

Co-design of interventions to improve acute care in hospital:

A rapid review of the literature and application of the BASE methodology, a novel system for the design of patient centered service prototypes

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Abstract

Co-design in acute care is challenged by the inability of unwell patients to participate in the process and the often transient nature of acute care.

We undertook a rapid review of the literature on co-design, co-production and co-creation of solutions for acute care that were developed with patients. We found limited little evidence for co-design methods in acute care.

We adapted a novel design driven method (BASE methodology) that creates stakeholder groups through epistemological criteria for the rapid development of interventions for acute care. We demonstrated feasibility of the methodology in two case studies:

A mHealth application with checklists for patients undergoing treatment for cancer and a patient held record for self-clerking on admission to hospital.

Keywords

co-design, co-production, acute care, hospital, patient-centred

Key learning points

1. Co-design is underutilised in acute care
2. For the co-design of novel interventions stakeholder should be aligned according to epistemological criteria
3. In acute care co-design challenges include limitations of sick patients to act in a system with strong hierarchies and continuity and visibility of safety critical information across changing providers

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Background

During 2020 healthcare has changed beyond recognition: With COVID-19 pandemic we have seen an explosion in demand, constraints on delivery and a collapse in the economy with resulting challenges to funding that has created a 'burning platform' for healthcare.¹ In order to deliver against these time and financial constraints radically different methods of creating innovative solutions are needed. UK Innovation and Research has puts design methodology at the heart of its innovation strategy.² For innovation this report recommends three lenses: What do people desire? What is technically feasible? What is financially viable? The same lenses can be applied to innovation in healthcare.

There is little doubt that health services are under increasing political and public pressure, struggling to provide adequate and safe services. They are in dire need of redesign for improvement. At the same time there is a growing acknowledgement that services are best designed in close collaboration with those who are using them – both health care professionals and patients and their support network. This has

resulted in a dramatic recent focus on the need to include patients and carers in the co-production of health services on both operational and health policy levels^{3,4} with accumulating evidence that services that are co-produced deliver better outcomes for patients with higher satisfaction for healthcare professionals and patients at a lower cost to the taxpayer.⁵⁻⁸

The terms co-production, co-creation, co-design are often used interchangeably⁹ but co-design might be related mostly to the process of planning new services. Co-design focuses on the use of stories and storytelling by patients to gain a deep appreciative understanding of the strengths and weaknesses of a present service, co-production involves producing a product or service together and comes after the co-design phase, and co-creation usually refers to both co-design and co-production taken together.¹⁰

Co-design in healthcare involves the equal partnership of individuals who work within the system (healthcare staff), individuals who have lived experience of using the system (patients and their families/carers) and the 'designers' of the new system (whether that be IT personnel in terms

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of electronic platforms to improve efficiency or researchers in terms of designing interventions to improve health systems).¹¹ Co-design involves working together to achieve better outcomes or improved efficiency.¹²

Despite the promotion of co-design/co-production and the focus on shared decision making¹³ it is doubtful how robust these principles are embedded in healthcare with little evidence for their role in hyperacute and emergency care^{14,15} and the current COVID pandemic.^{16,17} The bulk of published experience of participatory design has been in programs for patients with defined long-term conditions such as in Cystic Fibrosis¹⁸ or inflammatory bowel disease,^{19,20} or in primary care. However, co-production has lagged in the design of services dealing with life-threatening emergencies and unscheduled acute care.^{21,22} On one hand side emergency care in and out of the hospital is costly but due to the acute nature of the relevant conditions associated with significant safety risks,^{23,24} on the other hand side the patient's ability to partake in shared decision making or exert agency is limited by the severity of their disease and their dependency on immediately life-saving interventions.²⁵ Curiously funders and patients are rarely part of the same service design process. In order to improve the impact of co-design a broader range of drivers might therefore warrant consideration.

Co-design is often focused on user-experience as a key driver. It is arguable that this is challenging to keep it front and centre as a key driver in systems providing emergency medical care that are under extreme clinical and financial pressures. This raises important questions on how the impact of co-design might change if end-users i.e. patient representatives and healthcare staff co-designed the intervention and if the process would result in interventions that differ from current care-models in relation to the 'ownership' and agency of patients of the final product?

The BASE prototypology²⁶ is a design-led development method that ensures a holistic approach to collaboration through link of knowledge domains (epistemology) and participant characteristics (ontology). BASE prototypology emphasises that knowledge can be gained from different perspectives of a process: B for business (viability, 'How is it paid for', financial implications), A for art (desirability, 'How does it look', understanding of the physical form of objects or processes), S for science (evidence, 'How does it work', subject matter experts), E for engineering (feasibility, 'How is it made') and user experience ('How does it feel') (Figure 1).

In this paper we (1) review the literature on co-design, co-production and co-creation in acute

care, (2) describe in detail the processes employed in developing a novel template for co-design for healthcare teams in the challenging and complex environments of emergency care.

Through two case-studies we illustrate the value, feasibility and explore the boundaries of the process for designing interventions in acute care.

Methods

Rapid Review of the Literature

We undertook a rapid review of the literature:²⁷ we restricted the search to one database (PubMed), and articles were screened by only one reviewer.

Inclusion criteria were as follows:

- **Population:** Adult patients requiring urgent or emergency care in hospital but excluding intensive care or hospice settings
- **Outcomes:** Interventions created with patients
- **Intervention:** co-design of an artefact, process or service for patients
- **Study types:** observational and interventional studies.
- **Source types:** Published, peer-reviewed journal articles accessible through PubMed.

Studies describing interventions in children, editorials, discussion papers and studies that limited co-design to healthcare professional were excluded.

Search terms: Permutations of co-design, co-production, co-creation were linked to descriptors of emergency care (Appendix)

The following search string was entered into PubMed (coverage 1947–2014): ((emergency[Title/Abstract]) OR (deterioration[Title/Abstract])) AND ("co-design" OR "co-produce" OR "co-creation" OR "co-create" OR "co- production").

Validation of a novel intervention for co-design in acute care

Structure of the workshops

We applied the BASE prototypology²⁶ in two two-day workshops with case-studies set in acute care with participants selected according to the principles outlined above. Patient representatives were volunteers from a Macmillan User Involvement Group. Participants received preparatory materials prior to the workshops. Each two-day workshop began with introductions of new members and icebreaker activities related to the topic of the workshop with a joint evening meal at the end of day. This might have contributed to the forming of bonds between participants and supported the emotional energy required to understand the impact of adverse events on patients and their loved ones.

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Throughout the workshops interactive exercises were used to facilitate the co-design process including questions for small groups, discussion in pairs, personal reflections, discussion of case studies, mapping exercises of possible intervention components, mapping exercises of desired behavioural changes, choosing and agreeing on evaluation measures. Workshops were broken into discrete activities, which provided a chance for all team members to share their experiences of various aspects of team working, co-design and patient safety.

Co-design by prototyping: Scenario based design

We used design scenarios^{28–30} as useful tools for communicating ideas about user actions and a method that has been used for planning of healthcare emergencies³¹ and with patients.³² We mapped design scenarios to help formalize ideas and to take creative approaches to those ideas. This helped to root designs on terra firma taking a “what our users want/need” approach from the outset. User scenarios were designed to capture key tasks and interactions within a system rather than all possible interactions.

Choice of case studies

Emergencies are characterised by perceived or actual immediate risk to patients’ life. Acute care settings are typified by complex interactions of multiple professional groups with variable level of ownership of location, process and outcomes.³³ Professional groups usually have strong hierarchical structures. There is limited patient agency as the patients is acutely unwell and unable to safely remove themselves from the setting. Two case studies were chosen to exemplify the design challenge of improving safety in acute care:

Case study 1: The acute threat of catastrophic deterioration of patients in hospital (often described as ‘failure to rescue’);³⁴ this type of scenario is common and results in considerable preventable morbidity and mortality of patients,³⁵ mental health issues in clinicians³⁶ and cost for healthcare providers.

Case study 2: The presentation with a potentially life-threatening illness at the hospital front door at the interface between primary and secondary care. Care processes at the interface between providers and teams are over-represented in reports on adverse events. Patients die as a result of failure to act on information that is available but not shared or communicated or lacking in salience.^{37,38}

Ethics and funding

No ethics application was required for the literature review and workshops with patients. Participants signed consent for the dissemination of evidence from the workshops to be disseminated.

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Results

Results of the rapid literature review co-design in acute care

References were verified last on the 11th of July 2022. The search of the literature resulted in 82 references. These were reviewed by hand. 73 references were excluded: 44 contained the wrong population, 17 used wrong outcomes, 5 a wrong study design, 5 were the wrong type of publication and a further 4 had no patient involvement. One additional publication was identified from additional hand searches.³⁹ A recent systematic review of experience centred co-design in hospital was used to validate the search: no further studies in acute care were included in the systematic review.⁴⁰

The remaining 8 manuscripts were further investigated: 7 were from the UK and one from New Zealand (Table 1), all were from the last 10 years.

Two themes were identified as published topics for co-design work: 1. processes to assist patients to call for help in hospital (‘patient activated rapid response’),^{41,42} 2. service design guided by the experience of a patient group with a single specific condition such as asthma,⁴³ epilepsy,⁴⁴ palliative⁴⁵ or elderly patients³⁹ etc. Co-design resulted in new pathways in a small proportion of the studies. Design methods used for co-design were modifications of Plan-Do-Study-Act^{44,46} cycles and Experienced Based Co-design^{47,48} as well as a range of other less standardised methods.

We found limited evaluation of clinical impact of the co-design process in acute or emergency care and no study that compared several design methods.

Application of the BASE prototyping to co-design

Characteristics of workshop participants

Participants from all constituent groups of the BASE model were represented in the two workshops (Figure 1). Each workshop group was split into BASE ‘families’ for small-group activities. These did mirror the make-up of the whole group with at least one member of each constituent group represented in each of the ‘families’. The authors and patient representatives took part in both workshops, all other members of the teams changed.

Development of case studies

Real-life scenarios of patient safety events, including events with fatal outcomes were used. We sourced published reports on sepsis,⁴⁹ hospital care⁵⁰ and

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Table 1. Summary of the identified studies using co-design with patients in acute care

No	1 st author	Population	Method of co-design	Stake holder recruitment	Intervention	Impact measure
1	Subbe CP ⁴⁹ (2021, UK)	Hospitalised patients	PDSA cycle	Pragmatic, patients only	Patient held record	Feasibility
2	Noble A ⁴⁴ (2020, UK)	Patients with epilepsy	PDSA cycle	Health care professionals and purposive sample of service user representatives	First aid training for epilepsy	Pilot randomised controlled trial showed no significant clinical impact
3	McKinney A ⁴¹ (2020, UK)	Hospitalised patients	Research protocol	Health care professionals, patients and relatives	Intervention to detect and refer patient deterioration	n.a.
4	Strickland W ⁴² (2019, New Zealand)	Hospitalised patients	Survey of patients	Purposeful sampling of patients and family members	Co-design limited to survey development	n.a.
5	Newell K ⁴³ (2017, UK)	Patients with asthma	Not specified	Unclear	Asthma patient passport	Reduction of steps needed for patients to communicate their needs
6	Blackwell RW ⁴⁵ (2017, UK)	Elderly patients with palliative care needs	Experienced Based Co-design	ED and palliative care clinicians (interviews with patients separately).	Prioritisation exercise and training materials	Not measured
7	Piper D ⁴⁸ (2012, UK)	Patient accessing emergency departments	Experienced Based Co-design	Staff and patients	Changes to resources used in Emergency Departments	Patient & staff satisfaction
8	O'Donnel D ³⁹ (2019, UK)	Frail patients in acute care	Structured consensus building workshops	Membership of non-governmental organisations, community-based patient & public advocacy organisations	Priorities for frailty pathways	n.a.

adverse events⁵¹ rather than local events in order to maintain patient confidentiality and avoid the risks of litigation. Case scenarios were summarized in case-vignettes. Details of the sample cases were mapped against a timeline.

Both workshops followed the Double-Diamond methodology⁵² (Table 2). Weighting of the BASE groups in the 'families' varied between the workshops. Expert inputs were focused on different design-challenge specific topics. The Crazy-8 methodology⁵³ was used to ideate and develop solutions. Delivery in workshop 1 was only in the form of a prioritisation exercise with the expectation of continuous development of the prototype ideas outside of the workshop. In workshop 2, mock-ups were used in role-play to explore the functionalities of the proposed interventions.

Validation of case studies in clinical applications

Patient held checklists were a preferred intervention suggested by participants in Workshop 1: With funding from a separate grant a patient-held checklist was developed as part of a clinical trial to reduce adverse events from systemic cancer treatments

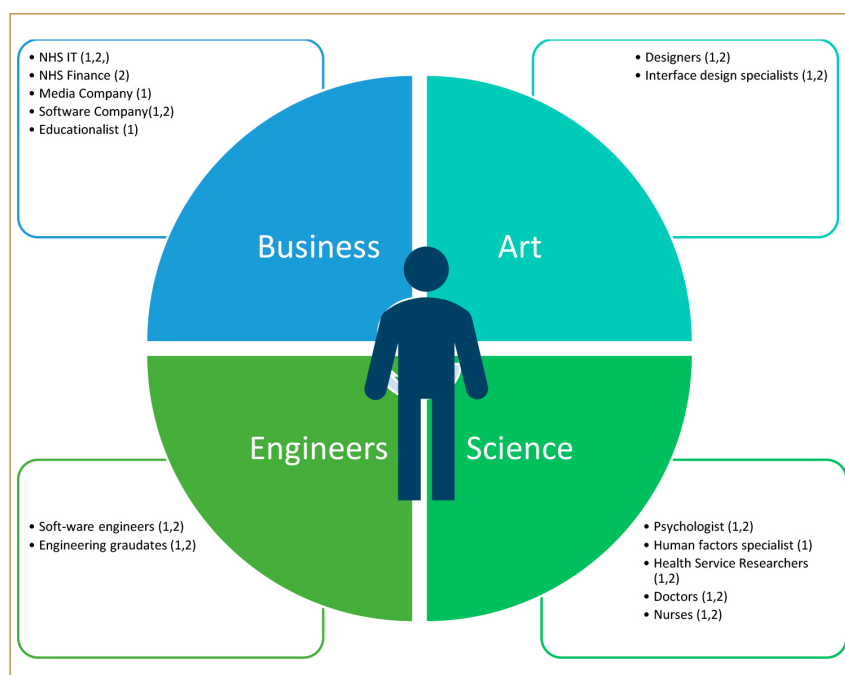


Figure 1. Workshop participants from case study 1 (1) and case study 2 (2) listed according to epistemological categories of the BASE methodology with the patient at the centre of all interactions: In addition to the categories listed four patient representatives participated in both workshops.

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Table 2. Application of the Double-Diamond method to the workshops. The Double-Diamond distinguishes a research phase with divergent discovery of the research area of interest, and convergent definition of the key problem, and a design phase with divergent development of concepts and convergent deployment of the final solutions.

Double-Diamond phase	Case study 1	Case study 2
Discovery of subject	Graphic storyboards	Storyboards Board-game on patient flow In-situ-simulation of a catastrophic emergency
Definition of problem	Limitations of sick patients to act in a system with strong hierarchies	Continuity and visibility of safety critical information across changing providers
Development of prototypes	Crazy-8 method Scenario-based design	Crazy-8 method Short movie clips
Delivery of outputs	Shared-checklists for patients with cancer and families developed into a smart-phone application	Express-check-in: patient-held documentation-system for admission to hospital

(i.e., chemo- and radio-therapy). Check-lists for complications of cancer from the United Kingdom Oncology Nurses Society were adapted with patients into smart-phone application that linked patients to a ‘safety buddy’ and their clinician and has since been tested by the first 100 users as part of a clinical trial.⁵⁴ The application was used over 3000 times in the first 60 days of testing with high reliability of inputs and excellent feedback from users. A patient ‘passport’ with key information was proto-typed in Workshop 2. This was further developed as part of a feasibility study. An ‘Express-Check-in’ for patients admitted to hospital that allows patients to document their history and clinical priorities in hospital records has been tested in over 100 patients.⁵⁵ Well over 80% of patients approached filled the documentation. Resulting records contained a significant proportion of unique information not mirrored in clinical records.

Reflection on the design process
Donabedian conceptualised a chain linking structure, process, and outcome.⁵⁶ Many co-design methods use focus groups with patient representatives.³² In contrast to other techniques, we integrated patient representatives into the groups, prototype development was undertaken in three sub-groups that each had a member of each of the BASE constituents: The collaborative methodology was hence mirrored in the enabling structure of the works-hops. The enabling structure of our method means that healthcare professionals don’t dominate the groups’ conversation.

Emotional experience of the safety challenges of acute care were reflected in both workshops. In the

first workshop we used witness reports of harmed patients and the empathic video of the mother of a patient who died as the result of a safety error. In the second workshop we complemented the secondary experience of reports from the literature with the primary emotional experience of shared immersive enactment of a medical emergency and subsequent prototyping of interventions with joint role play.

We found the input of our patient representatives throughout the workshops to be invaluable. The patient representatives brought the rich experience of their perception of how healthcare teams worked and their impressions of relationships among healthcare team members. We observed little hesitancy and hierarchical behaviour with patients participating, leading the narrative and development of the case-studies as much as other participants. This might be specific to the participants but might be an effect of a design methodology where structure facilitated the democratic group interactions.

Discussion

What we have shown

In the present study we have shown the co-design of interventions in acute care is feasible. We demonstrated the functionality of the BASE methodology as a model to define the constitution of a co-designing team. The link of scenario-based design with the BASE proto-typology allowed the generation of viable prototypes for complex healthcare problems within a very short time frame.

We believe that the heterogeneity of the groups helped to establish flat hierarchies. We started out workshops with clinical care studies that were observed and interpreted by all participants – including the non-clinicians. We believe that this approach assisted the patient focus and helped to avoid dominance of the discussion by clinicians.

Outputs from the two workshops have since been developed further and tested in clinical studies.

What others have shown

At current no authoritative guidelines on the balanced perspective of a stakeholder group that results in change exists: The BASE prototyping gives some guidance on the epistemology that might usefully guide the make-up.

Focus groups are a common way to involve users in the design of services or interventions in clinical trials.⁵⁷ In quality improvement patients can act in distinct roles⁵⁸ as ‘knowledge brokers’ who ‘who facilitate knowledge exchange and adoption’, a ‘technology of persuasion’ of clinicians about the

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importance of a problem. This resulting patient-centred interventions might however not always lead to real-world impact.⁵⁹ Experience based design has been used in a feasibility study to explore ways for patients to speak up in primary care.⁶⁰ Patients identified polypharmacy as a key threat to their safety.

Limitations and challenges of this study

Given that the rate of failed innovation or improvement interventions in the health service is high and that many are planned in desk-top exercises we believe that we have developed an engaging framework that allows teams to validate ideas in a structured manner with limited resources.

Patient representatives for our workshops were not selected in a representative fashion. Given the exploratory character of our study and its resulting limited sample size we refrained from measuring activation⁶¹ of participants or comparable systems of measurement. In the absence of comparative metric for design processes we can only state feasibility but are unable to qualify or quantify the differential impact of our co-design methodology.

Implications for clinical practice: Wicked problems

It is generally acknowledged that for a novel idea to become an innovation it needs to be feasible, viable and desirable.⁶² Our co-design method, while challenging at times, has many benefits including grounding the intervention in the real-world experiences of patients and healthcare teams. This might be of particular relevance in addressing ‘wicked’ or ‘complex’ problems that defy linear approaches.⁶³ The chosen scenarios were ‘Wicked Problems’⁶⁴ in that they are a “class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing.”⁶⁵ ‘Complex’ and ‘Wicked’ would seem to be barriers to other forms of design where the synchronous way of reviewing problems and solutions from multiple view-points at the same time would seem particularly pertinent.

Implications for research

It is generally acknowledged that for a novel idea to become an innovation it needs to be feasible, viable and desirable.⁶² Participatory Design provides a way to include stakeholders in designing solutions development and delivery of service improvement: Evaluation of the design process based on clinical impact is needed to compare output in relation to the design inputs and in comparison, to other ways to change services.

Conclusions

Designing for complex problems might benefit from the use of multiple perspectives. The design of interventions that allow those affected to own/control/deliver them would seem key for addressing patient safety problems. The BASE prototyping has the potential to facilitate future iterative developments of prototypes and allow the measurement of impact on behaviour of patients, carers and health-care professionals. Co-design has great potential as a methodology for engaging patients to help understand and redesign health systems and for enhancing patient outcomes even in acute care.

Data availability statement

All relevant data is contained in the manuscript.

Conflict of Interest Statement

None of the authors has any conflict of interest to report in relation to this manuscript.

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References

- Farrugia G, Plutowski RW. Innovation Lessons From the COVID-19 Pandemic. *Mayo Clin Proc.* 2020;**95**(8):1574–1577. doi:10.1016/j.mayocp.2020.05.024
- Innovate UK. Design in Innovation Strategy 2020–2024. London; 2020.
- Bradley P, Willson A, Buss P, *et al.* Achieving Prudent Healthcare in NHS Wales.; 2014.
- Rix A, Marrin K, Lewis P, Jones R, Shorrocks O. Prudent health care and patient activation An appraisal prepared for the Planned Care Programme Acknowledgements Acknowledgements are due to of the Planned Care Programme for their support and patience, and to Mike Spencer (1000 Lives) and Ruth Dineen (Co-production Wales) for their advice on Patient Experience and Co- production respectively. 2015.
- Clarke D, Jones F, Harris R, Robert G. What outcomes are associated with developing and implementing coproduced interventions in acute healthcare settings? A rapid evidence synthesis. *BMJ Open.* 2017;**7**. doi:10.1136/bmjopen-2016-014650
- Nesta. People powered health co production catalogue. 2012:89.
- Gallagher M, Wales H, Dineen R, Wales C-P. Seeing is Believing: Co-production Case Studies from Wales (version 06 - 12 January 2016). 2012.
- National Voices. Realising the value: how should we think about value in health and care? 2015;(September):20.
- Batalden M, Batalden P, Margolis P, *et al.* Coproduction of healthcare service. *BMJ Qual Saf.* 2015;(pii: bmjqs-2015-004315.).
- Alsem MW, van Meeteren KM, Verhoef M, *et al.* Co-creation of a digital tool for the empowerment of parents of children with physical disabilities. *Res Involv Engagem.* 2017;**3**(1). doi:10.1186/s40900-017-0079-6
- Davies N, Mathew R, Wilcock J, *et al.* A co-design process developing heuristics for practitioners providing end of life care for people with dementia. *BMC Palliat Care.* 2016;**15**(1):68. doi:10.1186/s12904-016-0146-z
- Bringing User Experience to Healthcare Improvement: The Concepts, Methods and Practices of Experience-Based Design: Amazon.co.uk: Bate, Paul, Robert, Glenn: 8601200768732: Books. <https://www.amazon.co.uk/Bringing-User-Experience-Healthcare-Improvement/dp/1846191769>. Accessed June 22, 2020.
- Joseph-Williams N, Lloyd A, Edwards A, *et al.* Implementing shared decision making in the NHS: lessons from the MAGIC programme. *BMJ.* 2017;**357**:j1744. doi:10.1136/bmj.j1744
- Melnick ER, Probst MA, Schoenfeld E, *et al.* Development and Testing of Shared Decision Making Interventions for Use in Emergency Care: A Research Agenda. *Acad Emerg Med.* 2016;**23**(12):1346–1353. doi:10.1111/acem.13045
- Flynn D, Knoedler MA, Hess EP, *et al.* Engaging patients in health care decisions in the emergency department through shared decision-making: A systematic review. *Acad Emerg Med.* 2012;**19**(8):959–967. doi:10.1111/j.1553-2712.2012.01414.x
- Simpson N, Milnes S, Steinfors D. Don't forget shared decision-making in the COVID-19 crisis. *Intern Med J.* 2020;**50**(6):761–763. doi:10.1111/imj.14862
- Contreras CM, Metzger GA, Beane JD, Dedhia PH, Ejaz A, Pawlik TM. Telemedicine: Patient-Provider Clinical Engagement During the COVID-19 Pandemic and Beyond. *J Gastrointest Surg.* 2020. doi:10.1007/s11605-020-04623-5
- Stevens DP, Marshall BC. A decade of healthcare improvement in cystic fibrosis: Lessons for other chronic diseases. *BMJ Qual Saf.* 2014;**23**(SUPPL1):i1–i2. doi:10.1136/bmjqs-2014-002871
- Crandall W, Kappelman MD, Colletti RB, *et al.* ImproveCareNow: The development of a pediatric inflammatory bowel disease improvement network. *Inflamm Bowel Dis.* 2011;**17**(1):450–457. doi:10.1002/ibd.21394
- Berry SK, Siegel CA, Melmed GY. Quality Improvement Initiatives in Inflammatory Bowel Disease. *Curr Gastroenterol Rep.* 2017;**19**(8). doi:10.1007/s11894-017-0581-x
- Piper D, Iedema R, Gray J, Verma R, Holmes L, Manning N. Utilizing experience-based co-design to improve the experience of patients accessing emergency departments in New South Wales public hospitals: An evaluation study. *Heal Serv Manag Res.* 2012;**25**(4):162–172. doi:10.1177/0951484812474247
- Bowen S, McSeveny K, Lockley E, Wolstenholme D, Cobb M, Dearden A. How was it for you? Experiences of participatory design in the UK health service. *CoDesign.* 2013;**9**(4):230–246. doi:10.1080/15710882.2013.846384
- Schenkel S. Promoting patient safety and preventing medical error in emergency departments. *Acad Emerg Med.* 2000;**7**(11):1204–1222. doi:10.1111/j.1553-2712.2000.tb00466.x
- Hogan H, Healey F, Neale G, Thomson R, Vincent C, Black N. Preventable deaths due to problems in care in English acute hospitals : a retrospective case record review study. 2012;(July). doi:10.1136/bmjqs-2012-001159
- Vennik FD, Van De Bovenkamp HM, Putters K, Grit KJ. Co-production in healthcare: rhetoric and practice. *Int Rev Adm Sci.* 2016;**82**(1):150–168. doi:10.1177/0020852315570553
- Parkinson JA, Eccles KE, Goodman A. Positive impact by design: The Wales Centre for Behaviour Change. *J Posit Psychol.* 2014;**9**(6):517–522. doi:10.1080/17439760.2014.936965
- Tricco AC, Antony J, Zarin W, *et al.* A scoping review of rapid review methods. *BMC Med.* 2015;**13**(1):1–15. doi:10.1186/s12916-015-0465-6/TABLES/6
- Design Scenarios - Communicating the Small Steps in the User Experience | Interaction Design Foundation. <https://www.interaction-design.org/literature/article/design-scenarios-communicating-the-small-steps-in-the-user-experience>. Accessed July 13, 2018.
- Rasoulifar R, Thomann G, Villeneuve F. Scenarios and the design process in medical application. *CIRP Des Conf Compet Des.* 2009;6.
- Carroll JM. Five reasons for scenario-based design. *Interact Comput.* 2000;**13**(1):43–60. doi:10.1016/S0953-5438(00)00023-0
- Reeder B, Demiris G. Building the PHARAOH framework using scenario-based design: A set of pandemic decision-making scenarios for continuity of operations in a large municipal public health agency. *J Med Syst.* 2010;**34**(4):735–739. doi:10.1007/s10916-009-9288-3
- Valaitis R, Longaphy J, Ploeg J, *et al.* Health TAPESTRY: Co-designing interprofessional primary care programs for older adults using the persona-scenario method. *BMC Fam Pract.* 2019;**20**(1):1–11. doi:10.1186/s12875-019-1013-9
- Institute of Medicine (US) and National Academy of Engineering (US) Roundtable on Value & Science-Driven Health Care. Healthcare System Complexities, Impediments, and Failures. In: Engineering a Learning Healthcare System: A Look at the Future. National Academies Press (US); 2011.
- Ou L, Chen J, Assareh H, Hollis SJ, Hillman K, Flabouris A. Trends and Variations in the Rates of Hospital Complications , Failure-to-Rescue and 30-Day Mortality in Surgical Patients in New South Wales , Australia , 2002–2009. 2014;**9**(5):2002–2009. doi:10.1371/journal.pone.0096164
- Taenzer AH, Pyke JB, McGrath SP. A review of current and emerging approaches to address failure-to-rescue. *Anesthesiology.* 2011;**115**(2):421–431.
- Seys D, Wu AW, Van Gerven E, *et al.* Health Care Professionals as Second Victims After Adverse Events : A Systematic Review. *Eval Health Prof.* 2012;**36**(2):135–162.
- Johnson JK, Farnan JM, Barach P, *et al.* Searching for the missing pieces between the hospital and primary care: mapping the patient process during care transitions. *BMJ Qual Saf.* 2012;**21** Suppl 1(Suppl 1):i97–105. doi:10.1136/bmjqs-2012-001215
- Johnson JK, Barach P, Vernooij-Dassen M, HANOVER Research Collaborative. Conducting a multicentre and multinational qualitative study on patient transitions. *BMJ*

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- Qual Saf.* 2012;**21 Suppl 1(Suppl 1)**:i22–8. doi:10.1136/bmjqs-2012-001197
39. O'Donnell D, Ní Shé É, McCarthy M, *et al.* Enabling public, patient and practitioner involvement in co-designing frailty pathways in the acute care setting. *BMC Health Serv Res.* 2019;**19(1)**. doi:10.1186/S12913-019-4626-8
 40. Hospital A, Chan RJ, Green T, *et al.* Use and reporting of experience-based codesign studies in the healthcare setting: a systematic review. doi:10.1136/bmjqs-2019-009570
 41. McKinney A, Fitzsimons D, Blackwood B, White M, McGaughey J. Co-design of a patient and family-initiated escalation of care intervention to detect and refer patient deterioration: Research protocol. *J Adv Nurs.* 2020;**76(7)**:1803–1811. doi:10.1111/jan.14365
 42. Strickland W, Pirret A, Takerei S. Patient and/or family activated rapid response service: Patients' perceptions of deterioration and need for a service. *Intensive Crit care Nurs.* 2019;**51**:20–26. doi:10.1016/J.ICCN.2018.11.007
 43. Newell K, Corrigan C, Punshon G, Leary A. Severe asthma: emergency care patient driven solutions. *Int J Health Care Qual Assur.* 2017;**30(7)**:628–637. doi:10.1108/IJHCQA-09-2016-0127
 44. Noble A, Nevitt S, Holmes E, *et al.* Seizure first aid training for people with epilepsy attending emergency departments and their significant others: the SAFE intervention and feasibility RCT. *Heal Serv Deliv Res.* 2020;**8(39)**:1–190. doi:10.3310/HSDR08390
 45. Blackwell RW née, Lowton K, Robert G, Grudzen C, Grocott P. Using Experience-based Co-design with older patients, their families and staff to improve palliative care experiences in the Emergency Department: A reflective critique on the process and outcomes. *Int J Nurs Stud.* 2017;**68**:83–94. doi:10.1016/j.ijnurstu.2017.01.002
 46. Subbe CP, Tomos H, Jones GM, Barach P. Express check-in: developing a personal health record for patients admitted to hospital with medical emergencies: a mixed-method feasibility study. *Int J Qual Heal care J Int Soc Qual Heal Care.* 2021;**33(3)**. doi:10.1093/INTQHC/MZAB121
 47. Blackwell RW née, Lowton K, Robert G, Grudzen C, Grocott P. Using Experience-based Co-design with older patients, their families and staff to improve palliative care experiences in the Emergency Department: A reflective critique on the process and outcomes. *Int J Nurs Stud.* 2017;**68**:83–94. doi:10.1016/j.ijnurstu.2017.01.002
 48. Piper D, Iedema R, Gray J, Verma R, Holmes L, Manning N. Utilizing experience-based co-design to improve the experience of patients accessing emergency departments in New South Wales public hospitals: An evaluation study. *Heal Serv Manag Res.* 2012;**25(4)**:162–172. doi:10.1177/0951484812474247
 49. Time to Act – Severe Sepsis: Rapid Diagnosis and Treatment Saves Lives. London ; 2013.
 50. Ham C (Ed). *Organising Care at the NHS Front Line: Who Is Responsible?* London; 2017.
 51. Johnson JK, Haskell HW, Barach PR. *Foundations for Core Competencies Case Studies in Patient Safety.* Burlington, MA 01803: Jones & Bartlett Learning; 2016.
 52. Diamond D. The Impact of Applying Design Thinking. 2020.
 53. Share and engage with the Design Sprint Community. <https://designsprintkit.withgoogle.com/methodology/phase3-sketch/crazy-8s>. Accessed May 17, 2020.
 54. Jones HV, Smith H, Cooksley T, *et al.* Checklists for Complications During Systemic Cancer Treatment Shared by Patients, Friends, and Health Care Professionals: Prospective Interventional Cohort Study. *JMIR mHealth uHealth.* 2020;**8(9)**:e19225. doi:10.2196/19225
 55. Subbe CP, Tomos H, Jones GM, Barach P. Express check-in: Developing a personal health record for patients admitted to hospital with medical emergencies: A mixed-method feasibility study. *Int J Qual Heal Care.* 2021;**33(3)**. doi:10.1093/INTQHC/MZAB121
 56. Donabedian A. The Quality of Care How Can It Be Assessed? *JAMA.* 1988;**260**:1743–1748.
 57. Gooberman-Hill R, Jinks C, Bouças SB, *et al.* Designing a placebo device: Involving service users in clinical trial design. *Heal Expect.* 2013;**16(4)**:100–110. doi:10.1111/hex.12043
 58. Armstrong N, Herbert G, Aveling EL, Dixon-Woods M, Martin G. Optimizing patient involvement in quality improvement. *Heal Expect.* 2013;**16(3)**. doi:10.1111/hex.12039
 59. Lawton R, O'Hara JK, Sheard L, *et al.* Can patient involvement improve patient safety? A cluster randomised control trial of the Patient Reporting and Action for a Safe Environment (PRASE) intervention. *BMJ Qual Saf.* 2017;**26(8)**:622–631. doi:10.1136/bmjqs-2016-005570
 60. Knowles S, Hays R, Senra H, *et al.* Empowering people to help speak up about safety in primary care: Using codesign to involve patients and professionals in developing new interventions for patients with multimorbidity. *Heal Expect.* 2018;**21(2)**:539–548. doi:10.1111/hex.12648
 61. Hibbard J, Gilbert H. *Supporting People to Manage Their Health: An Introduction to Patient Activation.*; 2014.
 62. How to Prototype a New Business – IDEO U. <https://www.ideo.com/blogs/inspiration/how-to-prototype-a-new-business>. Accessed June 22, 2020.
 63. Peters BG. What is so wicked about wicked problems? A conceptual analysis and a research program OPEN ACCESS. *Policy Soc.* 2017;**36(3)**:385–396. doi:10.1080/14494035.2017.1361633
 64. Buchanan R. *Wicked Problems in Design Thinking.* Vol 8.; 1992.
 65. Rittel, H.W.J. WMM. Rittel, Horst W. J., Dilemmas in a General Theory of Planning, *Policy Sciences*, 4:2 (1973:June) p.155. Policy. 1973;2:155.