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Impact of hospital length of stay on the distribution of Gram negative bacteria and likelihood of isolating a resistant organism in a Canadian burn center

Marsail Wanis [a,1], Sandra A.N. Walker [a,b,c,d,*], Nick Daneman [c,d,e], Marion Elligsen [b], Lesley Palmay [b], Andrew Simor [c,d,e], Robert Cartotto [f]

[a] University of Toronto, Leslie L. Dan Faculty of Pharmacy, Toronto, Ontario, Canada
[b] Sunnybrook Health Sciences Centre, Department of Pharmacy, Toronto, Ontario, Canada
[c] Sunnybrook Health Sciences Centre, Department of Microbiology and Division of Infectious Diseases, Toronto, Ontario, Canada
[d] Sunnybrook Research Institute, Toronto, Ontario, Canada
[e] University of Toronto, Faculty of Medicine, Toronto, Ontario, Canada
[f] Sunnybrook Health Sciences Centre, Ross Tilley Burn Centre, Toronto, Ontario, Canada

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ABSTRACT

Rationale: The impact of hospital length of stay (LOS) on the distribution and susceptibility of Gram negative bacteria (GNB) causing infection in burn patients remains unexplored. Knowledge of causative pathogens is important in guiding empiric antibiotic therapy.
Objectives: To characterize the distribution of GNB causing infection and to identify changes in susceptibility with LOS in a tertiary care burn center.
Methods: A retrospective review of all admissions to the Ross Tilley Burn Centre at Sunnybrook Health Sciences Centre with clinical cultures yielding GNB (duplicates excluded) between March 12, 2010 to July 17, 2013 was completed. Positive cultures were categorized into 5 clinically relevant time periods (in days) based on specimen collection date relative to the patient's date of admission: 0–7, 7–14, 14–21, 21–28, >28. Chi-square for proportions was used to compare the time periods.
Results: The proportion of patients with clinical cultures for *P. aeruginosa* increased with hospital LOS (0–7 days: 8% vs. >28 days: 55%; $p < 0.05$). Conversely, clinical cultures for *H. influenzae* occurred primarily within the first 7 days of hospitalization (0–7 days: 36% vs. >28 days: 0.7%; $p < 0.05$). *Enterobacteriaceae* isolation was highest between 7 and 14 days of hospitalization (7–14 days: 62% vs. >28 days: 38%; $p < 0.05$). Antibiotic resistance was directly proportional to hospital LOS (% patients with multidrug resistant GNB increased from 6% [LOS 0–7days] to 44% [LOS > 28 days]; $p < 0.05$).

* *Corresponding author at*: Sunnybrook Health Sciences Centre, 2075 Bayview Avenue, Toronto, Ontario, Canada M4N 3M5. Tel.: +1 416 480 6756.
E-mail address: sandra.walker@sunnybrook.ca (Sandra A.N. Walker).
[1] Present address: University Health Network, Toronto, Ontario, Canada.
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Conclusions: This study provides objective data documenting changes in species and resistance patterns of GNB causing infection in patients admitted to a burn center as a function of hospital LOS; which may support delaying the use of broad spectrum antibiotics (e.g. carbapenems and beta-lactam/beta-lactamase inhibitors) in clinically stable patients.

1. Introduction

Despite improvements in the early care of burn patients, multi-organ failure (MOF) remains the major cause of mortality in acute burn patients [1–3]; with sepsis responsible for 46–51% of multi-organ failure triggers [2,3]. Exposure to pathogens from burn wounds, invasive indwelling devices (catheters, intubation), and the gastrointestinal tract put burn patients at risk for burn wound infections, ventilator-associated pneumonia, catheter related blood stream infections, and catheter-associated urinary tract infections [4].

The incidence of infection increases as a function of length of hospital stay in acute burn patients [5]. Rajput et al. [5] identified an increase in the cumulative incidence of infection in burn patients from 10% in patients hospitalized up to 7 days, to 95% in those hospitalized for >50 days. With increased length of stay (LOS), a shift in the causative organisms associated with burn wound colonization has been observed. Altoparlak et al. [6] performed a prospective study on hospitalized burn patients to examine the changes in bacterial colonization over a mean hospital stay of 36.5 days. These investigators identified coagulase-negative staphylococci (CNST) and *Staphylococcus aureus* as the most prevalent isolates on admission wound cultures, with a shift in later weeks to *Pseudomonas aeruginosa* as the most common isolate [6].

Gram negative bacteria (GNB) are major hospital pathogens and exhibit less stable antibiotic susceptibility patterns than Gram positive bacteria [7]. This is probably due to GNB developing more rapid generation of resistance or transmission of resistant strains among patients [7,8]. There is a gap in the literature exploring the impact of LOS in a burn center on either the distribution of GNB species causing infection or susceptibility of GNB isolates causing infection. These descriptive data could assist in minimizing broad spectrum empiric antimicrobials in hemodynamically stable burn patients while ensuring appropriate early antibiotic therapy for those who are unstable [9]. Therefore, the objectives of this study were to characterize the distribution of different GNB species over time and to identify changes in the antibiotic susceptibility profile of GNB over time.

2. Materials and methods

2.1. Setting

This study was conducted at the American Burn Association-verified Ross Tilley Burn Centre (RTBC) at Sunnybrook Health Sciences Centre (SHSC) in Toronto, Ontario, Canada. SHSC is a tertiary care teaching hospital with 14 beds for adult burn center patients. RTBC is the major referral center for patients with severe burns for the province of Ontario (population 13 million); with an average of 163 annual burn patient admissions from 2010 to 2014. This study was approved by the Research Ethics Board at SHSC on February 7, 2014.

2.2. Study design

We conducted a retrospective cohort study of all patients admitted to the RTBC from March 12, 2010 to July 17, 2013, and evaluated the impact of time from hospital admission on the identity and susceptibility of Gram negative bacterial pathogens. Data was retrieved from the antimicrobial stewardship database (Stewardship Program Integrated Resource Information Technology [SPIRIT]) [10], a custom-made program for the antimicrobial stewardship program at SHSC.

2.3. Patient inclusion

Patients admitted to the RTBC from March 12, 2010 to July 17, 2013 with at least one clinical (non-screening) culture that yielded a Gram negative bacterial isolate were included in this analysis. Clinical cultures were defined as cultures collected for the purpose of assisting in the diagnosis of a clinical infection. Routine screening cultures (such as nasal or rectal swabs) for the purpose of infection prevention and control were excluded. We excluded duplicate cultures growing the same organism with the same susceptibility profile, for the same patient within 14 days or less of a prior specimen from that patient. The 14 day time period chosen was arbitrary but has been alluded to indirectly in the literature [7]. There is no agreed consensus on the definition of duplicate culture [11]; our definition had to take both time and the organism's antibiogram into consideration, as this best addressed the study's objectives, to minimize any bias.

2.4. Data extraction

All data were extracted retrospectively from the SPIRIT database and organized into a Microsoft Excel (MSExcel) database. Data extracted included: age, date of admission, date of culture collection, specimen type, organism identity, organism susceptibility to selected antibiotics (ceftriaxone, ceftazidime, gentamicin/tobramycin, piperacillin/tazobactam, meropenem, and ciprofloxacin), and whether systemic antibiotics with activity against GNB were administered from a time period between 3 days before and 7 days after specimen collection to reflect antibiotic treatment directed at Gram negative pathogens. The time period of 3 days before to 7 days