


# A new children's hospital with a larger floor space, single rooms, and V-shaped ward design: A pre–post evaluation of nurse time providing patient care and nurse, patient, and family experiences

Journal of Health Services Research & Policy  
2023, Vol. 0(0) 1–11  
© The Author(s) 2023  
Article reuse guidelines:  
[sagepub.com/journals-permissions](https://sagepub.com/journals-permissions)  
DOI: 10.1177/13558196221146658  
[journals.sagepub.com/home/hsr](https://journals.sagepub.com/home/hsr)  


Fenella J Gill<sup>1</sup> , Helen Nelson<sup>2</sup>, Natasha Bear<sup>2</sup>, Mary Tallon<sup>3</sup>, Catherine Pienaar<sup>4</sup>, Jade Ferullo<sup>2</sup> and Sue Baker<sup>2</sup>

## Abstract

**Background:** The impact of hospital building design on patients, families and nurses related to nursing care interactions is not well understood. This study reports a pre–post intervention study to understand the effects of the move to a new children's hospital in Perth, Australia, on nurse workflow activities and on patient, family, and nurse experiences.

**Methods:** We used a pre–post explanatory sequential design involving observation of nurse work tasks; measurement of the Practice Environment Scale and Nurse Work Index; weekly surveys of nurse, patient and family experiences; and nurse focus groups and interviews with patients and families. Survey data were analysed using linear regression; qualitative data analysis used a thematic approach.

**Results:** Nurse time spent walking almost doubled ( $p < 0.001$ ), from an estimated 10 min at T1 (pre-move) to around 20 min at T4 (12 months post-move), but there was no difference in nurse time providing patient care ( $p = 0.114$ ). The Practice Environment Scale and Nurse Work Index showed significantly reduced scores for nursing foundations for quality of care (adjusted mean difference  $-0.08$ ,  $p = 0.016$ ) and staffing and resource adequacy (adjusted mean difference  $-0.19$ ,  $p < 0.001$ ). This fall was mirrored in nurse experience surveys with a reduction in mean scores from T1 to T3 (3 months post-move) of  $-0.7$  ( $p < 0.001$ ) and from T1 to T4 of  $-0.4$  ( $p = 0.002$ ). Thematic analysis of qualitative data found that initial challenges appeared to reduce over time. Nurses reported difficulties managing workflow in the new wards and feelings of exhaustion at T3, but this changed to more positive accounts at T4. For patients and families there was a tension between leaving the old and familiar, enjoying the light and space of the new and shared observations that nurses appeared to be busier at T3. At T4, these experiences had changed to 'being a family in hospital' and confidence that a nurse was always close by.

**Conclusions:** Both benefits and challenges of the new hospital design were encountered from the perspective of nurses, patients, and families. Nurses spent double the time walking in the new environment, but time spent providing patient care was unchanged. Over time, the initial practice challenges reduced as nurses adapted to working in the new environment.

**Trial Registration:** ACTRN12618000775213.

## Keywords

hospital design, paediatric, nurse, nurse workload, children and family, experience

<sup>1</sup>Perth Children's Hospital, Child and Adolescent Health Service and School of Nursing, Faculty of Health Sciences, Curtin University and Curtin Enable Institute, Perth, Australia

<sup>2</sup>Perth Children's Hospital, Child and Adolescent Health Service, Perth, Australia

<sup>3</sup>Perth Children's Hospital, Child and Adolescent Health Service and School of Nursing, Faculty of Health Sciences, Curtin University, Perth, Australia

<sup>4</sup>Perth Children's Hospital, Child and Adolescent Health Service and Vaccine Safety, West Australian Department of Health, Perth, Australia

## Corresponding author:

Fenella J Gill, School of Nursing, Faculty of Health Sciences, Curtin University, Perth WA 6845, Australia.

Email: [f.gill@curtin.edu.au](mailto:f.gill@curtin.edu.au)

## Introduction

In 2018, a new children's hospital opened in Perth, Western Australia, which replaced an existing hospital founded in 1909. Planning of the new hospital began in 2008, at a time when there was considerable uncertainty about how best to design a children's hospital in the context of increasing recognition of patient rights, patient complexity and acuity, as well as workforce challenges.<sup>1,2</sup> Single-patient rooms were advocated to meet patient preferences, facilitate patient flow and social support, meet infection control guidelines, and reduce medication and communication error.<sup>1-3</sup> However, there was also recognition that single-patient rooms could increase nurse workload while simultaneously reducing nurse time spent with patients, negatively impacting patient safety and nurse satisfaction,<sup>4</sup> as well as reducing patient visibility and social interaction for patients and families.<sup>1</sup>

The design of the new children's hospital was informed by study findings of caregiver experience in single-room wards of six adult hospitals in the USA<sup>2</sup> and by evidence that acuity-adaptable single rooms, good acoustics, natural light, and nature views benefit patient healing and shorten patient length of stay.<sup>3,5</sup> Anticipated challenges for nurses to deliver patient care in the larger floor space included fatigue, stress,<sup>6</sup> teamwork and communication difficulties, and less ability to access support or help.<sup>7</sup> Overall, there was an expectation that moving into a new children's hospital would improve the care experience for children, families, and nurses and promote patient safety.

In this paper, we report a pre-post intervention study to understand the impact of the move to the new environment type on nurse workflow activities and on patient, family, and nurse experiences. Our study adds to an increasing evidence base around the impacts of changes in the physical inpatient environment and the role of building design for staff and patient experience.<sup>8-10</sup>

## Methods

### Setting

The study was set in the old children's hospital in Western Australia (pre-move), which included a separately located adolescent mental health unit, and the new children's hospital (2018, post-move). The new hospital had a 65% increased area for inpatient wards, with the number of adaptable single rooms increasing from 26% in the old hospital to 75% in the new building. We selected three inpatient areas for data collection, judged to be representative of paediatric inpatient services (surgical ward, medical ward, and specialty oncology unit), and based on staff interest in participating in the study. The design features of the new hospital, which sought to optimise nurse

time at the patient bedside, are described in [Online Supplement S1-A](#). In brief, key features included maximising natural light and views from patient rooms; facilitating the visual line of sight between staff, work areas, and patient rooms, and reducing excessive walking distance; decentralised nurse stations; flexible and portable storage units; automated dispensing machines (ADM) on each wing to improve medication stock management and secure storage and patient safety<sup>11</sup>; and digital hands-free communication technology for staff.

### Study design

We employed an explanatory sequential pre-post design<sup>12</sup> using (i) observations of nurse work tasks; (ii) surveys of nurses, inpatient children, and their families; and, informed by survey findings, (iii) interviews with inpatient children and their families and focus groups with nurses. The sequential nature of data collection and analysis supported data integration or 'mixing'.<sup>13</sup> Study details are described in the trial protocol.<sup>14</sup>

**Oversight.** The study was guided by the principles of health care improvement and included a steering group comprising two parents of children with chronic diseases who had experienced multiple hospital admissions, three ward clinical nurse managers, one pharmacist, and the hospital information communication technology system administrator, as well as researchers. In addition, two consumer advisory panels provided advice throughout the study. These included children and young people who had inpatient experience and parents with experiences of being in hospital with their children. The study followed the SQUIRE 2.0 Standards for Quality Improvement Reporting Excellence.<sup>15</sup>

### Data collection

Data were collected at three time points ([Online Supplement S1-B](#)): pre-move T1 (November 2017–January 2018); during the move T2 (June 2018); and post-move T3 (September 2018–November 2018) and T4 (May 2019–September 2019).

**Observation of nurse work tasks.** We sought to capture time and motion to document work tasks<sup>16</sup> by observing registered nurses providing clinical care in one of the three inpatient areas. Nurse work-tasks were documented on a paper data-collection tool using the following categories: direct care, indirect care, medication tasks, documentation, communication, motion, interruptions, and time spent with patient and families ([Online Supplement S1-C](#)).<sup>17</sup> Registered nurses were trained in the method for time and motion data collection and observed five registered nurses from

each of the participating wards ( $n = 15$ ). A convenience sample of participants was selected based on being rostered for direct patient care during the data collection periods and who anticipated they would be working on the equivalent ward in the new hospital in one year's time. Data were collected at points T1 and T4 and on the minute in maximum blocks of 2 hours to avoid observer fatigue, with a total of 4 hours of data collection per participant.<sup>18,19</sup> Inter-rater reliability was assessed by double data collection for 40 min; it was above 90% for seven of eight nurse observers (87% for one observer).<sup>18</sup> Each data collection sheet scored 15 min of data. Scores were tallied, summed, and entered into the Research Electronic Data Capture (REDCap) database.

**Practice Environment Nurse Work Index (PES-NWI).** We used the 30-item Practice Environment Work Index (PES-NWI)<sup>20</sup> to measure how nurse practice environments contribute to improved outcomes for nurses and patients.<sup>21</sup> PES-NWI items are worded to reflect domains at hospital (e.g. 'Nurses are involved in the internal governance of the hospital') and ward level (e.g. 'Enough registered nurses to provide quality patient care').<sup>20</sup> We opted for the original PES-NWI over a version that had been adapted for Australia,<sup>22</sup> as it better reflected the management structure of the children's hospital. We adapted the instrument with minor contextual wording changes (e.g. changing the term 'head nurse' to 'clinical nurse manager'; 'who is a good manager and leader') (Online Supplement S1-D). The PES-NWI contains five domains (subscales): nurse participation in hospital affairs (HA); nursing foundations for quality of care (FQ); nurse manager leadership, ability, and support of nurses (NM); staffing and resource adequacy (SR); and collegial nurse-physician relations (CR). Items are scored on a four-point Likert scale, from 1 (*strongly disagree*) to 4 (*strongly agree*).<sup>21</sup> The PES-NWI was distributed to all nurses working at the old children's hospital and the adolescent mental health unit at T1 ( $n = 886$ ) and all nurses working in the new children's hospital at T4 ( $n = 1000$ ). Nurse participants included enrolled nurses (ENs); registered nurses (RNs); clinical nurses (CNs) who are experienced RNs; and senior registered nurses (SRNs) who are clinical specialists and ward managers.

**Nurse, child, and family experience surveys.** We developed three participant experience surveys: of registered nurses providing clinical care in one of the three inpatient areas (13 items); of children who were inpatients in one of the three inpatient areas during data collection (9 items); and of inpatient children's families (13 items) (Online Supplement S1-E). All surveys were completed using the National Paediatric Toolkit, an electronic survey tool designed to engage children in patient experience feedback using interactive features,<sup>23</sup> and informed consent was sought prior to survey completion (parent and child consent was

provided for child surveys). Items were scored on a 5-point Likert-type scale, from 1 (*I disagree a lot*) to 5 (*I agree a lot*). Survey data were collected by research assistants at weekly intervals at points T1 (ten weeks), T3 (ten weeks), and T4 (five weeks) for nurses. Child and family survey data were collected at T1 (ten weeks), T3 (ten weeks), and T4 (nine weeks). While nurses might have been surveyed more than once during data collection, the child and family surveys captured responses from the cohort of inpatients and their families at each time point.

**Interviews and focus group discussions.** We conducted interviews with children who were inpatient in one of the three inpatient areas and their families at T3 and T4. Potential interview participants were identified by ward managers if they were physically well and they agreed to be contacted by researchers.

Children who spoke English, had experience of being an inpatient, had the cognitive ability to participate, were considered to be well enough, and who were a minimum age of eight years were invited to participate. Parents were present with child participants or answered without the child present at their discretion. All participants were purposively recruited from the ward by the nurse researcher following discussion with the ward clinical nurse managers or coordinators. Interviews were conducted in patients' single room accommodation or a quiet consultation room using open-ended semi-structured interview questions asking participating children and parents to share their views about the new hospital environment (Online Supplement S1-F). Interviews were audio-recorded following consent; they ranged from 20–40 min duration. Focus group discussions (FGDs) included nurses working in any inpatient area. We held four focus groups with a convenience sample of nurses at T3 and T4. Participants of three focus groups were nurses who worked on wards and one with ward clinical nurse managers. At T3, all participants had worked at the old and the new hospital. At T4, all participants worked at the new hospital. Focus groups were scheduled during the regular 60 min allocated for professional development. An email was sent to clinical nurse managers and staff development nurses to inform nurses of the focus group dates. Exclusion criteria of casual pool staff were stated in the email. Each nurse gave informed and written consent to participate in the research and completed a demographic survey.

Focus group discussions were guided by questions about the new hospital environment; questions were semi-structured and based on survey findings, to facilitate a deeper understanding of the concepts identified (Online Supplement S1-F). This approach allowed flexibility for participants to elaborate further on issues pertinent to them, as well as providing opportunity for the researcher to invite deeper insights with the use of prompts. Focus group discussions and interviews were audio-recorded.

## Analysis

**Observation of nurse work tasks.** Comparison of data on observation of nurse work tasks between T1 and T4 used percentage of total time (minutes) for each task divided by the total in a two-hour time period. In one case, only 225 min were recorded pre-move, and the percentage was adjusted for this case. A linear mixed model for each task category was used to determine change from pre to post with ward and domain entered as a random effect.

**Practice Environment Nurse Work Index (PES-NWI).** We calculated mean scores for each item of the PES-NWI, as well as subscale and composite scores. Differences between T1 and T4 were compared using linear regression with time entered as a covariate. We adjusted for potential confounders: part-time/fulltime work, experience (years), and gender. For subscale models with a significant  $p$ -value ( $p < 0.05$ ) for time, we further examined the scores by nurse category. An interaction term of nursing category and time was entered in the model. Contrasts were calculated post-move (T4) minus pre-move (T1) with a negative score representing a decrease in the PES-NWI. Contrasts are presented for both the unadjusted and adjusted analysis along with their corresponding 95% confidence intervals and  $p$ -values.

**Nurse, child, and family experience surveys.** Survey data were analysed using linear regression with T1 used as the reference category. Mean changes in scores (along with their corresponding 95% confidence intervals) were calculated from T1 to T3 and T1 to T4 for each of the surveys mean sum total scores. All statistical analyses were performed using Stata 16.1.<sup>24</sup>

**Interviews and focus group discussions.** Audio recordings were transcribed verbatim, and two researchers checked transcript accuracy. Data were de-identified and imported into NVivo18<sup>®</sup> data analysis software, and two researchers independently analysed data and generated codes using thematic analysis.<sup>25</sup> Initial codes were based on features identified in the raw data using inductive (at T3) and deductive approaches (T4).<sup>26</sup> The researchers' interpretation of findings from nurse focus groups at T3 was presented during a series of nurse participant workshops to substantiate issues raised and recommendations made by nurses during the focus groups.

## Ethics approval

The study protocol was prospectively registered<sup>14</sup> and received ethical approval from the Child and Adolescent Health Service Human Research Ethics Committee (RGS 0567).

## Results

### Observation of nurse work tasks

We collected a total of 59.6 hours of data before the move (T1;  $n = 15$ ) and 64.0 h 1 year after the move (T4,  $n = 16$ ). Nurses' mean time spent with patients fell from 47.6 h (standard deviation 12.3 h) at T1 to 40.8 h (SD 12.4) at T4, but this difference was not statistically significant (Table 1). Time spent walking almost doubled, from an estimated 10 min at T1 to around 20 min at T4. Time spent documenting significantly fell, as did time spent undertaking ward activities and indirect care activities, including supervision of others, while time communicating with other staff increased. There was no significant change in time spent conducting direct care activities.

### Practice Environment Nurse Work Index (PES-NWI)

The PES-NWI was completed by 452 nurses at T1 (51% response rate) and 360 nurses at T4 (36%). There was a significantly reduced score from T1 to T4 in nursing foundations for the quality of care subscale (adjusted mean difference  $-0.08$ ,  $p = 0.016$ ) and the staffing and resource adequacy subscale (adjusted mean difference  $-0.19$ ,  $p < 0.001$ ). Further examination of these subscales by nursing category indicated significant reduction in the registered nurses group responses ( $p = 0.004$  and  $p < 0.001$ , respectively) (Table 2)

### Nurse, child, and family experience surveys

A total of 378 nurses responded to the nurse experience survey (T1  $n = 154$ , T2  $n = 146$ , and T4  $n = 78$ ). Nurse survey scores decreased from T1 to subsequent time points with a mean change of  $-0.7$  (95%CI:  $-0.9$  to  $-0.5$ ,  $p = 0.001$ ) from T1 to T3 and  $-0.4$  (95%CI:  $-0.6$  to  $-0.1$ ,  $p = 0.002$ ) from T1 to T4. Nurses' preference for single patient rooms increased over time while staffing and time to provide patient care were considered to be inadequate (Online Supplement S1-G).

A total of 399 children responded to the child experience survey (T1  $n = 139$ , T3  $n = 147$ , and T4  $n = 113$ ) and 452 families to the family experience survey (T1  $n = 156$ , T3  $n = 165$ , and T4  $n = 131$ ). Families reported increased scores from pre-move to post-move, with a mean change score of  $0.4$  (95% CI:  $0.3$  to  $0.5$ ,  $p < 0.001$ ) from T1 to T3 and an increase of  $0.3$  (95%CI:  $0.2$  to  $0.5$ ,  $p < 0.001$ ) from T1 to T4. Individual item responses showed families' preferences for space, privacy, and quiet in single rooms (Online Supplement S1-H). There were no differences over time for child survey scores (Online Supplement S1-I).

**Table 1.** Observation of nurse work tasks pre-move (T1) and 12 months post-move (T4).

Area	T1 % mean (SD)	T4 % mean (SD)	Change score (95% CI)	p-Value
Nurse time spent with the patient	47.6 (12.3)	40.8 (12.4)	-6.8 (-15.2, 1.6)	0.114
Motion (walking time)	4.3 (3.1)	8.4 (2.8)	4.2 (2.3, 6.1)	<0.001
Documentation	13.4 (5.7)	9.2 (5.1)	-4.4 (-7.5, -1.3)	0.005
Medication	13.8 (5.8)	15.1 (7.8)	1.0 (-2.3, 4.4)	0.543
Communication	14.3 (5.6)	20.0 (5.6)	5.8 (2.2, 9.4)	0.002
Ward activities	8.7 (4.4)	4.7 (3.9)	-4.0 (-6.8, -1.1)	0.006
Direct care	34.6 (11.7)	32.8 (11.9)	-1.7 (-8.7, 5.2)	0.628
Indirect care	11.3 (4.5)	8.2 (3.0)	-3.1 (-5.7, -0.5)	0.019

**Table 2.** Practice environment scale and nurse work index (PESNWI) scores pre-move (T1) and 12 months post-move (T4).

	Pre-move (T1)		Post-move (T2)		Unadjusted		Adjusted <sup>a</sup>	
	n	Mean (SD)	n	Mean (SD)	Mean difference: post-pre (95% CI)	p value	Mean difference: post-pre (95% CI)	p-Value
<b>All nurses</b>								
Nurse participation in hospital affairs	383	2.49 (0.50)	296	2.49 (0.53)	0.01 (-0.07, 0.08)	0.890	0.00 (-0.08, 0.08)	0.935
Nursing foundations for quality of care	396	2.97 (0.41)	308	2.89 (0.43)	-0.09 (-0.15, -0.03)	0.005	-0.08 (-0.14, -0.01)	0.016
Nurse manager leadership, ability, and support of nurses	423	2.88 (0.60)	329	2.81 (0.63)	-0.07 (-0.16, 0.02)	0.130	-0.05 (-0.13, 0.04)	0.294
Staffing and resource adequacy	432	2.64 (0.60)	338	2.45 (0.62)	-0.19 (-0.28, -0.11)	<0.001	-0.19 (-0.28, -0.10)	<0.001
Collegial nurse-physician relations	435	3.04 (0.55)	341	3.04 (0.56)	0.00 (-0.07, 0.08)	0.909	0.02 (-0.07, 0.10)	0.706
Composite	343	2.79 (0.42)	257	2.74 (0.45)	-0.05 (-0.12, 0.02)	0.144	0.04 (-0.11, 0.03)	0.285
<b>Nursing foundations for quality of care, by nursing type</b>								
Enrolled nurse	27	2.90 (0.53)	20	3.02 (0.42)	0.12 (-0.13, 0.36)	0.339	0.18 (-0.09, 0.44)	0.202
Registered nurse	233	3.01 (0.40)	166	2.90 (0.45)	-0.11 (-0.20, -0.03)	0.008	-0.12 (-0.21, -0.04)	0.004
Clinical nurse	102	2.92 (0.41)	84	2.81 (0.42)	-0.11 (-0.23, 0.02)	0.092	-0.07 (-0.19, 0.05)	0.253
Senior registered nurse	34	2.95 (0.44)	38	2.92 (0.36)	-0.04 (-0.24, 0.16)	0.696	-0.01 (-0.20, 0.19)	0.943
<b>Staffing and resource adequacy, by nursing type</b>								
Enrolled nurse	28	2.71 (0.67)	19	2.78 (0.70)	0.06 (-0.29, 0.41)	0.729	0.11 (-0.27, 0.50)	0.557
Registered nurse	252	2.72 (0.57)	191	2.45 (0.64)	-0.27 (-0.38, -0.16)	<0.001	-0.28 (-0.39, -0.16)	<0.001
Clinical nurse	115	2.48 (0.64)	89	2.35 (0.61)	-0.13 (-0.30, 0.04)	0.125	-0.12 (-0.29, 0.04)	0.151
Senior registered nurse	37	2.54 (0.48)	39	2.48 (0.50)	-0.06 (-0.33, 0.21)	0.665	-0.03 (-0.31, 0.24)	0.821

<sup>a</sup>Adjusted for nursing experience (years), part-time/full-time, gender.

### Nurse focus group discussions

FGDs at T3 involved 32 nurses (31 females and 1 male, with a median experience of 10 years) with 9, 8, 9, and 5 participants, and FGDs at T4 involved 30 nurses (28 females and 2 males, with a median experience of 11 years) with 9, 8, 6, and 7 participants. We identified four key themes that provided further explanation for the decrease in nurse

staffing and resource adequacy reported above. These were *adapting to ward design* and *managing workflow* that were closely related to nurse experience of reduced visibility and interlinked with *care and responsibility* and *technological communication*. Table 3 provides a summary overview of identified themes with example quotes for illustration.

*Adapting to ward design.* Nurses liked the natural light and views in the new hospital, although at T3 and T4 many also

**Table 3.** Nurse focus groups and patient and family interview themes and exemplars.

Positive comment		Negative comment	
Nurse focus groups			
Adapting to ward design			
Natural light	T3: And the sunlight actually in the rooms is really good (N2.4) T4: It's a nicer feel when you come onto the ward. Like it's brighter, you've got windows looking out at (botanic garden) (N3.7)	V-shape	T3: But the worst bit for us, we can't see each other anymore. We used to have a big connection between our (ward) areas which was important for flow and for support, now you're very isolated (N1.6) T4: It feels very separate. . . you sometimes aren't aware that the other wing may really be struggling whereas your wing isn't as busy (N3.1)
Single rooms	T3: Good rest and.. more settled at night (N2.7). Single rooms are great ... for private conversations (N3.7) T4: For parents and children it's a much better facility. . . it's a lot more quiet (N3.2). It's . . . better with infection control and less pressure for us to manage the beds (N4.2)	Single rooms	T3: It's really difficult to sort of just eyeball anyone (N1.4). [Families] can't see their nurse and don't know what you're doing or if you're busy . . . sometimes they get annoyed (N3.3) T4: Their experience of you ends when you exit and then only starts again when you return. They don't see you running backwards and forwards to your four other patients (N4.1)
Managing workflow			
The design is good for parents	T4: I do like single rooms for the parents, there's a lot less complaints . . . And I would probably take that over the walking (N3.7)	Distance walked Time with patients	T3: It's actually a lot, 'cause of the space, distance walking we've got even less time to spend with patients (N3.5) T4: A lot more walking. And that's like tiring on nurses. . . taking away from the patients (N3.7)
Equipment	T3: Having monitors in each of the patient's rooms. It's great (N1.7) T4: Equipment-wise we're very fortunate (N3.1)	Pantry and central storeroom	T3: It's like going to your next door neighbour's house just to get something out of the storeroom (N2.2) T4: It's quite a walk (N4.3)
Staffing – adjusting over time	T4: We've actually implemented a new model of care which is two extra nurses per shift (N1.7). I definitely feel like we have come a long way (N2.3)	Staffing	T4: How could I fix that...? I'd just give myself an extra staff member (N2.6) You don't have the same capacity to educate and support junior nurses. You're more isolated and so [the required] resources for support of staff goes up (N1.1)
Adjusting to the new work environment	T4: It takes a little bit of work but you do adjust to the actual working environment . . . we support each other a little bit more (N4.6) We have just learnt to be a bit more like adaptable but I don't think things have actually gotten easier at all (N2.6)	Adjusting to the new work environment	T3: You know it's going to be better, whereas I think from my personal experience I'm more exhausted now than I was at [old hospital] . . . But the facilities are beautiful and it's a lovely hospital to be in (N1.8) T4: [Graduate nurses are] more isolated because no one's as visible and I think it's harder for [them] to access someone (N3.6)

(continued)

**Table 3.** (continued)

Positive comment		Negative comment	
Care and responsibility			
Automated medication dispensing system	T3: [The ADM] tells me exactly where everything is (N3.9) T4: You can go back and look what actually people have given, when they have given it (N3.1)	Responsible for care	T3: It's like we're always short staffed (N2.3) T4: Visibility's a problem. You can't just do a quick visual check on [others] like you would in a (shared ward) (4.3)
Technological communication			
Hands-free communication	T3: [Hands free communication] has improved communication (N2.3) T4: Thank goodness for [hands free communication] [context of visibility] (N2.4)	Hands-free communication	T3: It doesn't understand me (N3.5) T4: I hate it ... It doesn't get my accent ... (N2.1)
Child and family interviews			
Being a family in the physical new environment of the new hospital			
Light and views	T3: It's brighter, it's cleaner (P3) T4: Nice views (C3) T4: I like the new design (P2)	Nurses are stressed	T3: [Nurses have] got a lot on their hands and they're under pressure and I don't think that can be acceptable (P3) T4: [Nurses] will always make sure that the kids are looked after first before anything else... like they'll forgo breaks which is rough because ... they need breaks (P1)
Single room	T3: It's better 'cause you get your own space and you don't have to deal with other people (C2). There's a [parent] bed (P2) T4: It's a lot better because we have more privacy and we can do more stuff (C3). Having the privacy and quietness (P4)	Single room	T3: The only good thing about the rooms where it's like four (beds), you got to meet new parents (P1) T4: In the long term [it would be good] to turn [the single parent bed] into like a futon [double bed] so it would fold out so then [both] mum and dad could stay [so the family be able to stay together] (P1)
Leaving the old and familiar			
Loves the new hospital	T3: Everyone's a lot more brighter ... I think [nurses are] just more happier with the environment so they're more happier themselves (C6)	Misses the old hospital	T3: The old hospital was kind of like my second home, so this is just very new and it feels weird (C2). [The old hospital] was very much like going to your old grannie's house and a little bit comforting (P3)

Note. N = nurse, C = child, P = parent. Participant codes at T3 and T4 are not matched.

described reduced visibility and feeling isolated from colleagues in the 'V'-shaped ward design of the new hospital, and the experience of increased walking persisted. Despite these concerns, nurses preferred single rooms, saying they thought that patients and families were happier: *'It takes a little bit of work but you do adjust to the actual working environment ... we support each other a little bit more'* (Nurse 4.6).

*Managing workflow* related to single rooms in the new hospital in comparison to the shared patient rooms in the old hospital. The remote location of the ward pantry and central storeroom in the corridor (shared between two adjoining

wards) led to increased walking and concern that this detracted from providing patient care. One nurse who was allocated patients across both ends of the 'V'-shaped wings described feeling *'split amongst two'* (Nurse 4.1). At T3, the cumulative impact of managing workflow during this time of adjustment was described by some as feeling exhausted (Nurse 4.5), and *'we've just been keeping heads above water'* (Nurse 2.3). Most of the challenges described at T3 were no longer evident at T4 where managing workload was described positively with nurses feeling more familiar, having adapted to the new environment and technological

systems, and improved staff to patient ratios in some wards. At T4, the experience of reduced visibility was increased when new nurses joined the ward and a perception of being less able to support them in the single-room environment.

*Care and responsibility.* At T3, medication rooms were mostly viewed positively as being well-stocked, quiet spaces, free from distraction that supported medication safety although one nurse noted how being distraction-free could be a negative ‘when in the med [medication] room, you’re locked away, you can’t hear anything and you’re in there . . . and you can’t see the screens anymore, you can’t see the lights’ (Nurse 1). Reduced visibility of patients in single rooms contributed to nurses’ perceptions of being short staffed at T3. At T4, the provision of extra nurses had supported the adjustment for some nurses: ‘I ... feel like we have come a long way’ (Nurse 2.3).

*Communication.* Similarly at T3, adjusting to new communication systems was reported to be challenging. Computer systems and hands-free facilities were associated with a number of barriers, leading to less time available to provide patient care. Over time more benefits were identified, including the ability to send text messages. At T4, positive experiences included how the technology supported safe and timely administration of medications, and most nurses agreed that their workflow was facilitated by the hands-free communication technology: ‘It’s like the problem was the [increased] space and [hands free communication] fixed that problem’ (Nurse 2.6).

### Patient and family interviews

We conducted interviews with three children at T3, three different children at T4, five families at T3 (five mothers and one grandmother), and four different families at T4 (four mothers; children). Our analysis identified two themes: *being a family in the physical environment* of the new hospital and *leaving the old and familiar*. Patients and families shared positive views and experiences about the light bright spacious physical environment (Table 3). This included the comfort of rooming in, privacy, views, and quietness: ‘Its better cause you get your own space’ (Child 1). Other positive aspects of the physical ward design included functioning and easily accessible lifts, restaurants, parent lounges, and nice views. At T3, an identified sense of *leaving the old* was consistent with many affectionate reflections of familiarity, with the old hospital described as being ‘like a second home’ by some. Also, at T3, families observed that nurses appeared to be working in a more pressured environment and were less visible to them:

Because a lot of the time ... you look and there’s often not anyone [visible]. But for some reason that never seemed to happen at [the old hospital], the people always seemed to be on the ward. (Parent 3)

The theme *leaving the old* was no longer evident at T4. Families spoke positively about the physical design of wards, including privacy and space for the family to be together. Child 3 spoke of many ‘interesting things around the hospital’ including dedicated play space. Families described that warm connections with many of the same nurses had continued in the new hospital environment but were different in some ways: ‘like that mad dance minute is a fantastic idea. . . to see the nurses dancing and you know the staff are getting amongst it, the kids just radiate from that as well’ (Parent 4). There was a sense of confidence at T4 that the nurse was seen to be ‘never far away’ (Parent 2).

### Discussion

The new children’s hospital in Perth, Australia, was built with mainly acuity-adaptable single rooms, designed to promote natural light and views and optimise nurse time to provide patient care. Previous studies documented the benefits of (privacy) and challenges to (isolation, decreased visibility, and surveillance) patient single rooms from the perspective of adult patients, their families, and staff,<sup>5,8,9</sup> along with greater staff and family satisfaction in a new children’s hospital.<sup>10</sup> We found that children, families, and nurses all enjoyed the new children’s hospital, in particular the natural light and views. Families and children appreciated the privacy of single rooms that enabled them to be together as a family, which had been lacking in the old building. This is especially important in the paediatric context, where the immediate family includes the patient, their parents, and their siblings.

Nurses recognised single room benefits for children and families, and families reported an improved experience although children did not report a difference in their experience of care after the move. Nurses reported how using the new automated dispensing machine (ADM) supported them to provide safe and accountable patient care without taking additional time. Similar observations were documented in another recent Australian study of a new adult hospital.<sup>27</sup> At the same time, walking distances by staff significantly increased, a finding also reported by Maben et al.<sup>9</sup> of the move to a new adult hospital building with single rooms in England. However, we did not find significant differences in the time nurses spent with patients. This suggests that the design strategies to optimise nurse time in direct patient care may have been effective. Yet, others have suggested that interpretation is more complex than the spatial layout and needs to take into account individual nurse behaviours as well as experience level.<sup>28</sup>

Similar to Maben et al.<sup>9</sup> reporting in an adult setting, parents and children valued privacy afforded by single rooms that enabled them to be together as a family unit, but they also experienced isolation. Nurses acknowledged and appreciated that families preferred single rooms, yet sensed



rising expectations by families, in part because nurses were now less visible, an issue also reported by others.<sup>8,9,29</sup> Reduced visibility of patients has been linked to nurses perceiving inadequate resources and experiencing a lack of control over their practice.<sup>4</sup> The nursing gaze framework describes the complex process by which nurses assess patient needs against a background of what they consider to be normal in the context of the patient's condition and the work environment.<sup>30</sup> This gaze guides the setting of work priorities and supporting others.<sup>8</sup> Less experienced nurses learn this gaze and learn to prioritise care, through their interactions with and role modelling by experienced nurses.<sup>8</sup> The challenge of supervising other nurses in single room environments has been reported by others<sup>7</sup> and includes concern over loss of surveillance of patients.<sup>8, 9</sup> A year after moving to the new children's hospital, many nurses had adapted their work practices and spoke of their increased capacity to support others overall. Working in the reduced visibility environment, once they became familiar using technology, nurses especially valued the digital hands-free communication technology.

### *Strengths and limitations*

Study strengths were the multiple methods and data sources used to understand the impact of the new physical work environment on time spent by nurses in patient care and patient, family, and nurse experiences. Stakeholders, or knowledge users, including consumer and community involvement throughout the study ensured that the study measured outcomes that were of importance to nurses, children, and families. Other benefits included interpretation through knowledge users' lens and contribution to dissemination of findings.

A limitation of this study design was that there was no control group or data collected from another hospital. It is therefore not certain that all experiences and results can be attributed to the new hospital design and layout or instead the experience of moving to a new hospital itself. Other study limitations included collection of observation of nurse work task data on the minute using a pen and paper format. Using a manual method of data collection meant that interruptions were not adequately captured. Maben et al.<sup>5, 9</sup> and Westbrook et al.<sup>17</sup> reported the use of an automated hand-held computer device for data capture over the whole minute to enable identification of interruptions. Several other limitations are acknowledged. We used the validated PES-NWI instrument and although some items may have

been too generic for our specific purpose, we found significant decreases in the Staffing and Resource (SR) adequacy subscale over two time points. We also utilised the SR subscale in the nurse experience surveys and similarly found nurses reported significant decreases in staffing and resource adequacy after moving to the new work environment. These findings support the utility of the PES-NWI and the SR subscale for this study. The data for the PES-NWI were collected anonymously, and it is likely that some of the same participants completed the PES-NWI for T1 and T4.

The nurse experience surveys items we developed to assess the experience of single-patient rooms will require further refinement before being reused. The sample sizes for the observation of nurse work tasks and experience surveys were small as were the samples sizes for parent and child interviews. No fathers were interviewed. At T4, there were insufficient eligible child participants to be able to confirm data saturation, limiting the generalisability of our findings. At T4, the five-week (instead of ten-week) data collection period for the nurse survey is both a limitation and supports other findings of nurse fatigue. Nurses who had repeatedly responded to weekly surveys had become fatigued by heavy workloads experienced during the local respiratory infection season, and in recognition of the situation being experienced by nurses at that time, data collection was ceased early to avoid research burden. We recommend consideration be given to using other methodologies to capture data rather than repeatedly survey clinical staff.

### **Conclusion**

The new children's hospital design incorporates a larger floor area, 'V'-shape ward design, mainly single-patient rooms and architectural features to maximise natural light, quietness, and views of nature. Our evaluation revealed benefits and challenges. Although there was no significant change in nurses' time with patients and their families, nurses felt they spent less time providing patient care and their workload had increased. Over time, nurses had familiarised and adapted their work practices to the new environment. Patients and families were positive about the new environment but also recognised the negative effects for nurses. The complexities identified in this study can be used to assist new hospital design planners to consider potential impacts on nurse experience as well as nurse workflow.

## Acknowledgements

The authors gratefully acknowledge the contributions of the children, families, and nurses who participated in this study; the Consumer and Youth Advisory Panels; the Stakeholder group; and the data collectors: Sian Gannon, Natalie Middleton, Mary Mitchell, Jacq Noonan, and Serena Ricciardone.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Channel 7 Telethon Trust.

## Ethical statement

The authors declare that all the research meets the ethical guidelines.

## ORCID iD

Fenella J Gill  <https://orcid.org/0000-0003-4697-9640>

## Supplemental Material

Supplemental material for this article is available online.

## References

1. Rechel B, Wright S, Edwards N, et al. *Investing in hospitals of the future*. Copenhagen: World Health Organization, on behalf of the European Observatory on Health Systems and Policies, 2009.
2. Pati D, Harvey T and Cason C. Inpatient unit flexibility: design characteristics of a successful flexible unit. *Environ Behav* 2008; 40: 205–232.
3. Ulrich RS, Zimring C, Zhu X, et al. A Review of the research literature on evidence-based healthcare design. *HERD: Health Environments Res Des J* 2008; 1: 61–125.
4. Duffield C, Diers D, O'Brien-Pallas L, et al. Nursing staffing, nursing workload, the work environment and patient outcomes. *Appl Nurs Res* 2011; 24: 244–255.
5. Walsh WF, McCullough KL and White RD. Room for improvement: nurses' perceptions of providing care in a single room newborn intensive care setting. *Adv Neonatal Care* 2006; 6: 261–270.
6. Maguire DJ, Burger KJ, O'Donnell PA, et al. Clinician perceptions of a changing hospital environment. *Environ Res Des J* 2013; 6: 69–79.
7. Lin FF, Foster M, Chaboyer W, et al. Relocating an intensive care unit: an exploratory qualitative study. *Aust Crit Care* 2016; 29: 55–60.
8. Donetto S, Penfold C, Anderson J, et al. Nursing work and sensory experiences of hospital design: a before and after qualitative study following a move to all-single room inpatient accommodation. *Health Place* 2017; 46: 121–129.
9. Maben J, Griffiths P, Penfold C, et al. One size fits all? Mixed methods evaluation of the impact of 100% single-room accommodation on staff and patient experience, safety and costs. *BMJ Qual Saf* 2016; 25: 241–256.
10. Kotzer AM, Zacharakis SK, Reynolds M, et al. Evaluation of the built environment: staff and family satisfaction pre- and post-occupancy of the children's hospital. *Health Environments Res Des J* 2011; 4: 60–78.
11. Tsao NW, Lo C, Babich M, et al. Decentralized automated dispensing devices: systematic review of clinical and economic impacts in hospitals. *The Can J Hospital Pharmacy* 2014; 67: 138–148.
12. Creswell J and Creswell JD. *Research Design: qualitative, quantitative and mixed methods approaches*. 5th ed. Thousand Oaks, CA: Sage Publications, Inc, 2018.
13. Guetterman T, Fetters M and Creswell M. Integrating quantitative and qualitative results in health science mixed methods research through joint displays. *Ann Fam Med* 2015; 13: 554–561.
14. Australian New Zealand Clinical Trial Registry 2018. <https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=374037&isReview=true>
15. Ogrinc G, Davies L, Goodman D, et al. SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *BMJ Qual Saf* 2016; 25: 986–992.
16. Abbey M, Chaboyer W and Mitchell M. Understanding the work of intensive care nurses: a time and motion study. *Aust Crit Care* 2012; 25: 13–22.
17. Westbrook JI, Duffield C, Li L, et al. How much time do nurses have for patients? A longitudinal study quantifying hospital nurses' patterns of task time distribution and interactions with health professionals. *BMC Health Serv Res* 2011; 11: 319.
18. Ampt A, Westbrook JI, Creswick N, et al. A comparison of self-reported and observational work sampling techniques for measuring time in nursing tasks. *J Health Serv Res Policy* 2007; 12: 18–24.
19. Hefter Y, Madahar P, Eisen LA, et al. A time-motion study of ICU workflow and the impact of strain. *Crit Care Med* 2016; 44: 1482–1489.
20. Lake ET. Development of the practice environment scale of the Nursing Work Index. *Res Nurs Health* 2002; 25: 176–188.
21. Warshawsky NE and Havens DS. Global use of the practice environment scale of the nursing work index. *Nurs Res* 2011; 60: 17–31.

22. Middleton S, Griffiths R, Fernandez R, et al. Nursing practice environment: how does one Australian hospital compare with magnet hospitals? *Int J Nurs Pract* 2008; 14: 366–372.
23. Orovia Group. NPT: Fabio the frog. <https://www.nptoolkit.com/>.
24. Statacorp. *Stata statistical software: release 16*. 16 ed. College Station, TX: Statacorp LCC, 2019.
25. Clarke V and Braun V. Thematic analysis. *J Positive Psychol* 2017; 12: 297–298.
26. Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quantity* 2018; 52: 1893–1907.
27. Craswell A, Bennett K, Dalglish B, et al. The impact of automated medicine dispensing units on nursing workflow: A cross-sectional study. *Int J Nurs Stud* 2020; 111: 103773.
28. Yi LP and Seo H-BPM. The effect of hospital unit layout on nurse walking behavior. *Health Environments Res Des J* 2012; 6: 66–82.
29. Curtis P and Northcott A. The impact of single and shared rooms on family-centred care in children’s hospitals. *J Clin Nurs* 2017; 26: 1584–1596.
30. Ellefsen B, Kim HS and Ja Han K. Nursing gaze as framework for nursing practice: a study from acute care settings in Korea, Norway and the USA. *Scand J Caring Sci* 2007; 21: 98–105.