Abstract # 2466

What's Lurking in the Drain? Serial Transmission of NDM-1 *Klebsiella pneumoniae* to Patients Admitted 9 Months Apart to the Same ICU Room

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Abstract (*modified*)

Background:
We evaluated the role of an in-room sink in NDM-1 K. pneumoniae (NDMKP) transmission.

Methods:
In 10/2017, Infection Prevention (IP) initiated weekly point prevalence rectal screening cultures in 4 ICUs. In 3/2018, IP launched an epidemiologic and environmental investigation following identification of a patient with NDMKP rectal colonization. Environmental samples including swabs of biofilm from drains and water from p-traps were obtained from the in-room sink. Illumina whole genome sequencing (WGS) was performed on all NDMKP patient and environmental isolates. Single nucleotide variants (SNVs) were identified against the reference *Klebsiella pneumoniae* strain PMK1 (NZ_CP008929), and isolates within 25 SNVs of each other at whole-genome level were considered to be genomically related

Results:
Two patients were identified with NDMKP infection or colonization between July 2017 and March 2018. The index patient had prolonged hospitalization and developed NDMKP bacteremia on hospital day (HD) 30. Approximately 9 months later, the second patient was admitted to the same ICU room that had been occupied by the index patient for 13 days and was identified to have NDMKP rectal colonization on HD 5. Environmental samples from the in-room sink of the ICU room grew NDMKP. WGS demonstrated relatedness between NDMKP isolates from the 2 patients (8 SNV), the index patient and the sink (16 SNV), and the second patient and the sink (8 SNV). The in-room sink was replaced in 4/18 and no further cases of NDMKP infection or colonization have been identified at DUH in over 12 months.

Conclusion:
We report an NDM-1 *K. pneumoniae* transmission event possibly related to a contaminated in-room sink drain. Remarkably, 9 months elapsed between the index case and the second case, with no additional interim cases detected on weekly point-prevalence screening or clinical cultures. The long duration of time between and the index patient, secondary case, and sink culture may explain why WGS showed relatedness but not identical clones. Education around sink use, design, and more effective cleaning strategies are needed to mitigate environment-to-patient transmission of CPO.

Background

- Multiple outbreaks of carbapenemase-producing organisms (CPO) have been linked to the hospital water environment[1]
- In the Southeastern US, *Enterobacteriaceae* containing New Delhi Metallo-β-lactamase (NDM) are considered Tier 2 organisms (Targeted Multidrug-resistant Organisms that require enhanced containment efforts to stop spread) based on CDC guidance[2]
- Contaminated sink and shower drain traps were implicated in contributing to an outbreak of NDM-7-containing *K. pneumoniae* in Spain.[3]
- We evaluated the role of a sink in serial transmission of NDM-1-containing *K. pneumoniae* (NDMKP) in a medical ICU.

Methods

- Duke University Hospital (DUH) is a 957-bed academic medical center with 5 adult ICUs (122 ICU beds).
- In 2017, Infection Prevention (IP) worked with key stakeholders to develop a comprehensive CPO Prevention/Containment Bundle (Table 1).

Table 1: Carbapenemase-Producing Organism (CPO) Prevention/Containment Strategy	Timeline of Interventions
Infection Prevention (CPO Prevention Bundle)	
Routine surveillance for CPO (all hospital units)	2011-present
Point prevalence rectal screening cultures performed in response to newly identified hospital-onset CPO (all hospital units)	Aug 2017-present
Daily communication of CPO patient movement to key stakeholders (all hospital units)	Oct 2017-present
Increased audits/feedback of HCW compliance with hand hygiene and PPE compliance in/around CPO rooms (all hospital units)	
Enhanced cleaning and disinfection (Bleach and UVC light) in rooms of patients with CPO (all hospital units)	
Enhanced cleaning and disinfection (Bleach and UVC light) in all rooms on the unit (4 adult ICUs)	
Implementation of weekly point prevalence rectal screening cultures for CPO (4 adult ICUs)	
Increased education for HCW, hospital staff, patients, and families around CPO prevention/containment strategies (all hospital units)	
Environmental screening cultures for CPO performed when indicated by investigation findings (all hospital units)	Apr 2018-present
Laboratory Methods for CPO Identification	
Phenotypic identification of CPO by **DUH microbiology laboratory**	2011-present
Clinical CPO isolates sent to **state lab** for molecular testing (Turn-Around-Time (TAT) weeks-1 month)	2011-Aug 2017
Clinical CPO isolates sent to **reference lab** for molecular testing (TAT approximately 1 week)	Aug 2017-Aug 2018
Rectal screening cultures sent to **reference lab** for molecular testing (TAT approximately 1 week)	Oct 2017-Aug 2018
Clinical CPO isolates and positive rectal screening cultures reflexed to molecular testing (Carba-R™) in **DUH microbiology laboratory** (TAT 48 hours)	Aug 2018-present

- In March 2018, IP launched an epidemiologic and environmental investigation in response to identification of a patient with a positive rectal screening culture for NDMKP.
- Environmental samples including swabs of biofilm from drains and water from p-traps were obtained from an in-room sink with an epidemiologic link.
- Illumina whole genome sequencing (WGS) was performed on all NDMKP patient and environmental isolates.
- Single nucleotide variants (SNVs) were identified against the reference Klebsiella pneumoniae strain PMK1 (NZ_CP008929), and isolates within 25 SNVs of each other were considered to be genomically related.

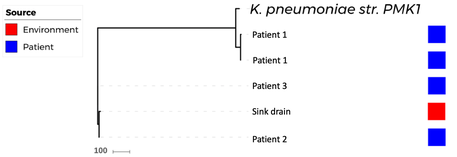
Results

- Three patients with NDMKP – 2 with infection and 1 with colonization were included in the investigation (Table 2).
- All 3 patients were hospitalized on the same unit but did not have overlapping hospitalizations.
- Patients 2 and 3 occupied the same room approximately 9 months apart and patient 1 had occupied a room 9 rooms away approximately 2.5 years prior to patient 2.
- Unit compliance with weekly point prevalence rectal screening culture collection was high at 92% (1997 collected/2182 ordered) on the unit between patient 2 and patient 3's hospitalizations.
- Environmental samples from the in-room sink drain of the ICU room grew NDMKP. The P-trap culture was negative.
- WGS demonstrated relatedness between NDMKP isolates from patients 2 and 3 (8 SNV), patient 2 and the sink (16 SNV), and patient 3 and the sink (8 SNV) (Figure). NDMKP isolates from patient 1 were not related to isolates from patients 2 and 3 or the sink drain (>25 SNV).
- The in-room sink was replaced in 4/2018 and no further cases of NDMKP infection or colonization have been identified at DUH in 18 months.

Table 2: Clinical and Epidemiological Characteristics of Patients Infected or Colonized with NDM-1 *K. pneumoniae*

Patient	Age	Admitting Diagnosis	Date of Isolation	Site of Isolation	Status
1	48	Liver transplant (in India) complicated by liver abscesses	2/2015	Liver abscess	Infected
2	67	Hospital transfer for respiratory failure due to thyroid mass	7/2017	Bacteremia	Infected
3	77	Hospital transfer for massive pulmonary embolism	3/2018	Rectal swab	Colonized

Figure: Whole Genome Sequencing Results of Patient and Environmental NDM-1 *K. pneumoniae* Isolates



Conclusions

- We report the first case of serial transmission of NDM-1 *K. pneumoniae* thought to be related to a contaminated sink drain.
- Despite the successful implementation and maintenance of a robust CPO infection prevention/containment bundle, an indirect NDM-1 *K. pneumoniae* transmission event via the in-room sink occurred 9 months after the index patient inhabited the room and presumably inoculated the sink.
- Education around sink use (with specific attention to separation of clean and dirty tasks), sink design, and more effective cleaning strategies are needed to mitigate patient-to-environment and environment-to-patient transmission of CPO.
- In situations where novel resistance mechanisms are identified or CPO is not yet endemic, sampling sink drains and p-traps in rooms inhabited by patients with newly diagnosed CPO infection or colonization for residual CPO contamination may be one strategy to identify persistent point sources for future transmission events.
- Early identification of sink contamination may allow for successful mitigation of CPO before biofilm reaches plumbing lines that cannot be removed.

References
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