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**Control strategy for carbapenemase-producing Enterobacteriaceae in nursing home:  
Perspectives inspired from three outbreaks.**

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## **Abstract**

We retrospectively assessed three outbreaks of carbapenemase-producing Enterobacteriaceae (CPE) in three nursing homes (NH) in Western France. In all, 10 cases of colonization or infection with CPE were detected upon admission in neighboring hospitals. Antibiotic consumption or high frailty was infrequent among them. NH should be included in a regional strategy to limit CPE spread.

## 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 (NH), the strategy relies on standard precautions with a focus on hand hygiene and excreta management. These measures are based on the assumption that the selection and colonization pressure are lower in NH than in hospitals, because there is a less susceptible population. However, residents generally stay a long time in NH during which they often require multiple hospitalizations, most of them leading to antibiotic treatment. These returns between hospitals and NH may play a role in CPE spread across facilities.[2]

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

## Methods

Clusters of CPE cases were investigated among three NHs in the Pays de la Loire region (west of France). NH<sub>A</sub>, NH<sub>B</sub> and NH<sub>C</sub> have respectively 408, 127, and 88 beds capacities, 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 (CL, RH, GB).

Data collected on CPE cases were: age, gender, length of residency in NH, comorbidities, frailty score, hospitalization records, and antibiotic treatments. Frailty score (GIR score) was calculated by evaluating 8 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 are: behavior, 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 ranges 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 (HH) audit was conducted, a surrogate for hand hygiene compliance (AHR index) was calculated based on the ratio between the alcoholic hands rub (AHR) consumption and a theoretical objective of four HH indications (3mL 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 analyzed using Bionumerics software (Applied Maths, Sint-Martens-Latem, Belgium) and band patterns were analyzed according to the Tenover criteria.[4]

## Results

The first cluster occurred in May 2014. Resident A<sub>1</sub> was admitted to the local University Hospital (UH) from NH<sub>A</sub>. This patient was found positive to OXA-48 producing *Klebsiella pneumoniae* (*Kp*-OXA48) in a urine sample, the day after his admission; she had several previous hospitalizations in UH. In July 2014, a resident from NH<sub>A</sub> (Patient A<sub>2</sub>) was detected positive for *Kp*-OXA48 on a screening for colonization through rectal swab performed in UH six days after her admission. Systematic rectal sampling at admission at UH of patients coming from NH<sub>A</sub> allowed identifying a third (A<sub>3</sub>) and fourth case (A<sub>4</sub>), later in 2014 and 2015. Residents A<sub>2</sub>, A<sub>3</sub> and A<sub>4</sub> were hosted in the same building of NH<sub>A</sub>, but different floors, sharing only night shifts. Resident A<sub>1</sub> was in a different building.

Another outbreak was detected in 2014 by UH, with three *Kp*-OXA48 cases (patients B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub>) identified. All were admitted from same NH (NH<sub>B</sub>). In NH<sub>B</sub>, residents B<sub>2</sub> and B<sub>3</sub> rooms were in the same unit. Resident B<sub>1</sub> was located at another floor but shared night shift workers with B<sub>2</sub> and B<sub>3</sub>.

No other outbreak was detected through systematic screening of all NH residents admitted at UH (600 to 700 samples per year between 2014 and 2016).

The last cluster was identified in an 845-bed general hospital (GH). First case (C<sub>1</sub>) was admitted from NH<sub>C</sub> in late 2015. Following this primary case, systematic faecal screening of residents admitted from the NH<sub>C</sub> was organized in the GH. Thirty-three residents were screened from December 2015 to July 2017, identifying two other cases of *Kp*-OXA48 (patient C<sub>2</sub> and C<sub>3</sub>) (Table 1). In NH<sub>C</sub>, the three residents were located in the same building. Resident C<sub>1</sub> and C<sub>3</sub> stayed at the same floor (same staff). Resident C<sub>2</sub> stayed at a different floor with a different staff but often visited resident C<sub>3</sub>. The three residents shared the same nursing team during 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<sub>C</sub> residents had the same PFGE profile. Residents in NH<sub>B</sub> and NH<sub>A</sub> also had the same PFGE profile (except A<sub>4</sub>), different from NH<sub>C</sub>.

At the facility level, none of the three NHs was equipped with bedpan washer-disinfector. After excreta elimination in the residents' toilets bedpans used for incontinent residents were taken care of in the residents' room with hand sprayers (NH<sub>A</sub> and NH<sub>C</sub>), or directly in the sink (NH<sub>B</sub>). AHR consumption index was respectively 74%, 44% and 30% in NH<sub>A</sub>, NH<sub>B</sub> and NH<sub>C</sub> during the outbreak periods. Antibiotic consumption, high frailty or

incontinence was infrequent among these 10 residents. Five of them had significant hospital stays in the year before CPE detection (Table 1).

## Discussion

Since 2013, repatriated patients from endemic countries have generated two large CPE outbreaks in the two major acute care hospitals of the region.<sup>[5]</sup> Among colonised/infected cases, some were discharged to NH 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 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 A<sub>1</sub> and A<sub>4</sub>. In both case, there was one known CPE carrier which was placed under contact precautions upon admission. Weekly screening revealed no secondary case, including these two NH residents during their stay. However, screening can lead to false negative, and the possibility of UH acquisition of CPE cannot be excluded. Five residents (respectively two in NH<sub>A</sub>, one in NH<sub>B</sub> and two in NH<sub>C</sub>) 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<sub>A</sub>, three residents out of four shared the same *Kp*-OXA48 strain (similar macrorestriction profile), with resident A<sub>4</sub> displaying a sporadic strain of unclear origin. In NH<sub>B</sub>, all residents shared the same strain, similar to that encountered in NH<sub>A</sub> residents, which was the outbreak strain of neighboring UH. In NH<sub>C</sub>, all residents shared the same strains, although different from NH<sub>A</sub>, NH<sub>B</sub> and UH. This strain was later confirmed as the outbreak strain from the closest University Hospital. NH<sub>A</sub>, NH<sub>B</sub> and UH are within a 30 kilometers radius, whereas

NH<sub>C</sub> is seven kilometers away from GH (GH is 150 km from UH). 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 NH in antimicrobial resistance spread has been previously demonstrated.[2,6] CPE spread in NH, with potential impact of surrounding hospitals has already been described, even in low prevalence countries.[7] In our experience, NHs 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 NHs consumed enough AHR consumption 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 fecal microorganisms.

In a national context of strict "search and isolate" strategy in hospitals, even if the reservoir and the transmissibility in NH seem low, one unknown carrier admitted in acute care from NH 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.[9] Successful interventions show that national and local strategies need to be consistent across the entire patient pathway, from acute care to NH.[9] A lapse in one link may have consequences on another. Despite the fact that hospital guidelines cannot be transposed to NHs, some compromises may be found. A first step would be to better understand the epidemiology of CPE in NH. 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. Secondly, the level of standard precaution in NH must be raised with external help from infection control teams. Finally, identification and screening of resident coming from NH hosting CPE patients at hospital admission might be considered. Our study tends to confirm the conclusions from



recent guidelines [10]. NHs have to 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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## 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;90:186–195.
- [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;37:761–767.
- [3] Syndicat National de Gériatrie Clinique. AGGIR : guide pratique pour la codification des variables, principaux profils des groupes iso-ressources. *Revue Gériatrie* 1994;19:249-260.
- [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;33:2233–2239.
- [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;89:248–253.
- [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;36:930–935.
- [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;34:1647–1655.
- [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 (in press)

[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 Suppl1:S1-44.

**Table 1.** Characteristics of the 10 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 NH stay (months)	Antibiotic treatment the 3 months before CPE identification	Frailty score
A1	91	F	KP-OXA48	Urine 27/05/2014	1	18	NO	3
A2	74	F	KP-OXA48	Rectal swab 01/07/2014	6	145	NO	5
A3	77	M	KP-OXA48 and EC- OXA48	Rectal swab 15/10/2014	1	57	NO	5
A4	66	M	KP-OXA48 and EC- OXA48	Rectal swab 12/08/2015	1	66	NO	4
B1	90	M	KP-OXA48	Urine 07/06/2014	0	28	YES	4
B2	93	M	KP-OXA48	Urine 21/07/2014	0	3	NO	3
B3	96	F	KP-OXA48	Urine 18/02/2016	5	35	NO	3
C1	84	F	KP-OXA48	Urine 11/12/2015	0	123	YES	2
C2	90	M	KP-OXA48	Rectal swab 16/01/2016	9	60	NO	4
C3	92	F	KP-OXA48 and EC- OXA48	Rectal swab 08/11/2016	7	140	NO	3

Abbreviations: KP, *Klebsiella pneumoniae*; EC, *Escherichia coli*; CPE, carbapenemase producing *Enterobacteriaceae*; NH, nursing home; F, female; M, male

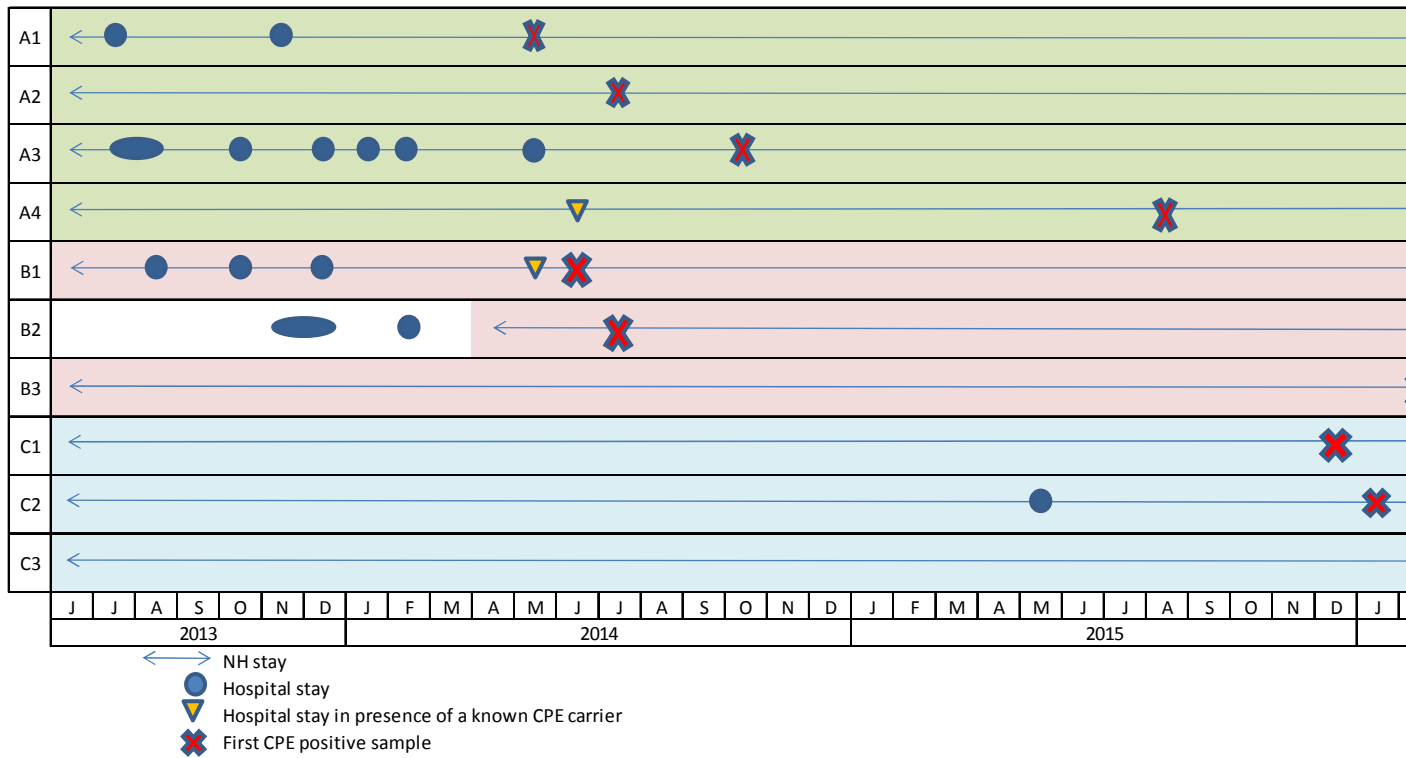


Figure 1: Synoptic table and epidemic curve of CPE colonized residents in NH1 (green), NH2 (red) and NH3 (blue). Hospital stays longer than 48h are indicated each months preceding first detection of CPE. Hospitalization in presence of a known CPE carrier is marked by a yellow triangle. Red crosses indicate month of first CPE detection.