Risk of acquiring multidrug-resistant Gram-negative bacilli from prior room occupants in the intensive care unit

S. Nseir[1,2], C. Blazejewski[1], R. Lubret[1], F. Wallet[3], R. Courcol[3] and A. Durocher[1,2]

1) *Intensive Care Unit, Calmette Hospital, University Hospital of Lille, Lille,* 2) *Medical Assessment Laboratory, Lille II University, Lille and* 3) *Microbiology Laboratory, Biology and Pathology Centre, University Hospital of Lille, Lille, France*

Abstract

The objective of this prospective cohort study was to determine whether admission to an intensive care unit (ICU) room previously occupied by a patient with multidrug-resistant (MDR) Gram-negative bacilli (GNB) increases the risk of acquiring these bacteria by subsequent patients. All patients hospitalized for >48 h were eligible. Patients with MDR GNB at ICU admission were excluded. The MDR GNB were defined as MDR *Pseudomonas aeruginosa*, *Acinetobacter baumannii* and extended spectrum β-lactamase (ESBL) -producing GNB. All patients were hospitalized in single rooms. Cleaning of ICU rooms between two patients was performed using quaternary ammonium disinfectant. Risk factors for MDR *P. aeruginosa*, *A. baumannii* and ESBL-producing GNB were determined using univariate and multivariate analysis. Five hundred and eleven consecutive patients were included; ICU-acquired MDR *P. aeruginosa* was diagnosed in 82 (16%) patients, *A. baumannii* in 57 (11%) patients, and ESBL-producing GNB in 50 (9%) patients. Independent risk factors for ICU-acquired MDR *P. aeruginosa* were prior occupant with MDR *P. aeruginosa* (OR 2.3, 95% CI 1.2–4.3, p 0.012), surgery (OR 1.9, 95% CI 1.1–3.6, p 0.024), and prior piperacillin/tazobactam use (OR 1.2, 95% CI 1.1–1.3, p 0.040). Independent risk factors for ICU-acquired *A. baumannii* were prior occupant with *A. baumannii* (OR 4.2, 95% CI 2–8.8, p <0.001), and mechanical ventilation (OR 9.3, 95% CI 1.1–83, p 0.045). Independent risk factors for ICU-acquired ESBL-producing GNB were tracheostomy (OR 2.6, 95% CI 1.1–6.5, p 0.049), and sedation (OR 6.6, 95% CI 1.1–40, p 0.041). We conclude that admission to an ICU room previously occupied by a patient with MDR *P. aeruginosa* or *A. baumannii* is an independent risk factor for acquisition of these bacteria by subsequent room occupants. This relationship was not identified for ESBL-producing GNB.

Keywords: *Acinetobacter baumannii*, colonization, environmental contamination, extended spectrum β-lactamase, Gram-negative bacilli, multidrug-resistant bacteria, *Pseudomonas aeruginosa*, room cleaning
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Corresponding author: S. Nseir, Réanimation Médicale, Hôpital Calmette, CHRU, boulevard du Pr Leclercq, 59037 Lille Cedex, France
E-mail: s-nseir@chru-lille.fr

Introduction

Multidrug resistant (MDR) bacteria are common among intensive care unit (ICU) patients. According to the results of a recent large international study performed in 1265 ICUs [1], infection was present in 51% of the 13 796 included patients. Infection was microbiologically confirmed in 69.8% of these patients, and MDR bacteria accounted for 44% of all bacteria. Patients with ICU-acquired infections related to MDR bacteria frequently receive inappropriate initial antibiotic treatment [2,3]. In addition, infections related to these bacteria are associated with increased morbidity and mortality [4,5].

Patients in the ICU are commonly exposed to broad-spectrum antimicrobial agents, and the ICU presents ample opportunities for the cross-transmission of MDR bacteria from patient to patient [6]. Environmental contamination with MDR bacteria occurs during the care of patients harbouring these bacteria [7,8]. Huang *et al.* [9] performed a 20-month retrospective multicentre study to determine the risk of acquiring resistant bacteria from prior room occupants. Among patients whose prior room occupant was positive for methicillin-resistant *Staphylococcus aureus* (MRSA), 3.9% acquired MRSA compared with 2.9% of patients whose prior room occupant was MRSA negative (OR 1.4, p 0.04). Among patients whose prior room occupant was positive for

vancomycin-resistant enterococci (VRE), these values were 4.5% and 2.8%, respectively (OR 1.4, p 0.02). Another recent study was performed during a 14-month period [10]. Weekly environmental cultures, and twice weekly patient surveillance cultures were performed in two ICUs. The authors found that prior room contamination, whether measured via environmental cultures or prior room occupancy by VRE-colonized patients, was highly predictive of VRE acquisition.

To the best of our knowledge, no study has evaluated the risk of acquiring MDR Gram-negative bacilli (GNB) from prior room occupants. However, these bacteria are frequently isolated in critically ill patients [1,11]. In addition, infections related to these bacteria are difficult to treat with frequent inappropriate initial antibiotic treatment, and high mortality and morbidity rates [3]. Therefore, we performed this prospective observational study to determine the relationship between colonization or infection with MDR GNB in prior room occupants and the risk of acquiring these bacteria by subsequent patients.

Patients and Methods

Study design

This prospective observational cohort study was conducted from December 2006 to December 2007. No informed consent was required by the local Institutional Review Board because of the non-interventional design of the study. Eligibility criteria included admission to the ICU during the study period, and length of ICU stay >48 h. Patients with colonization or infection related to MDR GNB at ICU admission were excluded.

Study population

The study was performed in a 30-bed medical and surgical ICU, including three ten-bed units. All ICU rooms were single beds. Healthcare workers did not share patient care between subunits. In addition, in each subunit the staff members were not responsible for specific ICU rooms. Cleaning of ICU rooms was performed at patient discharge using quaternary ammonium disinfectant. The infection control policy included isolation techniques, routine screening of MDR bacteria, written antibiotic treatment protocol, and continuous surveillance of nosocomial infections. In immunocompetent patients, isolation techniques were used for all patients at ICU admission, until receipt of screening results. Thereafter, these techniques were performed for all patients with infection or colonization related to MDR bacteria. Preventive isolation techniques were applied for all immunosuppressed patients. These techniques included use of protective gowns and gloves associated with adequate hand hygiene using alcohol-based hand rub formulations before and after patient contacts.

Routine screening of MDR bacteria was performed for all patients at ICU admission and weekly thereafter. This screening included nasal and rectal swabs. In addition, tracheal aspirate was performed in intubated or tracheotomized patients. Screening of MDR bacteria has been performed in our ICU as part of the infection control policy, and not for the purpose of this study. Other microbiological cultures were performed according to clinical status.

During the study period a quality audit was performed in 50 consecutive patients. Direct observation of healthcare workers was used by a student to assess compliance with disinfection protocol at patient discharge. A checklist of objects to clean was used to determine the percentage of objects cleaned at ICU discharge.

Data collection and definitions

All data on patient characteristics at ICU admission, and during ICU stay, were prospectively collected. The MDR GNB were defined as *Pseudomonas aeruginosa* resistant to ceftazidime or imipenem, *Acinetobacter baumannii*, and extended spectrum β-lactamase (ESBL) -producing GNB. The MDR GNB were defined as ICU-acquired if they were diagnosed >48 h after admission to ICU. A prior room occupant was considered as having the same MDR GNB as the next patient when any screening or diagnostic sample was positive for an MDR GNB that was subsequently isolated, on screening or diagnostic samples, in the next patient. Prior antibiotic treatment was defined as any antibiotic treatment during the 3 months preceding ICU admission. Colonization pressure was assessed daily, and was defined as the number of patients with MDR *P. aeruginosa*, *A. baumannii* or ESBL-producing GNB divided by the number of all patients in each ten-bed unit. McCabe score [12], chronic obstructive pulmonary disease [13] and immunosuppression [14] are defined elsewhere.

Statistical methods

SPSS 11.5 software (SPSS, Chicago, IL) was used for data analysis. Results are presented as number (percentage) for categorical variables. Distribution of quantitative variables was tested. Median values were 0 for several quantitative variables, because of their skewed distribution. Therefore, all quantitative variables are presented as mean ± SD. All p values were two-tailed. The statistical significance was defined as $p < 0.05$.

Univariate analysis was used to determine factors associated with ICU-acquired MDR *P. aeruginosa*, *A. baumannii* and