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Letter to the Editor

Temperature, humidity, and climate control in hospital units: A clue for understanding the seasonality of healthcare-associated pathogens

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To the Editor—The recent finding of seasonality of healthcare-associated infections and pathogens has posed novel challenges for the practice infection control.[1] However, several aspects remain unexplored, and several gaps in our understanding of that phenomenon exacerbate these challenges. First, most studies on seasonality have been conducted in temperate climates.[2,3] They have also focused mostly on seasons and weather, using parameters measured outside hospitals.[1,4,5] Therefore, it remains unclear why seasonality and associations with high temperatures are detected even in hospitals or hospital units with climate control.[1,6] To fill these gaps in our knowledge, we conducted a prospective ecological study in a teaching hospital in Brazil.

The study was conducted in Botucatu School of Medicine, a 450-bed teaching hospital that provides tertiary care for an area comprising 500,000 inhabitants. The hospital is located in a tropical climate (22°53′21“S, 48°29′40”W). It was originally built as a sanatorium for tuberculosis, and it has wide windows open to the outside and high ceilings. Climate control is used only in the 5 intensive care units (ICUs).

From July 2017 through June 2018, we measured the inside temperature and relative humidity in 15 wards (non–climate-controlled wards) and 1 medical-surgical ICU (11 beds). Average monthly parameters were calculated for the ICU and the other wards (in this case, the average measures of all 15 wards). We also surveilled all of these units for the incidence of healthcare-associated multidrug-resistant pathogens, both gram-positive organisms (ie, methicillin-resistant *Staphylococcus aureus* [MRSA] and vancomycin-resistant enterococci [VRE]) and gram-negative organisms (carbapenem-resistant Enterobacteriaceae [CRE], *Acinetobacter baumannii* [CRAB], and *Pseudomonas aeruginosa* [CRPA]). We calculated the aggregate incidence of both colonization and infection, that is, of any positive culture for the MDROs of interest from patients admitted for >3 days. Notably, the surveillance cultures (weekly nasal and rectal swabs) were collected only in the ICU.

We tested the association of temperature and humidity with the incidence of MDROs in both the ICU and 15 non-ICU wards using Poisson models in STATA version 14 statistical software (StataCorp, College Station, TX).

Our results are presented in Table 1. Briefly, in nonclimatized units, we detected a negative association of humidity with overall MDROs and gram-negative pathogens. In the ICU, temperature was positively associated with overall MDROs, overall gram-positive pathogens, VRE, and CRPA.

Notably, we detected associations of temperature inside a climate-controlled ICU with the incidence of gram-positive (VRE) and gram-negative (CRPA) pathogens. Interestingly, the temperature in the ICU presented only minor variations. The median daily temperature was 22.2°C (72.0°F), and the range was 19.6°C–23.8°C (67.3°F–74.8°F). Thus, even small increases in the temperature affected the incidence of MDROs in this study.

On the other hand, no impact of temperature on the incidence of MDROs was detected in non-ICU wards, where, paradoxically, the median value was higher (24.8 °C [76.6 °F]) and the range was larger (18.3°C–29.5°C [64.9°F–85.1°F]). Even though this finding contradicts previous findings of our group,[5] the smaller incidence of MDROs in the 15 wards, due both to less vulnerable patients and because we did not perform an active search using surveillance cultures, may have hindered the statistical power of our analysis.

An interesting aspect of our findings is that the inside temperature was significantly correlated with the temperature measured at a nearby meteorological station for both the climate-controlled ICU (Spearman's ρ, 0.63; $P < .001$) and the 15 wards without climate control (ρ, 0.79; $P < .001$). Therefore, outside weather conditions influenced inside temperature. This finding helps explain why seasonality of healthcare-associated infections and pathogens is found even in completely climate-controlled hospitals and wards.[1,6] In recent studies, we found that both outside and inside temperature in the operating theater were positively associated with the risk of acquiring a surgical site infection.[7,8]

The most important limitation of our study was the short period during which it was conducted. Because we studied only 1 year, no analysis of seasonality could be performed. Also, the statistical power of the data was low. Even so, we were able to identify the impact of small temperature changes in the incidence of MDROs. Our findings must be interpreted as “at least” associations. If the study had been conducted over a greater period, it is likely that other associations would have been detected.

Another limitation is that we did not perform molecular strain typing to determine whether there was greater cross transmission

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Table 1. Association of Average Monthly Temperature and Humidity With the Incidence of Multidrug-Resistant Organisms

Pathogens of Interest	Incidence[a]	IRR (95% CI)	
		Temperature (°C)	Relative Humidity (%)
Hospital wards (not climate-controlled)[b]			
Overall MDROs	4.50	1.00 (0.94–1.07)	**0.99 (0.98–0.99)**
Gram-positive	1.99	0.95 (0.67–1.05)	0.99 (0.98–1.01)
Methicillin-resistant *Staphylococcus aureus*	0.94	0.93 (0.80–1.07)	0.99 (0.98–1.02)
Vancomycin-resistant enterococci	1.05	0.97 (0.86–1.11)	0.99 (0.97–1.01)
Gram-negative	2.50	1.05 (0.96–1.14)	**0.98 (0.97–0.99)**
Carbapenem-resistant enterobacteriaceae	1.03	1.06 (0.93–1.21)	0.98 (0.97–1.00)
Carbapenem-resistant *Acinetobacter baumannii*	1.04	0.99 (0.87–1.13)	0.98 (0.96–1.00)
Carbapenem-resistant *Pseudomonas aeurginosa*	0.43	1.16 (0.94–1.41)	1.00 (0.98-1.03)
Intensive Care Unit (climate-controlled)			
Overal MDROs	44.65	**1.56 (1.14–2.17)**	0.97 (0.94–1.01)
Gram-positive	15.64	**2.26 (1.33–3.84)**	0.96 (0.91–1.01)
Methicillin-resistant *Staphylococcus aureus*	8.14	2.04 (0.77–4.29)	0.97 (0.90–1.04)
Vancomycin-resistant enterococci	7.49	**2.51 (1.18–5.37)**	0.94 (0.83–1.02)
Gram-negative	29.01	1.27 (0.84–1.91)	0.98 (0.95–1.02)
Carbapenem-resistant enterobacteriaceae	10.43	0.73 (0.36–1.48)	0.98 (0.93–1.05)
Carbapenem-resistant *Acinetobacter baumannii*	13.69	1.45 (0.80–2.62)	0.99 (0.95–1.06)
Carbapenem-resistant *Pseudomonas aeruginosa*	4.89	**2.55 (1.03–6.54)**	0.92 (0.84–1.01)

Note. IRR, incidence rate ratio; CI, confidence interval; MDROs, multidrug-resistant organisms.
[a]Per 1,000 patient days.
[b]Statistically significant results ($P < .05$) are presented in boldface.

of pathogens during warmer periods. Also, we did not test the hypotheses that have been raised to explain seasonality of healthcare-associated MDROs, such as understaffing due to summer vacations or increased reservoirs in inanimate surfaces.[1,9] However, our findings (as well as results from our previous studies[6]) stand in contrast to those reported by Fukuta et al,[10] who theorized that seasonality was inherent to multidrug-susceptible pathogens, which could have entered the hospital from the outside community.

In conclusion, we found that temperature changes inside climate-controlled units may impact the incidence of MDROs. Our findings reinforce the importance of strengthening infection control measures during warm periods.

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