Journal of Infection Prevention

Original Article

'Time to clean': A systematic review and observational study on the time required to clean items of reusable communal patient care equipment

Journal of Infection Prevention
2017, Vol. 18(6) 289–294

DOI: 10.1177/1757177417714046
jip.sagepub.com
SAGE

David Scott, Hayley Kane and Annette Rankin

Abstract

Background: Concerns have been raised over poor standards of hospital cleanliness and insufficient time for staff to clean reusable communal patient care equipment. These items may then act as vectors for the transmission of nosocomial pathogens between hospital patients.

Aim: To evaluate the impact of cleaning duration on nosocomial infection rates and estimate the time required to clean care equipment in accordance with national specifications (i.e. a 'time to clean').

Methods: A systematic review of the published literature on cleaning times and an observational study in which nine healthcare workers cleaned seven items of care equipment while the duration of time taken to clean each item was measured.

Results: A limited volume of low-quality evidence indicates that increased cleaning times in hospitals can reduce the incidence of healthcare-associated infections (HCAIs). The mean 'time to clean' for care equipment ranged from 166.3 s (95% confidence interval [CI] = 117.8–214.7) for a bed frame to 29.0 s (95% CI = 13.4–44.6) for a blood pressure cuff.

Discussion: 'Time to clean' estimates for care equipment provide an indication of how much protected time is necessary to ensure acceptable standards of cleanliness. Clinical trials are needed to further evaluate the impact of increased cleaning times on nosocomial infection rates.

Keywords

Cleaning, housekeeping, decontamination, medical equipment, environment, infection control

Date received: 6 January 2017; accepted: 12 May 2017

Background

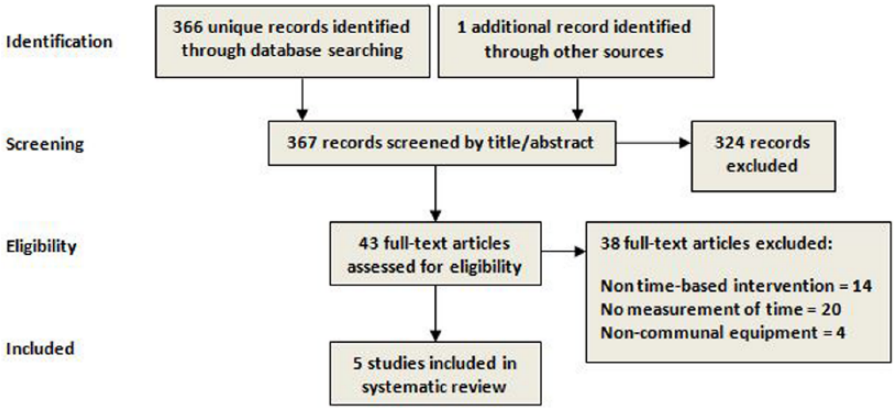
Current microbiological and epidemiological evidence indicates that contaminated surfaces of reusable communal patient care equipment may contribute to the transmission of nosocomial pathogens (Otter et al., 2013). Accordingly, existing research implies that improved cleaning and disinfection of these surfaces can reduce the incidence of healthcare-associated infections (HCAIs) (Donskey, 2013). A recent systematic review on the relationship between shared patient care items and HCAIs concluded that equipment is commonly contaminated with nosocomial pathogens, including multi-drug resistant organisms, which may be associated with patient colonisation and infection (Livshiz-Riven et al., 2015).

In Scotland, recent annual reports by the Healthcare Environment Inspectorate (HEI) have expressed concerns over a consistently poor standard of cleaning in some hospital departments. In particular, seven of the inspections carried out in emergency departments recognised 'significant shortcomings with either the cleanliness of the department, patient equipment, or both' (Healthcare Improvement Scotland, 2015: 17); yet these findings are not unique to

Health Protection Scotland, Glasgow, UK

Corresponding author:
David Scott, Health Protection Scotland, Meridian Court, 5 Cadogan Street, Glasgow G2 6QE, UK.
Email: d.scott5@nhs.net

Figure 1. PRISMA flow diagram (Moher et al., 2009).



Scotland (Carling et al., 2010). It is advocated by the authors of the HEI report that hospitals should be establishing systems to ensure a sufficient 'time to clean' between patients.

The NHSScotland *National Infection Prevention and Control Manual* recommends that reusable communal patient care equipment should be decontaminated between each use, as well as at regular predefined intervals as part of an equipment cleaning protocol (Health Protection Scotland, 2016). While responsibility for cleaning particular items is often delegated to either nursing or domestic staff on the basis of local policy, there may still be confusion over which member of staff acquires responsibility at a given time and place (Dumigan et al., 2010). The need to frequently clean patient care equipment may therefore place a substantial burden on both nursing and domestic staff. Estimates of the time required to clean individual items would allow for protected time to be accommodated, ensuring that equipment is cleaned with the appropriate frequency.

This systematic review aimed to evaluate the published literature to: (1) provide an estimate of the time currently being spent by healthcare workers on cleaning shared patient care equipment, both nationally and internationally; and (2) assess the impact of cleaning times on the incidence of HCAIs. The observational component of the study intended to provide estimates of the time required by healthcare workers to clean individual items of reusable communal patient care equipment in accordance with the NHSScotland National Cleaning Services Specification (NCSS) (Health Facilities Scotland, 2016).

Methods

Systematic review

The databases MEDLINE, CINAHL and EMBASE were searched to identify relevant published literature. A combination of Medical Subject Headings (MeSH) and free-text search terms were developed and adapted to suit each database, including the following: 'housekeepers', 'cleaners', 'domestics', 'medical equipment', 'shared equipment' and 'non-invasive equipment'. In addition, Google Scholar was used to search for grey literature relevant to the subject. All literature searches were conducted in May 2016. Articles were excluded from the review on the basis of the following criteria: article was published in a language other than English; article did not concern the decontamination of reusable communal patient care equipment (i.e. off-topic); or article concerned reusable medical devices (e.g. ultrasound transducers). The time period 2000–2016 was chosen for the database search, following a scoping exercise on publication activity relevant to the subject.

The systematic review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) format for study identification and selection (Figure 1). Initially, the title and abstract of each article were screened for relevance by the lead reviewer. Of those articles that were deemed potentially relevant, the full text was retrieved and screened against the exclusion criteria. For situations in which it was unclear whether studies should be included, consensus was reached through discussion with the other reviewers. Reference Manager (Reference Manager Version 12, Thomson Reuters) was used for bibliographic management.

Critical appraisal of the studies was carried out using the Scottish Intercollegiate Guidelines Network (SIGN) methodology (SIGN, 2012). As a further measure, the McDonald–Arduino evidentiary hierarchy was used as a framework for assessing the evidence relevant to the impact of time spent on equipment cleaning (McDonald and Arduino, 2013). Together, these two systems classify evidence on the basis of both study design (e.g. interrupted time series) and outcome measure (e.g. reduction in microbial bioburden); such a combination allows the evidence to be graded on multiple parameters of quality.

Observational study

The observational component of the study was conducted in the clinical skills laboratory of Glasgow Caledonian University. Ethical approval from the regional NHS Research Ethics Committee was not necessary for this study as it would not impact upon patient care. Written informed consent was obtained from all participants who volunteered for the study. These participants were recruited by contacting senior managers responsible for domestic services and infection control. Nine participants cleaned selected items of communal patient care equipment and the duration of cleaning for each item was recorded using a stopwatch. Seven high-touch items of care equipment were chosen from the published literature: bed frame, bed rails, bedside table, call system, notes trolley, blood pressure (BP) cuff and intravenous (IV) drip (Cheng et al., 2015; Smith et al., 2012).

The participants included two infection control nurses, three hospital domestic staff (all with experience of at least one year) and four non-clinical infection control staff. Involvement of the non-clinical staff was used to estimate the time taken by newly employed domestic staff without any prior training; in such circumstances, the domestic staff provided a demonstration of the cleaning procedure for each item in advance, in accordance with the NCSS. The observers were not masked to the occupation of participants, although data collection forms were subsequently made anonymous using randomly allocated numbers. This measure ensured that the data analyst remained unaware of participant occupation until data analysis had been completed. Data were collated in a spreadsheet and analysed using SPSS (SPSS Statistics Version 21, IBM). The 'time to clean' was summarised by calculating the means, medians and percentiles for each item. One-way ANOVA was used to determine if there was a statistically significant difference in 'time to clean' between the three occupations.

Results

Systematic review

The literature search identified 367 unique articles following de-duplication. After screening by title and abstract, 43 proceeded to the subsequent stage. Following screening by full text, five articles were included for critical appraisal. No articles were excluded during the appraisal process. Two articles (Saito et al., 2015; Zoutman et al., 2015) estimated the time currently being spent by healthcare workers on cleaning shared patient care equipment and three articles (Dancer et al., 2009; Rampling et al., 2001; Wilson et al., 2011) evaluated interventions which increased the time spent on cleaning (Table 1). The quality of included studies was predominantly of SIGN level 3 evidence (e.g. cross-sectional studies); however, there were a few studies classified as SIGN level 2+ evidence (e.g. cross-over studies). Similarly, the studies varied across the McDonald–Arduino evidentiary hierarchy from level V (i.e. demonstrating a reduced incidence of infections) to level II (i.e. demonstrating in-use bioburden reduction). Consequently, the evidence was judged to be of low to moderate quality.

Saito et al. (2015) concluded from their observational study that healthcare workers undertaking multiple roles as a part of their job (e.g. registered nurses) tended to perform cleaning and disinfection tasks with a lower frequency and for a shorter duration. In particular, housekeepers spent almost twice as long on equipment cleaning (23 min per shift) than registered nurses (13 min per shift). The average duration of time spent cleaning fixed surfaces (e.g. beds and chairs) was over nine times as long for housekeepers (94 min per shift) as it was for registered nurses (10 min per shift). Zoutman et al. (2015) used a questionnaire distributed to senior managers to ascertain that routine cleaning of a private room required nearly half as long a mean time (17.3 min) as that needed to clean a ward room (34.2 min) with an unspecified number of beds. Likewise, terminal cleaning of a private room took almost twice as much time (30.4 min) as routine cleaning, mainly due to additional tasks (e.g. replacement of privacy curtains). This observation implies that higher room turnover, resulting from a shorter length of stay, would further increase the amount of time required to keep patient rooms clean.

The interventional studies that evaluated the impact of increased cleaning times operated in one of three different forms: (1) increasing the daily frequency of routine cleaning; (2) increasing the total number of working hours for cleaning staff; or (3) recruiting additional cleaning staff. All three studies demonstrated a reduction in either environmental contamination and/or HCAIs. However, no single study examined the effect of an increased cleaning time in isolation; therefore, it was not possible to determine whether these outcomes were due to the increased time spent cleaning or other elements of the intervention.

Observational study

Of the seven high-touch items of communal patient care equipment, the bed frame required the longest mean 'time to clean' (166.3 s; 95% confidence interval [CI] = 117.8–214.7), followed by the bedside table (83.4 s; 95% CI = 55.2–111.7). In contrast, the call system (31.3 s; 95% CI = 15.0–47.5) and the BP cuff (29.0 s; 95% CI = 13.4–44.6) underwent the shortest mean cleaning times (Table 2). Figure 2 shows a box plot summary of 'time to clean' (in seconds) by item.

Despite variation in the experience of participants, there was broad uniformity in the time taken by different occupations to clean the selected items. One-way ANOVA determined that there were no statistically significant differences between non-clinical, nursing and domestic staff in the mean 'time to clean' ($P = 0.69$).

Table 1. Characteristics of included studies.

Studies estimating current cleaning times					
Authors (date)	Study design	Country	Population		Outcome
Saito et al. (2015)	Cross-sectional study	USA	144 healthcare workers, including 31 housekeepers and 34 registered nurses, across three general hospitals and two university teaching hospitals.		Observed frequency of cleaning and disinfecting tasks (recorded at 5-min intervals) as a proportion of shifts (% of total shifts) and observed time spent performing cleaning and disinfecting tasks per shift (min/shift).
Zoutman et al. (2015)	Cross-sectional study	Canada	50 senior managers responsible for environmental services/housekeeping across acute care hospitals.		Estimates of the time required to perform routine cleaning and terminal cleaning of private, semi-private and ward rooms.
Studies evaluating increased cleaning times					
Authors (date)	**Study design**	**Country**	**Population**	**Time-based intervention**	**Outcome**
Wilson et al. (2011)	Randomised cross-over study	UK	Two intensive care units.	Twice daily cleaning, in addition to usual once daily cleaning for three two-month periods.	Statistically significant reduction in environmental methicillin-resistant *Staphylococcus aureus* (MRSA) per bed-area day from 14.6% to 9.1% ($P = 0.006$), sampled from five randomly selected sites around the bed areas, staff hands and communal sites.
Dancer et al. (2009)	Non-randomised cross-over study	UK	Two matched surgical wards.	An additional member of cleaning staff introduced for a period of six months.	Statistically significant reduction in levels of environmental contamination of 32.5% ($P < 0.0001$), by weekly sampling of ten hand-touch sites and a borderline statistically significant reduction in new MRSA infections of 26.6% ($P = 0.032$).
Rampling et al. (2001)	Interrupted time series	UK	One general surgical ward.	An increase in routine domestic cleaning time from 66.5 h to 123.5 h per week for a period of six months.	Reduction in patient acquisition of an outbreak strain of MRSA from 30 cases in the six months prior to the intervention to three cases over the following six months.

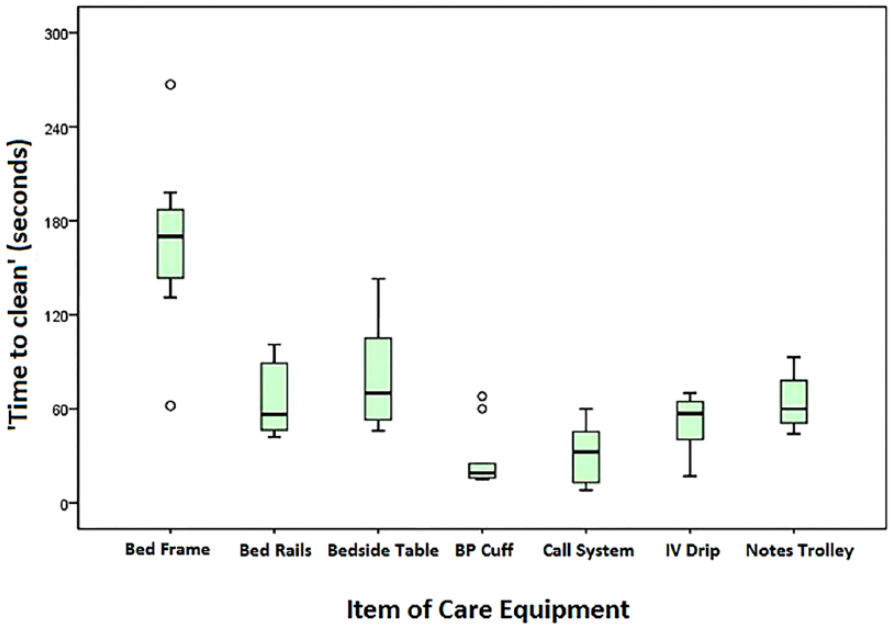
Table 2. Mean 'time to clean' for selected items for all occupations.

Item	Mean 'time to clean' (s)	95% CI
Bed Frame	166.3	117.8–214.7
Bed Rails	65.9	46.3–85.4
Bedside Table	83.4	55.2–111.7
Call System	31.3	15.0–47.5
Notes Trolley	65.2	51.7–78.8
BP Cuff	29.0	13.4–44.6
IV Drip	50.6	32.9–68.2

Discussion

The limited evidence retrieved within this review is indicative of the lack of original research conducted in the field of decontamination more generally. Perhaps unsurprisingly, the evidence base was of low quality, particularly with regard to the impact of increased cleaning times on the occurrence of HCAIs. Of the few trials relevant to this issue, most adopted a cross-over design that evaluated a complex intervention with multiple cleaning components. In order to determine the effect of modifying cleaning times, it would be necessary to design a trial that evaluated this component in isolation from other modifications to the cleaning regime (e.g. use of microfibre technology). Even if a 'wash-out' period is incorporated into a cross-over trial, it is difficult to

Figure 2. Box plot of 'time to clean' for selected items for all occupations.



establish whether the period is sufficient to exclude 'carry over' between treatments. For this reason, it would be advisable to conduct a trial with independent treatment and control groups, in which the control group is allocated standard cleaning practice. In addition, future trials should include a sufficient follow-up period to prove sustained, long-term improvements in cleanliness and a consequential impact on patient-relevant outcome measures.

The only available estimates of the time spent by healthcare workers on cleaning were provided by studies conducted in Canada and the USA. These estimates may not be representative of cleaning times in North America, let alone accurately depict cleaning times on an international level. Additional detailed surveys on the time currently spent by healthcare workers on cleaning are essential to inform the content of interventions for future trials evaluating modified cleaning times. There is also a lack of clarity over the terminology used to distinguish reusable communal patient care equipment from reusable medical devices (RMDs) or fixtures and fittings in the patient environment. For example, Livshiz-Riven et al. (2015) list ultrasound transducers as non-invasive portable items potentially shared between patients, which might otherwise be categorised as RMDs. Likewise, Saito et al. (2015) include ward furniture, such as bedside tables, as 'fixed surfaces' belonging to a separate category from patient care equipment. Such confusion interferes with attempts to provide accurate estimates of the time spent on cleaning communal patient care equipment.

Relatively little research attention has been paid to the physical components of decontamination, such as the efficacy of different scrubbing actions (Sattar and Maillard, 2013) or the duration of time healthcare workers spend cleaning surfaces. In light of this absence, we aimed to provide an estimate of the time required for healthcare workers, including both experienced and novice domestic staff, as well as nurses, to clean selected items of reusable communal patient care equipment in accordance with procedures outlined in the NCSS. The format of the observational component did incur a number of limitations: in particular, the study did not intend to evaluate the effectiveness of cleaning by different occupations. Rather, it aimed to provide cleaning time estimates that represented the variable experience of healthcare workers in the NHS. This is particularly noteworthy when considering the high level of staff turnover for hospital domestic workers in the UK (Davies, 2005). However, despite the broad occupational range of participants, only nine individuals volunteered for the study and a larger sample size might have improved external validity of the estimates. The higher proportion of infection control staff might be expected to have raised cleaning times through greater thoroughness, yet Xu et al. (2015) found that infection control professionals were less effective at cleaning high-touch surfaces than environmental service workers.

Since the data used for this paper was drawn from a larger unpublished study on equipment cleaning within hospital wards, operating theatres and intensive care units, not all participants were available to clean every single item. Recognising this limitation, the missing data (7.9%) were balanced across both occupations and items, and is therefore unlikely to have influenced the findings of the study. In addition, the study was conducted within a simulated

teaching ward, instead of a clinical ward with ongoing patient care; hence, the circumstances may not have been entirely representative of cleaning duties in the near-patient environment (e.g. patient belongings on bedside tables necessitating removal prior to cleaning). On the other hand, this study offers the strength of being the first study, following a systematic search of the literature, to provide estimates of the time required for healthcare workers in the NHS to clean items of reusable communal patient care equipment.

Conclusion

'Time to clean' estimates suggest that the most frequently handled items on a hospital ward offer potential sites for targeted cleaning that could maximise reduction of pathogen transmission rates at a relatively minimal expense of time.

Acknowledgements

The authors acknowledge their colleagues at Health Protection Scotland and Health Facilities Scotland, as well as the domestic services staff of NHS Greater Glasgow and Clyde, who participated in this study and the members of the national decontamination expert advisory steering group. The authors also thank Glasgow Caledonian University for providing use of their clinical skills laboratory. The original data are available on request from the corresponding author.

Declaration of conflicting interests

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

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Scottish Antimicrobial Resistance and Healthcare Associated Infection (SARHAI) Commissioning Group.

Peer review statement

Not commissioned; blind peer-reviewed.

References

Carling PC, Parry MF, Bruno-Murtha LA and Dick B. (2010) Improving environmental hygiene in 27 intensive care units to decrease multidrug-resistant bacterial transmission. *Critical Care Medicine* 38: 1054–1059.

Cheng VC, Chau PH, Lee WM, Ho SK, Lee DW, So SY, Wong SC, Tai JW and Yuen KY. (2015) Hand-touch contact assessment of high-touch and mutual-touch surfaces among healthcare workers, patients, and visitors. *Journal of Hospital Infection* 90: 220–225.

Dancer SJ, White LF, Lamb J, Girvan EK and Robertson C. (2009) Measuring the effect of enhanced cleaning in a UK hospital: a prospective cross-over study. *BMC Medicine* 7: 28.

Davies S. (2005) *Hospital Contract Cleaning and Infection Control*. UNISON: London.

Donskey CJ. (2013) Does improving surface cleaning and disinfection reduce health care-associated infections? *American Journal of Infection Control* 41: S12–19.

Dumigan DG, Boyce JM, Havill NL, Golebiewski M, Balogun O and Rizvani R. (2010) Who is really caring for your environment of care? Developing standardized cleaning procedures and effective monitoring techniques. *American Journal of Infection Control* 38: 387–392.

Health Facilities Scotland. (2016) *NHSScotland National Cleaning Services Specification*. Available at: http://www.hfs.scot.nhs.uk/publications/1479818599-The%20NHSScotland%20National%20Cleaning%20Services%20Specification%20%20-%20June%202016.pdf (accessed 5 December 2016).

Health Protection Scotland. (2016) *NHSScotland National Infection Prevention and Control Manual*. Available at: http://www.nipcm.hps.scot.nhs.uk/ (accessed 5 December 2016).

Healthcare Improvement Scotland. (2015) *Ensuring Your Hospital is Safe and Clean: HEI Annual Report 2013–2014*. Available at: http://healthcareimprovementscotland.org/his/idoc.ashx?docid=3b2c0699-bbbc-4c6c-bf1b-b6bad1159b9c&version=-1 (accessed 5 December 2016).

Livshiz-Riven I, Borer A, Nativ R, Eskira S and Larson E. (2015) Relationship between shared patient care items and healthcare-associated infections: a systematic review. *International Journal of Nursing Studies* 52: 380–392.

McDonald LC and Arduino M. (2013) Climbing the evidentiary hierarchy for environmental infection control. *Clinical Infectious Diseases* 56: 36–39.

Moher D, Liberati A, Tetzlaff J, Altman DG and the PRISMA Group. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of Internal Medicine* 151: 264–269.

Otter JA, Yezli S, Salkeld JA and French GL. (2013) Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. *American Journal of Infection Control* 41: S6–11.

Rampling A, Wiseman S, Davis L, Hyett AP, Walbridge AN, Payne GC and Cornaby AJ. (2001) Evidence that hospital hygiene is important in the control of methicillin-resistant *Staphylococcus aureus*. *Journal of Hospital Infection* 49: 109–16.

Saito R, Virji MA, Henneberger PK, Humann MJ, LeBouf RF, Stanton ML, Liang X and Stefaniak AB. (2015) Characterization of cleaning and disinfecting tasks and product use among hospital occupations. *American Journal of Industrial Medicine* 58: 101–111.

Sattar SA and Maillard J-Y. (2013) The crucial role of wiping in decontamination of high-touch environmental surfaces: review of current status and directions for the future. *American Journal of Infection Control* 41: S97–104.

Scottish Intercollegiate Guidelines Network. (2012) *SIGN 50 A guideline developer's handbook*. Available at: http://www.sign.ac.uk/pdf/sign50.pdf (accessed 5 December 2016).

Smith SJ, Young V, Robertson C and Dancer SJ. (2012) Where do hands go? An audit of sequential hand-touch events on a hospital ward. *Journal of Hospital Infection* 80: 206–211.

Wilson AP, Smyth D, Moore G, Singleton J, Jackson R, Gant V, Jeanes A, Shaw S, James E, Cooper B, Kafatos G, Cookson B, Singer M and Bellingan G. (2011) The impact of enhanced cleaning within the intensive care unit on contamination of the near-patient environment with hospital pathogens: a randomized crossover study in critical care units in two hospitals. *Critical Care Medicine* 39: 651–658.

Xu H, Jin H, Zhao L, Wei X, Hu L, Shen L, Wei L, Xie L, Kong Q, Wang Y and Ni X. (2015) A randomized, double-blind comparison of the effectiveness of environmental cleaning between infection control professionals and environmental service workers. *American Journal of Infection Control* 43: 292–294.

Zoutman DE, Ford BD, Sopha K and Wylie B. (2015) The influence of patient room type, cleaning procedure and isolation precautions on room cleaning times in Canadian acute care hospitals. *Canadian Journal of Infection Control* 30: 213–217.