



# Diffusion and transmission of carbapenem-resistant *Klebsiella pneumoniae* in the medical and surgical wards of a university hospital in Milan, Italy



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## KEYWORDS

Multidrug-resistant agents;  
Carbapenem-resistant *Klebsiella pneumoniae*;  
Cross-transmission;  
Infections control measures;

**Summary** Carbapenem-resistant *Klebsiella pneumoniae* (CRKP) is emerging as a public health problem worldwide. In Italy, a remarkable increase in CRKP cases has been reported since 2010. In this study, CRKP diffusion, distribution and in-hospital transmission trends were evaluated in a university hospital in Milan, Italy, from January 2012 to December 2013. Isolates from 63 newly detected CRKP-positive patients were genotyped, and possible transmission was determined by combining the molecular results with data concerning the patients' admission and in-hospital transfers. Most of the cases (90.4%) were from general medical and surgery wards, and the remaining 9.6% were from the intensive care unit. Fifteen of the 46 hospital-associated cases (32.6%) were attributable to in-hospital transmission. After the

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Active surveillance;  
Active screening

introduction of targeted and hospital-wide control measures, the transmission index significantly decreased from 0.65 to 0.13 ( $p = 0.01$ ). There was also a decrease in the overall nosocomial case incidence, from 0.37 to 0.17 per 1000 person-days ( $p = 0.07$ ). Our findings indicate that the spread of CRKP in Northern Italy hospitals may go far beyond high-risk settings (i.e., intensive care units) and that strict surveillance should be extended to general areas of care.

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## Introduction

Carbapenem-resistant *Klebsiella pneumoniae* (CRKP), the resistance of which is largely due to broad-spectrum  $\beta$ -lactamase production (i.e., carbapenemases) [1], are becoming some of the most challenging multidrug-resistant pathogens worldwide [1–3]. Infections that are caused by CRKP are difficult to treat because of the very limited treatment options that are available, which consequently often lead to poor patient outcomes, increased morbidity and mortality, and higher hospital costs [4–6]. Hospitals are particularly important reservoirs of these pathogens because of the combination of seriously ill patients, intensive antibiotic use, and close patient/patient and patient/healthcare worker contact, which encourage the spread of CRKP and infectious outbreaks [7–11].

Bundled interventions consisting of strict hand hygiene, the isolation of infected or colonized patients, and the active surveillance of high-risk wards, such as intensive care units (ICUs), have been recommended as key strategies for preventing CRKP transmission in healthcare facilities [12,13]. However, there is little evidence as to what is the best and most sustainable preventive approach, particularly in contexts in which CRKP is endemic [14,15], which may at least partially explain the disparity in the infection control practices that are used in different hospitals [16,17].

The CRKP infection number has sharply increased in Italy over recent years [18,19], and a series of hospital outbreaks have been described [20–22]. Furthermore, data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) shows that the overall proportion of CRKP isolates from clinical specimens increased from 2.2% in 2009 to 19.4% in 2012 [18]. However, the CRKP infection burden varies widely from hospital to hospital, possibly because of location, case mix, and human and material resource differences [18].

Following an increase in the CRKP infection number at our hospital, we introduced a hospital-wide

protocol for implementing a set of control measures in January 2013. The aim of this paper was to describe the trends of newly detected CRKP cases and the relative contribution of patient-to-patient transmission in the year prior to and after its introduction.

## Methods

### Setting

Luigi Sacco Hospital is a university teaching hospital in Milan, Italy, which admits an average of 20,000 patients per year. It has 506 licensed beds in 27 wards, each of which has its own dedicated medical and nursing staff, including: 339 beds belonging to 19 medical (mainly internal medicine and infectious disease) wards; 159 to eight surgery wards (general surgery, cardiac surgery, orthopedics and urology), and eight to a single ICU. The medical wards have rooms with 2–3 beds, all of the surgery wards have rooms with two beds, and the ICU has eight single cubicles. During the study period, the mean individual patient hospital stay duration was eight days.

### Study design and definitions

This study retrospectively analyzed all of the newly identified CRKP cases between January 1, 2012, and December 31, 2013.

A case patient was defined as someone whose clinical or screening samples led to CRKP isolation, and a record was made of each case patient's age, gender, major underlying disease(s), and history of hospitalizations and/or antibiotic treatments in the previous three months; the date of the current hospital admission and the date of the first CRKP detection; the admission ward and any inter-ward transfers; and the discharge or death date.

The patients who were identified as having CRKP within the first 72 h of admission were defined as community-associated cases or imported healthcare-associated cases if they had been

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