Modeling intrafacility spread of KPC-producing bacteria in long-term acute care hospitals in the Chicago region, USA

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Background

Nosocomial outbreaks of *Klebsiella pneumoniae* carbapenemase-producing Enterobacteriaceae (KPC) are being reported increasingly. The first recognition of KPC in metropolitan Chicago, Illinois, USA, was in 2007. Prevalence rose rapidly thereafter, especially in long-term acute care hospitals (LTACHs). Using mathematical models we studied the spread of KPCs in LTACHs, determined the transmission capacity of KPC, and investigated the effect of cohorting.

Methods

Data

Room occupancy, admission cultures, and every-other-week point prevalence cultures from four LTACHs in the Chicago region from June 2012 until June 2013.

Adopted cohort stragies

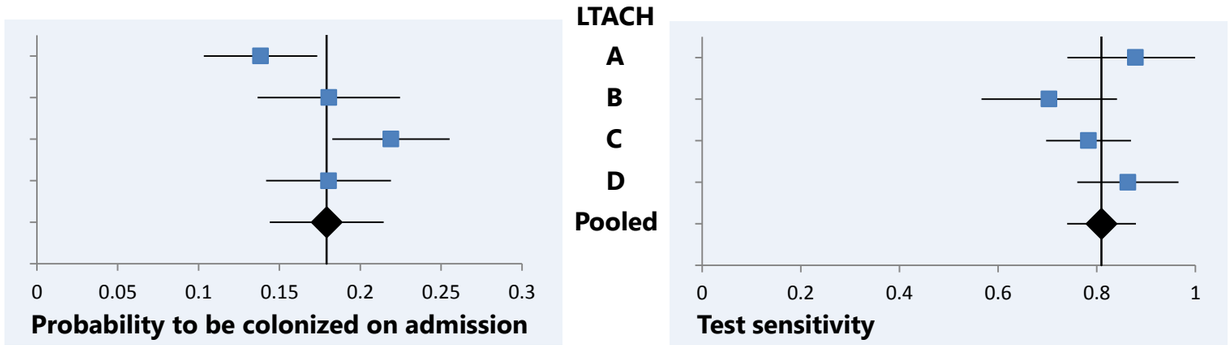
- pure cohort (all KPC+ patients on one floor)
- single rooms for KPC+ patients
- mixed cohort (all KPC+ patients on one floor, supplemented with KPC- patients).

Modeling of the transmission process

- using a data-augmented MCMC-method with Metropolis-Hastings algorithm
- background transmission rate α (including transmissions independent of the colonization pressure, such as endogenous selection)
- patient-dependent transmission rate β (including transmissions dependent on the colonization pressure: β * ward prevalence)

Results

6757 surveillance cultures of 3257 admissions were included, with a median LOS per admission of 24 days. The average prevalence of KPC among patients as calculated by the model was 35%. The overall estimates were 0.0022 for α and 0.011 for β, indicating that 64% of the acquisitions were due to patient-dependent transmission and 36% to background transmission. 18% of patients were colonized on admission to the LTACHs and sensitivity of the screening process to detect KPC was 81% (Figures). The number of acquisitions per 1000 patient days was lowest in the LTACHs with a pure cohort ward or private rooms for colonized patients compared to mixed cohort wards (Table).



Figures: Parameter estimates (mean, 95% CI)

Table: Acquisitions per 1000 patient days for the four LTACHs with different cohort strategies

LTACH	Cohort strategy	Acquisitions per 1000 pt days, model estimate (median, 95% CrI)
A	**Mixed cohort**	4.0 (3.0-5.0)
B	**Single rooms**	2.8 (1.7-3.8)
C	**Mixed cohort**	3.8 (3.0-4.6)
D	**Pure cohort**	2.7 (1.6-3.9)

Conclusion

The prevalence of KPC-producing bacteria in LTACHs is high, primarily due to a high admission prevalence and the resultant impact of high colonization pressure on risk of cross-transmission. Use of a pure cohort or single rooms for KPC+ patients in LTACHs seemed to limit transmission compared to use of a mixed cohort.

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