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Original Investigation

Hemodialyzer Reuse and Gram-Negative Bloodstream Infections

Chris Edens, PhD,[1,2] Jacklyn Wong, PhD,[2,3] Meghan Lyman, MD,[1,2] Kyle Rizzo, MPH,[3] Duc Nguyen, MD,[1] Michela Blain, MD,[1] Sam Horwich-Scholefield, MPH,[3] Heather Moulton-Meissner, PhD,[1] Erin Epson, MD,[3] Jon Rosenberg, MD,[3] and Priti R. Patel, MD, MPH[1]

Background: Clusters of bloodstream infections caused by *Burkholderia cepacia* and *Stenotrophomonas maltophilia* are uncommon, but have been previously identified in hemodialysis centers that reprocessed dialyzers for reuse on patients. We investigated an outbreak of bloodstream infections caused by *B cepacia* and *S maltophilia* among hemodialysis patients in clinics of a dialysis organization.

Study Design: Outbreak investigation, including matched case-control study.

Setting & Participants: Hemodialysis patients treated in multiple outpatient clinics owned by a dialysis organization.

Predictors: Main predictors were dialyzer reuse, dialyzer model, and dialyzer reprocessing practice.

Outcomes: Case patients had a bloodstream infection caused by *B cepacia* or *S maltophilia*; controls were patients without infection dialyzed at the same clinic on the same day as a case; results of environmental cultures and organism typing.

Results: 17 cases (9 *B cepacia* and 8 *S maltophilia* bloodstream infections) occurred in 5 clinics owned by the same dialysis organization. Case patients were more likely to have received hemodialysis with a dialyzer that had been used more than 6 times (matched OR, 7.03; 95% CI, 1.38-69.76) and to have been dialyzed with a specific reusable dialyzer (Model R) with sealed ends (OR, 22.87; 95% CI, 4.49-∞). No major lapses during dialyzer reprocessing were identified that could explain the outbreak. *B cepacia* was isolated from samples collected from a dialyzer header-cleaning machine from a clinic with cases and was indistinguishable from a patient isolate collected from the same clinic, by pulsed-field gel electrophoresis. Gram-negative bacteria were isolated from 2 reused Model R dialyzers that had undergone the facility's reprocessing procedure.

Limitations: Limited statistical power and overmatching; few patient isolates and dialyzers available for testing.

Conclusions: This outbreak was likely caused by contamination during reprocessing of reused dialyzers. Results of this and previous investigations demonstrate that exposing patients to reused dialyzers increases the risk for bloodstream infections. To reduce infection risk, providers should consider implementing single dialyzer use whenever possible.

INDEX WORDS: Hemodialysis; dialyzer reuse; dialyzer reprocessing; bloodstream infection (BSI); *Burkholderia cepacia*; *Stenotrophomonas maltophilia*; Gram-negative bacteria; patient safety; outbreak; contamination; decontamination; human error; infection prevention; dialysis organization; end-stage renal disease (ESRD); case-control.

More than 400,000 individuals receive maintenance hemodialysis for end-stage renal disease in the United States.[1] More than 6,000 outpatient clinics provide regular hemodialysis treatments for these patients. Each treatment requires the use of a dialyzer[2] (Fig S1, provided as online supplementary material). Some dialyzers are designated for single-use, whereas others may be reused for multiple treatments of the same patient. Reusable dialyzers must be reprocessed using a multistep procedure involving rinsing, testing, and disinfection of the dialyzer and associated parts, such as removable header caps and O-rings.[3] Dialyzer reuse has been associated with adverse outcomes,[4] including bloodstream infections (BSIs),[5] pyrogenic reactions,[6-8] hospitalizations,[9] and death.[9-11]

Burkholderia cepacia and *Stenotrophomonas maltophilia* are Gram-negative bacteria commonly found in water and soil. In health care settings, previous outbreaks of BSIs caused by these pathogens have been associated with contaminated medication, improper handling and disposal of used medical equipment, and inadequate hand hygiene.[12-14] Outbreaks of BSI caused by these and other similar

From the [1]Division of Healthcare Quality Promotion and [2]Epidemic Intelligence Service, Centers for Disease Control and Prevention, Atlanta, GA; and [3]California Department of Public Health, Richmond, CA.

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Address correspondence to Chris Edens, PhD, Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333. E-mail: wedens@cdc.gov

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pathogens among hemodialysis patients have been attributed to contamination during dialysis circuit priming practices, lapses in medication preparation and handling, the practice of dialyzer reuse and reprocessing, and improper storage and disinfection of reused dialyzers.[15-23]

In August 2014, the California Department of Public Health and the Centers for Disease Control and Prevention (CDC) became aware of clusters of BSIs caused by *B cepacia* and *S maltophilia* among hemodialysis patients at multiple outpatient dialysis clinics owned by a single dialysis organization. In September 2014, we initiated an investigation that included a matched case-control study, direct observations of infection control practices and dialyzer reprocessing at select dialysis organization clinics, and environmental sampling and testing of reprocessed dialyzers from dialysis organization clinics. The purpose of the epidemiologic analysis was to assess risk factors for infection. We conducted observations of key practices to identify lapses that could have led to the outbreak. Environmental sampling was performed to help identify possible sources of contamination that resulted in patient infections.

METHODS

Case Definition

A definite case was a positive blood culture for *B cepacia* or *S maltophilia* from September 1, 2013, through September 30, 2014, in a patient who had received hemodialysis at any dialysis organization clinic in the previous week. A possible case was a positive blood culture for *Pseudomonas aeruginosa*, *Proteus* species, *Morganella morganii*, *Serratia marcescens*, *Xanthomonas* species, *Ralstonia pickettii*, or *Candida parapsilosis* during the same timeframe in a patient who had received hemodialysis at any dialysis organization clinic in the previous week.

Case Finding and Review

The dialysis organization provided outpatient dialysis services in several states. The dialysis organization maintains a database of microbiology results for specimens submitted to their centralized laboratory from any of their clinics. We reviewed these data to identify all positive blood cultures for an organism of interest between April 1, 2012, and September 30, 2014. We examined this expanded timeframe in order to understand the baseline frequency of infections.

We performed additional case finding by contacting infection preventionists at 14 local hospitals that frequently cared for patients from clinics A and B (dialysis organization clinics with highest case counts). Infection preventionists were asked to query their hospital microbiology records for any admission or emergency department blood culture positive for *B cepacia* or *S maltophilia* for September 1, 2013, through September 30, 2014. For all positive infection preventionist responses, we determined whether the patient was a dialysis organization client and if case definition criteria were met.

We developed a standard form to abstract information from electronic medical records for patient demographics, medical history, dialysis session details, and relevant outcomes. We collected dialyzer use count, which was recorded in the electronic medical record as the number of times a specific dialyzer had been used prior to that treatment session.

Case-Control Study

Only definite cases were included in the case-control study and subsequent analysis. We performed a 1:3 matched case-control study, with cases and controls individually matched on clinic and treatment date, to assess risk factors associated with BSIs following dialysis treatment. Controls were randomly selected from patients who were treated at the same clinic on the same date as the matched case. For each case, we first determined the likely exposure date, and for that date, obtained a complete list of all patients treated at the case patient's clinic. This patient list was then numbered and a random number generator was used to facilitate random selection of 3 controls for each case. Thus, each case patient's exposure date was matched to a treatment date of controls. The case patient's exposure date was defined by the timing of symptom onset (ie, fever, chills, or low blood pressure) relative to dialysis treatment. For case patients whose symptom onset was during dialysis, the date of onset was the presumed exposure date. For case patients whose symptom onset occurred before or after a dialysis treatment session, the presumed exposure date was the most recent dialysis treatment that preceded symptom onset. Patients were excluded from control selection if any of the following criteria were met 7 days prior to or after the exposure date of interest: positive blood cultures for any organism, antibiotic exposure, or signs or symptoms of a BSI (ie, fever, chills, or unexplained decrease in blood pressure). If a patient was excluded, another control was randomly selected from the patient list.

All statistical analyses were performed using SAS Enterprise Guide, version 5.1 (SAS Institute Inc). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using matched univariate logistic regression with exact conditional analysis. Dialyzer use count was examined as a categorical and continuous variable. For the categorical variable, we divided dialyzer use into 2 categories relative to the median number of dialyzer uses among all cases and controls.

Clinic Observations and Reprocessing Assessment

We conducted site visits at 6 dialysis organization clinics and separated observations into categories based on the types of procedures observed. This was done to better understand how practices differed between dialysis organization clinics. Category 1 observations included observations of injectable medication preparation and handling and handling, and reprocessing of used dialyzers. Category 2 observations targeted infection control practices of the hemodialysis treatment, including vascular access care, management of blood tubing during priming, and disinfection of prime buckets. At clinics A and B, we performed both category 1 and 2 observations in order to better understand what may have contributed to the large number of cases there. We performed only category 1 observations at clinics C to F, which were chosen based on geographic location (ie, closest to where the team was based), dialyzer reprocessing equipment in use, and occurrence of cases. These clinics were visited to provide more information on how reprocessing methods were performed across dialysis organization clinics, including clinics with and without cases. Some clinics that had definite cases were not visited due to geographic limitations.

Company-Wide Assessment

We conducted an organization-wide assessment of dialyzer reprocessing practices by examining data provided by the dialysis organization. Requested information included data for reprocessing equipment (whether automated or manual) and percentage of patients at each clinic undergoing treatment with reusable dialyzers.