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HEALTH AND SOCIAL CARE ERGONOMICS: PATIENT SAFETY IN PRACTICE

Sue Hignett, Sara Albolino & Ken Catchpole. [Health and social care ergonomics: patient safety in practice](#). Pages: 1-4.

This Special Issue on Human Factors in Healthcare was suggested by Prof. Sara Albolino, at the IEA Triennial Congress in 2015 (Melbourne, Australia) as current Chair of the International Ergonomics Association (IEA) Technical Group on Healthcare. It provides a collection of papers to illustrate current research which is helping to introduce and implement Ergonomics (Human Factors) theory and practice into health care.

Sue Hignett, Alexandra Lang, Laura Pickup, Christine Ives, Mike Fray, Celine McKeown, Sarah Tapley, Matthew Woodward & Paul Bowie. [More holes than cheese. What prevents the delivery of effective, high quality and safe health care in England?](#) Pages: 5-14.

What prevents the delivery of effective, high quality and safe health care in the National Health Service (NHS) in England? This paper presents 760 challenges which 330 NHS staff reported as preventing the delivery of effective, high quality and safe care. Some problems have been known for over 25 years (staff shortages, finance and patient complexity) but other challenges raise questions about the commitment of the NHS to patient and staff safety. For example, Organisational Culture leading to 'stifling bureaucracy', 'odds stacked against smooth [...] working' and Workload resulting in 'firefighting daily' and 'perpetual crisis mode'. The role of Human Factors/Ergonomics professional input (engagement with safety scientists) is discussed in the context of success stories and examples of Human Factors Integration from other safety critical industries (Defence, Nuclear and Rail). **Practitioner Summary:** 760 challenges to the quality, effectiveness and safety of health care were identified at Human Factors/Ergonomics taster workshops in England. These are used to challenge health care providers to think about a Human Factors Integration (HFI systems) approach for safety, well-being and performance for all people involved in providing and receiving health care.

- **Keywords:** Human factors, education, patient safety, systems, healthcare, ergonomics, human factors integration

Laura Pickup, Alexandra Lang, Sarah Atkinson & Sarah Sharples. *The dichotomy of the application of a systems approach in UK healthcare the challenges and priorities for implementation. Pages: 15-25.*

There is increasing demand for a systems approach within national healthcare guidelines to provide a systematic and sustainable framework for improvements in patient safety. Supported by this is the growing body of evidence within Human Factors/Ergonomics (HFE) healthcare literature for the inclusion of this approach in health service design, provision and evaluation. This paper considers the current interpretation of this within UK healthcare systems and the dichotomy which exists in the challenge to implement a systems approach. Three case studies, from primary and secondary care, present a systems approach, offering a novel perspective of primary care and blood sampling. These provide practical illustrations of how HFE methods have been used in collaboration with healthcare staff to understand the system for the purpose of professional education, design and safety of clinical activities. The paper concludes with the challenge for implementation and proposes five roles for systems HFE to support patient safety. **Practitioner Summary:** healthcare is classified as a complex and dynamic system within this paper and as such HFE system methods are presented as desirable to understand the system, to develop HFE tools, to deliver education and integrate HFE within healthcare systems.

- **Keywords:** Systems, patient safety, human factors, ergonomics, healthcare

Ken R. Catchpole, Elyse Hallett, Sam Curtis, Tannaz Mirchi, Colby P. Souders & Jennifer T. Anger. *Diagnosing barriers to safety and efficiency in robotic surgery. Pages: 26-39.*

Recent studies exploring the effects of surgical robots on teamwork are revealing challenges not reflected in clinical studies. This study is a sub analysis of observational data collected from 89 procedures utilising the da Vinci systems. Previous analyses had demonstrated interactions between flow disruptions and contextual factors. This study sought a more granular analysis to provide better insight for improvement. Raters sub-classified disruptions, based upon the original notes, grouped according to four operative phases (pre-robot; docking; surgeon on console; undocking; and finish). The need for repeated utterances; additional supplies retrieval; fogging or matter on the endoscope and procedure-specific training were particularly disruptive. Variations across phases reflect differing demands across the operative course. Combined qualitative and quantitative observational methodologies can identify otherwise undocumented sources of process variation and potential failure. Future observational frameworks should attempt to merge human reliability analysis, a priori modelling, and *post hoc* analyses of observational data. **Practitioner Summary:** Robotic surgery introduces new challenges into the operating room. Direct observation was used to classify and identify flow disruptions in order to diagnose problems in need of improvement. This technique complements other error prediction and system diagnostic methods which may not account for the complexity and transparency of health care.

- **Keywords:** Health care ergonomics, teamwork, human-machine systems, complex systems, patient safety

Tommaso Bellandi, Alessandro Cerri, Giulia Carreras, Scott Walter, Cipriana Mengozzi, Sara Albolino, Eleonora Mastrominico, Fernando Renzetti, Riccardo Tartaglia & Johanna Westbrook. *Interruptions and multitasking in surgery: a multicentre observational study of the daily work patterns of doctors and nurses. Pages: 40-47.*

The aim of this study was to obtain baseline data on doctors' and nurses' work activities and rates of interruptions and multitasking to improve work organisation and processes. Data were collected in six surgical units with the WOMBAT (Work Observation Method by Activity Timing) tool. Results show that doctors and nurses received approximately 13 interruptions per hour, or one interruption every 4.5 min. Compared to doctors, nurses were more prone to interruptions in most activities, while doctors performed multitasking (33.47% of their time, 95% CI 31.84–35.17%) more than nurses (15.23%, 95% CI 14.24–16.25%). Overall, the time dedicated to patient care is relatively limited for both professions (37.21%, 95% CI 34.95–39.60% for doctors, 27.22%, 95% CI 25.18–29.60% for nurses) compared to the time spent for registration of data and professional communication, that accounts for two-thirds of doctors' time and nearly half of nurses' time. Further investigation is needed on strategies to manage job demands and professional communications. **Practitioner Summary:** This study offers further findings on the characteristics and frequency of multitasking and interruptions in surgery, with a comparison of how they affect doctors and nurses. Further investigation is needed to improve the management of job demands and communications according to the results.

- **Keywords:** Multitasking and interruptions, doctors' and nurses' workload, safety in surgery, structured observations

Gyuchan Thomas Jun, Aneurin Canham, Ander Altuna-Palacios, James R. Ward, Ran Bhamra, Stephen Rogers, Amalin Dutt & Priyal Shah. *A participatory systems approach to design for safer integrated medicine management.* Pages: 48-68.

It is recognised that whole systems approaches are required in the design and development of complex health care services. Application of a systems approach benefits from the involvement of key stakeholders. However, participation in the context of community based health care is particularly challenging due to busy and geographically distributed stakeholders. This study used action research to investigate what processes and methods were needed to successfully employ a participatory systems approach. Three participatory workshops planned and facilitated by method experts were held with 30 representative stakeholders. Various methods were used with them and evaluated through an audit of workshop outputs and a qualitative questionnaire. Findings on the method application and participation are presented and methodological challenges are discussed with reference to further research. **Practitioner Summary:** This study provides practical insights on how to apply a participatory systems approach to complex health care service design. Various template-based methods for systems thinking and risk-based thinking were efficiently and effectively applied with stakeholders.

- **Keywords:** Health care ergonomics, participatory ergonomics, systems approach, sociotechnical system, patient safety

Michelle A. Jahn & Barrett S. Caldwell. *Community health integration through pharmacy process and ergonomics redesign (CHIPPER).* Pages: 69-81.

As the expansion and utilisation of community pharmacy systems increases, so does the risk for an adverse drug event to occur. In attempts to mitigate this risk, many community pharmacies implement health information technology (IT); however, there are challenges in integrating the wider systems components necessary for a successful implementation with minimal unintended consequences. The purpose of this paper is to introduce a Community Health Integration through Pharmacy Process and Ergonomics Redesign (CHIPPER) framework, which explores the multiple angles of health IT integration to support medication delivery processes in community pharmacy systems. Specifically, CHIPPER identifies the information flows that occur between different parts

of the system (initiation, upstream, midstream and downstream) with varying end-users and tasks related to medication delivery processes. In addition to the justification and presentation of the CHIPPER model, this paper reviews several broad applications for CHIPPER and presents two example studies that demonstrate the CHIPPER framework.

Practitioner Summary: Most medication delivery in the US occurs through outpatient-based community pharmacy practice. Community pharmacies are challenged by inconsistent and incomplete information flow and technology integration between providers, pharmacy practitioners and patients. This paper presents a framework for improved healthcare systems engineering analysis of pharmacy practice, with case study examples.

- **Keywords:** Pharmacy, information technology, healthcare systems, work processes

Robin Sue Mickelson & Richard J. Holden. *Medication adherence: staying within the boundaries of safety.* Pages: 82-103.

An important domain of patient safety is the management of medications in home and community settings by patients and their caregiving network. This study applied human factors/ergonomics theories and methods to data about medication adherence collected from 61 patients with heart failure accompanied by 31 informal caregivers living in the US. Seventy non-adherence events were identified, described, and analysed for performance shaping factors. Half were classified as errors and half as violations. Performance shaping factors included elements of the person or team (e.g. patient limitations), task (e.g. complexity), tools and technologies (e.g. tool quality) and organisational, physical, and social context (e.g. resources, support, social influence). Study findings resulted in a dynamic systems model of medication safety applicable to patient medication adherence and the medication management process. Findings and the resulting model offer implications for future research on medication adherence, medication safety interventions, and resilience in home and community settings.

Practitioner Summary: We describe situational and habitual errors and violations in medication use among older patients and their family members. Multiple factors pushed performance towards risk and harm. These factors can be the target for redesign or various forms of support, such as education, changes to the plan of care, and technology design.

- **Keywords:** Patient safety, resilience, medication adherence, chronic disease, human factors in healthcare

Anam Parand, Giuliana Faiella, Bryony Dean Franklin, Maximilian Johnston, Fabrizio Clemente, Neville A. Stanton & Nick Sevdalis. *A prospective risk assessment of informal carers' medication administration errors within the domiciliary setting.* Pages: 104-121.

Increasingly, medication is being administered at home by family and friends of the care-recipient. This study aims to identify and analyse risks associated with potential drug administration errors made by informal carers at home. We mapped medication administration at home with a multidisciplinary team that included carers, health care professionals and patients. Evidence-based risk-analysis methodologies were applied: Healthcare Failure Modes and Effect Analysis (HFMEA), Systematic Human Error Reduction and Prediction Analysis (SHERPA) and Systems-Theoretic Accident Model and Processes (STAMP). The process of administration comprises seven sub-processes. Thirty-four possible failure modes were identified and six of these were rated as high risk. These highlighted that medications may be given with a wrong dose, stored incorrectly, not discontinued as instructed, not recorded, or not ordered on time, and often caused by communication and support problems. Combined risk analyses contributed unique information helpful to better understand the medication

administration risks and causes within homecare. **Practitioner Summary:** Increasingly, medication is being administered at home by family and friends of the care-recipient. This study identifies risks associated with potential drug administration errors made by informal carers at home through consensus-based quantitative techniques. The different analyses contribute unique information helpful to better understand the administration risks and causes.

- **Keywords:** Patient safety, medication errors, HFMEA, SHERPA, risk assessment

Tom W. Reader, Geetha Reddy & Stephen J. Brett. [Impossible decision? An investigation of risk trade-offs in the intensive care unit.](#) Pages: 122-133.

In the intensive care unit (ICU), clinicians must often make risk trade-offs on patient care. For example, on deciding whether to discharge a patient before they have fully recovered in order to create a bed for another, sicker, patient. When misjudged, these decisions can negatively influence patient outcomes: yet it can be difficult, if not impossible, for clinicians to evaluate with certainty the safest course of action. Using a vignette-based interview methodology, a naturalistic decision-making approach was utilised to study this phenomena. The decision preferences of ICU clinicians ($n = 24$) for two common risk trade-off scenarios were investigated. Qualitative analysis revealed the sample of clinicians to reach different, and sometimes oppositional, decision preferences. These practice variations emerged from differing analyses of risk, how decisions were 'framed' (e.g. philosophies on care), past experiences, and perceptions of group and organisational norms. Implications for patient safety and clinical decision-making are discussed. **Practitioner Summary:** Physicians managing ICUs have to make rapid decisions with incomplete information and suboptimal resources. A qualitative vignette-based interview study examined how such decisions are made. We found physicians used a heterogeneous mixture of risk assessments, factual knowledge and prior experience to make judgements, which leads to potential for inconsistent decision-making.

- **Keywords:** Risk trade-offs, decision-making, patient safety, intensive care

Siobhan M. Heiden & Barrett S. Caldwell. *Considerations for developing chronic care system for traumatic brain injury based on comparisons of cancer survivorship and diabetes management care.* Pages: 134-147.

Experts in traumatic brain injury (TBI) rehabilitation recently proposed the framing of TBI as a chronic disease rather than a discrete event. Within the framework of the Chronic Care Model (CCM), a systematic comparison of three diseases – cancer survivorship, diabetes management and TBI chronic care – was conducted regarding chronic needs and the management of those needs. In addition, comparisons of these conditions require comparative evaluations of disease management characteristics and the survivor concept. The analysis found diabetes is more established within the CCM, where care is integrated across specialists and primary care providers. No single comparison provides a full analogue for understanding the chronic care health delivery system for TBI, indicating the need for a separate model to address needs and resources for TBI survivors. The findings from this research can provide practitioners with a context to develop a robust continued care health system for TBI. **Practitioner Summary:** We examine development of a chronic care system for traumatic brain injury. We conducted a systematic comparison of Chronic Care Model elements of decision and information support. Development of capabilities using a benchmark of diabetes care, with additional insights from cancer care, provides insights for implementing TBI chronic care systems.

- **Keywords:** Health care systems engineering, traumatic brain injury, Chronic Care Model, chronic care, disease management

Linsey M. Steege, Kalyan S. Pasupathy & Diane A. Drake. *A work systems analysis approach to understanding fatigue in hospital nurses*. Pages: 148-161.

Occupational fatigue is an important challenge in improving health and safety in health care systems. A secondary analysis of cross-sectional data from a survey sample comprised 340 hospital nurses was conducted to explore the relationships between components of the nursing work system (person, tasks, tools and technology, environment, organisation) and nurse fatigue and recovery levels. All components of the work system were significantly associated with changes in fatigue and recovery. Results of a tree-based classification method indicated significant interactions between multiple work system components and fatigue and recovery. For example, the relationship between a task variable of 'excessive work' and acute fatigue varied based on an organisation variable related to 'time to communicate with managers/supervisors'. A work systems analysis contributes to increased understanding of fatigue, allowing for a more accurate representation of the complexity in health care systems to guide future research and practice to achieve increased nurse health and safety. **Practitioner Summary:** This paper explored the relationships between nursing work system components and nurse fatigue. Findings revealed significant interactions between work system components and nurses' fatigue and recovery. A systems approach allows for a more accurate representation of complexity in work systems and can guide interventions to improve nurse health and safety.

- **Keywords:** Macroergonomics, fatigue, hospital nurses, occupational health, safety

Yu-San Chang, Yu-Hsuan Wu, Hsiang-Lan Chen & Chung-Yao Hsu. *Is one day off sufficient for re-adaptation to a daytime routine after two consecutive nights of work?* Pages: 162-168.

Fast rotation three-shift working schedules are common in the medical field in Taiwan. This study investigated whether 24 h off is sufficient for re-adaptation to a daytime routine after working two night shifts (NSs) by comparing changes in cognitive function, anxiety state and objectively measured sleep propensity between those working two NSs followed by 24 h off ($n = 21$, 2NS-off) and an off-duty group ($n = 21$, OD). The results showed that nurses in the 2NS-off group were less alert and had decreased visual attention performance and executive function ability than the OD group during the daytime. One day off appeared to be insufficient to adapt back to a daytime shift after two NSs. Further studies are warranted to investigate whether a longer sequence of consecutive NSs (e.g. four NSs) followed by two days off is suitable for a fast rotation three-shift work schedule to allow for optimal performance throughout the next daytime shift. **Practitioner Summary:** The medical field in Taiwan mandates at least 24 h off between night and day shifts, but this appears to be insufficient for re-adapting to a daytime shift after two night shifts. A longer sequence of consecutive night shifts followed by two days off may be more suitable.

- **Keywords:** Adaptation, cognitive function, nurse, rapid rotation shift, shift work

Chantal Trudel, Sue Cobb, Kathryn Momtahan, Janet Brintnell & Ann Mitchell. *Human factors considerations in designing for infection prevention and control in neonatal care – findings from a pre-design inquiry*. Pages: 169-184.

Qualitative data collection methods drawn from the early stages of human-centred design frameworks combined with thematic analysis were used to develop an understanding of infection prevention practice within an existing neonatal intensive care unit. Findings

were used to generate a framework of understanding which in turn helped inform a baseline approach for future research and design development. The study revealed that a lack of clarity between infection transmission zones and a lack of design attributes needed to uphold infection prevention measures may be undermining healthcare workers' understanding and application of good practice. The issue may be further complicated by well-intentioned behavioural attitudes to meeting work objectives; undue influences from spatial constraints; the influence of inadvertent and excessive touch-based interactions; physical and/or cognitive exertion to maintain transmission barriers; and the impact of expanding job design and increased workload to supplement for lack of effective barriers. **Practitioner Summary:** Despite high hand hygiene compliance within a neonatal intensive care unit, healthcare workers expressed concerns about the unit design and infection prevention practice. Early inquiry methods from human-centred design and thematic analysis helped develop a framework to understand how design can be used to aid infection prevention.

- **Keywords:** Infection prevention and control, neonatal intensive care unit, human factors, ergonomics, design

Sara Albolino, Giulia Dagliana, Dariana Illiano, Michela Tanzini, Francesco Ranzani, Tommaso Bellandi, Ismaele Fusco, Irene Bellini, Giulia Carreras, Mariarosaria Di Tommaso & Riccardo Tartaglia. *Safety and quality in maternal and neonatal care: the introduction of the modified WHO Safe Childbirth Checklist. Pages: 185-193.*

Maternal and neonatal mortality and morbidity associated with childbirth is a problem of the highest priority. This research has been aimed at testing a modified version of the WHO Safe Childbirth Checklist in one Italian hospital and to evaluate the tool in terms of its impact on clinical practice and safety. Results show that the presence of correctly compiled partogram tool is strongly and significantly associated with the checklist implementation (OR = 14.9, 95% confidence interval [CI] = 3.5, 63.9). Compliance to the checklist was high for mid-wives (96%) and very low for obstetricians (3%). The discrepancy is the result of a misinterpretation by obstetricians: they signed only in case they prescribed therapy or when they identified risk factors, but not to underline that they checked for those factors independently by their existence. While the checklist promotes the interdisciplinary work, field studies generally show strong hierarchical rather than partnership interaction. **Practitioner Summary:** The study is aimed at evaluating: the checklist impact on clinical practice through a prospective pre- and post-intervention study based on clinical records review, the usability of the tool and the user's compliance. The research gives evidences on the importance of the tool for reducing risks related to delivery.

- **Keywords:** Maternal and neonatal safety, childbirth checklist, users' compliance, risks in delivery