**Evidence-based Practice Center**
**Technical Brief Protocol**

**Project Title: Environmental Cleaning for the Prevention of Healthcare-Associated Infections (HAI)**

## I.    Background and Objectives for the Technical Brief

Environmental cleaning is a fundamental principle of infection prevention in healthcare settings. Contaminated hospital surfaces play an important role in the transmission of dangerous pathogens, including *Clostridium difficile*, and antibiotic-resistant organisms such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE). Therefore, appropriate disinfection of those surfaces and equipment which patients and healthcare personnel touch is necessary to reduce exposure. However, the comparative effectiveness of disinfectants, application methods and contamination assessment techniques is unknown, and no consensus exists around benchmarks for cleanliness. This technical brief is intended to map the evidence addressing environmental cleaning, with particular attention given to patient-centered outcomes.

### Disinfection Strategies

There are a wide variety of chemical disinfectants approved for use in the hospital setting. The most commonly used surface disinfectants are quaternary ammonium compounds and sodium hypochlorite. The effectiveness of chemical disinfectants can depend both upon the antimicrobial activity of the disinfectant and appropriate application, including adequacy of cleaning, appropriate contact time, and concentration of the disinfectant. A second disinfectant strategy aims to produce "self-disinfecting" surfaces through impregnating or coating surfaces with heavy metals such as copper, silver, germicides, or other modalities (e.g., altering surface topography, activated antimicrobial-releasing surfaces).[1,2] Ideally, disinfection strategies should consider cleaning of fixed room surfaces as well as mobile, or "orphan", devices, such as blood pressure cuffs or computers-on-wheels.

With growing concern that room surfaces may still be inadequately disinfected even with the use of interventions to improve terminal room cleaning following patient discharge, the use of "no-touch" modalities for hospital room disinfection have been developed. These include ultraviolet light (UV-C)[3-5] or fogging with hydrogen peroxide vapor or mist.[6-8] Both of these processes can only be used for terminal cleaning, when patient rooms are empty, and must be preceded by adequate room cleaning to ensure physical removal of organic material or debris from surfaces. A UV-C system cannot disinfect areas without a direct or indirect line of sight, and both UV-C and "fogging" require significant time for effective disinfection and therefore impact bed turnaround time.

### Assessing Contamination Following Environmental Cleaning

Clinical and environmental services staff are faced with distinct challenges as pathogens are capable of surviving for prolonged periods of time on environmental surfaces and may be transmitted to new room occupants following discharge of colonized or infected

patients, even when terminal cleaning has been performed. Effective strategies must therefore be put in place to assess the effectiveness of environmental cleaning and disinfection in healthcare settings to reduce HAIs.

Visual inspection is the most simple method for evaluating cleanliness, but concerns about the adequacy of visual inspection alone[9-11] have fostered the development of technology-based approaches. Several strategies have emerged that may improve the quality of assessment but introduce additional expense and other potential disadvantages. One such alternative is to use aerobic colony counts (ACCs), which are a culture-based method for assessing environmental contamination. Use of ACCs requires the collection and processing of specimens, which increases costs and room turnaround time. Another technique is the use of invisible fluorescent markers placed on high-touch room surfaces before cleaning with UV light inspection following cleaning. This approach provides immediate, direct feedback to environmental services personnel, but also increases costs. Bioluminescence-based adenosine triphosphate (ATP) assays have been developed as another alternative that offers direct, rapid feedback and provides a quantitative measure of cleanliness. However, the detected presence of ATP does not necessarily indicate viable pathogens on the tested surface. As genomic and polymerase chain reaction (PCR)-based technologies become less expensive and more widespread, these may also have a role in assessing environmental contamination and effectiveness of disinfection.

A related and important consideration that will be addressed in this technical brief is the need for identifying standardized criteria for determining that surfaces are "clean" on the basis of each monitoring modality. While routine cleaning strategies may not be expected to result in a completely sterile environment, consensus is needed on the threshold of contamination below which pathogen transmission is minimized and can be considered safe.

**Managing and Monitoring Environmental Services Personnel**

Monitoring the operational processes associated with environmental cleaning services, and properly training and managing the staff charged with these duties, are additional elements necessary for preventing transmission of HAIs. Strategies for assessing compliance may include use of checklists, direct observation (open or covert), and surveys of personnel and patients. Process evaluation and improvement should also consider important human factors and logistical concerns that interact with environmental cleaning procedures, including workflow, staffing, staff training and supervision, collaboration between support services and clinical staff, institutional leadership, and patient preferences. This technical brief will explore these factors and their impact on reducing HAIs.

## II. Guiding Questions

**GQ1:** What are the options for cleaning, disinfecting and monitoring the patient-care environment to reduce surface contamination and prevent HAIs?

- What approaches are currently in use, and what strategies have recently emerged?

- How do cleaning, disinfection, and monitoring strategies interact?
- What advantages and disadvantages may be associated with each option?
- Are there current benchmarks for defining "clean" surfaces? If so, could they serve as useful surrogate measures for HAI transmission? If not, what approaches could be used to establish benchmarks?

**GQ2:** What elements interact with and impact the *implementation* of cleaning, disinfection and monitoring?

- What equipment is necessary to support environmental services operations?
- What other resources are required?
- What are important considerations when training environmental services staff?
- What are current FDA and OSHA regulations that govern disinfection interventions?
- What role do outside contractors serve in the selection and implementation of strategies, and staff training and monitoring?

**GQ3:** What data exist for the effectiveness of different cleaning/disinfection/monitoring options, including for specific pathogens and surfaces, and where are the gaps?

**GQ4**: What future research is needed to address key gaps in the evidence base?

- What outcomes are relevant?
  - HAI rate
  - colonization rate
  - surface pathogen bioburden
  - pathogen/infection specific data vs. composite of common pathogens
  - patient satisfaction
  - cost analysis
- How can studies control for important confounders?
  - multi-component HAI reduction interventions
  - movement of pathogens across surfaces and hospital areas
  - exposure to diverse sources of colonization/infection (e.g. patients, visitors, staff)
  - length of data collection follow-up
- How can research be designed in the context of innumerable combinations of pathogen(s), method(s), and surface type(s) or location(s)?
  - combining or collapsing categories to streamline data and yield more generalizable conclusions
  - representative strategies that can be adapted

### III. Methods

### 1. Data Collection:

### A. Discussions with Key Informants

The KIs will have expertise in one or more of the following areas: infectious disease and infection control, environmental disinfection, hospital epidemiology, microbiology, and the implementation of environmental services in healthcare settings. KIs will be queried on the clinical effectiveness of disinfecting agents and modalities, and the processes and barriers associated with implementation and monitoring. They will be asked about the challenges associated with measuring patient-centered outcomes and the optimal use of surrogate measures. KIs will also provide insight into how environmental services can be monitored in healthcare settings, and the potential impact of cleaning strategies on operational factors such as workflow and patient flow.

KI input will be helpful for informing GQ 1, 2 and 4. KI input will also be used to refine the systematic literature search, identify grey literature resources, provide information about ongoing research, confirm evidence limitations, and recommend approaches to help fill these gaps. Table 1 presents potential questions that would be asked to the KIs.

**Table 1. Potential KI Questions**

| KI Group | Potential Questions |
|---|---|
| Clinical and environment-al services experts | 1. What do you see as the most important advantages and disadvantages of currently used cleaning agents and disinfection strategies? What areas of improvement would you like to see in currently marketed technologies? <br> 2. How do you think the effectiveness of an environmental cleaning intervention to prevent HAIs should be measured? <br> 3. How can environmental services be monitored in real-world settings? <br> 4. Since studies of cleaning and monitoring may not report patient infections as an outcome, what are potential surrogate measures? <br> 5. What long-term outcomes – if any – are reported in existing research, and what long-term outcomes would be most useful for future research to include? <br> 6. In addition to measures of infection rates, what patient-centered outcomes are most important when evaluating cleaning and monitoring? <br> 7. What operational factors (e.g. ease of use, availability, workflow, logistics, cost) are important to consider when implementing cleaning and disinfection processes? Which factors are the biggest barriers? <br> 8. What confounding factors pose a challenge to interpreting research on cleaning and monitoring, and how can studies be designed to minimize these confounders? <br> 9. Where do you think are the most important gaps in current knowledge, and can you recommend approaches to help fill these gaps? <br> 10. Can you suggest strategies we might use to organize, present, and disseminate the findings of this technical brief? |
| Payers | 1. What information about environmental cleaning is most needed by payers? <br> 2. What criteria (clinical effectiveness, safety, adherence to FDA regulations, market value, others) are the most critical when making payment coverage decisions for patients with HAIs? <br> 3. What market incentives, if any, favor the use of particular environmental cleaning products or technologies? Would you consider creating such incentives? <br> 4. What kinds of research would be most useful to make evidence-based coverage decisions? |

| KI Group | Potential Questions |
|---|---|
| | 5. In studies evaluating the effectiveness of environmental cleaning, what patient outcomes would be most useful or helpful to payer coverage decisions? |
| | 6. Are you aware of any current payer/hospital collaborations that are making strides in this field? |
| | 7. What areas of improvement would you like to see in currently marketed technologies? |
| | 8. Are there any specific variables (e.g., insurance status, patient requiring ICU care, hospital characteristics) that you would like us to abstract from the studies that would make the brief more informative to payers? |
| Patient Advocates | 1. How important is cleanliness to patients, family members and guests, compared with other hospital room considerations (such as noise, food, privacy)? |
| | 2. What factors might make a patient room appear to be more clean, or less clean, from the perspective of patients (family/guests)? |
| | 3. What aspects of room cleaning and disinfection processes do patients (family/guests) often notice and remember? |
| | 4. What contributes to patient (family/guest) satisfaction with room cleaning and disinfection processes? What is associated with dissatisfaction? |
| | 5. What outcomes would be most meaningful to patients when assessing the quality of room cleaning and disinfection processes? |

## B. Grey Literature Search

Grey literature will be most helpful for addressing recently emerging technologies, and identifying important contextual factors such as relevant federal regulations, and staff training and management policies. The following gray literature sources will be searched using text words: Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), Food and Drug Administration (FDA), ClinicalTrials.gov, ECRI, Healthcare Standards, Medscape, and the National Guideline Clearinghouse™ (NGC). We will also search the websites of relevant professional organizations, such as the Society for Healthcare Epidemiology of America (SHEA), Infectious Diseases Society of America (IDSA), Association for Professionals in Infection Control and Epidemiology (APIC), American Organization for Nurse Executives (AONE), Association for the Healthcare Environment (AHE), Society of Hospital Medicine (SHM), University Healthsystem Consortium (UHC), Institute for Healthcare Improvement (IHI), and the American Nurses Credentialing Center's Magnet Recognition Program. Finally, input from the KIs will be used to identify other grey literature sources.

## C. Published Literature Search

Published literature will be used to answer GQ 1 and 3. Literature searches will be performed by Medical Librarians within the Evidence-based Practice Center (EPC) Information Center, and will follow established systematic review protocols. We will search the following databases using controlled vocabulary and text words: MEDLINE, PubMed (unprocessed records only), EMBASE, CINAHL, and the Cochrane Library. Searches will cover the literature published from January 1, 1990 through 2014. This timeframe is likely to include contemporary disinfection technologies and monitoring approaches, while excluding strategies that are no longer in use. Additionally, significant advances in hand hygiene and other infection control protocols have emerged during

approximately the past twenty-five years. Older studies may not reflect these important improvements in the clinical environment. Search dates may be adjusted based on the quantity and quality of the available literature. Appendix 1 presents a sample search strategy.

Literature screening will be performed in duplicate using the database Distiller SR (Evidence Partners, Ottawa, Canada). Literature search results will initially be screened for relevancy. Relevant abstracts will be screened in duplicate. Studies that appear to fit the scope of the brief will be retrieved in full and screened again in duplicate. All disagreements will be resolved by consensus discussion among the two original screeners. Studies will be included if they address a guiding question; present data on adult patients admitted to a hospital setting; address "high-touch" surfaces that comprise the environmental reservoir of a patient care area; and are full-length English language publications. Studies will be excluded if they occur exclusively in pediatric, ambulatory, or long-term care settings; address only routes of transmission that are not inherent to the environmental reservoir (e.g. caregiver hands or stethoscopes, patient and guest personal items, linens and similar items with distinct disinfection procedures); or are available only as abstracts. The literature searches will be updated during the Peer Review process, before finalization of the review.

## 2. Data Organization and Presentation:

### A. Information Management

Descriptive characteristics will be abstracted from published studies and tabled. Factors to be abstracted will include, but may not be limited to, PICOTS categories (population, intervention, comparator, outcomes, timing, setting.) We will highlight features that can be important for developing an evidence map and identifying research gaps. These may include study design, patient population, hospital characteristics, hand hygiene policies and similar concurrent infection control procedures, pathogen type, infection site, type of cleaning or monitoring modality, focus and scope of outcome measure, and analytical technique used to evaluate outcomes. KI interviews will help refine which data points should be abstracted, and how they might be organized.

Grey literature sources will be searched to identify clinical practice guidelines, white papers or position statements, regulatory or safety profiles of interventions, reports of adverse events, descriptions and evaluations of emerging disinfection technologies and monitoring strategies, and influential perspectives on real-world facilitators and barriers to implementation. These sources will be examined to find evidence on recently emerging approaches to cleaning and monitoring, and inform theory on questions that have not been frequently or robustly addressed in the published literature.

KI interviews will be documented during each call by a designated member of the project team. Notes will be reviewed and discussed by the investigators to evaluate how KI input confirms or varies from published evidence. KI discussions will also provide insight on emerging disinfection and monitoring strategies, evidence gaps, and human and system factors that impact implementation.

### B. Data Presentation

Data will be organized into an evidence map that chronicles the scope and depth of existing research on cleaning, disinfection, and monitoring processes, while highlighting important gaps in the evidence base. Characteristics and outcomes abstracted from published studies and grey literature will be presented in evidence tables, and also summarized and combined into larger categories to populate the evidence map. Significant perspectives and insights gathered from the KIs will be summarized narratively. KI feedback will inform our approach to constructing an evidence map, and their input will also be important for confirming and prioritizing opportunities for further research.

## IV. References

1.   ECRI Institute. Copper surfaces in the intensive care unit for preventing hospital-acquired infections. Plymouth Meeting (PA): ECRI Institute; 2013 Apr. 9 p. (Health Technology Forecast).

2.   Salgado CD, Sepkowitz KA, John JF, et al. Copper surfaces reduce the rate of healthcare-acquired infections in the intensive care unit. Infect Control Hosp Epidemiol. 2013 May;34(5):479-86. PMID: 23571364

3.   Jinadatha C, Quezada R, Huber TW, et al. Evaluation of a pulsed-xenon ultraviolet room disinfection device for impact on contamination levels of methicillin-resistant Staphylococcus aureus. BMC Infect Dis. 2014;14(1):187. Also available: http://dx.doi.org/10.1186/1471-2334-14-187. PMID: 24708734

4.   Qureshi Z, Yassin MH. Role of ultraviolet (UV) disinfection in infection control and environmental cleaning. Infect Disord Drug Targets. 2013 Jun;13(3):191-5. PMID: 23961739

5.   ECRI Institute. Ultraviolet light environmental disinfection systems. Plymouth Meeting (PA): ECRI Institute; 2012 Feb 16. 7 p. (Hotline Response).

6.   Passaretti CL, Otter JA, Reich NG, et al. An evaluation of environmental decontamination with hydrogen peroxide vapor for reducing the risk of patient acquisition of multidrug-resistant organisms. Clin Infect Dis. 2013 Jan;56(1):27-35. Also available: http://dx.doi.org/10.1093/cid/cis839. PMID: 23042972

7.   Manian FA, Griesnauer S, Bryant A. Implementation of hospital-wide enhanced terminal cleaning of targeted patient rooms and its impact on endemic Clostridium difficile infection rates. Am J Infect Control. 2013 Jun 1;41(6):537-42. Also available: http://dx.doi.org/10.1016/j.ajic.2012.06.014.

8.   ECRI Institute. Hydrogen peroxide vapor technology for decontaminating health facilities. Plymouth Meeting (PA): ECRI Institute; 2012 Nov. 16 p. (Hotline Response).

9.   Snyder GM, Holyoak AD, Leary KE, et al. Effectiveness of visual inspection compared with non-microbiologic methods to determine the thoroughness of post-discharge cleaning. Antimicrob Resist Infect Control. 2013;2(1):26. Also available: http://dx.doi.org/10.1186/2047-2994-2-26. PMID: 24088298

10.  Mulvey D, Redding P, Robertson C, et al. Finding a benchmark for monitoring hospital cleanliness. J. Hosp. Infect. 2011 Jan;77(1):25-30. Also available: http://dx.doi.org/10.1016/j.jhin.2010.08.006. PMID: 21129820

11.  Sherlock O, OConnell N, Creamer E, et al. Is it really clean? An evaluation of the efficacy of four methods for determining hospital cleanliness. J. Hosp. Infect. 2009 Jun;72(2):140-6. Also available: http://dx.doi.org/10.1016/j.jhin.2009.02.013. PMID: 19321226

## V. Definition of Terms

Environmental cleaning: processes associated with cleaning and disinfection of surfaces and substances that can pose a risk of harm to patients

Environmental services: an operational unit within a hospital or health care facility that is responsible for cleaning, housekeeping, laundry, and related duties

HAIs: healthcare associated infections; infections transmitted to patients while in a healthcare facility or during medical treatment

Colonization: the presence of bacteria or bacterial infection on a patient's body without signs or symptoms of infection-related illness; or bacteria present on a surface that may come into contact with a patient

## VI. Summary of Protocol Amendments

There are no amendments.

## VII. Key Informants

Within the Technical Brief process, Key Informants serve as a resource to offer insight into the clinical context of the technology/intervention, how it works, how it is currently used or might be used, and which features may be important from a patient or policy standpoint. They may include clinical experts, patients, manufacturers, researchers, payers, or other perspectives, depending on the technology/intervention in question. Differing viewpoints are expected, and all statements are crosschecked against available literature and statements from other Key Informants. Information gained from Key Informant interviews is identified as such in the report. Key Informants do not do analysis of any kind nor contribute to the writing of the report and have not reviewed the report, except as given the opportunity to do so through the public review mechanism

Key Informants must disclose any financial conflicts of interest greater than $10,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals are invited to serve as Key Informants and those who present with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential conflicts of interest identified.

## VIII. Peer Reviewers

Peer reviewers are invited to provide written comments on the draft report based on their clinical, content, or methodologic expertise. Peer review comments on the preliminary draft of the report are considered by the EPC in preparation of the final draft of the report. Peer reviewers do not participate in writing or editing of the final report or other products. The synthesis of the scientific literature presented in the final report does not necessarily represent the views of individual reviewers. The dispositions of the peer review comments are documented and will be published three months after the publication of the Evidence report.

Potential Reviewers must disclose any financial conflicts of interest greater than $10,000 and any other relevant business or professional conflicts of interest. Invited Peer

Reviewers may not have any financial conflict of interest greater than $10,000. Peer reviewers who disclose potential business or professional conflicts of interest may submit comments on draft reports through the public comment mechanism.

**Appendix 1. Sample Search Strategy**

| Set # | Concept | Search Statement |
|---|---|---|
| 1 | Infection (broad terms) | "hospital infection"/de<br><br>("health care acquired" next/1 (infection* OR pathogen*)) OR ("healthcare acquired" next/1 (infection* OR pathogen*)) OR ("hospital acquired" next/1 (infection* OR pathogen*)) OR ("health care associated" next/1 (infection* OR pathogen*)) OR ("healthcare associated" next/1 (infection* OR pathogen*)) OR ("hospital associated" next/1 (infection* OR pathogen*))<br><br>(HAI OR HAIS OR HAP OR HAPS):ti |
| 2 | Infection (specific terms) | ("clostridium difficile" OR "clostridium difficile infection" OR "methicillin resistant staphylococcus aureus" OR "methicillin resistant staphylococcus aureus infection" OR enterococcus OR "vancomycin resistant enterococcus" OR "enterococcal infection")/de<br><br>((antibiotic OR methicillin OR vancomycin) next/1 resistan*):ti,ab<br><br>(difficile OR "methicillin resistant staphylococcus aureus" OR ("vancomycin resistant" next/1 enterococc*)):ti,ab<br><br>(CDI OR MRSA OR VRE):ti |
| 3 | Setting (healthcare) | ("health care facility" OR hospital OR "hospital discharge")/de<br><br>("acute care" OR "burn unit" OR "burn units" OR "common area" OR "common areas" OR "healthcare facility" OR "healthcare facilities" OR "health care facility" OR "health care facilities" OR hospital OR hospitals OR institution OR institutions OR "intensive care" OR "patient care area" OR "medical facility" OR "medical facilities" OR "patient care areas" OR "patient room" OR "patient rooms" OR "patients rooms" OR "health care setting" OR "health care settings" OR ward OR wards):ti,ab |
| 4 | Setting (surfaces) | ("disease carrier" OR fomite OR hospital bed" OR "hospital equipment" OR "surface property")/de<br><br>("bed rail" OR "bed rails" OR bedrail* OR bathroom* OR cart OR carts OR chair OR chairs OR commode* OR counter OR counters OR "environmental reservoir" OR environmental reservoirs" OR fomes OR fomites OR "high-touch area" OR "high-touch areas" OR "mobile equipment" OR "portable medical equipment" OR railing OR railings OR "shared medical equipment" OR surface OR surfaces OR wheelchair*):ti,ab<br><br>surface*:ti |
| 5 | Combine sets (specific infections) | S2 AND (S3 OR S4) |
| 6 | Combine sets (infections and surfaces) | S4 AND (contaminat* OR infection* OR pathogen*):ti,ab |
| 7 | Combine sets (all infections and all surfaces) | S1 OR S5 OR S6 |
| 8 | General cleaning | (cleaning OR disinfection OR "environmental sanitation" OR hygiene OR "hospital hygiene" OR "infection control")/de<br><br>("cleaning method" OR "cleaning methods" OR "cleaning routines" OR "discharge cleaning: OR "environmental cleaning" OR "environmental cleanliness" OR "environmental decontamination" OR "environmental disinfection" OR "environmental hygiene" OR "environmental sanitation" OR housekeeping OR "room cleaning" OR "room decontamination" OR "surface cleaning" OR "surface disinfection" OR "terminal cleaning"):ti,ab<br><br>(cleaning OR decontamination OR disinfect* OR "hospital hygiene"):ti |

| 9 | Disinfectants | "antiinfective agent"/de |
|---|---|---|
| | | "disinfectant agent"/exp |
| | | (disinfectant* OR germicid* OR sporicid*):ti |
| | | (alcohol OR alcohols OR bleach* OR "calcium hypochlorite" OR chlorine OR "ethyl alcohol" OR "hydrogen peroxide" OR "hydrogen peroxides" OR "isopropyl alcohol" OR phenolics OR "quaternary ammonium" OR "sodium hypochlorite") |
| | | ("disinfecting agent" OR "disinfecting agents" OR "hospital disinfectant" OR "hospital disinfectants" OR "surface disinfectants"):ti,ab |
| 10 | Automated cleaning | ("disinfection system" OR "ultraviolet irradiation" OR vapor OR "water vapor")/de |
| | | (automat* OR ultraviolet OR UV OR vaporis* OR "vaporiz*"):ti |
| | | ("aerosol devices" OR "automated device" OR "automated devices" OR "automated cleaning" OR "automated disinfection" OR "copper silver ionisation" OR "copper silver ionization" OR  fogging OR "germicidal irradiation" OR "hydrogen peroxide decontamination" OR "hydrogen peroxide system" OR "hydrogen peroxide systems" OR "hydrogen peroxide vapor" OR "hydrogen peroxide vapour" OR "room sterilization" OR "room sterilization" OR "silver ion" OR "silver ions" OR steam*):ti,ab |
| | | (ultraviolet OR UV) next/1 (disinfection OR light OR irradiation) |
| 11 | Enhanced coatings and surfaces) | (antimicrobial* OR copper OR coating* OR microbiocid*):ti |
| | | (copper next/1 (coating* OR surface*)):ti,ab |
| | | "self disinfecting":ti,ab |
| 12 | Combine sets (all cleaning and coatings) | S8 OR S9 OR S10 OR S11 |
| 13 | Cleaning personnel | ("health care personnel" OR "hospital service")/de |
| | | ("cleaning personnel" OR "cleaning service" OR "cleaning services" OR "cleaning staff" OR "healthcare worker" OR "healthcare workers" OR housekeeper* OR housekeeping OR "service worker" OR "service workers"):ti,ab |
| 14 | Combine sets (all infections and cleaning methods / cleaning personnel) | S7 AND (S12 OR S13) |