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Short communication

Multidrug-resistant bacteria transmitted through high-density EEG in ICU

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ABSTRACT

Purpose: Prevention of multidrug resistant (MDR) bacterial contamination remains a major challenge in ICUs. Many hospital outbreaks involving MDR transmitted through environmental contamination have been reported. Bedside high-density EEG allow for dynamic cognitive evaluation in brain-injured patients and is used more and more frequently in clinical practice to evaluate brain function and predict outcome in severely neurologically impaired patients. Unfortunately, the material used for this procedure is not entirely disposable.
Method: We performed a systematic analysis of MDR bacterial contamination in patients contaminated in our ICU using specific bacteriological methods.
Results: We report a proven case of cross-contamination of an extended-spectrum beta-lactamase (ESBL)-producing *Klebsiella pneumoniae* strain, and a possible case of cross-contamination of a carbapenem-resistant *Acinetobacter baumannii* strain.
Conclusion: Cross-contamination of MDR bacteria is possible through high-density EEG material. However, appropriate procedures can decrease this risk.

1. Introduction

Prevention of multidrug resistant (MDR) bacterial contamination remains a major challenge in ICUs and contact precautions have been implemented to prevent cross-contamination. Transmission has nevertheless been observed through environmentalcontamination

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in many hospital outbreaks involving MDR bacteria. Patients with brain damage are often hospitalized in intensive care units (ICUs). As with all ICU patients, they are exposed to multidrug-resistant (MDR) bacteria by direct transmission through staff hands or by environmental and material contamination. Their neurological status requires performing multiple neurological explorations such as bedside cognitive high density-EEG which allows for dynamic evaluation of brain function [1–4]. We report cross-contamination by two MDR bacteria through high-field EEG devices with 256 sponge electrodes used for high-density EEG.

2. Material and methods

The neurological ICU (NICU) of Pitié-Salpêtrière hospital is an 8-bed ICU in the center of Paris, France [5–7].

High-density EEGs are realized as previously described [6,8]. Essentially, a net with 256 sponge electrodes is soaked in a saline solution, and applied to a patient's scalp without scalp abrasion. The sensor lead bundle is isolated from both the bed and the patient through a plastic sheet. After approximately 40 min, the EEG net is removed and soaked in disinfectant solution (Septanios®, http://www.nmmedical.fr/septanio-md.html).

MDR bacteria screening is routinely performed on admission, using nasal and rectal swabs, and weekly thereafter. Swabs are plated on selective media to detect methicillin-resistant *Staphylococcus aureus* (MRSA) and MDR Gram-negative bacteria. Species identification is performed using the API system (bioMérieux, Marcy l'Etoile, France) and susceptibility testing is systematically performed on all isolates growing on the selective media. If a carbapenem-resistant Gram-negative strain is isolated, presence of carbapenemase genes is detected by in-house PCR. The Diversilab® semi-automated repetitive-sequence-based PCR (rep-PCR) is used to confirm isolate clonality. Patients are isolated pre-emptively using contact isolation precautions on admission that are removed only in case of negative admission screening.

3. Results

Four cases of cross-contamination with carbapenem-resistant *Acinetobacter baumannii* (CRAB) were identified within a 2-month period in 2012, including three cases concomitantly colonized by extended-spectrum beta-lactamase-producing *Klebsiella pneumoniae* (ESBL-Kp).

3.1. Cases

Case 1: A 74 year-old man was admitted to the NICU in 2012 for respiratory distress. His past medical history was remarkable for low-grade follicular B lymphoma diagnosed in 1991. He had been hospitalized for 2 months for encephalitis workup. MDR screening was negative on admission and pre-emptive contact precautions were therefore removed 3 days after admission. His neurological status worsened, and he became comatose. High-density EEG was performed 1 month after admission and a multimodal brain MRI a few days later. The weekly rectal swab performed 3 days after MRI was positive for ESBL-Kp and isolation precautions were put into effect. A respiratory sample taken the same day displayed carbapenem-resistant *A. baumannii* (CRAB) with results 2 days later.

Case 2: A 57 year-old man was hospitalized in the surgical ICU early in 2012, 1 month after the former patient, for gastrointestinal bleeding and hepatic encephalopathy due to liver cirrhosis. His past medical history was remarkable for cirrhosis and several hospitalizations in the hepatology and general ICUs in recent months. High-density EEG was performed in the surgical ICU by the NICU staff because the patient remained comatose 8 days after admission. This procedure took place 8 days after the high-density EEG in Case 1. A blood culture drawn 2 weeks after admission was positive for CRAB the same day as the respiratory sample in the former patient. A respiratory sample taken 1 day later from patient 2 was positive for CRAB and ESBL-Kp.

In coordination with the Infection Control Team (ICT), these two patients were placed under strict contact isolation precautions with dedicated nurses and admission of new patients were limited in the two ICUs. Contact patients from both ICUs were screened for asymptomatic digestive and cutaneous carriage of the two MDR bacteria according to local recommendations. Discharged contact patients were traced and destination hospitals were informed. Four days after these measures, rep-PCR analysis confirmed that the two CRAB isolates were undistinguishable, and in-house PCR identified the chromosomal blaOXA-66 carbapenemase gene.

Case 3: Following the alert, one discharged contact patient was identified as being CRAB-positive on her screening rectal swab performed outside our facility. A 22 year-old woman had been admitted to the NICU for 4 days for neurological evaluation of a comatose state after cardiac arrest. She was hospitalized in the NICU at the same time as patient 1, but before the implementation of contact precautions (for geographic location see Fig. 1B). A neurological examination was performed just before MRI, EEG, and high-density EEG. The systematic screening swabs performed on admission displayed ESBL-producing *Escherichia coli*.

Case 4: A 39 year-old man was admitted to the NICU for *Streptococcus pneumoniae* meningitis. Patient 1 was under contact isolation precautions when he was admitted, but the team dedicated to patient 1 treated patient 4 for the first 2 days (Fig. 1B). Patient 4 underwent neurological examination, brain CT but neither EEG, MRI nor high density EEG. As a contact patient of MDR cases, he was screened for MDR bacteria and was positive for CRAB and ESBL-Kp on a sample taken 4 days after the isolation precautions for patient 1 were implemented (Fig. 1B).

3.2. Analysis

The geographic location of the patients within the hospital and the NICU is presented in Fig. 1 and in the Supplementary Table. Since the first 2 patients were never hospitalized in the same ward, indirect transmission via surfaces or cross-transmission through staff hands is unlikely. There are therefore two possible sources to explain this contamination: hand or gown carriage by physicians conducting neurological evaluation in the two wards and contamination of EEG and high-density EEG systems used for both patients. The first hypothesis seems unlikely because of the time period and the distance between the 2 ICUs. EEG and high-density EEG systems were sampled for MDR contamination and their use was discontinued. Despite the fact that the EEG system was used in three out of four cases, it was not considered the most likely source of contamination because disposable electrodes were systematically used. The high-density EEG head cap made of 256 non-disposable sponge electrodes was negative for *CRAB* but positive for ESBL-Kp. The latter isolate was identical to the isolates harbored by three of the four patients according to rep-PCR analysis (Fig. 1D), suggesting that the head cap could be the source of contamination. In addition, rep-PCR analysis showed that patient 1 and 4 CRAB isolates were identical (Fig. 1C). Unfortunately, the CRAB isolates from patients 2 and 3 were not available for molecular typing. However, Case 1 and Case 4 were both CRAB- and ESBL-Kp identical according to rep-PCR analysis (Fig. 1C and D) and Cases 1, 2, and 4 had identical ESBL-Kp. This suggests that the two MDR isolates were simultaneously transmitted through the head cap.

The high-density EEG device could not have been responsible for patient 4's contamination as he did not have this procedure.