

Grifería de agua como fuente de infección por *Pseudomonas aeruginosa* y colonización en pacientes de cuidados intensivos neonatales y adultos.

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Se investigó la presencia de *Pseudomonas aeruginosa* en nuestras unidades de cuidados intensivos neonatales y adultos. Utilizando la reacción de polimerasa en cadena de consenso intergénico repetitivo enterobacterial, mostramos asociaciones espaciales y temporales con la identidad clonal entre los clones de los pacientes y los grifos adyacentes. Los grifos de ambas unidades estaban altamente colonizados con *P aeruginosa* y con otras bacterias transmitidas por el agua.

En la unidad de cuidados intensivos neonatales, el uso estricto de agua estéril para el aseo de neonatos puede haber contribuido a una reducción en el aislamiento clínico de *Pseudomonas aeruginosa* post intervención.



Brief Report

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

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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.

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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

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Conflicts of interest: None to report.

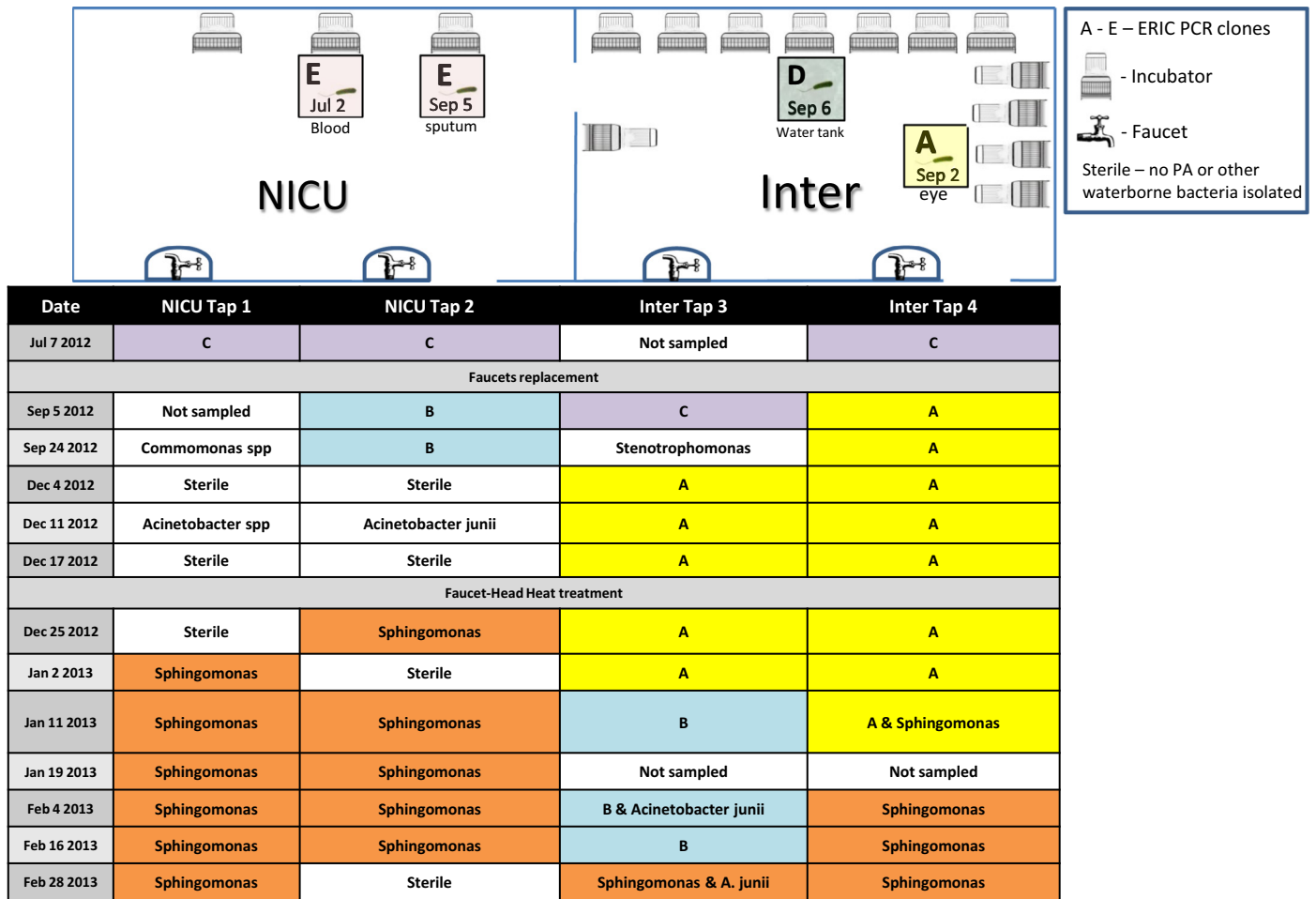


Fig 1. Schematic outline of neonatal intensive care unit (NICU) and enterobacterial repetitive intergenic consensus polymerase chain reaction (ERIC-PCR) clone analysis. *Inter*, intermediate.

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 described⁶ 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

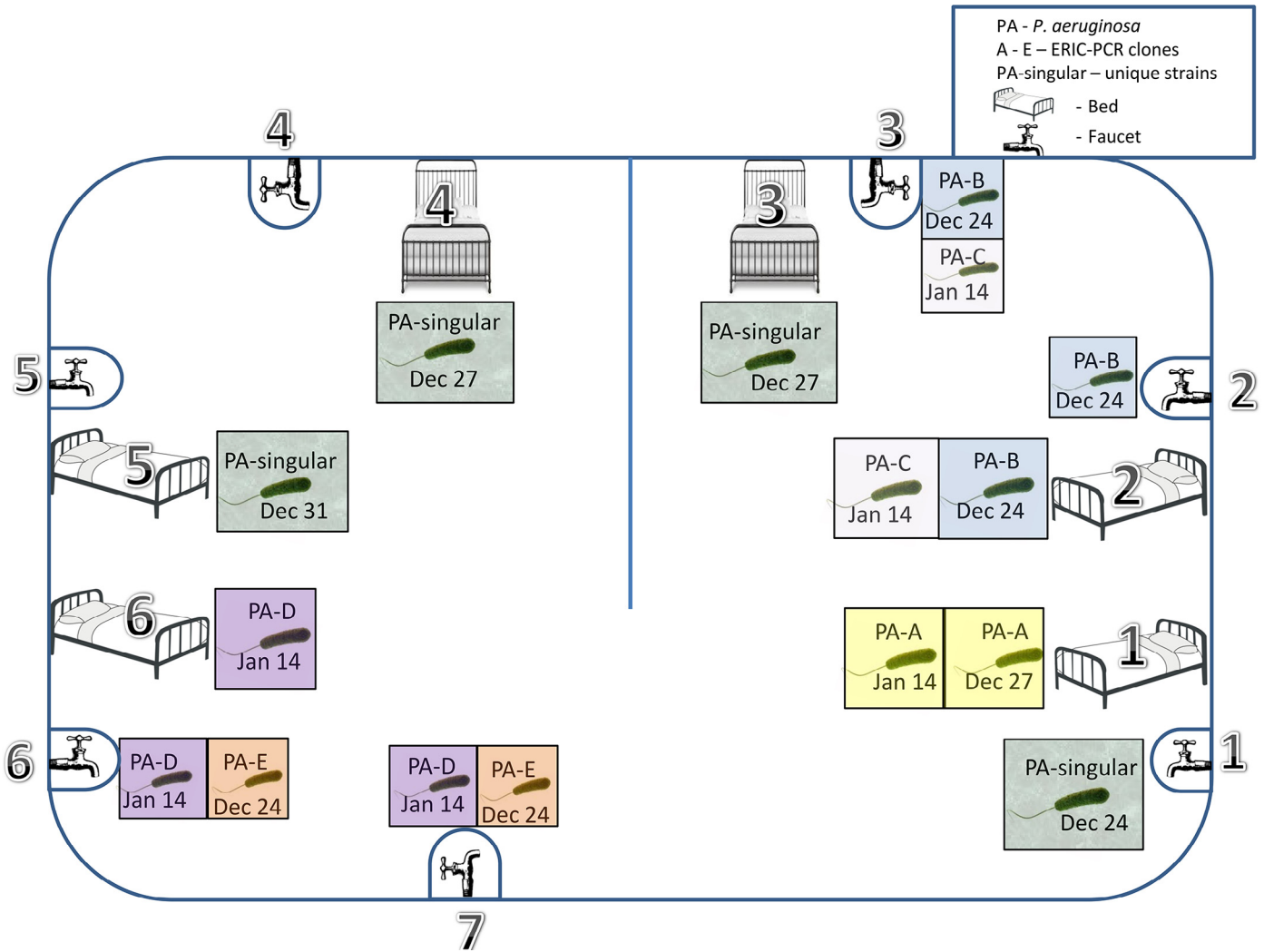


Fig 2. Schematic outline of the medical-surgical intensive care unit (MSICU) and enterobacterial repetitive intergenic consensus polymerase chain reaction (ERIC-PCR) clone analysis.

(blood and sputum cultures from 2 different neonates, 2 months apart), but not in any of the environmental cultures. Clone A was found in faucets 3 and 4 and also in an eye culture from a nearby neonate, concurrently. Faucets were persistently contaminated with the same clone until replaced by a new clone or by other waterborne bacteria, including *Stenotrophomonas* spp, *Acinetobacter* spp, *Comamonas* spp, and *Sphingomonas* spp. The latter had been predominant in NICU faucets since January 2013, but no clinical cases were seen.

Tap water was banned from use as part of the investigation, and during the 30 months after the intervention we had only 3 neonates with *P. aeruginosa* from clinical cultures (0.29 compared with 2.2 cases per 1,000 hospitalization-days during the 4 months before the intervention).

MSICU

Regular hand hygiene monitoring in the unit was initiated during February 2013 and across 4 months the average compliances were 68% (22 out of 32) and 63% (50 out of 79) among doctors and nurses, respectively. Five out of 7 faucets (70%) and all 7 patients sampled were colonized with *P. aeruginosa*. Five ERIC-PCR clones (clones A-E) were found (Figure 2). On 3 occa-

sions, the same clone was found in 2 adjacent faucets (taps 2 and 3 on December 24, and taps 6 and 7 on both December 24 and January 14). In 2 patients the same clone was found also in the nearest faucets (bed 6 and bed 2, twice), demonstrating a clear association. *Stenotrophomonas* spp were found in sputum cultures from 2 patients, and also in the nearest faucet of 1 of them (bed 4, both on January 14), but molecular analysis was not performed. *Acinetobacter baumannii* was endemic in the MSICU at this period in time,⁴ but was never isolated from the faucets.

DISCUSSION

The 2 investigations showed spatial and temporal relation with clonal identity between the patients and the nearest taps. Both units' faucets were highly colonized and cross-colonization between adjacent faucets was observed. Faucet replacement or sterilization were not efficient, as was previously described,⁷ and clones tended to persist until replaced by other *P. aeruginosa* clones or by other bacteria. Exclusive use of sterile water for bathing neonates (as recommended by some authorities⁸) may have contributed to the reduction in clinical cases during the following months (along with improving hand hygiene practices).

In contrast, tap water was being used for bathing in the MSICU, and hence contaminated tap water had direct access to patients' skin and potentially mucous membranes. Although most clinical isolates were not typed and consequently could not be linked to environmental sources, in the 2 cases with linkages, both patients had ventilator-associated pneumonia with the same clone found in the nearest faucet.

Environmental infection control guidelines do not prohibit tap water use in ICUs, with the exception of preventing secondary *Legionella* infection.⁹ Consensus has not been reached regarding aerators, but decontamination and removal are recommended during outbreaks. Despite the above, not all NICUs in Israel use tap water freely. Surveying 22 (out of 26) NICUs in Israel, in 5 units extremely low-birth-weight neonates are bathed with sterile water, and 1 unit treats faucets with hot water and sodium hypochlorite every morning. We did not ban the use of tap water altogether, but stressed the superiority of alcohol-based handrubs.

CONCLUSIONS

NICUs experiencing colonization of *P aeruginosa* or other waterborne organisms should be vigilant with the use of tap water, and may consider switching to sterile water for bathing neonates. In adult ICUs, avoidance of tap water use altogether, potentially by using disposable cloths prepackaged with 2% chlorhexidine gluconate, may be prudent.¹⁰

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