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Ward assessment of SmartIdeas Project: bringing source isolation to the patient

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SUMMARY

Most UK hospitals lack enough single rooms to provide source isolation for all infected patients. The aim of this study was to test prototype isolation systems on general wards together with specifically designed portable sink units and toilets. Questionnaires were offered to staff, patients and visitors covering ease of use and acceptability. A total of 53 patients were isolated, with concurrent collection of environmental samples and staff hand hygiene audit. Blocking of beds next to infected patients was avoided but patients and staff were concerned about limited space and communication. Hand hygiene compliance on entry or exit to/from an isolated bed space significantly improved [43/76 (56.6%) to 107/147 (72.8%), $P < 0.05$]. Although popular, the toilets were mechanically unreliable. Low levels of microbial contamination (<1–3.4 cfu/cm^2) were present within all isolated bed spaces. The highest colony counts were obtained from high contact sites (e.g. remote controls). Meticillin-resistant *Staphylococcus aureus* (MRSA) was present at similar levels inside all systems. Although one system was designed to provide airborne as well as contact isolation, MRSA was isolated from air inside and outside the system suggesting poor efficiency of the air door. The finding was confirmed by aerobiology tests at the Health Protection Agency Laboratory, Porton Down, UK. A trial of redesigned units is required to establish efficacy (Trial Identifier: ISRCTN02681602).

Introduction

Source isolation and hand hygiene are core measures for preventing spread of hospital-acquired infections. Patients may acquire pathogens through contact with staff or relatives' hands, the local environment or airborne skin particles.[1,2] In many hospitals there are insufficient single rooms to isolate colonised patients, blocking beds and delaying transfers.[3]

A Department of Health survey of 600 National Health Service staff identified additional single rooms as the most pressing need for infection control and the National Innovations Centre was commissioned to manage the development. The purpose of this pilot study was to assess potential solutions.

Methods

The study was performed at University College London Hospitals (UCLH) between 22 April and 24 July 2009 and was approved by the UCL/UCLH Ethics Committee. Consent was sought from all patients aged >18 years who were admitted and who required isolation, but for whom no single room was available. Patients could be withdrawn from the study if patient care was affected.

Three temporary isolation systems (below) were evaluated. The cleaning of each system was similar to that of a standard isolation room.

Temporary side room

A temporary side room (TSR) (Renfrew Creative, Abbey Meadow, Leicester, UK) was designed to provide airborne as well as contact isolation for infections (Figure 1). The SR comprised an aluminium frame ($2.5 \times 2.85 \times 1.98$ m) with clear plastic sheets attached at either side. A remote control motor was used to pull opaque sheets across for privacy. At the head end, a plastic apron abutted the wall.

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Figure 1. Temporary side room (TSR).

At the foot end there was a hinged flap with an alcohol gel dispenser (Purell, Gojo Industries, UK), an open doorway protected by a stream of HEPA filtered air (air door) and a fixed assembly (situated both inside and outside the unit) comprising a wash basin, waste bin, glove and apron dispenser. A ceiling of 100 μm fabric mesh was attached at the level of the curtain rails (Figure 1).

Glass LCD screens

The second system comprised 164 cm high glass liquid crystal display (LCD) screens (Renfrew Creative) supported on a 40 × 100 cm wheeled base (Figure 2). Three screens placed each side of the bed provided contact isolation. When privacy was required, a remote control was used to turn the screens opaque.

KwickScreen

The KwickScreen (Design London, Royal College of Art/Imperial College London, London, UK) was a retractable room divider comprising a semi-rigid RolaTube™ frame, stabilised via attachment to the curtain rail, and a plastic screen (Figure 3). The screen, 160 cm high with a 2 cm gap between the base and the floor, was extendable to a maximum of 4 m.

Figure 2. Liquid crystal display (LCD) glass screens.

Figure 3. The KwickScreen system.

Study procedures

Portable sink units were used with an 80 L refillable reservoir for chlorinated water (5 ppm chlorine, Aqua Clean tablets, Clean Tabs Ltd, UK). Portable, waterless toilets were available. A fan ensured negative pressure from the bowl avoiding the dissemination of infectious aerosols. Instead of a water flush, a plastic sleeve was drawn into the toilet, heat-sealed and cut, dropping into a drawer below. Bags were disposed via clinical waste.

Face-to-face questionnaires were delivered to staff, patients and their relatives/visitors. A list of statements used a 5-point Likert scale (strongly disagree to strongly agree). Acceptability to 80% of the participants was taken as an endpoint.

Sixty-five 30 min sessions of unobtrusive observation were conducted using Pittet's criteria.[4]

High frequency contact sites within each isolated bed area (bed foot rail, rim of over-bed table, record folder and locker) were sampled throughout each patient's stay using blood agar contact plates (diameter 55 mm; Oxoid, Basingstoke, UK). Contact sites specific to each system [e.g. glove and apron dispensers, patient remote control (for blinds or screens)] were sampled.

Dataloggers (LogTag HAXO-8; LS Technology, Bournemouth, UK) were used to monitor the temperature and humidity. Air was

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sampled microbiologically (100 L/min for 10 min) using an MAS 100 Eco Air Sampler (VWR International, Lutterworth, UK).

Similarity between patient and environmental MRSA isolates was determined via pulsed-field gel electrophoresis (Staphylococcal Reference Unit, HPA Colindale, London, UK).

Results

Most patients were isolated due to meticillin-resistant *Staphylococcus aureus* (MRSA) infection and/or carriage (45/53, 85%) (Table I).

Hand hygiene

Twenty-six of the 65 observation periods focused on a TSR, 19 on glass screens and 20 on a KwickScreen system. By comparison with control (non-isolated) bed spaces, hand hygiene compliance on entry/exit was significantly improved from 56.6% to 72.8% ($\chi^2 = 5.3$, $P < 0.05$) (Table II). The presence of an isolation system significantly improved hand hygiene compliance of doctors ($\chi^2 = 15.6$, $P < 0.005$).

System acceptability

Staff

Fifty-seven questionnaires were completed; respondents included doctors, nurses, healthcare assistants, therapists and cleaners. Sixty-five percent of respondents thought temporary isolation systems would help prevent transmission of infection. General concerns included lack of space, adequate training on use and purpose and ease of cleaning.

Seventy-two percent of respondents (24 of 33) thought that there was insufficient space within a TSR to perform routine tasks whereas 50% felt that there would not be enough space to perform invasive procedures. Despite the unit incorporating a 'quick release' system, 13 staff members expressed concern that the TSR could hinder emergency access, and 10 felt closed in when working within the unit; 21 thought that the TSR reminded them to wash their hands but only seven used the TSR sink assembly. By comparison, 11 were observed to use the ward basin and three the alcohol gel.

Six staff members responded to questions concerning the LCD glass screens. Five felt that there was insufficient space to perform routine tasks, and four did not think the screens could be rapidly removed in an emergency; the base of the screen assembly was considered a significant trip hazard. The portable sink unit was not used during any of the 19 observation sessions whereas the ward basin was used seven times and alcohol gel five times.

When nursing a patient isolated using the KwickScreen system, seven of 15 respondents felt that there was inadequate room to perform routine tasks, and nine reported feeling claustrophobic. Again, the portable sink unit was not used during any of the observation periods, whereas the ward basin was used by 13 staff members and alcohol gel once.

Isolated patients

Responses were obtained from nine patients in a TSR, eight isolated using glass screens and nine using the KwickScreen system. The TSR was considered the most effective of the three in terms of preventing transmission of infection, although three such isolated patients felt cut off from staff. One patient refused to enter a TSR and three withdrew consent, citing claustrophobia and/or excessive heat.

The relative humidity inside the TSR reflected that of the ward. However, the internal ambient temperature was recorded as being 0.5–1.0 °C higher. As an example, over 20 days, the mean temperature of a ward was 23.9 ± 0.53 °C, and inside a TSR sited on the ward was 24.4 ± 0.65 °C.

Four patients isolated using the glass screens did not feel that there was enough room for their visitors. Two patients isolated using the Kwickscreen system reported feeling 'closed in'.

Visitors and patients in the same bay as those isolated

Nineteen of the 29 patients questioned thought that the systems would prevent infection spreading but 11 said that their installation made them feel anxious about the spread of infection.

Ten of 14 patients thought that the TSR would encourage hand hygiene but six thought that it affected the ability of staff to perform their routine activities. Only three patients stated that the TSR affected their personal space and took space away from their visitors. Of 14 patients using either of the screens, 11 thought that they would encourage hand hygiene but seven felt that their presence affected their communication with staff.

Waterless toilets

The method of changing the sleeve cartridge was not clear to seven of 22 staff members questioned. Furthermore, the plastic sleeves regularly became caught in the roller mechanism so that the toilets were frequently out of use and questionnaires could only be completed by seven patients. Only one patient did not find the toilet comfortable or easy to use but two felt that the privacy in the bay was insufficient.

Table I
Patient characteristics for each isolation system

	Temporary side room ($N = 11$)	Glass screen ($N = 16$)	KwickScreen ($N = 26$)
No. of systems	5	4	3
Male:female	4:7	10:6	18:8
Age (years) (mean ± SD)	65.0 ± 16.3	58.4 ± 17.8	59.5 ± 17.4
Days from admission to entry [median (quartiles)]	13.0 (5.5, 42.0)	10.5 (4.8, 18.8)	4 (1.3, 11.8)
Medical:surgical	8:3	8:8	9:17
MRSA	6	14	25
Clostridium difficile	2	0	0
Diarrhoea (cause unknown)	3	0	0
Resistant Gram-negative	0	2	1
Colonised:infected	4:7	12:4	22:4
Hours from request to installation [median (range)]	4 (1–21)	4 (0–18)	5 (0–23)
Days stay in system [median (quartiles)]	8.4 (2.9, 21.3)	6.4 (5.4, 13.7)	6.9 (5.7, 12.4)
Transferred to single room	3	1	5
Declined to enter	2	0	0

MRSA, meticillin-resistant *Staphylococcus aureus*.

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Table II
Staff hand hygiene compliance (opportunities taken/total opportunities)

	Control	TSR	Glass screen	KwickScreen	Total for all systems
Hygiene on entry and/or exit	56.6% (43/76)	66.6% (32/48)	80.0% (36/45)	72.2% (39/54)	72.8% (107/147)
Doctors	0% (0/17)	100% (6/6)	50% (3/6)	60% (3/5)	70.6% (12/17)
Healthcare assistant	48.5% (16/33)	71.4% (10/14)	30% (3/10)	70% (7/10)	58.8% (20/34)
Nurse	57.9% (11/19)	58.8% (10/17)	56.3% (9/16)	51.6% (16/31)	35/64 (55.7%)

TSR, temporary side room.

Microbiological results

Sampling was performed within 46 isolated bed areas (9 TSRs, 15 sets of glass screens, 22 KwickScreens). Aerobic colony counts >2.5 cfu/cm^2 were taken to indicate hygiene failures.[5,6] However, in general, low levels of microbial contamination (< 1 to 3.4 cfu/cm^2) were present within all isolated bed spaces.

The level of contamination detected on sites located inside and outside of the TSRs was similar (≤2 cfu/cm^2). Of all the sites specific to the TSR, the remote control was the most heavily contaminated (1.12 cfu/cm^2 [IQR: 0.23–2.86]; $N = 16$). MRSA was recovered from the remote control on two occasions. MRSA was found twice on the outside glove dispenser (MRSA-negative patient) and five times on the outside apron dispenser (one MRSA positive and four non-MRSA patients). The ceiling fabric of each TSR was also sampled; four were positive for MRSA.

On two occasions, MRSA was recovered from air samples taken inside and outside of a TSR occupied by an MRSA-positive patient. Molecular typing showed that the MRSA outside the unit was indistinguishable from the strain inside, and both were indistinguishable from the clinical isolate. MRSA was also recovered from air samples taken inside and outside of a TSR occupied by an MRSA-negative patient. Again, the two isolates were indistinguishable. Identical strains were isolated from surfaces within the TSR, the air inlet filters and grill and from the air inside another TSR on the same ward and also housing a non-MRSA patient. The air outlet yielded MRSA, although this was a different strain to that isolated elsewhere.

The leading edge of the glass screens was sampled on 48 occasions. On two of these occasions, contamination levels were >2 cfu/cm^2. The median aerobic colony count was 0.24 cfu/cm^2 (IQR: 0.16–0.41). MRSA was isolated on three occasions (two MRSA patients and one non-MRSA patient). For the remote control within these types of unit, the median aerobic colony count was 2.12 cfu/cm^2 (IQR: 1.24–3.05; $N = 15$) although on one occasion contamination levels were >8 cfu/cm^2. MRSA was recovered once.

The leading edge of the KwickScreen system showed similar bacterial contamination to that of the glass screens (0.32 cfu/cm^2; IQR: 0.11–0.81; $N = 63$). MRSA was isolated from two screens near MRSA-positive patients. Vancomycin-resistant enterococcus (VRE) was recovered once.

Portable sink units installed at 26 different bed areas were sampled on 69 occasions. The sink units were consistently more contaminated than any of the other target sites sampled; the median aerobic colony count ranged from 0 to 20 cfu/cm^2. Sink units situated inside the bed space were less contaminated (1.42 cfu/cm^2; IQR: 0.63–3.32) than those outside the bed space (1.78 cfu/cm^2; IQR: 0.73–4.02). MRSA was isolated from internal sink units on nine occasions but from only one outer unit. *Pseudomonas aeruginosa* was recovered from 20 sink units and enterococci from four. An ESBL-producing *Klebsiella pneumoniae* was recovered from sink units associated with two adjacent bed areas; both isolates had similar susceptibiliy patterns.

Discussion

Single room isolation reduces the risk of infection and colonisation and many authors believe that an increase in the number of single rooms would decrease hospital infection rates.[7–9] The proportion of single room accommodation in most UK hospitals is well below recommended levels, however, and in the study hospitals was 29% and 14%.[9]

Existing Trexler isolation tents are cumbersome and simple tasks such as lifting or washing the patient or changing a dressing are exhausting and lengthy.[10,11] By contrast, the TSR allowed staff and visitors full and easy access to the patient via an air door, which was intended to filter, decontaminate and recycle air inside the unit while preventing air outside from entering. Finding MRSA inside and outside of TSRs with or without an MRSA patient suggested that the air door was not efficient. Tests conducted by the Health Protection Agency (Biosafety Unit, Porton Down, UK) using potassium iodide particles confirmed that the efficiency of the air door was only 30–70%. The protection factor against ingress or egress of tracers was <100 and smoke tests suggested that air flow from the air door dragged external air into the room (personal communication, J. Walker, S. Parks). A redesigned door is being evaluated.

To prevent staphylococcal infections, direct contact transfer must be prevented.[11,12] The isolation systems significantly improved hand hygiene compliance, primarily among doctors. Nonetheless, staff used the ward basin and/or alcohol gel in preference to the portable sink unit. Education plus improved mechanical reliability should encourage increased use. However, the sinks were consistently more contaminated than any of the other target sites sampled. Moisture and limited use of the sink units allowed organisms to persist. Chlorination of the reservoir was not audited in this study.

The contracted facilities company was paid for cleaning the temporary isolation systems and for each installation. Assembly time for each TSR was 2 h compared with 10–20 min for the screen-based systems. The total logistics and labour costs for this pilot study were £8,305, £33,221 per annum; these include costs associated with installing, dismantling and terminal cleaning the systems, transporting the systems between hospital sites and the co-ordination of their installation. A full-time support engineer was needed although a maintenance contract was preferable. To cover 730 beds with a 4% population prevalence of MRSA, the total running cost for isolation rooms and screens for a year would be £136,014 including nurse labour and daily cleaning but not engineering support. Accelerated discharge from ICU to the general ward during the study was equivalent to an annual saving of £43,040.[1]

The limited space in the TSR prompted design of different sizes and moving the sink to avoid obstruction. The base of the glass screens was reduced and the appearance of the KwickScreens improved. This small pilot study could not establish efficacy in preventing spread of infection but suggested that there may be benefits in improving bed usage and hand hygiene, as well as patient dignity. A full trial of efficacy is now needed with redesigned units.

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Conflict of interest statement

None declared.

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