountability are explored. Conclusion The above themes inform our understanding of developing, measuring and sustaining safety culture in health care teams. However, further research is warranted to accurately understand how to measure and improve safety culture. Implications for nursing management To support a safety culture, initiatives to facilitate effective communication between nurse practitioners and other health care professionals must be introduced. Nurse managers should adopt leadership strategies that will support nurses' psychological safety and create a just culture.	
Do safety briefings improve patient safety in the acute hospital setting? A systematic review	Ryan, S., Ward, M., Vaughan, D., Murray, B., Zena, M., O'Connor, T., Nugent, L. and Patton, D.	2019	Aims To synthesize current knowledge about the impact of safety briefings as an intervention to improve patient safety. Background Improving safety in health care remains an ongoing challenge. There is a lack of evidence underpinning safety enhancing interventions. Design Mixed method multi-level synthesis. Data Sources Four health literature databases were searched (Cinahl, Medline, Scopus and Health Business Elite) from January 2002 – March 2017. Review Methods Thomas and Harden approach to mixed method synthesis. Results Following quality appraisal, 12 studies were included. There was significant heterogeneity in study aims, measures, and outcomes. Findings showed that safety briefings achieved beneficial outcomes and can improve safety culture. Outcomes included improved risk identification, reduced falls, enhanced relationships, increased incident reporting, ability to voice concerns, and reduced length of stay. Conclusion	Journal of Advanced Nursing https://doi.org/10.1111/jan.13984

			Healthcare leaders should embrace the potential of safety briefings by promoting their effective use whilst allowing for local adaptation.	
The application of human reliability analysis to three critical care procedures	Reddy, K., Byrne, D., Breen, D., Lydon, S. and O'Connor, P.	2020	Background Procedures carried out in the intensive care unit are prone to human error. Standardisation has been suggested as an approach for reducing errors. This study used human reliability analysis methodologies to examine commonly performed critical care procedures: endotracheal suctioning; ultrasound-guided right internal jugular vein cannulation; and rapid-sequence intubation. Methods The subgoals, or individual steps, required to complete the three procedures were identified using hierarchical task analysis. The systematic human error reduction and prediction approach was then used to identify potential human errors at each subgoal, the level of risk and how these potential errors could be prevented. Results Endotracheal suctioning procedure was broken down into 129 subgoals, of which 49 (38.0%) were high-risk. Ultrasound-guided right internal jugular venous cannulation was divided into 224 subgoals, of which 131 (58.4%) were medium-risk, and 20 (8.9%) were identified as high-risk. Rapid sequence intubation was divided into 167 subgoals. A total of 73 (43.7%) of these subgoals were judged to be high-risk. Conclusions The use of human reliability analysis techniques can support healthcare professionals to gain an in-depth understanding of how particular procedures are carried out in order to reduce the risk of, and improve training in, how to perform these procedures.	Reliability Engineering & System Safety https://doi.org/10.1016/j.ress.2020.107116
Informing healthcare team performance: Integrating data to improve quality and safety	Ward, M., McAuliffe, E., Fitzsimons, J. and O'Donovan, R.	2019	A worldwide rising demand for health care means increasing resource investment in health systems, with the concomitant requirement for greater accountability. Greater accountability requires the generation of more and more data and information. Health care is frequently described as fragmented or siloed, and this is reflected in how data is captured, managed, and shared throughout the system. Data relating to business performance, quality, and patient safety is extracted from different systems, and its primary use is to inform senior decision makers about organizational-level performance.	International Perspectives in Psychology https://doi.org/10.1037/ipp0000101

			Meanwhile, health care teams at a local level when asked if they are performing well in relation to quality and safety are often unable to answer this question. This policy brief summarizes the results of a study undertaken as part of the Collective Leadership for Safety Culture research program to codesign a suite of quality and safety performance indicators to assist acute hospital health care teams to monitor and improve their quality and safety performance. Recommendations are presented for senior decision makers in the acute hospital setting to inform policy on the gathering and management of Quality and Safety data.	
Prospective Validation of a Checklist to Predict Short-term Death in Older Patients After Emergency Department Admission in Australia and Ireland.	Cardona, M., O'Sullivan, M., Lewis, E.T., Turner, R.M., Garden, F., Alkhouri, H., Asha, S., Mackenzie, J., Perkins, M., Suri, S., Holdgate, A., Winoto, L., Chang, David C.W., Gallego-Luxan, B., McCarthy, S., Hillman, K. and Breen, D.	2018	Background Emergency departments (EDs) are pressured environment where patients with supportive and palliative care needs may not be identified. We aimed to test the predictive ability of the CriSTAL (Criteria for Screening and Triaging to Appropriate alternative care) checklist to flag patients at risk of death within 3 months who may benefit from timely end-of-life discussions. Methods Prospective cohorts of >65-year-old patients admitted for at least one night via EDs in five Australian hospitals and one Irish hospital. Purpose-trained nurses and medical students screened for frailty using two instruments concurrently and completed the other risk factors on the CriSTAL tool at admission. Post discharge telephone follow-up was used to determine survival status. Logistic regression and bootstrapping techniques were used to test the predictive accuracy of CriSTAL for death within 90 days of admission as primary outcome. Predictability of in-hospital death was the secondary outcome. Results A total of 1,182 patients, with median age 76 to 80 years (IRE-AUS), were included. The deceased had significantly higher mean CriSTAL with Australian mean of 8.1 (95% confidence interval [CI] = 7.7–8.6) versus 5.7 (95% CI = 5.1–6.2) and Irish mean of 7.7 (95% CI = 6.9–8.5) versus 5.7 (95% CI = 5.1–6.2). The model with Fried frailty score was optimal for the derivation (Australian) cohort but prediction with the Clinical Frailty Scale (CFS) was also good (areas under the receiver-operating characteristic [AUROC] = 0.825 and 0.81, respectively). Values for the validation (Irish) cohort were AUROC = 0.70 with Fried and 0.77 using CFS. A minimum of five of 29 variables were sufficient for accurate prediction, and a	Academic Emergency Medicine https://doi.org/10.1111/acem.13664

			cut point of 7+ or 6+ depending on the cohort was strongly indicative of risk of death. The most significant independent predictor of short-term death in both cohorts was frailty, carrying a twofold risk of death. CriSTAL's accuracy for in-hospital death prediction was also good (AUROC = 0.795 and 0.81 in Australia and Ireland, respectively), with high specificity and negative predictive values. Conclusions The modified CriSTAL tool (with CFS instead of Fried's frailty instrument) had good discriminant power to improve certainty of short-term mortality prediction in both health systems. The predictive ability of models is anticipated to help clinicians gain confidence in initiating earlier end-of-life discussions. The practicalities of embedding screening for risk of death in routine practice warrant further investigation.	
The Development of a Methodology for Contextual User Research in Healthcare Design Projects.	Healion D, O'Dowd E, Russell S.	2018	The impact of human factors in the usage of medical devices and delivery of healthcare is increasingly being recognized as a significant contributor to patient experience and safety. This paper presents a methodology for undertaking contextual user research during healthcare design projects (in home, primary or acute care settings) by which all relevant human factors of a procedure can be recorded, documented and analyzed. An innovative method of graphically representing the results of this analysis is proposed which visualizes the interactions and interdependencies between all stakeholders and artefacts involved in a procedure and the environment in which it takes place. The proposed methodology is intended to assist researchers, designers, architects and healthcare professionals during the research phase of a healthcare design project to reveal user needs, identify potential risks, provide documentation for regulatory adherence and inform the development of a comprehensive and inclusive design brief. The paper presents the context and development of this systematic process, which draws on empirical and theoretical methodologies, a studio based pedagogy, and the experience of delivering real-world educational design projects in partnership with healthcare clinicians and medical device companies. It also highlights the capacity for this form of learning to align with Universal Design for Learning (UDL) principles. The application of the methodology has the ability to extract key environmental, user and human factors insights. Most importantly, these insights can inform the design process, positively impact on patient experience and safety through improvements in	Studies in Health Technology and Informatics https://pubmed.ncbi.nlm.nih.gov/30371480/

			device development and care delivery, and enable the creation of more inclusive and accessible healthcare solutions.	
Medical device design				
Rapid repair of percutaneous endoscopic gastrostomy tubes using three-dimensional printing: A case series	O'Sullivan, K.J., O'Sullivan, A., Kermavnar, T., McNally, P., Dunne, C., Linnane, B., and O'Sullivan, L.W.	2023	Presented are four cases involving urgent interventions to repair PEG tube failures in PEG dependent patients. We report on the practical utility of 3D printed devices designed for contingency repair of pediatric PEG tubes when other options, including surgical approaches or manufacturer supplied repairs, were not possible. The patients were dependent on PEG for nutrition and/or medication, treated at the University Hospital Limerick or Children's Hospital Ireland – Crumlin, Ireland. Each were unsuitable for surgery. PEG tube fractures occurred in 4 children (2 female, 2 male; aged 6–15 years) with chronic complex medical conditions at 5-6 years dwell time. In each case novel sealing devices were created and customized to address fractured PEG tubes. The designs were 3D printed using biocompatible materials. The PEG tube fractures were effectively sealed with the 3D printed devices within 24 h, and tube potency was completely restored in one case for up to 205 days.	Annals of 3D printed Medicine, Volume 9 https://www.sciencedirect.com/science/article/pii/S2666964122000455#:~:text=The%20designs%20were%203D%20printed,for%20up%20to%20205%20days.
Tape it up: scientific experiment testing the best taping method for intercostal chest drains	Domanska, K., O'Sullivan, A., Mulcahy, N., Galvin, R., Cummins, F	2023		Emergency Medical Journal, 40, 726-727. https://pubmed.ncbi.nlm.nih.gov/37679028/
Design and Initial Testing of a Novel Disposable Oscillating Positive Expiratory Pressure Device,	O'Sullivan, K.J., Linnane, B., McGrath, D., Dunne, C., and O'Sullivan, L.W.,	2023	**Background:** Oscillating positive expiratory pressure (OPEP) devices play a key role in airway clearance, particularly in patients with cystic fibrosis. These devices, however, have the potential to become reservoirs for pathogenic organisms and require daily, or even more frequent, cleaning. This places a large burden on patients and their carers. **Aims:** The objective of this work was to develop a disposable OPEP device, with comparable mechanical performance to commercial devices that negates the need for cleaning after use thus reducing microbiological risks. **Methods:** 3D printing was used to iterate and develop a prototype disposable device (The University of Limerick OPEP, abbreviated to the UL-OPEP) that was	Irish Journal of Medical Science. 192, 2291-2299 https://pubmed.ncbi.nlm.nih.gov/36417107/#:~:text=Results%3A%20The%20prototype%20disposable%20device,of%201.28%20cmH2O.

			compared with a selection of commercially available devices for mean pressure and oscillation amplitude (cmH_2O), as well as oscillation frequency (Hz). All devices were tested using a healthy volunteer at a target expiratory flow of ~ 20 L/min. The target therapeutic range was 10-20 cmH_2O at a flow rate of 10-20 L/min as is reported widely in the literature. **Results:** The prototype disposable device achieved a mean pressure of 14.82 cmH_2O at a mean flow rate of 18.82 L/min, and generated an oscillation frequency of 26 Hz with an amplitude of 1.28 cmH_2O. These characteristics compare favourably with existing, more complex, reusable OPEP devices. **Conclusions:** The UL-OPEP device is a small, disposable OPEP device that generates pressure and oscillation amplitudes for clinically effective airway clearance. The device negates the need for cleaning and disinfecting, removing the risk of devices acting as a potential reservoir for pathogenic organisms while maintaining mucus-clearing benefits.	
Preliminary assessment on the effects of line width, layer height and orientation on strength and print time for FDM printing of total contact casts for the treatment of diabetic foot ulcers	Mulcahy, N., O'Sullivan, K.J., O'Sullivan, A. and O'Sullivan, L.	2023	Abstract The application of 3D Printing (3DP) for use in fracture casts and orthopaedic splints has been explored in several studies. The challenge of 3D printed casts is their size and relatively long production time compared to traditional/fibreglass casts. This preliminary study aims to determine the effects of three specific parameters specifically in the context of manufacturing Total Contact Casts (TCCs) for the treatment of diabetic foot ulcers. The effects of printing parameters have been evaluated previously in the literature. However, there are little data in single experiments on layer height ratio dependent on line width; typically, lower values of layer height have been assessed that remain constant with all line widths. The combination of line width, layer height and print orientation have been evaluated here, with a focus on achieving quickest possible print time without sacrificing part strength in the context of 3D printed TCCs. Flexural testing was conducted on FDM-printed PLA test specimens with 36 different treatments, adjusting the above parameters. The relationship between part strength (flexural modulus and maximum flexural stress) and print time was investigated. It was determined that a low layer height could be paired with a high line width to achieve optimal part strength, considering also print time. The specific	Annals of 3D Printed Medicine, https://doi.org/10.1016/j.stlm.2023.100115

			application, and associated direction of forces/loads is an important consideration when selecting a print orientation to optimise mechanical performance. A case example applied to the printing of a TCC is also presented.	
Design and initial testing of a novel disposable oscillating positive expiratory pressure device.	O'Sullivan, K.J., Dunne, C.P., Linnane, B., McGrath, D. and O'Sullivan, L.	2022	Background Oscillating positive expiratory pressure (OPEP) devices play a key role in airway clearance, particularly in patients with cystic fibrosis. These devices, however, have the potential to become reservoirs for pathogenic organisms and require daily, or even more frequent, cleaning. This places a large burden on patients and their carers. Aims The objective of this work was to develop a disposable OPEP device, with comparable mechanical performance to commercial devices that negates the need for cleaning after use thus reducing microbiological risks. Methods 3D printing was used to iterate and develop a prototype disposable device (The University of Limerick OPEP, abbreviated to the UL-OPEP) that was compared with a selection of commercially available devices for mean pressure and oscillation amplitude (cmH_2O), as well as oscillation frequency (Hz). All devices were tested using a healthy volunteer at a target expiratory flow of ~ 20 L/min. The target therapeutic range was 10–20 cmH_2O at a flow rate of 10–20 L/min as is reported widely in the literature. Results The prototype disposable device achieved a mean pressure of 14.82 cmH_2O at a mean flow rate of 18.82 L/min, and generated an oscillation frequency of 26 Hz with an amplitude of 1.28 cmH_2O. These characteristics compare favourably with existing, more complex, reusable OPEP devices. Conclusions The UL-OPEP device is a small, disposable OPEP device that generates pressure and oscillation amplitudes for clinically effective airway clearance. The device negates the need for cleaning and disinfecting, removing the risk of devices acting as a potential reservoir for pathogenic organisms while maintaining mucus-clearing benefits.	Irish Journal of Medical Science https://doi.org/10.1007/s11845-022-03225-1

Differential Impact of Central Venous Catheters versus Arteriovenous Fistulae on Quality of Life among Irish Haemodialysis Patients.	Maguire, I.C., Browne, L.D., Dawood, M., Leahy, F., Ryan, M.C., White, E., O'Sullivan, A., O'Sullivan, L. and Stack, A.G.	2022	Key Points • The study compares the effect of vascular access (arteriovenous fistula versus central venous catheter) on health-related quality of life. Arteriovenous fistula users were more satisfied with their access but dissatisfied with physical complications of access type, including bruising, bleeding, and pain. • Central venous catheter users were more dissatisfied with social aspects of access care such as showering and bathing. Background Arteriovenous fistulae (AVF) have superior clinical outcomes compared with central venous catheters (CVC) among patients undergoing hemodialysis (HD). Yet, there is increasing recognition that health-related quality of life (HRQoL) may be more important to patients than survival and that differences may exist between AVF and CVCs in this regard. This study compared HRQoL between AVF and CVC in an Irish cohort. Methods We conducted a cross-sectional survey among prevalent patients undergoing hemodialysis (*N*=119) dialyzing with either an AVF or CVC at a regional program. The Short Form 36 (SF-36) and a validated Vascular Access Questionnaire (SF-VAQ) compared QoL between AVF and CVC in domains of physical functioning, social functioning, and dialysis complications. Multivariable logistic regression compared differences between groups for outcomes of physical functioning, social functioning, and dialysis complications expressed as adjusted odds ratios and 95% CI. Results Mean age was 66.6 years; 52% were using an AVF and 48% had a CVC. Patients dialyzing with an AVF were more satisfied with their access when asked directly (6.2 versus 5.0; *P*<0.01). Physical functioning scores for bleeding, swelling, and bruising were significantly higher for AVF than CVC (*P*=0.001, *P*=0.001, and *P*<0.001, respectively). In contrast, patients with a CVC reported greater difficulties in bathing and showering than those using an AVF (4.4 versus 2.0; *P*<0.001), whereas patients with an AVF expressed greater concerns with physical appearances. Compared with AVF, CVC users were less likely to report difficulties in physical functioning (OR=0.35; 95% CI, 0.12 to 0.94; *P*=0.04) but	Kidney360 Differential Impact of Central Venous Catheters versus Arteriovenous Fistulae on Quality of Life among Irish Haemodialysis Patients - PMC (nih.gov)

			more likely to report dialysis complications (OR=1.94; 95% CI, 0.69 to 5.87; *P*=0.22). Conclusions Vascular access contributes to HRQoL in hemodialysis. CVCs are associated with fewer difficulties from bleeding and bruising but greater negative effect on social activities, including bathing and showering. Overall, patients with a CVC had lower dissatisfaction scores than patients with an AVF when all three domains were added. Innovation in vascular access design and engineering may confer benefits and improve patient comfort on HD.	
User centered development and performance assessment of a modular full body exoskeleton (Axosuit)	Bai, S., Islam, M.R., Power, V. and O'Sullivan, L.W.,	2022	This paper presents the design and preliminary performance assessment of a full-body assistive exoskeleton (AXO-SUIT) for older adults. AXO-SUIT is a system that consists of separate lower-body and upper-body modular exoskeletons, which can be combined to form a full-body system to provide flexible physical assistance as needed. The full-body exoskeleton comprises 27 degrees of freedom (dof), of which 17 are passive and 10 active. It can assist people in walking, standing, carrying and handling tasks. A user-centered design approach was adopted throughout the development of the exoskeleton. This paper describes the design process of AXO-SUIT, involving a review of user needs, a kinematic and kinetic motion study, and innovative system design. Tests with the developed systems were conducted on selected end-user subjects, covering both performance evaluations at different levels and usability testing. End-user testing results show the effectiveness of the exoskeleton in providing flexible physical assistance.	Biomimetic intelligence and Robotics, 2, 1-8 https://www.sciencedirect.com/science/article/pii/S2667379721000322#:~:text=This%20paper%20describes%20the%20design,different%20levels%20and%20useability%20testing.
Differential Impact of Central Venous Catheters verses Arteriovenous Fistulae on Quality of Life among Haemodialysis Patients	Maguire, I., Browne, L., Dawood, M., Leahy, F., Ryan, M., White, E., O'Sullivan, A., O'Sullivan, L. W., and Austin Stack	2022	**Background:** Arteriovenous fistulae (AVF) have superior clinical outcomes compared with central venous catheters (CVC) among patients undergoing hemodialysis (HD). Yet, there is increasing recognition that health-related quality of life (HRQoL) may be more important to patients than survival and that differences may exist between AVF and CVCs in this regard. This study compared HRQoL between AVF and CVC in an Irish cohort. **Methods:** We conducted a cross-sectional survey among prevalent patients undergoing hemodialysis (*N*=119) dialyzing with either an AVF or CVC at a regional program. The Short Form 36 (SF-36) and a validated Vascular Access Questionnaire (SF-VAQ) compared QoL between AVF and CVC in domains of physical functioning, social functioning, and dialysis complications. Multivariable	Kidney 360, 3(6) 1065-1072. https://pubmed.ncbi.nlm.nih.gov/35845328/#:~:text=CVCs%20are%20associated%20with%20fewer,all%20three%20domains%20were%20added

			logistic regression compared differences between groups for outcomes of physical functioning, social functioning, and dialysis complications expressed as adjusted odds ratios and 95% CI. **Results:** Mean age was 66.6 years; 52% were using an AVF and 48% had a CVC. Patients dialyzing with an AVF were more satisfied with their access when asked directly (6.2 versus 5.0; *P*<0.01). Physical functioning scores for bleeding, swelling, and bruising were significantly higher for AVF than CVC (*P*=0.001, *P*=0.001, and *P*<0.001, respectively). In contrast, patients with a CVC reported greater difficulties in bathing and showering than those using an AVF (4.4 versus 2.0; *P*<0.001), whereas patients with an AVF expressed greater concerns with physical appearances. Compared with AVF, CVC users were less likely to report difficulties in physical functioning (OR=0.35; 95% CI, 0.12 to 0.94; *P*=0.04) but more likely to report dialysis complications (OR=1.94; 95% CI, 0.69 to 5.87; *P*=0.22). **Conclusions:** Vascular access contributes to HRQoL in hemodialysis. CVCs are associated with fewer difficulties from bleeding and bruising but greater negative effect on social activities, including bathing and showering. Overall, patients with a CVC had lower dissatisfaction scores than patients with an AVF when all three domains were added. Innovation in vascular access design and engineering may confer benefits and improve patient comfort on HD.	
The application of 3D printing in Palliative Care: A systematic review	Kermavnar, T., Guttridge, C., Mulcahy, N., Duffy, E., Twomey, F. and O'Sullivan, L.W.,	2022	**Background** Three-dimensional printing (3DP) enables the production of highly customised, cost-efficient devices in a relatively short time, which can be particularly valuable to clinicians treating patients with palliative care intent who are in need of timely and effective solutions in the management of their patients' specific needs, including the relief of distressing symptoms. **Method** Four online databases were searched for articles published by December 2020 that described studies using 3DP in palliative care. The fields of application, and the relevant clinical and technological data were extracted and analysed. **Results** Thirty studies were reviewed, describing 36 medical devices, including anatomical models, endoluminal stents, navigation guides, obturators, epitheses, endoprostheses and others. Two-thirds of the studies were published after the year 2017. The main reason for using 3DP was the difficulty of producing customised devices with traditional methods. Eleven papers described proof-of-concept studies that did not involve human testing. For those devices that were	BMJ Supportive and Palliative Care, 1-10. https://spcare.bmj.com/content/early/2022/09/06/bmjspcare-2021-003196

			tested on patients, favourable clinical outcomes were reported in general, and treatment with the use of 3DP was deemed superior to conventional clinical approaches. The most commonly employed 3DP technologies were fused filament fabrication with acrylonitrile butadiene styrene and stereolithography or material jetting with various types of photopolymer resin. **Conclusion** Recently, there has been a considerable increase in the application of 3DP to produce medical devices and bespoke solutions in the delivery of treatments with palliative care intent. 3DP was found successful in overcoming difficulties with conventional approaches and in treating medical conditions requiring highly customised solutions.	
Warmed contrast media temperature loss in traditional manifold systems during angiographic procedures	O'Sullivan, K.J., Kermavnar, T. and O'Sullivan, L.W.,	2022	Background Extrinsic warming of contrast media (CM) to 37 °C before angiographic procedures is performed to improve bolus kinetics and avoid potential adverse effects. Extrinsically warmed CM readily loses temperature after removal from the warming cabinet, but the extent of its cooling has not been previously investigated. Purpose To assess temperature loss of extrinsically warmed CM in tubing of traditional angiographic manifolds during simulated angiography. Material and Methods In total, 35 scheduled diagnostic angiographic procedures were observed in a hospital setting. Relevant time points of CM use during the procedures were recorded. The shortest, median, and longest procedures were then simulated in the experimental laboratory to measure CM temperatures at specific times at three locations along the tubing system. Results The angiographic procedures lasted 7.0–26.6 min (median = 11.7 min), with the total duration dependent primarily on the time from contrast being removed from the warming cabinet to the commencement of imaging. During the simulated procedures, consistent patterns of temperature loss were observed. By the last simulated angiographic run, injected CM temperature decreased by 7.4–16.4 °C, depending on procedure length. Most of the heat loss occurred in the tubing between the CM bottle and coronary control syringe. Conclusion	Acta Radiologica, 63, 1627-1633. https://journals.sagepub.com/doi/full/10.1177/02841851211055393

			During angiographic procedures, prewarmed CM loses its temperature rapidly with the duration of exposure to ambient room temperature. If no additional measures are employed to maintain its temperature outside of the warming cabinet, extrinsic warming has limited impact on injected CM temperature	
An initial evaluation of the safety of a disposable oscillating positive expiratory pressure device in patients with chronic obstructive pulmonary disease: A sort-term pilot study	O'Sullivan, K., Power, V., Linnane, B., McGrath, D., Fogarty, H., Ryan, M., White, R., Noonan, C., Mulloy, E., O'Sullivan, L.W., and Dunne, C.,	2021	Background Handheld oscillating positive expiratory pressure (OPEP) devices have been a mainstay of treatment for patients with hypersecretory conditions such as cystic fibrosis (CF) and chronic obstructive pulmonary disease (COPD) since the 1970s. Current devices are reusable and require regular cleaning and disinfection to prevent harbouring potentially pathogenic organisms. Adherence to cleaning regimens for respiratory devices is often poor and in response to this, a prototype disposable OPEP device—the 'UL-OPEP' (University of Limerick—Oscillating Positive Expiratory Pressure device)—was developed to mitigate the risk of contamination by pathogens. The device was previously evaluated successfully in a group of paediatric CF patients. The aim of the current study was to initially evaluate the safety of the prototype in patients with COPD over a period of 1 month to ensure no adverse events, negative impacts on lung function, exercise tolerance, or quality of life. Data on user experience of the device were also collected during post-study follow-up. Methods A sample of 50 volunteer participants were recruited from pulmonary rehabilitation clinics within the local hospital network. The patients were clinically stable, productive, and not current or previous users of OPEP devices. Participants were invited to use a prototype disposable OPEP device daily for a period of 1 month. Pre- and post-study lung function was assessed with standard spirometry, and exercise tolerance with the 6-min-walk-test (6MWT). Quality of life was assessed using the St. George's Respiratory Questionnaire (SGRQ), and user experience of the prototype device evaluated using a post-study questionnaire. Results 24 Participants completed the study: 9 were female. Overall median age was 67.5 years, range 53–85 years. Lung function, 6-min walk test, and SGRQ scores showed no significant change post-study. User feedback was positive overall. Conclusions	

			The results indicate that the UL-OPEP is safe to use in patients with COPD. No adverse events were recorded during the study or in the follow-up period of 2 weeks. The device did not negatively impact patients' lung function, exercise tolerance, or quality of life during short term use (1 month), and usability feedback received was generally positive. Larger, longer duration studies will be required to evaluate efficacy. *Registration* The study was approved as a Clinical Investigation by the Irish Health Products Regulatory Authority (CRN-2209025-CI0085).	
Occupational exoskeletons: A roadmap towards large-scale adoption of Occupational exoskeletons	Crea, S., Beckerle, P., de Looze, M., de Pauw, K., Grazi, L., Kermavnar, T., Masood, J., O'Sullivan, L.W., Pacifico, I., Rodriguez-Guerrero, C., Vitiello, N., Ristic-Durrant, D. and Veneman, J.,	2021	The large-scale adoption of occupational exoskeletons (OEs) will only happen if clear evidence of effectiveness of the devices is available. Performing product-specific field validation studies would allow the stakeholders and decision-makers (e.g., employers, ergonomists, health, and safety departments) to assess OEs' effectiveness in their specific work contexts and with experienced workers, who could further provide useful insights on practical issues related to exoskeleton daily use. This paper reviews present-day scientific methods for assessing the effectiveness of OEs in laboratory and field studies, and presents the vision of the authors on a roadmap that could lead to large-scale adoption of this technology. The analysis of the state-of-the-art shows methodological differences between laboratory and field studies. While the former are more extensively reported in scientific papers, they exhibit limited generalizability of the findings to real-world scenarios. On the contrary, field studies are limited in sample sizes and frequently focused only on subjective metrics. We propose a roadmap to promote large-scale knowledge-based adoption of OEs. It details that the analysis of the costs and benefits of this technology should be communicated to all stakeholders to facilitate informed decision making, so that each stakeholder can develop their specific role regarding this innovation. Large-scale field studies can help identify and monitor the possible side-effects related to exoskeleton use in real work situations, as well as provide a comprehensive scientific knowledge base to support the revision of ergonomics risk-assessment methods, safety standards and regulations, and the definition of guidelines and practices for the selection and use of OEs.	Wearable Technologies, 2, E11 https://www.cambridge.org/core/journals/wearable-technologies/article/occupational-exoskeletons-a-roadmap-toward-largescale-adoption-methodology-and-challenges-of-bringing-exoskeletons-to-workplaces/33096E40515BC1CCBBB53B6A4B328E3F
The Application of Additive Manufacturing /	Kermavnar, T. and	2021	Additive Manufacturing (AM) facilitates product personalization and iterative design, which makes it an ideal technology for ergonomic product development. In this study, a systematic review was conducted of the literature regarding the	Applied Ergonomics, 97, 103528.

3D printing in Ergonomic Aspects of Product Design: A Systematic Review	O'Sullivan, L.W.,		use of AM in ergonomic-product design, and methodological aspects of the studies were analyzed. A literature search was performed using the keywords "3D print*," "additive manufacturing," "ergonomic*" and "human factors". Included were studies reporting the use of AM specifically in ergonomic design of products/prototypes including the detailing of an ergonomic testing methodology used for evaluation. Forty studies were identified pertaining to the fields of medicine, assistive technology, wearable technology, hand tools, testing devices and others. The most commonly used technology was fused deposition modeling with polylactic acid, but the overall preferred material was acrylonitrile butadiene styrene. Various combinations of objective/subjective and qualitative/quantitative product evaluation methods were used. Based on the findings, recommendations were developed to facilitate the choice of most suitable AM technologies and materials for specific applications in ergonomics.	https://doi.org/10.1016/j.apergo.2021.103528
Assessment of the microbial load of airway clearance devices used by a cohort of children with cystic fibrosis	Linnane, B., O'Connell, N.H., Obande, E., Dunne, S.S., Clancy, C., Kiernan, M.G., McGrath, D., O'Sullivan, K.J., O'Sullivan, L.W. and Dunne, C.P.,	2021	**Background** Positive expiratory pressure (PEP) devices are an important element of the management of cystic fibrosis, and of other respiratory diseases. Whereas there have been reports in the literature of contamination of airway clearance devices and their surfaces by microbial pathogens, there is little evidence available regarding such contamination and its contribution to respiratory infection. **Aim** To establish whether pathogenic bacteria can contaminate PEP devices in the context of normal cleaning and maintenance practices. **Methods** Patients' home-use clearance devices were brought to a routine clinic appointment and collected for microbiology sampling and analysis. The patients were provided with replacement devices. Nineteen such devices were collected from 17 patients, reflecting use of multiple devices by some patients. Swabs were taken and cultured from each patient's used device, the patient's airway, as well as from new unopened and unused devices that acted as controls. **Results** Seven of 19 devices (37%) tested positive for presence of pathogenic bacteria. Device-cleaning methods varied among patients and non-sterilization methods	Infection Prevention In Practice, 3, 100153-100162. https://www.sciencedirect.com/science/article/pii/S2590088921000421

			were found to be ineffective at removing pathogens. Microbial species found on the devices did not correlate with those identified from airway swabs. **Conclusion** This study demonstrates the presence of pathogens on positive expiratory pressure devices. The potential for transmission of these pathogens to the patient's airway and the risk of infection remains unclear and requires further study.	
A short-term evaluation of a prototype disposable Oscillating Positive Expiratory Pressure (OPEP) device in a cohort of children with cystic fibrosis	O'Sullivan, K.J., McGrath, D., Linnane, B., O'Sullivan, L.W. and Dunne, C.,	2021	Background Oscillating Positive Expiratory Pressure (OPEP) devices are important adjuncts to airway clearance therapy in patients with cystic fibrosis (CF). Current devices are typically reusable and require daily, or often more frequent, cleaning to prevent risk of infection by acting as reservoirs of potentially pathogenic organisms. In response, a daily disposable OPEP device, the UL-OPEP, was developed to mitigate the risk of contamination and eliminate the burdensome need for cleaning devices. Methods A convenience sample of 36 participants, all current OPEP device users, was recruited from a paediatric CF service. For one month, participants replaced their current OPEP device with a novel daily disposable device. Assessment included pre- and post-intervention lung function by spirometry, as well as Lung Clearance Index. Quality of life was assessed using the Cystic Fibrosis Questionnaire – Revised, while user experience was evaluated with a post-study survey. Results 31 participants completed the study: 18 males; median age 10 years, range 4–16 years. Lung function (mean difference ± SD, %FEV1 = 1.69 ± 11.93; %FVC = 0.58 ± 10.04; FEV1: FVC = 0.01 ± 0.09), LCI (mean difference ± SD, 0.08 ± 1.13), six-minute walk test, and CFQ-R were unchanged post-intervention. Participant-reported experiences of the device were predominantly positive. Conclusions The disposable OPEP device maintained patients' lung function during short term use (≤ 1 month), and was the subject of positive feedback regarding functionality while reducing the risk of airway contamination associated with ineffective cleaning.	BMC Pulmonary Medicine, 21, 158-167. https://bmcpulmmed.biomedcentral.com/articles/10.1186/s12890-021-01525-3

3D printing of medical devices used directly to treat patients: a systematic review	Kermavnar, T., Shannon, A., O'Sullivan, K.J., McCarthy, C., Dunne, C.P., O'Sullivan, L.W.,	2021	Until recently, three-dimensional (3D) printing/additive manufacturing has not been used extensively to create medical devices intended for actual clinical use, primarily on patient safety and regulatory grounds. However, in recent years there have been advances in materials, printers, and experience, leading to increased clinical use. The aim of this study was to perform a structured systematic review of 3D-printed medical devices used directly in patient treatment. A search of 13 databases was performed to identify studies of 3D-printed medical devices, detailing fabrication technology and materials employed, clinical application, and clinical outcome. One hundred and ten papers describing one hundred and forty medical devices were identified and analyzed. A considerable increase was identified in the use of 3D printing to produce medical devices directly for clinical use in the past 3 years. This is dominated by printing of patient-specific implants and surgical guides for use in orthopedics and orthopedic oncology, but there is a trend of increased use across other clinical specialties. The prevailing material/3D-printing technology used were titanium alloy/electron beam melting for implants, and polyamide/selective laser sintering or polylactic acid/fused deposition modeling for surgical guides and instruments. A detailed analysis across medical applications by technology and materials is provided, as well as a commentary regarding regulatory aspects. In general, there is growing familiarity with, and acceptance of, 3D printing in clinical use.	3D printing and Additive Manufacturing, 8, 366-408 https://pubmed.ncbi.nlm.nih.gov/36655011/
3D Printed Devices for Healthcare in Response to COVID 19 – Lessons Learned To-Date	Guttridge, C., O'Sullivan, A., O'Sullivan, K.J. and O'Sullivan, L.W.	2021	During the first surge of the coronavirus disease 2019 (COVID-19) there was a tremendous global response from three-dimensional (3D) printing communities and individuals to support local health care systems and staff. The responses involved a range of 3D printer users from amateur makers to conglomerate manufacturers creating personal protective equipment (PPE) and other supplies of which there were shortages. These new supply chains resulted from the democratization of 3D printing, open source file sharing, mass production of desktop machines, and the relatively cheap cost of 3D printers. The democratized state of 3D printing facilitated an altruistic movement of makers with ranging experience, to work alongside traditional manufacturers to make medical supplies. With the critical nature of the shortages and the sharp increase in COVID-19 infections, many standards and regulations were bypassed, and good manufacturing processes disregarded, in cases. The outcomes from this article is	3d Printing and Additive Manufacturing, 8, 340-342. https://pubmed.ncbi.nlm.nih.gov/36654938/

			a set of six lessons learned from the authors' perspective regarding the use of 3D printing during the initial phase of the COVID-19 pandemic. We note challenges experienced around volume manufacturing, infection control requirements of produced parts and the cleanability of devices, mechanical strength considerations, good manufacturing practices, product and intellectual property (IP) liability, and the role of involving clinical stakeholders.	
Bespoke 3D Printed Eye Cover in Rhabdomyosarcoma	O'Sullivan, A.G., Duffy, E, O'Sullivan, K.J, Cronin, U., Lyons, E, O'Sullivan, L.W., Twomey, F.,	2021	**Background** We report a case of using 3D printing to create a bespoke eye cover for an 18-year-old man with left maxillary alveolar rhabdomyosarcoma. Further, the patient had proptosis causing chemosis and subsequent conjunctival abrasions. This had been managed by taping a large dressing around the eye for a number of weeks previously. **Methods** A 3D scanner was used to capture the surface topography of the patients face. The data were imported into a CAD package and used as a guide to create a bespoke eye cover. The final design was 3D printed in a biocompatible material for use by the patient. **Results** The scan, modelling, and printing of the bespoke cover was completed successfully in less than 72 hours.	BMJ Supportive and Palliative Care, Published online ahead of print. https://spcare.bmj.com/content/early/2021/02/22/bmjspcare-2021-002900
A radiopaque nanoparticle-based ink using PolyJet 3D printing for medical applications	Shannon, A., O'Sullivan, K.J., Clifford, S. and O'Sullivan, L.W.,	2020	The aim of this study was to develop a 3D printable radiopaque ink and successfully print a finished artifact. Radiopaque 3D printing would be hugely beneficial to improve the visibility of medical devices and implants, as well as allowing more realistic phantoms and calibration aids to be produced. Most 3D printing technologies are polymer based. Polymers are naturally radiolucent, allowing X-rays to pass through, showing up as faint dark grey regions on X-ray detectors, as for soft tissues. During this study, a 3D printable ultraviolet (UV) curable resin containing zirconium oxide (ZrO_2) nanoparticles was developed. 5 wt. % ZrO_2 was dispersed in a base resin using a high-shear mixer. Particles remained in suspension for 6–8 h at room temperature, allowing time for 3D printing. A model of a hand including radiopaque bones and a test block demonstrating a range of internal radiopaque features were successfully 3D printed. Radiopacity was demonstrated in the 3D-printed models, and there was good dispersion of ZrO_2 within the resin matrix. The impregnated resin remained UV curable and viscosity was not compromised. In this study, 3D-printed	3D Printing and Additive Manufacturing, 7, 259-267. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9586492/

			radiopaque features demonstrated clear radiopacity under X-ray and microcomputed tomography imaging.	
Technology acceptance and perceptions of robotic assistive devices by older adults – Implications for exoskeleton design,	Shore, L., De Eyto A. and O'Sullivan, L.W.,	2020	**Aim:** This study explored and interpreted insights expressed by a cohort of older adults related to their life experience, their experiences using or assisting someone with assistive devices, and their perceptions of robots and robotic assistive devices, including lower limb exoskeletons. **Method:** A grounded theory study was undertaken with 24 older adult participants over five months. Each participant participated in a structured interviewed regarding their experiences with technologies and in particular their perceptions of assistive technologies. Themes from the interviews were coded using Nvivo software. **Results:** Five main themes emerged from this study - (1) Aging & life stage experiences, (2) Quality of Life, (3) Assistive Technologies, (4) Health Conditions & Care, (5) Products & Service Systems. These have influenced new constructs for a hybrid design tool that incorporates stages of Usability and TAMs (Technology Acceptance Models) to gauge (a) Perception, (b) Experience and (c) Perceived Impact by older adults of lower limb exoskeletons. **Conclusions:** Emerging technologies such as robotic assistive devices require a specific enquiry to understand how best to optimise acceptance by older adults and avoid feelings by them of frustration, embarrassment and ultimately abandonment of these devices. Implications for rehabilitation Older adults frequently require rehabilitation and assistance with ambulation Exoskeletons are forms of assistive technologies for rehabilitation, and they are moving from clinical use to more day care use, including as part of daily living These results help explain factors related to the perception of exoskeletons by older adults, which if considered during exoskeleton design, could improve the technology uptake and compliance with this technology use by these users.	Disability and Rehabilitation: Assistive Technology, 29, 1-9. https://pubmed.ncbi.nlm.nih.gov/32988251/
Technology acceptance and perceptions of robotic assistive devices by older adults – implications for	Shore, L., de Eyto, A. and O'Sullivan, L.	2020	Aim This study explored and interpreted insights expressed by a cohort of older adults related to their life experience, their experiences using or assisting someone with assistive devices, and their perceptions of robots and robotic assistive devices, including lower limb exoskeletons. Method	Disability and Rehabilitation: Assistive Technology https://doi.org/10.1080/17483107.2020.1817988

exoskeleton design.			A grounded theory study was undertaken with 24 older adult participants over five months. Each participant participated in a structured interviewed regarding their experiences with technologies and in particular their perceptions of assistive technologies. Themes from the interviews were coded using Nvivo software. Results Five main themes emerged from this study – (1) Aging & life stage experiences, (2) Quality of Life, (3) Assistive Technologies, (4) Health Conditions & Care, (5) Products & Service Systems. These have influenced new constructs for a hybrid design tool that incorporates stages of Usability and TAMs (Technology Acceptance Models) to gauge (a) Perception, (b) Experience and (c) Perceived Impact by older adults of lower limb exoskeletons. Conclusions: Emerging technologies such as robotic assistive devices require a specific enquiry to understand how best to optimise acceptance by older adults and avoid feelings by them of frustration, embarrassment and ultimately abandonment of these devices.	
Exoscore: A design tool to evaluate factors associated with technology acceptance of soft lower limb exosuits by older adults	Shore, L., Power, V., Hartigan, B., Schulein, S., Graf, E., de Eyto, A., and O'Sullivan, L.W.,	2019	**Objective:** This pilot study proposed and performs initial testing with Exoscore, a design evaluation tool to assess factors related to acceptance of exoskeleton by older adults, during the technology development and testing phases. **Background:** As longevity increases and our aging population continues to grow, assistive technologies such as exosuits and exoskeletons can provide enhanced quality of life and independence. Exoscore is a design and prototype stage evaluation method to assess factors related to perceptions of the technology, the aim being to optimize technology acceptance. **Method:** In this pilot study, we applied the three-phase Exoscore tool during testing with 11 older adults. The aims were to explore the feasibility and face validity of applying the design evaluation tool during user testing of a prototype soft lower limb exoskeleton. **Results:** The Exoscore method is presented as part of an iterative design evaluation process. The method was applied during an exoskeleton research and development project. The data revealed the aspects of the concept design that rated favorably with the users and the aspects of the design that required more attention to improve their potential acceptance when deployed as finished products.	Human Factors, 62, 391-400 https://pubmed.ncbi.nlm.nih.gov/31419179/

			Conclusion: Exoscore was effectively applied to three phases of evaluation during a testing session of a soft exoskeleton. Future exoskeleton development can benefit from the application of this design evaluation tool. **Application:** This study reveals how the introduction of Exoscore to exoskeleton development will be advantageous when assessing technology acceptance of exoskeletons by older adults. **Keywords:** designing for the elderly; home health; product design; usability/acceptance measurement and research; wearable devices.	
An Evaluation of a novel disposable oscillating positive expiratory pressure (OPEP) device in a cohort of children with Cystic Fibrosis	O'Sullivan, K.J., Power, V., McGrath, D., Dunne, C., O'Sullivan, L.W., Linnane, B.,	2019	**Methods:** A convenience sample of 36 participants, all current OPEP device users, was recruited from a paediatric CF service. For a period of one month, participants replaced their current OPEP device (used daily for up to 6 months) with the SoloPep device (daily disposable). Lung function was assessed immediately before and after adopting the new device using Spirometry. Lung Clearance Index (LCI) was assessed via multiple-breath nitrogen washout. User experience of SoloPep was evaluated with a post-study questionnaire, rated on five-point Likert scales. All participants were trained at the first clinic visit to use the SoloPep device. This was performed using a proprietary software program. **Results:** 31 participants completed the study: 13 females; median age 10 years, range 4-16 years. Lung function (%FEV1, mean ± SD; baseline = 83.26 ± 19.63, follow-up = 86.31 ± 20.95) and LCI (mean ± SD; baseline = 10.05 ± 2.86, follow-up = 9.66 ± 2.10) were unchanged post-intervention. The majority of participants believed that SoloPep was easy to use (72% Strongly Agree; 24% Agree; 4% Neutral), dealt with issues they had with cleaning of their current OPEP device (72% Strongly Agree; 16% Agree; 12% Neutral), and encouraged them to perform OPEP therapy more regularly (52% Strongly Agree; 28% Agree; 16% Neutral, 4% Strongly Disagree). All agreed that they would adopt SoloPep as their usual OPEP device (76% Strongly Agree; 24% Agree). No adverse device-related events were reported during SoloPep use. **Conclusion:** SoloPep demonstrated equivalence to existing OPEP devices in this cohort and may be a useful adjunct to aid airway clearance, reducing risk of cross-contamination.	European Respiratory journal https://erj.ersjournals.com/content/54/suppl_63/PA4530
Oscillating Positive Expiratory	O'Sullivan, K. J., Collins, L., McGrath, D.,	2019	**Background:** Oscillating positive expiratory pressure devices aid removal of excess secretions and reduce gas trapping in patients with hypersecretory pulmonary diseases, for example, cystic fibrosis. Oscillating positive expiratory	Respiratory Care, 64, 398-405

Pressure therapy may be performed poorly by children with cystic fibrosis	Linnane, B., O'Sullivan, L.W. and Dunne, C.,		pressure works when the patient exhales actively against a fixed resistor, which generates mean intrapulmonary pressures of 10-20 cm H_2O with rapid fluctuations of at least 1 cm H_2O from the mean. In this study, we evaluated the performance of oscillating positive expiratory pressure therapy by paediatric subjects with cystic fibrosis to determine adherence to target therapeutic pressures.	https://pubmed.ncbi.nlm.nih.gov/30944227/#:~:text=Conclusions%3A%20Despite%20standardized%20instruction%2C%20the,compromised%20due%20to%20poor%20technique
An evaluation of a novel disposable Oscillating Positive Expiratory Pressure (OPEP) device in children with Cystic Fibrosis,	O'Sullivan, K.J., Power, V., Dunne, C., McGrath, D., O'Sullivan, L.W., Linnane, B.,	2019	**Methods:** A convenience sample of 36 participants, all current OPEP device users, was recruited from a paediatric CF service. For a period of one month, participants replaced their current OPEP device (used daily for up to 6 months) with the SoloPep device (daily disposable). Lung function was assessed immediately before and after adopting the new device using Spirometry. Lung Clearance Index (LCI) was assessed via multiple-breath nitrogen washout. User experience of SoloPep was evaluated with a post-study questionnaire, rated on five-point Likert scales. All participants were trained at the first clinic visit to use the SoloPep device. This was performed using a proprietary software program. **Results:** 31 participants completed the study: 13 females; median age 10 years, range 4-16 years. Lung function (%FEV1, mean ± SD; baseline = 83.26 ± 19.63, follow-up = 86.31 ± 20.95) and LCI (mean ± SD; baseline = 10.05 ± 2.86, follow-up = 9.66 ± 2.10) were unchanged post-intervention. The majority of participants believed that SoloPep was easy to use (72% Strongly Agree; 24% Agree; 4% Neutral), dealt with issues they had with cleaning of their current OPEP device (72% Strongly Agree; 16% Agree; 12% Neutral), and encouraged them to perform OPEP therapy more regularly (52% Strongly Agree; 28% Agree; 16% Neutral, 4% Strongly Disagree). All agreed that they would adopt SoloPep as their usual OPEP device (76% Strongly Agree; 24% Agree). No adverse device-related events were reported during SoloPep use. **Conclusion:** SoloPep demonstrated equivalence to existing OPEP devices in this cohort and may be a useful adjunct to aid airway clearance, reducing risk of cross-contamination.	European Respiratory Journal, 54, S63 https://erj.ersjournals.com/content/54/suppl_63/PA4530
Active Back Support Exoskeletons, how assistive strategies	Toxiri, S., Koopman, A.S., Lazzaroni, M., Ortiz, J.,	2019	Active exoskeletons are potentially more effective and versatile than passive ones but designing them poses several additional challenge. An important open challenge for active exoskeletons is associated with assistive strategies, by which the actuation forces are modulated relative to the user's movements and assistance needs. This paper addresses an element of this challenge for an active	Tijdschrift voor Human Factors (Dutch Ergonomics Journal), 44, 11-15

determine effectiveness	Power, V., de Looze, M.P., O'Sullivan, L.W., Caldwell, D.,		exoskeleton prototype aimed at reducing compressive loads on the lumbar spine, which is associated to the risk of musculoskeletal injury during manual material handling (i.e., repeatedly lifting objects). During manual handling tasks, two key factors related to biomechanical loading are posture, e.g. forward inclination of the torso, and external mass lifted. Specific control strategies, accounting for these two factors, were implemented and evaluated experimentally. The results indicate a significant reduction in muscular activity (circa. 30%) at the lower back when using the exoskeleton with the different strategies. With such strategies, the proposed exoskeleton can quickly adjust to different task conditions (which makes it versatile compared to using multiple, task specific devices) as well as to individual preference (which promotes user acceptance). Additionally, the strategies explored are potentially applicable to many exoskeleton types for industrial use.	https://doi.org/10.3389%2Ffrobt.2018.00053
Design and Evaluation of a Soft Assistive Lower Limb	Di Natali, C., Poliero, T., Sposito, M., Graf, E., Bauer, C., Pauli, C., Bottenberg, E., de Eyto, A., O'Sullivan, L.W., Hidalgo, A.F., Sherly, D.., Stadler, K.S., Caldwell, D.G. and Ortiz, J.,	2019	Wearable devices are fast evolving to address mobility and autonomy needs of elderly people who would benefit from physical assistance. Recent developments in soft robotics provide important opportunities to develop soft exoskeletons (also called exosuits) to enable both physical assistance and improved usability and acceptance for users. The XoSoft EU project has developed a modular soft lower limb exoskeleton to assist people with low mobility impairments. In this paper, we present the design of a soft modular lower limb exoskeleton to improve person's mobility, contributing to independence and enhancing quality of life. The novelty of this work is the integration of quasi-passive elements in a soft exoskeleton. The exoskeleton provides mechanical assistance for subjects with low mobility impairments reducing energy requirements between 10% and 20%. Investigation of different control strategies based on gait segmentation and actuation elements is presented. A first hip–knee unilateral prototype is described, developed, and its performance assessed on a post-stroke patient for straight walking. The study presents an analysis of the human–exoskeleton energy patterns by way of the task-based biological power generation. The resultant assistance, in terms of power, was 10.9% ± 2.2% for hip actuation and 9.3% ± 3.5% for knee actuation. The control strategy improved the gait and postural patterns by increasing joint angles and foot clearance at specific phases of the walking cycle.	Robotica, 37, 2014-2034. https://www.cambridge.org/core/journals/robotica/article/design-and-evaluation-of-a-soft-assistive-lower-limb-exoskeleton/FD592CA3B8D8D61883CA918EA2EE2D3A

A single arm, practical application assessment of user experience and peristomal skin condition among persons with an ileostomy using a new barrier seal with assisted flow,	Kelleher, K., Hunt, R., Hannigan, A., Coffey, C., Moloney, M.C., Ahern, M., Conway, E., O'Sullivan, L.W.,	2019	**Abstract** Peristomal skin complications are a common problem for persons with an ileostomy. **Purpose:** The purpose of this pilot study was to solicit user feedback and perform an initial assessment of the performance of a new barrier seal designed to decrease the risk of chemical-induced dermatitis. **Methods:** Seven (7) potential participants who were at least 18 years of age, >6 months post-surgery, with an end or loop ileostomy and unbroken peristomal skin, and who were capable of changing their appliance themselves or had the availability of care assistance were identified and recruited by the stoma care nurse at the University Hospital, Limerick, Ireland. At the initial visit and after 1 and 2 weeks, participants were asked to rate device comfort, security, and handling; skin condition was assessed by the research nurse using the Ostomy Skin Tool. Descriptive statistics were used to tabulate the results. **Results:** Five (5) participants completed the study. Discoloration, erosion, and tissue overgrowth scores improved in 3 of 5 patients, and the mean Ostomy Skin Tool score decreased from 5.4 ± 2.19 at the initial assessment to 4 ± 1.87 at the week 2 visit. Comfort, handling, and security ratings increased from a median of 8 at the beginning of the study to 10 at week 2. **Conclusion:** Initial patient feedback regarding the new product was positive, and skin assessment results suggest the new seal may help improve peristomal skin condition. Larger studies with longer patient follow-up are needed to confirm the results of this pilot evaluation.	Wound Ostomy Management, 65, 14-19 https://pubmed.ncbi.nlm.nih.gov/30724745/
3D modelling of non-intestinal colorectal anatomy	White, E., McMahon, M., Walsh, M., Walsh, M., Coffey, J.C. and O'Sullivan, L.W.,	2019	**Abstract** **Purpose:** There is a paucity of methods to model soft anatomical tissues. Accurate modelling of these tissues can be difficult with current medical imaging technology. **Methods:** The aim of this research was to develop a methodology to model non-intestinal colorectal tissues that are not readily identifiable radiologically to enhance contextual understanding of these tissues and inform medical device design. The models created were used to inform the design of a novel medical device to separate the mesocolon from the retroperitoneum during resection of the colon. We modelled the peritoneum and the mesentery. The mesentery was used to indicate the location of Toldt's fascia.	International Journal of Computer Assisted Radiology and Surgery, 14, 73-82 https://pubmed.ncbi.nlm.nih.gov/30244306/

			Results: We generated a point cloud dataset using cryosection images as the target anatomy is more visible than in CT or MRI images. The thickness of the mesentery could not be accurately determined as point cloud data do not have thickness. A denser point cloud detailing the mesenteric boundaries could be used to address this. **Conclusions:** Expert anatomical and surgical insight and point cloud data modelling methods can be used to model soft tissues. This research enhances the overall understanding of the mesentery and Toldt's fascia in the human specimen which is necessary for medical device innovations for colorectal surgical procedures.	
Evaluation of use behaviour with an oscillating positive expiratory pressure device in paediatric cystic fibrosis patients	O'Sullivan, K., **O'Sullivan, L.W.,** Dunne, C., McGrath, D. and Linnane, B.,	2018	**Background:** OPEP devices are indicated to remove excess secretions and reduce gas trapping in patients with hypersecretory pulmonary diseases e.g. Cystic Fibrosis (CF), bronchiectasis, chronic bronchitis. OPEP works by actively exhaling to functional residual capacity via a fixed resistor, to generate mean pressures of 10-20 cmH2O at a flow rate of 10-20 L/min, with an Inspiration: Expiration (I:E) ratio of 1:3 or 1:4. The current study sought to evaluate user behaviour during OPEP therapy in paediatric CF patients. **Methods:** 21 paediatric patients were recruited at the CF unit in University Hospital Limerick, Ireland. Each subject used an OPEP device twice daily and received standardised training and instructions from the same specialist physiotherapist. Use behaviour was evaluated using a flow and pressure sensor placed in-line between the subject's mouth and OPEP device. Each subject was asked to perform ten expirations as per their normal routine. Each expiration was recorded separately for analysis. **Results:** None of the subjects achieved the specified therapeutic ranges during expiration (Figure 1). Mean pressure = 16.19 cmH2O [SD=6.78], with a mean flow = 31.28 L/min [SD=8.85]. Mean Expiration length = 2.53s [SD=1.36], with mean I:E ratio = 1:1.24 [range: 1:0.36 – 1:2.42]. **Interpretation:** Despite standardised instruction and good adherence to twice daily OPEP therapy, subjects demonstrated poor technique and large variance during use. Multiple cofounding factors may contribute to this phenomenon.	European Respiratory Journal, 52, S62 https://erj.ersjournals.com/content/52/suppl_62/PA4620
Incorrect performance of Oscillating	O'Sullivan, K.J., Collins, L., McGrath,	2018	No abstract available!	Paediatric Pulmonology, 53, 345-346

Positive Expiratory Pressure (OPEP) therapy by children with cystic fibrosis	D., Linnane, B., O'Sullivan, L.W. and Dunne, C.P.,			https://www.ul.ie/research/publications/incorrect-performance-of-oscillating-positive-expiratory-pressure-therapy-in
Changes in peristomal skin condition and user experience of a novel ostomy seal addressing chemical dermatitis: A six-week safety and efficacy study	Hunt, R., Kelleher, K. and O'Sullivan, L.W.,	2018	**Purpose:** This purpose of this study was to evaluate a novel barrier ring with an assisted flow mechanism by assessing changes in peristomal moisture-associated skin damage (MASD) and perceptions of comfort, security, handling, and discretion in persons with an ileostomy for 6 months or longer. **Design:** Single-arm, open-labeled feasibility study. **Subjects and settings:** Twenty participants (aged ≥18 years) with an ileostomy for 6 months or more participated in the study and 12 completed data collection. The primary reason for dropouts concerned compatibility issues with the barrier ring when used with certain convex pouching systems. **Methods:** Participants used the barrier ring along with their normal ostomy pouching system for a period of 6 weeks. Changes in skin condition were assessed using the Ostomy Skin Tool (OST). Participants' perception of the barrier rings' comfort, security, handling, and discretion were also recorded on a 10-point scale, where participants would offer a low score if their experience was negative and a higher score if their experience was positive. Participants changed pouches and barrier rings at their own discretion. For participants who completed the study, the average skin condition and median ratings of comfort, security, handling, and discretion at 6 weeks were compared to baseline values. **Results:** Twelve of the 20 participants (60%) completed the study. For those who completed, the mean score on the OST decreased from 6.2 ± 1.90 (mean ± SD) at baseline to 3.4 ±1.73 at 6 weeks, indicating a mean reduction of 2.8 (95% CI, -1.6 to -3.9; $P < .001$). The peristomal skin condition of 9 participants improved, whereas 3 experienced no change. All participants who completed the study rated comfort, handling, security, and discretion highly (median score 10 at baseline and at 6 weeks). **Conclusions:** Study findings indicate the novel ostomy barrier ring may reduce levels of peristomal MASD in persons living with an ileostomy, though a more extensive trial with a control group is recommended.	Journal of Wound Ostomy Care Nursing, 45, 444-448 https://pubmed.ncbi.nlm.nih.gov/30188392/

Children with cystic fibrosis may perform Oscillating Positive Expiratory Pressure (OPEP) therapy incorrectly	O'Sullivan, K.J., Collins, L., McGrath, D., Linnane, B., O'Sullivan, L.W., Dunne, C.P.,	2018	No abstract available!	Chest, 154, 1, 231-232 https://pubmed.ncbi.nlm.nih.gov/30044744/
Cuff Pressure Algometry in Patients with Chronic Pain as Guidance for Circumferential Tissue Compression for Wearable Soft Exoskeletons: A Systematic Review	Kermavnar, T., Power, V., de Eyto, A. and O'Sullivan, L.W.,	2018	In this article, we report on a systematic review of the literature on pressure-pain thresholds induced and assessed by computerized cuff pressure algometry (CPA). The motivation for this review is to provide design guidance on pressure levels for wearable soft exoskeletons and similar wearable robotics devices. In our review, we focus on CPA studies of patients who are candidates for wearable soft exoskeletons, as pain-related physiological mechanisms reportedly differ significantly between healthy subjects and patients with chronic pain. The results indicate that circumferential limb compression in patients most likely becomes painful at ~10-18 kPa and can become unbearable even below 25 kPa. The corresponding ranges for healthy control subjects are 20-42 kPa (painful limits) and 34-84 kPa (unbearable levels). In addition, the increase of pain with time tends to be significantly higher, and the adaptation to pain significantly lower, than in healthy subjects. The results of this review provide guidance to designers of wearable robotics for populations with chronic pain regarding rates and magnitudes of tissue compression that may be unacceptable to users.	Soft Robotics, 5, 497-511 https://pubmed.ncbi.nlm.nih.gov/29957130/
A study of laparoscopic instrument use during colorectal surgery	White, E., McMahon, M., Walsh, M., Coffey, J.C. and O'Sullivan, L.W.,	2018	The aim of this study was to quantify laparoscopic instrument use and actions of both limbs during a sample of common colorectal surgical procedures. A method was devised using Observer XT software to code video recordings. Anonymised HD video recordings of nine laparoscopic colorectal procedures performed by a single surgeon were analysed. We determined the percentage and frequency of instrument use and limb actions throughout the total laparoscopic surgical duration, as well as the duration of instrument inactivity. Seven instruments and seven actions were studied across nine surgical procedures. Manoeuvring, blunt dissection, and tenting up tissues accounted for the longest amount of total surgical time (non-dominant hand (NDH) 29%, dominant hand (DH) 39%),	Applied Ergonomics, 78, 301-308 https://pubmed.ncbi.nlm.nih.gov/29519498/

			followed by grasping (NDH 33%, DH 9%), and cauterising (NDH <0.2%, DH 8%). Least time was spent performing other actions such as suction/irrigation (NDH 0.01%, DH 3%) and stapling colorectal tissue (NDH 0.03%, DH 0.5%). The total duration of instrument use and hand actions by the dominant and non-dominant hands were similar overall. However, the frequency of actions performed was lower for the non-dominant hand. This indicates that the non-dominant hand spent more time holding actions than switching between actions, supporting the actions of the dominant hand. These findings highlight the lengthy durations of laparoscopic surgical procedures involved in navigating to anatomical planes and moving tissues. Further, the results detail the extent of secondary functions performed with the surgical instruments.	
Foreseeing the microbiology of bespoke 3D printed medical device	Dunne, C.P., O'Sullivan, K.K., O'Sullivan, L.W., Linnane, B. and O'Connell, N.H.,	2018	No Abstract available!	Journal of Hospital Infection, 99, 237-238 https://pubmed.ncbi.nlm.nih.gov/29555487/
Toward a model of Human Information Processing for Laparoscopic Colorectal Surgery	White, E., McMahon, M., Walsh, M., Coffey, J.C. and O'Sullivan, L.W.,	2018	**Objective:** To create a human information-processing model for laparoscopic surgery based on already established literature and primary research to enhance laparoscopic surgical education in this context. **Design:** We reviewed the literature for information-processing models most relevant to laparoscopic surgery. Our review highlighted the necessity for a model that accounts for dynamic environments, perception, allocation of attention resources between the actions of both hands of an operator, and skill acquisition and retention. The results of the literature review were augmented through intraoperative observations of 7 colorectal surgical procedures, supported by laparoscopic video analysis of 12 colorectal procedures. **Results:** The Wickens human information-processing model was selected as the most relevant theoretical model to which we make adaptions for this specific application. We expanded the perception subsystem of the model to involve all aspects of perception during laparoscopic surgery. We extended the decision-	Journal of Surgical Education, 75, 3, 749-757 https://pubmed.ncbi.nlm.nih.gov/28986274/

			making system to include dynamic decision-making to account for case/patient-specific and surgeon-specific deviations. The response subsystem now includes dual-task performance and nontechnical skills, such as intraoperative communication. The memory subsystem is expanded to include skill acquisition and retention. **Conclusions:** Surgical decision-making during laparoscopic surgery is the result of a highly complex series of processes influenced not only by the operator's knowledge, but also patient anatomy and interaction with the surgical team. Newer developments in simulation-based education must focus on the theoretically supported elements and events that underpin skill acquisition and affect the cognitive abilities of novice surgeons. The proposed human information-processing model builds on established literature regarding information processing, accounting for a dynamic environment of laparoscopic surgery. This revised model may be used as a foundation for a model describing robotic surgery.	
The use of 3D Printing to Create a Bespoke Repair of a Percutaneous Endoscopic Gastrostomy (PEG) Tube in Patient Unfit for Surgical Replacement	O'Sullivan, K, O'Sullivan, A., Linnane, B., Power, N. and O'Sullivan, L.W.,	2018	We report a case of three-dimensional (3D) printing being used to solve a difficult bedside clinical problem and avoidance of substantial risk associated with alternative solutions. A 15-year-old male with advanced cystic fibrosis developed a small (~1mm) linear tear in his Percutaneous Endoscopic Gastrostomy (PEG) tube, approximately 40 mm from the skin surface. The patient's advanced condition precluded replacement of the PEG tube under general anaesthetic. Attempts to manage the tear with adhesive tapes yielded limited success. 3D printing was used to create a bespoke sealing device overnight, rectifying the leak and allowing enteral feeding to recommence unimpeded. The device is functioning well, several months post-discharge of the patient.	British Medical Journal – Innovations, 4, 29-31. https://www.proquest.com/docview/2132836485?parentSessionId=zmb176Q%2FxTzM0SLxaUBMG77AGplGv9LKaRE2XKLA2pc%3D&sourcetype=Scholarly%20Journals
Technology Acceptance and User Centered Design of Exoskeletons for Older Age Adults	Shore, L., Power, V., de Eyto, A. and O'Sullivan, L.W.,	2018	Assistive robots are emerging as technologies that enable older adults to perform activities of daily living with autonomy. Exoskeletons are a subset of assistive robots that can support mobility. Perceptions and acceptance of these technologies require understanding in a user-centred design context to ensure optimum experience and adoption by as broad a spectrum of older adults as possible. The adoption and use of assistive robots for activities of daily living (ADL) by older adults is poorly understood. Older adult acceptance of technology	Robotics, 7, 3-16 https://www.mdpi.com/2218-6581/7/1/3#:~:text=Exoskeletons%20are%20a%20subset%20of,of%20older%20adults%20as%20possible.

			is affected by numerous factors, such as perceptions and stigma associated with dependency and ageing. Assistive technology (AT) models provide theoretical frameworks that inform decision-making in relation to assistive devices for people with disabilities. However, technology acceptance models (TAMs) are theoretical explanations of factors that influence why users adopt some technologies and not others. Recent models have emerged specifically describing technology acceptance by older adults. In the context of exoskeleton design, these models could influence design approaches. This article will discuss a selection of TAMs, displaying a chronology that highlights their evolution, and two prioritised TAMs—Almere and the senior technology acceptance model (STAM)—that merit consideration when attempting to understand acceptance and use of assistive robots by older adults.	
3D printing to create a percutaneous endoscopic gastrostomy tube in patient unfit for surgical replacement	O'Sullivan, K., O'Sullivan, A.G., Dunne, C.P., Power, N., O'Sullivan, L.W. and Linnane, B.,	2018	No abstract available!	Irish Journal of Medial Science, S427-428 **https://www.ul.ie/research/publications/3d-printing-to-create-bespoke-repair-of-percutaneous-endoscopic-gastrostomy**
Investigation of the effect of cannula size and gas flow rate on aerosol delivery during simulated paediatric high flow nasal therapy	O'Sullivan, K.J., White, R., Lynch, C., O'Sullivan, L.W., Dunne, C., McGrath, D.,	2018	High Flow Nasal Therapy (HFNT) is increasingly used across a variety of patient populations. It has the potential for use for the concurrent delivery of a large range of medications in the form of an aerosol to the airways. The objective of this study was to evaluate the effects of gas flow rate and cannula size on aerosol delivery during simulated paediatric HFNT.	Irish Journal of Medical Science, 187, S278-279 https://www.researchgate.net/publication/329183669_Investigation_of_the_Effect_of_Cannula_Size_and_Gas_Flow_Rate_on_Aerosol_Delivery_during_Simulated_Paediatric_High_Flow_Nasal_Therapy
Digital health technology, AI and HFE				
Developing a Framework for	Vining, R., McDonald,	2022	This paper proposes a framework for developing a trustworthy artificial intelligence (AI) supported knowledge management system (KMS) by integrating	Lecture Notes in Computer Science

Trustworthy AI-Supported Knowledge Management in the Governance of Risk and Change	N., McKenna, L., Ward, M., Doyle, B., Liang, J., Hernandez, J., Guilfoyle, J., Arwa Shuhaiber, Geary, U., Fogarty, M. and Brennan, R.		existing approaches to trustworthy AI, trust in data, and trust in organisations. We argue that improvement in three core dimensions (data governance, validation of evidence, and reciprocal obligation to act) will lead to the development of trust in the three domains of the data, the AI technology, and the organisation. The framework was informed by a case study implementing the Access-Risk-Knowledge (ARK) platform for mindful risk governance across three collaborating healthcare organisations. Subsequently, the framework was applied within each organisation with the aim of measuring trust to this point and generating objectives for future ARK platform development. The resulting discussion of ARK and the framework has implications for the development of KMSs, the development of trustworthy AI, and the management of risk and change in complex socio-technical systems.	https://doi.org/10.1007/978-3-031-17615-9_22
Human Factors and Ergonomics in Healthcare AI.	Sujan, M. et al.	2021	This White Paper outlines eight key human factors and ergonomics (HF/E) principles and methods relevant to the design and use of artificial intelligence (AI) in healthcare.	Chartered Institute of Ergonomics and Human Factors https://ergonomics.org.uk/static/e71c0db9-320b-4812-bd1d7791089c2aae/human-factors-in-healthcare-ai-white-paper.pdf.
Evaluation of an Access-Risk-Knowledge (ARK) Platform for Governance of Risk and Change in Complex Socio-Technical Systems.	Ulfvengren, P., Geary, U., Guilfoyle, J., Shuhaiber, A., Hernandez, J., Fogarty, M., Healy, U., Tallon, C. and Brennan, R.	2021	Three key challenges to a whole-system approach to process improvement in health systems are the complexity of socio-technical activity, the capacity to change purposefully, and the consequent capacity to proactively manage and govern the system. The literature on healthcare improvement demonstrates the persistence of these problems. In this project, the Access-Risk-Knowledge (ARK) Platform, which supports the implementation of improvement projects, was deployed across three healthcare organisations to address risk management for the prevention and control of healthcare-associated infections (HCAIs). In each organisation, quality and safety experts initiated an ARK project and participated in a follow-up survey and focus group. The platform was then evaluated against a set of fifteen needs related to complex system transformation. While the results highlighted concerns about the platform's usability, feedback was generally positive regarding its effectiveness and potential value in supporting HCAI risk	International Journal of Environmental Research and Public Health IJERPH | Free Full-Text | Evaluation of an Access-Risk-Knowledge (ARK) Platform for Governance of Risk and Change in Complex Socio-Technical Systems (mdpi.com)

			management. The ARK Platform addresses the majority of identified needs for system transformation; other needs were validated in the trial or are undergoing development. This trial provided a starting point for a knowledge-based solution to enhance organisational governance and develop shared knowledge through a Community of Practice that will contribute to sustaining and generalising that change.	
A risk governance framework for healthcare decision support systems based on socio-technical analysis	Basereh, M., Brennan, R., Corrigan, S. and Abgaz, Y.	2020	We are developing an Artificial Intelligence (AI) risk governance framework based on human factors and AI governance principles to make automated healthcare decision-support safer and more accountable. Today, the healthcare system is facing a huge overload in reporting, which has made manual processing and comprehensive decision-making impossible. Emerging advances in AI and especially Natural Language Processing seem an attractive answer to human limitations in processing high volumes of reports. However, there are known risks to automation, including the risk in change of deploying AI itself into organisations, emotions, and ethics, which are rarely taken into consideration when making AI-based decisions. To explore this, we will first construct a Decision Support System (DSS) tool based on a knowledge graph extracted from real-world healthcare reports. Then, the tool will be deployed in a controlled manner in a hospital and its operation will be analysed using an established socio-technical methodology developed by the Centre for Innovative Human Systems in Trinity College Dublin over 25 years of research. We will contribute by integrating computer science with organizational psychology and the use of human factors methods to identify the impact of AI-based healthcare DSS, their associated risks, and the ethical and legal challenges. We hypothesize that collaborating with the organisational psychologists to consider the global system of human decision-making and AI-based DSS will help in minimizing the AI-based decision-making risk in a way that ensures fairness, accountability, and transparency. This study will be carried out with our partner hospital, St. James in Dublin.	DCU online Research Access Service https://doras.dcu.ie/24651/