Contamination of Hospital Drains by Carbapenemase-Producing Enterobacterales (CPE) in Ontario, Canada

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Introduction

- CPE outbreaks linked to hospital wastewater drainage systems
- Determined prevalence of CPE in hospital drains exposed to inpatients with CPE, compared drain and room occupant CPE using whole-genome sequencing, and explored risk factors for drain contamination

Methods

- 10 hospitals → cultured hand hygiene sink, patient use sink, and shower drains exposed to inpatients with CPE from Oct. 2007 to Jan. 2018
- Illumina and MinION sequencing to compare drain/room occupant CPE isolates and carbapenemase gene-containing plasmids
- Multi-level logistic regression model to explore risk factors for drain contamination

Results

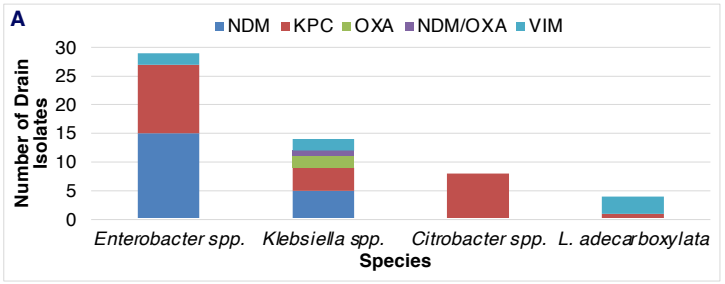
- 1209 drains in 501 patient rooms and 71 communal shower rooms exposed to 310 inpatients with CPE
- 53 (4%) drains at 7 (70%) hospitals yielded 62 CPE isolates
  - 49 patient room drain CPE isolates
  - 13 communal shower room drain CPE isolates

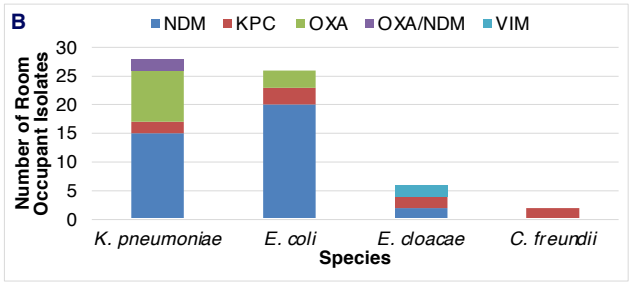
Table. Unit- and room-level factors associated with drain contamination.

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Type of drain (referent=patient use sink)		
Hand hygiene sink	3.60 (1.14-11.32)	**3.75 (1.17-11.99)**
Shower	13.84 (4.70-40.77)	**12.95 (4.29-39.08)**
Room type (referent=patient)		
Communal shower	3.09 (1.44-6.60)	1.30 (0.55-3.07)
Unit type (referent=rehabilitation)		
Intensive care	0.96 (0.12-7.40)	1.40 (0.16-12.59)
Medical	2.73 (0.65-11.41)	2.66 (0.58-12.30)
Surgical	1.24 (0.23-6.62)	1.23 (0.21-7.33)

Conclusion: 4% of drains were CPE-contaminated. Drain CPE unrelated to patient exposure suggests contamination by undetected colonized patients or retrograde transmission. Drain types had different contamination risks.

Figure. The distribution of CPE gene/species combinations of CPE in drains (n=55) (**A**) and room occupants (n=62) (**B**).





- 4/49 (8%) patient room drain CPE isolates could be linked by sequencing to a prior room occupant. Drain/room occupant linked pairs:
  - *Citrobacter freundii* ST18 isolates separated by 8 SNVs
  - Related *bla*$_{KPC}$-containing IncN3-type plasmids (different species)
  - Related *bla*$_{KPC-3}$-containing IncN-type plasmids (different species)
  - Related *bla*$_{oxa-48}$-containing IncL/M-type plasmids (different species)

  In all cases, patients were colonized prior to drain exposure and so likely contaminated drains (not acquired from drains).

- Matches among drain isolates (possible retrograde transmission):
  - 10 drain isolates on 2 units with related *bla*$_{NDM-1}$-containing IncHI2A/HI2-type plasmids (9 *Enterobacter hormaechei* ST66 separated by 0-6 SNVs, 1 *Klebsiella oxytoca)*