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Brief Report

Water faucets as a source of *Pseudomonas aeruginosa* infection and colonization in neonatal and adult intensive care unit patients

Regev Cohen MD [a,*], Frida Babushkin MD [a], Zvi Shimoni MD [a], Shoshana Cohen BA, RN [a], Eti Litig MA, RN [b], Maurice Shapiro MD [c], Amos Adler MD [d,e], Svetlana Paikin MD [f]

[a] *Infectious Diseases Unit, Sanz Medical Center, Laniado Hospital, Netanya, Israel*
[b] *Neonatal Intensive Care Unit, Sanz Medical Center, Laniado Hospital, Netanya, Israel*
[c] *Medical-Surgical Intensive Care Unit, Sanz Medical Center, Laniado Hospital, Netanya, Israel*
[d] *National Center of Infection Control, Ministry of Health, Tel Aviv, Israel*
[e] *Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel*
[f] *Microbiology Laboratory, Sanz Medical Center, Laniado Hospital, Netanya, Israel*

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We investigated the occurrence of *Pseudomonas aeruginosa* in our neonatal and adult intensive care units. Using enterobacterial repetitive intergenic consensus polymerase chain reaction, we showed spatial and temporal associations with clonal identity between patients' and adjacent faucets' clones. Both units' taps were highly colonized with *P aeruginosa* and with other waterborne bacteria. In the neonatal intensive care unit, strict use of sterile water for bathing neonates may have contributed to a reduction in clinical isolation of *P aeruginosa* postintervention.

INTRODUCTION

Pseudomonas aeruginosa is a leading pathogen causing ventilator-associated pneumonia in intensive care unit (ICU) patients. Colonized water and point-of-use fixtures have been incriminated as a cause of infections and outbreaks in ICUs.[1] Point-of-care water filter use reduced *P aeruginosa* infections in surgical ICUs and in transplant units.[2] In neonatal ICUs (NICUs) *P aeruginosa* is usually acquired from environmental sources (ie, exogenous), which should be investigated.[3]

During June-September 2012, 4 clinical isolates of *P aeruginosa* were reported in our NICU (blood, eye, ear, and sputum cultures from 4 different neonates), which triggered this investigation. During this period of time, *P aeruginosa* was found in ~35% of ventilated patients in the medical-surgical ICU (MSICU),[4] so we investigated the faucets in this unit as well.

METHODS

The study was conducted in Sanz medical center, a 400-bed community hospital located in central Israel. The NICU usually contains 15 incubators, with 4 faucets located in 2 rooms (a NICU and an intermediate unit). The MSICU is a single-hall 6-bed unit with 6 faucets, each located near a bed and with no physical barrier between patient units. A seventh faucet is located near the nurses' station. Schematic outlines are shown in Figures 1 and 2.

NICU investigation

We interviewed the staff, openly observed hand hygiene compliance according to the World Health Organization 5 Moments for Hand Hygiene,[5] and obtained environmental cultures from selected incubators (inner surfaces, water tanks, and niches of the dismantled incubator parts immediately after being cleaned). Faucets were cultured on several occasions (Figure 1) using a bacterial swab by rubbing the tip into the distal part of the faucet. Aerators were dismantled from all faucets, cultured from their inner part using a swab, and were not repositioned. Contaminated faucets were occasionally replaced or treated. This treatment included 1 hour of soaking in an enzymatic fluid (Endozyme Xtreme Power, Ruhof, NY); pressure washing, including the channels; dishwashing at 93°C; dehydration at 120°C; and finally sterilization by ethylene oxide. During the intervention and since, neonates were bathed only with warmed

* Address correspondence to Regev Cohen, MD, Infectious Diseases Unit, Sanz Medical Center, Laniado Hospital, Netanya, Israel.
E-mail address: regevco@gmail.com, regevc@laniado.org.il (R. Cohen).

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Conflicts of interest: None to report.

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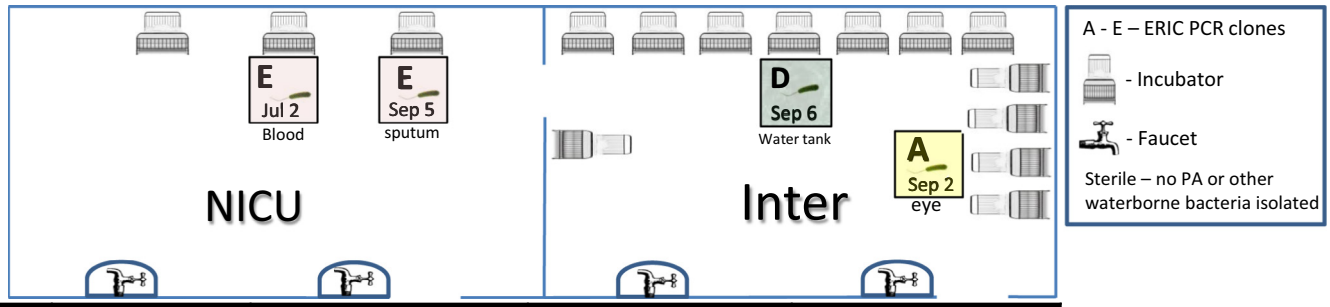

Date	NICU Tap 1	NICU Tap 2	Inter Tap 3	Inter Tap 4
Jul 7 2012	C	C	Not sampled	C
Faucets replacement				
Sep 5 2012	Not sampled	B	C	A
Sep 24 2012	Commomonas spp	B	Stenotrophomonas	A
Dec 4 2012	Sterile	Sterile	A	A
Dec 11 2012	Acinetobacter spp	Acinetobacter junii	A	A
Dec 17 2012	Sterile	Sterile	A	A
Faucet-Head Heat treatment				
Dec 25 2012	Sterile	Sphingomonas	A	A
Jan 2 2013	Sphingomonas	Sterile	A	A
Jan 11 2013	Sphingomonas	Sphingomonas	B	A & Sphingomonas
Jan 19 2013	Sphingomonas	Sphingomonas	Not sampled	Not sampled
Feb 4 2013	Sphingomonas	Sphingomonas	B & Acinetobacter junii	Sphingomonas
Feb 16 2013	Sphingomonas	Sphingomonas	B	Sphingomonas
Feb 28 2013	Sphingomonas	Sterile	Sphingomonas & A. junii	Sphingomonas

Fig 1. Schematic outline of neonatal intensive care unit (NICU) and enterobacterial repetitive intergenic consensus polymerase chain reaction (ERIC-PCR) clone analysis. *Inter*, intermediate.

sterile water, and tap water was allowed only for hand hygiene practices.

MSICU investigation

All tap aerators were removed and tap water were used only for bathing the patients. All other uses of tap water, such as drinking, moistening, and mouth treatments, were allowed using only sterile water. The units' faucets were sampled on 2 different days (December 24, 2012, and January 14, 2013), concurrently with surveillance cultures of pharyngeal, sputum, and urine from patients.

Microbiology

Samples were collected with swabs (Transsystem; Copan Diagnostics Inc., Murrieta, CA) and transferred within 30 minutes for culturing on tryptic soy blood agar, chocolate agar, MacConkey agar and fluid thioglycolate medium (Hy-labs, Rehovot, Israel). After overnight incubation at 35°C, broth samples were subcultured to the same media plates whenever no growth was detected on the initial plates. Bacteria were identified with Vitek 2 (BioMerieux, Marcy-l'Étoile, France). Typing was done by enterobacterial repetitive intergenic consensus polymerase chain reaction (ERIC-PCR) as previously described[6] and compared visually.

RESULTS

NICU

Infection control nurses visited the NICU weekly, but regular hand hygiene monitoring was initiated on December 2012. An infection control physician assessed the frequency of catheter-associated bloodstream infections since October 2012. During the investigation, we intensified the monitoring of standard precautions adherence. Few cases of infection control breaches were noted (mainly wearing artificial nails and hand apparel). Hand hygiene compliance improved during the 6 months after December 2012: Among nurses the monthly compliance ranged from 50%-96% and averaged 71% (164 out of 230 opportunities), and among doctors monthly compliance ranged from 25%-65% and averaged 47% (61 out of 129 opportunities). Ethanol 70% with chlorhexidine gluconate 0.5% w/v (Septol; Teva Medical, Ashdod, Israel) was used for hand hygiene. No *P aeruginosa* was cultured from health care worker hands or from the cleaned incubators. Cultures from incubator water tanks grew *P aeruginosa* once and *Achromobacter* spp and *Acinetobacter* spp on other occasions.

All 4 faucets were colonized at least once with *P aeruginosa* during several months. Faucet replacement and treatment were futile. ERIC-PCR analysis yielded 5 clones (clones A-E) (Figure 1). Clones A, B, and C were found in the faucets. A unique clone (clone D) was found in a water tank of 1 incubator, and clone E was found in 2 clinical samples