Final Report: Fit for purpose? Organisational productivity and workforce wellbeing in workspaces in Hospital (FLOURISH): A pilot study

April 2019: Auton E., Clay-Williams R., Cartmill J., Braithwaite J. and Rapport F.
Final report: **Fit for purpose? Organisational productivity and workforce wellbeing in workspaces in Hospital (FLOURISH): A pilot study**

Prepared for the staff members of Macquarie University Hospital

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# Contents

List of Tables and Images.................................................................................................................................4
Acknowledgements ......................................................................................................................................................4
Summary of Team ..................................................................................................................................................5
Abbreviations ..........................................................................................................................................................6
Executive Summary ................................................................................................................................................7

1. Introduction..........................................................................................................................................................9
   1.1 Workspace Design.........................................................................................................................................9
   1.2 Study Site..................................................................................................................................................11
   1.3 Conceptual Framework ...............................................................................................................................12
   1.4 Mobile Methods....................................................................................................................................13

2. Method..............................................................................................................................................................14
   2.1 Study Objective .........................................................................................................................................14
   2.2 Aims........................................................................................................................................................14
   2.3 Study Design..........................................................................................................................................14
   2.4 Sample and Setting .................................................................................................................................14
   2.5 Recruitment Procedure..........................................................................................................................15
   2.6 Data Collection.....................................................................................................................................15
   2.7 Data Analysis.......................................................................................................................................17
   2.8 Ethics Approval ...................................................................................................................................18

3. Results.............................................................................................................................................................19
   **Fit-for-Purpose Spaces** ...............................................................................................................................20
   3.1 Theme 1: Spatial Reminders through Objects in Space ...........................................................................20
   3.2 Theme 2: Accommodating Space ...........................................................................................................21
   **Unfit-for-Purpose Spaces** ...........................................................................................................................24
   3.3 Theme 3: Sterile and Contaminated Space .............................................................................................24
   3.4 Theme 4: The Alcove ...............................................................................................................................27
   3.5 Theme 5: The Changing Dynamics of Space .........................................................................................29
   3.6 Theme 6: Cold Space .............................................................................................................................33

4. Discussion..........................................................................................................................................................34
   4.1 Implications for Research ........................................................................................................................37
   4.2 Implications for Practice ........................................................................................................................37
   4.3 Strengths and Limitations ........................................................................................................................38

5. Conclusion.........................................................................................................................................................38

6. Recommendations Resulting from this Study .............................................................................................38
   6.1 Recommendation 1: ................................................................................................................................39
   6.2 Recommendation 2: ................................................................................................................................39
   6.3 Recommendation 3: ................................................................................................................................39

7. References..........................................................................................................................................................40
List of Tables and Images

Table 1. Six Themes of Workspace and Practice in One Gastroenterological Surgical Unit ......................19
Image 1. Sink where surgeons scrub in outside Theatre 21 .................................................................25
Image 2. Architectural plan of Theatre 21 .............................................................................................27
Image 3. Arthur writing notes in his alcove .........................................................................................28
Image 4. Airconditioning vents directly above where surgeons stand in Theatre 21 .........................33

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# Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>GI</td>
<td>Gastroenterology</td>
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<tr>
<td>HREC</td>
<td>High Risk Ethics Committee</td>
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<tr>
<td>WAD</td>
<td>Work-as-Done</td>
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<td>WAI</td>
<td>Work-as-Imagined</td>
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Executive Summary

Background and Aims: Good workspace design is key to the quality of people’s work, safety, and wellbeing (happiness, health and productivity), and yet the healthcare workforce is rarely consulted about how workspaces should function. Consequently, we lack vital knowledge about optimal hospital design in line with workforce need, to impact positively on employees’ safety and good care delivery. Hospitals are currently designed more according to Work-As-Imagined (WAI) than Work-As-Done (WAD). WAI is based on a managerial understanding of how work is performed, whereas WAD is what actually happens in the workplace. This innovative study aimed to examine WAD and the effect of workspace-use on healthcare professional practice, health and safety, and productivity.

Methods: Between June 2018 and April 2019 a textual and visual qualitative, in-depth assessment took place of one Australian, private, university hospital’s gastroenterology surgical unit. It involved 50 hours of observations and informal interviews with employees and patients crossing hospital spaces (mobile methods), and the interpretation of five architectural plans and 45 photographs of spatial use. Researcher fieldnotes were analysed thematically, and visual data were analysed using a predefined visual taxonomy. Overarching themes and categories were considered in combination to build an iterative and dynamic picture to address the study aims around workspace-use, spatial management and workforce experience, including people’s perceptions of health, safety and productivity.

Results: Drawing on a mobile methodology, the innovative, qualitative study revealed spaces that both support and hinder WAD. In this study, fit-for-purpose spaces allowed effective doctor-patient communication to take place, and for people to work and function in relative comfort and privacy, harmoniously through a shared understanding of each other’s roles and responsibilities, while high-quality care and the maintenance of sterile practices could be upheld. Unfit-for-purpose spaces, characterised by cold temperatures, crowded and uncontrolled surgical areas, and the lack of private space resulted in physical discomfort for staff, disrupted work practices and threats to the maintenance of sterile spaces and practices and team collaboration and harmony. Despite this, most staff creatively found ways to manage unfit-for-purpose spaces, adopting new habits and approaches – ‘workarounds’, and accommodating one another, while altering clothing to keep warm and purposefully bounding spaces, according to their body-language and spatial management, to ensure they were perceived by others as ‘private’. 
Conclusion: Arrangements of fit-for-purpose and unfit-for-purpose workspaces, and their effects on health, wellbeing and productivity, as well as their impact on safety, workspace-use and experience highlight important considerations in hospital workspace design. In this study the gastroenterology team’s use of surgical theatres, clinical and non-clinical spaces were illustrative of the way that people manage their working lives. The study data indicated how people can be negatively affected by unfit-for-purpose spaces, with workarounds demanding more time and ingenuity to carry out even the most routine functions. Results also indicated the need to creatively expand spatial options, so that alcoves become offices and theatres become walkways, not only to ease surgical patient throughput but also for more general professional access, enabling people to function effectively while moving fluidly from one space to another.

While new habits and approaches can help staff circumvent the negative implications of unfit-for-purpose spaces and inappropriately-placed objects within them, they can also lead to unexpected consequences. These include staff regularly ‘rewriting the rules’, talking during difficult operations, crossing sterile boundaries and sharing confidences in unexpected ways. This can lead to staff going ‘rogue’ – making autonomous decisions, reinventing spatial layout, and redesigning the functionality of different spaces, adapting clothing for more sustained precision medicine practices, such as those taking place in the operating theatre. Only through adaptation and flexibility, within the setting where unfit-for-purpose spaces abound, can everyday working practices be maintained.

Recommendations: We offer three recommendations to ensure the reduction of unfit-for-purpose spaces and the growth of fit-for-purpose spaces across both clinical and non-clinical areas: 1) the inclusion of small, private spaces on surgical wards aligned to operating theatres to ensure people have the necessary privacy to function effectively, and more consideration of privacy within shared spaces, where people react according to their close proximity not only to the work in hand, but also to one another; 2) hospital clothing that is well-maintained and suitable for the purpose for which it was designed (this will reduce the opportunity of contamination across sterile and unsterile spaces and lead to greater pride in group identification); and 3) better ergonomic use of objects in spaces, (the implications of which need further thought), to ensure the workforce are able to conduct their work in comfort, harmoniously, and to the benefit of both the team and the patients under their care. We recommend this report is shared for greater awareness of vital improvements to spatial use and function, with the aspiration that fit-for-purpose, high-quality and safe spatial practices can be increased in these critical theatre areas.
Reducing waste and reconsidering what might be inappropriate spatial use, according to team functioning and group and personal wellbeing, will improve the safety of patients and staff. This is particularly evident when staff attempt to operate on patients in cold spaces that lack clear boundaries between sterile and non-sterile spaces. Furthermore, beyond the operating theatre, when privacy is lacking and personal space is makeshift and tenuous, this has ramification for reduced productivity and wellbeing, with the potential to lead to more strained interactions with others.

The three recommendations we outline above include the need to construct smaller, more adaptive and protected workspaces within surgical units, to make adjustments to the design of hospital attire to suit theatre temperatures and to consider which are the sterile spaces and how sterile practices could conform better to those sterile spaces, such as the need to relocate air-conditioning units. This study also illustrates how innovative, mobile methods are an effective tool for investigating WAD. Mobile methods offer a clear understanding of what workforces are actually achieving in hospitals as different groups of people situate themselves within or across different types of clinical and non-clinical spaces, while data captured using mobile methods can enable the formulation of recommendations for hospital designs that have the potential to transform hospitals into better-quality, safer places for all concerned.

1. Introduction

1.1 Workspace Design

Workspaces are socially constructed environments and active parts of our lives. They are places where “social relationships are produced, reproduced, contested and transformed”. The primary function of workspaces is to support a workforce in delivering a service or product of the highest quality to the benefit of a client group (also known as the ‘customer’, ‘user’ or, in the case of a healthcare workspace, the ‘patient’). They are also places where employees should feel safe and healthy. When these primary factors align, secondary benefits result: psycho-social wellbeing, productivity, and economic viability, and when managed effectively, workspaces can be said to be better able to cope with individual and system challenges, thus termed ‘resilient’. Studies of workspace design, across different industries, have predominantly concentrated on ergonomics, including stress and safety in the workplace. They have assessed the effect of stress on individual and organisational productivity and job satisfaction, leading to new socio-behavioural interventions. The Australian National Workplace Health Project, for example, concentrated on introducing new behavioural interventions such as healthy eating, to enhance fitness and wellbeing, while work in stress and safety has led to new definitions of psychosocial factors that affect strain and employee health. Wilson et al., and Allen et al., examined absenteeism and job
satisfaction with strong correlations found between higher absenteeism and workplace stress, and between lower job satisfaction and lower organisational commitment and turn-over.\textsuperscript{18}

**Reduced psychosocial wellbeing**

Reduced psychosocial wellbeing has been described as an antecedent to lower productivity and customer satisfaction,\textsuperscript{15, 19} and is also linked to psychological withdrawal.\textsuperscript{15} Having examined psychosocial wellbeing in some detail, Vischer\textsuperscript{14} urges us to now turn our attention to the physical environment, which is under-examined – its layout, makeup and objects within it – that are affected by its design, as strong indicators of a workforce’s productivity, health and safety. Vischer calls this “environmental psychology”.\textsuperscript{14 (p 175)} This view is echoed by the work of Veitch et al.\textsuperscript{20} who also noted that most research in the physical environment fails to lead to clearer workspace design – leaving this still largely uncharted territory.\textsuperscript{16}

**Increased working hours**

In 2015, in Australian healthcare (where this study is situated) over 460,000 registered healthcare professionals are actually working a 42-72 hour-week, rather than a 38 hour-week (the prescribed number of working hours for optimal health and safety), with one in two doctors described by the Australian Medical Association as working unsafe hours.\textsuperscript{21, 22} With a growing number of hours in work, good workspace design is crucial to people’s safety, productivity and job satisfaction.\textsuperscript{23} According to the Productivity Commission’s Report on Government health services,\textsuperscript{24} at least 100 medical disasters occur each year causing death or serious harm. This includes unsafe operations, removal of wrong body parts and foreign bodies remaining in patients after operations. Overstretched staff, crowded hospitals and lengthy waiting times, as well as a lack of individualised, appropriate care exacerbates the prevalence of such errors, with 82 Sentinel Events recorded in NSW alone between 2015-16. Yet despite these statistics, healthcare employees, who are vital players in keeping the nation safe, are not fully engaged in hospital planning\textsuperscript{25} and do not report on their workspace needs or the needs of their patients.

**Increased medical errors and error reporting**

Longer working hours lead to more medical errors, with one-in-ten patient encounters currently associated with a medical error (unsafe procedure or wrong drug).\textsuperscript{22} Up to 18,000 Australians die unnecessarily each year from errors,\textsuperscript{26} also estimated as the third leading cause of death in the United States.\textsuperscript{27} Errors result from tiredness, inefficiencies in the workplace, and ill-placed technology and objects, leading the workforce to find themselves under increasing stress.\textsuperscript{2, 22, 28} Error-reporting is also on the increase globally, which in turn has led to a whistleblowing society that is said to de-motivate the workforce.\textsuperscript{27} A
demotivated workforce can make further errors (such as an incorrect operation). In Australia, a rapid rise in doctors’ mental health problems, including burnout and suicide, has been characterised as an ‘epidemic’ and ‘crisis’. This is exacerbated by an ageing Australian population, with hospitalisation rates growing yearly, especially for the over 65s, and hospitals stretched to capacity as a result of limited resources.

We need to urgently address the challenges outlined in this introduction. By assessing how to improve hospital workspaces and the enhanced psychosocial wellbeing of the workforce (including reducing levels of stress, inefficiency and tiredness) we may have the opportunity to reduce medical errors and error reporting.

The proposed study offers unique insights into workspace use and the link between workspaces and employee wellbeing, to directly address these significant challenges, and through the translation of findings into practical outputs, to ensure workspaces are safer, healthier and more productive environments for people to work in. In turn, this offers the potential to reduce medical errors and error reporting, improve safety, health and wellbeing, and professionals’ sense of productivity and effective practice.

1.2 Study Site

The hospital operating theatre is the site where this study was situated. The operating theatre was chosen as a site that is contained, and thus easily identifiable for in-depth, discursive and observational investigation, while the linked surgical unit’s gastroenterology spaces and wards offered a set of spaces where highly technical work and personal patient-professional discussions takes place, and where collaborative and harmonious teamwork is crucial to staff and patient safety, wellbeing and productivity. Operating theatres and their linked spaces and wards are also one of the most inaccessible areas in a hospital, making a challenging test-bed for spatial investigation, while the use of space is highly regulated within operating theatres to ensure sterile and safe environments for the workforce.

To elaborate, Fox proposed that there are three ‘circuits of hygiene’ in operating theatres that serve to protect the surgical space and those working within it – the instrument circuit, the staff circuit, and the patient circuit. These all help maintain the sterile environment, so that operations may be performed safely. The instrument circuit ensures that the route of clean and sterile equipment remains separate from the contaminated equipment. The staff circuit refers to the staff-only access points that regulate entry and exit to the theatres. The patient circuit is the limited access to patient holding rooms and the anaesthetic room. Fox argued that the architecture acts as a reminder to staff to follow sterile procedures; “it can be
‘read’ and contributes to the routines necessary for safe, sterile surgery”. While there is a growing body of knowledge about social relationships in operating theatres, we will use mobile methods (see 1.4) to explore a broader suite of issues, namely workforce health, wellbeing and productively, professional perceptions of workspace use and experience, and patient and professional safety. Good workspace design is key to the quality of people’s work, their safety, and wellbeing (health, wellbeing and sense of productivity), and yet the healthcare workforce, despite being a sector where effective function is crucial to national wellbeing, is rarely consulted about how workspaces should function effectively. Consequently, we lack vital knowledge about optimal hospital design in line with healthcare workforce needs, to impact positively on employees, and ultimately to deliver, high-quality, and safe care.

1.3 Conceptual Framework

In complex adaptive systems such as healthcare, WAD on the front line of patient care is always different from WAI by those who design and implement workspaces. WAD and WAI are concepts derived from the field of resilient health care. Assumptions about work being undertaken in the working environment are often misguided, because they are founded on a misunderstanding of the healthcare environment. Thus, WAI is how work is understood by those who are separated from it by time or space (e.g. policymakers, legislators, governments). WAI is typically a high-level and often overly simplified view of what is actually going on, in this case in a hospital setting, but does not account for the myriad small and large adjustments that health care professionals make in their everyday practice to get the work done. Due to misalignment between WAI and WAD, when rules are mandated or prescribed in terms of WAI, they can be difficult (or even impossible) to follow through by clinicians. WAD, on the other hand, within a hospital setting, is defined according to people’s actual perceptions of their roles, responsibilities and activities and considerations of what it takes to function effectively, despite fragmented, complex, resource-restrained and challenging circumstances in which they often find themselves. Understanding WAD requires an exploration of not only work practices and perceptions, but also systems and settings within which people work, individual and group work patterns, approaches to policy and practice, and aspirations for improvement. WAD in hospitals is frequently epitomised by the workforce’s struggle to ‘make do’ in unsuitable spaces. This struggle can lead to unsafe practices or personal concerns, even workforce demoralisation, and until hospital spaces are adequately matched to the needs of the workforce, this could continue to lead to expensive, impactful mistakes being made and a lowering of standards of care.

Studies on workspaces in Australia and internationally have overwhelmingly focused on the perspectives of clients or managers and executives, while the views and experiences of employees is under-
Rarely does research seek information from employees about their work environments, and little has been done worldwide to map healthcare landscapes in terms of productivity, safety and personal health and wellbeing. Furthermore, research on a human scale often prioritises questionnaires and focus group data, collecting information outside the workplace about workers’ self-reported attitudes and behaviours at work, rather than understanding work \textit{in situ}. Without immersion in the landscape, we cannot fully comprehend how people function, or understand WAD from the worker’s perspective.

1.4 Mobile Methods

Mobile methods is an innovative methodology that involves researchers undertaking data collection through observations undertaken ‘on the hoof’, often moving alongside research participants as they observe their day-to-day practices. They are useful for capturing the increasing mobilities of people, goods and objects as they traverse different spaces and settings. Through images, ideas and textual communications, they can offer innovative insights into people’s sense of identity, interaction, and power within organisations. Mobile methods are also used to describe organisational structures, adaptation and complexity. In this study, we focused on a narrow aspect of mobile methods called ‘shadowing’ where a researcher “follow[s] selected people in their everyday occupations for a time”, and in the process, where a researcher asks people questions, often on the move, while listening to them and observing what they do, when they do it, and who they speak and relate to. Shadowing allows researchers to describe and understand patterns of social, occupational and spatial engagement. Shadowing can be accomplished using a variety of forms of travel (e.g. driving, taking the train, or horse-riding), but in this study, we selected walking, for its slow, variable and flexible nature and as a result of its appropriateness to a hospital context. Shadowing allows us to understand the complexities of the surgical work environment, how it varies, how work is connected within and beyond the operating theatre, and how results are achieved.

There are several other advantages of shadowing. Firstly, shadowing allows a researcher to observe participants’ spatial practices \textit{in situ} while simultaneously accessing their experiences and interpretations of what is happening. This means a researcher can assess WAD in clinical workspaces because they can witness what people actually do in their everyday working life rather than what people say they do in experience-distant situations (such as in surveys or interviews). Secondly, mobility is such a pervasive feature of our lives, and is constitutive of modern medical work, where, for instance, a consultant surgeon may inhabit and transverse multiple spaces in order to conduct her/his work. Thirdly, because researchers engage participants \textit{in situ} and encourage reflection, mobile methods have the potential to initiate or advance professional growth and social change. Finally, shadowing is an educational technique as well.
as a research method, particularly in the medical and nursing fields. In a surgical context, for instance, a nurse trainee may be assigned to an experienced scout nurse whom he follows for a period of time in order to observe what the role entails. In this context, shadowing is the method used to ensure WAD is produced and reproduced between experienced healthcare professionals and newcomers. This means that the researcher holds a dual role; that of research participant, observing others’ work, and that of observer, walking in the footsteps of healthcare professionals, to examine how people function and learn about WAD. Thus, the method has the potential to generate deeper and more nuanced insights in the context of workspace use and professional practice, in comparison to other qualitative methods.

2. Method

2.1 Study Objective

The study sought to assess and interpret how spatial design of surgical workspaces influences workers’ productivity, health and safety, and to explore the perspectives of a surgical team on workspace-use and personal experience. The setting was one Australian private hospital’s gastroenterology team’s surgical spaces and linked spaces.

2.2 Aims

(1) Clarify how the gastroenterology surgical team (the ‘case’) arrange, traverse and share their workspace with others
(2) Reveal how different case members manage and perceive spatiality and the objects within surgical and linked spaces
(3) Disclose individual and team member views on WAI and WAD, productivity, health and wellbeing and safety
(4) Assess how enabling and disabling qualities of space affect WAD
(5) Define the complexities of the case, including the impact of gastroenterology surgical team workspace use and function on people’s lives

2.3 Study Design

This is a qualitative, intra-method study using: (1) in-situ observations of spatial use, (2) shadowing and informal conversations with healthcare professionals and patients (‘mobile methods’) and (3) the collection of images (photographs and architectural plans) of the spatial layout of one private hospital’s gastroenterology surgical team’s surgical and other workspaces. This study used mobile methods and visual data techniques to most appropriately describe and visualise spatial functionality. The study was conducted between June 2018 and April 2019.
2.4 Sample and Setting

The case site is a private teaching hospital located within the bounds of an Australian university campus, co-located with a university medical faculty, and comprising 182 beds, 12 operating theatres, 2 cardiac and angiogram suites and other facilities and amenities that are accessed by members of the surgical unit team (e.g. pharmacy, cafeterias and other leisure spaces, and a medical imaging suite). The hospital is privately funded, and considered an affluent, metropolitan organisation, which is dedicated to a culture of continuous improvement through research and education, making it an ideal pilot site for this study.

This study examined one small, fixed-member team, who offer a typical example of a gastroenterology team working in this setting, caring for a culturally homogenous, predominately English-speaking population. The composition of the gastroenterology team (including one to two consultant surgeons, two scout nurses, one scrub nurse, one anaesthetist, and one anaesthetic nurse) is typical of these types of hospital units and arrangements. The surgical team comprised one colorectal surgeon for relatively straight-forward procedures (colonoscopies or hernia repairs) however, for more complex cases (e.g. low anterior resection for rectal cancer), the team can involve two colorectal surgeons who work together. The case site is a relatively modern hospital (completed 2010), with cutting-edge diagnostic and treatment technology such as fully-integrated digital operating suites and electronic medical records. As a result, it is a good example of contemporary Australian hospital architecture.

This proof-of-concept, pilot study generated in-depth knowledge of one case, and by so doing, not only created research strategies transferrable to other settings, but also brought the hospital and the university staff into a stronger research collaboration. However, having undertaken the pilot, this now has the potential to be expanded to other units at the study site, and other settings and wards in and beyond the hospital in question, through shared knowledge and shared goals.

2.5 Recruitment Procedure

Group 1 Healthcare professionals

Healthcare professionals were recruited using purposive sampling. Prior to the start of the observation phase, the research team (FR, RC-W and EA) gave a full briefing of the aims, methods and intended outcomes of the study to the core gastroenterology team (including a surgeon, an anaesthetist, an anaesthetist nurse, a scrub nurse, and a circulating nurse), while other gastroenterology staff members were invited to attend the meeting if they wished, to raise any queries. At the end of the briefing, those willing to be involved signed a consent form. Healthcare professionals were recruited to ensure a wide
variety of observations could be undertaken of different professionals’ spatial use, perceptions of space and practice and working relationships.

Allowances were made for pilot work in relation to any incidental interactions during data collection with members of the wider gastroenterology surgical team (who were either not present at the meeting or were present but unwilling to consent at that time). It was agreed that were this to happen the hospital staff member in question would be verbally informed about the study when they came into contact with the study researcher and if they elected to participate, would be asked to sign a participant consent form, retrospectively. If they elected not to participate, however, they would not be observed as part of the study.

The observation phase of the study examined how staff members negotiated and moved through space alongside the gastroenterology team members who were being shadowed and their patients, to ensure that data collection remained consistent with the stated study aims and objectives. The researcher did not collect any information of a personal, identifiable nature, nor were any clinical details collected about patients and families from either direct patient contact or from their case records.

**Group 2 Patients**

While patients were not the focus of this study, it was clear that they would be incidentally observed as a result of the shadowing proposed with healthcare professionals, and as a consequence, a responsible recruitment approach was designed. Patients would be recruited using time-frame sampling so that during the study recruitment phase, the first 20 patients who were due to undergo surgery, who were aged 18 years or older, who were being managed by the case study team, and who were able to speak English, would be contacted in the order in which were to be put onto the surgery list. Time-frame sampling, whereby each person has an equal opportunity of being recruited over a certain predefined time period, ensures recruitment is undertaken according to the order in which participants agree to take part in a study. After being approached for participation, this method removes the opportunistic recruitment of patients, and any researcher or hospital selection bias. It is a valuable technique when researchers are unable or unwilling to predetermine the sample of patients who will be attending the hospital clinic at any one time and is useful for setting an important framework around recruitment. A dedicated clinical liaison officer undertook the recruitment and consent process on behalf of the study team in order to remove any researcher involvement until post-consent. In most cases, recruitment and consent took place prior to the scheduled day of a patient’s surgery as patients were identified on the clinical liaison officer’s list of
surgeries. On the day of surgery, the dedicated study researcher then introduced herself to the patient, verbally reconsented the patient and, when necessary, collected a signed study consent form.

### 2.6 Data Collection

**Shadowing and fieldnotes**

Mobile methods can provide useful insights into workforce experience of studied space, and in this case, how healthcare professionals perceived workspace enabling or hampering work practices and relationships. Understanding how staff members construct their workspace and consider these constructions as they attend to daily routines and interactions and how construction is related to movement through space is a vital element of clarifying workspace use, workspace experience (patient and professional), health and wellbeing, and workforce safety and productivity (Aims 1-5).

Mobile methods supported this assessment, enabling the researcher to move through space with others or alone, while watching and learning how surgeons, nurses, trainee doctors, students, anesthetists, administrative staff and others from the gastroenterology team interacted with one another, other hospital staff members, and patients. Mobile methods were undertaken by a dedicated study researcher (EA) for approximately 50 hours in total, at different times of the day, within the gastroenterology unit’s defined spaces and across to other spaces that team members used (such as leisure spaces and a cafeteria), to ensure naturalistic behaviours could be observed. This enabled a detailed examination of WAD, and the use and influence of space on people’s daily healthcare practices. This included how staff conversed with one another and with patients, and how staff interacted in and across a variety of rooms and areas. The spaces included: surgical theatres, a cafeteria, a lunchroom, wards, corridors, waiting rooms and meeting rooms. Consistent with mobile methods (as part of a suite of ethnographic approaches), data quality was strengthened through a rigorous recording process; brief notes were handwritten during shadowing, and then more detailed fieldnotes were typed up within a few days of the shadowing event.\(^{47}\) The data generated from shadowing was spatially contextualised in pictorial and written forms in order to take advantage of a mobile, place-sensitive method.

**Photographs, drawings and architectural plans**

The purpose of this component of data capture was to highlight the layout of the workspaces in question, variations between spaces (number, shape, location, size, and open and closed areas), comparing the look of different spaces, (for example communal and private), and noting spatial use (Aims 1, 2 and 4). The visual data were collected not as ends in themselves, but to supplement the fieldnotes and support the study researcher in acquiring a deeper and more layered knowledge and understanding of the areas she
moved within and across. The study researcher created drawings and diagrams showing spatial layout and function, obtained the architectural plans of the areas that participants worked in, and took photographs of shared and private spaces. This technique of undertaking a detailed visual investigation is in line with the team’s prior work in the area, including data gathering undertaken in primary and community care settings. Photographs and architectural plans allow for a better understanding of how participants see, think, feel and memorise experience. It is important to note that any images of individuals (healthcare professionals or patients) were de-identified or destroyed.

2.7 Data Analysis

Fieldnotes were analysed using thematic analysis techniques with two experienced qualitative analysts (primary and secondary) (EA and FR) working together to ensure the process was rigorous, to discuss major and minor themes occurring and their concomitant categories, and to arrive at a consensus opinion over any variance. Issues of significance were categorised, with recurring categories organised into common themes. The secondary analyst (FR) examined a sub-sample of data to ensure methodological veracity.

Photographic data and plans were subjected to their own discrete analysis through well-published visual data analysis techniques which build on some of the team members’ previous research. The team applied a predefined schematic framework (a visual taxonomy), designed to be used across a variety of healthcare settings. The taxonomy takes account of visual content and context, but also of object clustering and positioning. The taxonomy examines the ‘affect’ of data (the feelings to which the photographs give rise), the frequency of spatial presentations, the way objects and spaces function, and what photographs and architectural plans reveal about professionals’ working patterns. The photographs have been considered for the different social and professional practices they display and how settings reflect group and individuals’ workings.

Architectural plans and photographs were analysed by team members through group-work activity. Applying the visual taxonomy, photographs were compared and contrasted while the analysis of architectural plans indicated the frequency distributions of the relationships between percentage space use and spatial arrangement and assisted with an assessment of objects in space (distribution, frequency and clustering).

All visual and textual data were considered corroboratively to develop an in-depth understanding of the complete dataset, with no one dataset taking precedence. In this research report, the visual data analysis
and architectural plan analysis is not reported separately but within the comprehensive results section as a way of underpinning understanding of the mobile methods work. Data from the researcher’s fieldnotes were therefore considered to stand alongside the architectural plans and photographs, and to be of equal significance and interest. Key themes and categories derived from complete datasets were refined as data analysis continued.

2.8 Ethics Approval
Ethical approval for this project was obtained from the MQ Human Research Ethics Committee (Approval number: 5201800282). Governance was approved by the Health Clinical Research Executive (CRG2018005).

3. Results
The results are reported in six sections (see Table 1) including discussions of both fit-for-purpose and unfit-for-purpose spaces and spatial use. In each section, where results are presented, including those with verbatim quotations included, participants have been given an alias to protect their identity and uphold data confidentiality and the ethical principles surrounding the reporting of qualitative data. Some of the diagrammatic data and photographs taken by the dedicated study researcher have been included for reference purposes.

Section 3.1 describes the first theme identified in the findings; Theme 1: Spatial Reminders Through Objects in Space. Section 3.2 describes Theme 2: Accommodating Space. Section 3.3 describes Theme 3: Sterile and Contaminated Space. Section 3.4 describes Theme 4: The Alcove. Section 3.5 describes Theme 5: The Changing Dynamics of Space, and Section 3.6 describes Theme 6: Cold Space.

Table 1. Six Themes of Workspace and Practice in One Gastroenterological Surgical Unit

<table>
<thead>
<tr>
<th>Theme Number</th>
<th>Theme Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Spatial Reminders Through Objects in Space</td>
</tr>
<tr>
<td>2.</td>
<td>Accommodating Space</td>
</tr>
<tr>
<td>3.</td>
<td>Sterile and Contaminated Space</td>
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<tr>
<td>4.</td>
<td>The Alcove</td>
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<tr>
<td>5.</td>
<td>The Changing Dynamics of Space</td>
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<tr>
<td>6.</td>
<td>Cold Space</td>
</tr>
</tbody>
</table>
The data for sections 3.1 to 3.6 present the key concepts within each theme, with supporting fieldnotes indented. Results are reported according to the mobile methods approach, from the perspective of the observer (EA). In some sections, conversations and field notes are included.

**Fit-for-Purpose Spaces**

**3.1 Theme 1: Spatial Reminders through Objects in Space**

Signs and objects around the hospital ward can act as spatial reminders of where healthcare professionals have to be at any one time, and what they are expected to do in different sections of the hospital or the surgical ward. This is particularly relevant and useful for surgeons, given that their demands are so varied:

We wait for the elevator in order to travel down to the medical imaging, Arthur [surgeon] glances towards the doors to the recovery unit and the sign that sits above it and exclaims “oh!” His finger points straight up and signals to the left and Arthur strides towards the recovery door. We enter and see a patient and his wife waiting patiently. Arthur apologises and they discuss the patient’s post-surgery home care … We arrive at medical imaging and check Pam’s [patient] scans. As we wait in the hallway, Arthur tells me that he’s been thinking about my interest in space and that he “wouldn’t have remembered to go and see that patient in recovery, because although Eliza [scout nurse] asked me, no one wrote it down…”. I explain the concept of a dialogical relationship to Arthur, and wonder if such a relationship can occur outside of a person-to-person interaction, can the space itself tell you what to do next? This idea seems to resonate with Arthur, and he agrees “Yes, I had forgotten, but as we were waiting by the elevator, I saw the doors to recovery and that reminded me… The space reminded me!” (Fieldnote, 27 August 2018).

Space in this respect becomes more than an inanimate, unrecognised, or taken-for-granted part of people’s lives – it becomes the active ‘go-between’, between the healthcare professional and their duties and responsibilities, directing them purposefully in their journey through care, and playing a part in mapping out and directing their relationships with patients and other healthcare professionals.

Objects in space are also key to preparing staff for the role they are about to enact, and in providing a lead indicator of what tasks are about to come up so that they can be mentally prepared for undertaking those tasks. The elevator to the medical imaging suite, for example, and the changing room where staff dress in scrubs ready for the next operation all act as a reminder of the ways in which staff can mentally prepare, and thus adopt the right persona. As staff put on their scrubs or as the surgeon picks up the scalpel to
begin the operation a sense of quiet descends. This is accepted practice, enabling a different to the sense of space as noise levels reduce.

3.2 Theme 2: Accommodating Space

Given that the hospital is a private, metropolitan site, in a wealthy health system, the preoperative patient rooms are single and large, with attached bathrooms, while several areas are available to accommodate family members and friends. The privacy of this arrangement means doctor-patient conversations and examinations can occur easily and afford patients and families ample privacy, in comfort and without interruption. The sections below are examples of this, and the way that space, for patients at least, ensures private and sometimes complex and uncomfortable conversations take place between patients and healthcare professionals quite openly and frankly:

David [anaesthetist] asks Madeline [anaesthetic nurse] to: “keep an eye on the patient while his back is turned”. He says to the patient, who appears to just be waking up, “I’m going to take out your breathing tube now”. As he says this, Madeline automatically rubs the patient’s hand. I am standing behind the machinery, out of view of Madeline and David. Arthur can see me writing in my notebook and asks me what I’m describing. I tell him and he responds, “she’s old and frail, you can’t teach that you know”, referring to Madeline’s behaviour. David says, “How are you going, we’re just going around to the recovery room” (Fieldnotes, 14 June 2018).

We leave Theatre 21 and head towards the front desk where we run into Yvette [Arthur’s patient], her bed in the hallway is in line with the primary staff station. One of the nurses is gaining her written consent for the procedure. Arthur stops to introduce himself. She clings to the bedclothes pulling them closer to her body and appears slightly concerned. He asks, “Are you cold?” and she nods. Arthur disappears around the corner and retrieves a towel and white hospital blanket. He hands the towel to me and instructs me to hold onto it. He pulls down Yvette’s existing hospital blanket and folds the new one into a rectangle and lays it on top of her and then pulls up the existing blanket. He then takes the towel and wraps it around her head. She smiles and thanks him (Fieldnotes, 21 June 2018).

Yvette is wheeled into the operating theatre. Her bed sits parallel to the anaesthetic door. She looks frightened. About five staff surround her, they discuss her situation, asking her to roll from the mobile bed to the surgical bed but decide against it. She looks much too frail and
frightened for such a task. They decide to lift her instead. Yvette looks confused and Matilda [anaesthetic nurse] says kindly “Stay still sweetheart”. Yvette tries to sit up and Matilda says, “You don’t have to do anything, we’ll do it all”. The staff members hold a side of the sheet and she is quickly lifted into the air and onto the surgical bed. There is some fuss over her pillow arrangement, the pillow is moved from under her to a basket and then back under her head. Yvette feebly protests the fuss and Matilda insists she has the appropriate head support, commenting, “No you’re not, we want you to be comfortable” (Fieldnotes, June 21, 2018).

We return to the wards but stop to visit Rachel. Her husband sits in the chair to her right. Arthur introduces me to her, and I take a seat and so does he. Both Rachel and her husband smile at me warmly. Rachel sits up in bed, less than a meter away from Arthur:

A: “We’ve had a surgery run late, much later than we’d hoped. And because yours is an elective surgery I’ve come to talk to you about whether we should do it”.
R: “Oh…. No. But I’ve fasted and everything, and I know it’s elective but as soon as we said we’d do the surgery, I’ve been in so much pain. The last two weeks, I’ve had pain every day”.
A: “Hmm…. You see, my operating partner, Paul, who I usually do surgeries with has to go before your surgery, he actually has to get on a plane, he has a divided family and ….which has nothing to do with this but … so he has to go and so we can still do it but it won’t be as good”.
R: Oh, I really don’t want to have to wait.
A: And I really wanted to come in here and for you to look at me and tell me, “Oh Arthur you look so tired”.
R: “We did think this was a possibility, when we heard you were coming up on the ward to see us.” Rachel looks at husband who nods in agreement.
Husband: “We should discuss it, but my immediate thoughts are, if we’re going to do it, we should do it under the best possible conditions.
A: I can leave you to discuss it?
R: When would the surgery happen?
A: In two weeks, maybe, but I can’t promise anything.
R: Two weeks! I can’t wait that long.
A: We’d make sure you were the first person on the list, so this doesn’t happen again.
A: You’re probably going to be a bit angry with me when you leave… but we want it done right.
Rachel and her husband react in a neutral fashion to this statement. They make plans with Arthur for the upcoming surgery and he tells the nurse not to charge them for the current stay. They part on good terms, having accepted the unwelcome news. We return to the operating theatre and on the elevator ride he mentions his conference presentation. I ask Arthur how it went, and he says that some people loved it and told him so at the end and he felt others didn’t understand what he was talking about. I tell him that it’s not a result that I’m surprised by.

As Arthur enters Theatre 21 he says, “well I’ve convinced Rachel to delay her surgery”. Adrian [scout nurse] stands in front of us and raises his hands into the air and yells “YES”. He is clearly one of many relieved staff members to hear this news (Fieldnotes, July 5, 2018).

On Monday afternoon, as I stand behind the equipment next to Arthur who is furiously writing up his notes, I catch two of nurses (one who has participated in the operation and one who has not) who stop to chat. One comments on the anaesthetic nurses’ lip-gloss and she produces it, explaining that it is new. She removes the cap to reveal a pink hue. She offers it to the other nurse to smell, who exclaims with delight at the scent as if to affirm the well-selected new purchase. I note down the interaction in my book and Arthur momentarily looks up and asks me what is happening. I explain and he smiles and returns to his notes (Fieldnotes, 14 June 2018).

Space can be flexible and accommodating of not only the teams’ work, but also private and personal exchanges, as seen in the examples above of an exchange between a surgeon, a patient and a patient’s family, and on occasion, accommodates personal exchanges between healthcare professionals, though this is a lot less common. In all cases, accommodating spaces allow exchanges to be varied and run their course, moving, for example, from purely professional business to private and personal matters. Accommodating spaces can also be enabling. They can empower patients to express dissatisfaction with a service or voice their pain and disappointment in a missed operation. Furthermore, accommodating spaces can be inspiring, allowing for the hopes of speedy care delivery to actualise from dashed expectations.

There is the rare occasion when accommodating spaces allow staff to exchange confidences, such as in the example of the two gastroenterology nurses, who are comfortable enough within the surgical unit to share intimacies. In addition, accommodating spaces can engender negotiations between people, as they flex or stand firm on a particular point being made. In the case of the patient waiting for an important operation,
accommodating spaces are more likely to lead to accommodating decision-making, and in the case of the two nurses exchanging personal information, more likely to ensure a sense of sanctity within which to enjoy a quiet moment in time.

A ‘nice’ or well-appointed space may also serve to set the tone of discussions. In a ‘nice’ space, there is an expectation that discussions will be polite and respectful, and that there will be no disagreement or unpleasantness, including complaints about surgical or ward issues such as delays. This is reinforced by the style, tone and level of the healthcare professional breaking bad news, such as the postponement of surgery.

**Unfit-for-Purpose Spaces**

### 3.3 Theme 3: Sterile and Contaminated Space

Surgical spaces that the surgical team frequent were evidently mapped out in terms of areas that are sterile or unsterile. The staff members belong to either the sterile or the unsterile space, and these areas are indicated through clinical devices such as surgical instruments in both visible and less visible ways. All staff members monitor the sterile and unsterile boundaries between spaces so that transgressions do not occur. Staff members also demonstrate an awareness of the sterile and contaminated spaces in the way they perform their duties, and in their ability to contain their own body movements to the spaces to which they mainly belong. Moreover, staff members monitor garments or instruments in their possession to ensure they do not transgress these boundaries. They keep garments and instruments close to hand at all times, and by so doing, ‘claim’ them for themselves.

Maintaining sterile boundaries leads to a maintenance of areas pre-demarcated and agreed upon by the team as sterile within the surgical unit. This is not only important in ensuring patients’ sustained health and safety, but also in ensuring tight team management of space and the management of the team’s physical proximity to one another and distance from each other:

The washing process takes 5 minutes or so. As the surgeon washes, a satisfied grin spreads across his face. I ask Arthur: “Is there something mediative about it?” “Yep… it’s warm too” he replies. Arthur first washes his hands thoroughly, and then his arms, up to his elbows. He holds his hands upwards as he washes, rewashing his hands and elbows 3 or 4 times. It seems excessive, but I have read about a surgeon’s elaborate washing rituals before, and so I am unsurprised. He then uses a small plastic pick to scrape quickly but thoroughly beneath each nail. His nails are so short that little dirt could hide underneath them. We discuss cosmetic
surgery and he tells me that Frank [a cosmetic surgeon whom we have just met] loves noses and would have enjoyed straightening Alma’s nose. I ask him if he’d enjoy the process, whether that patient was male or female” and he says: “Yes, I think so, he just loves noses”. When he sees me watching him, Arthur comments: “You have to get into all these places you wouldn’t usually wash”. After cleaning his nails, he spreads out both set of fingers and using the other hand, scrubs between each finger. The sink is large enough to accommodate such a process, it is broader and deeper than a typical sink and the shelves do not jut out, so Arthur has the height to move his arms up and down and side to side comfortably (see Image 1). He clasps his hands together at the end, and moves his interlinked arms across the steady stream of water to ensure all the suds wash away. His elbows are at a forty-five degree angle and his hands are situated a little higher than his elbows. As the water runs down his arm, some it is making its way into the sink and the remainder onto the floor. Arthur tells me: “When I’m doing ‘bottom things’ I don’t bother with the full wash”. He points to the wall: “Usually there’s a sign telling you how long to wash for”. Hands still clasped together, he taps his elbow on the large, flat button to the right of the door, and the door swings open to Theatre 21 (Fieldnotes, August 27, 2018).

Arthur exits from scrubbing up, he uses his foot to push open the door, holding his wet hands together, as if in prayer, and strides across the room to retrieve a small blue cloth from a silver table to the left of the anaesthetic room doors. His steps are purposeful and fast-paced and command a sense of authority, as if no one is to step within his path. He spends a good half a minute drying his hands, wiping in between his fingers. He holds the top end of the gown and with one firm stroke, the gown unravels quickly. Although I have seen Arthur do this several times before, this always appears a dramatic and theatrical aspect of surgical preparation which takes place next to the silver tray between the anaesthetic area and the exit doors. Only Arthur inhabits this space, except for the moment when he has his gloves on and needs a nurse to fix the gown at the back of the neck and middle of his back. This job does not
fall to any one nurse, however, and is a task that could be taken on by an auxiliary nurse, a surgical nurse or one of the two scout nurses. (Fieldnotes, July 5, 2018).

One of the scout nurses is altering something underneath the patient’s bed and Piper [surgical registrar], with her arms outstretched in front of her body and in a sterile uniform says, “Can we please have access?” The scout nurse’s head pops up and she quickly dodges to the side. Piper makes her way to the right-hand side of the patient’s bed. She turns to Arthur and says: Do you want to start here”? He replies, “No you start there”. They debate this for a minute and in the end, both remain stationary in their original positions. Arthur tells me: “That’s us, negotiating who’s going to be the primary surgeon”, he adds, “Piper has lots of experience with this type of surgery” and I see that the harmonic [scalpel] is in Piper’s hand (Fieldnotes, July 12, 2018).

David, Matilda and Madeline [three of the team members] stand over near the entrance doorway in a semi-circle, they look at ease, chatting about non work-related topics, having little else to do. They wear their blue coats loosely, as Sophie [trainee scout nurse] does today, once the patient is incubated, they have no reason to go near the patient’s body and maintaining sterility of the space is not their priority. David and the auxiliary nurses may rotate the bed, replenish the drip as the surgery progresses, and monitor the machines in the corner of the room, but they are located well away from the surgical instruments and are unlikely to come into contact with the sterile sheet. In contrast, the scout and surgical nurses are constantly dealing with the issue of sterility. The scout nurses live on the boundary between the sterile and contaminated areas and their actions, and use of space, reflect this fine line (Fieldnotes, July 12, 2018).

The theatre is particularly cold today, perhaps because we’ve been standing for almost five hours now. Jenny [scout nurse] has a long-sleeved, navy blouse over her scrubs which is tied at the waist. I look around and realise that all the (female) nurses are wearing their uniform in this popular, late nineties style. I ask Jenny where these tops are stored and why she is wearing it in this manner. She tells me that they are available in the women’s changing rooms and that she wears it this way because then her top does not touch the sterile area. To make her point, she undoes the tie and the shirt flaps around loosely. She adds, “the buttons also don’t really do up, they always pop open”. I take a closer look, they are indeed the feeble silver clip buttons which seem to be of poor quality. She undoes a few and she tries to do
them up, she is surprised by the few that stay fastened but about half do not stay in place, she re-ties her shirt (Fieldnotes, July 5, 2018).

I stand next to Jenny who is wearing her blue overshirt open rather than tied at the waist as it was the last time we spoke. I ask her about it, and she chuckles, saying that I’d got her thinking about it. She tells me that they’re overstaffed so she is not doing much of the active scout nurse work today (Fieldnotes, July 12, 2018).

While sterile and contaminated spaces are clearly predefined, by both people’s actions (such as the use of instruments) and activities that take place within them (such as the operation), members of the team are constantly making autonomously informed decisions about the way they, and the sterile and unsterile spaces they frequent, should be managed. This includes how to wash, what to wear, how to avoid certain areas or aspects of space, and how to uphold sterile practices. Staff also decide which actions to avoid and when more flexibility needs to be built in to their work regimes. How people act, behave and consider these issues, and the amorphous nature of how considerations change, along with people’s response to the situation in hand at any one time, enables people to adapt to, and control space. However, when this is out of kilter with the changing needs and expectations of the unit as a whole tensions rise, and there is often a fine line, a mark that cannot be overstepped, for harmonious, good working relations.

### 3.4 Theme 4: The Alcove

The surgical theatre contains a narrow, small alcove at the back of the room where Arthur has a stool and a makeshift desk to support his laptop (see orange highlight in Image 2). After surgery, he sits there quietly to write up his surgical notes, communicate with other healthcare practitioners about his surgical findings and observations, and complete a range of administrative tasks (see Image 3). Prior to surgery, Arthur uses this alcove to review patient notes and communicate with his surgical partner (surgery in this team is undertaken by a surgeon-pair). His reviews, and the use of this space relate to his writings about surgical findings, research matters, an upcoming surgery or private matters.

The structure, size and location of the alcove affords Arthur

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Image 2. Architectural plan of Theatre 21
some (though not complete) privacy, and relief from staff interruptions:

Arthur takes a quick phone call between surgeries about a topic unrelated to the operation. This is conducted in his corner, the alcove, where his two computers reside, and the monitors mostly shield him from the view of others. It acts as a makeshift office within the theatre. He uses a low metal table (otherwise used for surgical procedures) as his desk. Spread across it, he has a clean small white towel which is almost the perfect size but hangs a little at the front. His laptop sits off to the right and this is where he sits and writes up his notes about the surgery or other matters. Although he is generally a chatty, vibrant man, it is common knowledge whilst an unspoken rule that he is not to be disturbed during his writing time. In this space Arthur is bounded by quietude, his back facing the entrance means he is bounded within and by the space and emits an attitude of ‘do not disturb’. Behind him, the scene transforms from a quiet to a busy space – for a period of time, the operating area of the room is somewhat deserted, but this can quickly change. Arthur often sits in the alcove, either devoted to writing up his notes from the operation or drafting letters to general practitioners (from the private or public healthcare system). He also spends time taking calls (both personal and work-related but rarely operation-related) (Fieldnotes, June 14, 2018).

I stand next to Arthur and I am careful to say nothing, I know he is busy writing up his notes. Amalia [surgical nurse] comes to talk to him and asks Arthur to sign a medical certificate to acknowledge the completion of the surgery. Five minutes later, Sophie [trainee scout nurse] comes to tell him that he needs to see Mr Allen [patient] on the ward. After she leaves, Arthur says: “It’s worth noting that … The constant interruptions, it’s irritating, but they won’t see that” (Fieldnotes, July 5, 2018)

Bounded space has a vital role to play in the personalisation of the surgical team environment. While bounded space is rare, when it is in evidence it is a useful device for establishing hierarchy. Within the
alcove, the surgeon is ‘king’. He can create a recognised distance between himself and his team, even through body-language, if not a physical border, and while indicating who is in charge and what role divisions entail bounded space upholds the need for rules and regulation. However, whilst bounded space speaks to hierarchical establishments and the quietude and respect senior figures expect, without a physical barrier, there are always opportunities for boundaries to dissolve. The distance between people and spaces is forever being tested, often foreshortened, and even here, within the boundary of a quiet, personalised alcove, interruptions can occur.

3.5 Theme 5: The Changing Dynamics of Space

During surgery, staff members beyond the core surgical team frequently enter the ward’s theatre space through the “exit door”. They do this to seek advice from the surgeon or surgeon-pair, to gather information about the current surgery, or for purely social reasons. In most cases, additional personnel entering the surgical space in this way is a temporary interruption and non-problematic. However, when other staff members enter the surgical space, during challenging surgeries, that demand additional concentration or quiet, the space becomes overcrowded and noisy, it can lead to core team members becoming distracted. This means requests for equipment or assistance cannot be heard. In raised voices, the surgeons ask staff members to be quiet so that they can concentrate and make audible requests. The dynamics of space also changes where surgeons conduct paired surgeries. Then surgeons are often more removed from other staff members talking together and depending on one another to a greater extent than on other team members:

While performing the colonoscopy, Arthur brings up various topics of conversation including the television show: *Call the Midwife*. Arthur, David and I discuss the show briefly, and Arthur tells me that he and David have a crush on nurse Jenny [the protagonist in *Call the Midwife*]. Arthur and David tease me as I write my fieldnotes and ask me if nurse Jenny will end up in them (which she, of course, does). Our light-hearted and at times playful conversations are typical of what I have come to observe in surgery over the past few months, in the context of routine procedures like colonoscopies. The informality today also exists because after several months of observing the staff members seem comfortable having me around. The act of taking notes, however, still makes the staff members somewhat nervous and self-conscious, and this discomfort is often verbally expressed (Fieldnotes, August 27, 2018).
Arthur and Paul [surgeon] talk to each other constantly throughout the surgery, but it is difficult to hear what they’re saying. They only raise their voices when a request is made to another staff member. Although we are all in the same room, the dynamics of the team is different today. There is an absence of social conversation and Paul and Arthur talk primarily to one another, except for when they require something. For instance, Paul says: “David, can we do a body roll please? …body roll.” Soon after, Arthur requests: “Can that screen go down please… Sophie…” I notice that although both Amalia and David are in close proximity to Arthur and Paul, they are not included in either the social or medical dialogue as has occurred before (Fieldnotes, July 5, 2018).

David receives a work-related phone call and after thirty seconds or so, Arthur interrupts him and requests that he moves outside. Sophie and Louise [scout nurses] sit next to one another in the corner to chat, and Louise points to the computer a few times. Arthur stands parallel to the patient, watching the monitor, and Paul stands in between her legs. In a loud voice, Arthur says: “I don’t know what you’re talking about, but can you guys stop talking over there?” Offering an explanation, Paul adds: “It’s turned into an intense surgery”. Louise responds, “It’s about work stuff”. Arthur is holding the harmonic but asks Paul in a lower voice: “Do you want to operate?” Paul replies no. I stand opposite Arthur, off to the left of the screen he is looking at. I have become accustomed to the beeping noise that the harmonic makes when it cuts and cauterises the tissue, but the instrument suddenly makes a more forceful sound, almost like an ambulance. I am surprised by the noise and even though my mouth and nose are covered by the mask, my change in affect must have been somehow noticeable. Arthur asks me, “What’s wrong?” I’m surprised by the question because my reaction was fleeting, and, I had presumed, safely concealed beneath my mask. I respond quickly, referencing the change in the harmonic’s noise, and he seems satisfied with this answer although it is clearly not something that he himself had noticed. In an educative manner, Paul comments that the noise changes when the harmonic takes longer to cut through the tissue. Five minutes pass and Sophie and Louise begin to chat again in low voices. Arthur responds almost immediately, “I know I’m sounding like a real dick and I know you’re whispering but I need to NOT see you guys talking out of the corner of my eye. I like people to be happy but it’s distracting. If you need to talk, talk behind me, not in my eyeline”. The nurses stop immediately and remain silent. I feel embarrassed for them but not particularly empathic – I wonder how they could have not noticed how tense Arthur is today, how long the surgery is
lasting, and the drawn-out, indecision between the two consultants within the altered environment (Fieldnotes, July 5, 2018).

After participating in a complex six-hour, unfinished surgery, Arthur and I travel up to the ward to visit Margaret [patient]. Margaret stands in close proximity to Arthur and pulls up her top to reveal a colostomy bag. He asks her to cough and he feels her abdomen, she begins to tell him all the symptoms she’s been experiencing, her facial expressions downcast. Arthur listens patiently for thirty seconds or so and then interrupts, “Margaret, I can’t do this now. You’ll have to make a booking in my clinical rooms and see me privately on Wednesday, we’ve had a big day in surgery and I’m having to say no to everyone today.” She reiterates how much pain she’s experiencing but agrees to the consultation. As we leave, she follows behind us and admits she was nervous to book with Arthur. Margaret’s neediness strikes me. For the first time, I see the weight of responsibility baring down on Arthur. He no longer looks bright and energetic, and he walks as fast as usual; I suspect not in haste to get to his next patient. He tells me that we are not going to the lunchroom (situated next to the surgical theatres) to eat today, that he needs something more “substantial”. We head to the downstairs cafeteria and while I am filling up two glasses of water, he orders us hot chocolates and toasted sandwiches…With lunch in hand, Arthur heads for the glass doors which leads to the outdoor tables fashioned with white umbrellas. It appears to be a strange choice for a winter’s afternoon, but the absence of others makes me think that the seating location is purposeful. To my surprise, the sun offers some warmth and we change seats to ensure that we are exposed to the heat but not blinded by the sun. We spend twenty minutes or so engrossed in conversation about qualitative research, how he met other academics in the study team, and my research trajectory. Arthur comments again, “I don’t know what you’re getting out of this, I don’t know what you’re seeing”. Then he asks me, “what are you looking for?” I say that I’m not completely sure, that there is no hypothesis like there is in a quantitative research study, and that I’m waiting to see what strikes me as interesting or important or raises questions”. Arthur tells me that we could have shared lunch (as we usually do) but on our plates I see hardly any leftovers and realise how ravenous we both were. After another twenty minutes Arthur tells me that his internal alarm clock is going off and that we must return to the theatre. I have not finished my lunch, so I quickly eat the remainder of my sandwich and take a last mouthful of hot chocolate (Fieldnotes, July 5, 2018).
Within an ever-changing dynamic, use and experience of space changes. Different groups of people and individuals conceptualise space in their own way, from those with hierarchical presence, the consultant surgeon, or paired surgeon, to those temporarily entering and exiting the surgical theatre – the supportive nurse or anaesthetist, the porter or member of a different staff team, using the entry and exit routes as walkways, and in the case of this research study, the mobile methods researcher, using the entry and exit routes to conduct observations and write notes. In each case, the conceptualisation of space can differ, thus raising and lowering expectations, and confronting people’s understanding of what is at stake in the use and management of space. The more people use the same space, the more likely that disruptions to regular work practices will occur, leading to greater disjuncture in working habits and work relationships, and the greater likelihood of irregularities or mistakes being made. When two surgeons work together, side by side, or when one surgeon is experiencing the intensity of an operation, the stakes are often higher. Then space closes in; and the dynamics of the use of space becomes more rule-bound and regulated.

For the individual surgeon, whose focus must necessarily narrow as the practical phase of the surgery begins, the larger space and its noisy activities can become a distraction from the task at hand. Then it is particularly important that the use of lighting, placement of the instruments and use of internal cameras can assist surgeons to keep focussed. Furthermore, it is critical that surgeons at these critical times feel the maximum effect of a useful and supportive physical location.

When spatial dynamics change, particularly at the periphery of the operation, where people’s entry and exit from a theatre can make spatial use a more transitory and less formalised affair, it is often the case that the space immediately surrounding the operation becomes less casual and more intense. We see examples of this in this study, when on a number of occasions, a surgeon needs to exert his authority so that staff abide more rigorously to the demarcation of space. Yet spatial-use and team expectation is a rapidly changing feast. An ever-changing spatial dynamic will continue to ensure that people behave and react in unexpected ways, exerting their individual personalities to continuously test the boundaries of spatial requirement, with unexpected circumstances leading to unexpected spatial consequences.

When surgery is over and one of the surgeons and the researcher meet to relax, space expands. Then, space become less intense, and within a welcoming environment outside the immediate domain of the operating theatre and surgical ward, while faced by a sunny outdoor cafeteria, two different individuals share space casually. As a result, conversations take place that would only be enabled in this context.
In between the intensity of the theatre and the laxity of the cafeteria sits the mobile spaces that surgeons and other staff members frequent. These are the places where patients reside, where they wait, reflect, recuperate or consider their surgical options. These are also the places where team members and other hospital staff enter and exit the ward. The dynamics of these mobile spaces afford certain freedoms. They enable purposeful decision-making to take place or the aimless passing of time. They allow for direct interaction or indirect removal from others’ company. Here mobile and more dynamic space serves a purpose, encouraging movement, a direct interaction with a patient for a set period of time, or the removal of oneself from direct interaction, the dipping in and out of numerous conversations and responsibilities.

3.6 Theme 6: Cold Space

The surgical theatre is a cold space (in physical terms). The temperature is kept at a minimum, in order to adhere to the regulations of surgical procedure laid down by the hospital site. However, the cold space appears to affect most staff members and even some patients, with the placement of an air-conditioning unit directly above the surgical table appearing to create particular discomfort for Arthur as he operates (see Image 4). Arthur often wore small towels or pieces of cloth around his neck to keep himself warm, and would, on occasion, move the overhanging lights so they could sit between his head and the air conditioning unit and thus act as a shield against the cold draft of air:

As Arthur performs the coloscopy, he returns to his discussion about motorbikes, and tells us that he once owned a Yamaha 360: “I still have dreams about it, it was smooth”. Arthur shivers and looks up… in an irritated tone he says, “I’m right under the…” He holds the colonoscope with one hand and reaches up with his other to pull across the large light which now shelters him from the cold air pouring out of the air-conditioning directly above him (Fieldnotes, August 27, 2018).

In this theme we note that space is not always welcoming and supportive. Indeed, space can be an obstacle, an intrusion, with disabling features and qualities. Space can work against team functioning, can create a barrier between people and their productive working patterns, and can instil tension in a team at
the most critical moment in teamwork. When space is intrusive, its intrusive qualities cannot simply be ignored, and the team must look for creative ways to manage space more effectively, often relying on ‘workarounds’ to enable them to overcome the problems that spatial intrusions create, and in order for them to continue working alongside one another.

4. Discussion

Arrangements of fit-for-purpose and unfit-for-purpose workspaces, and their effects on health, wellbeing and productivity, as well as their impact on safety, workspace-use and experience highlight important considerations in hospital workspace design. Our six themes (spatial reminders through objects in space, accommodating space, sterile and contaminated space, the alcove, the changing dynamics of space, and cold space) illustrate important aspects of workplace design that impact performance and safety for surgical teams and their patients.

The importance of spatial objects within the workspace as cognitive aids and preparation cues appears to have been previously under-recognised in the healthcare literature. Cognitive aids are important prompts to ensure that users complete a designated task. The importance of physical objects as memory aids has long been recognised in safety-critical industries such as aviation. However, in healthcare, evidence for the usefulness of cognitive aids for successfully completing complex tasks is mixed. Aide memoires have been successfully used in surgery to improve record keeping. However, to date, aid memoires and cognitive aids appear to be limited to written objects, such as documents or checklists. Our finding that spatial objects act as memory cues when preparing for surgery, and also as a form of mental ‘grounding’ to prepare surgeons to enter the surgical role, is novel to healthcare research, and has been hiding in plain sight. Further research is needed on how this occurs, which aspects of design are important, and how to leverage design to improve cognition and performance.

From the field of human factors, we know that the design of workspace constrains the way that work can be enacted, whether in healthcare or other industries. Furthermore, we know that flexible workspace design is effective among knowledge workers. Studies in Emergency Departments and Critical Care Units have shown that workspace design can improve communication, teamwork and security, and that accommodating spaces are more pleasant to work in and can encourage patient and family participation in care. Dean et al. contend that the increasing reliance on teamwork in healthcare requires new thinking about workspace and how it is configured in hospitals. Our findings, that accommodating spaces can support team working and positive clinician patient interactions, add to this body of evidence.
The surgical space is mapped by the invisible boundary between sterile and contaminated space. The sterile space is such an important aspect of surgery that its maintenance has become associated with rituals.\textsuperscript{59} We found that handwashing, for example, was both necessary and also an important ritual that enabled the experienced surgeon to relax into the comfort of the surgical space and adopt the calm, professional persona necessary to perform the operation.

We found the division between sterile and contaminated spaces to be used as a proxy for other boundaries: for example, the workspace of the surgical team versus the space of other hospital clinicians, the ‘core’ work environment versus the ‘non-core’ workspaces, such as offices or recreational spaces. Sterile and contaminated spaces have the potential to be used as a form of control – a way of denoting in-group relations (who may be privileged to inhabit the sterile space and who is out of favour), as well as the position denoted by certain spaces, that less privileged groups of people such as visitors, porters or other healthcare professionals and researchers must inhabit. These are the people who must ‘stay over there’, at the periphery of the sanctity of the precious operating spaces. Using space in this way is not unique to healthcare: in aviation, there is a strong demarcation between the flight deck and the aircraft cabin. Rules about who can enter the flight deck and when (exacerbated by security issues since ‘9/11’), serve to maintain control and status in favour of the pilots.\textsuperscript{60, 61}

In addition to the division between sterile and non-sterile space, we found that bounded space played an important role in the surgical team’s functioning. Rather than being a part of the formal operating theatre design, however, bounded space had to be artificially constructed to meet the needs of individuals within the team (e.g. the alcove). Having a piece of one’s own space has been found to be associated with increased feelings of commitment to an organisation, but claiming space within shared workspaces can also be seen as negative territorial behaviour by co-workers.\textsuperscript{62} This suggests that, for most effective team functioning, it would be preferable to formally create individual workspaces where required, rather than forcing team members to create their own spaces for individual work in areas that others might perceive as theirs. This can even extend to the perception that space has been purloined for another’s use.

We found that the changing dynamics of space, as members of the surgical team moved through the hospital, influence the way that work was enacted, and the tenor of work communication. Spaces such as corridors, that are not traditionally ‘owned’ or occupied by either doctors or nurses, have the potential to disrupt the normal hospital hierarchies.\textsuperscript{63} Our participants were less constrained in these spaces, allowing for greater variation to be exhibited in WAD. Greater variation in individual behaviour in the common spaces also resulted in a larger number of, and less predictable, encounters between staff members, and
staff and patients. While there were potential benefits to the increased interactions, there were also associated distractions and disruptions, giving rise to greater potential for error and/or conflict.

Within the operating theatre itself, environmental factors were found to be an important contextual factor for WAD. The physical requirements of the operating theatre, such as temperature and airflow, are designed in accordance with guidelines to minimise the transmission of bacteria that can lead to surgical infection. From the International Society of Infectious Diseases’ guidelines for infection control in the operating theatre,\textsuperscript{64} we learn that: “Ventilation of ORs should filter air at a minimum of 20 air changes/hour of which at least four changes should be with fresh air. If resources allow, this air should be high-efficiency filtered (HEPA). The temperature of ORs should be kept between 68 F (20 C) and 75 F (24 C), with humidity of 20% to 60%.” Temperatures of between 21 C and 24 C are considered to be appropriate temperatures for deskwork.\textsuperscript{65} However, as we did not record the temperature of the room at the position of the surgeon during our study, we do not know if the temperature was within these limits. As temperatures decrease below 21 C, vasoconstriction can reduce fingertip sensitivity and speed of finger movement\textsuperscript{65} – both of which might be considered important for surgery. While we did not observe this in our participants, at least one surgeon was sufficiently bothered by the cool temperature that he was led to wear additional clothing and employed a workaround to avoid it. It should be possible to design the theatre environment to provide a comfortable working environment for the surgeons, either via alternate placement of air-conditioning ducts or through provision of suitable protective clothing.

In this study the gastroenterology team’s use of surgical theatres, clinical and non-clinical spaces were illustrative of the way that people manage their working lives. The study data indicated how people can be negatively affected by unfit-for-purpose spaces, with workarounds demanding more time and ingenuity to carry out even the most routine functions. Data also indicated the need to creatively expand spatial options, so that alcoves become offices and theatres become walkways, not only to ease surgical patient throughput but also for more general professional access, enabling people to function effectively while moving fluidly from one space to another.

While new habits and approaches can help staff circumvent the negative implications of unfit-for-purpose spaces and inappropriately-placed objects within them, they can also lead to unexpected consequences. These include, staff regularly ‘rewriting the rules’, talking during difficult operations, crossing sterile boundaries and sharing confidences in unexpected ways. This can also lead to staff going ‘rogue’ – making autonomous decisions, reinventing spatial layout, redesigning the functionality of different spaces, and adapting clothing for more sustained precision medicine practices, such as those taking place in the
operating theatre. Only through adaptation and flexibility, within the setting where unfit-for-purpose spaces abound, can everyday working practices be maintained. However, it is important to note that ongoing adaptation must also be coupled with ongoing awareness of the safety implications of any workarounds for effective performance.

4.1 Implications for Research
This is the first Australian case-study of this type. It is the first time we have enrolled a Gastroenterological Surgical Unit examining workspace and practice, and the first study to apply this mix of methods within the Australian hospital’s ‘built environment’. Our findings are available to contribute to: a) stronger knowledge transfer between researchers, healthcare professionals and hospital managers (exchange and synthesis of ideas), b) new understandings of spatial design and organisational productivity, and c) clearer recognition of the strengths and weaknesses of different spatial arrangements from the perspective of healthcare staff. The insights generated offer ways to create a more productive hospital workforce, and safer and more fulfilling work environments for clinicians.

The study is significant in investigating the use of mobile methods to understand WAD and has the potential for a new method in resilient health care research. Internationally, the field of resilient healthcare is in its infancy in terms of methodological development, in particular in deriving suitable methods for understanding WAD by clinicians delivering patient care. We have shown mobile methods to have a place in the toolbox for investigating WAD, and in enabling collection of objective data to contribute to our understanding of how clinicians make small and large adjustments to successfully achieve desired goals in their everyday work.

This work provides baseline data from which to develop future research in the field. A larger, multisite study would have the capacity to produce a set of clearly-defined quality improvement measures (QIMs) for hospital design to drive positive change. QIMs will be a practical output for a larger, multisite study, that has the potential for national and international impact. By optimising workspace for more productive and empathic working practices, reducing healthcare workforces’ stressors, and enhancing staff members’ physical and psychosocial wellbeing, the work promises to afford patients and healthcare professionals safer healthcare environments.

4.2 Implications for Practice
Our findings help to clarify the role of workspace design in the everyday work of a surgical team. We have illustrated how seemingly inconsequential design choices, such as positioning of air-conditioning
outlets, can affect the well-being of surgical team members and potentially impact on performance. We have also seen how, if we do not design workspaces to meet the needs of clinicians, they will employ workarounds that may be successful in solving immediate problems but may present longer-term difficulties in terms of standardisation of practice. By designing safe and harmonious work environments that support team communication and movement, we aim to build environments where surgery can function in an effective and safe manner.

4.3 **Strengths and Limitations**

This was a unique proof-of-concept pilot study, and the first of its kind to be undertaken in an Australian hospital context, employing mobile methods to enable a named researcher to get close to a specialist gastroenterology surgical team, and to investigate first hand its work patterns and work relationships. However, the sample size (one small, fixed team with the study researcher primarily shadowing one team member), and single site location (a private, affluent, metropolitan hospital, serving a homogenous population group) limits the scope of the findings.

5. **Conclusion**

Arrangements of fit-for-purpose and unfit-for-purpose workspaces, and their effects on happiness, health and productivity, as well as their impact on safety can highlight important considerations in hospital workspace design. We offer several recommendations, including the construction of smaller, more adaptive and protected workspaces within surgical units, adjusting the design of hospital attire to suit theatre temperatures and sterility purposes, and the relocation of air-conditioning units. This study also illustrated how the innovative mobile methodology is an effective tool for investigating WAD. The mobile methods methodology offers a clearer understanding of what workforces are actually achieving in hospitals and enables the formulation of recommendations for hospital design to transform hospitals into better-quality, safer places where teams can work more harmoniously; happy in the knowledge that the spaces in which they perform their duties are fit-for-purpose.

6. **Recommendations Resulting from this Study**

The results of this study have highlighted several key areas that require further research and development to improve productivity, wellbeing and safety in a gastroenterology workspace. Three recommendations are outlined below, along with suggested future research strategies. As a result of the mobile methods work undertaken in this proof-of-concept, pilot study, we would recommend the following:
6.1 Recommendation 1:
Construction of small, adaptable and protected workspaces within theatres that surgeons and other team members can use for a variety of activities, including formal or informal communication and private conversations, note-taking and emailing. This suggests greater use of multifunction areas, where surgeons and other team members can find both space for wide-ranging, multi-disciplinary communication, and temporary privacy, amid a busy surgical setting.

Workspaces far from surgical theatres such as university offices are inconvenient locations for note-taking or impromptu discussions. Instead designers need to focus on providing small, easily adaptable spaces within a surgical team’s immediate locale that keep staff visibly connected to one another, yet at the same time acoustically separated, which are adaptable to use for a variety of activities.

6.2 Recommendation 2:
Mandatory hospital-supplied clothing such as surgical jackets that are adapted to fit the purpose for which they are designed, these could be more tightly-fitting, for example, with functional buttons, to ensure that the sterile-contaminated boundaries of the surgical space are maintained.

6.3 Recommendation 3:
The placement of air-conditioning outlets could be more carefully thought-through; while designers could take into consideration staff members’ comfort levels, particularly in relation to the demands of their everyday work (e.g. the extended duration of complex surgeries and therefore the extended exposure to cold conditions).
7. References


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