CONTAINMENT OF AN OUTBREAK OF KPC-PRODUCING KLEBSIELLA PNEUMONIAE IN A GERIATRIC WARD

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ECCMID Copenhagen, Denmark 25 - 28 April 2015

ESCMID European Society of Clinical Microbiology and Infectious Diseases

Objectives

To evaluate the effect of a bundle of infection control measures on the horizontal transmission of *Klebsiella pneumoniae* carbapenemase (KPC)-producing *K. pneumoniae* during an outbreak in a geriatric ward.

Methods

A bundled intervention, ESCMID-SHEA Guidelines based, was implemented in the Geriatric ward of the Maggiore Hospital of Lodi, Italy to contain an outbreak of KPC *Klebsiella pneumoniae* occurred from August to October 2013**.** Infection control measures were implemented following the detection of the index carbapenem-resistant *K. pneumoniae* isolate, but the outbreak continued to evolve with more isolates being detected. Infection control measures were therefore progressively reinforced, including:

Infection control measures

Hand-hygiene and contact precautions

Wash hands before entering and leaving a patient's room
Put on gown, gloves and shoe covers before entering patient's room
Use disposable devices in the room when possible
Discard gown, gloves and shoe covers before leaving patient's room
Monitor adherence and provide feedback

Patient cohorting and dedicated staff

Cohort KPC-KP colonized or infected patients (in single room or double room with spatial isolation) and no sharing of rooms with non-infected patients
Dedicate nursing staff and equipment to KPC-KP patients

Health care staff education

Competency-based CRE education provided to all stakeholders
Repeated meetings with hospital medical, nursing and environmental staff
Observation of hand washing procedures and immediate feedback
Review of contact isolation

Active surveillance culture of rectal swabs in order to:

Rapidly identify new cases
Monitor existing cases
Monitor effectiveness of infection control measures
Implement cohorting

Environmental and medical equipment cleaning and disinfection

Twice a day with *active chloride* (5.000 ppm) plus weekly or prior to a new bed occupancy with a whole room dry mist disinfection system based on a solution of 5-8% *hydrogen peroxide* and 60 ppm *active silver ions* (1mL/m3 intensity of treatment)

Environmental-surface sampling

Determine adequacies in hospital cleaning

Microbiological investigations

Rectal swabs were plated onto chromogenic CRE-selective media (ChromID CARBA SMART agar, Biomerieux) and incubated at 35°C for 18-24 h.
Carbapenem resistance of the isolated bacterial strains was initially detected by routine methods (Vitek 2 System, bioMèrieux) according to EUCAST guidelines and production a carbapenemases was identified by Rosco KPC/MBL Confirm Kit.
The genetic relatedness of all KPC–producing *K. pneumoniae* isolates was evaluated using pulsed-field gel electrophoresis (PFGE) analysis.
Susceptibility to ertapenem, imipenem, and meropenem was verified using E-test (AB Biodisk); colistin and tigecycline MICs were also evaluated.
Phenotypic screening for the presence of carbapenemases was performed by a commercial test Rosco Diagnostica KPC and MBL confirm kit.
Molecular typing of KPC-KP was accomplished with pulsed-field gel electrophoresis (PFGE) using restriction endonuclease XbaI.

Evaluation of environmental disinfection practices

Surface samples were taken from 10 high touch environmental surfaces which included: room door handle, headboard, footboard, bed frame, bedside table top, bedside table handle, light switch, floor corner, sink taps, soap dispenser.

Case number age/sex	1. 93 ♂	2. 64 ♀	3. 71 ♂	4. 80 ♂	5. 78 ♂	6. 86 ♀	7. 91 ♂	8. 82 ♂	9. 72 ♀	10. 93 ♀	11. 89 ♂	12. 89 ♀	13. 59 ♂	14. 85 ♂
Type of admission	Medical Unit	First aid	Medical Unit	Medical Unit	Medical Unit	First aid	Medical Unit	Medical Unit	Medical Unit	Rehabilitation	Medical Unit	Medical Unit	Medical Unit	First aid
Admission date	07.29.13	07.20.13	08.19.13	09.04.13	08.20.13	08.07.13	09.09.13	08.09.13	08.24.13	09.09.13	09.21.13	09.19.13	10.10.13	10.21.13
Detection date	08.10.13	08.17.13	08.30.13	09.05.13	09.07.13	09.10.13	09.13.13	09.13.13	09.13.13	09.13.13	09.23.13	09.26.13	10.14.13	10.29.13
Type of sample	Urine	Urine	Pus	Urine	Urine	Urine	Urine	Rectal swab	Rectal swab	Rectal swab	Sputum	Urine	Rectal swab	Sputum
Pattern of acquisition	Infection	Infection	Infection	Infection	Infection	Colonization	Colonization	Colonization	Colonization	Colonization	Colonization	Infection	Colonization	Infection
Length of isolation	12	2	53	12	9	32	26	1	28	8	5	16	11	13
Discharge date	08.22.13	08.19.13	10.22.13	09.16.13	09.15.13	10.22.13	10.10.13	09.14.13	10.11.13	09.20.13	09.27.13	10.12.13	10.22.13	10.31.13
Outcome	Surgery	Dead	Home	Home	Infectious Diseases Unit	Home	Home	Home	LTCFacility	Home	Infectious Diseases Unit	Home	Home	Home

Figure 1. Comparison of isolates using Fingerprinting II version 3.0 software (Bio-Rad) with the unweighted pair-group method with arithmetic averages (UPGMA).

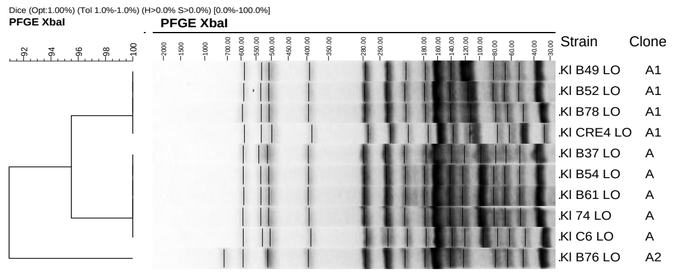
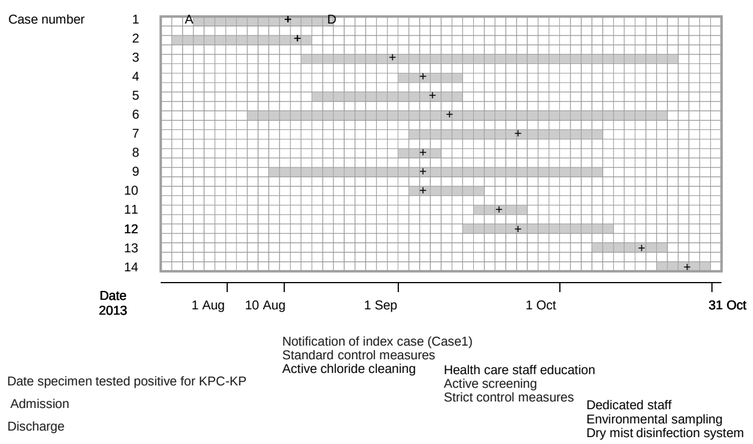


Figure 2. Outbreak of KPC-KP and infection control measures progressively introduced.



Results

KPC-producing *K. pneumoniae* patients were recovered from clinical and screening specimens of 14 patients, aged 59–93 years, that had been hospitalized in the ward for a median of 12 days (range: 4-33 days) before CRKP identification. Seven were treated for KPC *Klebsiella pneumoniae* infection and seven were found to be asymptomatically colonized. Six patients had urinary tract infections, one had a respiratory tract infection.

Characteristics of patients and KPC-producing K. pneumoniae isolates in the Geriatric Ward of the Maggiore Hospital of Lodi are summarized in the Table 1.

All strains collected were susceptible only to colistin and gentamicin. Intermediate susceptibility to tigecycline occurred in 8 isolates.

PFGE analysis of the *K. pneumoniae* isolates showed the presence of a single Clone named A. This clone, isolated from August 2013, presented two subtypes A1 (4 isolates) and A2 (one isolate) differing by not more than 3 bands from A.

Before cleaning the surfaces all samples collected in the rooms resulted colonised, with an average density of mesophile organisms up to 85 CFU/57 cm^2 (range 3-320). After manual cleaning with detergent followed by active chloride disinfection, an average density of organisms of 35 CFU/57 cm^2 (range 1-150) was recorded and KPC-KP were found from samples collected in 3 rooms. After hydrogen peroxide disinfection, a density of bacteria in the range of 0 and 5 CFU/57 cm^2 was observed and no KPC-KP were found.

The outbreak was ultimately controlled within a 3-month period of time, with no novel carbapenem-resistant isolates being detected thereafter.

Conclusions

Our data indicate that the hydrogen peroxide and active silver ions disinfection system, together with the manual cleaning procedures, is non inferior vs. active chloride based procedure. Hydrogen peroxide resulted effective in minimizing the overall microbial load on the hospital room surfaces and in eradicating KPC-KP.

The application of strict infection control measures combined with automated technologies in disinfection allows the containment of an outbreak and reinforces the importance of rapid identification and notification of multidrug-resistant Gram-negative bacteria to reduce transmission.

References: ESCMID-SHEA Guidelines: infection prevention and control measures to reduce transmision of multidrug-resistant Gram-negative bacteria in hospitalized patients. Chairs: Ruef C, Singh N. Official Symposium 23rd ECCMID, Berlin.