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Discussion paper

Assessing a temporary isolation room from an infection control perspective: A discussion paper

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Abstract *Introduction:* Assessing the functionality and infection control implications of new technologies presents significant challenges. In this discussion paper, we present our approach to assessing infection control aspects of a new isolation room, the RediRoom™ (prototype). We report how we evaluated this room, lessons learnt and suggestions for future evaluations in this area.
Methods: There is no documented method for evaluating a novel temporary isolation room. We combined a range of existing tools to undertake a technical assessment. Three approaches were used, an assessment against standards or guidelines; professional assessment; and a cleaning assessment.
Results: To assess compliance against existing recommendations related to the built environment and isolation rooms, elements contained within Australasian and United Kingdom guidelines were used. We were able to identify which elements in these guidelines were of the most value and relevance. An ultraviolet (UV) solution with fluorescent light assessment was used to assess the ability to clean surfaces. This approach was a useful objective measure. A professional assessment is potentially subjective, but provides an opportunity to identify other potential issues and benefits. In this study, the RediRoom™ performed well against all three approaches. We identified limitations in using existing guidelines for a temporary isolation room.

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Conclusion: In our study, the use of video and video reflexive ethnography for the professional assessment would have been useful. We propose a revised list of assessment against which new isolation solutions or technologies could be assessed, with the view of others continuing to build on this.

Highlights

- We present our approach to assessing infection control aspects of a new isolation room.
- Existing guidelines for isolation rooms are not entirely suitable for assessing temporary isolation rooms.
- A multifaceted approach to evaluating new isolation approaches is warranted.

Introduction

Infection control and the prevention of infection is not a modern development. Historically, it focused on asepsis; however, ongoing pharmacological improvements to combat infections have triggered the unwanted complication of drug resistance in some transmissible pathogens. Preventing the spread of these drug-resistant pathogens in the healthcare setting is challenging and has led to modern advances in infection control methods [1]. However, further research is required to determine how effective these methods are, how they can be improved or whether completely new innovations are necessary to prevent the spread of infection.

Strategies and approaches within current infection control methods include (but are not limited to) hand hygiene, environmental cleaning, use of personal protective equipment and patient-specific strategies such as chlorhexidine bathing and screening for pathogens and isolation techniques [2—6]. Patients with pathogens transferred by contact, droplet or airborne, are often isolated to prevent and control the spread of infection [5]. However, isolation is only possible in hospitals with sufficient single rooms. Prevention of infection has been one of the main drivers for the increasing availability of single rooms. There are also other benefits such as improving staff-to-patient communication, patient confidentiality and privacy, family support and patient satisfaction are also important [7]. Conversely, single occupancy isolation rooms may have some potential drawbacks, such as financial cost, decreased staff productivity and reductions in the patient's quality of life while in hospital [8].

There is ongoing debate about the design of wards, including the balance between open and shared patient room accommodation and provision of single rooms [9]. Hospitals are expected to be flexible enough to respond to variations in demand levels and meet changing clinical and patient priorities [10]. Governments and health boards across the world have and continue to struggle with this dilemma, reflected by the diversity of approaches and recommendations on the required proportion of single rooms in hospitals [7,11—13]. New technologies and innovations enabling flexible patient isolation may provide a partial solution.

Assessing the functionality and infection control implications of new technologies presents significant challenges to researchers. In this discussion paper, we present our approach to assessing infection control aspects of a new isolation room, the RediRoom™. This room assessed was a prototype. For the purpose of this paper, the term 'isolation room' is used, noting there are differences in terminology between countries. In the context of this paper, isolation room means a single room capable of preventing the spread of infection via contact and droplet transmission routes.

The RediRoom™ is a temporary and disposable room, developed by CareStrategic Ltd. The RediRoom™ can be deployed quickly to isolate a patient requiring contact or droplet precautions. The room can be deployed in an existing hospital ward area, such as a bay or shared accommodation. In this paper, we report how we evaluated this temporary isolation room, lessons learnt and suggestions for improvements to guide future evaluations in this area. A functionality assessment (i.e. ability to undertake clinical activities) of the RediRoom™ was undertaken separately and reported elsewhere. Therefore, this discussion paper focuses on infection control issues, rather than the ability to undertake clinical activities in the RediRoom™.

The approach

Design

There is no documented method for evaluating a novel temporary isolation room in the literature. In our study, we combined a range of existing tools to undertake a technical assessment of the RediRoom™. The utilisation of this multiple faceted approach, provides the means whereby to evaluate its effectiveness in facilitating infection control in the context of a hospital environment.

Setting

The study was set in the Avondale College, School of Nursing clinical laboratory, Clinical Education Centre,

Sydney campus. The RediRoom™ was installed in the simulated clinical ward environment at the School of Nursing (Fig. 1). Though not contained in a functioning hospital ward, the context chosen provided all the factors which would entail an effective evaluation with outcomes transferable to a functioning hospital ward.

Data collection tools and approach

An assessment of the RediRoom™ from an infection control perspective comprised three different approaches:

- an assessment against standards or guidelines
- professional assessment of installation and dismantling; and
- a cleaning assessment.

These three approaches were undertaken by an evaluation team (two experienced infection control professionals), possessing more than 30 years' infection control experience between them. The evaluation team members also hold several postgraduate qualifications and have considerable experience in evaluating infection control products and technologies both in the experimental and hospital context.

Assessment against standards

This component of the assessment used elements within the following two guidelines, namely recommendations within the Australasian Health Facility Guidelines [14] and the Department of Health (NHS) Infection control in the built environment document [15]. Compliance against specific recommendations within these publications was checked. For the Australasian Health Facility Guidelines (2015) these included: Class S (820.006.015); design principles for isolation rooms (820.006.060); functional classification of isolation rooms (820.006.076); surfaces and finishes (880.001.000—880.001.025); ceilings (880.002.005); gaps (880.004.000—880.004.015); walls (880.006.000) [14].

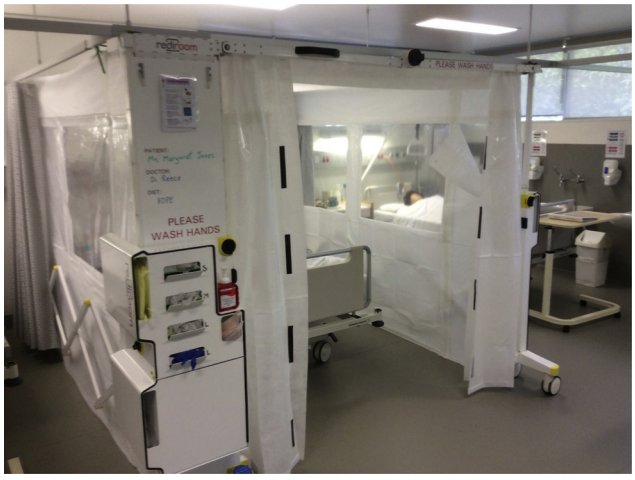

Figure 1 The installed RediRoom™ (prototype) used in the technical assessment.

For the NHS's infection prevention and control checklist these included the protocols for: section 3.5, 3.6, 3.18—3.20, 3.28, 3.119—3.127, 3.130—3.131, 3.135—3.140, 3.151, 3.159—3.161 (if applicable) [15].

The evaluation team selected the criteria for which the room would be assessed (listed above), before they viewed the RediRoom™. Therefore, there were elements chosen that were not relevant or could not be assessed because they did not apply to the RediRoom™.

Professional assessment

The professional assessment process also focused on the installation and dismantling of the RediRoom™ from an infection control perspective. To do this, the evaluation team observed the RediRoom™ being assembled and dismantled by a member of the CareStrategic Ltd. team.

Cleaning

There are a number of different methods that can used to evaluate environmental cleanliness [16]. In this case, ultraviolet (UV) solution with fluorescent light assessment (Ecolab® DAZO®) was used to detect how easily the RediRoom™ could be cleaned. The evaluation team applied the UV solution onto 12 surfaces inside the RediRoom™ and subsequently cleaned the surface with a detergent wipe. The surfaces evaluated, included the doors (inside and outside); window; front, back and the two side walls, each at high and low parts of the wall; the ceiling and under the flap around the window. The solution was allowed to dry, before it was cleaned using a neutral detergent wipe. The application and review of the UV solution and fluorescent light was consistent with documented practice [17,18]. Twelve RediRoom™ surfaces were evaluated using this method and this process was repeated a second time.

Data analysis

As this is a discussion paper, it includes only limited data analysis using descriptive statistics where required, e.g. in the calculation of proportions for compliance against standards (met/partially met/not met) to evaluate whether a surface could be cleaned sufficiently to remove the UV solution.

Findings

Assessment against standards

The combination of the elements chosen from the two selected guidelines meant 19 criteria were assessed, with the other criteria not applying to the RediRoom™. One example of a selected standard that was not relevant was section 3.137 of NHS Infection control in the built environment: *"Reusable curtains should be able to withstand decontamination in health care laundering processes"*. There are no curtains in the RediRoom™ and as the room is disposable, there is no laundering requirement either.

Of the 19 criteria assessed, the RediRoom™ was fully compliant with 17, with the other two judged to be partially compliant. The two partially met criteria were section 3.18 and 3.20 of the NHS guideline. These refer to the storage and use of personal protective equipment (PPE) and additional storage for the care and treatment of patients in isolation facilities. The evaluation team felt that the design of the RediRoom™ promoted the use of PPE, as PPE is available immediately outside the room. With a foot-operated door for entry, it was possible to enter and leave the room, without touching any doors or curtains. However, once inside the RediRoom™, there was limited opportunity for any further PPE storage. While this could be a positive from an infection control perspective as it would limit clutter and potential contamination of PPE, the lack of space was balanced by the RediRoom™ being able to have a bedside table and patient locker for storage.

Both the assessment guidelines referred to hand hygiene facilities. The RediRoom™ does not have a hand wash basin, but does have alcohol-based rub dispensers appropriately placed both inside and directly outside the room. For this reason, the reviewers marked these criteria as "met". The RediRoom™ did have perforated plastic at the back of the room, to enable oxygen and other equipment to be deployed into the room. The walls were sealed to the floor and the room had a ceiling, again with a seal to walls. For these reasons, the room was considered compliant against a criteria that refers to no gaps in the walls or ceiling. Others experts may take a different view.

The evaluation team also identified many positive infection control design features of the RediRoom™, enabling it to meet the standards against the standards assessed. These include, but were not limited to:

- smooth cleanable impervious surfaces;
- efficient design that does not require additional lighting within the room, rather utilising light from the patient environment in which it was installed. This reduces the potential for dust to accumulate and the need for cleaning;
- foot operated doors; and
- an excellent seal between the walls and the floor. Upon removal, the floor surface did not feel sticky or tacky.

Professional assessment

After reviewing the installation of the RediRoom™, the evaluation team established that this process presented minimal infection control risk, fundamentally because the room was not contaminated. Fig. 2 is an image of the RediRoom™ before installation. It was not within the scope or expertise of the evaluation team to assess any health and safety issues associated with the installation process. The room was installed in less than five minutes. The dismantling of the room, completed by one person, required consideration on how the walls would be removed so as to minimise contamination of the person undertaking the dismantling as well as the wider environment. The walls of the room were adhered to the floor, to create a seal. The walls and adhesive used were easily removed leaving no residue. The canopy (walls, doors and ceiling) of the

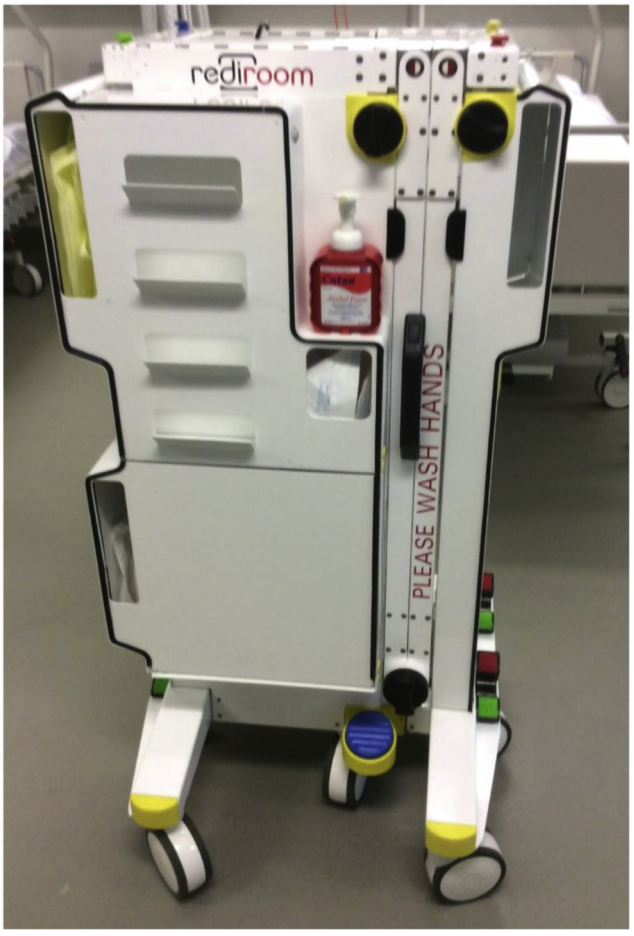

Figure 2 The RediRoom™ unit (prototype), prior to installation. Note: The bracket holder the alcohol-based hand rub is universal.

RediRoom™ was sequentially dismantled, by unhooking it from the frame. The canopy represents the disposable component of the RediRoom™. By folding the canopy inwards, the inside (potentially contaminated canopy) did not come into contact with the person dismantling it. The bed could be cleaned, then removed from inside the RediRoom™ before dismantling, if this was deemed necessary. With this protection, enhanced by the use of PPE, the reviewers felt there was limited potential contamination of the person dismantling the room. The disposable component of the RediRoom™ (canopy) was subsequently disposed of into a clinical waste bin.

Cleaning

The UV solution was applied to 24 surfaces in total. The solution was removed completely 23 times (96%) and partially removed once (4%). There were no difficulties cleaning the surfaces with respect to the stability of the RediRoom™ or force required to clean. The same amount of effort was required to remove the UV solution as to clean a hospital surface. The surface that was 'partially cleaned' was under a window flap, inhibiting the smooth surface profile somewhat. The UV solution was fully removed the second time it was applied and cleaned.

Upon patient discharge or subsequent discontinuation of the RediRoom™ the canopy is disposed of. However, the frame of the RediRoom™ can be reused, for future patients, only requiring the installation of a new canopy. The frame sits on the outside of the canopy, therefore reducing any contamination. However, the frame would require appropriate decontamination. The frame has a hard surface and thus cleaning the frame would require the same as cleaning other pieces of equipment (as per manufacture's instructions and local policy), such as bed frames. Cleaning of the RediRoom™ frame did not fit in the assessment scope of this study.

Discussion

We professional assessment a technical assessment of a disposable temporary isolation room, the RediRoom™ using three different approaches. The assessment was designed before the researchers viewed the RediRoom™, and the team was unable to locate any previous documented approach in the peer-reviewed literature. The assessment involved a review of the isolation room against existing guidelines, a cleaning assessment and a professional assessment, focussing potential contamination (personal and environmental). As the RediRoom™ is not like any other product known to the researchers, in that it was not attempting to be a permanent solution or used to provide an isolation solution for patients requiring airborne precautions, comparisons to other products was not possible and many elements of existing isolation room guidelines were irrelevant. The approach employed to evaluate the RediRoom™ created the opportunity to learn valuable lessons. These lessons could be used in the future, to help develop protocols for the purpose of undertaking technical assessments of temporary infection control isolation rooms.

To assess compliance against existing recommendations related to the built environment and isolation rooms, elements contained within the Australasian Health Facility Guidelines and the Department of Health (NHS) Infection control in the built environment document were used [14,15]. Although many of these elements were irrelevant to a temporary isolation room, they were valuable in developing the study protocol, specifically providing some objectivity and consistency to the assessment. Through this experience, we were able to identify which elements contained in the guidelines used, were of the most value and relevance. These elements have been slightly modified from the initial guidelines and are summarised in Table 1. The

Table 1 Considerations when assessing temporary isolation rooms.

Element for consideration	Adopted/incorporated from
The provision of sufficient space, including a risk-based approach, is appropriate in ensuring the environment is suitable for clinical activities (from an infection control perspective).	NHS — section 3.5 ACHFG — 880.001.010
Spacing should take into account the amount of, and easy access to, equipment and the ability to avoid cross-contamination	NHS — section 3.6
Appropriate storage of, and ready access to, clean PPE that promotes use exists.	NHS — section 3.18
Design supports and/or enhances compliance with hand hygiene	NHS — section 3.28
Surfaces are smooth, cleanable and impervious, with limited horizontal surfaces	NHS — sections 3.119, 3.125, 3.131 ACHFG — 880.001.005, 880.001.010, 880.001.015, 880.004.010
Surfaces are suitable for cleaning with products commonly used in the healthcare environment in which they are being used	NHS — section 3.131 ACHFG — 880.001.005
Efficient and effective fixtures that support the provision of clinical care, but limit infection transmission risk, environmental contamination and ease of cleaning.	NHS — sections 3.122, 3.123 NHS — section 3.124 ACHFG — 880.001.010, 880.002.005
Processes used to enter and exit the room should minimise infection transmission risks	NHS — sections 3.125, 3.126
Walls or curtains should enable them to be quick and convenient to replace, dispose of or be cleaned in a laundry; or where curtains to do not exist, the walls should provide sufficient protection against infection transmission.	NHS — sections 3.135, 3.120, 3.136, 3.137, 3.138, 3.139, ACHFG — 880.004.00, 880.004.010, 880.004.010
Waste can be disposed of easily and in a manner that is compliant with and or enhances compliance organisational policy and practice. Waste bins should be an appropriate size to the purpose of the room, with no requirement to contaminate hands during waste disposal.	NHS — sections 3.151, 3.159, 3.160, 3.161

proposed elements of this study are neither exhaustive nor described in detail. Rather, they can be utilised as a potential prompt by which to consider the assessment system and are potentially more flexible and relevant to evaluating temporary isolation rooms than existing guidelines.

In our evaluation of the RediRoom™, it complied very well with the vast majority of elements, however many of the elements were not relevant to the use of this system. It would be valuable if future guidelines took into consideration the potential for temporary or disposable isolation rooms being utilised in the hospital context. With emerging and re-emerging pathogens and increasing antibiotic resistance, the need for flexible solutions for isolation including temporary isolation rooms, are potentially going to become more common. Additional recommendations around assembly and dismantling of rooms would also therefore be beneficial.

The approach we used to evaluate cleaning, was not designed to evaluate and improve cleaning in the as initially designed [18] but rather whether the surfaces of room could actually be cleaned. The walls of the RediRoom™ were smooth, impervious and easy cleaned. The surfaces were flat with no horizontal surface or surfaces that were likely to accumulate dirt or dust. These elements are important infection control considerations and the use of a UV solution was an appropriate method whereby infection control considerations could be objectively employed for determining whether a surface could be cleaned to acceptable standards. It was not possible for the researchers to evaluate the impact of disinfectants on the material of the RediRoom™, nor was there an evaluation for cleaning the RediRoom™ frame, post canopy removal. At the time of assessment, the design of the frame was being refined by the company and hence would be subject to change. For this reason, it was not examined in this study. From this experience, we believe the use of an UV solution was valuable and should be considered in future work.

The use of videos, in particular video reflexive ethnography, provides a potentially useful approach to evaluating novel infection control technologies. This approach provides an opportunity for those being assessed or those conducting the assessment, to have time for reflect on their assessment or views. Such an approach permits multiple viewings, ensuring that potential issues and or solutions were not missed. The video provides objective data that allows participants to 'step outside themselves' and rather than having to rely on their memories or perceptions Further, it would provide the opportunity to share this with other colleagues and seek their opinion. This approach has been used in other forms of infection control research and education, specifically in improving compliance with personal protective equipment [19,20]. In our study, the use of video and video reflexive ethnography of the dismantling of the RediRoom™ would have been useful. This approach, however, could remain subjective in its assessment, unless there were specified criteria against which it could be assessed. A further method to evaluate the level of contamination in removing or dismantling temporary isolation would be of added benefit, but was beyond the scope of our project.

Authorship statement

BM and JC designed the study. BM and JC collected data. BM analysed the data and drafted the manuscript. TW, ZW and JC had critical review and input into the manuscript. All authors approved the final version of the manuscript.

Conflicts of interest

One of the authors has an Editorial affiliation with the journal. They played no role in the peer review or decision making process. All other authors have no conflicts to declare. The authors have no relationship whatsoever with the owners or manufacturers of the RediRoom™. CareStrategic Ltd., the owners of the RediRoom™, provided the RediRoom™ free of charge to the researchers for their research. No member of CareStrategic Ltd. or any of its partners were involved in the study design, data collection, analysis or manuscript preparation. A research collaborative agreement was signed with CareStrategic Ltd. before the research started. This legal agreement provided exclusive rights to research and publishes the findings at the sole discretion of the researchers.

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Provenance and peer review

Not commissioned; externally peer reviewed.

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