

MedTechVic



How might the built environment prevent or actively support people experiencing delirium?

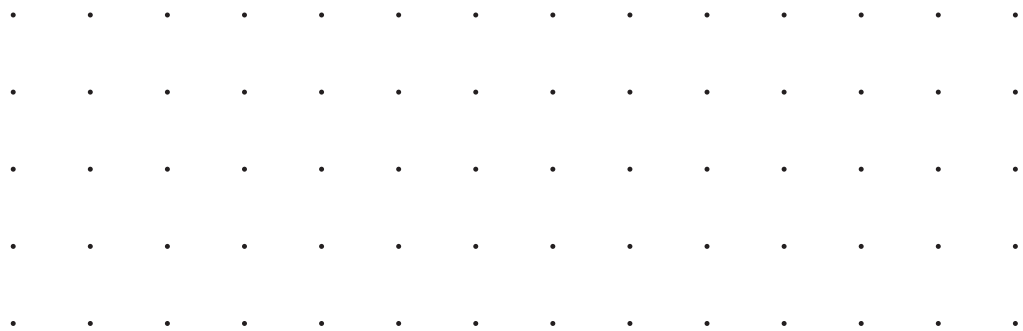
Prepared by MedTechVic



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We respectfully acknowledge the Wurundjeri People of the Kulin Nation, who are the Traditional Owners of the land on which this document was prepared, and pay our respect to their Elders past, present and emerging.

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Executive summary

Delirium is a sudden and severe change in brain function that leads to disorganised thinking, inattention and altered consciousness.

Delirium is associated with significant adverse outcomes, including increased risk of death, falls, cognitive decline and extended hospital stays. Despite its impact, many hospitals lack design features that minimise the risk of delirium.

Several environmental factors contribute to the onset and management of delirium in hospitals. Key elements include noise, lighting and the familiarity of the space.

Excessive noise can disrupt sleep and exacerbate delirium symptoms. The sterile, unfamiliar nature of hospital environments often exacerbates patients' feelings of disorientation and vulnerability, further complicating delirium management.

Healthcare professionals and caregivers emphasise the importance of the built environment in reducing the severity of delirium. Lighting, familiar environments, sensory stimulation and orientation aids are crucial in supporting patients. Architectural design modifications, including noise-reducing materials, dynamic lighting systems and more engaging, human-scaled interiors, can significantly impact patient outcomes.

This report identifies four key recommendations to enhance the hospital environment for patients with delirium, as below.

By integrating these recommendations into hospital design, healthcare facilities can create more supportive environments that not only enhance patient well-being but also potentially reduce the incidence and severity of delirium. Investing in thoughtful design strategies and advanced technological innovations is essential to adapt to the changing population and mitigate the long-term costs associated with delirium.

Recommendations

1



Noise levels should be reduced to create a calm environment and enhance sleep quality

2



Lighting should be designed to minimise disruptions to routines and well-being of all staff and patients

3



Interior design should be made more 'familiar' and engaging, reducing the clinical feel of the space

4



Floor plans and layouts should be improved to enhance navigation and safety

These recommendations and solutions have been informed from the data collected from healthcare professionals, consumers, product and communication designers, and architects.

Introduction

Delirium is a sudden and serious change in brain function that leads to disorganised thought processes, inattention and altered levels of consciousness.¹ It usually occurs without any previous brain disorders and has a fluctuating course.¹ Older adults, especially those over 65, are most at risk of developing delirium.² In Australia, about 10–18% of people aged 65 and older have delirium when they are admitted to the hospital, and another 2–8% develop it during their hospital admission.³ Although more common in older adults, delirium can affect people of all ages, especially in critical care or palliative care settings.

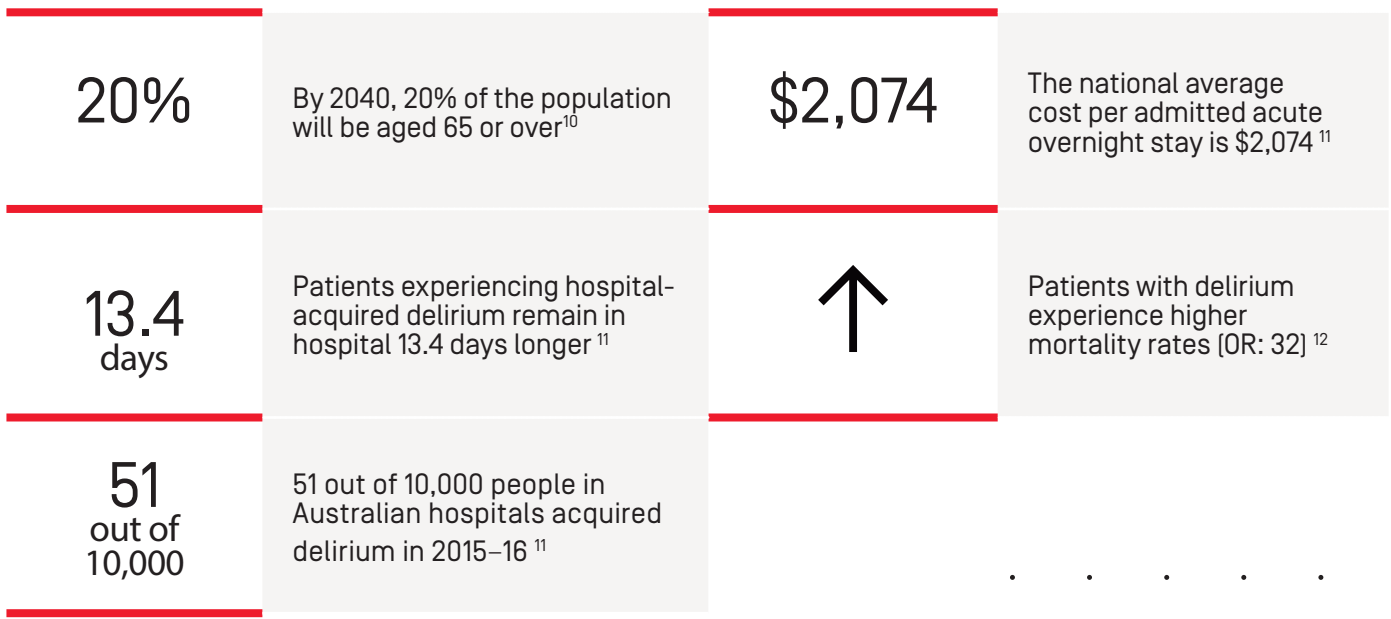
Delirium is a significant challenge in hospitals because it leads to adverse patient outcomes.⁴ Those who experience delirium are at a higher risk of death, falls, cognitive decline, extended hospital stays and even permanent placement in care facilities than other patients.⁵

While the exact cause of delirium isn't fully understood, several factors can increase the risk, including age, pre-existing conditions, severe illness, and drug or alcohol withdrawal. Indeed, the hospital environment itself may also play a role in triggering delirium⁶; for over 50 years, experts have suggested that the physical surroundings in healthcare settings can impact patient outcomes.^{7,8}

In intensive care units (ICUs), delirium is usually treated with medication, but non-drug approaches have also been shown to be effective.⁹ Programs that focus on keeping patients active, oriented and maintaining good sleep hygiene have been shown to prevent delirium, suggesting that adapting the environment may have a significant role in the prevention and management of the condition.

Despite compelling evidence, many hospitals are not designed to minimise the risk of delirium, and clinical guidelines offer little advice on how to create supportive environments for patients experiencing or at risk of delirium.

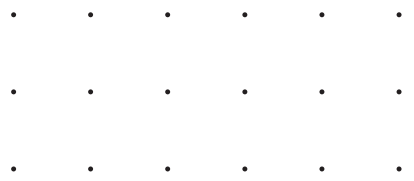
We sought to gather the experiences and perspectives of healthcare professionals, family members, and caregivers who have cared for individuals with delirium. Our goal was to identify the perceived environmental challenges in their care. We then collaborated with architects and designers to develop recommendations for modifying the hospital environment to prevent and better support patients with delirium.



What is the built environment?

The built environment includes the following:

- **Ambiant features** – including noise, air quality, light and temperature.
- **Physical layout** – including room size, and door and window placement.
- **Interior design** – including furniture, signs, equipment and artworks.



Ambiant features

Noise, air quality, light and temperature

Physical layout

Room size, door and window placement

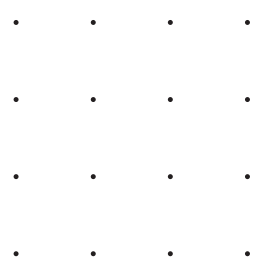


Interior design

Furniture, signs, equipment and artworks



Multidisciplinary input



Involvement of a multidisciplinary team

This White Paper presents a synthesis of information compiled through comprehensive analysis based on the insights of over 100 Australian healthcare professionals, consumers, architects and designers together (as shown in Figure 1) with the best evidence from contemporary literature. Through their shared experiences, perspectives, and recommendations, we explore the critical impact of the hospital built environment on the experience of delirium. Drawing from a rich array of sources, including surveys, co-design discovery, ideation workshops and in-depth interviews.

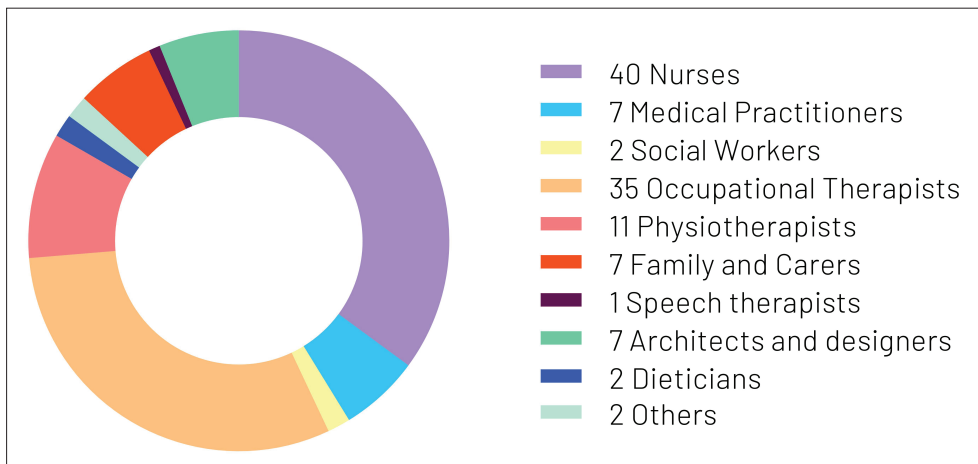


Figure 1

Importance of built environment elements in reducing severity of delirium

The healthcare professionals who have experience in caring for people with delirium see the built environment as extremely important in reducing the severity of delirium. In addition to the importance of staff interaction, the elements of the built environment selected as the most important were lighting, familiar environment, sensory stimulation and orientation aids (as shown in Figure 2).

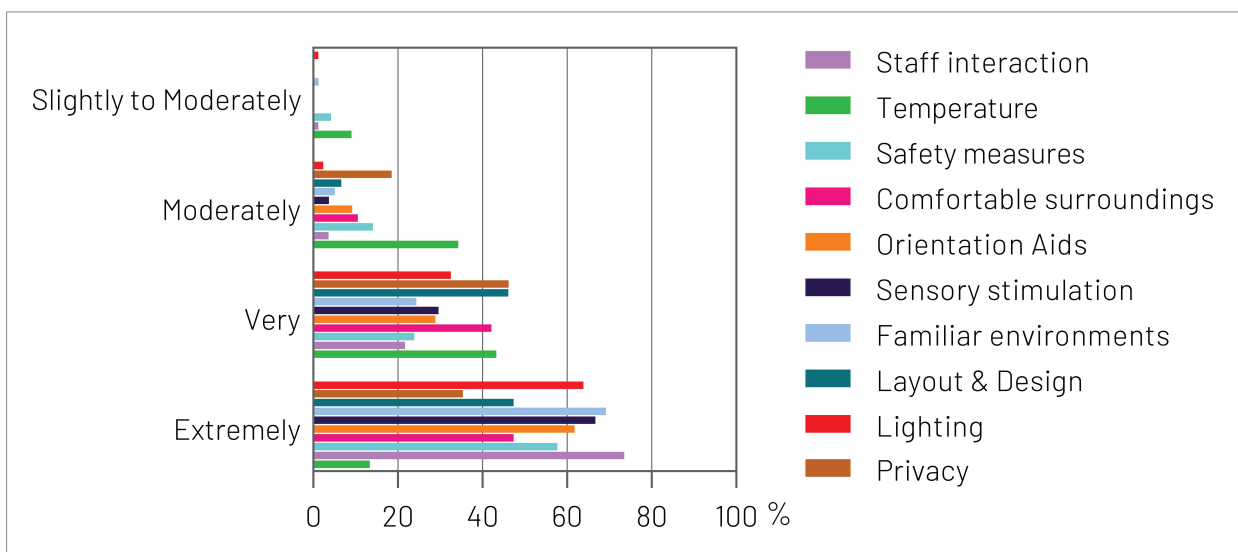


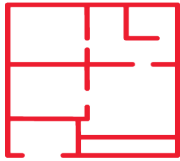


Figure 2

Key themes identified

Environmental issues interfering with the management of delirium

A number of environmental factors have been identified to contribute to the development and management of delirium in the hospital environment. Throughout our surveys, workshops, and interviews, three overarching themes emerged: visual and auditory factors, unfamiliar space and floor plans.

	Visual and auditory factors
	Unfamiliar space
	Floor plans

Recommendations

The recommendations and solutions listed in this document (pages 11–18) have been informed from the data collected from healthcare professionals, consumers, product and communication designers, and architects. Relevant literature is provided to support some of the solutions.



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Visual and auditory factors

The impact of noise

Our participants commonly referred to issues associated with high noise levels from various sources. Noise was reported to come from staff and visitor conversations, medical equipment, announcements and alarms. Consensus view indicated that noise was perceived as highly disruptive to patients, disturbing their sleep and exacerbating agitation and confusion. Based on the feedback from our workgroup, short-term incidental internal noise (noises that originate within the building) are the prominent cause of disturbance. In contrast, external noise intrusion (noises coming from outside the hospital) is less of a concern. Noise in patients' room and nurses' stations have both been shown to exceed the World Health Organization-recommended sound levels.^{13,14} One study identified that 40% of patients reported poor or very poor sleep quality in Australian hospitals¹⁵ with noise being recognised as the primary cause of sleep disruption. The issues of noise in the management of delirium are well supported by the literature, as many investigations have highlighted that deprivation or disruption to sleep can contribute to delirium.^{16, 17, 18}

“Certainly for many of our patients, noise is a big one. Actually, when I think about it, many of the patients turn around to say that they have disrupted sleep, which we know is a key factor for patients with delirium, that they have their sleep-wake cycle disturbed and that they're woken up in the middle of the night. Often it's from noise, from squeaky shoes, I hate to say it's squeaky doors. So our patients are quite open and honest with what it is that makes them feel a bit discombobulated.”

The impact of light

Our participants emphasised the critical role of natural light in patient wellbeing. It was agreed that a lack of natural light due to absence of windows or obstructed views is associated with negative outcomes such as disorientation and low morale. Poor lighting, such as insufficient natural light or overly harsh artificial light, impacts patient experience and recovery. Access to and control over light sources is a significant concern. Patients in shared rooms often lack equal access to natural light, and the ability to adjust lighting is limited. Curtains and blinds often block natural light and contribute to a dull environment. It is well recognised that the natural day-night or light-dark cycle directly mediates the circadian rhythm in mammals.¹⁹ Any disruption to this light-dark cycle alters our circadian rhythm, which affects our sleep cycle and can lead to poor-quality sleep. Hence, unsurprisingly, the lack of access to daylight has been linked to the development or worsening of delirium in hospitalised patients.^{20, 21}

“I think light is also a big one. I'm not a specialist in light or lux, but certainly from my experience, what we use in hospitals is normally, generally very fluorescent, very unnatural, very unnatural. I feel like you're at the casino or something, don't we? [sic]”

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Floor plans

Several issues in the flooring, walls and door design, such as colour and texture, were believed to significantly impact patients with delirium. It was mentioned that inappropriate choices of design can lead to misperceptions, potentially increasing the risk of falls. Too many visual elements, and constant movement and congestion due to trolleys and other equipment were said to overwhelm patients, contributing to delirium. Healthcare professionals were concerned with the safety of the patients with delirium and emphasised the importance of securing access to potentially harmful areas. Participants often mentioned the issue of poorly visible signage, which makes it challenging for patients to identify their rooms and find bathrooms and other essential facilities. It was agreed that clear wayfinding and strategic design choices are important to assist patients with delirium. The lack of access to outdoor space and fresh air was often mentioned by carers of patients with delirium and seen as interfering with patient's wellbeing. The literature has reported that the complexity of the hospital environment can be overwhelming for patients, especially those experiencing delirium or dementia²⁶ and the visual environment was recognised to be a vital element, not only for hospital staff morale and productivity but also to improve the quality and overall experience of patients and expediate recovery rates.²⁷

“And when the person with delirium wakes up, if they get up because they want to go to toilet and the toilet sign is not clear enough, because that's my observation, they will go to the light and the light is where the nurse is outside their door. So they miss the toilet. And when they miss the toilet and they actually want to find the toilet, because of the delirium, it acts on their frustration. So I would suggest to have a very clear big signage and also that it's not in English, better in pictures.”


Unfamiliar space

Healthcare professionals and family members and carers of patients who experienced delirium highlighted the sterile nature of hospital environments, as well as them being unfamiliar and not conducive to comfort. The healthcare professionals mentioned that activities and engagement, including physical activity, conversations, games and reading, and diverse personalised activities, could help restore a sense of normality and autonomy. The presence of family members was seen as a vital component in helping patients with delirium feel safe, engaged and oriented. Participants noted that the lack of familiarity, the absence of private spaces and having to share a bedroom may not only decrease the engagement of the patients, but also exacerbate feelings of vulnerability and loss of dignity.

It was also noted that Indigenous patients, especially those from remote areas, faced unique challenges in hospital settings, such as unfamiliarity with confined spaces, hence the need for a culturally appropriate environment. The views from our participants regarding the unfamiliarity of the space in the management of delirium is supported by a number of reports indicating that patients in more familiar settings exhibit lower levels of anxiety and confusion, which can help in reducing the development, intensity and duration of delirium episodes.^{22, 23}

In addition, studies have indicated that patients with delirium benefit significantly from the involvement of family members in their care, resulting in decreased rates of delirium and faster recovery times.^{24, 25}

“I wish they could have just secluded a room and made it more familiar with her, maybe with something she's more comfortable with, maybe some home familiarity essentials so that she could feel more comfortable in our room and also get to relax. Because [without] this sometimes I find it is confusing and it causes us stress and anxiety.”



Recommendation 1: Noise levels should be minimised to create better conditions for sleep and wellbeing

To support patients experiencing delirium, it is important to:

- Minimise disruptive noise
- Maintain a quiet environment where possible
- Encourage staff and visitors to be aware of their noise levels, especially during designated quiet hours.

Auditory solutions

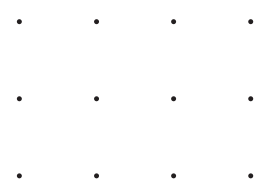
Technological solutions such as noise reducing materials in the environment and on equipment can be used to manage unavoidable background noises reaching patients in order to:

- Isolate the noise source
- Relocate the noise source
- Redirect the noise source (absorption and diffusion).

Noise redirection [acoustic treatments]

Use sound-absorbing materials on walls and ceilings and install double-glazing to reduce external noise

Sound-absorbent cleanable wall panels may be used to absorb noise such as from the nurses' station and corridors. Installation of sound-absorbing ceiling tiles is one cost-effective, feasible approach to reduce indoor noise levels.²⁸ One study provided evidence that, compared to ceilings with a hard surface, the installation of sound-absorptive ceilings can reduce overall noise levels and improve the reverberations in nurse stations.²⁹



Noise-reducing curtains: Use noise-reducing curtains in patient areas to absorb sound and decrease noise levels

Enhanced privacy curtains versus standard privacy curtains were found to provide auditory reductions through sound absorption reduction of 20–30%.³⁰

Rubber-lined castors and wheels for all mobile equipment, trolleys and gurneys, and sliding glass doors with soft closers and dampers that cannot be slammed or closed quickly

Adopting the use of doors with better sound insulation performance in patient rooms has been shown to significantly decrease the noise impact from the corridor and with the potential to extend the 'quiet period' for patients' sleep during the nighttime.²⁹

Noise isolation

Potential for insulating nursing stations

There are proposals to insulate nurses' stations with glass partitions to isolate noise generated in the area while maintaining the visibility of patients. However, a systematic review regarding the effectiveness of decentralised nurse stations reported weak evidence of noise reduction but improvement in patient outcomes, and patient experience and satisfaction.³¹

Dedicated quiet zones: Create quiet zones and insulated visitor booths to provide peaceful environments for patients and visitors

There is evidence for the benefits of quiet time interventions and visitor management in hospitals, particularly for improving sleep, reducing stress, and lowering the risk of delirium.³² It has been demonstrated that decreasing anxiety and reducing stress can support healing and recovery.

Noise relocation

Optimised hospital layout: Reroute high-traffic areas away from patient rooms and consider dedicated service corridors to minimise noise

Shared corridors immediately adjacent to patient rooms are generally noisy due to a variety of activities. It has been shown that the addition of a dedicated service corridor in one ICU significantly improved noise control and staff stress and satisfaction.³³

Alternative announcement systems: Investigate the necessity of public announcements in inpatient areas, and explore alternatives like visual codes, Bluetooth earpieces, and silent call systems

A rapid review conducted in 2019 examined existing evidence to assess the impact of restricting overhead calling services (or implementing "quiet hospitals") on patient experience and staff wellbeing.³⁴ The findings indicated that there is currently insufficient evidence to support the widespread use of such practices. However, the Northern Private Hospital has pioneered a new patient call system that eliminates overhead announcements, instead notifying nurses of patient call bell requests through vibrating pagers.³⁵ Additionally, the Department of Health, in collaboration with several hospitals, developed the Hospital Environment Audit Tool (HEAT) – an evidence-based tool designed to help staff assess their hospital environments.³⁶ One of its modules focuses on sensory and thermal factors, encouraging hospitals to reduce noise levels.³⁷

Other

Calming music: Play calming music or specific sound frequencies (sound masking) to reduce patient agitation and promote relaxation

A recent meta-analysis of six studies indicated approximately a 50% reduction in risk of delirium after exposure to music compared to non-exposure in postsurgical and critically ill ICU patients.³⁸ Most studies in this review reported a high adherence in the music groups and cost-efficient interventions. In addition, patient-survey data revealed high participant enjoyment.



Recommendation 2: Lighting should be designed to minimise disruptions to routines and wellbeing of all staff and patients

Due to light's visual (seeing) and nonvisual (physiological and psychological) effects on people, good lighting design is of paramount importance. To support patients experiencing delirium:

- Maximise access to natural light to help regulate circadian rhythms, especially in shared rooms where access to natural lighting is limited
- Minimise unnecessary synthetic lighting at night to enhance sleep quality and wellbeing
- Educate and train staff on the importance of appropriate lighting and how to adjust it based on individual patient needs.

Note: These recommendations and suggestions do not negate the need to comply with AS/NZS 1680 and any applicable statutory requirements, national or local, for healthcare lighting. Furthermore, installations should comply with the relevant infection control requirements.

Lighting solutions

Technical solutions

Dynamic lighting systems: Artificial lights that mimic daylight to support circadian rhythms

Dynamic lighting systems use LED technology that automatically adjusts lighting conditions based on various factors, like time of day, and can be adapted to various situations or activities. This type of technology has been piloted in one ICU setting and was found to be associated with a decrease in both the prevalence and the severity of delirium by modulating circadian melatonin rhythms.³⁹

Smart glass and light-filtering curtains: Use smart glass technologies or light-filtering curtains to allow natural light while maintaining privacy

A smart glass is a type of glass that can change its optical properties, becoming opaque or tinted, in response to electrical or thermal signals. In opaque mode, it allows daylight to penetrate the room but preserves the privacy of the occupants. The coating that darkens the glass reduces the probability of glare by controlling the amount of daylight passing through the window. A more cost-effective smart glass technology that uses adhesive smart film is also now available. It can be retrofitted onto existing windows and glazing without the need to replace them. To date, there is no evidence of the impact of the use of smart glass in hospital.

Medical equipment and technology lighting: Reduce light coming from medical equipment, screens and technology to decrease unnecessary light disturbances during the night

This can be achieved by repositioning the equipment out of sight, incorporating sensors that activate when medical professionals are near, or adding covers. Another suggestion to mitigate both noise and light from medical equipment was using data telemetry, which transmits the patient monitoring information to nurse stations and tablet devices, allowing for the equipment displays to be darkened during the night and alarms to sound at the nurses' station. To date, there is no evidence of the impact of reducing medical equipment lighting on patient's wellbeing.

Managing natural light: Retrofit automated blinds

A simple, cost-effective solution to ensure the window blinds open at the appropriate time is to use an automated blind. It was suggested having an additional light-filtering blind would ensure patients comfort and privacy while allowing light into the room.

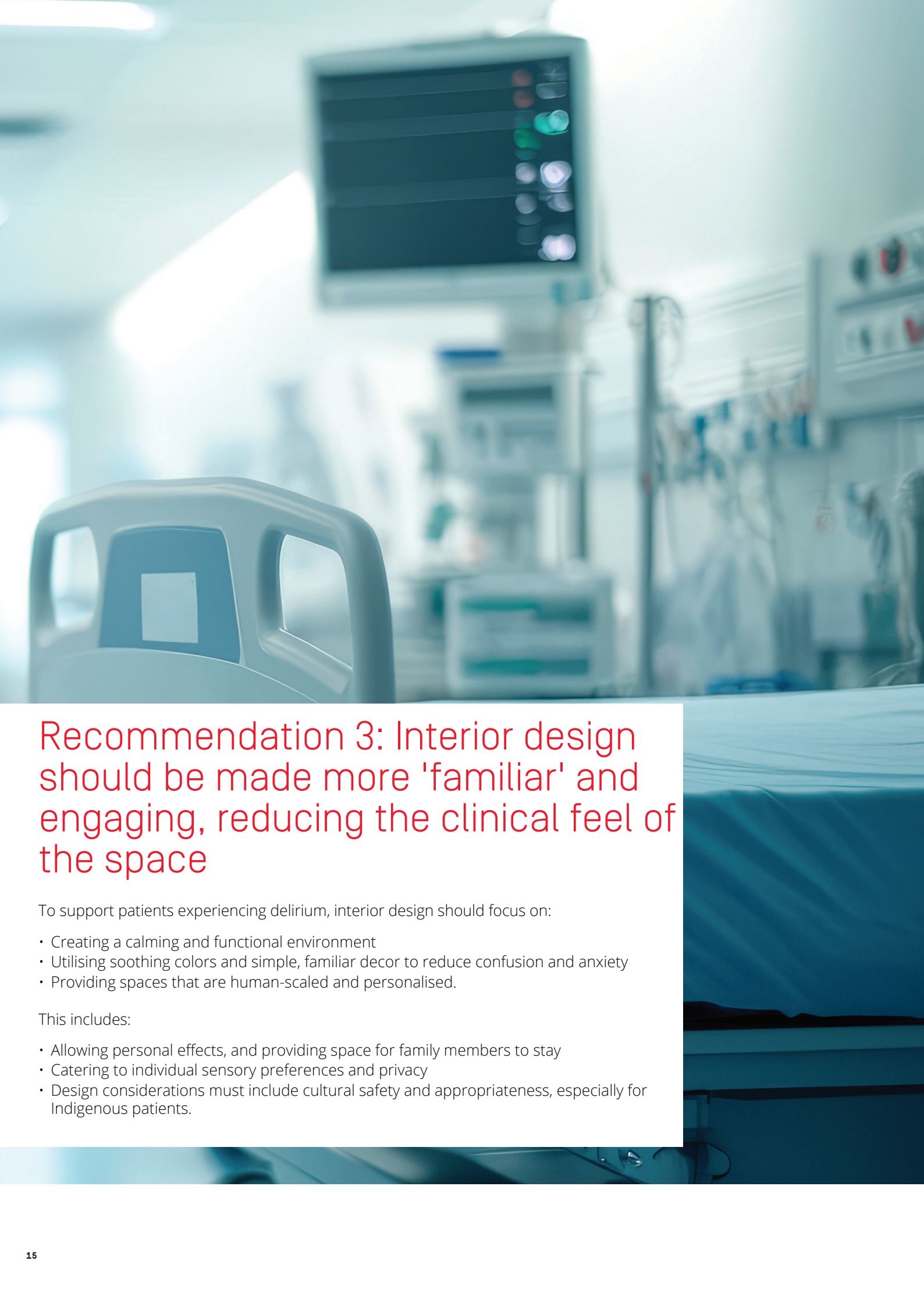
Architectural solutions

Daylighting: Consider daylighting techniques, using windows, skylights, and optimised facades to bring natural light into the spaces

Daylighting is the optimisation of natural light in a building, which can be achieved by considering the location and sizing of windows/openings, orientations, surface reflectance, and glare prevention. Computer simulations are utilised by experts to evaluate the design of a new building or implementation of lightboxes and shelves, which help to redirect daylight into existing buildings. Daylight is suggested to improve patients' visual comfort, but also brings potential benefits to physical health. Studies have shown that parallel bed placement to the window significantly reduced lengths of stay in patients with an experience of delirium⁴⁰ and admission to a room with a window was independently associated with a decreased risk of delirium in the ICU.⁴¹

Building design and layout: maximising daylight entering a building by floorplate optimisation

A floorplate in a building refers to the overall shape, layout, and size of a single level or floor within the structure. Floorplate design plays a critical role in determining the functionality of interior spaces, access to natural light, and overall building efficiency. Shallow or narrow floorplates were suggested as they allow more natural light to penetrate deeper into the interior spaces; however, layout will need to be considered regarding the efficiency for the staff. Further, integrating courtyards or light wells into the design provides natural light to spaces that are otherwise deep within the building, it could also provide staff and patients access to a safe outdoor space.



Recommendation 3: Interior design should be made more 'familiar' and engaging, reducing the clinical feel of the space

To support patients experiencing delirium, interior design should focus on:

- Creating a calming and functional environment
- Utilising soothing colors and simple, familiar decor to reduce confusion and anxiety
- Providing spaces that are human-scaled and personalised.

This includes:

- Allowing personal effects, and providing space for family members to stay
- Catering to individual sensory preferences and privacy
- Design considerations must include cultural safety and appropriateness, especially for Indigenous patients.

Interior design solutions

Create areas for visitors to stay and interact with patients with comfortable and engaging surroundings

Family members play a critical role in creating a familiar environment for patients with delirium. Their presence can provide emotional support and reassurance, which helps patients to feel safer and more at ease. Studies have indicated that patients with delirium benefit significantly from the involvement of family members in their care, resulting in lower rates of delirium and faster recovery times.^{24, 25} Providing an environment that can help facilitate family visitation could improve both the experience of the family member and the patient.

Design of communal spaces: Create communal areas that encourage engagement and movement, such as spaces for making tea/coffee, having meals, and participating in activities like knitting or playing music

Calming colour schemes: Use balanced contrasts and avoid harsh colour clashes, prefer natural tones over white to create a calming and less clinical environment

Although there is no data in patients with delirium, green colour was found to be significantly supportive in inducing favourable impacts to manage depression, anxiety and stress levels of patients with impeded mobility, compared with blue and yellow.⁴²

Personalised and human-scaled spaces: Design spaces that allow for personalisation (bring in personal items), color schemes that make the environment feel more homely and less clinical

Interactive digital displays: Install screens in patient rooms and communal areas to provide access to information, facilitate communication with family and friends, and offer games and activities

Cultural appropriateness: Ensure hospital design is culturally safe and appropriate, particularly for Indigenous patients, by incorporating familiar and culturally relevant elements

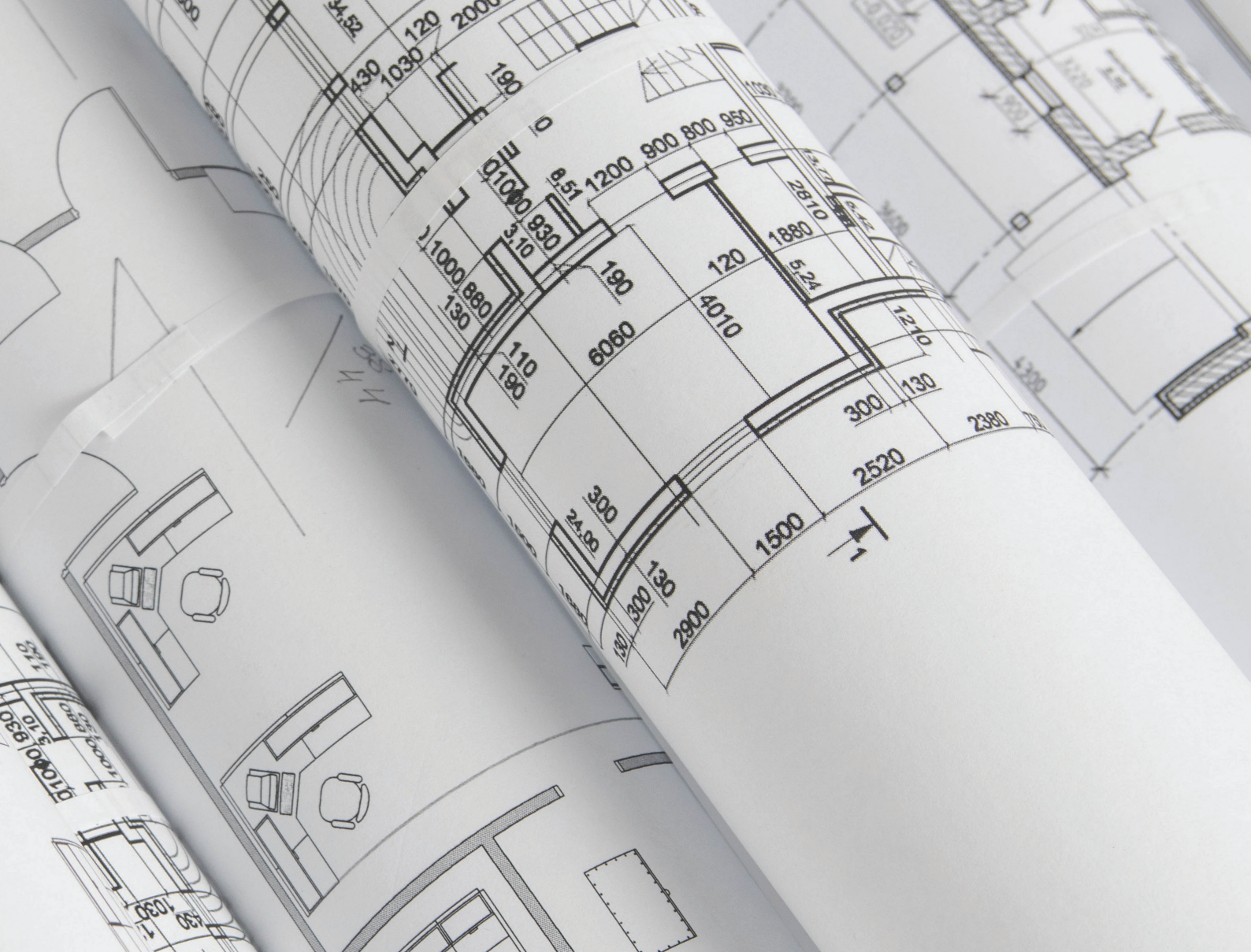
The literature indicates that early mobilisation and family participation are recommended as non-pharmacological interventions for effectively preventing ICU delirium in the PADIS (Pain, Agitation/Sedation, Delirium, Immobility and Sleep) guidelines.⁴³ A recent meta-analysis investigating non-pharmacological interventions to prevent delirium indicated that multi-treatment interventions, especially those involving early mobilisation and family participation were the most effective non-pharmacological strategies in the reduction of ICU delirium incidence.⁴⁴ Likewise, another recent systematic review indicated that a supportive physical environment was important to family and carers for adults with delirium enhancing interaction and engagement.⁴⁵

Room optimisation: Consider using modular furniture to reconfigure spaces for personal or professional preferences and needs

The provision of reconfigurable modular furniture that can be easily moved and stored would allow for further personalisation of the space, this could be helpful for healthcare professionals if more room is required for equipment, assessments and examinations. Further, in-built storage within the room/furniture design may improve functionality and comfort. The idea of creating a friendly environment using specific furniture has previously been proposed in dementia care settings.⁴⁶

Projector or screen showing natural calming scenery to relax and engage patients

Natural visual stimuli may provide engagement and relaxation. The projection of outdoor scenery onto the wall to mimic an outside view may improve the viewers sense of wellbeing. This idea is supported by a recent study where a screen-based digital therapeutic intervention (displaying pastoral scene layered with animations of butterflies and flowers blooming for four hours a day) was shown to reduce delirium associated agitation and reduced the proportion of patients who received unscheduled medications for delirium and agitation management.⁴⁷

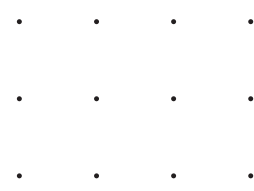


Recommendation 4: Floor plans and layouts should be improved to enhance navigation and safety

For patients experiencing delirium, physical construction and floor plan design should:

- Prioritise safety and ease of navigation
- Implement clear, intuitive layouts with well-defined pathways to minimise confusion
- Minimise the risk of patients accessing harmful areas.

Improving safety and navigation



Zone-based design: Use zone-based design with different colors or tones to aid navigation without compromising critical evacuation routes

The importance of using correct colour schemes in medical facilities has been shown to contribute to the welfare of patients.⁴⁸ Research indicates that the colour scheme significantly contributes to landmark and route knowledge in hospital wards.⁴⁸

Safety-oriented design: Consider disguising doors to prevent access to harmful areas by wandering patients with delirium

By camouflaging entry points, patients, especially those prone to wandering due to delirium or dementia, are less likely to attempt to abscond. In support to this recommendation, a study in a dementia care setting, which shares similarities with the management of delirium, found that using visual design techniques to disguise exit doors significantly reduced the number of attempts by patients to leave the unit.⁴⁹

Standardised and integrated signage: Implement standardised signage across hospitals, integrating it within the hospital's aesthetic using natural colours and discreet placement to maintain a calming environment

The existing guidelines regarding signage mainly focused on practicality and safety^{50, 51}, and few consider the navigation problems that vulnerable patients may experience.⁵² Nevertheless, a previous study indicates that preferred signage for older people with dementia includes symbols along with terminology.⁵³



Simulated exterior experiences: Develop areas that simulate outdoor experiences and hobbies, like gardens with bird feeders or small coffee vendors, to enhance patient engagement and comfort

Access to outdoors and fresh air: Place delirium wards on the ground floor or enable access to balconies or courtyards with plants and sunlight

Non-invasive security measures: Implement wearable wristbands and motion sensors in risk areas linked to alarm systems to discreetly control access and notify staff of potential dangers



Feasibility, cost and implementation

The solutions provided can be categorised into three types of implementations, new build, refurbishment, and adjustment/modification.

New build

In a new build, there is significant flexibility in design, allowing for the creation of spaces that are optimally tailored to modern healthcare needs. This provides the opportunity to integrate innovative solutions and advanced technologies seamlessly, ensuring that all aspects from layout and infrastructure to materials and systems – are aligned with the latest standards in patient care and operational efficiency. However, new builds typically involve higher costs and longer timelines, as they require extensive planning, permits, and construction. New builds also allow for future-proofing strategies, such as adaptable layouts and scalable systems, to accommodate potential growth and changes over time.

New build has been included for many of design interventions in the feasibility analysis (page 20) due to the flexibility in the concept design at the start of new projects.

Refurbishment/renovation

Refurbishment involves updating and improving spaces within an existing structure, offering a cost-effective alternative to new builds. This approach allows for significant enhancements to outdated areas, such as modernising patient rooms or upgrading facilities, while preserving the core of the original building. Refurbishments must navigate existing infrastructure constraints, such as load-bearing walls and outdated systems, which can affect feasibility and cost. While refurbishments generally incur lower costs than new constructions, careful planning is required to ensure that updates are compatible with the existing structure and meet current standards.

Adjustment/modification

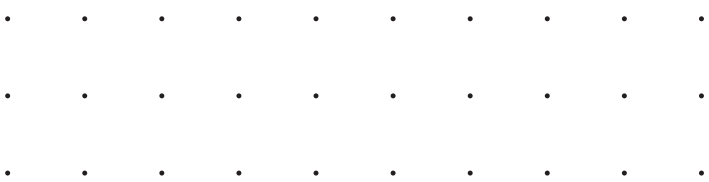
Adjustments or modifications target specific updates or changes within an operational hospital, such as adding/ updating new equipment or furniture, reconfiguring rooms, or enhancing features like lighting and acoustics with minimal difficulty. This approach is typically less disruptive and faster to implement compared to larger-scale projects, making it suitable for ongoing facilities. Adjustments or modifications are generally more cost-effective and feasible than extensive refurbishments or new builds, as they focus on addressing immediate needs with minimal impact on daily operations. However, their scope is limited by existing infrastructure, and costs can vary based on the complexity and scale of the changes needed.

Considerations, factors, and variables impacting the cost of building interventions

Building costs for hospital interventions are impacted by multiple factors, including the quality and integrity of the existing structure, which can affect the feasibility and cost of upgrades like window frame replacements or glazing improvements. For example, double glazing, often used to reduce noise and regulate temperature in hospital environments, may require consultation with experts in window manufacturing and glazing to ensure the best design option is selected for the specific budget. Maintenance costs are another key factor, as certain products may lack durability resulting in higher long-term expenses. Engaging with architects, builders, and materials experts early can help ensure durable, low-maintenance choices are made.

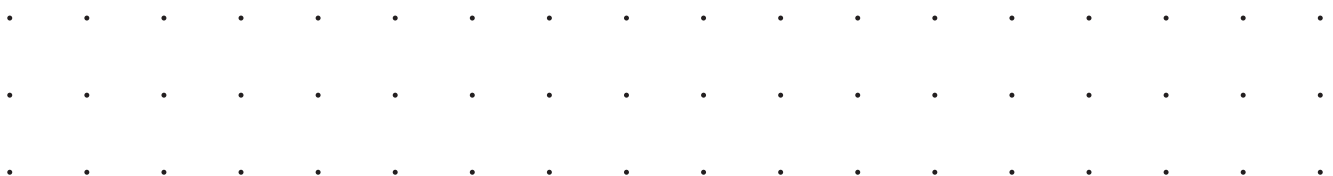
Additional considerations include the costs associated with building permits and planning approvals, which are essential for both new and existing hospital projects. It is also important to account for potential delays, which can extend project timelines and increase costs. Sourcing materials from local manufacturers can help reduce transport and delivery expenses. All of these variables – maintenance, permits, delays and transport – play a significant role in determining whether a design intervention will be classified as low, medium or high cost, as outlined in the table on pages 20–21.

Further guidance and information can be found at www.vic.gov.au/tafe-toolkit-cost-planning.



Feasibility analysis

Theme	Solution/recommendation	Type of solution			Cost	Implementation
		New build	Renovation	Modification		
Noise	Sound Absorbing Materials and Solutions					
	Double glazing	✓	✓		Medium	Moderate
	Ceiling insulation	✓	✓		Medium	Moderate
	Sounds dampening flooring	✓	✓		Medium	Moderate
	Walls and partitions	✓	✓		Medium	Moderate
	Noisy Traffic and Nurses Station					
	Service Corridor	✓			High	Difficult
	Insulated nurse station with visibility	✓	✓		Medium	Moderate
	Hospital layout traffic optimisation	✓	✓		Medium	Moderate
	Dedicated quiet zones	✓	✓		Medium	Easy
	Review and modify announcements and communication systems	✓		✓	Medium	Easy
	Implementing access to calming music					
	Localised personal music systems		✓	✓	Low	Moderate
	A dedicated space for music	✓	✓		Low	Easy
	Light	Smart windows				
Electrochromatic glass		✓			High	Difficult
Self-adhesive switchable smart film			✓	✓	Medium	Moderate



Theme	Solution/recommendation	Type of solution			Cost	Implementation
		New build	Renovation	Modification		
Light continued	Artificial light to mimic daylight (dynamic lighting systems)	✓	✓		Low	Easy
	Daylighting					
	Atrium and light shafts	✓			High	Difficult
	Automated Blinds on timer	✓		✓	Low	Easy
	Medical equipment lights					
	Cover / reorientation	✓		✓	Low	Easy
	Redesign – Sensors or data telemetry		✓	✓	Medium	Difficult
	Built-in storage for personal belongings	✓	✓	✓	Medium	Easy
Comfort, familiarity & privacy	Incorporate space for family	✓	✓		Medium	Moderate
	Opt for flexible and modular furniture			✓	Low	Easy
Activity & engagement	Use interactive displays and screens	✓		✓	Medium	Easy
	Create quiet booths or areas	✓	✓		Medium	Moderate
	Simulate exterior experiences	✓	✓		Low	Moderate
Signage, wayfinding & interior aesthetics	Use standardized signage across hospitals	✓		✓	Low	Easy
	Use of wall murals			✓	Low	Easy
	Avoid excessive use of white – Repaint / furnishings	✓	✓	✓	Low	Easy
Safety & accessibility	Camouflage entry points	✓	✓	✓	Low	Easy
	Use wearable wristbands / motion sensors			✓	Low	Moderate

Summary and next steps

The revised Delirium Clinical Care Standard, quality statement 2 of the Australian Commission on Safety and Quality in Health Care³, provides recommendations for clinicians in managing delirium and recommends multicomponent delirium prevention interventions focused on risk factor management and environmental optimisation.

Interventions include mobilisation activities, reorientation, activity engagement, sleep promotion, maintaining a quiet environment and appropriate lighting. Multicomponent non-pharmacological interventions have indeed been shown to be more effective than single component non-pharmacological intervention and usual care in reducing the incidence of ICU delirium especially those involving early mobilisation and family participation.⁴⁴

This White Paper makes recommendations to facilitate delirium care through optimisation of the hospital environment, while acknowledging that this is only one aspect of delirium care.

This report advocates for designing the built environment with a balance of functionality and patient's experience to create spaces that support both clinical care and patient wellbeing.⁵⁴ Creating a more supportive environment not only enhances patient wellbeing, but can also increase clinician job satisfaction.⁵⁵

When designing new spaces, the needs and experiences of those who spend the most time in the space – patients, nursing staff and support staff – should be consulted, and their needs prioritised. These end users are intimately familiar with the day-to-day realities of hospital life and the challenges posed by the built environment. Listening to their feedback during the design process ensures that spaces are created with their needs in mind. A recent review focussing on user involvement in building design

reported that involving users in the design process may properly align the building design and the needs and preferences of both current and potential users, enhancing the performance for the activities in the building.⁵⁶

Delirium is linked to longer hospital stays and higher chances of institutionalisation.⁵ This results in increased costs, both from extended hospital stays and the need to manage related complications.

In Australian hospitals, the national average cost per admitted acute overnight stay is \$2,074.¹¹ The total cost of delirium in Australia was estimated to be \$8.8 billion in 2016–2017, ranging between \$5.3 billion and \$12.1 billion.⁵⁷

Considering that delirium is most frequent in older people, and that it is predicted that by 2040 20% of the Australian population will be 65 or over¹⁰, the cost of delirium is likely to rise.

Given these figures, investing in thoughtful design strategies and advanced technological innovations to improve all hospital environments needs to be considered to adapt to the changing population.

Delirium is a significant burden on both patients and healthcare systems, hence investing in hospital design that focuses on patient wellbeing may reduce the burden of delirium and associated costs in the long term.

Natural light, noise reduction, clear navigation, comfortable environments and mobility-friendly spaces are all critical elements of clever hospital design that can have a lasting impact on the management and prevention of delirium.





References

1. [APA] APA. Diagnostic and statistical manual of mental disorders (5th edn). Arlington, VA: American Psychiatric Publishing; 2013.
2. Fong TG, Tulebaev SR, Inouye SK. Delirium in elderly adults: diagnosis, prevention and treatment. *Nat Rev Neurol*. 2009;5(4):210-20.
3. Delirium Clinical Care Standard. In: Care ACoSaQIH, editor. Australian Commission on Safety and Quality in Health Care 2021.
4. Gibb K, Seeley A, Quinn T, Siddiqi N, Shenkin S, Rockwood K, Davis D. The consistent burden in published estimates of delirium occurrence in medical inpatients over four decades: a systematic review and meta-analysis study. *Age Ageing*. 2020;49(3):352-60.
5. Tropea J, LoGiudice D, Liew D, Gorelik A, Brand C. Poorer outcomes and greater healthcare costs for hospitalised older people with dementia and delirium: a retrospective cohort study. *Int J Geriatr Psychiatry*. 2017;32(5):539-47.
6. Evensen S, Saltvedt I, Lydersen S, Wyller TB, Taraldsen K, Sletvold O. Environmental factors and risk of delirium in geriatric patients: an observational study. *BMC Geriatr*. 2018;18(1):282.
7. Nightingale F. Notes on nursing: What it is, and what it is not. New York, NY: Dover. 1969.
8. Ampt A, Harris P, Maxwell M. The Health Impacts of the Design of Hospital Facilities on Patient Recovery and Wellbeing, and Staff Wellbeing: A Review of the Literature. University of New South Wales: Sydney: Centre for Primary Health Care and Equity; 2008.
9. Burton JK, Craig L, Yong SQ, Siddiqi N, Teale EA, Woodhouse R, et al. Non-pharmacological interventions for preventing delirium in hospitalised non-ICU patients. *Cochrane Database Syst Rev*. 2021;11(11):CD013307.
10. Older Australians. In: Welfare AloHa, editor. 2024.
11. (AU) IHPA. Activity Based Funding Admitted Patient Care 2015-16, acute admitted episodes, excluding same day.
12. Travers C, Byrne GJ, Pachana NA, Klein K, Gray L. Delirium in Australian hospitals: a prospective study. *Curr Gerontol Geriatr Res*. 2013;2013:284780.
13. Yoder JC, Stasiunas PG, Meltzer DO, Knutson KL, Arora VM. Noise and sleep among adult medical inpatients: far from a quiet night. *Arch Intern Med*. 2012;172(1):68-70.
14. Hill J, LaVela S. Noise Levels in Patient Rooms and at Nursing Stations at Three VA Medical Centers. *Health Environments Research & Design Journal*. 2015;9(1):54-63.
15. Adams C, Harrison R, Schembri A, Junge M, Walpola R. The silent threat: investigating sleep disturbances in hospitalized patients. *Int J Qual Health Care*. 2024;36(2).
16. Cho I, Kim J, Jung S, Kim SY, Kim EJ, Choo S, et al. The Impact of Persistent Noise Exposure under Inflammatory Conditions. *Healthcare (Basel)*. 2023;11(14).
17. Hashimoto Y, Kano O, Ebihara S. Noise pareidolia test for predicting delirium in hospitalized older patients with cognitive decline. *Geriatr Gerontol Int*. 2022;22(10):883-8.
18. Cornock MA. Stress and the intensive care patient: perceptions of patients and nurses. *J Adv Nurs*. 1998;27(3):518-27.
19. Sanchez REA, Kalume F, de la Iglesia HO. Sleep timing and the circadian clock in mammals: Past, present and the road ahead. *Semin Cell Dev Biol*. 2022;126:3-14.
20. Delaney LJ, Van Haren F, Lopez V. Sleeping on a problem: the impact of sleep disturbance on intensive care patients - a clinical review. *Ann Intensive Care*. 2015;5:3.
21. Luther R, McLeod A. The effect of chronotherapy on delirium in critical care - a systematic review. *Nurs Crit Care*. 2018;23(6):283-90.
22. Caspi E. Wayfinding difficulties among elders with dementia in an assisted living residence. *Dementia (London)*. 2014;13(4):429-50.
23. Dalkea H, Littlea J, Niemann E, Camgoza N, Steadmana G, Hilla S, Stott L. Colour and lighting in hospital design. *Optics & Laser Technology*. 2006;38:343-65.
24. Inouye SK. Delirium in older persons. *N Engl J Med*. 2006;354(11):1157-65.
25. Martinez FT, Tobar C, Beddings CI, Vallejo G, Fuentes P. Preventing delirium in an acute hospital using a non-pharmacological intervention. *Age Ageing*. 2012;41(5):629-34.
26. Martinez F, Donoso AM, Marquez C, Labarca E. Implementing a Multicomponent Intervention to Prevent Delirium Among Critically Ill Patients. *Crit Care Nurse*. 2017;37(6):36-46.
27. Mohsen S, Moss SJ, Lucini F, Krewulak KD, Stelfox HT, Niven DJ, et al. Impact of Family Presence on Delirium in Critically Ill Patients: A Retrospective Cohort Study. *Crit Care Med*. 2022;50(11):1628-37.
28. Philbin MK, Gray L. Changing levels of quiet in an intensive care nursery. *J Perinatol*. 2002;22(6):455-60.
29. Deng Z, Xie H, Kang J. The effectiveness of acoustic treatments in general hospital wards in China. *Building and Environment*. 2023;244.
30. Pope DS, Miller-Klein ET. Acoustic assessment of speech privacy curtains in two nursing units. *Noise Health*. 2016;18(80):26-35.

31. Fay L, Cai H, Real K. A Systematic Literature Review of Empirical Studies on Decentralized Nursing Stations. *HERD*. 2019;12(1):44-68.
32. Lim R. Benefits of quiet time interventions in the intensive care unit: a literature review. *Nurs Stand*. 2018;32(30):41-8.
33. Wang Z, Downs B, Farell A, Cook K, Hourihan P, McCreery S. Role of a service corridor in ICU noise control, staff stress, and staff satisfaction: environmental research of an academic medical center. *HERD*. 2013;6(3):80-94.
34. Corey J, Garrubba M, Melder A. Quiet Hospitals: A Rapid Review. Melbourne Australia: Centre for Clinical Effectiveness, Monash Health; 2019.
35. Hospital adopts new technologies to reduce noise [press release]. 2024.
36. Hospital environment audit tool - policy and procedure. In: Care DoHaA, editor. 2024.
37. Victoria DoHHS. Policies and procedures – Sensory and thermal environment- Hospital Environment Audit Tool.
38. Golubovic J, Neerland BE, Aune D, Baker FA. Music Interventions and Delirium in Adults: A Systematic Literature Review and Meta-Analysis. *Brain Sci*. 2022;12(5).
39. Spies C, Piazena H, Deja M, Wernecke KD, Willemeit T, Luetz A, Group ICUDW. Modification in ICU Design May Affect Delirium and Circadian Melatonin: A Proof of Concept Pilot Study. *Crit Care Med*. 2024;52(4):e182-e92.
40. Jafarifiroozabadi R, Joseph A, Bridges W, Franks A. The impact of daylight and window views on length of stay among patients with heart disease: A retrospective study in a cardiac intensive care unit. *J Intensive Med*. 2023;3(2):155-64.
41. Lee HJ, Bae E, Lee HY, Lee SM, Lee J. Association of natural light exposure and delirium according to the presence or absence of windows in the intensive care unit. *Acute Crit Care*. 2021;36(4):332-41.
42. Hettiarachchi A, Perrera U. Colour as an agent to manage depression, anxiety and stress levels of mobility impaired individuals in healthcare facilities. *FARU Journal*. 2022;9(1).
43. Devlin JW, Skrobik Y, Gelinas C, Needham DM, Slooter AJC, Pandharipande PP, et al. Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU. *Crit Care Med*. 2018;46(9):e825-e73.
44. Chen TJ, Traynor V, Wang AY, Shih CY, Tu MC, Chuang CH, et al. Comparative effectiveness of non-pharmacological interventions for preventing delirium in critically ill adults: A systematic review and network meta-analysis. *Int J Nurs Stud*. 2022;131:104239.
45. Lee-Steere K, Mudge A, Liddle J, Bennett S. Understanding family carer experiences and perceptions of engagement in delirium prevention and care for adults in hospital: Qualitative systematic review. *J Clin Nurs*. 2024;33(4):1320-45.
46. Australia D. Creating a dementia-friendly home 2024 [Available from: <https://www.dementia.org.au/living-dementia/home-life/creating-dementia-friendly-home>].
47. Nicholas M, Wittmann J, Norena M, Ornowska M, Reynolds S. A randomized, clinical trial investigating the use of a digital intervention to reduce delirium-associated agitation. *NPJ Digit Med*. 2023;6(1):202.
48. Young AJ, Mikyoung H. Contribution of colour-zoning differentiation to multidimensional spatial knowledge acquisition in symmetrical hospital wards. *Indoor and built environment*. 2021;30(6):787-800.
49. Kincaid C, Peacock J. The Effect of a Wall Mural on Decreasing Four Types of Door-Testing Behaviors. *The Journal of Applied Gerontology*. 2003;22(1):76-88.
50. Australasian Health Facility Guidelines Part C - Design for Access, Mobility, OHS and Security C.0005 - Signage. In: Alliance AHL, editor. 2016.
51. The Department of Human Services V. Design guidelines for hospitals and day procedure centres. 2004.
52. Part W – Wayfinding Guidelines. In: Guidelines IHF, editor. 2023.
53. Gresham M, Taylor L, Keyes S, Wilkinson H, McIntosh D, Cunningham C. Developing evaluation of signage for people with dementia. *Housing, Care and Support*. 2019;22(3):153-61.
54. Douglas CH, Douglas MR. Patient-friendly hospital environments: exploring the patients' perspective. *Health Expect*. 2004;7(1):61-73.
55. Brambilla A, Rebecchi A, Capolongo S. Evidence Based Hospital Design. A literature review of the recent publications about the EBD impact of built environment on hospital occupants' and organizational outcomes. *Ann Ig*. 2019;31(2):165-80.
56. Bueno Ferrari Caixeta M, Minto Fabricio M, Tzortzopoulos P. User involvement in building design – a state-of-the-art review. *Pós Revista do Programa de Pós-Graduação em Arquitetura e Urbanismo da FAUUSP*. 2019;26(48).
57. Pezzullo L, Streatfeild J, Hickson J, Teodorczuk A, Agar MR, Caplan GA. Economic impact of delirium in Australia: a cost of illness study. *BMJ Open*. 2019;9(9):e027514.

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