



The DiskCover® System

Key Clinical Data Points for Objection Rebuttal

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Scope

This document outlines the most common objections to adoption of The DiskCover System. Rebuttals are provided for each objection, backed by citations and clickable hyperlinks to clinical evidence from literature published in peer-reviewed scientific journals.

This document will not outline efficacy of The DiskCover System. Such information and supporting clinical evidence can be found on <https://diskcover.com/>.



Disclaimer for prospects: Data is referenced from publicly accessible scientific journals. Reference to such works should not be misconstrued as advocacy of The DiskCover System by the related works' authors.

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Objection 1:

- “Disk covers do not protect patients from the tubing”
-

Refutation:

The majority of pathogens that a clinician harbors are in two places, the fingertips, and the stethoscope diaphragm, after those locations the population is small.¹ Therefore, these two locations should be cleaned and/or protected.

Aside from the fingertips and the stethoscope diaphragm, contact with the patient is minimal. Neither the physician's elbows, nor the stethoscope tubing are rubbed on the patient like the diaphragm and the fingertips. If you believe that you should clean the entire stethoscope, then you should also clean both entire arms between patients. However, **as the elbows and stethoscope tubing are rarely, and never intentionally, in direct contact with the patient, full barrier precautions for the tubing are not necessary.**

If protocols are in place at a facility that require disinfection of the stethoscope tubing, they may still be carried out in addition to use of The DiskCover System.

Citation:

1. Longtin Y. Contamination of Stethoscopes and Physicians' Hands After a Physical Examination. Mayo Clin Proc. 2014;89(3):291-299.





Contamination of Stethoscopes and Physicians' Hands After a Physical Examination

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Abstract

Objectives: To compare the contamination level of physicians' hands and stethoscopes and to explore the risk of cross-transmission of microorganisms through the use of stethoscopes.

Patients and Methods: We conducted a structured prospective study between January 1, 2009, and May 31, 2009, involving 83 inpatients at a Swiss university teaching hospital. After a standardized physical examination, 4 regions of the physician's gloved or ungloved dominant hand and 2 sections of the stethoscopes were pressed onto selective and nonselective media; 489 surfaces were sampled. Total aerobic colony counts (ACCs) and total methicillin-resistant *Staphylococcus aureus* (MRSA) colony-forming unit (CFU) counts were assessed.

Results: Median total ACCs (interquartile range) for fingertips, thenar eminence, hypothenar eminence, hand dorsum, stethoscope diaphragm, and tube were 467, 37, 34, 8, 89, and 18, respectively. The contamination level of the diaphragm was lower than the contamination level of the fingertips ($P<.001$) but higher than the contamination level of the thenar eminence ($P=.004$). The MRSA contamination level of the diaphragm was higher than the MRSA contamination level of the thenar eminence (7 CFUs/25 cm² vs 4 CFUs/25 cm², $P=.004$). The correlation analysis for both total ACCs and MRSA CFU counts revealed that the contamination level of the diaphragm was associated with the contamination level of the fingertips (Spearman's rank correlation coefficient, $p=.80$; $P<.001$ and $p=.76$; $P<.001$, respectively). Similarly, the contamination level of the stethoscope tube increased with the increase in the contamination level of the fingertips for both total ACCs and MRSA CFU counts ($p=.56$; $P<.001$ and $p=.59$; $P<.001$, respectively).

Conclusion: These results suggest that the contamination level of the stethoscope is substantial after a single physical examination and comparable to the contamination of parts of the physician's dominant hand.

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The patient-to-patient transmission of microorganisms is a major threat to hospitalized patients and causes significant morbidity and mortality. The present evidence indicates that health care workers' hands are the main route of cross-transmission.^{1,2} Small medical equipment, such as stethoscopes, may also contribute to the dissemination of microorganisms, but the evidence supporting this hypothesis is less robust and their role in microorganism propagation is poorly understood. Similar to any piece of medical equipment, stethoscopes have the theoretical capacity to be vectors of pathogens through a multistep process. First, stethoscopes must acquire microorganisms after contact with a source patient.³ Second, these organisms must then survive on the object for at least several minutes and be transferred to the skin of a second patient during

subsequent use. Numerous factors may affect the risk of transmission at each of these steps,^{2,3} and assessing transmissibility is better achieved by studying 1 step at a time.

Many factors must be considered when conducting such studies. For example, as no piece of noncritical equipment used on patient wards is meant to be sterile, most objects in the health care environment will yield microorganisms when sampled. However, the clinical significance of detecting low levels of contamination is uncertain. One way to solve this difficulty and better understand the relative contribution of stethoscopes in the transmission of microorganisms is to place their levels of contamination into perspective with those of a universally recognized vector of dissemination, that is, the physician's own hands. If the number of bacteria recovered from stethoscopes is much lower



For editorial
comment, see
page 277

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Longtin Y. Contamination of Stethoscopes and Physicians' Hands After a Physical Examination. Mayo Clin Proc. 2014;89(3):291-299.



Objection 2:

- “We use disposable, dedicated patient disposables”
 - “We use high-quality, dedicated patient disposables”
-

Refutation:

Both high-quality and disposable, dedicated patient stethoscopes are susceptible to infection, and can spread infection among staff.¹

Moreover, regarding disposable stethoscopes, studies reveal that misdiagnosis rates resulting from use of disposable stethoscopes are between 11% and 31%, given a number of harm between 3 to 10.^{2,3}

If there is ever litigation around the use of disposables, due to either a doctor getting sick or a patient receiving a misdiagnosis due to the use of a disposable stethoscope, it will be indefensible.

Disk covers are acoustically invisible and superior to disposable stethoscopes.³ In 800 high fidelity stethoscope auscultations using a SimMan:

- No diagnostic accuracy difference with (n=400) or without (n=400) a disk cover barrier ($p=1.0$)³
- No differences in digital acoustic output tracing amplitude ($p=1.0$)³

Citations:

1. Whittington AM. Bacterial contamination of stethoscopes on the intensive care unit. *Anaesthesia*, 2009, 64: 620–624.
2. Mehmood M. Comparing the auscultatory accuracy of health care professionals using three different brands of stethoscopes on a simulator. *Medical Devices: Evidence and Research* 2014;7 273–281.
3. Kalra, S. 2021 Jan;96(1):263-264. doi: 10.1016/j.mayocp.2020.10.029.



Bacterial contamination of stethoscopes on the intensive care unit

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Summary

We assessed how often bedside stethoscopes in our intensive care unit were cleaned and whether they became colonised with potentially pathogenic bacteria. On two separate days the 12 nurses attending the bedsides were questioned about frequency of stethoscope cleaning on the unit and the bedside stethoscopes were swabbed before and after cleaning to identify colonising organisms. Twenty-two health care providers entering the unit were asked the same questions and had their personal stethoscopes swabbed. All 32 non-medical staff cleaned their stethoscopes at least every day; however only three out of the 12 medical staff cleaned this often. Out of 24 intensive care unit bedside stethoscopes tested, two diaphragms and five carpieces were colonised with pathogenic bacteria. MRSA cultured from one carpiece persisted after cleaning. Three out of the 22 personal stethoscope diaphragms and five carpieces were colonised with pathogens. After cleaning, two diaphragms and two carpieces were still colonised, demonstrating the importance of regular cleaning.

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Stethoscopes were first identified as potential vectors for bacterial infection over 30 years ago [1]. Both the diaphragm and carpieces of physician's personal stethoscopes and bedside stethoscopes are frequently colonised with a variety of pathogenic organisms including methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) which cause significant morbidity and mortality on the intensive care unit (ICU) [2–5]. Cleaning stethoscopes with isopropyl alcohol dramatically reduces the number of bacterial colonies on the diaphragm by 94–100% [2, 3], however regular cleaning has little impact on the colonisation of the carpieces [4]. How often a stethoscope must be cleaned to limit contamination is not well established although there is a correlation between degree of contamination and frequency of cleaning [4].

As is usual practice in critical care, patients on our 12-bed mixed medical and surgical ICU are strictly barrier nursed, with visiting physicians requested to use the bedside stethoscopes, and not their personal equipment. Our unit's infection control guidelines advise that the bedside stethoscopes should be cleaned at the

start of every shift. Our study aimed to answer the following questions:

What was the current stethoscope cleaning practice on our unit?

What was the level of bacterial contamination of stethoscopes?

What was the impact of current user decontamination practice on such contamination?

Methods

The Chairman of our local Research Ethics Committee reviewed the protocol and confirmed that formal ethical committee approval was not required. The study was performed on two separate days, 3 months apart, to ensure that the bedside stethoscopes had been frequently used between study days. On each study day, the 12 nursing staff attending each bed space were asked to complete an anonymous questionnaire asking how often they cleaned the bedside stethoscopes and what method they used. The diaphragm and bell of the stethoscopes were then swabbed with a sterile cotton bud, montenmed



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ORIGINAL RESEARCH

Comparing the auscultatory accuracy of health care professionals using three different brands of stethoscopes on a simulator

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Background: It is considered standard practice to use disposable or patient-dedicated stethoscopes to prevent cross-contamination between patients in contact precautions and others in their vicinity. The literature offers very little information regarding the quality of currently used stethoscopes. This study assessed the fidelity with which acoustics were perceived by a broad range of health care professionals using three brands of stethoscopes.

Methods: This prospective study used a simulation center and volunteer health care professionals to test the sound quality offered by three brands of commonly used stethoscopes. The volunteer's proficiency in identifying five basic auscultatory sounds (wheezing, stridor, crackles, holosystolic murmur, and hyperdynamic bowel sounds) was tested, as well.

Results: A total of 84 health care professionals (ten attending physicians, 35 resident physicians, and 39 intensive care unit [ICU] nurses) participated in the study. The higher-end stethoscope was more reliable than lower-end stethoscopes in facilitating the diagnosis of the auscultatory sounds, especially stridor and crackles. Our volunteers detected all tested sounds correctly in about 69% of cases. As expected, attending physicians performed the best, followed by resident physicians and subsequently ICU nurses. Neither years of experience nor background noise seemed to affect performance. Postgraduate training continues to offer very little to improve our trainees' auscultation skills.

Conclusion: The results of this study indicate that using low-end stethoscopes to care for patients in contact precautions could compromise identifying important auscultatory findings. Furthermore, there continues to be an opportunity to improve our physicians and ICU nurses' auscultation skills.

Keywords: auscultation skills, acoustics, training programs

Introduction

Contact precautions are commonly implemented in hospitals to prevent the spread of multidrug resistant (MDR) bacteria from infected or colonized patients to other individuals in their vicinity.^{1–3} Those precautions include the use of dedicated and sometimes disposable medical equipment while caring for those patients. Examples of disposable medical equipment being used in those circumstances include blood pressure cuffs, pulse oximetry probes, and stethoscopes.⁴

Multiple brands of stethoscopes are commercially available; prices, and potentially quality, vary. Multiple health care professionals in our medical center have raised concerns over the quality of some of the brands of stethoscopes used to care for patients in contact precautions. In addition, the literature offers very little information about the fidelity with which acoustics are conducted to the examiners' ears using the available stethoscopes.⁴

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Medical Devices: Evidence and Research 2014:7 273–281

[Mehmood M. Comparing the auscultatory accuracy of health care professionals using three different brands of stethoscopes on a simulator. Medical Devices: Evidence and Research 2014;7:273–281.](#)



LETTERS TO THE EDITOR

levels of physical activity have been consistently associated, in a dose-dependent manner, with reduced ASCVD events and mortality risks after adjustment for major ASCVD risk factors.^{3,4} Although we agree with Dr Langland that the available evidence supports the view that a very highly active person with a CAC score ≥ 100 is at lower risk of ASCVD than a less active person with the same CAC score, the evidence regarding absolute risk for adverse cardiovascular outcomes in such patients is limited at present and should therefore be interpreted with caution. Statin therapy is associated with reduced incidence of ASCVD events across the spectrum of baseline risk, and, although risk may be lower in highly active individuals for a given level of CAC, it is uncertain whether risk of ASCVD events is low enough to justify withholding statin therapy in those with CAC scores ≥ 100 .⁵ Clinical judgment and a clinician–patient dialog is required regarding the potential benefits and risks of statin therapy in highly active patients with borderline or intermediate estimated 10-year risk and CAC scores ≥ 100 .

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- Grundy SM, Stone NJ, Bailey AL, et al. 2018 AHA/ACC/AACVPR/AAP/AHA/ABC/ACPM/ADA/AGS/ASA/ASPC/NLA/PCNA guideline on the management of blood cholesterol: A Report of

Mayo Clin Proc. ■ January 2021;96(1):259–266
www.mayoclinicproceedings.org

the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019;139(15):e082-e1143.

- Cholesterol Treatment Trialists' (CTT) Collaboration, Mihaylova B, Emberson J, et al. The effects of lowering LDL cholesterol with statin therapy in people at low risk of vascular disease: meta-analysis of individual data from 27 randomised trials. Lancet. 2012;380(9841):581–590.

- Arnett DK, Blumenthal RS, Albert MA, et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: Executive Summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019;74(10):1376–1414.
- 2018 Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. Washington, DC: US Department of Health and Human Services; 2018. Available at: <https://health.gov/paguidelines/secondedition/report>. Accessed October 4, 2020.

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Aseptic Disposable Stethoscope Barrier:
Acoustically Invisible and Superior to Disposable Stethoscopes

To The Editor: Health care-associated infections (HAIs) occur in ~1.7 million patients annually, and 100,000 patients die, at a cost of \$147 billion.¹ Overall, 85% of stethoscopes (the physician's third hand) are contaminated with the identical pathogens as found on the hands.² Although hand hygiene is emphasized, cleaning stethoscopes between patients occurs in as few as 10% of encounters.³

Unfortunately, Centers for Disease Control and Prevention (CDC) guidelines rely on outdated strategies, instructing providers to clean their own stethoscopes, an intervention that has repeatedly been a dismal failure. Contemporary methods to decrease stethoscope-mediated transmission of pathogens include single-use disposable aseptic diaphragm barriers placed on high-fidelity stethoscopes⁴ (Figure) or auscultation with a disposable single-use stethoscope. How these strategies affect the stethoscope's auscultatory function has not been previously described. Our purpose was to evaluate the auscultation impact of a disposable aseptic barrier and the physician's preferences vs a disposable stethoscope.

We performed an institutional review board-exempt prospective evaluation assessing the sound transmission effects of an aseptic barrier (Disk-Cover, AseptiScope Inc, San Diego, California) placed on a stethoscope diaphragm. Using the Littmann 3200 recording stethoscope (3M, Maplewood, Minnesota) and a simulation mannequin (ISTAN, CAE, Sarasota, Florida), 28 physicians performed auscultations in prespecified locations, for 15 seconds of respiratory wheezes, normal heart sounds, systolic murmurs, and diastolic murmurs. Physicians were blinded to the barriers' presence and received sounds in random order. Digital audio files



FIGURE. Stethoscope barrier dispenser and stethoscope with barrier.

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Objection 3:

- “There is no proof that stethoscopes transmit pathogens between patients”

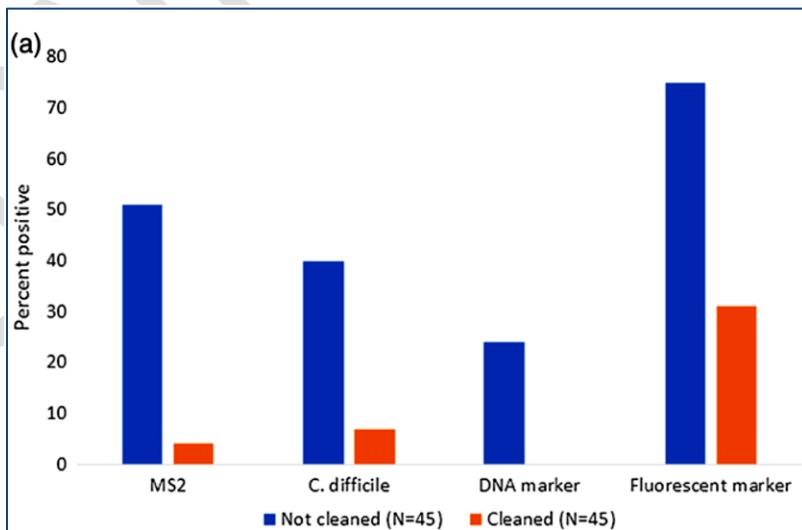
Refutation:

Data Point 1:

In a study, pathogen surrogate markers (cauliflower viral DNA in a bacteriophage) were applied to a mannequin. The mannequin was auscultated with an unprotected stethoscope, then the same stethoscope was used to auscultate a second, clean mannequin, absent of the surrogate markers. The second mannequin was then cultured and the results are shown in the below graph.

Transmission of Bacteriophage MS2, Clostridioides difficile spores, and fluorescent marker were observed regardless of whether the stethoscope was cleaned between auscultation of the two mannequins or not.¹

Transfer of pathogen surrogate markers from a contaminated to clean mannequin by stethoscopes¹



Objection 3:

- “**There is no proof that stethoscopes transmit pathogens between patients**”
-

Refutation cont.:

Data Point 2:

The transfer of 31 benign surrogate patient and environment markers was observed within a hospital over 3 months. Of 145 observed contact interactions, 28.3% transferred to a second patient. **The stethoscope had the highest number of transfer events, even higher than the hands.²**

Data Point 3:

Non-toxigenic *C. diff* spores were inoculated onto disinfected stethoscope diaphragms and volunteer's forearms. A standard exam pressing the stethoscope diaphragm for 5 seconds in 12 locations (for heart, lung, and abdomen exams) was done on 35 known *C. diff* patients, and **an observed 14% of exams subsequently transferred *C. diff* spores.³**

Citations:

1. Alhmidi H, Li DF, Cadnum JL, et al. Use of simulations to evaluate the effectiveness of barrier precautions to prevent patient-to-patient transfer of healthcare-associated pathogens. *Infect Control Hosp Epidemiol.* 2021 Apr;42(4):425-430.
2. Thakur, Manish, et al. “Use of Viral DNA Surrogate Markers to Study Routes of Transmission of Healthcare-Associated Pathogens.” *Infection Control & Hospital Epidemiology*, vol. 42, no. 3, 2020, pp. 274-279.
3. Vajravelu RK, Guerrero DM, Jury LA, et al. Evaluation of stethoscopes as vectors of Clostridium difficile and methicillin-resistant Staphylococcus aureus. *Infect Control Hosp Epidemiol.* 2012 Jan;33(1):96-8. doi: 10.1086/663338.



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Original Article

Use of simulations to evaluate the effectiveness of barrier precautions to prevent patient-to-patient transfer of healthcare-associated pathogens

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Abstract

Background: There is controversy regarding whether the addition of cover gowns offers a substantial benefit over gloves alone in reducing personnel contamination and preventing pathogen transmission.

Design: Simulated patient care interactions.

Objective: To evaluate the efficacy of different types of barrier precautions and to identify routes of transmission.

Methods: In randomly ordered sequence, 30 personnel each performed 3 standardized examinations of mannequins contaminated with pathogen surrogate markers (cauliflower mosaic virus DNA, bacteriophage MS2, nontoxicogenic *Clostridioides difficile* spores, and fluorescent tracer) while wearing no barriers, gloves, or gloves plus gowns followed by examination of a noncontaminated mannequin. We compared the frequency and routes of transfer of the surrogate markers to the second mannequin or the environment.

Results: For a composite of all surrogate markers, transfer by hands occurred at significantly lower rates in the gloves-alone group (OR, 0.02; $P < .001$) and the gloves-plus-gown group (OR, 0.06; $P = .002$). Transfer by stethoscope diaphragms was common in all groups and was reduced by wiping the stethoscope between simulations (OR, 0.06; $P < .001$). Compared to the no-barriers group, wearing a cover gown and gloves resulted in reduced contamination of clothing (OR, 0.15; $P < .001$), but wearing gloves alone did not.

Conclusions: Wearing gloves alone or gloves plus gowns reduces hand transfer of pathogens but may not address transfer by devices such as stethoscopes. Cover gowns reduce the risk of contaminating the clothing of personnel.

(Received 12 February 2020; accepted 10 September 2020)

Healthcare personnel frequently acquire pathogens on their hands and clothing during patient care activities.¹ Such contamination places personnel at risk for colonization or infection with pathogens and contributes to transmission.^{1,2} The use of gloves reduces the risk for hand contamination, including with *Clostridioides difficile* spores that are resistant to killing by alcohol hand sanitizer.^{3–5} The addition of cover gowns to gloves has been shown to reduce contamination of the clothing of personnel.⁶ However, there is controversy regarding whether the addition of gowns offers a substantial benefit in reducing the risk for pathogen transmission. Some studies have demonstrated reductions in pathogen transmission with the use of gloves and gowns,^{7–9} but others have not.^{10,11} Moreover, personnel often contaminate their skin and clothing during the removal of contaminated gloves and gowns.^{1,12}

Simulations using benign surrogate markers can be useful in understanding the spread of pathogens and in testing

interventions.^{1,13–17} Commonly used benign surrogate markers include live viruses (eg, enveloped and nonenveloped bacteriophages), viral DNA, and fluorescent tracers.^{13–18} The bacteriophages have characteristics similar to live pathogenic viruses (ie, susceptible to alcohol hand sanitizer and nonsporcidal disinfectants), whereas viral DNA is more similar to *C. difficile* spores (ie, not affected by alcohol or nonsporcidal disinfectants but denatured by bleach and reduced by mechanical washing or wiping).¹⁸ In this study, we used simulated patient care interactions to compare the effectiveness of different levels of barrier precautions in reducing the transfer of multiple surrogate markers. We hypothesized that the use of gloves would reduce transfer of pathogens and that the addition of a cover gown would further reduce transfer.

Methods

Simulated patient care interactions

The study protocol was approved by the Institutional Review Board of the Louis Stokes Cleveland VA Medical Center. The study was conducted in 2 adjacent simulated patient rooms with life-sized mannequins in hospital beds. One mannequin was

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Original Article

Use of viral DNA surrogate markers to study routes of transmission of healthcare-associated pathogens

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Abstract

Background: The hands of healthcare personnel are the most important source for transmission of healthcare-associated pathogens. The role of contaminated fomites such as portable equipment, stethoscopes, and clothing of personnel in pathogen transmission is unclear.

Objective: To study routes of transmission of cauliflower mosaic virus DNA markers from 31 source patients and from environmental surfaces in their rooms.

Design: A 3-month observational cohort study.

Setting: A Veterans' Affairs hospital.

Methods: After providing care for source patients, healthcare personnel were observed during interactions with subsequent patients. Putative routes of transmission were identified based on recovery of DNA markers from sites of contact with the patient or environment. To assess plausibility of fomite-mediated transmission, we assessed the frequency of transfer of methicillin-resistant *Staphylococcus aureus* (MRSA) from the skin of 25 colonized patients via gloved hands versus fomites.

Results: Of 145 interactions involving contact with patients and/or the environment, 41 (28.3%) resulted in transfer of 1 or both DNA markers to the patient and/or the environment. The DNA marker applied to patients' skin and clothing was transferred most frequently by stethoscopes, hands, and portable equipment, whereas the marker applied to environmental surfaces was transferred only by hands and clothing. The percentages of MRSA transfer from the skin of colonized patients via gloved hands, stethoscope diaphragms, and clothing were 52%, 40%, and 48%, respectively.

Conclusions: Fomites such as stethoscopes, clothing, and portable equipment may be underappreciated sources of pathogen transmission. Simple interventions such as decontamination of fomites between patients could reduce the risk for transmission.

(Received 10 January 2020; accepted 31 August 2020)

Colonized or infected patients often contaminate their skin, clothing, and the environment with healthcare-associated pathogens.¹ Such contamination may serve as a source for transmission. The hands of healthcare personnel are generally considered the primary source for transfer of pathogens from patient to patient.¹ The clothing of personnel, portable equipment such as thermometers, and stethoscopes have also been implicated as potential sources of transmission.^{2–9} However, although many studies have demonstrated frequent contamination of clothing and shared devices, there is uncertainty regarding the importance of these items in pathogen transmission. A better understanding of routes of transmission is needed to develop effective control strategies.

In several recent studies, cauliflower mosaic virus DNA markers have been used to as benign surrogate markers to study routes of pathogen transmission.^{10–14} For example, in a medical and surgical intensive care unit, it was demonstrated that a viral DNA marker inoculated onto shared portable equipment disseminated widely to surfaces in patient rooms and provider work areas and to other types of portable equipment.¹¹ The viral DNA marker is like *C. difficile* spores in that it is not affected by alcohol hand sanitizer or quaternary ammonium disinfectants but is denatured by sodium hypochlorite and reduced by mechanical washing or wiping.¹⁵ In simulations of patient care, a cauliflower mosaic virus DNA marker and *C. difficile* spores demonstrated similar dissemination to the environment, but the DNA marker was more frequently detected on skin and clothing of personnel after removal of personal protective equipment.¹⁵ In the current study, we used cauliflower mosaic virus DNA markers to examine routes of transfer of pathogens from patient to patient. We hypothesized that personnel clothing,

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Thakur, Manish, et al. "Use of Viral DNA Surrogate Markers to Study Routes of Transmission of Healthcare-Associated Pathogens." *Infection Control & Hospital Epidemiology*, vol. 42, no. 3, 2020, pp. 274–279..



Objection 4:

- “**You do not have a study comparing baseline HAI rates before and after use of The DiskCover System”**
-

Refutation:

The challenge here is one of costs. The perfect study could easily be proposed, but it would be an extremely **difficult and expensive** (~\$10 million budget) endeavor.

A lesser funded study may propose obtaining baseline HAI rates, then recording HAI rates after implementation of The DiskCover System in the same environment for a period and seeing if HAI rates are affected. However, the results of such a study would be **inconclusive** unless all other variables affecting HAI rates other than the stethoscope, such as preventing visitors, keeping food sterile, ensuring all equipment is clean, etc., are removed.

Finally, a study that proposes tests to see if a disk cover protected diaphragm transmits infection from a known infected patient to another patient would be **unethical**. Patients would have to sign a consent form that they may knowingly be subjected to dangerous pathogens. Whether they sign it or not, the entire idea of the study is unfeasible.

In lieu of such a difficult and expensive baseline HAI rate comparison study, the mounting clinical evidence that cements the stethoscope as a dangerous vector, as well as the efficacy of aseptic barriers for stethoscope diaphragms, are provided together. Such articles can be accessed on The DiskCover System Clinical Library website at <https://diskcover.com/clinical-library/>.



Objection 5:

- “Our protocol is to clean with an alcohol wipe between every patient, so our staff already does this.”
-

Refutation:

Before going into clinical evidence, a very apparent issue with alcohol wipe cleaning of the stethoscope diaphragm is the time consumption. Suppose an ER doctor regularly sees 50 patients a day. If this doctor is to wipe their stethoscope for 60 seconds before each patient, that's 50 minutes a day allocated entirely to cleaning their stethoscope.

Data Point 1:

Stethoscope hygiene compliance by staff is difficult and often unenforced. In a direct observational study of a hospital's emergency, labor and delivery, and ICU departments, 400 healthcare provider-to-patient interactions were observed. **Only in 4% of these interactions was the stethoscope cleaned correctly per CDC guidelines.¹**

Data Point 2:

Commonly used cleaning practices reduce contamination but are only partially effective.² A study found that immediately after cleaning with 65% isopropyl alcohol, the stethoscope diaphragm maintains a pathogen rate of 28%.³

Data Point 3:

Enforced training of healthcare workers on stethoscope hygiene and disinfection of the stethoscope diaphragm has been demonstrated to be ineffective.⁴ Although disinfection habits improved and the overall bacterial loads of contamination were reduced after intervention, contamination rate by nosocomial pathogens and MDR bacteria did not decrease significantly.⁴



In Summary:

Stethoscope hygiene compliance is difficult to enforce, and even when staff correctly clean their stethoscopes as per CDC guidelines, a significant amount of stethoscope diaphragms are still infected with pathogens. **Therefore, cleaning with an alcohol wipe is both implausible and ineffective.**

Citations:

1. Vasudevan, Rajiv S., et al. "Observation of Stethoscope Sanitation Practices in an Emergency Department Setting." American Journal of Infection Control, vol. 47, no. 3, 2019, pp. 234–237, <https://doi.org/10.1016/j.ajic.2018.08.028>.
2. Knecht, Infection Control & Hospital Epidemiology (2018), 0,1-7 doi:10.1017/ice.2018.319
3. Parmar RC, Valvi CC, Sira P, Kamat JR. A prospective, randomised, double-blind study of comparative efficacy of immediate versus daily cleaning of stethoscope using 66% ethyl alcohol. Indian J Med Sci. 2004 Oct;58(10):423-30. PMID: 15523163.
4. Lee, Raeseok, et al. "A Quasi-Experimental Study on Stethoscopes Contamination with Multidrug-Resistant Bacteria: Its Role as a Vehicle of Transmission." PLOS ONE, vol. 16, no. 4, 2021, <https://doi.org/10.1371/journal.pone.0250455>.



Am J Infect Control. 2019 Mar;47(3):234-237. doi: 10.1016/j.ajic.2018.08.028. Epub 2018 Nov 8.

Observation of stethoscope sanitation practices in an emergency department setting

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Affiliations + expand

PMID: 30415805 DOI: 10.1016/j.ajic.2018.08.028

Abstract

Background: Stethoscopes harbor pathogens that can be transferred to patients when proper sanitary measures are not taken. Our aim was to assess medical provider stethoscope cleaning and hand hygiene in an emergency department setting.

Methods: The frequency and methods of stethoscope cleaning during and after provider-patient encounters were observed anonymously in an emergency department of the VA San Diego Healthcare System.

Results: Among the total of 426 encounters, 115 (26.9%) involved the use of a personal stethoscope. In 15 of these 115 encounters (13.0%), the provider placed a glove over the stethoscope before patient contact. In 13 of these 115 encounters (11.3%), the provider cleaned the stethoscope with an alcohol swab after patient interaction. Stethoscope hygiene with water and a hand towel before patient interaction was observed in 5 of these 115 encounters (4.3%). Hand sanitizer use or handwashing was observed in 213 of the 426 encounters (50.0%) before patient interaction. Gloves were used before patient interaction in 206 of these 426 encounters (48.4%). Hand sanitizer or handwashing was used in 332 of the 426 encounters (77.9%) after patient interaction.

Conclusions: Rates of stethoscope and hand hygiene performance were lower than expected. Further investigation of stethoscope contamination and the associated risk of nosocomial infection are needed. Perhaps clearer guidelines on proper stethoscope cleaning would reduce this risk.

Keywords: Emergency department; Hospital-acquired infection; Hygiene; Stethoscope.

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Vasudevan, Rajiv S., et al. "Observation of Stethoscope Sanitation Practices in an Emergency Department Setting." American Journal of Infection Control, vol. 47, no. 3, 2019, pp. 234–237, <https://doi.org/10.1016/j.ajic.2018.08.028>.



Infection Control & Hospital Epidemiology (2019), 40, 171–177
doi:10.1017/ice.2018.319



Original Article

Molecular analysis of bacterial contamination on stethoscopes in an intensive care unit

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Abstract

Background: Culture-based studies, which focus on individual organisms, have implicated stethoscopes as potential vectors of nosocomial bacterial transmission. However, the full bacterial communities that contaminate in-use stethoscopes have not been investigated.

Methods: We used bacterial 16S rRNA gene deep sequencing, analysis, and quantification to profile entire bacterial populations on stethoscopes in use in an intensive care unit (ICU), including practitioner stethoscopes, individual-use patient-room stethoscopes, and clean unused individual-use stethoscopes. Two additional sets of practitioner stethoscopes were sampled before and after cleaning using standardized or practitioner-preferred methods.

Results: Bacterial contamination levels were highest on practitioner stethoscopes, followed by patient-room stethoscopes, whereas clean stethoscopes were indistinguishable from background controls. Bacterial communities on stethoscopes were complex, and community analysis by weighted UniFrac showed that physician and patient-room stethoscopes were indistinguishable and significantly different from clean stethoscopes and background controls. Genera relevant to healthcare-associated infections (HAIs) were common on practitioner stethoscopes, among which *Staphylococcus* was ubiquitous and had the highest relative abundance (6.8%–14% of contaminating bacterial sequences). Other HAI-related genera were also widespread although lower in abundance. Cleaning of practitioner stethoscopes resulted in a significant reduction in bacterial contamination levels, but these levels reached those of clean stethoscopes in only a few cases with either standardized or practitioner-preferred methods, and bacterial community composition did not significantly change.

Conclusions: Stethoscopes used in an ICU carry bacterial DNA reflecting complex microbial communities that include nosocomially important taxa. Commonly used cleaning practices reduce contamination but are only partially successful at modifying or eliminating these communities.

(Received 1 August 2018; accepted 13 November 2018)

Stethoscopes are frequently used on multiple patients, and they have been implicated as vectors for nosocomial transfer of bacteria responsible for healthcare-associated infections (HAIs). It is well documented that practitioner stethoscopes are not routinely disinfected,^{1,2} and studies based on bacterial culture show that they may be contaminated with potential pathogens including methicillin-resistant and -sensitive *Staphylococcus* spp, multidrug-resistant *P. aeruginosa*, *Acinetobacter* spp, *Enterococcus* spp, *Escherichia coli*, *Klebsiella* spp, and *Streptococcus* spp.^{3–5} Culture-based studies have also shown that thorough stethoscope decontamination can significantly reduce pathogen colony-forming units (CFUs),^{6,7} although the impact of actual practitioner practices is less clear. Culture-based studies are limited, however, because culture can only identify agents of *a priori* interest but not entire microbial communities that may be present.

In contrast to culture, which is focused on individual bacteria and is only semi-quantitative, emerging molecular approaches using next-generation sequencing can provide unbiased profiling of entire bacterial communities in a manner that is both comprehensive and highly quantitative.^{8,9} These powerful approaches have revolutionized studies of the microbiome and of microbial ecology. Here, we used next-generation sequencing to investigate bacterial contamination on several types of stethoscopes in a medical intensive care unit (ICU), including stethoscopes carried by practitioners and used with multiple patients. We also investigated the effects of cleaning protocols that are used by practitioners in everyday practice.

Materials and Methods

Sample collection method (set A)

Stethoscope samples were collected in the medical ICU at the Hospital of the University of Pennsylvania. Stethoscope diaphragms were swabbed for 60 seconds using a flocked swab

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Clinical Trial > Indian J Med Sci. 2004 Oct;58(10):423-30.

A prospective, randomised, double-blind study of comparative efficacy of immediate versus daily cleaning of stethoscope using 66% ethyl alcohol

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PMID: 15523163

Abstract

Objective: Studies have demonstrated frequent contamination of stethoscope and usefulness of different disinfectants. Albeit, studies on the precise mode of cleaning and frequency of cleaning are lacking. This study was carried out to determine efficacy of 66% ethyl alcohol as disinfectant, rate of recontamination without cleaning and benefits of daily versus immediate cleaning.

Methodology: Prospective, randomised, double blind study of 100 stethoscopes. Four cultures were obtained: before cleaning (Group A), immediately after cleaning with 66% ethyl alcohol (Group B), at the end of 4 days without cleaning (Group C) and at the end of 4 days after cleaning once a day (Group D). Samples were analysed using standard microbiological methods and Colony-forming unit (CFU) count and residual microorganism was computed for all the positive cultures. Medical staff was asked about the cleaning practices. Statistical analysis was carried out using 95% confidence interval and Chi-square test.

Results: 90% of the stethoscopes were contaminated with one or more microorganisms. Immediate cleaning and daily cleaning were associated with a significant reduction in the rate of contamination to 28% and 25% respectively. CFU count in groups B and D dropped to less than 10 in 75% and 84.7%, while the mean residual rates were 5.2% and 3.65% respectively. Groups B and D showed no statistically significant difference in terms of efficacy of disinfection.

Conclusions: 66% ethyl alcohol is an effective disinfectant. The effects of immediate cleaning and cleaning once a day on residual flora on the diaphragm of stethoscope is comparable.

[Parmar RC, Valvi CC, Sira P, Kamat JR. A prospective, randomised, double-blind study of comparative efficacy of immediate versus daily cleaning of stethoscope using 66% ethyl alcohol. Indian J Med Sci. 2004 Oct;58\(10\):423-30. PMID: 15523163.](#)



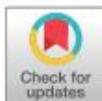
RESEARCH ARTICLE

A quasi-experimental study on stethoscopes contamination with multidrug-resistant bacteria: Its role as a vehicle of transmission

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Data Availability Statement: All data files are available from EPOPS database (<https://doi.org/10.8888/EPOPS202101201MI>).

Abstract

Stethoscopes have been suggested to be a possible vector of contact transmission. However, only a few studies have focused on the prevalence of contamination by multidrug-resistant (MDR) bacteria and effectiveness of disinfection training to reduce. This study is to investigate the burden of stethoscope contamination with nosocomial pathogens and multidrug-resistant (MDR) bacteria and to analyze habit changes in disinfection of stethoscopes among healthcare workers (HCWs) before and after education and training. We performed a prospective pre and post quasi-experimental study. A total of 100 HCWs (55 doctors and 45 nurses) were recruited. HCWs were surveyed on their disinfection behavior and stethoscopes were cultured by pressing the diaphragm directly onto a blood agar plate before and after education on disinfection. Pulsed-field gel electrophoresis was performed to determine the relatedness of carbapenem-resistant *Enterobacteriaceae*. Most of the stethoscopes were contaminated with microorganisms before and after the intervention (97.9% and 91.5%, respectively). The contamination rate of stethoscopes with nosocomial pathogens before and after education was 20.8% and 19.2%, respectively. Stethoscope disinfection habits improved (55.1% vs 31.0%; $p<0.001$), and the overall bacterial loads of contamination were reduced (median colony-forming units, 15 vs 10; $p = 0.019$) after the intervention. However, the contamination rate by nosocomial pathogens and MDR bacteria did not decrease significantly. A carbapenemase-producing *Klebsiella pneumoniae* isolates from a stethoscope was closely related to isolates from the patients admitted at the same ward where the stethoscope was used. Stethoscopes were contaminated with various nosocomial pathogens including MDR bacteria and might act as a vehicle of MDR bacteria. Continuous, consistent education and training should be provided to HCWs using multifaceted approach to reduce the nosocomial transmission via stethoscopes.

Lee, Raeseok, et al. "A Quasi-Experimental Study on Stethoscopes Contamination with Multidrug-Resistant Bacteria: Its Role as a Vehicle of Transmission." PLOS ONE, vol. 16, no. 4, 2021, <https://doi.org/10.1371/journal.pone.0250455>.



Objection 6:

- “Disk covers are too expensive”
-

Refutation:

This objection is best answered with direct economic comparison to current standards of stethoscope hygiene, but clinical data can be used in support.

Data Point 1: Cost of hospital-acquired C. diff infections

According to the Centers for Disease Control and Prevention (CDC), Clostridioides difficile hospital-acquired infections in U.S. hospitals cost up to \$4.8 billion each year in excess care costs for acute care facilities alone.² **The cost of a single case of C. diff is ~\$35,000,¹ while the cost of each single-use Disk Cover from AseptiScope is under \$0.40 (actual price will vary by hospital). One prevented case of C. diff would pay for nearly 100,000 auscultations.**



**Data Point 2: Cost of Current Stethoscope Hygiene Standards -
Disposables Stethoscopes**

Beyond the poor quality and inefficacy of disposable stethoscopes lies the costs associated with their use.

Disposable stethoscopes on the **low-end of both cost and quality**, such as the yellow plastic stethoscopes one may commonly mistake for a child's toy, **cost on average ~\$2.00 per unit at bulk pricing**.

On the **higher end**, disposable stethoscopes cost on average **~\$7.00 per unit**.



**Data Point 3: Cost of Current Stethoscope Hygiene Standards -
Alcohol Wipes**

Certain pathogens have become increasingly resistant to alcohol-based disinfectants over the years due to their continued use in healthcare environments.³ The CDC estimated the cost of antimicrobial resistance is \$55 billion every year in the United States.⁴

The DiskCover System is intentionally designed to remove the need for antimicrobials. The use of aseptic barriers inherently excludes development of resistant pathogens and does not increase the probability of expanding MDROs. Disk cover barriers offer an aseptic surface and can be considered a tool consistent with quality antimicrobial stewardship practice.

Citations:

1. Zhang, Shanshan, et al. "Cost of Hospital Management of Clostridium Difficile Infection in United States—a Meta-Analysis and Modelling Study." *BMC Infectious Diseases*, vol. 16, no. 1, 2016, <https://doi.org/10.1186/s12879-016-1786-6>.
2. "Nearly Half a Million Americans Suffered from Clostridium Difficile Infections in a Single Year." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 22 Mar. 2017.
3. Pidot, Sacha J., et al. "Increasing Tolerance of Hospital Enterococcus Faecium to Handwash Alcohols." *Science Translational Medicine*, vol. 10, no. 452, 2018, <https://doi.org/10.1126/scitranslmed.aar6115>.
4. Dadgostar, Porooshat. "Antimicrobial Resistance: Implications and Costs." *Infection and Drug Resistance*, Volume 12, 2019, pp. 3903–3910., <https://doi.org/10.2147/idr.s234610>.



RESEARCH ARTICLE

Open Access



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Cost of hospital management of *Clostridium difficile* infection in United States—a meta-analysis and modelling study

Shanshan Zhang^{1,2*}, Sarah Palazuelos-Munoz³, Evelyn M. Balsells¹, Harish Nair¹, Ayman Chit^{4,5} and Moe H. Kyaw⁴

Abstract

Background: *Clostridium difficile* infection (CDI) is the leading cause of infectious nosocomial diarrhoea but the economic costs of CDI on healthcare systems in the US remain uncertain.

Methods: We conducted a systematic search for published studies investigating the direct medical cost associated with CDI hospital management in the past 10 years (2005–2015) and included 42 studies to the final data analysis to estimate the financial impact of CDI in the US. We also conducted a meta-analysis of all costs using Monte Carlo simulation.

Results: The average cost for CDI case management and average CDI-attributable costs per case were \$42,316 (90 % CI: \$39,886, \$44,765) and \$21,448 (90 % CI: \$21,152, \$21,744) in 2015 US dollars. Hospital-onset CDI-attributable cost per case was \$34,157 (90 % CI: \$33,134, \$35,180), which was 1.5 times the cost of community-onset CDI (\$20,095 [90 % CI: \$4991, \$35,204]). The average and incremental length of stay (LOS) for CDI inpatient treatment were 11.1 (90 % CI: 8.7–13.6) and 9.7 (90 % CI: 9.6–9.8) days respectively. Total annual CDI-attributable cost in the US is estimated US\$6.3 (Range: \$1.9–\$7.0) billion. Total annual CDI hospital management required nearly 2.4 million days of inpatient stay.

Conclusions: This review indicates that CDI places a significant financial burden on the US healthcare system. This review adds strong evidence to aid policy-making on adequate resource allocation to CDI prevention and treatment in the US. Future studies should focus on recurrent CDI, CDI in long-term care facilities and persons with comorbidities and indirect cost from a societal perspective. Health-economic studies for CDI preventive intervention are needed.

Keywords: *Clostridium difficile*, Economic analysis, Systematic review, Meta-analysis

Abbreviations: CDI, *clostridium difficile* infection; CIs, confidence intervals; CO CDI, community-onset CDI; HCF, healthcare facility; HIV, human immunodeficiency virus; HO-CDI, hospital-onset cdI; ICD-9-CM, the international classification of diseases, ninth revision, clinical modification; ICUs, intensive care units; IQR, interquartile range; LTCF, long-term care facility; NIS, national independent sample; SD, standard deviation; US, United States

Zhang, Shanshan, et al. "Cost of Hospital Management of Clostridium Difficile Infection in United States—a Meta-Analysis and Modelling Study." BMC Infectious Diseases, vol. 16, no. 1, 2016, <https://doi.org/10.1186/s12879-016-1786-6>.



| REPORT | INFECTIOUS DISEASE

Increasing tolerance of hospital *Enterococcus faecium* to handwash alcohols

SACHA J. PIDOT , WEI GAO, ANDREW H. BUULTJENS , IAN R. MONK , ROMAIN GUERILLOT , GLEN P. CARTER, JEAN Y. H. LEE , MARGARET M. C. LAM, M. LINDSAY GRAYSON, [...], AND TIMOTHY P. STINEAR +11 authors [Authors Info & Affiliations](#)

SCIENCE TRANSLATIONAL MEDICINE • 1 Aug 2018 • Vol 10, Issue 452 • DOI: 10.1126/scitranslmed.aar6115

699 74



Alcohol loses its luster

Alcohol-based disinfectants are a key way to control hospital infections worldwide. Pidot *et al.* now show that the multidrug-resistant bacterium *Enterococcus faecium* has become increasingly tolerant to the alcohols in widely used hospital disinfectants such as hand rub solutions. These findings may help explain the recent increase in this pathogen in hospital settings. A global response to *E. faecium* will need to include consideration of its adaptive responses not only to antibiotics but also to alcohols and the other active agents in disinfectant solutions that have become so critical for effective infection control.

Pidot, Sacha J., et al. "Increasing Tolerance of Hospital *Enterococcus Faecium* to Handwash Alcohols." *Science Translational Medicine*, vol. 10, no. 452, 2018, <https://doi.org/10.1126/scitranslmed.aar6115>.



Infection and Drug Resistance

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REVIEW

Antimicrobial Resistance: Implications and Costs

This article was published in the following Dove Press journal:
Infection and Drug Resistance

Porooshad Dadgostar
Milken Institute of Public Health, George Washington University, Washington, DC, USA

Infection and Drug Resistance downloaded from https://www.dovepress.com on 17-Nov-2022.
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Abstract: Antimicrobial resistance (AMR) has developed as one of the major urgent threats to public health causing serious issues to successful prevention and treatment of persistent diseases. In spite of different actions taken in recent decades to tackle this issue, the trends of global AMR demonstrate no signs of slowing down. Misusing and overusing different antibacterial agents in the health care setting as well as in the agricultural industry are considered the major reasons behind the emergence of antimicrobial resistance. In addition, the spontaneous evolution, mutation of bacteria, and passing the resistant genes through horizontal gene transfer are significant contributors to antimicrobial resistance. Many studies have demonstrated the disastrous financial consequences of AMR including extremely high healthcare costs due to an increase in hospital admissions and drug usage. The literature review, which included articles published after the year 2012, was performed using Scopus, PubMed and Google Scholar with the utilization of keyword searches. Results indicated that the multifactorial threat of antimicrobial resistance has resulted in different complex issues affecting countries across the globe. These impacts found in the sources are categorized into three different levels: patient, healthcare, and economic. Although gaps in knowledge about AMR and areas for improvement are obvious, there is not any clearly understood progress to put an end to the persistent trends of antimicrobial resistance.

Keywords: antimicrobial resistance, AMR, implications, cost

Background

Antimicrobial Resistance (AMR) occurs when microorganisms including bacteria, viruses, fungi, and parasites become able to adapt and grow in the presence of medications that once impacted them.^{1,2} AMR is considered a significant threat to the public health systems not just in developing countries but throughout the world.^{1,3} The fact that infectious diseases can no longer be treated with antibiotics depicts an unknown future in health care.⁴ Infection with AMR leads to serious illnesses and prolonged hospital admissions, increases in healthcare costs, higher costs in second-line drugs, and treatment failures.^{3,5,6} For instance, just in Europe, it has been estimated that antimicrobial resistance has been correlated with more than nine billion euros per year.^{3,7} Furthermore, according to the Centers for Disease Control and Prevention (CDC), antimicrobial resistance adds a 20 billion dollar surplus in direct healthcare costs in the United States, which is exclusive of about 35 billion dollars in loss of productivity annually.⁸

The daunting threat of antimicrobial resistance is of particular importance in the category of antibiotic resistance in bacteria.³ According to the CDC, more than two million people in the United States become ill with antibiotic-resistant diseases every year, resulting in a minimum of 23,000 deaths.⁸ Antibiotic resistance compromises a human immune system's capacity to fight infectious diseases and also

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Dadgostar, Porooshad. "Antimicrobial Resistance: Implications and Costs." *Infection and Drug Resistance*. Volume 12, 2019, pp. 3903–3910., <https://doi.org/10.2147/IDR.S234610>.



Summation:

A New Normal for The Clinician's Third Hand: Stethoscope Hygiene and Infection Prevention

On November 6th, 2022, I published an article in the press in the *American Journal of Infection Control*, titled *A New Normal for the Clinician's Third Hand: Stethoscope Hygiene and Infection Prevention*¹ outlining all key clinical arguments presented in this document on the importance of adopting The DiskCover System, an innovation in and elevation of stethoscope hygiene alongside.

The authors include these highly influential professionals in the field of infection prevention and control:

- **Roy F. Chemaly**, MD, MPH, FIDSA, FACP, Department of Infectious Diseases, Infection Control at **MD Anderson**
- **Francesca Torriani**, MD, FIDSA, AAHIVS, Medical Director, Infection Prevention and Clinical Epidemiology at **UC San Diego Health**
- **Zainab Shahid**, MD, FACP, FIDSA, Infection Prevention in Immunocompromised People at **Memorial Sloan Kettering**
- **Sanjeet Dadwal**, MD, Chief, Division of Infectious Diseases at **City of Hope**

This article is an excellent tool to reference to prospects, as it is a publication in one of if not the most influential peer-reviewed journals in the field of American infection control that summarizes the most key findings in the contemporary field of stethoscope hygiene and infection prevention. Published not by industry but by infectious disease and infection prevention experts from some of the most influential cancer centers across the nation, this is strong evidence backing the elevation in stethoscope hygiene through adoption of The DiskCover System for vulnerable patients.



Table. Comparison of Stethoscope Hygiene Attributes¹

Attribute	Stethoscope Hygiene Strategies		
	Isopropyl Alcohol Wipes	Single Use Stethoscopes	The DiskCover System
Rapid to use (<2 seconds)	NO	YES	YES
Prevents between patient contamination	NO	YES	YES
Always provides aseptic patient contact	NO	NO	YES
May transfer pathogens between staff	NO	YES	NO
Impairs auscultation	NO	YES	NO
Inexpensive (<50 cents)	YES	NO	YES
Digital use compliance monitoring	NO	NO	YES
Remote supply status monitoring	NO	NO	YES
May harm stethoscope tubing	YES	NO	NO
Evidence of increasing E. faecium resistance	YES	NO	NO
Evidence of increased C. difficile sporulation	YES	NO	NO
May allow C. difficile transfer between patients	YES	NO	NO
Evidence of increased A. baumannii growth	YES	NO	NO

