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Assessing changes in stethoscope hygiene during COVID-19: a multi-centre cross-sectional study

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SUMMARY

Background: The COVID-19 (SARS-CoV-2) pandemic has increased infection control vigilance across several modes of patient contact. However, it is unknown whether hygiene pertaining to stethoscopes, which carry the potential for pathogenic contamination, has also shifted accordingly.

Aim: To characterize pandemic-related changes in stethoscope hygiene.

Methods: We surveyed healthcare providers at three major medical centres. Questions quantitatively (Likert scale and frequency) assessed stethoscope hygiene beliefs and practices with two components: before and during COVID-19. Participants were grouped based on performance of optimal stethoscope hygiene (after every patient) before and during COVID-19. Groups were compared using χ^2 and analysis of variance (ANOVA).

Findings: Of the 515 (10%) who completed the survey, 55 were excluded ($N = 460$). Optimal hygiene increased from 27.4% to 55.0% ($P < 0.001$). There were significant increases in Likert scores for all questions pertaining to knowledge of stethoscope contamination ($P < 0.001$). Belief in stethoscope contamination increased ($P < 0.001$) despite no change in perceived hygiene education. Resident physicians were less likely compared with attending physicians and nurses to have adopted optimal hygiene during COVID-19 ($P < 0.001$).

Conclusion: Despite a positive shift in stethoscope hygiene during COVID-19, optimal hygiene was still only performed by around half of providers. Educational interventions, particularly targeting early-career providers, are encouraged.

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Introduction

Healthcare-associated infections are associated with significant mortality and cost [1,2]. Whereas extensive focus has been placed on hand hygiene, little emphasis has been placed

on stethoscope hygiene. Stethoscopes have been shown to be contaminated by infectious pathogens, including meticillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and *Klebsiella* spp. [3–6]. Furthermore, stethoscopes have been shown to harbour the same level of contamination as a provider's hand, and pathogens on the stethoscope can be transferred to patients upon contact [7,8].

The COVID-19 era has led to an increase in infection control vigilance, with greater emphasis on hand hygiene and barrier precautions [9]. Current recommendations from the Centers for Disease Control and Prevention classify the stethoscope as a 'non-critical' medical device; with the recommendation being that such devices should be cleaned with an alcohol or bleach disinfectant from once weekly to after each patient contact, unless visibly soiled [10]. Recent articles have addressed the role of the stethoscope during COVID-19, with one article arguing for its disuse in lieu of ultrasound in an effort to limit medical device contact with patients [11,12]; however, it is important to note that patient contact with an ultrasound probe is nearly identical if not more extensive than that of a stethoscope. Notably, a recent commentary expressed the need for updated stethoscope hygiene guidelines, further indicating that stethoscope hygiene is gaining attention [13].

In this study, we aimed to assess how healthcare providers' knowledge, attitudes, and practices surrounding stethoscope hygiene have changed during the COVID-19 pandemic. Additionally, we aimed to identify provider groups that might be deficient in stethoscope hygiene in order to identify potential targets for future intervention.

Methods

Participants and data collection

The survey was distributed as a Qualtrics™ web-link to healthcare providers via institution-specific e-mail listservs at three University of California (UC) medical centres: UC San Diego, UC Davis, and UC Irvine. Respondents included physicians (attendings, residents, fellows), nurses (RN, NP, LVN), and physician assistants. Responses were anonymous, and there was no time limit for survey completion. Data collection occurred from July 16th, 2020 to January 11th, 2021. Participants were excluded if they reported '0' stethoscope usage for both before and during COVID-19 (i.e. never used a stethoscope at any point). At the time of data collection, none of the participating UC healthcare systems had specific policies or regulations regarding stethoscope sanitation, and no policy changes regarding stethoscope hygiene had been added since the onset of the COVID-19 pandemic. This study was granted exempt status from the Institutional Review Boards of the participating study sites.

Survey instrument

We developed a 33-question survey asking providers about frequency of stethoscope use, perceptions of safety, and pathogen transmission associated with stethoscopes. The survey questions had two parts: 'before COVID-19' and 'during COVID-19'. Demographic data (age, sex, provider type, years in practice) were also obtained. Survey questions utilized a combination of five-point Likert scale (strongly disagree to

strongly agree), binary (yes/no), categorical frequency, and free-response questions.

Statistical analysis

A margin-of-error calculation was performed using the final study cohort to assess population generalizability. Descriptive statistics were performed to characterize the demographics of study participants. Categorical percentages for stethoscope usage and hygiene frequency were calculated to compare 'before COVID-19' to 'during COVID-19' responses. Mean Likert scores for 'before' and 'during' COVID-19 responses were compared using the paired Wilcoxon-signed rank test. Sub-group analyses were performed by grouping respondents based on performance of optimal vs other stethoscope hygiene before and during COVID-19. Optimal stethoscope hygiene was defined as answering 'after every patient' in response to the survey question 'How often do you clean your stethoscope?' All other responses to this question were categorized as other. Respondents who cleaned 'after every patient' before and during COVID-19 were termed 'optimal cleaners'; those who did not clean 'after every patient' before but did so during COVID-19 were 'influenced cleaners'; and those who did not clean 'after every patient' either before or during COVID-19 were 'suboptimal cleaners'. Due to low sample size ($N = 3$), respondents who reported cleaning 'after every patient' before but not during COVID-19 were excluded from the sub-group analysis. One-way analysis of variance (ANOVA) and Pearson's chi-squared test with post-hoc analysis were performed to assess group differences. Multivariate logistic regression was used to assess 'during COVID-19' predictors of being in the 'influenced cleaners' versus 'suboptimal cleaners' group, using provider characteristics and Likert responses as predictors. Due to the limited research in this area, predictors in our final model were selected based on a forward stepwise conditional approach in addition to those with a-priori importance (age, sex, provider type, and number of years in practice). Predictors were chosen based on a significance level of $P < 0.05$. Respondents with missing data for the chosen predictors were excluded from this analysis. All analyses were performed using SPSS v27 (IBM, Armonk, NY, USA).

Results

Of the invited 5022 participants, 515 (10.3%) completed the survey. Fifty-five participants (1.1%) were excluded for reporting no stethoscope usage both before and during COVID-19, leaving 460 (9.2%) included in our analysis cohort. The overall margin of error was $\pm 4\%$ at the 95% confidence level. Respondent characteristics are listed in [Table I](#). Among the physician respondents (75.9%), 65% were in general internal medicine, family medicine, or paediatrics, with 11% in medicine/paediatric subspecialties; 8% were in emergency medicine, 5% in surgical specialties, 4% in critical care, 3% in obstetrics–gynaecology, and 5% other specialties.

Stethoscope usage and hygiene frequency

Categorical rates of the stethoscope usage and hygiene frequency before and during COVID-19 are displayed in [Tables II and III](#). For both time-periods, the greatest portion of providers used

Table I
Demographics of survey respondents, July 2020 to January 2021 (N = 460)

Characteristic	No.
Sex	
Male	167 (36.3%)
Female	290 (63.0%)
Did not disclose	3 (0.7%)
Age (years), mean (SD)	40.4 (16.5)
No. of years in practice, mean (SD)	11.4 (11.2)
Provider type	
Attending physician	217 (47.2%)
Resident physician	132 (28.7%)
Physician's assistant	3 (0.7%)
Nurse (LPN, RN, BSN, MSN, NP)	106 (23.0%)
Did not disclose	2 (0.4%)

Table II
Stethoscope usage before and during COVID-19 across University of California medical centres

Frequency of use	Before COVID-19 (N = 459)	During COVID-19 (N = 446)
0	0.2%	4.9%
1–3	16.8%	25.1%
3–6	23.7%	27.4%
7–10	21.8%	19.5%
10–15	17.6%	11.0%
>15	19.8%	12.1%

Table III
Stethoscope changing frequency before and during COVID-19 across University of California medical centres

Changing frequency	Before COVID-19 (N = 435)	During COVID-19 (N = 431)
Never	1.4%	1.4%
Once per year	1.1%	0.2%
Once per month	6.2%	0.7%
Once per week	16.1%	6.0%
Once daily	18.6%	10.2%
Several times daily	29.2%	26.5%
After every patient	27.4%	55.0%

stethoscopes three to six times per day (23.7% and 27.4% respectively). Notably, there was a significant decrease from before COVID-19 to during COVID-19 in the number of respondents who reported higher levels of stethoscope usage: 10–15 times (17.6%–11.0%; $\chi^2 = 10.01$, $P < 0.01$) and >15 times (19.8%–12.1%; $\chi^2 = 8.16$, $P < 0.01$). For reported stethoscope cleaning rates, there was a significant increase in the number of respondents who reported optimal stethoscope cleaning 'after every patient' when comparing before to during COVID-19 (27.4% vs 55.0%; $\chi^2 = 68.28$, $P < 0.001$) (Tables II and III).

Knowledge and beliefs

Supplementary Table S1 shows the survey response frequencies for the knowledge and belief-based questions in the survey, as well as the results of non-parametric tests when

comparing before and during COVID-19 responses. The majority of respondents agreed that the stethoscope is important in the evaluation of patients before COVID-19 with a mean \pm SD Likert score of 4.31 ± 0.78 ; however, whereas respondents continued to believe that the stethoscope is important in the evaluation of patients during COVID-19 (4.16 ± 0.90), there was a significant decrease in the Likert scores compared to before COVID-19 ($P < 0.001$). In addition, there was a significant decrease in scores when providers were asked whether the 'stethoscope makes patients feel safe' (before 3.81 ± 0.84 vs during 3.59 ± 0.87 ; $P < 0.001$).

For questions pertaining to knowledge about stethoscope contamination, there was a significant increase in scores across all questions with a 'before' and 'during' component (all P -values < 0.001). Notably, the percentage of providers who reported that they agreed or strongly agreed that they were 'hesitant to use their stethoscope' increased from 13.4% before COVID-19 to 33.9% during COVID-19. Providers were also asked about the COVID-19 virus specifically, reporting mild affirmative belief that stethoscopes could be contaminated with COVID-19 (3.69 ± 0.84) and a slightly greater belief that the stethoscope can transmit the COVID-19 virus to patients (4.0 ± 0.7).

There were no significant differences in provider responses for perceived education, time to clean one's stethoscope, and access to stethoscope cleaning supplies. However, respondents reported decreased confidence in their ability to clean a stethoscope (before 4.01 ± 0.84 vs during 3.92 ± 0.92 ; $P < 0.001$). Furthermore, there was also a decrease in belief that current methods of stethoscope hygiene are adequate (before 3.49 ± 0.91 vs during 3.41 ± 0.96 ; $P < 0.017$) (Supplementary Table S1).

Predicting who is likely to change their stethoscope cleaning habits

Individuals who completed both components of the question 'How often do you clean your stethoscope?' ($N = 419$) were further subdivided into 'suboptimal cleaner', 'optimal cleaner', and 'influenced cleaner' groups based on their before and during COVID-19 response. Subgroup comparisons using Pearson's χ^2 and ANOVA results are shown in Table IV. Post-hoc analysis found that females were less likely than males to be in the 'suboptimal cleaner' group and more likely to be in the 'optimal cleaner' group compared to the other two groups (both P -values < 0.01). Residents were more likely to be in the 'suboptimal cleaner' group and less likely to be in the 'optimal cleaner' group compared to the other groups (both P -values < 0.01). Attendings were more likely to be in the 'influenced cleaner' group, whereas nurses were less likely an 'influenced cleaner' and more likely to be in the 'optimal cleaner' group compared to the other groups (all P -values < 0.01). The mean number of years in practice was significantly lower in the 'suboptimal cleaner' group (nine years) compared to the 'influenced cleaner' and 'optimal cleaner' groups (both 14 years; $P < 0.001$).

The results of a multivariate regression model predicting the odds of membership in the 'influenced cleaner' vs 'suboptimal cleaner' group are shown in Supplementary Table S2. The following factors were significant covariates in our model: female provider (odds ratio: 1.8; 95% confidence interval: 1.0–3.2),

Table IVStethoscope cleaning subgroup comparison of baseline characteristics using ANOVA and Pearson χ^2 -test for independence

Characteristic	Suboptimal cleaner (%; Z or SD) (N = 184)	Influenced cleaner (%; Z or SD) (N = 121)	Optimal cleaner (%; Z or SD) (N = 111)	χ^2 or one-way ANOVA
Sex				χ^2 (2) = 10.1 $P = 0.007^a$
Male	82 (44.6%; 2.7)	45 (37.2%; 0.1)	29 (26.1%; -2.9)	
Female	102 (55.4%; -2.7)	76 (62.8%; 0.1)	82 (73.9%; 2.9)	$\phi = 0.155$
Age (years), mean	38 (22)	43 (12)	42 (13)	$P = 0.076^b$
No. of years in practice (mean)	9 (9)	14 (12)	14 (12)	$P < 0.001^b$
Provider type				χ^2 (4) = 74.5 $P < 0.001^a$
Resident	81 (44.0%; 6.0)	31 (25.6%; -1.0)	9 (8.1%; -5.7)	
Attending	74 (40.2%; -2.9)	75 (62.0%; 3.6)	51 (45.9%; -0.5)	$\phi = 0.423$
Nurse	29 (15.8%; -3.1)	15 (12.4%; -3.2)	51 (45.9%; 6.8)	

ANOVA, analysis of variance; SD, standard deviation.

N = 416; Z, adjusted standardized residual.

^a Post-hoc analysis performed using the adjusted standardized residuals method.^b Post-hoc analysis performed by Fisher's least significant difference.

belief that contaminated stethoscopes present a danger to patients (1.8; 1.2–2.5), having adequate access to cleaning supplies (1.8; 1.4–2.5), being hesitant to use one's stethoscope due to risk of infection (1.3; 1.1–1.6), and believing that current methods of stethoscope hygiene are adequate (1.5; 1.1–2.0).

Discussion

This study demonstrates that the COVID-19 pandemic has sparked a significant positive shift in several stethoscope hygiene beliefs and practices. However, though there was a notable increase in performance of optimal stethoscope hygiene, 45% of physicians reported not performing optimal hygiene during COVID-19. These findings agree with prior survey-based and observational studies reporting highly variable but largely deficient rates of stethoscope hygiene [14–20]. Furthermore, our study identified that resident physicians and newer providers were less likely to have improved stethoscope hygiene. Overall, our study corroborates the notion that concern regarding stethoscope contamination has increased during COVID-19, and importantly that there is still need for substantial improvement [21].

Despite robust evidence supporting stethoscope contamination, as well as relatively strong belief in the potential dangers of poor stethoscope hygiene as demonstrated in our study, it is important to acknowledge a lack of evidence demonstrating causation between contaminated stethoscope and nosocomial infections. Prior studies have implicated the stethoscope in infection control outbreaks, usually by identifying the causative pathogen on a provider's stethoscope [22–24]; however, there have been no studies to quantify the burden of disease attributed to the stethoscope. Thus, whereas further investigation is needed to clarify the role of the stethoscope in infection transmission, we should seek to address the potential danger of stethoscope contamination before such evidence arises in order to preserve a central element of clinical and bedside medicine [25].

Prior studies on hand hygiene interventions have found that social pressures and increased perception of hygiene risk promote lasting improvements in hygiene behaviour [26]. This

phenomenon might explain the improvement in stethoscope hygiene observed in this study as well as increases in hand hygiene during COVID-19 [27,28]. Amid the greater infection control vigilance and social pressure catalysed by the pandemic, interventions to improve stethoscope hygiene might be more effective; according to the results of our study, resident physicians, who were least likely to perform optimal hygiene during COVID-19, might be an appropriate focus for such interventions. Prior interventions for stethoscope hygiene have met with mixed success, including notable studies from Holleck *et al.* demonstrating no change in hygiene rates after implementing robust educational interventions [20,29,30]. However, since these studies occurred prior to COVID-19, providers might have lacked the impetus to change their behaviours prior to COVID-19. The shifts in beliefs and practice demonstrated in our study suggest that providers might be more labile to change in the face of a perceived real threat rather than a theoretical risk. If an educational/systems-based intervention were to be designed and implemented, the results of our multivariate regression analyses as well as the analysis by Muniz *et al.* indicate that targeting cleaning time/methodology and access to cleaning supplies might improve the effectiveness of such intervention [31].

Although this is the first investigation of stethoscope hygiene practices during COVID-19, there are limitations. Despite a reasonable sample size, the response rate was low. However, the margin of error ($\pm 4\%$) for population generalizability was also low. The majority of respondents were general practitioners in internal medicine, family medicine, and paediatrics. The low response rate from other specialties, including surgical specialties, limits the generalizability of these results to those provider populations. Furthermore, because these sites were solely based within the University of California system, our results might not be generalizable to other healthcare systems. Because this was a self-report assessment, social desirability bias might have influenced responses, and we did not include a social desirability measure due to length considerations. Finally, since this study was cross-sectional, there might be recall bias in asking respondents to report their behaviour prior to COVID-19, although prior studies have validated self-reported behaviour measures [32].

In conclusion, this study found that optimal stethoscope hygiene performance rose significantly from 27.2% to 55.4% during the COVID-19 pandemic; yet, nearly one half of providers continued not to perform optimal stethoscope hygiene. However, whereas stethoscope hygiene performance remained deficient, we did observe an increase in stethoscope hygiene beliefs. Since providers perceived no change in education during COVID-19, there may be a role for interventions targeting stethoscope hygiene. Early-career medical professionals (resident physicians), who were less likely to have performed optimal stethoscope hygiene during the pandemic, may be an appropriate target for an such an intervention. Although further investigation into stethoscope hygiene is needed to fully characterize its role in infection transmission, it is clear that providers are aware of its potential danger and may be more willing to change. Further studies should be performed implementing such interventions with the ultimate goal of keeping patients safe from all potential sources of infection.

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Author contributions

All authors contributed to the planning, analysis, and writing of this article.

Conflict of interest statement

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jhin.2022.05.019>.

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