



Short report

Control strategy for carbapenemase-producing Enterobacteriaceae in nursing homes: perspectives inspired from three outbreaks

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SUMMARY

Three outbreaks of carbapenemase-producing Enterobacteriaceae (CPE) in three nursing homes in western France were retrospectively assessed. In all, ten cases of colonization or infection with CPE were detected upon admission in neighbouring hospitals. Antibiotic consumption or high frailty was infrequent among them. Nursing homes should be included in a regional strategy to limit CPE spread.

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Introduction

French recommendations for the control of carbapenemase-producing Enterobacteriaceae (CPE) in hospitals consist of a strict ‘search and isolate’ strategy [1].

In nursing homes, the strategy relies on standard precautions with a focus on hand hygiene and excreta management. These measures are based on the assumption that the

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selection and colonization pressure are lower in nursing homes than in hospitals, because there is a less susceptible population. However, residents generally stay a long time in nursing homes during which they often require multiple hospitalizations, most of them leading to antibiotic treatment. These returns between hospitals and nursing homes may play a role in CPE spread across facilities [2].

In this study, we describe three episodes of intra-nursing home spread of CPE detected in neighbouring hospitals. These episodes give perspectives to improve the consistency of control measures across settings.

Methods

Clusters of CPE cases were investigated among three nursing homes in the Pays de la Loire region (west of France). Nursing home A (NH_A), NH_B, and NH_C have 408-, 127-, and 88-bed capacities, respectively, with full occupancy. A case was defined as a resident found to be positive with CPE, either on screening or clinical sample.

The retrospective investigation was performed by three investigators (C.L., R.H., G.B.).

Data collected on CPE cases were: age, gender, length of residency in nursing home, comorbidities, frailty score, hospitalization records, and antibiotic treatments. Frailty score (GIR score) was calculated by evaluating eight variables with either A, B, or C score (A: can realize this action spontaneously, alone, fully and correctly; B: can partially realize this action; C: cannot or will not realize this action). Variables assessed were: behaviour, orientation in time and space, body toilet, dressing, eating, urinary and faecal elimination, moving from bed to chair on his/her own, walking. Frailty score ranged from 1 (fully dependent) to 6 (fully independent) [3]. For each cluster, the geographical situation of cases and the sharing of staff were examined. At the facility level, hand hygiene and the excreta management practices were assessed. Since no hand hygiene audit was conducted, a surrogate for hand hygiene compliance (AHR index) was calculated based on the ratio between the alcohol-based hand rub (AHR) consumption and a theoretical objective of four hand hygiene indications (3 mL per friction) per day per resident.

Clonal relatedness among all CPE isolates was investigated by pulsed-field gel electrophoresis (PFGE), performed according to the manufacturer's instructions (BioRad, Marnes-la-Coquette, France). PFGE profiles were analysed using BioNumerics software (Applied Maths, Sint-Martens-Latem, Belgium) and band patterns were analysed according to the Tenover criteria [4].

Results

The first cluster occurred in May 2014. Resident A1 was admitted to the local university hospital from NH_A. This patient was found positive to OXA-48-producing *Klebsiella pneumoniae* (Kp-OXA48) in a urine sample, the day after his admission; he had had several previous hospitalizations in the university hospital. In July 2014, a resident from NH_A (patient A2) was detected positive for Kp-OXA48 on screening for colonization through rectal swab performed in university hospital six days after her admission. Systematic rectal sampling at admission at university hospital of patients coming from NH_A allowed

identifying a third (A3) and fourth (A4) case, later in 2014 and 2015. Residents A2, A3, and A4 were hosted in the same building of NH_A, but different floors, sharing only night shifts. Resident A1 was in a different building.

Another outbreak was detected in 2014 by the university hospital, with three Kp-OXA48 cases (patients B1, B2, and B3) identified. All were admitted from the same nursing home (NH_B). In NH_B, residents B2 and B3 rooms were in the same unit. Resident B₁ was located on another floor but shared night shift workers with B₂ and B₃.

No other outbreak was detected through systematic screening of all nursing home residents admitted at university hospital (600–700 samples per year between 2014 and 2016).

The last cluster was identified in an 845-bed general hospital. First case (C1) was admitted from NH_C in late 2015. Following this primary case, systematic faecal screening of residents admitted from the NH_C was organized in the general hospital. Thirty-three residents were screened from December 2015 to July 2017, identifying two other cases of Kp-OXA48 (patients C2 and C3) (Table I). In NH_C, the three residents were located in the same building. Residents C1 and C3 stayed on the same floor (same staff). Resident C2 stayed on a different floor with a different staff but often visited resident C3. The three residents shared the same nursing team during the night.

The characteristics of the ten cases involved in the three outbreaks are summarized in Table I; the epidemic curves are represented in Figure 1.

The strains isolated from the three NH_C residents had the same PFGE profile. Residents in NH_B and NH_A also had the same PFGE profile (except A4), different from NH_C.

At the facility level, none of the three nursing homes was equipped with bedpan washer-disinfector. After excreta elimination in the residents' toilets, bedpans used for incontinent residents were cleaned in the residents' room with hand sprayers (NH_A and NH_C), or directly in the sink (NH_B). AHR consumption index was 74%, 44%, and 30% in NH_A, NH_B, and NH_C during the outbreak periods, respectively. Antibiotic consumption, high frailty, or incontinence was infrequent among these 10 residents. Five of these had significant hospital stays in the year before CPE detection (Table I).

Discussion

Since 2013, repatriated patients from endemic countries have generated two large CPE outbreaks in the two major acute care hospitals of the region [5]. Among colonized/infected cases, some were discharged to nursing homes without specific precautions. In favourable contexts (low infection control awareness and compliance) CPE slowly spread to several residents. The subsequent hospitalization of these colonized residents insidiously exposed acute care hospitals to a potential outbreak. Out of our 10 patients, five had had several hospital stays in the year before being detected positive with CPE. However, none of these hospital stays overlapped with a known CPE carrier stay, except for residents A1 and A4. In both cases, there was one known CPE carrier which was placed under contact precautions upon admission. Weekly screening revealed no secondary case, including these two nursing home residents during their stay. However, screening can lead to false-negative results, and the possibility of university hospital acquisition of CPE cannot be excluded. Five

Table 1
 Characteristics of the ten resident CPE carriers identified during three outbreaks in the three different nursing homes

Resident	Age	Gender	CPE strain	Date of 1st CPE-positive sample	Delay between admission and positive sample (days)	Duration of nursing home stay (months)	Antibiotic treatment the 3 months before CPE identification	Frailty score	Continence	No. of days of hospitalization in the year before CPE identification	Travel abroad in the previous 3 years
A1	91	F	KP-OXA48	Urine May 27 th , 2014	1	18	No	3	Faecal and urinary incontinence	17	None
A2	74	F	KP-OXA48	Rectal swab Jul 1 st , 2014	6	145	No	5	Continent	0	None
A3	77	M	KP-OXA48 and EC-OXA48	Rectal swab Oct 15 th , 2014	1	57	No	5	Continent	72	None
A4	66	M	KP-OXA48 and EC-OXA48	Rectal swab Aug 12 th , 2015	1	66	No	4	Continent	0	None
B1	90	M	KP-OXA48	Urine Jun 7 th , 2014	0	28	Yes	4	Continent	27	None
B2	93	M	KP-OXA48	Urine Jul 21 st , 2014	0	3	No	3	Continent	19	None
B3	96	F	KP-OXA48	Urine Feb 18 th , 2016	5	35	No	3	Continent	0	None
C1	84	F	KP-OXA48	Urine Dec 11 th , 2015	0	123	Yes	2	Faecal and urinary incontinence	2	None
C2	90	M	KP-OXA48	Rectal swab Jan 16 th , 2016	9	60	No	4	Continent	14	None
C3	92	F	KP-OXA48 and EC-OXA48	Rectal swab Nov 8 th , 2016	7	140	No	3	Faecal and urinary incontinence	0	None

CPE, carbapenemase-producing Enterobacteriaceae; KP, *Klebsiella pneumoniae*; EC, *Escherichia coli*; F, female; M, male.

residents (respectively two in NH_A, one in NH_B and two in NH_C) never had a significant hospital stay before being found CPE positive. Since there was also no history of travel abroad in any of these cases, NH acquisition seems highly likely in these residents.

This hypothesis tends to be confirmed by PFGE banding patterns. Indeed, in NH_A, three residents out of four shared the same *Kp*-OXA48 strain (similar macrorestriction profile), with resident A4 displaying a sporadic strain of unclear origin. In NH_B, all residents shared the same strain, similar to that encountered in NH_A residents, which was the outbreak strain of the neighbouring university hospital. In NH_C, all residents shared the same strains, although different from NH_A, NH_B, and the university hospital. This strain was later confirmed as the outbreak strain from the closest university hospital. NH_A, NH_B, and the university hospital are within a 30 km radius, whereas NH_C is seven kilometers away from the general hospital (which is 150 km from university hospital). These data tend to confirm the risk of intra-institution spread of multidrug-resistant Enterobacteriaceae (MRE) in the geographical area surrounding major acute care hospitals.

The role of nursing homes in antimicrobial resistance spread has been previously demonstrated [2,6]. CPE spread in nursing homes, with potential impact of surrounding hospitals, has already been described, even in low-prevalence countries [7]. In our experience, nursing homes are exposed to the risk of MRE carriers, being directly downstream of acute care hospitals. Despite a theoretical lower selective and colonization pressure in these settings, the spread of MRE is facilitated by the lack of standard infection control precautions. None of the three nursing homes consumed enough AHR to comply with four hand hygiene events per resident per day. Excreta management involved basins cleaned in residents' rooms, increasing the risk for environmental contamination with faecal micro-organisms.

In the national context of a strict 'search and isolate' strategy in hospitals, even if the reservoir and the transmissibility in nursing homes seem low, one unknown carrier admitted in acute care from nursing homes can generate an invisible outbreak of carriage. If not rapidly and accurately controlled, this dissemination generates major financial consequences and a subsequent infectious risk at the population scale [8]. Successful interventions show that national and local strategies need to be consistent across the entire patient pathway, from acute care to nursing homes [9]. A lapse in one link may have consequences on another. Whereas hospital guidelines cannot be transposed to nursing homes, some compromises may be found. A first step would be to better understand the epidemiology of CPE in nursing homes. Point prevalence surveys for CPE carriage need to be performed through the different healthcare sectors (from acute care to nursing home) for a better understanding of the regional epidemiology. Second, the level of standard precaution in nursing homes must be raised with external help from infection control teams. Finally, identification and screening of residents coming from nursing homes hosting CPE patients at hospital admission might be considered. This study tends to confirm the

conclusions from recent guidelines [10]. Nursing homes must be considered as high-risk units where isolation or screening should not be encouraged, but where information regarding MRE should be diffused and adherence to standard precautions prompted.

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Conflict of interest statement

None declared.

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References

- [1] Lepelletier D, Berthelot P, Lucet JC, Fournier S, Jarlier V, Grandbastien B, National Working Group. French recommendations for the prevention of "emerging extensively drug-resistant bacteria" (eXDR) cross-transmission. *J Hosp Infect* 2015;90:186–95.
- [2] van den Dool C, Haenen A, Leenstra T, Wallinga J. The role of nursing homes in the spread of antimicrobial resistance over the healthcare network. *Infect Control Hosp Epidemiol* 2016;37:761–7.
- [3] Syndicat National de Gériatrie Clinique. AGGIR: guide pratique pour la codification des variables, principaux profils des groupes iso-ressources. *Revue Gériatrie* 1994;19:249–60.
- [4] Tenover FC, Arbeit RD, Goering RV, Mickelsen PA, Murray BE, Persing DH, et al. Interpreting chromosomal DNA restriction patterns produced by pulsed-field gel electrophoresis: criteria for bacterial strain typing. *J Clin Microbiol* 1995;33:2233–9.
- [5] Semin-Pelletier B, Cazet L, Bourigault C, Juvin ME, Boutoille D, Raffi F, et al. Challenges of controlling a large outbreak of OXA-48 carbapenemase-producing *Klebsiella pneumoniae* in a French university hospital. *J Hosp Infect* 2015;89:248–53.
- [6] D'Agata EMC, Habtemariam D, Mitchell S. Multidrug-resistant gram-negative bacteria: inter- and intradissemination among nursing homes of residents with advanced dementia. *Infect Control Hosp Epidemiol* 2015;36:930–5.
- [7] Weterings V, Zhou K, Rossen JW, van Stenis D, Thewessen E, Kluytmans J, et al. An outbreak of colistin-resistant *Klebsiella pneumoniae* carbapenemase-producing *Klebsiella pneumoniae* in the Netherlands (July to December 2013), with inter-institutional spread. *Eur J Clin Microbiol Infect Dis* 2015;34:1647–55.
- [8] Birgand G, Leroy C, Nerome S, Luong Nguyen LB, Lolom I, Armand-Lefevre L, et al. Costs associated with implementation of a strict policy for controlling spread of highly resistant microorganisms in France. *BMJ Open* 2016;6:e009029.
- [9] Ben-David D, Masarwa S, Fallach N, Temkin E, Solter E, Carmeli Y, et al. Success of a national intervention in controlling carbapenem-resistant Enterobacteriaceae in Israel's long-term care facilities. *Clin Infect Dis* 2018 Jul 9 [Epub ahead of print].
- [10] Wilson AP, Livermore DM, Otter JA, Warren RE, Jenks P, Enoch DA, et al. Prevention and control of multi-drug-resistant Gram-negative bacteria: recommendations from a Joint Working Party. *J Hosp Infect* 2016;92(Suppl 1):S1–44.