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Is new always better? Exploring the ripple effects of hospital redevelopment: A study protocol

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8 **Is new always better? Exploring the ripple effects of hospital redevelopment: A study**
9 **protocol**
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ARTICLE SUMMARY

Introduction

Hospital redevelopment projects typically intend to improve hospital functioning and modernise the delivery of care. There is research support for the proposition that redevelopment along evidence-based design principles can lead to improved quality and safety. However, it is not clear how redevelopment influences the wider context of the hospital and its functioning. That is, beyond a limited examination of intended outcomes (e.g. improved patient satisfaction), are there additional consequences (positive, negative, or unintended) occurring within the hospital after the physical environment is changed? Is new always better? The primary purpose of this study is to explore how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.

Methods and analysis

We propose to conduct a longitudinal, mixed-methods, case-study of a large metropolitan hospital in Australia. The study design consists of a series of measurements over time that are interrupted by the natural intervention of a hospital redevelopment. How hospital redevelopment influences the wider context of the hospital will be assessed in six domains: expectations and reflections of hospital redevelopment, organisational culture, staff interactions, staff wellbeing, efficiency of care delivery, and patient experience. Methods of data collection include: a hospital-wide staff survey, semi-structured interviews, a network survey, a patient experience survey, analysis of routinely-collected hospital data, and observations. Two wards in the hospital not involved in the redevelopment will act as controls. Data will be analysed using thematic, statistical, and network analyses respectively, for the qualitative, quantitative, and relational data.

Ethics and dissemination

The study has been reviewed and approved by the relevant Ethics Committee in New South Wales, Australia. The results will be actively disseminated through peer-reviewed journals, conference presentations, and in report format to the stakeholders.

Strengths and limitations of this study

- This study will be the first of its kind to explore how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.
- The project design, including the development of tools, was conducted in collaboration with the hospital under investigation.
- A key strength of the study is the use of mixed-methods and multiple time points of data collection.
- A limitation of the study is that findings may be specific to the hospital under investigation.

Is new always better? Exploring the ripple effects of hospital redevelopment: A study protocol

BACKGROUND

Healthcare systems worldwide are facing significant challenges to their long-term sustainability and the delivery of safe, effective, quality care.[1-3] Ageing populations, increasing costs of medical advances, issues with health workforce retention, outdated and inadequate infrastructure, concerns about the quality and safety of health services, and wasteful spending are some of the many challenges facing contemporary healthcare systems.[1, 4, 5] For hospitals, as healthcare institutions providing in-patient treatment 24 hours a day, seven days a week, one of their major challenges lies with ageing populations and overall population growth. Indeed, hospitals worldwide are experiencing a higher incidence of elderly people with greater demand for hospital services and hospital beds.[4, 6]. One way to respond to this challenge is through hospital expansion, redevelopment and modernisation.

The redevelopment of hospitals in high-income countries appears to be increasingly common,[e.g. 7, 8] for several reasons. First, hospitals must evolve and adapt to match the changing healthcare needs of the communities they service.[9] Indeed, hospitals everywhere are challenged to meet the demands of ageing populations and overall population growth; expansion through hospital redevelopment is a way to resolve consequent issues such as inadequate infrastructure. Second, hospitals must adapt to changing trends and technological advances in medicine. For example, the use of mechanical lifters at the bedside,[10] or point-of-care testing,[11] may require reconfiguration of beds in the ward. Third, hospital redevelopment may take place when existing infrastructure is found to compromise staff safety or infection control for patients. For example, the redevelopment of operating theatres to include laminar flow was a deliberate strategy aimed at reducing infection rates.[12]

Another reason for hospital redevelopment lies in the well-documented association between an aesthetically appealing hospital environment and positive outcomes.[13-16] To this end, stakeholders may make design decisions on the basis of evidence, to improve not only the physical appearance, but the functioning of the hospital, including: improved quality of care, patient and staff satisfaction, and financial savings.[13] For example, a post-occupancy study into the development of a garden in a paediatric hospital found an increase in patient and staff satisfaction.[17] In another study of redevelopment, patients were more likely to report shorter perceived waiting times and better perceived staff interactions when in a more attractive waiting room, compared to patients in a less attractive waiting room.[18]

While the literature suggests that redevelopment projects and the implementation of new design features in hospitals are associated with improved outcomes for staff, patients, and the broader organisation,[19] these outcomes have only been addressed in a linear frame.

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3 This means hospital redevelopment has typically been assessed by evaluating how one
4 feature (e.g. a new garden) impacts one intended outcome (e.g. satisfaction), rather than
5 exploring possible unintended consequences of changing the hospital system. This suggests
6 that there is a need for a more indepth examination of the potential ripple effects of a
7 hospital redevelopment. This is particularly important given how interconnected and
8 complex hospital systems are.[20, 21]
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11 Healthcare and healthcare organisations have been described as complex adaptive systems,
12 characterised by non-linear and often unpredictable processes.[22, 23] In introducing a
13 potentially large long-term change (and short-term disruption) as hospital redevelopment
14 into a complex interconnected system, this perspective highlights that we need to look
15 beyond just the intended or desired outcomes of hospital redevelopment. In taking a
16 complex systems perspective to examine how redevelopment may influence the hospital,
17 we recognise that we cannot isolate single factors (e.g. patient satisfaction). Rather, we
18 need to consider the influence on many complex and interconnected levels and agents of
19 the hospital system.[19] For example, one potential factor that could be unintentionally
20 influenced by hospital redevelopment is the way staff interact with one another and
21 patients. Researchers have suggested that we know little about the role of the hospital
22 environment in supporting or restricting collaborative ways of working among staff.[13]
23 Therefore, rather than assuming that the redevelopment of hospitals will only lead to a
24 particular intended outcome, we argue there is a need to consider the unintended ripple
25 effects and widespread influences of introducing an environment change into this complex
26 system. Based on these issues, we pose the question: is new always better? Beyond the
27 targeted outcome under investigation, do we really know what happens within the hospital
28 after the physical environment is comprehensively changed?
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34 **METHODS AND ANALYSIS**

35 **Study aim**

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39 The present research aims to explore how hospital redevelopment influences the wider
40 context of the hospital and its functioning. In particular, the study will explore how hospital
41 redevelopment may influence the organisation, staff and patients in both intended and
42 unintended ways.
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44 **Study design**

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47 We propose to conduct a pragmatic, longitudinal, mixed-methods case-study of a large
48 metropolitan hospital in Australia. As illustrated in Figure 1, the design is a mixture of pre-
49 post data collection points and a series of measurements over time that are interrupted by
50 the natural intervention of the hospital redevelopment (i.e. interrupted time series (ITS)
51 data). ITS is a quasi-experimental method for assessing routinely collected data over evenly
52 spaced out intervals to assess the impact of change.[24] The combination of these methods
53 of data collection allows for a rich and dynamic exploration of how hospital redevelopment
54 influences the organisation, staff and patients, in intended and unintended ways. This
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3 includes both a broad analysis of hospital-level data and an in-depth analysis of four specific
4 wards. These wards were chosen in discussion with hospital executives, to cover wards
5 undergoing and not undergoing redevelopment during the study. That is, two wards are
6 moving into a new building during the redevelopment project, one ward will not be moved
7 into the new building but will remain in its current location, and one ward was moved to a
8 new building two years prior. In essence, the wards moving are the intervention wards and
9 those not moving act as controls. The various data collection methods apply to all four
10 wards.
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16 INSERT FIGURE 1 HERE
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20 How hospital redevelopment influences the wider context of the hospital will be assessed at
21 three levels: organisation, staff and patients; and six domains: expectations and reflections,
22 organisational culture, staff interactions, staff wellbeing, efficiency and patient experience
23 (Figure 2). These domains will be captured by six methods of data collection: hospital-wide
24 staff survey, semi-structured interviews, network survey, patient experience survey, analysis
25 of routinely-collected hospital data, and observations (Table 1). Of these six methods, two
26 (hospital data and patient experience) will be assessed at a minimum of six observations
27 points. The other four methods of data collection will be assessed at two time points, pre-
28 and post- the intervention of hospital redevelopment. Data collection, particularly for
29 interviews, network survey, and observations, will occur in a sequential manner (e.g. design
30 of the network survey depends on the analysis of interview data).
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INSERT FIGURE 2 HERE

Table 1. Domains to be assessed and corresponding methods

Method	Domains					
	Expectations & reflections	Organisational culture	Staff interactions	Staff wellbeing	Efficiency	Patient experience
Hospital-wide staff survey		x		x		
Semi-structured interviews	x		x			
Network survey	x	x	x	x		
*Patient experience survey	x					x
*Hospital data					x	x
Observations		x	x		x	

* Data captured at multiple time points; all other methods are captured at two time points, pre- and post-intervention.

Study setting

The project will be conducted at a large metropolitan hospital in New South Wales (NSW), Australia. The intervention under investigation is a hospital redevelopment in which the opening of a new acute services building will see the relocation of several wards. In addition to a broad, hospital-level exploration, four wards were chosen for an in-depth analysis: Maternity; Intensive Care; Surgical; and, Respiratory.

Study procedures

Routinely-collected hospital data

Routinely collected hospital data, such as throughput rates and bed occupancy, will be made accessible to the research team. This hospital data will be used to explore indicators of change at the hospital- and ward-levels and make inferences about how hospital redevelopment influences the efficiency of care delivery. This data will be captured at equal monthly intervals, forming part of the ITS analysis.

Patient experience survey

Patient experience data will be captured using a hospital platform already in place. At present, the hospital under investigation has an online survey platform to collect patient experience data, which can be analysed on the ward level. The present project will tap into

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3 this platform in order to explore how hospital redevelopment influences patient experience.
4 The questions asked are routinely collected and used to examine overall experience of
5 hospital care. Patient experience survey data will be collected at multiple time points, for
6 ITS analysis.
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8 Hospital-wide staff survey 9

10 In NSW, Australia, employees working in the public sector, including public hospitals, are
11 invited to participate in the 'People Matter Employee Survey'; a validated survey where
12 employees can express their views and experiences in their workplace.[25] Survey findings
13 are demarcated by agency, such as by each hospital in the NSW public sector (including the
14 hospital under investigation). The survey is distributed and completed annually over a one-
15 month period. Survey responses will be made accessible to the research team in
16 aggregated, unidentifiable form. This data will be analysed and used to understand the
17 changes in attitudes and experiences of all hospital staff, at two timepoints, pre- and post-
18 the redevelopment.
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22 Semi-structured interviews 23

24 Semi-structured interviews were chosen because they enable an in-depth understanding of
25 a new area with little previous research.[26] The purpose of the interviews before the
26 intervention will be to collect information on: (1) the expectations of hospital staff regarding
27 how hospital redevelopment may influence their work; (2) a detailed understanding of
28 hospital culture and current ways of working, (3) any uncertainties they may have about the
29 hospital redevelopment project, and (4) staff predictions of how ways of working with other
30 staff might change in light of the redevelopment. The questions for the interviews taking
31 place after the intervention will be similar, but with a focus on reflections on the change,
32 and perceptions of how the hospital redevelopment may have influenced them personally,
33 other staff, culture, and ways of working together. Participants eligible for inclusion in the
34 interviews will be all staff working on the four wards under investigation, either part-time or
35 full-time. By all staff we mean clinicians, administrative, managerial, and domestic staff.
36 Findings from these interviews will be used to develop the subsequent network survey and
37 observational component of the research.
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43 Network survey 44

45 Surveys are a common tool of data collection used to understand the attitudes and
46 perceptions of healthcare professionals.[27] Questions in this survey will be partly
47 dependent upon the analysis of interview data.
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49 *Part 1: Demographics and other outcomes* 50

51 The first part of the survey will be used to collect demographic data, expectations and
52 reflections on the hospital redevelopment project, organisational culture, and measures of
53 staff wellbeing (such as job satisfaction and burnout). The same questions will be used pre-
54 and post- the intervention.
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Part 2: Social network survey

Part 2 of the survey will consist of a social network survey. Social network research involves the investigation of social structures such as collaboration, through the use of networks and graph theory.[28] This provides a basis to investigate a range of collaborative issues, including silo-working and bottlenecks in communication flow,[29] in order to explore how hospital redevelopment influences patterns of staff interaction. The collection of network data to assess interactions is an established tool[29] used in previous healthcare research.[30, 31]

In this part of the survey, staff will be presented with a list of names of other staff on the ward where they work, and asked to indicate which staff members they work with most closely. Staff will also have the opportunity to list any other names not provided on the list. Given the sequential nature of the study design, the exact wording of the network questions is dependent on the interview findings. The survey will be similar after the intervention, with the exception of additional open-ended questions asking how patterns of interaction may have changed in response to the hospital redevelopment project.

Observations

Generally speaking, observational data will be used to provide a rich description of how hospital redevelopment influences the ways staff work together. Observational data collection will be complementary to the quantitative data of the network survey and will add explanatory value to understanding how the hospital system may change and evolve over time in response to redevelopment. Using observations in conjunction with social network research, as well as in healthcare research more broadly, helps illuminate taken-for-granted and unintended aspects of collaboration that may not be disclosed in surveys or other forms of data collection.[32] Observations will also provide rich data relating to the culture on the wards and how it might be influenced by redevelopment, which is otherwise difficult to capture in self-report questionnaires. Given the sequential nature of this study, specific observational methods will be designed based on interview and survey findings.

Data analyses

Interview and observational data will be analysed using the qualitative method of thematic analysis,[33] using an open coding process[34]. Data collection and analysis will occur iteratively; questions used for interviews and guides for observations will be continuously refined and expanded in light of emerging findings. Qualitative data will be analysed using NVivo, Version 11.4, for coding and qualitative data analysis.

For quantitative analysis, demographic and descriptive data (staff wellbeing, organisational culture) collected from the network survey, will be analysed using SPSS Statistics Version 22.0. Relational data from the network survey will be graphically presented using Gephi 0.9.2 software, and analysed using stochastic actor-based models.[35] These social network analysis techniques include the analysis of endogenous (structural, network self-

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3 organisation) and exogenous (individual characteristics) variables. Trends in time series data
4 will be graphically presented using line graphs, and statistically analysed using segmented
5 regression analysis on SPSS.
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7 **Integrating results**

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9 Qualitative, quantitative and network results from the diverse data collection methods will
10 be integrated to form an overall picture of ways hospital redevelopment may influence the
11 organisation, staff and patients in both intended and unintended ways. Data will be
12 synthesised using a mixed-methods matrix;^[36] a way to triangulate data and display
13 findings emerging from each level (patient, staff, organisational) and the various methods of
14 data collection. The matrix will delineate data for the intervention and control wards to
15 allow for comparison. Data will be categorised as positive, negative or neutral, pre- and
16 post-hospital redevelopment. The nature of influence will be classified as either intended or
17 unintended (e.g. intended that patient satisfaction will increase). Classification of what
18 changes were intended or unintended will be deduced in consultation with key stakeholders
19 at the hospital. This will be followed by consideration of where there is agreement, partial
20 agreement, silence, or dissonance between findings from different methods on different
21 levels.^[36]
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26 **DISCUSSION**

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28 This study seeks to explore a significant gap in the literature, namely, how redevelopment
29 influences the wider context of the hospital and its functioning. This research is timely as
30 hospital redevelopment projects are ubiquitous and on the rise.^[e.g. 7, 8] The exploratory
31 nature of this study enables the identification of unintended influences, positive or
32 negative, that come from conducting a redevelopment project in the hospital physical
33 environment. If unintended consequences of hospital redevelopment on the organisation,
34 staff and patients are revealed, then we may be able to delineate and propose ways to deal
35 with these factors. These findings may be used to guide policies on how to implement major
36 hospital redevelopment projects with minimal disruption and awareness of the intended
37 and unintended effects of this large change.
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42 As to limitations, the findings may not be generalisable to all instances of hospital
43 redevelopment. Another potential limitation lies in the two time-point data collection for
44 four or the six methods of this study. Detected changes assessed by these methods can, in
45 some instances, be affected by numerous other factors, such as, seasonal, auto-
46 correlational and non-stationary biases often found in two-time point longitudinal data.^[24]
47 In including ITS data and control wards, this limitation will be addressed as such biases can
48 be identified when there are numerous time points and varied contexts. Therefore, the
49 combination of pre-post and ITS data collection along with multi-level analysis of the
50 complex hospital system is beneficial in the exploration of unintended influences to answer
51 the question: is new always better?
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ETHICS AND DISSEMINATION

The study has been reviewed and approved by the relevant Ethics Committee in NSW, Australia. There are no known health or safety risks associated with participation in any aspect of the described study. The results will be actively disseminated through peer-reviewed journals, conference presentations, and in report format to the stakeholders.

Author contributions

All authors contributed to the study concept and study design. CP drafted the manuscript, then all authors read, critically revised and approved the final manuscript.

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Competing Interests

None declared.

Abbreviations

NSW New South Wales

ITS Interrupted time series

RTP Research training program

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3 **FIGURE LEGENEDS**

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5 **Figure 1.** Data collection points over time

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7 **Figure 2.** Domains to be assessed

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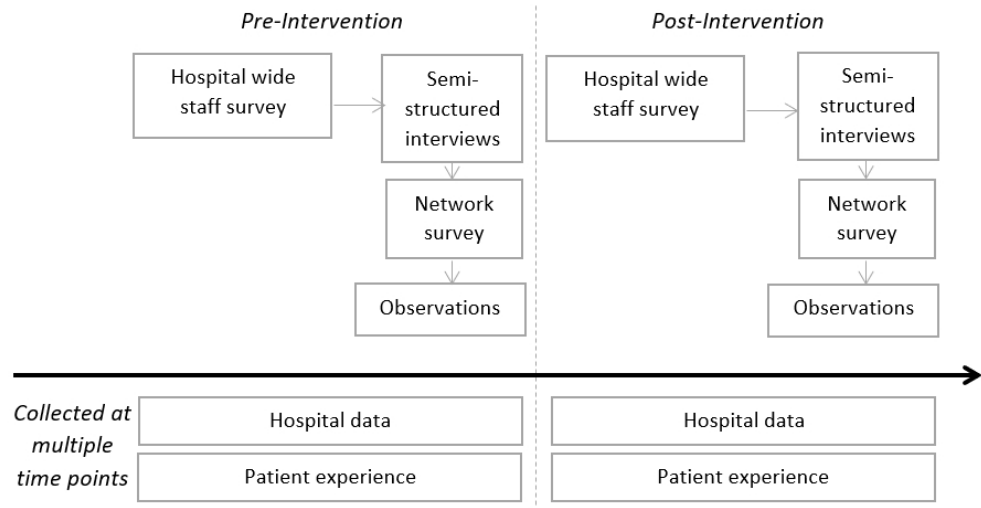


Figure 1. Data collection points over time

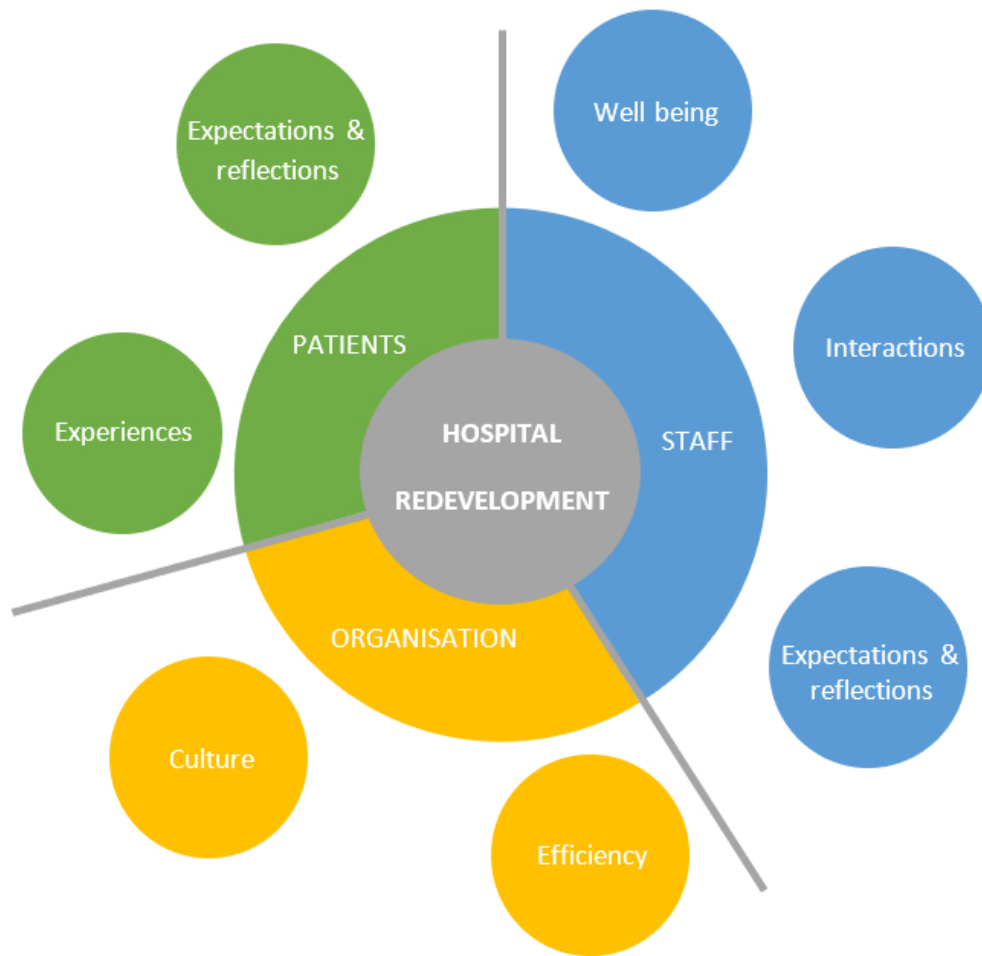


Figure 2. Domains to be assessed

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Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal, mixed-methods study

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Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal, mixed-methods study

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ARTICLE SUMMARY

Introduction

Hospital redevelopment projects typically intend to improve hospital functioning and modernise the delivery of care. There is research support for the proposition that redevelopment along evidence-based design principles can lead to improved quality and safety. However, it is not clear how redevelopment influences the wider context of the hospital and its functioning. That is, beyond a limited examination of intended outcomes (e.g. improved patient satisfaction), are there additional consequences (positive, negative, or unintended) occurring within the hospital after the physical environment is changed? Is new always better? The primary purpose of this study is to explore how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.

Methods and analysis

We propose to conduct a longitudinal, mixed-methods, case-study of a large metropolitan hospital in Australia. The study design consists of a series of measurements over time that are interrupted by the natural intervention of a hospital redevelopment. How hospital redevelopment influences the wider context of the hospital will be assessed in six domains: expectations and reflections of hospital redevelopment, organisational culture, staff interactions, staff wellbeing, efficiency of care delivery, and patient experience. Methods of data collection include: a hospital-wide staff survey, semi-structured interviews, a network survey, a patient experience survey, analysis of routinely-collected hospital data, and observations. A total of four wards will be examined, with two acting as controls. Data will be analysed using thematic, statistical, and network analyses respectively, for the qualitative, quantitative, and relational data.

Ethics and dissemination

The study has been reviewed and approved by the relevant Ethics Committee in New South Wales, Australia. The results will be actively disseminated through peer-reviewed journals, conference presentations, and in report format to the stakeholders.

Strengths and limitations of this study

- This study will be the first of its kind to explore how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.
- The project design, including the development of tools, was conducted in collaboration with the hospital under investigation.
- A key strength of the study is the use of mixed-methods and multiple time points of data collection.
- A limitation of the study is that findings may be specific to the hospital and the wards under investigation.

Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal, mixed-methods study

BACKGROUND

Healthcare systems worldwide are facing significant challenges to their long-term sustainability and the delivery of safe, effective, quality care.[1-3] Ageing populations, increasing costs of medical advances, issues with health workforce retention, outdated and inadequate infrastructure, concerns about the quality and safety of health services, and wasteful spending are some of the many challenges facing contemporary healthcare systems.[1, 4, 5] For hospitals, as healthcare institutions providing in-patient treatment 24 hours a day, seven days a week, one of their major challenges lies with ageing populations and overall population growth. Indeed, hospitals worldwide are experiencing a higher incidence of elderly people with greater demand for hospital services and hospital beds.[4, 6]. One way to respond to this challenge is through hospital expansion, redevelopment and modernisation.

The redevelopment of hospitals in high-income countries appears to be increasingly common,[e.g. 7, 8] for several reasons. First, hospitals must evolve and adapt to match the changing healthcare needs of the communities they service.[9] Hospitals everywhere are challenged to meet the demands of ageing populations and overall population growth; expansion through hospital redevelopment is a way to resolve consequent issues such as inadequate infrastructure. Second, hospitals must adapt to changing trends and technological advances in medicine. For example, the use of mechanical lifters at the bedside,[10] or point-of-care testing,[11] may require reconfiguration of beds in the ward. Third, hospital redevelopment may take place when existing infrastructure is found to compromise staff safety or infection control for patients. For example, the redevelopment of operating theatres to include laminar flow was a deliberate strategy aimed at reducing infection rates.[12] Another reason for hospital redevelopment lies in the well-documented association between an aesthetically appealing hospital environment and positive outcomes.[13-16] To this end, stakeholders may make design decisions on the basis of evidence, to improve not only the physical appearance, but the functioning of the hospital, including: improved quality of care, patient and staff satisfaction, and financial savings.[13]

While the literature suggests that redevelopment projects and the implementation of new design features in hospitals are associated with improved outcomes for staff, patients, and the broader organisation,[17] these outcomes have only been addressed in a linear frame. This means hospital redevelopment has typically been assessed by evaluating how one feature (e.g. a new garden) impacts one intended outcome (e.g. satisfaction), rather than exploring possible unintended consequences of changing the hospital system. This suggests that there is a need for a more indepth examination of the potential ripple effects of a hospital redevelopment. This is particularly important given how interconnected and complex hospital systems are.[18, 19]

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3 Healthcare and healthcare organisations have been described as complex adaptive systems,
4 characterised by non-linear and often unpredictable processes.[20, 21] In introducing a
5 potentially large long-term change (and short-term disruption) as hospital redevelopment
6 into a complex interconnected system, this perspective highlights that we need to look
7 beyond just the intended or desired outcomes of hospital redevelopment. In taking a
8 complex systems perspective to examine how redevelopment may influence the hospital,
9 we recognise that we cannot isolate single factors (e.g. patient satisfaction). Rather, we
10 need to consider the influence on many complex and interconnected levels and agents of
11 the hospital system.[17] For example, one potential factor that could be unintentionally
12 influenced by hospital redevelopment is the way staff interact with one another and
13 patients. Researchers have suggested that we know little about the role of the hospital
14 environment in supporting or restricting collaborative ways of working among staff.[13] This
15 perspective aligns with recent moves to re-appraise change management theory – to one
16 that no longer perceives organisational change as planned, uniform and predictable, but an
17 emergent process in a multi-layered, complex ecosystem that is driven as much from the
18 bottom up as the top down.[22]

25 Therefore, rather than assuming that the redevelopment of hospitals will only lead to a
26 particular intended outcome, we argue there is a need to consider the unintended ripple
27 effects and widespread influences of introducing an organisational change into this complex
28 system. Based on these issues, we pose the question: is new always better? Beyond the
29 targeted outcome under investigation, do we really know what happens within the hospital
30 after the physical environment is comprehensively changed?

34 **METHODS AND ANALYSIS**

36 **Study aim**

39 The present research aims to explore how hospital redevelopment influences the wider
40 context of the hospital and its functioning. In particular, the study will explore how hospital
41 redevelopment may influence the organisation, staff and patients in both intended and
42 unintended ways.

45 **Study design**

47 We propose to conduct a pragmatic, longitudinal, mixed-methods case-study of a large
48 metropolitan hospital in Australia. As illustrated in Figure 1, the design is a mixture of pre-
49 post data collection points and a series of measurements over time that are interrupted by
50 the natural intervention of the hospital redevelopment (i.e. interrupted time series (ITS)
51 data). ITS is a quasi-experimental method for assessing routinely collected data over evenly
52 spaced out intervals to assess the impact of change.[23] The combination of these methods
53 of data collection allows for a rich and dynamic exploration of how hospital redevelopment
54 influences the organisation, staff and patients, in intended and unintended ways.

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8 How hospital redevelopment influences the wider context of the hospital will be assessed at
9 three levels: organisation, staff and patients; and six domains: expectations and reflections,
10 organisational culture, staff interactions, staff wellbeing, efficiency and patient experience
11 (Figure 2). These domains will be captured by six methods of data collection: hospital-wide
12 staff survey, semi-structured interviews, network survey, patient experience survey, analysis
13 of routinely-collected hospital data, and observations (Table 1). Of these six methods, two
14 (hospital data and patient experience) will be assessed at a minimum of six observations
15 points. The other four methods of data collection will be assessed at two time points, pre-
16 and post- the intervention of hospital redevelopment. Data collection, particularly for
17 interviews, network survey, and observations, will occur in a sequential manner (e.g. design
18 of the network survey depends on the analysis of interview data).
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INSERT FIGURE 2 HERE

Table 1. Domains to be assessed and corresponding methods

Method	Domains					
	Expectations & reflections	Organisational culture	Staff interactions	Staff wellbeing	Efficiency	Patient experience
Hospital-wide staff survey		x		x		
Semi-structured interviews	x	x	x			
Network survey	x	x	x	x		
*Patient experience survey	x					x
*Hospital data					x	x
Observations			x		x	

* Data captured at multiple time points; all other methods are captured at two time points, pre- and post-intervention.

Study setting

The project will be conducted at a public, metropolitan hospital in New South Wales (NSW), Australia. The hospital has between 200 and 500 beds, and is currently undergoing a multimillion-dollar development to meet the growing needs of the community. The redevelopment will see the opening of a new acute services building, the relocation of several wards to this new building, increases in resources (equipment, staffing), and the adoption of new approaches: new ways of working and new e-medical systems of care delivery. These changes are set to be in place by mid-2019. This study includes both a broad analysis of hospital-level data and an in-depth analysis of four specific wards; two wards moving into the new building during the redevelopment project (Maternity and Intensive Care Unit), one ward will not be moved into the new building but will remain in its current location (Surgical), and one ward was moved to a new building two years prior (Respiratory). In essence, the wards moving are the intervention wards and those not moving act as controls. Chosen wards were equivalent in bed, and staff numbers. Although these wards differ somewhat in the type of care delivered, they are deemed to be sufficiently homogeneous; they were chosen in discussion with hospital executives, to cover wards undergoing and not undergoing redevelopment during the study.

Study procedures

Routinely-collected hospital data

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3 Routinely collected hospital data, such as throughput rates and bed occupancy, will be made
4 accessible to the research team. This hospital data will be used to explore indicators of
5 change at the hospital- and ward-levels and make inferences about how hospital
6 redevelopment influences the efficiency of care delivery. This data will be captured at equal
7 monthly intervals, forming part of the ITS analysis.
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10 Patient experience survey

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13 Patient experience data will be captured using a hospital platform already in place. At
14 present, the hospital under investigation has an online survey platform to collect patient
15 experience data, which can be analysed on the ward level. The present project will tap into
16 this platform in order to explore how hospital redevelopment influences patient experience.
17 The questions asked are routinely collected and used to examine overall experience of
18 hospital care. The survey will include the previously validated short form Picker Patient
19 Experience Questionnaire-15 (PPE-15) for measuring patient perceived quality of
20 hospitalization. PPE-15 measures patients' subjective experience of care during their
21 hospital stay.[24] This survey data will be collected at multiple time points, for ITS analysis.
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25 Hospital-wide staff survey

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28 In NSW, Australia, employees working in the public sector, including public hospitals, are
29 invited to participate in the 'People Matter Employee Survey'; a validated survey where
30 employees can express their views and experiences in their workplace.[25] Survey findings
31 are demarcated by agency, such as by each hospital in the NSW public sector (including the
32 hospital under investigation). The survey is distributed and completed annually over a one-
33 month period. The response rate of the last annual survey for this hospital was 39%, slightly
34 higher than the relevant local health district and an increase over previous years. Survey
35 responses will be made accessible to the research team in aggregated, unidentifiable form.
36 This data will be analysed and used to understand the changes in attitudes and experiences
37 of all hospital staff, at two timepoints, pre- and post- the redevelopment.
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41 Semi-structured interviews

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44 Semi-structured interviews were chosen because they enable an in-depth understanding of
45 a new area with little previous research.[26] The purpose of the interviews before the
46 intervention will be to collect information on: (1) a detailed understanding of the hospital's
47 culture and current ways of working; (2) the expectations of hospital staff regarding how the
48 ongoing hospital redevelopment might influence their work; (3) any uncertainties they had
49 about the hospital redevelopment project, and (4) staff predictions of how ways of working
50 with other staff might change in light of the redevelopment. The questions for the
51 interviews taking place after the intervention will be similar, but with a focus on reflections
52 on the change, and perceptions of how the hospital redevelopment may have influenced
53 them personally, other staff, culture, and ways of working together. Participants eligible for
54 inclusion in the interviews will be all staff working on the four wards under investigation,
55 either part-time or full-time. By all staff we mean clinicians, administrative, managerial, and
56 domestic staff. The number of interview participants will be approximately 40 (at each time
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3 point), with a minimum of 10 participants per ward or until data saturation is reached. Semi-
4 structured interviews will be conducted by the first author in private settings at the
5 participants' place of work (in ward interview rooms or private offices). At times where
6 participants are unable to meet the researcher in person, interviews will be conducted over
7 the phone in similar private settings. Findings from these interviews will be used to develop
8 the subsequent network survey and observational component of the research.
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11 12 Network survey

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14 Surveys are a common tool of data collection used to understand the attitudes and
15 perceptions of healthcare professionals.[27] Questions in this survey will be partly
16 dependent upon the analysis of interview data.
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19 *Part 1: Demographics and other outcomes*

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21 The first part of the survey will be used to collect demographic data, expectations and
22 reflections on the hospital redevelopment project, organisational culture, and measures of
23 staff wellbeing (such as job satisfaction and burnout). The same questions will be used pre-
24 and post- the intervention.
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27 *Part 2: Social network survey*

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29 Part 2 of the survey will consist of a social network survey. Social network research involves
30 the investigation of social structures such as collaboration, through the use of networks and
31 graph theory.[28] This provides a basis to investigate a range of collaborative issues,
32 including silo-working and bottlenecks in communication flow,[29] in order to explore how
33 hospital redevelopment influences patterns of staff interaction. The collection of network
34 data to assess interactions is an established tool[29] used in previous healthcare
35 research.[30, 31] In this part of the survey, staff will be asked to report which staff members
36 they work with most closely. Given the sequential nature of the study design, the exact
37 wording of the network questions is dependent on the interview findings. The survey will be
38 similar after the intervention, with the exception of additional open-ended questions asking
39 how patterns of interaction may have changed in response to the hospital redevelopment
40 project.
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46 47 Observations

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49 Generally speaking, observational data will be used to provide a rich description of how
50 hospital redevelopment influences the ways staff work together. Observational data
51 collection will be complementary to the quantitative data of the network survey and will
52 add explanatory value to understanding how the hospital system may change and evolve
53 over time in response to redevelopment. Using observations in conjunction with social
54 network research, as well as in healthcare research more broadly, helps illuminate taken-
55 for-granted and unintended aspects of collaboration that may not be disclosed in surveys or
56 other forms of data collection.[32] Observations will also provide rich data relating to the
57 culture on the wards and how it might be influenced by redevelopment, which is otherwise
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3 difficult to capture in self-report questionnaires. Given the sequential nature of this study,
4 specific observational methods will be designed based on interview and survey findings.
5

6 7 **Data analyses**

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9 Interview and observational data will be analysed using the qualitative method of thematic
10 analysis,[33] using an open coding process[34]. Data collection and analysis will occur
11 iteratively; questions used for interviews and guides for observations will be continuously
12 refined and expanded in light of emerging findings. Qualitative data will be analysed using
13 NVivo, Version 11.4, for coding and qualitative data analysis.
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16
17 For quantitative analysis, demographic and descriptive data (staff wellbeing, organisational
18 culture) collected from the network survey, will be analysed using SPSS Statistics Version
19 22.0. Relational data from the network survey will be graphically presented using Gephi
20 0.9.2 software, and analysed using stochastic actor-based models.[35] These social network
21 analysis techniques include the analysis of endogenous (structural, network self-
22 organisation) and exogenous (individual characteristics) variables. Trends in time series data
23 will be graphically presented using line graphs, and statistically analysed using segmented
24 regression analysis on SPSS.
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28 **Integrating results**

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30 Qualitative, quantitative and network results from the diverse data collection methods will
31 be integrated to form an overall picture of ways hospital redevelopment may influence the
32 organisation, staff and patients in both intended and unintended ways. Data will be
33 synthesised using a mixed-methods matrix;[36] a way to triangulate data and display
34 findings emerging from each level (patient, staff, organisational) and the various methods of
35 data collection. The matrix will delineate data for the intervention and control wards to
36 allow for comparison. Data will be categorised as positive, negative or neutral, pre- and
37 post-hospital redevelopment. The nature of influence will be classified as either intended or
38 unintended (e.g. intended that patient satisfaction will increase). Classification of what
39 changes were intended or unintended will be deduced in consultation with key stakeholders
40 at the hospital. This will be followed by consideration of where there is agreement, partial
41 agreement, silence, or dissonance between findings from different methods on different
42 levels.[36]
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49 **Patient and public involvement**

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51 The Institute consults with patients, their representatives and the general public regularly to
52 ensure that adequate input is secured for research projects and programs of research. A key
53 partner is the Consumers Health Forum of Australia. Patients were not directly involved in
54 the development of the research question, study design, recruitment or conduct of the
55 study. However, the staged nature of the study design means that concerns raised by
56 patients in the survey before the intervention can be used to refine research questions and
57 methods to assess the effects of hospital redevelopment once the move into the new
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3 hospital building takes place. At the end of the study, final results will be disseminated
4 broadly to patients and the wider public.
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6 7 **DISCUSSION**

8
9 This study seeks to explore a significant gap in the literature, namely, how redevelopment
10 influences the wider context of the hospital and its functioning. This research is timely as
11 hospital redevelopment projects are ubiquitous and on the rise.[e.g. 7, 8] The exploratory
12 nature of this case-study enables the identification of unintended influences, positive or
13 negative, that come from conducting a redevelopment project in the hospital physical
14 environment. If unintended consequences of hospital redevelopment on the organisation,
15 staff and patients are revealed, then we may be able to delineate and propose ways to deal
16 with these factors. These findings may be used to guide policies on how to implement major
17 hospital redevelopment projects with minimal disruption and awareness of the intended
18 and unintended effects of this large change.
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23 As to limitations, the findings may not be generalisable to all instances of hospital
24 redevelopment and may be specific to the four wards and one hospital examined in this
25 study. They were purposively chosen rather than randomised. While findings may not be
26 generalisable, the qualitative test is credibility and the protocol has been designed to
27 optimise research credibility at each point. This in-depth case-study provides the
28 opportunity to uncover theoretical insights into the processes of change in the healthcare
29 system and how such processes can impact staff, patients, and the organisation. Another
30 potential limitation lies in the two time-point data collection for four or the six methods of
31 this study. Detected changes assessed by these methods can, in some instances, be affected
32 by numerous other factors, such as, seasonal, auto-correlational and non-stationary biases
33 often found in two-time point longitudinal data.[23] In including ITS data and control wards,
34 this limitation will be addressed as such biases can be identified when there are numerous
35 time points and varied contexts. Therefore, the combination of pre-post and ITS data
36 collection along with multi-level analysis of the complex hospital system is beneficial in the
37 exploration of unintended influences to answer the question: is new always better?
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47 **ETHICS AND DISSEMINATION**

48 The study has been reviewed and approved by the relevant Ethics Committee in NSW,
49 Australia. There are no known health or safety risks associated with participation in any
50 aspect of the described study. The results will be actively disseminated through peer-
51 reviewed journals, conference presentations, and in report format to the stakeholders.
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54 **Author contributions**

55 CP, JB and BG conceptualised the study. CP drafted the initial manuscript, assisted by KC, JL
56 and LE. All authors contributed to the refinement of the final manuscript.
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Competing Interests

None declared.

Data availability

There are no data in this work.

Abbreviations

NSW New South Wales

ITS Interrupted time series

RTP Research training program

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3 **FIGURE LEGENEDS**
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5 **Figure 1.** Data collection points over time
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8 **Figure 2.** Domains to be assessed
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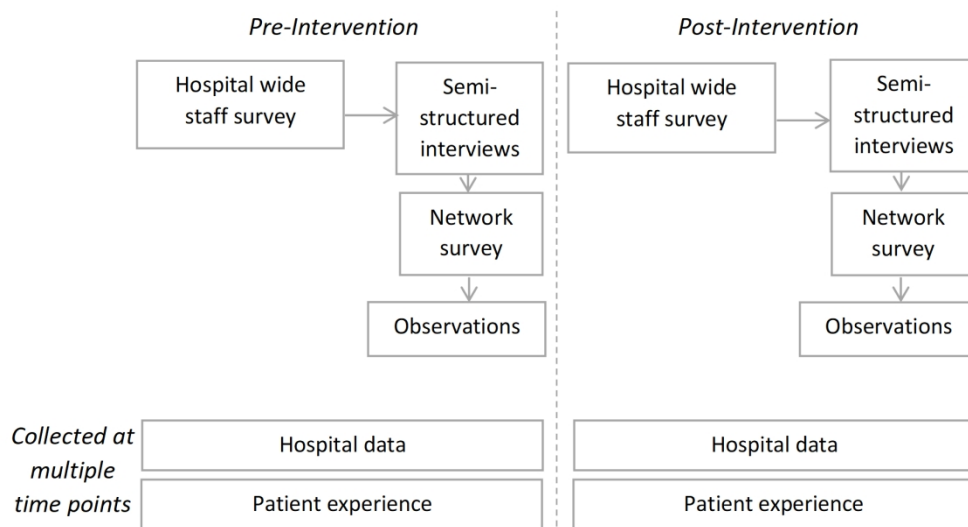


Figure 1. Data collection points over time

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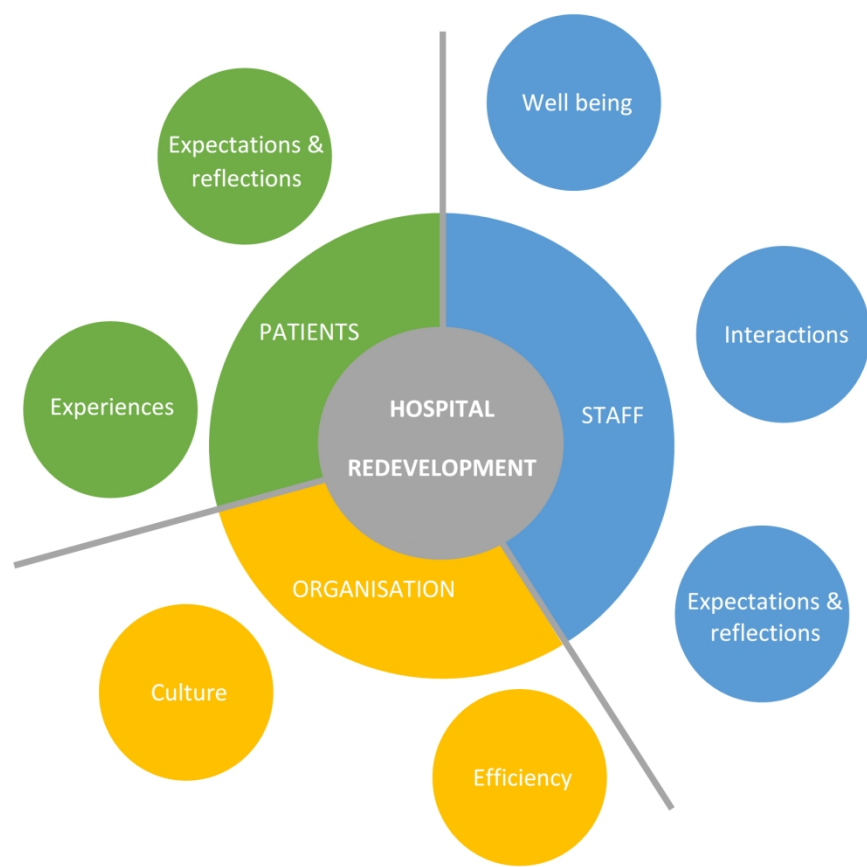


Figure 2. Domains to be assessed
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Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal, mixed-methods study

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9 **Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal,**
10 **mixed-methods study**
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ARTICLE SUMMARY

Introduction

Hospital redevelopment projects typically intend to improve hospital functioning and modernise the delivery of care. There is research support for the proposition that redevelopment along evidence-based design principles can lead to improved quality and safety. However, it is not clear how redevelopment influences the wider context of the hospital and its functioning. That is, beyond a limited examination of intended outcomes (e.g. improved patient satisfaction), are there additional consequences (positive, negative, or unintended) occurring within the hospital after the physical environment is changed? Is new always better? The primary purpose of this study is to explore the ripple effects of how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.

Methods and analysis

We propose to conduct a longitudinal, mixed-methods, case-study of a large metropolitan hospital in Australia. The study design consists of a series of measurements over time that are interrupted by the natural intervention of a hospital redevelopment. How hospital redevelopment influences the wider context of the hospital will be assessed in six domains: expectations and reflections of hospital redevelopment, organisational culture, staff interactions, staff wellbeing, efficiency of care delivery, and patient experience. Methods of data collection include: a hospital-wide staff survey, semi-structured interviews, a network survey, a patient experience survey, analysis of routinely-collected hospital data, and observations. In addition to a hospital-level analysis, a total of four wards will be examined in-depth, with two acting as controls. Data will be analysed using thematic, statistical, and network analyses respectively, for the qualitative, quantitative, and relational data.

Ethics and dissemination

The study has been reviewed and approved by the relevant Ethics Committee in New South Wales, Australia. The results will be actively disseminated through peer-reviewed journals, conference presentations, and in report format to the stakeholders.

Strengths and limitations of this study

- This study will be the first of its kind to explore how hospital redevelopment may influence the organisation, staff and patients in both intended and unintended ways.
- The project design, including the development of tools, was conducted in collaboration with the hospital under investigation.
- A key strength of the study is the use of mixed-methods and multiple time points of data collection.
- A limitation of the study is that findings may be specific to the hospital and the wards under investigation.

Exploring the ripple effects of an Australia hospital redevelopment: A protocol for a longitudinal, mixed-methods study

BACKGROUND

Healthcare systems worldwide are facing significant challenges to their long-term sustainability and the delivery of safe, effective, quality care.[1-3] Ageing populations, increasing costs of medical advances, issues with health workforce retention, outdated and inadequate infrastructure, concerns about the quality and safety of health services, and wasteful spending are some of the many challenges facing contemporary healthcare systems.[1, 4, 5] For hospitals, as healthcare institutions providing in-patient treatment 24 hours a day, seven days a week, one of their major challenges lies with ageing populations and overall population growth. Indeed, hospitals worldwide are experiencing a higher incidence of elderly people with greater demand for hospital services and hospital beds.[4, 6]. One way to respond to this challenge is through hospital expansion, redevelopment and modernisation.

The redevelopment of hospitals in high-income countries appears to be increasingly common,[e.g. 7, 8] for several reasons. First, hospitals must evolve and adapt to match the changing healthcare needs of the communities they service.[9] Hospitals everywhere are challenged to meet the demands of ageing populations and overall population growth; expansion through hospital redevelopment is a way to resolve consequent issues such as inadequate infrastructure. Second, hospitals must adapt to changing trends and technological advances in medicine. For example, the use of mechanical lifters at the bedside,[10] or point-of-care testing,[11] may require reconfiguration of beds in the ward. Third, hospital redevelopment may take place when existing infrastructure is found to compromise staff safety or infection control for patients. For example, the redevelopment of operating theatres to include laminar flow was a deliberate strategy aimed at reducing infection rates.[12] Another reason for hospital redevelopment lies in the well-documented association between an aesthetically appealing hospital environment and positive outcomes.[13-16] To this end, stakeholders may make design decisions on the basis of evidence, to improve not only the physical appearance, but the functioning of the hospital, including: improved quality of care, patient and staff satisfaction, and financial savings.[13]

While the literature suggests that redevelopment projects and the implementation of new design features in hospitals are associated with improved outcomes for staff, patients, and the broader organisation,[17] these outcomes have mainly been addressed in a linear frame. This means hospital redevelopment has typically been assessed by evaluating how one feature (e.g. a new garden) impacts one intended outcome (e.g. satisfaction), rather than exploring possible unintended consequences of changing the hospital system. Further, there has been a focus on physical change, rather than the behavioural, cultural or social shifts characteristic of organisational change.[18] As the physical environment of the hospital is altered, other social processes may be unintendedly influenced, for example, roles, responsibilities, culture, and the way staff work together. Indeed, past research has revealed that the behaviours and social interactions of staff are influenced by the physical healthcare environment. This was shown for formal teamwork and communication[19] as well as informal communication patterns such as support and

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3 socialization.[20, 21] An example of a ripple effect is that beneficial working relationships between
4 adjacent units may be disrupted if they move apart, possibly leading to poorer quality of patient
5 care. This suggests that there is a need for a more indepth examination of the potential ripple
6 effects of a hospital redevelopment, beyond the physical changes.
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10 This is particularly important given how interconnected and complex hospital systems are.[22, 23]
11 Healthcare and healthcare organisations have been described as complex adaptive systems,
12 characterised by non-linear and often unpredictable processes.[24, 25] In introducing a potentially
13 large long-term change (and short-term disruption) as hospital redevelopment into a complex
14 interconnected system, this perspective highlights that we need to look beyond just the intended or
15 desired outcomes of hospital redevelopment. In taking a complex systems perspective to examine
16 how redevelopment may influence the hospital, we recognise that we cannot isolate single factors
17 (e.g. patient satisfaction). Rather, we need to consider the influence on many complex and
18 interconnected levels and agents of the hospital system.[17] This perspective aligns with recent
19 moves to re-appraise change management theory – to one that no longer perceives organisational
20 change as planned, uniform and predictable, but an emergent process in a multi-layered, complex
21 ecosystem that is driven as much from the bottom up as the top down.[26]
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26 Therefore, rather than assuming that the redevelopment of hospitals will only lead to a particular
27 intended outcome, we argue there is a need to consider the unintended ripple effects and
28 widespread influences of introducing an organisational change into this complex system. Based on
29 these issues, we pose the question: is new always better? Beyond the targeted outcome of
30 improving the physical infrastructure, do we really know what happens within the hospital after the
31 physical environment is comprehensively changed?
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35 **METHODS AND ANALYSIS**

36 **Study aim**

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38 The present research aims to explore how hospital redevelopment influences the wider context of
39 the hospital and its functioning. In particular, the study will explore how hospital redevelopment
40 may influence the organisation, staff and patients in both intended and unintended ways.
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45 **Study design**

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47 We propose to conduct a pragmatic, longitudinal, mixed-methods case-study of a large
48 metropolitan hospital in Australia. As illustrated in Figure 1, the design is a mixture of pre-post data
49 collection points and a series of measurements over time that are interrupted by the natural
50 intervention of the hospital redevelopment (i.e. interrupted time series (ITS) data). ITS is a quasi-
51 experimental method for assessing routinely collected data over evenly spaced out intervals to
52 assess the impact of change.[27] The combination of these methods of data collection allows for a
53 rich and dynamic exploration of how hospital redevelopment influences the organisation, staff and
54 patients, in intended and unintended ways.
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8 How hospital redevelopment influences the wider context of the hospital will be assessed at three
9 levels: organisation, staff and patients; and six domains: expectations and reflections,
10 organisational culture (i.e. shared beliefs and attitudes), staff interactions, staff wellbeing,
11 efficiency of care delivery and patient experience (Figure 2). These domains are underpinned by
12 considerations of key literature [13, 14] and will be captured by six methods of data collection:
13 hospital-wide staff survey, semi-structured interviews, network survey, patient experience survey,
14 analysis of routinely-collected hospital data, and observations (Table 1). Of these six methods, two
15 (hospital data and patient experience) will be assessed at a minimum of six observations points. The
16 other four methods of data collection will be assessed at two time points, pre- and post- the
17 intervention of hospital redevelopment. Data collection, particularly for interviews, network survey,
18 and observations, will occur in a sequential manner (e.g. design of the network survey depends on
19 the analysis of interview data).
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INSERT FIGURE 2 HERE

Table 1. Domains to be assessed and corresponding methods

Method	Domains					
	Expectations & reflections	Organisational culture	Staff interactions	Staff wellbeing	Efficiency	Patient experience
Hospital-wide staff survey		x		x		
Semi-structured interviews	x	x	x			
Network survey	x	x	x	x		
*Patient experience survey	x					x
*Hospital data					x	x
Observations			x		x	

* Data captured at multiple time points; all other methods are captured at two time points, pre- and post-intervention.

Study setting

The project will be conducted at a public, metropolitan hospital in New South Wales (NSW), Australia. The hospital has between 200 and 500 beds, and is currently undergoing a multimillion-dollar development to meet the growing needs of the community. The redevelopment will see the opening of a new acute services building, the relocation of several wards to this new building, increases in resources (equipment, staffing), and the adoption of new approaches: new ways of working and new e-medical systems of care delivery. These changes are set to be in place by mid-2019. This study includes both a broad analysis of hospital-level data and an in-depth analysis of four specific wards; two wards moving into the new building during the redevelopment project (Maternity and Intensive Care Unit), one ward will not be moved into the new building but will remain in its current location (Surgical), and one ward was moved to a new building two years prior (Respiratory). In essence, the wards moving are the intervention wards and those not moving act as controls. Chosen wards were equivalent in bed, and staff numbers. Although these wards differ somewhat in the type of care delivered, they are deemed to be sufficiently homogeneous; they were chosen in discussion with hospital executives, to cover wards undergoing and not undergoing redevelopment during the study.

Study procedures

Routinely-collected hospital data

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3 Routinely collected hospital data, such as throughput rates and bed occupancy, will be made
4 accessible to the research team. This hospital data will be used to explore efficiency as an indicator
5 of change at the hospital- and ward-levels and make inferences about how hospital redevelopment
6 influences the efficiency of care delivery. This data will be captured at equal monthly intervals,
7 forming part of the ITS analysis.
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10 Patient experience survey

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13 Patient experience data will be captured using a hospital platform already in place. At present, the
14 hospital under investigation has an online survey platform to collect patient experience data, which
15 can be analysed on the ward level. The present project will tap into this platform in order to explore
16 how hospital redevelopment influences patient experience. The questions asked are routinely
17 collected and used to examine overall experience of hospital care. The survey will include the
18 previously validated short form Picker Patient Experience Questionnaire-15 (PPE-15) for measuring
19 patient perceived quality of hospitalization. PPE-15 measures patients' subjective experience of
20 care during their hospital stay.[28] This survey data will be collected at multiple time points, for ITS
21 analysis.
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25 Hospital-wide staff survey

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28 In NSW, Australia, employees working in the public sector, including public hospitals, are invited to
29 participate in the 'People Matter Employee Survey'; a validated survey where employees can
30 express their views and experiences in their workplace.[29] Survey findings are demarcated by
31 agency, such as by each hospital in the NSW public sector (including the hospital under
32 investigation). The survey is distributed and completed annually over a one-month period. The
33 response rate of the last annual survey for this hospital was 39%, slightly higher than the relevant
34 local health district and an increase over previous years. Survey responses will be made accessible
35 to the research team in aggregated, unidentifiable form. This data will be analysed and used to
36 understand the changes in attitudes and experiences of all hospital staff, at two timepoints, pre-
37 and post- the redevelopment.
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41 Semi-structured interviews

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44 Semi-structured interviews were chosen because they enable an in-depth understanding of a new
45 area with little previous research.[30] The purpose of the interviews before the intervention will be
46 to collect information on: (1) a detailed understanding of the hospital's culture and current ways of
47 working; (2) the expectations of hospital staff regarding how the ongoing hospital redevelopment
48 might influence their work; (3) any uncertainties they had about the hospital redevelopment
49 project, and (4) staff predictions of how ways of working with other staff might change in light of
50 the redevelopment. The questions for the interviews taking place after the intervention will be
51 similar, but with a focus on reflections on the change, and perceptions of how the hospital
52 redevelopment may have influenced them personally, other staff, culture, and ways of working
53 together. Participants eligible for inclusion in the interviews will be all staff working on the four
54 wards under investigation, either part-time or full-time. By all staff we mean clinicians,
55 administrative, managerial, and domestic staff. By collecting diverse staff perspectives we can shed
56 light on how different types and levels of hospital staff may be influenced by the redevelopment.
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3 The number of interview participants will be approximately 40 (at each time point), with a
4 minimum of 10 participants per ward or until data saturation is reached. Semi-structured interviews
5 will be conducted by the first author in private settings at the participants' place of work (in ward
6 interview rooms or private offices). At times where participants are unable to meet the researcher
7 in person, interviews will be conducted over the phone in similar private settings. Findings from
8 these interviews will be used to develop the subsequent network survey and observational
9 component of the research.
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13 Network survey

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16 Surveys are a common tool of data collection used to understand the attitudes and perceptions of
17 professionals working in health services;[31] in this case, all types of staff working in the hospital
18 under redevelopment. Questions in this survey will be partly dependent upon the analysis of
19 interview data.
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21 *Part 1: Demographics and other factors*

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24 The first part of the survey will be used to collect demographic data and expectations and
25 reflections on the hospital redevelopment project. Existing validated measures will be used to
26 examine organisational culture,[32] measures of staff wellbeing (such as job satisfaction,[33]
27 burnout,[34] intention to leave[35]), and readiness for organisational change.[36] The same set of
28 questions will be used pre- and post- the intervention.
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31 *Part 2: Social network survey*

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34 Part 2 of the survey will consist of a social network survey. Social network research involves the
35 investigation of social structures such as collaboration, through the use of networks and graph
36 theory.[37] This provides a basis to investigate a range of collaborative issues, including silo-
37 working and bottlenecks in communication flow,[38] in order to explore how hospital
38 redevelopment influences patterns of staff interaction. The collection of network data to assess
39 interactions is an established tool[38] used in previous healthcare research.[39, 40] In this part of
40 the survey, staff will be asked to report which staff members they work with most closely. Given
41 the sequential nature of the study design, the exact wording of the network questions is dependent
42 on the interview findings. The survey will be similar after the intervention, with the exception of
43 additional open-ended questions asking how patterns of interaction may have changed in response
44 to the hospital redevelopment project.
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49 Observations

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52 Generally speaking, observational data will be used to provide a rich description of how hospital
53 redevelopment influences the ways staff work together. Observational data collection will be
54 complementary to the quantitative data of the network survey and will add explanatory value to
55 understanding how the hospital system may change and evolve over time in response to
56 redevelopment. Using observations in conjunction with social network research, as well as in
57 healthcare research more broadly, helps illuminate taken-for-granted and unintended aspects of
58 collaboration that may not be disclosed in surveys or other forms of data collection.[41]
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3 Observations will also provide rich data relating to the culture on the wards and how it might be
4 influenced by redevelopment, which is otherwise difficult to capture in self-report questionnaires.
5 The observations will include all types of hospital staff (clinical and non-clinical). Given the
6 sequential nature of this study, specific observational methods will be designed based on interview
7 and survey findings.
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10 **Data analyses**

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13 Interview and observational data will be analysed using the qualitative method of thematic
14 analysis,[42] using an open coding process[43]. Data collection and analysis will occur iteratively;
15 questions used for interviews and guides for observations will be continuously refined and
16 expanded in light of emerging findings. Qualitative data will be analysed using NVivo, Version 11.4,
17 for coding and qualitative data analysis.
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20
21 For quantitative analysis, demographic and descriptive data (staff wellbeing, organisational culture)
22 collected from the network survey, will be analysed using SPSS Statistics Version 22.0. Relational
23 data from the network survey will be graphically presented using Gephi 0.9.2 software, and
24 analysed using stochastic actor-based models.[44] These social network analysis techniques include
25 the analysis of endogenous (structural, network self-organisation) and exogenous (individual
26 characteristics) variables. Trends in time series data will be graphically presented using line graphs,
27 and statistically analysed using segmented regression analysis on SPSS.
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31 **Integrating results**

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33 Qualitative, quantitative and network results from the diverse data collection methods will be
34 integrated to form an overall picture of ways hospital redevelopment may influence the
35 organisation, staff and patients in both intended and unintended ways. Data will be synthesised
36 using a mixed-methods matrix:[45] a way to triangulate data and display findings emerging from
37 each level (patient, staff, organisational) and the various methods of data collection. The matrix will
38 delineate data for the intervention and control wards to allow for comparison. Data will be
39 categorised as positive, negative or neutral, pre- and post-hospital redevelopment. The nature of
40 influence will be classified as either intended or unintended (e.g. intended that patient satisfaction
41 will increase). Classification of what changes were intended or unintended will be deduced in
42 consultation with key stakeholders at the hospital. This will be followed by consideration of where
43 there is agreement, partial agreement, silence, or dissonance between findings from different
44 methods on different levels.[45]
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50 **Patient and public involvement**

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52 The Institute consults with patients, their representatives and the general public regularly to ensure
53 that adequate input is secured for research projects and programs of research. A key partner is the
54 Consumers Health Forum of Australia. Patients were not directly involved in the development of
55 the research question, study design, recruitment or conduct of the study. However, the staged
56 nature of the study design means that concerns raised by patients in the survey before the
57 intervention can be used to refine research questions and methods to assess the effects of hospital
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3 redevelopment once the move into the new hospital building takes place. At the end of the study,
4 final results will be disseminated broadly to patients and the wider public.
5

6 7 **DISCUSSION**

8
9 This study seeks to explore a significant gap in the literature, namely, how redevelopment
10 influences the wider context of the hospital and its functioning. This research is timely as hospital
11 redevelopment projects are ubiquitous and on the rise.[e.g. 7, 8] The exploratory nature of this
12 case-study enables the identification of unintended influences, positive or negative, that come from
13 conducting a redevelopment project in the hospital physical environment. The study looks at social,
14 behavioural and cultural changes that may come as a result of the physical change (e.g. teamwork
15 and culture). If unintended consequences of hospital redevelopment on the organisation, staff and
16 patients are revealed, then we may be able to delineate and propose ways to deal with these
17 factors. These findings may be used to guide policies on how to implement major hospital
18 redevelopment projects with minimal disruption and awareness of the intended and unintended
19 effects of this large change.
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25 As to limitations, the findings may not be generalisable to all instances of hospital redevelopment
26 and may be specific to the four wards and one hospital examined in this study. They were
27 purposively chosen rather than randomised. While findings may not be generalisable, the
28 qualitative test is credibility and the protocol has been designed to optimise research credibility at
29 each point. This in-depth case-study provides the opportunity to uncover theoretical insights into
30 the processes of change in the healthcare system and how such processes can impact staff,
31 patients, and the organisation. Another potential limitation lies in the two time-point data
32 collection for four or the six methods of this study. Detected changes assessed by these methods
33 can, in some instances, be affected by numerous other factors, such as, seasonal, auto-correlational
34 and non-stationary biases often found in two-time point longitudinal data.[27] In including ITS data
35 and control wards, this limitation will be addressed as such biases can be identified when there are
36 numerous time points and varied contexts. Therefore, the combination of pre-post and ITS data
37 collection along with multi-level analysis of the complex hospital system is beneficial in the
38 exploration of unintended influences to answer the question: is new always better?
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44 **ETHICS AND DISSEMINATION**

45
46 The study has been reviewed and approved by the relevant Ethics Committee in NSW, Australia.
47 There are no known health or safety risks associated with participation in any aspect of the
48 described study. The results will be actively disseminated through peer-reviewed journals,
49 conference presentations, and in report format to the stakeholders.
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51

52 **Author contributions**

53
54 CP, JB and BG conceptualised the study. CP drafted the initial manuscript, assisted by KC, JL and LE.
55 All authors contributed to the refinement of the final manuscript.
56
57

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1
2
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4 is supported by multiple grants, including the National Health and Medical Research Council
5 (NHMRC) Partnership Grant for Health Systems Sustainability (ID: 9100002).
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8 **Competing Interests**

9

10 None declared.
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13 **Data availability**

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15 There are no data in this work.
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18 **Abbreviations**

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20 NSW New South Wales
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22 ITS Interrupted time series
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24 RTP Research training program
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FIGURE LEGENEDS

Figure 1. Data collection points over time

Figure 2. Domains to be assessed

For peer review only

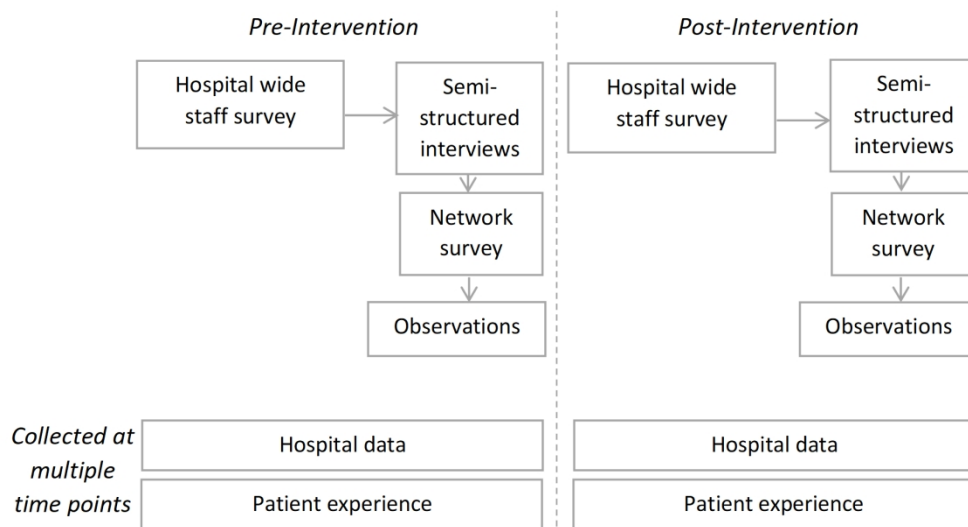


Figure 1. Data collection points over time

163x92mm (300 x 300 DPI)

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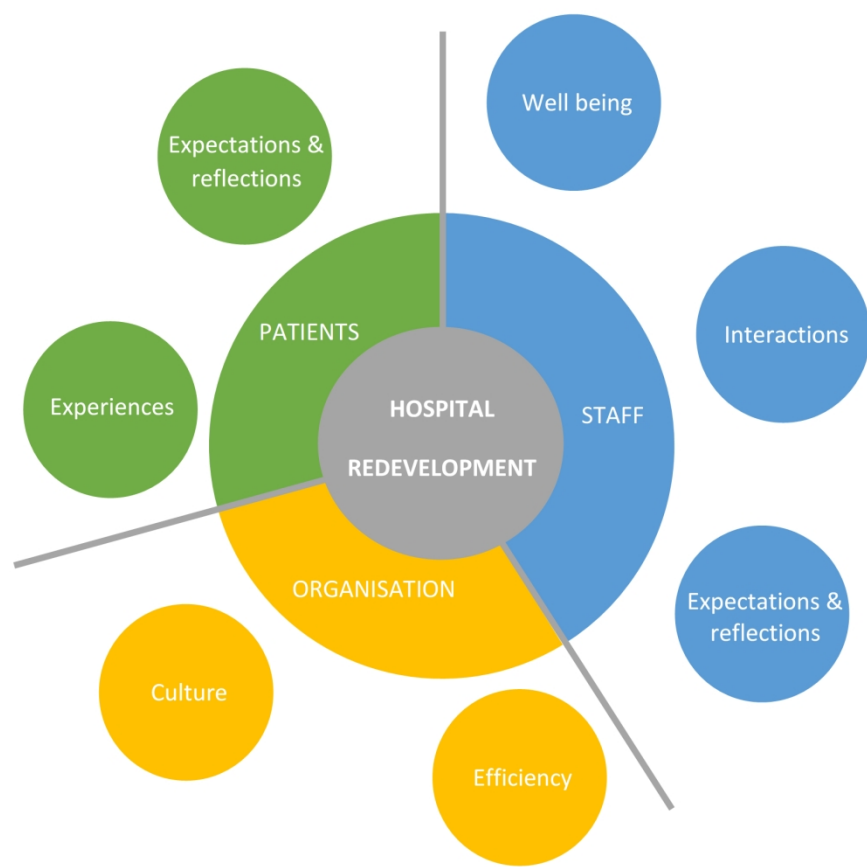


Figure 2. Domains to be assessed
164x148mm (300 x 300 DPI)