American Journal of Infection Control ■■ (2016) ■■-■■

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief Report

Detection of temporal clusters of health care–associated infections or colonizations with *Pseudomonas aeruginosa*

A. Lefebvre MD [a,b,*], J.C. Lucet MD, PhD [c,d], X. Bertrand MD, PhD [e,f], P. Chavanet MD, PhD [b,g], K. Astruc MD [a], C. Quantin MD, PhD [h,i], P. Vanhems MD, PhD [j,k], L.S. Aho-Glélé MD [a]

[a] *Hospital Epidemiology and Infection Control Department, Dijon University Hospital, Dijon, France*
[b] *Laboratory of Environmental Microbiology and Health Risks, University of Burgundy, Dijon, France*
[c] *Hygiene and Infection Control Unit, Hospital Group Bichat—Claude Bernard, Public Assistance of Paris Hospitals, Paris, France*
[d] *Paris Diderot University, Paris, France*
[e] *Infection Control Department, CHU Besançon, Besançon, France*
[f] *Chrono-environment Laboratory, UMR CNRS 6249, University of Franche-Comté, Besançon, France*
[g] *Infectious Diseases Department, Dijon University Hospital, Dijon, France*
[h] *Biostatistics and Medical Information Department, Dijon University Hospital, Dijon, France*
[i] *Epidemiology Department—EA 4184, University of Burgundy, Dijon, France*
[j] *Infection Control, Epidemiology and Prevention Department, Hospital Group Edouard Herriot, Lyon, France*
[k] *Epidemiology and Public Health Team, Claude Bernard University, Lyon, France*

Key Word:
Water

We investigated temporal clusters of *Pseudomonas aeruginosa* cases between 2005 and 2014 in 1 French university hospital, overall and by ward, using the Kulldorff method. Clusters of positive water samples were also investigated at the whole hospital level. Our results suggest that water outlets are not closely involved in the occurrence of clusters of *P aeruginosa* cases.

Loveday et al[1] identified several studies focusing on *Pseudomonas aeruginosa* that were conducted during endemic periods and were found to provide evidence of a link between water systems and *P aeruginosa* infection. However, this link is still not clear. Guidelines vary across countries and among experts,[2-6] from sampling water if a water source is suspected in health care–associated infections[2,3] to systematic monitoring for *Legionella* and *P aeruginosa*.[6]

We searched for temporal clusters of *P aeruginosa* cases in 1 French university hospital and tried to link them to water colonization. We hypothesized that contaminated water outlets would lead to clusters of cases, particularly if several water outlets in the same ward were contaminated because of low water use, localized biofilms, corrosion of a part of the water network, or localized scale deposits.

METHODS

Dijon University Hospital (France) has 1,800 beds, with medical and surgical departments and intensive care units (ICUs). All *P aeruginosa* health care–associated infections or colonizations from January 2005-April 2014 were extracted from the bacteriology laboratory database. The study population has been described elsewhere.[7] The Kulldorff temporal scan was used to detect clusters in the hospital overall and by ward (117 hospitalization wards) with the SaTScan software (Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA). The temporal unit was one day. The number of person days per month (from admission to discharge) was obtained from administrative databases, which record all hospitalizations for each ward. The number of days per month was divided by the number of days in the month to take the population-at-risk for each day into account in Poisson models. The maximal size of the cluster was set at 1,000 days, and 999 Monte-Carlo iterations were used to test the null hypothesis. Analyses were repeated with adjustments for secular log-linear trends and the day of week. Analyses by ward took account global temporal variations.[8] A *P* value <5% was considered significant.

Nearly 20% of water outlets in each unit had to be randomly sampled once every quarter, after removing the filter if it was fitted.

* Address correspondence to A. Lefebvre, MD, Equipe Opérationnelle D'hygiène, CHU Reims, Hôpital Maison Blanche, 45 rue Cognacq Jay, 51092 Reims cedex, France.
E-mail address: alefebvre@chu-reims.fr (A. Lefebvre).
Conflicts of Interest: None to report.

0196-6553/
http://dx.doi.org/10.1016/j.ajic.2016.05.031

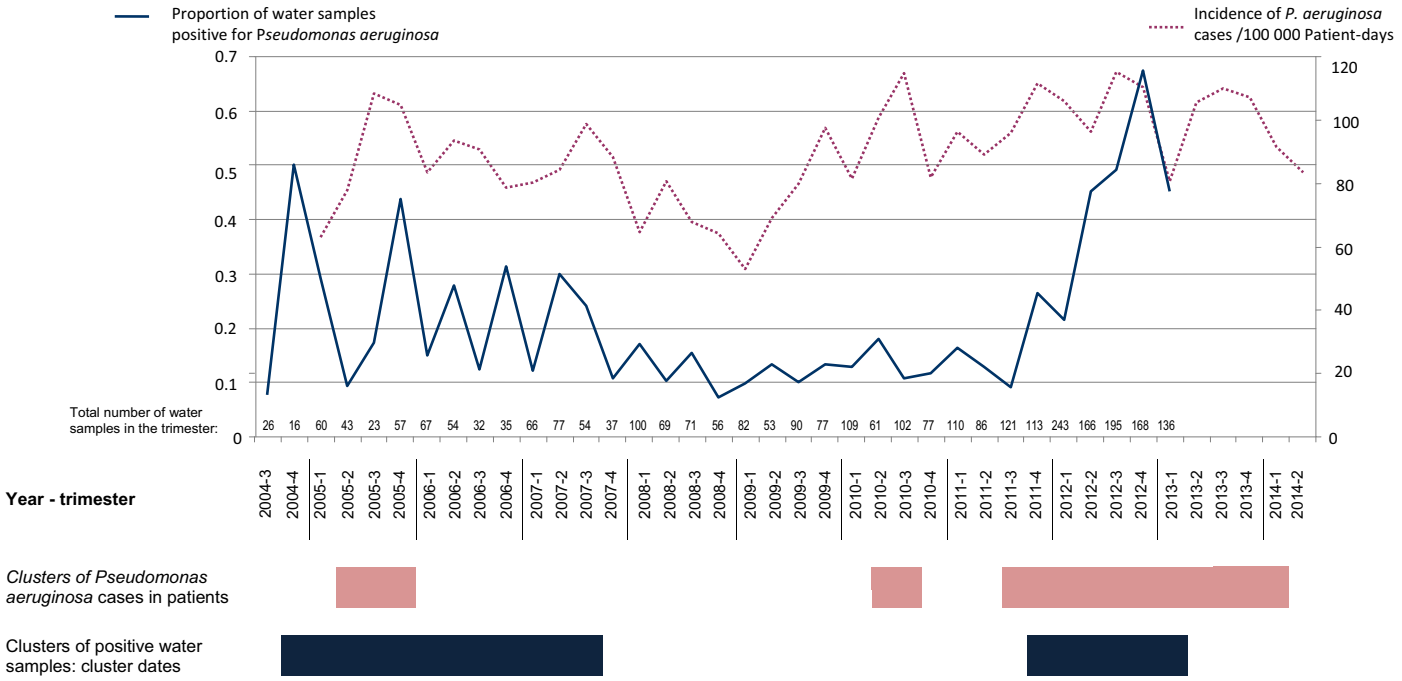

Fig 1. Evolution of the incidence of *Pseudomonas aeruginosa* health care–associated cases and proportion of water samples positive for *P aeruginosa* by quarter, and distribution of the clusters detected with the SaTScan software.

Table 1
Retrospective temporal clusters of *Pseudomonas aeruginosa* detected at Dijon University Hospital overall and by ward with the SaTScan software between January 2005 and April 2014

Localization of the cluster	Dates	Filters systematically fitted in the unit	Adjustment method	*P* value	Observed/expected cases
Hospital overall	June 8, 2005-December 16, 2005	—	Adjustment for population at risk	.005	258/190.32 = 1.36
			Adjustment for population at risk, days of week, and temporal trend		258/185.67 = 1.39
Hospital overall	June 21, 2010-September 27, 2010	—	Adjustment for population at risk	.023	150/100.44 = 1.52
Hospital overall	July 13, 2011-February 11, 2014	—	Adjustment for population at risk	.001	1322/1129.21 = 1.17
Hematology—continued monitoring	July 28, 2005-November 21, 2005	Yes: all outlets	Adjustment for population at risk, days of week, and temporal trend	.011	18/3.55 = 5.07
Medical intensive care unit	March 16, 2010-July 5, 2010	Yes: outlets used for bathing patients	Adjustment for population at risk	.007	40/14.42 = 2.8
			Adjustment for population at risk, days of week, and temporal trend	.012	40/14.58 = 2.7
Endocrinology unit	October 22, 2012-November 13, 2012	No: filters fitted only if water samples were positive	Adjustment for population at risk	.017	9/0.72 = 12.5
			Adjustment for population at risk, days of week, and temporal trend	.045	9/0.78 = 11.5

Only the first sample in the same water outlet during the quarter was kept. Water samples of hospitalization wards from July 2004-February 2013 were included. Clusters of water samples positive for *P aeruginosa* were detected at the whole hospital level. The time unit was the quarter, and the maximal duration of clusters was set at 50% of the period.

RESULTS

During 2005-2014, 3,946 isolates of *P aeruginosa* were recovered from 2,996 patients. The incidence rate was 89.8 per 100,000 patient days (95% confidence interval, 87.0-92.6).

Of 2,932 water samples, 493 (16.8%; 95% confidence interval, 15.5%-18.2%) were positive for *P aeruginosa*. No clear correlations were found between the proportion of positive water samples and cases (Fig 1).

For the hospital overall, 3 clusters of cases were detected (Table 1, Fig 1). Clusters of positive water samples were observed during 2 of the 3 periods with a cluster of cases. Analyses by ward allowed the detection of 3 clusters. Of 43 samples taken in the hematology ward, 2 were contaminated with >100 colony forming units (CFU)/mL during the cluster. During 2005-2013, such a contamination occurred only one other time, and lower contaminations (1-6 CFU/mL) occurred 4 times. Of 45 water samples taken in the medical ICU, 2 were positive, both outside the cluster period. In the endocrinology ward, 2 of the 31 water samples taken were positive, both outside the cluster period.

DISCUSSION

Our hospital is spread over several sites. The role of contamination of the water system in the simultaneous occurrence of clusters in different sites seems unlikely. However, temperature conditions or low water flow from outlets in several wards at the same period (period of bed closures) could favor simultaneous colonizations of water systems. The cluster of hospital-acquired *P aeruginosa* cases

detected in 2011-2014 was wide and was not detected when the time trend was taken into account. It probably reflected the overall trend. Two shorter clusters, both starting in June, were observed. However, bed closures usually occurred during the Christmas period and in July-August. Clusters of positive water samples occurred in the same periods as 2 of the 3 clusters of human cases, but 1 of the clusters of positive water samples started after the cluster of cases.

Three clusters were detected by searching through wards. The infection control department regularly visited the hematology ward and never observed the absence of filters. However, 2 water outlets were found to be positive with >100 CFU/mL of *P aeruginosa* during the cluster of cases, whereas only 1 water sample was found to be positive outside the cluster period. The efficiency of filters and their appropriate use could be questioned. The medical ICU was moved in 2010. The cluster overlapped the move. The disruption of the ward during the move could explain an increase in cross-transmission. During this period, an alert was issued by the bacteriology laboratory for a cluster of *P aeruginosa* in respiratory samples. Genotyping made it possible to connect this cluster to a contaminated endoscope. The water used to clean the endoscope was not contaminated. For the endocrinology ward, no water outlets were found to be positive during the cluster period. An increased incidence related to other causes, such as changes in practices, cannot be excluded.

This study has limitations. The ward in which the isolate was obtained did not necessarily correspond to the ward in which the transmission occurred. However, patients rarely moved from one ward to another. Clusters linked to a contamination of a particular outlet would be difficult to identify through analyses by ward because they would be diluted in the data of patients in other rooms in the ward. Genotyping methods were not used in this retrospective study.

Although the clusters were investigated over a long period, few were detected. This indicates that cross-transmission or water network contamination rarely resulted in outbreaks in our facility, outside particular wards that accommodate patients with a high risk of *P aeruginosa* acquisition, such as hematology units.

Acknowledgment

We thank Philip Bastable for his editorial assistance.

References

1. Loveday HP, Wilson JA, Kerr K, Pitchers R, Walker JT, Browne J. Association between healthcare water systems and Pseudomonas aeruginosa infections: a rapid systematic review. J Hosp Infect 2014;86:7.
2. Sehulster L, Chinn R, CDC, HICPAC. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep 2003.52:1-42.
3. HFS, HPS and Pseudomonas aeruginosa and Water (Scotland) Group. Guidance for neonatal units (NNUs) (levels 1, 2 & 3), adult and paediatric intensive care units (ICUs) in Scotland to minimise the risk of Pseudomonas aeruginosa infection from water. Glasgow, Scotland: Health Protection Scotland; 2014.
4. Department of Health. Health technical memorandum 04-01 addendum: Pseudomonas aeruginosa advice for augmented care units. London, England: 2013.
5. Prevention and Control of Infection from Water Systems in Healthcare Facilities Sub-Committee of the HPSC Scientific Advisory Committee. Guidelines for the prevention and control of infection from water systems in healthcare facilities. Dublin, Ireland: Health Protection Surveillance Centre; 2014.
6. Ministère de la Santé et des Solidarités. L'eau dans les établissements de santé—Guide technique: Direction Générale de la Santé—Direction de l'Hospitalisation et de l'Organisation des soins. 2005.
7. Lefebvre A, Bertrand X, Vanhems P, Lucet JC, Chavanet P, Astruc K, et al. Detection of temporal clusters of healthcare-associated infections or colonizations with pseudomonas aeruginosa in two hospitals: comparison of SaTScan and WHONET software packages. PLoS ONE 2015;10:e0139920.
8. Kulldorff M, Heffernan R, Hartman J, Assuncao R, Mostashari F. A space-time permutation scan statistic for disease outbreak detection. PLoS Med 2005;2:e59.