

Akira Ukimura¹, Yuriiko Shibata¹, Tomoyuki Yamada¹, Toyofumi Nakanishi¹, Yukimasa Ooi¹, Hideaki Shima¹, Takashi Nakano^{1,2}
 1. Osaka Medical College; Infection Control Center 2. Osaka Medical College; Department of Microbiology and Infection Center



Introduction

In Japan, cooperation among hospitals on infection control has been incentivized through additional reimbursement by the universal health insurance policy since 2012. We organized Hokusetsu Infection Control Network including 8 large well-resourced hospitals and 16 small-sized hospitals in north part of Osaka in 2012, supported by local public health centers. *Pseudomonas aeruginosa* strains generally carry intrinsic resistance to various antimicrobial agents.

Monnet conducted a two-dimensional analysis of antimicrobial resistance and the use of corresponding antimicrobial agents (*Int J Antimicrob Agents*. 2000;15:91). We modified a two-dimensional analysis of antimicrobial resistance with addition of data of hand hygiene.

Methods

We collected the data of hospital use of carbapenem (defined daily dose/100 patient-days), and frequency of use of alcohol based hand rubs by hospital workers (times/patient-days) from 8 large, well-resourced hospitals and 9 small hospitals from April 2013 to March 2014 (period 1) and April 2014 to March 2015 (period 2). We collected the data of *Pseudomonas aeruginosa* isolates resistant to carbapenem from November 2013 to December 2013 during period 1 and November 2014 to December 2014 during period 2.

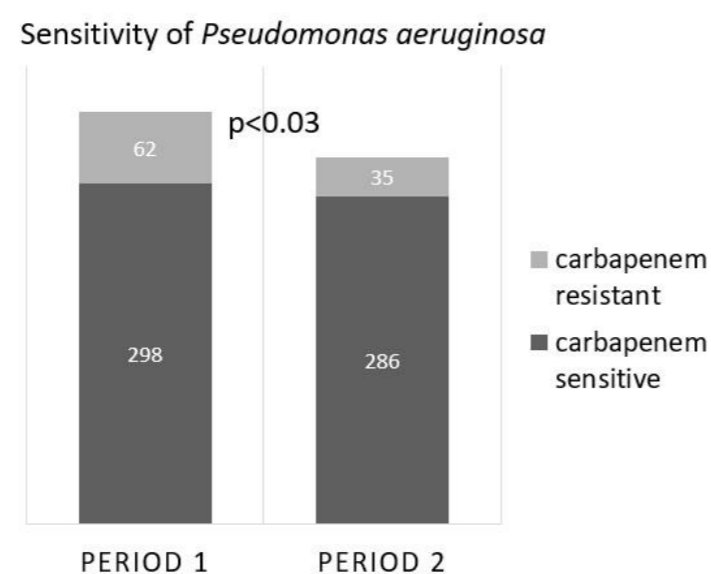
We divided these hospitals in 4 areas according to Monnet's two-dimensional analysis model (A: high level of resistance with low antimicrobial use, B: low level of resistance with low antimicrobial use, C: high level of resistance with high antimicrobial use, and D: low level of resistance with relatively high antimicrobial use). We added the data of hand hygiene to Monnet's two-dimensional analysis model. The study protocol was approved by the Institutional Review Board of Osaka Medical College.

Results

Median resistance of *P. aeruginosa* isolates to carbapenem was 12.5% (62/360) in period 1 and 6.3% (35/321) in period 2. The ratio of carbapenem resistant *P. aeruginosa* among total *P. aeruginosa* in period 2 was significantly less than one in period 1 ($p < 0.03$). (Figure 1)

Median use of carbapenem (DDD/100 patient-days) was 1.02 in period 1 and 0.84 in period 2. Median employment of hand hygiene procedures (times/patient-days) was 2.2 in period 1 and 3.5 in period 2.

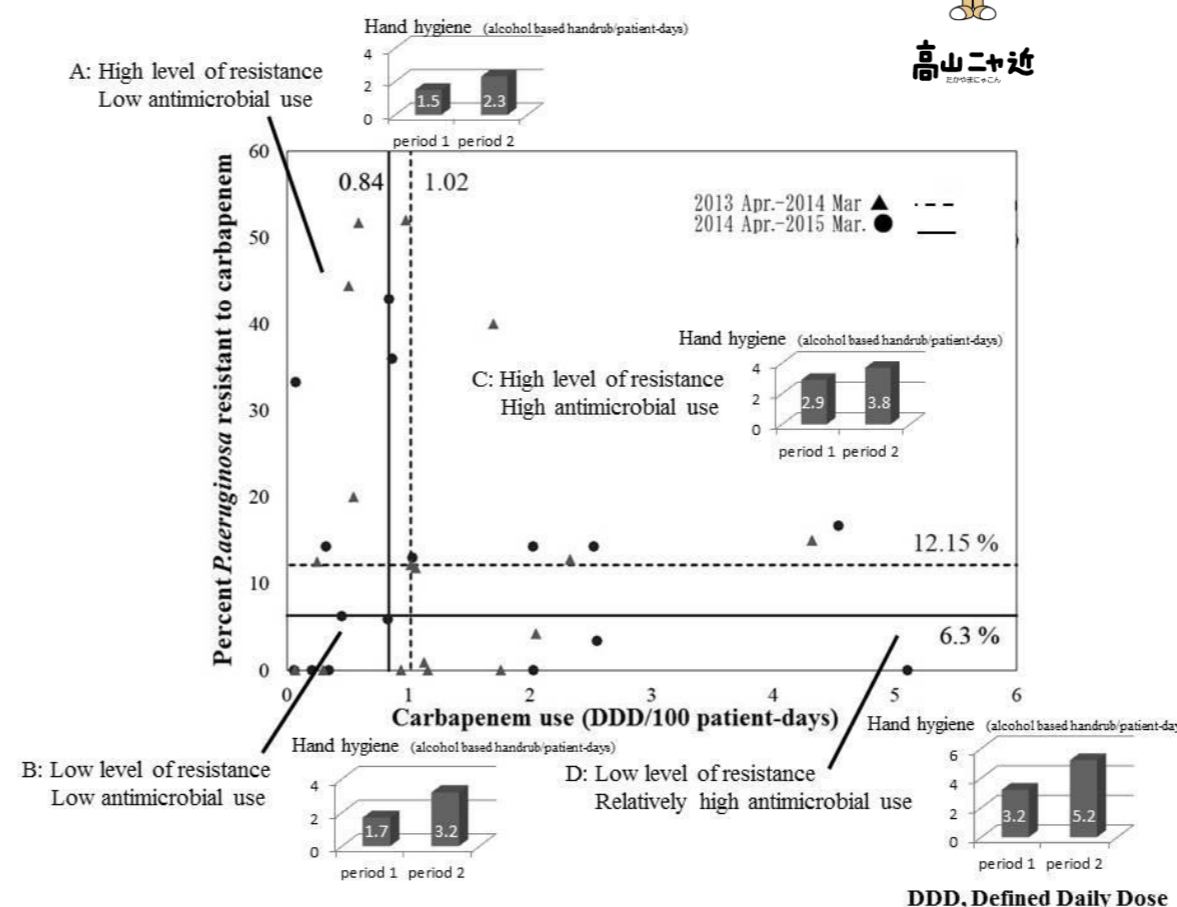
Figure 1



Discussion

Multidrug-resistant *Pseudomonas aeruginosa* (MDRP) infection is associated with increased mortality, and treatment options are limited. Numerous factors responsible for antimicrobial resistance in hospitals have been identified. They can broadly be classified in four categories: (1) antimicrobial use issues such as overuse, misuse and co-usage of antimicrobials; (2) infection control issues such as compliance to barrier precautions, workload, existence of outbreaks, reservoirs and patient transfers; (3) patient issues such as severity of illness and utilization of medical devices; and (4) community issues including prevalence of resistance in the area. In general, a number of devices appear to be associated with MDRO acquisition, either due to the confounding effect or as a consequence of poor hand hygiene.

Figure 2



Due to resource limitations, infection control for MDRP, is difficult to implement in small-sized hospitals in Japan. The framework of Hokusetsu Infection Control Network makes it possible for small-sized hospitals to obtain support from experienced infection control practitioners in large, well-resourced hospitals. We hypothesized that cross-contamination due to poor hand hygiene and devices might be the cause of high incidence of carbapenem resistant *Pseudomonas aeruginosa* in period 1

Our investigation has several limitations. First, the period of surveillance of isolates was only 2 months. Second, nine hospitals don't have bacterial laboratory.

Conclusion

Three-dimensional analyses (using modified Monnet's method) of antimicrobial resistance, antimicrobial agent use, and hand hygiene surveillance data are useful for assessing measures to reduce antimicrobial resistance. We recommended that 4 hospitals in area C should limit the use of carbapenem and 4 hospitals in area A should control cross-transmission resulting from poor hand hygiene (2.3 in period 2).

Acknowledgements

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References

1. D.L.Monnet et al. *Int J Antimicrob Agents* 15 (2000) 91–101
2. A. Kanayama, A Ukimura et al. *Journal of Hospital Infection* 93 (2016) 35-41

Conflict of interest

None declared.