**bla**\textsubscript{VIM}-producing *Enterobacter cloacae* in Ontario, Canada: Links between Sewage, Surface Water, and Human Isolates

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**Background**

- In Canada, carbapenemase-producing Entrobacteriaceae (CPE) are rare and usually imported from CPE- endemic countries.
- We report two patient clusters – none with hospitalizations abroad – of Verona integron-encoded metallo-β-lactamase producing *Enterobacter cloacae* (VIM-EC) linked to isolates from water in Ontario, Canada.

**Methods**

- We analyzed population-based data from Toronto Invasive Bacterial Diseases Network (TIBDN) surveillance from first identified CPE in 2007 until March 2016 to identify VIM-EC colonized or infected patients.
- Sewage treatment plants (STP) and surface water from one watershed (WS) in the population area were sampled in 2015. Pulsed-field gel electrophoresis (PFGE) and plasmid sequencing (PS) were performed on all patients and water samples.
- All VIM-positive patients were screened for hospital admissions or outpatient visits within the TIBDN between 2011 and 2016 to identify epidemiological links between patients. Hospital admissions abroad were also registered.

**Figure 1.** Inpatient and outpatient healthcare contacts in the TIBDN surveillance area as well as hospital admissions abroad of patients with VIM-producing *Enterobacter cloacae*, 2011-2016

**Results**

- We identified 11 patients with VIM-EC; median age 76.5y; median Charlson score 2. Five developed an urinary tract infection; one a bloodstream infection (BSI). In-hospital mortality was 18% (2/11, whereof one with VIM-BSI).
- Ten patients comprised 2 PFGE clusters: Cluster I (in red) linked 4 patients to a WS sample (with different plasmids). Three of 4 patients came from different long-term care facilities. Two patients shared the same room in hospital C, but not at the same time.
- Cluster II (in yellow) linked 6 patients to a STP sample (same plasmid between patient and water samples). All six patients were linked to hospitals F and G (Fig 1; Fig 2).
- Although all patients had significant healthcare exposure before VIM detection, none of the 10 patients linked to a cluster had been hospitalized abroad. The patient with a unique PFGE isolate (patient 1, in green) had been hospitalized in Croatia in the same city and time as a reported VIM–*E. cloacae* outbreak (Fig 3).

**Figure 2.** Map of south central Ontario indicating locations of environmental and patient samples positive for VIM-producing *Enterobacter cloacae*. Clustering based on PFGE, letters indicate results of plasmid sequencing.

**Figure 3.** PFGE of 11 patient and 2 water samples with VIM-producing *Enterobacter cloacae*. (patient 11 was colonized with an *E. hormaechei* strain)

**Conclusions**

- Most VIM-EC in Ontario seem to be autochthonous given the lack of hospital admissions abroad for most patients.
- Not all patients among PFGE clusters can be linked despite thorough epidemiological work-up. Positive water samples involving the same strains and plasmids as found in patient samples suggest that water may be an important reservoir.
- More work is urgently needed to identify environmental CPE reservoirs and to investigate potential risks in long-term care facilities.

\textsuperscript{*} Patient 3 and 4 occupied the same room in hospital C, but not at the same time. \textsuperscript{1} Four different long-term care facilities in four patients

PFGE, Pulsed Field Gel Electrophoresis; TIBDN, Toronto Invasive Bacterial Diseases Network

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