THE EFFECT OF ACTIVE AND LATENT ERRORS IN BUILDING MAINTENANCE ON PATIENT OUTCOMES IN THE NHS

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RESEARCH AIM

Between April 2016 and March 2021, ***2,734,172*** incidents were reported in NHS England where the patient suffered iatrogenic harm and 7.25m near misses. Over ***50,000*** *patients* came to severe harm or died—an equivalent of ***19 full Jumbo Jets a year***.

Of these incidents over ***150,000*** were directly caused by the infrastructure. In the same time period the cost to rectify backlog maintenance in the NHS almost doubled from £5.2bn to over £9bn.

The aim of the research is to:

1) ***Understand the direct infrastructure impact to patient harm***
2) ***Understand the role infrastructure plays in creating latent failures within the system***
3) ***Look at how the research can support policies to improve backlog maintenance***

PHILOSOPHY

The philosophical stance taken not only guides the research, but also supports the duplication of the research. The approach adopted for this research is:

- ***Ontological Stance:*** ***Pragmatism***
- ***Methodology:*** ***Mixed Method Approach***
- ***Axiological Assumption:*** ***Biased****

* The axiological assumption is biased as the researcher is also a Director of Estates in the NHS.

LITERATURE REVIEW

The review adopted a five stage approach set in grounded theory: Define-Search-Select-Analyse-Present (1). The initial search was analysed to further define search criteria and terminology. The literature search was divided into two phases: an in-depth review of patient harm literature, and a systematic review of key search engines to appraise the public literature.

The in-depth review mapped 2,708 papers demonstrated that there is a paucity of research within the classification of Infrastructure & Buildings, making up 0.15% (fig. 1) of all articles, against over 5% of all incidents reported in the NHS.

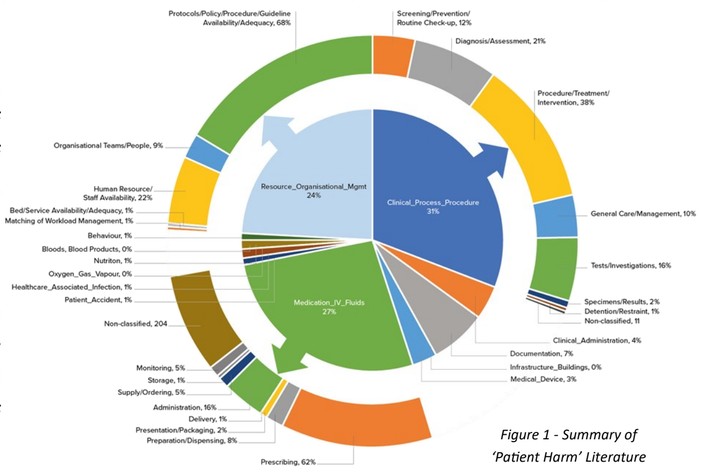


Figure 1 - Summary of 'Patient Harm' Literature

HARM

Through the work of Reason in 1990 (2), a taxonomy of error was developed noting that all failure, whether individual or system, are of intentional skill-based actions. Reason also developed a model of understanding the root cause of error dependent on its origin in time and space within a system – The Swiss Cheese Model (fig 2). This model helped explain the latency of errors or violations within a system and how they attribute to an active error, often more than the errors of the person at the sharp end. While this model is critiqued for being over-simplistic (3), it is evident that healthcare are still fixated on the sharp end relationship.

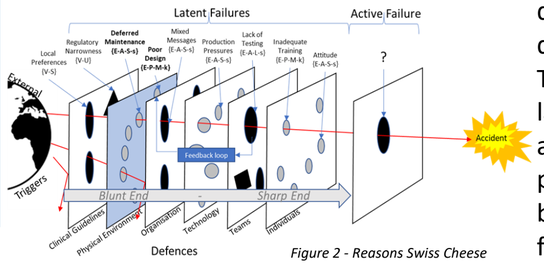


Figure 2 - Reasons Swiss Cheese

PATIENT HARM

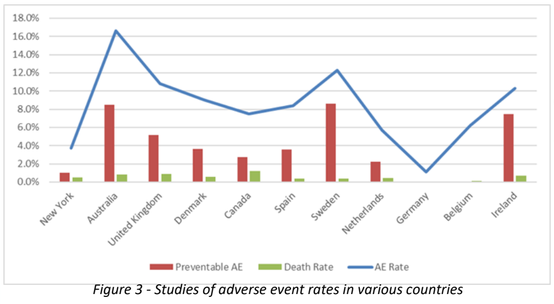


Figure 3 - Studies of adverse event rates in various countries

In 1999 The Institute of Medicine in the U.S. published the first report 'To Err Is Human' (4). The report was to become a catalyst for a much wider patient safety movement. The report highlighted U.S. two studies. The first study found that there were an estimated 98,609 adverse events, with over 16% of all adverse events leading to permanent disability or death (5). The second study found that 1.9% of all admissions resulted in adverse events (6). A meta study in 2017 found comparable harm rates across the world (7) (figure 3).

It is argued that the attitude within healthcare is that errors are regarded as an individual's fault due to lack of attention or lack of caring (8). However, it is further argued that the individual has been set up to fail by poor design, maintenance, or management decisions. Further, due to the complexity of errors there cannot be a universal way of reducing errors, but requires parties at each stage of the system to create safe methods of error reduction, including development, design, construction and maintenance (8).

INFRASTRUCTURE

Despite limited research in the area of backlog maintenance studies across water, ventilation, and electrical systems between 1996 and 2020 have shown numerous impacts to health, and unfortunately death. However, the link between health outcomes, infrastructure issues and backlog maintenance has yet to be made. One study in 2015 used CQC ratings against ERIC data to understand whether the complexity of a hospital has an effect on patient quality matrix (9); while another determined whether age of buildings has a link to levels of critical backlog maintenance (10). Neither study commented on levels of patient harm. This pattern is repeated in several studies across healthcare facilities. There is sufficient research that links health outcomes to patient harm due to infrastructure failures, but these are isolated cases or individual studies and none define the failure of the estate in terms of backlog. In order to fully understand the impact of the infrastructure a systematic review of patient harm, and how much of it has a root cause within backlog maintenance needs to be undertaken.

METHODOLOGY

The initial phase of research is focused on the utilisation of secondary from the National Patient Safety Agency (NPSA) . To date the NPSA have recorded over 20 million patient safety incidents on the National Learning and Reporting System (NRLS) (11)

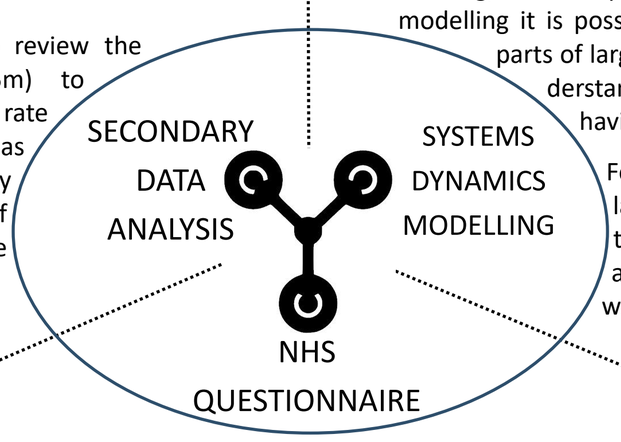
All NRLS records from between 01 April 2016 the and 31 March 2021 for all acute NHS trusts in England (c9 million records) were provided by the NPSA. The data will be reviewed for duplications and blank files.

The remaining records will be analysed firstly from a quantitative perspective, using count, descriptive and inferential analysis to asses the trends in the data both geographically and over time.

Using thematic analysis software, the records with the primary classification of 'Work & Environment' (c575,000) will be analysed to understand the direct cause/ effect of infrastructure on patients and patient pathways

The next steps is to review the remaining 8.5m records. A sample sub-set of the ten other primary categories will be taken and analysed. This sample will support the refining of a code book by which to review the full data set.

The final step will be to review the remaining records (c8.5m) to determine the frequency rate that themes occur as latent factors to the primary contributing factors of patient harm within the NHS



While it is important to understand the 'what' and the 'how' estate infrastructure is harming patient outcomes, it is equally important, if not more so to understand why the current levels of harm is not affecting policy maker's decisions, or at the very least those who influence the policy makers – the directors of estates and facilities.

A cross-sectional survey questionnaire will be devised to understand senior management perceptions of backlog maintenance within the NHS. The questionnaire was directed at directors of estates across the acute sector to triangulate the findings of both the NRLS secondary data results and the findings from the SD modelling .

The quantitative element of the survey results utilised the Creswell 5 stage method for analysing data (17), with the the free text elements of the survey were analysed using thematic analysis with the aid of computer software.

To explore how estate infrastructure interacts with the environment, patients, and staff of a healthcare facility, Operations Research (OR) methodologies, specifically the Strategic OR techniques of simulation and modelling, will be applied. By using simulation modelling it is possible to analyse component parts of large complex systems and understand the emergent behaviour of the system (12).

Focusing on the three main latent factors discovered in the secondary data analysis, the SD modelling was undertaken in two stages.

Soft SD Modelling: Creating initial causal loop diagrams (CLD's) utilising modelling software 'Vensim', the three CLD's were subjected to analysis by industry experts using the Delphi model (figure 4) (13). Once a level of consensus has been reached on the model, it was reviewed to assess whether there is sufficient insight into the impact of the system that it moves to the next stage -Hard SD Modelling.

By developing the Hard SD model it is possible to understand the behaviour of the system at a strategic level (14). It also permits the running of simulations and the testing of hypothesis (15).

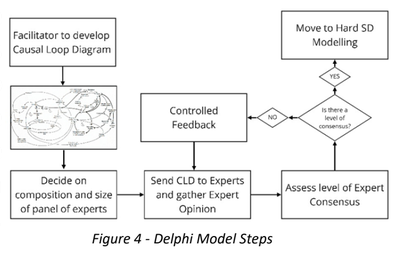


Figure 4 - Delphi Model Steps

The Sterman (2000) five stage model of undertaking Hard SD modelling (16) has been applied in the development of the three models .

The survey will be supported by a limited number of semi- structured interviews to delve deeper into the question of policy influence and decision making(18).

About the Author

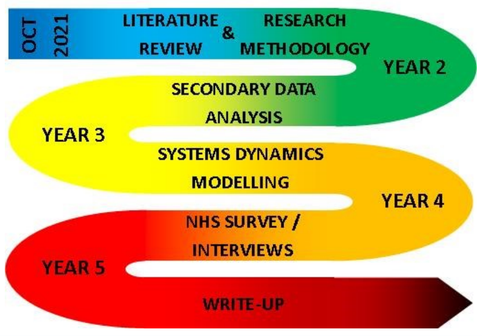
Academic & Membership

- Fellow of IHEEM — *2022* — *Healthcare Engineering and Estates Management*
- MBA — *2009* — *University of Surrey: Distinction*
- BA(Hons) Business — *1994* — *University of Huddersfield: 2:1*
- BTEC HND Management — *1993* — *Ysgol Emrys-Ap-Iwan: Distinction*

Professional

- Director of Estates, Facilities & Capital — *2020 - Present* — NHS University Hospital Southampton NHS Foundation Trust
- Director of Estates & Facilities — *2019 - 2020* — Brighton and Sussex University Hospitals NHS Trust
- Director of Estates, Facilities & Capital — *2015 - 2019* — NHS University Hospitals Sussex NHS Foundation Trust
- Associate Director of Facilities — *2013 - 2015* — Barts Health NHS Trust
- Area Facilities Manager — *2011 - 2013* — G4S
- Head of Catering Services — *2009—2011* — Guy's and St Thomas' NHS Foundation Trust

TIMEFRAME



ETHICS

Due to the nature of the research, involving anonymized patient information and interaction with NHS staff, ethical approval was sought for the secondary data analysis stage:

- ***HRA Application: Approved on 9/7/22***
- ***UHS Research Committee: Approved on 7/7/22***
- ***UoS ERGO II: Approved on 7/9/22***

Subsequent approvals will be needed for the systems dynamics modelling and the questionnaire to NHS professionals.

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