where the social determinants of health have been fully addressed and health equity is our new undeniable goal.

The next crisis will come. Let us plan for a better outcome.

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References

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The stethoscope: a potential vector for COVID-19?

Case presentation

A 32-year-old cardiology resident was scheduled to round on the COVID-19 wards at a large, government teaching hospital in Bahrain. To cover the increasing workload, the hospital required additional medical personnel to provide care for the numerous COVID-19 patients that were being seen. Prior to examining COVID-19-positive patients, she donned appropriate personal protective equipment (PPE)—a gown, gloves, N95 mask, and face shield. As part of her physical exam, she was obliged to auscultate her patients with a stethoscope, listening for cardiopulmonary abnormalities that can be comorbid with severe COVID-19 infection. Thus, she was required to unzip her gown and keep her stethoscope either in her ears or around her neck. She used a standard-length Littman Cardiology™ stethoscope, requiring her to be in close proximity to the patient (i.e. lean over to the patient's level).

One day after her rounds, she developed a sore throat. She subsequently was tested positive for COVID-19 via polymerase chain reaction (PCR). The resident cardiologist remembered one patient that she had examined where she suspected the transmission occurred. She recalls examining a patient who was COVID-19 positive. Prior to the patient's intubation she applied her own stethoscope directly to the patient's chest to perform auscultation. The resident was perspiring and beginning to feel exhausted from her prior rounding and was breathing heavily as she unzipped her gown to place the stethoscope back within. The resident believes that COVID-19 viral particles which were transmitted to the stethoscope became aerosolized and inhaled as she brought the stethoscope close to her mouth while tucking it back into her gown. The resident recovered, re-tested negative for COVID-19, and has now returned to her normal duties.

The COVID-19 pandemic has called into question the triple-faceted role of the stethoscope: a diagnostic tool, symbol of patient–provider connection, and possible vector for infectious disease (*Figure 1*). A recent article in the *American Journal of Medicine* discusses developments in each arm of this triple role with reference to COVID-19, arguing that developments in stethoscope diagnostic technology, a need to bolster clinical skills, and developments in stethoscope hygiene methods will perpetuate both its relevance and safety. This argument was made in light of those who believe the stethoscope will become obsolete with the development of more advanced technologies, as well as its potential to transmit disease.[1] It is clear that a contaminated stethoscope might pose a danger to patients and providers, and can be a potential vector for the transmission of COVID-19, as illustrated in the case above. Thus, providers should seek to educate themselves on stethoscope contamination, assess the current methods of hygiene, and innovate accordingly rather than cast the stethoscope aside.

Studies have demonstrated that stethoscopes can harbour similar levels and types of microbes to those on one's hand.[2] Thus, it is no surprise that the stethoscope has been christened as the physician's 'third hand', with reference both to its potential for pathogen transmission and its integral role in patient–provider connection. Despite this, no clear guidelines exist for performing stethoscope hygiene. The Centers for Disease Control (CDC) classifies the stethoscope as a 'non-critical' medical device (i.e. only in contact with intact skin, not with bodily fluids), and recommends cleaning between as often as after contact with each patient to once weekly using an alcohol or bleach-based disinfectant.[3] It has been demonstrated that viruses, including COVID-19,[4] are capable of surviving on skin and other surfaces for an extended period of time.[5] Thus, current guidelines may not adequately reflect the risk that stethoscope contamination poses.

COVID-19 has fostered an era of increased infection control vigilance, and thus the benefits of the stethoscope must be rationally weighed against the risks. In the vignette posed here, the cardiology

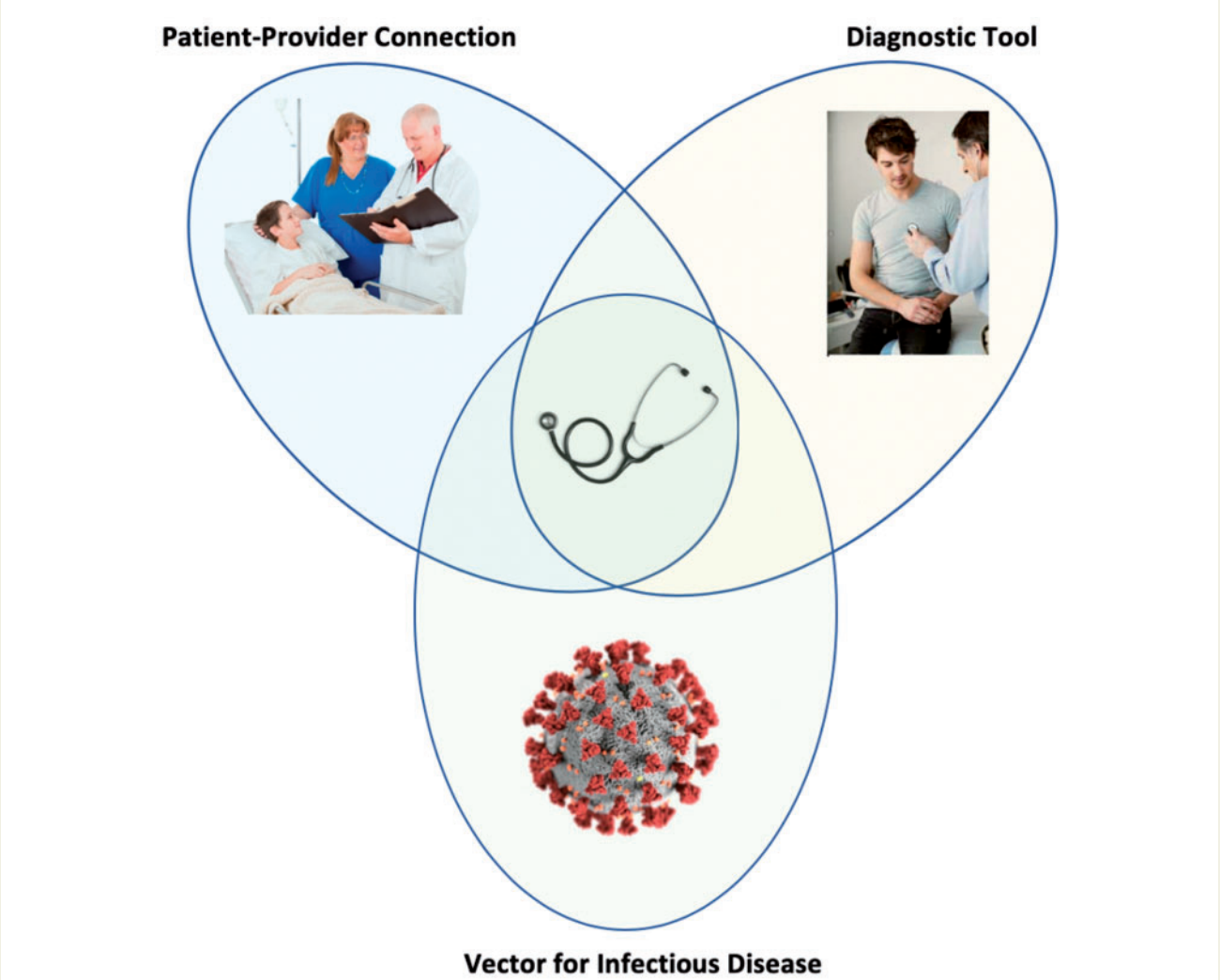

Figure 1 The three-faceted role of the stethoscope. The stethoscope lies at the intersection of three roles in medicine: diagnostic tool; connection between provider and patients; and a potential vector for infectious disease. As increased infection control vigilance has placed the stethoscope in a position of contention; each facet of the stethoscope must be weighed in consideration of medicines's cherished symbol.

resident felt the need to use her stethoscope to assess the COVID-19 patients on her round. Her likely rationale was the utility it provides in assessing the variety of cardiopulmonary abnormalities that can manifest during a COVID-19 infection. One of the most common manifestations of COVID-19 infection is multifocal pneumonia, often occurring prior to acute respiratory distress and need for mechanical ventilation.[6] While pneumonia is diagnosed most definitively using imaging modalities (CT and X-ray) and laboratory testing, resource-limited scenarios might necessitate the usage of a stethoscope to listen for pulmonary indications (coarse breath sounds). Furthermore, there is growing evidence that cardiovascular disease is highly comorbid with COVID-19 infection, leading to worse outcomes. The most common cardiovascular comorbidities among hospitalized COVID-19 patients are hypertension, coronary artery disease, and diabetes mellitus.[7,8] In addition, recent reports have implicated COVID-19 in causing myocardial injury and left ventricular systolic dysfunction.[9] Considering the sequelae of COVID-19 cardiopulmonary manifestations, auscultation using a stethoscope can be highly warranted. Therefore, emphasis must be placed on ensuring that the stethoscope can be used safely.

Assessments of stethoscope hygiene practices have widely demonstrated deficits in adherence and method. Direct observational studies have demonstrated stethoscope hygiene rates using recommended methods (wiping with alcohol, bleach, hydrogen peroxide, etc.) between 11.3% and 24%, with unconventional practices also being reported such as placing a glove over the stethoscope prior to auscultation or washing it with water/hand towel in a sink.[10,11] Such findings imply that while stethoscope hygiene practices are deficient, providers who are cognizant of stethoscope contamination are struggling to find an effective form of hygiene that does not impede workflow—a proverbial 'cry for help.' With regard to current methods of stethoscope hygiene, providers cite lack of access to cleaning supplies, forgetfulness, or a lack of time as reasons for not performing stethoscope hygiene.[12]

Healthcare guidelines advise against using personal stethoscopes in contact precaution settings in order to limit the potential for cross-contamination; rather, single-patient disposable stethoscopes are often used for such patients. However, the audio quality of single-patient stethoscopes is quite poor,[13] and it has been demonstrated that these

stethoscopes can be contaminated with pathogens that can potentially be transmitted to providers, who must share this stethoscope.[14] Proper cleaning of these stethoscopes between usage may not occur in high-workflow environments, such as the intensive care unit (ICU). Thus, a more feasible and effective modality of stethoscope hygiene is warranted.

A ray of hope for stethoscope hygiene is technological innovation. Among the solutions presented in recent years have been a UV-LED case for the stethoscope diaphragm,[1], stethoscopes made from antimicrobial copper alloys,[16] and disposable stethoscope diaphragm covers.[17] The challenge imposed by the first two innovations is a lack of complete microbial disinfection. Given that it is unknown what viral dose threshold corresponds to COVID-19 pathogenesis, current infection control standards might necessitate a method that ensures zero transmission. Stethoscope diaphragm covers alone can provide an aseptic contact surface during auscultation,[17] but one is likely to encounter the same impediments stated for conventional stethoscope cleaning.[12] A company based in San Diego, USA (AseptiScope Inc., San Diego, CA, USA) has attempted to overcome this issue by developing a touch-free diaphragm barrier dispenser.[1] A recent article discussed the role of stethoscope contamination during COVID-19, stating that a specific barrier for the stethoscope is needed to prevent stethoscope contamination and subsequent transmission to patients and providers.[18] A touch-free stethoscope diaphragm dispenser might be a feasible solution for this need.

In the era of COVID-19, the stethoscope carries both profound utility as well as risk to patients if effective hygiene practices are not implemented. Thus, providers need to exercise caution when auscultating patients with COVID-19 given the risk for cross-contamination. However, rather than casting aside the stethoscope due to this risk, safety should be bolstered through education, hygiene practice, and consideration of innovative solutions.

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In Memoriam

Dr Norman M. Kaplan (1931–2020): a giant in the field of hypertension has departed

The Guru, the Almanac, the Encyclopaedia, and the Legend of hypertension—Norman Kaplan passed away on 5 April 2020 in Dallas, TX, USA. He spent his entire professional career at the University of Texas Southwestern Medical School in Dallas—except for 1 year at the National Institutes of Health

Norman's parents had a small grocery store in Dallas; and the son of a grocer went on to become a peerless global commander in the field of hypertension. A graduate of the University of Texas Southwestern Medical School in 1954, he trained at the same institution in Internal Medicine and Endocrinology. After a year of collaborative work at NIH with the renowned Dr Fred Bartter (of Bartter' s syndrome), Norman joined the faculty of his alma mater—in 1961—where he remained until 2015. Upon stepping down, he told a medical reporter 'Sixty-one years is enough'!

Norman's scientific contributions to the field of hypertension are extraordinary. Although he lived for 90 calendar years, his impact on the field of hypertension will be felt for a long time. The majority of his contributions to hypertension are well known and recorded. Therefore, I would like to draw attention and comment on some of his 'characteristic' but less widely publicized papers. Amazingly, he identified some of the precursors of aldosterone synthesis (*Journal of Clinical Investigation* 1962; 41:715–724) and actually measured the aldosterone content of adrenal adenoma (*Journal of Clinical Investigation* 1967; 46:728–734). It is because of his insight that random sampling of urine for metanephrine to screen for pheochromocytoma became an acceptable substitute for the laborious 24-h urine collections (*Archives of Internal Medicine* 1977; 137:190–193).