This study has several limitations. We primarily surveyed first-call clinicians from a single center with a modest sample size. Variability between clinicians and institutions is likely; therefore, these findings may not be generalizable to other units. However, these findings could be used to develop local assessments. Surveys were conducted as soon as feasible after EACs, but responses may have been subject to recall bias. Lastly, participation in the first survey could have influenced responses in the second survey.

Opportunities may exist to improve EAC utilization. Judicious use of EACs has the potential to reduce antibiotic use and aligns with the national "Choosing Wisely" campaign to reduce medical overuse.[9] Additional studies are needed to clarify the indications and role of EACs in the management of mechanically ventilated patients.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2019.347

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References

1. Willson DF, Hoot M, Khemani R, *et al.* Pediatric ventilator-associated infections: the Ventilator-Associated INfection Study. *Pediatr Crit Care Med* 2017;18(1):e24–e34.
2. Grohskopf LA, Sinkowitz-Cochran RL, Garrett DO, *et al.* A national point-prevalence survey of pediatric intensive care unit-acquired infections in the United States. *J Pediatr* 2002;140:432–438.
3. Durairaj L, Mohamad Z, Launspach JL, *et al.* Patterns and density of early tracheal colonization in intensive care unit patients. *J Crit Care* 2009; 24:114–121.
4. Willson DF, Conaway M, Kelly R, Hendley JO. The lack of specificity of tracheal aspirates in the diagnosis of pulmonary infection in intubated children. *Pediatr Crit Care Med* 2014;15:299–305.
5. Venkatachalam V, Hendley JO, Willson DF. The diagnostic dilemma of ventilator-associated pneumonia in critically ill children. *Pediatr Crit Care Med* 2011;12:286–296.
6. Willson DF, Kirby A, Kicker JS. Respiratory secretion analyses in the evaluation of ventilator-associated pneumonia: a survey of current practice in pediatric critical care. *Pediatr Crit Care Med* 2014;15:715–719.
7. Gauvin F, Dassa C, Chaibou M, Proulx F, Farrell CA, Lacroix J. Ventilator-associated pneumonia in intubated children: comparison of different diagnostic methods. *Pediatr Crit Care Med* 2003;4:437–443.
8. Craven DE, Chroneou A, Zias N, Hjalmarson KI. Ventilator-associated tracheobronchitis: the impact of targeted antibiotic therapy on patient outcomes. *Chest* 2009;135:521–528.
9. Morgan DJ, Croft LD, Deloney V, *et al.* Choosing wisely in healthcare epidemiology and antimicrobial stewardship. *Infect Control Hosp Epidemiol* 2016;37:755–760.

Microbial contamination of heater cooler units used in extracorporeal membrane oxygenation is not aerosolized into the environment: A single-center experience

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Heater-cooler units (HCUs) used in cardiopulmonary bypass and extracorporeal membrane oxygenation (ECMO) can generate infectious aerosols containing *Mycobacterium chimaera*, a slow-growing nontuberculous mycobacterium (NTM) associated with disseminated infection. Since the identification of *M. chimaera* infective endocarditis in 2013, many more cases of deep-seated infections with *M. chimaera* have been identified and linked to the use of contaminated Stöckert 3TLivaNova (London, United Kingdom) HCUs.[1] Few studies have analyzed the water contamination of HCUs used in ECMO.[2] In this study, we aimed to ascertain whether HICO-Variotherm units (Chalice Medical, Worksop, UK) used in ECMO were colonized with *Mycobacterium*

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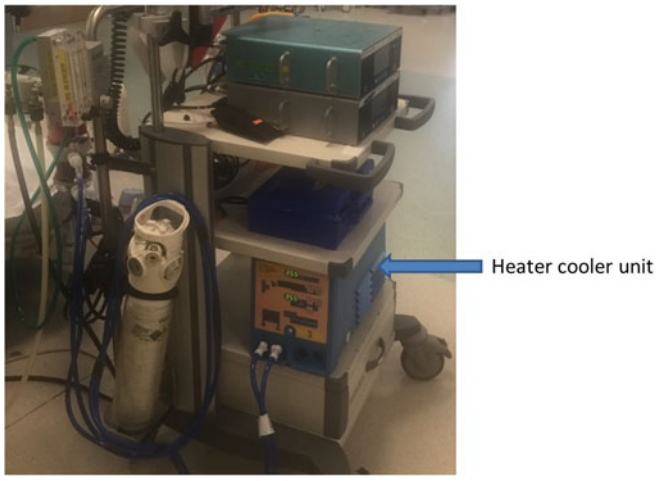

Fig. 1. A heater cooler device.

spp and to assess the associated risk of aerosolization into the critical care environment.

Methods

Study setting

This investigation was conducted in the cardiothoracic critical care unit (CTCCU) of Wythenshawe hospital (Manchester, UK) which is a conventionally ventilated unit (ie, no HEPA filters). At the time of study (November 2017), 3 HICO-Variotherm HCUs (Chalice Medical) were in use for patients undergoing veno-venous ECMO for 7–15 days for severe respiratory failure (Fig. 1).

Water samples

In the CTCCU, filtered tap water is used for the HCUs and water testing is not routinely performed. A serological pipette was used to transfer a sample (100 mL) of the water circulating through each HCU to a sterile sample container. Each water sample was cultured on tryptone soya agar (TSA; Oxoid, Basingstoke, UK), and potential marker organisms were identified using matrix-assisted laser desorption/ionization time-of-flight mass spectroscopy (MALDI-TOF MS). To culture for *Mycobacterium* spp, a 50-mL aliquot of each water sample was decontaminated and neutralized (BBL Mycoprep system, Becton Dickinson, Oxford, UK) before being passed through a 0.2-µm membrane filter. Each filter was transferred to a Middlebrooks 7H11 agar plate and incubated at 37°C for up to 6 weeks. To provide a more rapid indication of the presence or absence of *Mycobacterium* spp, each water sample was also assayed using an in-house quantitative polymerase chain reaction (qPCR) assay incorporating previously published primers.[3] A qPCR assay was also used to detect the presence of *Legionella* spp using a method validated in a previous study.[4]

Air samples

Air samples were collected immediately adjacent to each HCU and at the bedside (~1 m from the unit). We used two types of air samplers. First, we used an impaction sampler (AirIdeal, bioMérieux UK Limited, Basingstoke, UK), in which airborne microorganisms are impacted on the surface of an agar plate. At each position, 3 consecutive samples were taken, each incorporating a different culture media: TSA, cetrimide agar (for *Pseudomonas aeruginosa*), or Middlebrooks 7H11. On each occasion, the sampler was operated at 100 L per minute for 5 minutes (sample volume, 0.5 m^3 of air).

Second, we used a liquid impinger (Coriolis µ, Bertin Instruments, France), in which airborne microorganisms are concentrated in a collecting fluid. The sampler was operated once (300 L per minute for 10 minutes or 3 m^3 of air) at each position, and the collecting fluid (phosphate buffered saline + 0.01% Tween 20) was cultured (in duplicate) on TSA, cetrimide agar, and Middlebrook 7H11 agar plates. Each plate was assayed for the presence or absence of *Mycobacterium* spp and *Legionella* spp using qPCR.

Water and air samples were obtained on the same day. The presence of organisms in both would imply contamination of the HCU with associated aerosolization into the surrounding clinical environment.

Results

Water samples

A single water sample was taken from each of the 3 ECMO units. The number of bacteria cultured (on TSA) ranged from 5.7×10^6 CFU/L to 3.8×10^7 CFU/L (n = 3). In all cases, the predominant organism was identified as *Ralstonia* spp (ie, *picketti* or *insidiosa*). No NTM were cultured from the water samples. However, when analyzed via qPCR *Mycobacterium* spp were detected in water taken from 2 of the 3 ECMO units at a level of 10.2 GU/L (the theoretical equivalent of 3.4×10^3 GU/L water) and 14.6 GU/3mL (~4.8×10^3 GU/L water) (Table 1). A *Legionella* spp was detected in water taken from 2 of the 3 ECMO units at a mean concentration of 80.9 GU/3mL (~3.4×10^4 GU/L water; n = 2) and 1,029 GU/3mL (~3.4×10^5 GU/L water; n = 2). *Legionella pneumophila* was not detected.

Air samples

Neither *Ralstonia* spp nor *Mycobacterium* spp were cultured from any of the 12 air samples (Table 1). *Mycobacterium* spp was not detected in any of the 6 air samples analyzed via PCR. *Legionella pneumophila* was detected in 1 air sample (86 GU/m^3). The organism could not be cultured from the sample, so viability (or source) could not be confirmed.

Discussion

Mycobacteria chimaera produces biofilm that enables it to persist in water systems and its hydrophobicity favors aerosolization.[5] In our study, we detected *Mycobacteria* spp in 2 of 3 ECMO water samples. However, unlike previous studies on HCUs used for cardiothoracic bypass, aerosolization into the environment was not demonstrated.

The *Ralstonia* genus is a group of gram-negative nonfermenters that are well adapted to surviving in low nutrient conditions, which allows them to persist in various water supplies.[6] We found high numbers of *Ralstonia* spp in the water circulating the ECMO units but none in associated air samples.

The ECMO machines are air-tight and closed systems in contrast to the HCUs used in cardiothoracic surgery, which may have precluded the release of aerosols.[7] *Mycobacteria chimaera* contamination of ECMO devices was reported by Trudzinki et al.[2] As in our study, they did not find any mycobacteria in the 9 room air samples or other environmental samples. Although transmission of *M. chimaera* from an ECMO device to a patient is yet to be described, the theoretical risk of aerosolization remains when machines are decontaminated or emptied or when circuits are broken during use. Regular and effective

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Table 1. Organisms Cultured From Water Collected From All 3 ECMO Units

	ECMO Unit 1		ECMO Unit 2		ECMO Unit 3	
Organism	Culture	qPCR	Culture	qPCR	Culture	qPCR
Water sample (n=1)						
Ralstonia spp	Detected	...	Detected	...	Detected	...
Mycobacterium spp	Not detected	Not detected	Not detected	Detected	Not detected	Detected
Legionella spp	...	Detected	...	Not detected	...	Detected
L. pneumophila		Not detected		Not detected		Not detected
Air sample (n=4)						
Ralstonia spp	Not detected	...	Not detected	...	Not detected	...
Mycobacterium spp	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Legionella spp		Not detected		Not detected		Detected
L. pneumophila	...	Not detected	...	Not detected	...	Detected

Note. ECMO, extracorporeal membrane oxygenation; qPCR, quantitative polymerase chain reaction.

decontamination of the HCUs and microbiological surveillance are vital steps in mitigating the risk of infection due to *M. chimera* and other opportunistic pathogens.

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References

1. Van Ingen J, Kohl TA, Kranzer K, *et al.* Global outbreak of severe *Mycobacterium chimaera* disease after cardiac surgery: a molecular epidemiological study. *Lancet Infect Dis* 2017;17:1033–1041.
2. Trudzinski FC, Schlotthauer U, Kamp A, *et al.* Clinical implications of *Mycobacterium chimaera* detection in thermoregulatory devices used for extracorporeal membrane oxygenation (ECMO), Germany, 2015 to 2016. *Euro Surveill* 2016;21:1–8.
3. Bruijnesteijn van Coopenraet ES, Lindeboom JA, Prins JM, *et al.* Real-time PCR assay using fine-needle aspirates and tissue biopsy specimen for rapid diagnosis of mycobacterial lymphadenitis in children. *J Clin Micro* 2004;42:2644–2650.
4. Collins S, Jorgensen F, Willis C, *et al.* Real-time PCR to supplement gold-standard culture-based detection of *Legionella* in environmental samples *J Appl Microbiol* 2015;119:1158–1169.
5. Walker J, Moore G, Collins S, *et al.* Microbiological problems and biofilms associated with *Mycobacterium chimaera* in heater-cooler units used for cardiopulmonary bypass. *J Hosp Infect* 2017;96:209–220.
6. Safni I, Cleenwerck I, De Vos P, *et al.* Polyphasic taxonomic revision of the *Ralstonia solanacearum* species complex: proposal to emend the descriptions of *Ralstonia solanacearum* and *Ralstonia syzygii* and reclassify current *R. syzygii* strains as *Ralstonia syzygii* subsp. *syzygii* subsp. nov., *R. solanacearum* phylotype IV strains as *Ralstonia syzygii* subsp. *indonesiensis* subsp. nov., banana blood disease bacterium strains as *Ralstonia syzygii* subsp. *celebesensis* subsp. nov., and *R. solanacearum* phylotype I and III strains as *Ralstonia pseudosolanacearum* sp. nov. *Int J Syst Evol Microbiol* 2014;64:3087–3103.
7. Struelens MJ, Plachouras D. *Mycobacterium chimaera* infections associated with heater-cooler units (HCU): closing another loophole in patient safety. *Euro Surveill* 2016;21:30397.

Efficacy of a wearable ultraviolet-C light device for semiautomated decontamination of stethoscopes between each use

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Stethoscope diaphragms are often contaminated with pathogens such as *Clostridioides difficile* and methicillin-resistant *Staphylococcus aureus* (MRSA).[1–5] Moreover, the frequency of acquisition and transfer of *C. difficile* and MRSA during patient examinations has been shown to be similar for stethoscopes and hands.[1,2] Applying hand sanitizer to stethoscopes or wiping with alcohol or disinfectant wipes or swabs can reduce bacterial contamination.[1,6] However, stethoscopes are rarely cleaned in clinical practice.[6]

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