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The hidden expense of stethoscope hygiene versus the real costs of failure

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Editorial

It is well established that the stethoscope is covered in pathogens. Thus, it is recommended that to decrease the population of pathogens that reside on a stethoscope diaphragm, it should be cleaned with at least 60 seconds of alcohol scrubbing before each patient contact [1]. Unfortunately, compliance with these recommendations has never been demonstrated. In fact, the converse is well documented, with recommendation compliant stethoscope hygiene rates rarely exceeding double digits [2,3]. This is because, if performed appropriately before each patient contact, it requires a significant amount of time that could otherwise be dedicated to patient care.

Modeling suggests the time and financial costs associated with clinician's adherence to recommended stethoscope cleaning are not insignificant. This includes the following: (1) the number of auscultating physicians per day in an emergency department (ED); (2) the number of patients seen per clinician; (3) the mean hourly clinician costs; and (4) the hospital compliance rate of stethoscope hygiene. Using an example of a high-acuity area, such as a small 20-bed ED, in which a clinician auscultates an average of 30 times per shift, over three physician shifts per day (90 auscultations per day = 32,850 auscultations per year), with an average annual US emergency physician's salary of USD 352,000 [4], and if observing perfect stethoscope hygiene compliance, results in 547 hours of stethoscope hygiene a year. This is a cost of USD 115,990.40/yr dedicated entirely to clinicians in a single unit for cleaning their stethoscope.

Unfortunately, the reality is that stethoscope hygiene compliance is often much lower than 100%. At a more commonly observed 11% rate of compliance [2,3] physicians would instead be spending 60 hours per year on stethoscope cleaning, at a cost of USD 12,722.89/yr. This model suggests that lower stethoscope hygiene compliance might be cost saving in itself. However, the relationship that lower compliance may lead to higher costs from healthcare-associated infections (HAIs) must be considered.

Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridioides difficile (C. diff)* are two examples of pathogens that are commonly found on stethoscope diaphragms [5,6] and US hospital costs of these nosocomial HAIs are estimated to be an average of USD 38,561 per MRSA-related infection [7] and USD 24,205 per *C. diff* infection [8]. Examining the frequency of pathogen transmission occurrences via the stethoscope diaphragm and their associated costs to the hospital must consider the following: (1) the annual exposure; (2) the likelihood of *C. diff* (5.0%) or MRSA (7.4%) on a clinician's stethoscope diaphragm [5,6]; (3) the hospital compliance rate of stethoscope hygiene; and (4) the probability of pathogen exposure resulting in an infection. When this model is applied to the previous example of three clinicians each seeing 20 patients a day in the ED, the annual number of auscultations would equal 32,850 patient contacts and would result in 1,642 and 2,431 transmission events of *C. diff* and MRSA, respectively, onto a patient.

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Table 1. Cost results based on different infection rates after pathogen exposure in a 20-bed emergency department

Infection rate	*Clostridioides difficile*		MRSA	
	No. of cases per year (no. of exposure per year = 1,642)	Total cost per year[a] (USD) (cost per case = USD 24,205)	No. of cases per year (no. of exposure per year = 2,431)	Total cost per year[b], USD (cost per case = USD 38,561)
Immunocompetent (97.3%)				
1%	16	386,715	24	912,108
2%	32	773,430	47	1,824,215
3%	48	1,160,145	71	2,736,323
Immunocompromised (2.7%)				
20%	4	107,310	7	253,103
30%	9	214,621	13	506,206
30%	13	321,931	20	759,309

MRSA, methicillin-resistant *Staphylococcus aureus*.
[a]Total annual cost: lowest possible, USD 494,025; highest likely, USD 1,482,076. [b]Total annual cost: lowest possible, USD 1,165,211; highest likely, USD 3,495,632.

The data to calculate the conversion of exposure rate to infection rate is unknown, as no randomized study has ever consented patients to determine infection rates after pathogen exposure. However, we performed a sensitivity analysis, using an estimate of 2.7% of the population as being immunocompromised [9] with a higher estimated infection rate (ranging from 10% to 30%), and the remaining 97.3% of the population being immunocompetent hospitalized patients with lower infection risks (estimated at 1%–3%). Using *C. diff* and MRSA exposure parameters, applied to the above population, sustaining infection rates of 1% to 3% for immunocompetent, and 10% to 30% for immunosuppressed, provides a total annual cost estimate of stethoscope hygiene errors that range from USD 1,659,236 to 4,977,708 for *C. diff* and MRSA, in a single hospital unit (Table 1).

Unfortunately, *C. diff* and MRSA represent only a small portion of surface pathogens found in the contemporary ED. As reported in the recent pandemic, it must also be considered that the hygiene of stethoscopes may affect the transmission of other pathogens, including respiratory infections such as COVID-19 [10] and influenza. How effectively these pathogens, as well as other infectious diseases (e.g., Ebola), are transmitted by the stethoscope is unknown, but any transmission is likely to increase medical costs.

With the challenges and low success rates of personal stethoscope cleaning, alternatives have been promoted. The single-patient stethoscope is a commonly used strategy. Although less expensive than a HAI resulting from the failure of stethoscope hygiene, it is not cost neutral. For example, a 20-bed ED spending an average of USD 6.00 per single-patient stethoscope on 32,000 patient encounters would be spending USD 192,000 on disposable stethoscopes per year. Secondly, the inferior acoustic qualities of the disposable stethoscope may contribute to actual patient misdiagnosis, with an estimated number needed to harm of 10 [9]. Finally, the sharing of stethoscopes among practitioners, while decreasing pathogen exposure to the patient, has been demonstrated to have concerning rates of pathogens (e.g., Pseudomonas) shared among the clinical staff [11].

Most recently, dispensers of touch free stethoscope barriers have been promoted as elevating stethoscope hygiene to that similar of the gloved hand and providing 100% aseptic patient contact [12]. Their single unit costs are less than 50 cents, and their application time requires less than 2 seconds. When considered in terms of the time compressed requirements of contemporary emergency medicine practice, the ability to save the 1 minute between every patient stethoscope contact by the application of a touch free barrier, rather than the requirement of washing the stethoscope's diaphragm for 60 seconds with an alcohol swab, suggests the barrier strategy is the optimal guideline compliant intervention. Ultimately, barriers may solve the failures of the unwashed personal stethoscope or the shared disposable stethoscope.

Given the extensive morbidity that occurs with failure to clean the stethoscope, and the fiscal value proposition resulting from the prevention of stethoscope related hospital associated infections, we suggest that improvements in stethoscope hygiene should be supported at the national and regulatory level. This should include the implementation of standardized institutional protocols, as well as support via national subsidies and public funds to insure the implementation and compliance in the use of touch free stethoscope barriers.

ARTICLE INFORMATION

Conflicts of interest

William Frank Peacock is an Editorial Board member of *Clinical and Experimental Emergency Medicine*, but was not involved in the peer reviewer selection, evaluation, or decision process of this

article. Additionally, he has also received research grants from Abbott, Brainbox, Quidel, Roche, and Siemens; serves as a consultant for Abbott, Astra-Zeneca, Biocogniv, Brainbox, Bristol Meyers Squibb, Instrument Labs, Janssen, Osler, Quidel, Roche, Siemens, Spinchip, and CSL-Vifor; and holds stock or ownership interests in AseptiScope Inc, Brainbox Inc, Biocogniv Inc, Braincheck Inc, Coagulo Inc, Comprehensive Research Associates LLC, Comprehensive Research Management Inc, Emergencies in Medicine LLC, Fast Inc, Forrest Devices, Ischemia DX LLC, Lucia Inc, Prevencio Inc, RCE Technologies, ROMTech, ScPharma, Trivirum Inc, and Upstream. The author has no other conflicts of interest to declare.

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Data availability
Data sharing is not applicable as no new data were created or analyzed in this study.

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