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Our Third Hand: Stethoscope Hygiene in the Era of Alcohol-Resistant Organisms

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The stethoscope is one of the oldest tools in the physician's armamentarium. To this day, it persists as a highly visible image in the practice of medicine; it is used actively and is recommended in most health care encounters and is expected by patients.[1] Yet, while health care workers have been taught for more than150 years,[2] and more recently are mandated to perform the World Health Organization (WHO) 5 moments of hand hygiene between every single patient,[2] stethoscope hygiene practices are only marginally adopted.[3,4] This persists despite that the stethoscope diaphragm carries the same quantity and diversity of pathogens associated with health care. Moreover, many of the most virulent pathogens are resistant or have evolved resistance to alcohol. In this context, alcohol has direct relevance in the era of multidrug resistant organisms (MDROs). This article provides context on how stethoscope hygiene is a critical component of effective prevention of infections associated with health care.

In October 2022, with the winding down of the coronavirus disease 2019 (COVID-19) pandemic and following the first in-person meeting of the Infectious Disease Society of America in the prior 3 years, a group of stethoscope and infectious disease experts gathered to discuss the challenges of stethoscope hygiene in the era of increasing antimicrobial resistance and MDROs. The importance of this meeting was to enhance awareness that the stethoscope can serve as a vector for pathogens and to provide solutions to mitigate this challenge. Multiple studies characterizing the pathogens that are present on stethoscopes have demonstrated that microbes associated with hospital acquired infection, including MDROs,[5-7] can be cultured from the stethoscope diaphragm. This is true despite the practitioner cleaning their stethoscope. In fact, various studies have documented that in bacterial cultures of more than 300 stethoscopes, the sum of *Acinetobacter baumannii*, and methicillin-resistant *Staphylococcus aureus* (MRSA) were found on about 10% of all stethoscope diaphragms.[6,7]

The stethoscope diaphragm, commonly referred to as the clinicians "third hand,"[8] represents the point of vector contact for the stethoscope. Although no randomized controlled trial has demonstrated the acquisition of an infectious disease between patients solely via the stethoscope, studies using nontoxigenic bacterial species as a tracer have demonstrated that the stethoscope represents a potential opportunity for pathogen transmission in various health care settings. Studies employing nonpathogenic bacterial cultures have demonstrated that the stethoscope's diaphragm is where the majority of pathogens reside in numbers second only to the practitioner's fingertips.[9] In addition, like the elbows that rarely contact the patient (such that their

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hygiene would have little impact in pathogen transmission), neither does stethoscope tubing. These facts ultimately provide the basis for optimal hygiene to focus not only on the fingertips but also on the stethoscope diaphragm because these represent some of the highest vector risks for pathogen transmission in the health care setting.

That the stethoscope is an effective vector for organism transmission was clearly demonstrated in a proof-of-concept study performed at the Cleveland VA hospital in 2011.[10] In this investigation, the stethoscope was definitively established as an effective potential vector for the transmission of nontoxigenic *Clostridium difficile* between exposed and nonexposed volunteers. This vector risk was further detailed by simulation studies using cauliflower mosaic virus. While documenting similar between-patient transmission findings as the VA *C. difficile* study, Alhmidi et al[11] reported the additional concern that current stethoscope hygiene standards do not change between-patient transmission risks. In other words, we cannot wash our way to safety.

If pathogens are ubiquitous on the stethoscope, and the stethoscope is an effective agent of transmission, then what are the interventions that may successfully interrupt such an undesirable health care event? Data must mature with consistent results for evidence-based recommendations and guidelines to be put in place. Today, the Centers for Disease Control and Prevention (CDC) recommends that the stethoscope should be "cleaned weekly, unless visibly soiled."[12] Unfortunately, even if "weekly cleaning unless visibly soiled," was an effective intervention (which is doubtful), the methods of weekly cleaning remain poorly defined by the CDC. The generally accepted standard is that isopropyl alcohol swabs, easily available in most hospital environments, should be used to clean the stethoscope diaphragm. This is problematic in that cleaning the stethoscope has shown limited impact. Some authors have demonstrated that cleaning with a 70% isopropyl alcohol solution, for a full 60 seconds, may result in a decreased bacterial load.[13] However, multiple authors have demonstrated that, even with diligent cleaning using isopropyl alcohol, 28% of stethoscopes will continue to harbor pathogens of concern.[14] Unfortunately, alcohol swab cleaning provides suboptimal results. The evidence is consistent on this point; the stethoscope will continue to undermine infection control protocols until guidelines recognize the issue and elevate stethoscope hygiene requirements.

To make the potential for MDRO transmission worse, stethoscope hygiene is not immune to the challenge of antibiotic resistance. Combating pathogens, as is done with antibiotics, is unlikely to be a successful long-term strategy for stethoscope hygiene. Historically, isopropyl alcohol was viewed as an effective antiseptic agent for hand hygiene and other surfaces. Unfortunately, and similar to antibiotics, antiseptic agents may be susceptible to deteriorating efficacy and contribute to the emergence of bacterial resistance. In a study comparing the kill rates of isopropyl alcohol on colonies of *Enterococcus faecium* from 1997 versus the kill rates of isopropyl alcohol on contemporary *E. faecium* colonies, investigators found a disconcerting 23% decrease in effectiveness. While this represents a single pathogen species, the concept that pathogens may develop resistance to surface cleaners is not unreasonable and may represent a significant downstream threat.

Of equal concern, beyond a diminishing kill rate, is that fact that reproductive stimulation may occur as a response to isopropyl alcohol exposure. It has been demonstrated by Edwards et al[15] in populations of the MDRO *A. baumannii*, that exposure to lower concentrations of isopropyl alcohol may result in an adaptive response leading to increased number of bacterial colonies in vitro. This concerning finding has also been demonstrated with *C. difficile*. Like *A. baumannii*, studies have suggested that some specific species of *C. difficile* may increase their sporulation rate when exposed to common hospital disinfectants.[16] Clinically, this means that diligent health care workers, who reliably use alcohol swabs to clean their stethoscope, will not be able to wash their way out of exposing their patients to some pathogens and could potentially worsen exposures.

Because isopropyl alcohol is one of the most commonly available antiseptics in US hospitals, a consideration of those pathogens that are killed on exposure to it is critical in interpreting the CDC's recommendation to clean weekly unless visibly soiled. The list of pathogens documented to have limited effect from alcohol exposure include those that have been the cause of large infectious outbreaks, such as norovirus,[17] hepatitis A,[18] poliovirus,[18] cryptosporidium,[19] and *C. difficile*.[16]

C. difficile represents a pathogen of considerable concern in the health care setting based on substantial morbidity and mortality in the susceptible host. *C. difficile* can be transmitted via spores that are mainly unaffected by isopropyl alcohol. The Environmental Protection Agency listed, frequently peroxide-based, "K" antiseptics are required to combat this pathogen. Also problematic, according to the CDC, *C. difficile* spores can survive for months to years on surfaces, making the stethoscope diaphragm a particularly concerning vector in its transmission.[20] In fact, from a study performed at the Leicester Royal Infirmary (a 918-bed hospital in Leicester, UK), *C. difficile* was isolated from 4.9% of stethoscope diaphragms.[16]

Ultimately, the consideration of human behavior on their ability to prevent MDRO pathogen exposure from the stethoscope must be considered. Several studies have evaluated the stethoscope cleaning habits of health care workers. Self-reported stethoscope hygiene rates are usually in the range of 50% of patient contacts.[21,22] However, this rate of stethoscope cleanings is not supported by direct observation. In surreptitious observational studies, where practitioners were unaware that their hygiene practices were being recorded, health care workers cleaned their stethoscope with isopropyl alcohol for 60 seconds between patients in less than 5% of encounters.[3,4] If this continues to be the standard for stethoscope hygiene, the MDROs are likely going to win.

Attempts to "wash our way out of this" and the various educational interventions to improve health care worker stethoscope hygiene practices have not been a resounding success. Recently, a study by Lee et al[23] specifically evaluated the impact of hygiene interventions on MDRO contamination rate on the stethoscope diaphragms. They documented a carbapenem-resistant *Enterobacteriaceae* stethoscope diaphragm contamination rate before an intervention of 20.8%, only dropping to 19.2% afterward. The reasons given for their sustained failure of stethoscope hygiene education included a lack of available supplies, a lack of knowledge of the presence of a target pathogen, and the inability to fully clear pathogens in the presence of biofilm, even in the event of compliance with 60 seconds of cleaning.[24]

Ultimately, the current limitation of cleaning agents, increasing resistance in pathogens, alteration in pathogen pattern in response to environmental hygiene agents, and the inability to improve health care worker compliance to provide consistent stethoscope diaphragm hygiene, all support the application of a strategy commonly used throughout the clinical environment. That is the use of a disposable barrier. Once properly applied, there is no failure of a barrier, there is no evolution of resistance to a barrier, there is no persistence of a biofilm, and with modern application systems, the time requirement for compliance is negligible (<2 sec). Further, barriers are inexpensive and allow the use of a practitioner's personal stethoscope. This latter consideration is extremely important because the alternative to the personal stethoscope is the shared disposable single patient stethoscopes. Unfortunately, these tend to be grotesquely inefficient tools. Recent studies have demonstrated that the use of a disposable stethoscope was associated with misdiagnosis rates of 10.9%-33.1%.[25,26] Beyond the unacceptable misdiagnosis rates, the use of the disposable stethoscope simply shifts the pathogen exposure from between patients to between staff. Studies have shown that even after cleaning, ~5% earpieces of disposable shared stethoscopes are contaminated with pseudomonas.[27] Finally, in the consideration of aseptic barriers versus the disposable stethoscope, barriers cost pennies with minimal disposable volume compared to the disposable stethoscope that costs several dollars and contribute to much larger volumes of medical waste.

Several qualities should be considered when evaluating a stethoscope barrier. The barrier should provide an aseptic and an inert patient contact surface, be rapidly applied in a touch free fashion, contain no latex, be a single-patient use, leave no residue behind on the stethoscope, and be acoustically invisible. Studies of patient's, physician's, and nurse's perceptions regarding stethoscope diaphragm barriers, performed at large leading teaching hospitals across the US, have demonstrated a marked preference for a barrier. Of equal advantage was the opinion that the availability of barriers significantly improves health care worker stethoscope hygiene compliance, as well as patient safety. We need a win against the MDROs, a contribution to which may be mitigating the risk of their transmission as part of a multipronged approach for which stethoscope barriers are a demonstrated part of the solution. We conclude that aseptic barriers are likely the simple answer to this problem.

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