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Research note

Culturing rate and the surveillance of bloodstream infections: a population-based assessment

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ABSTRACT

Objectives: Diagnosis of a bloodstream infection (BSI) requires a positive blood culture. However, low culturing rates will underestimate the true incidence of BSI and high rates may increase the risk of false-positive results. We sought to investigate the relationship between culturing rates and the incidence of BSI at the population level.
Methods: Population-based surveillance was conducted in the western interior of British Columbia, Canada, between 1 April 2010 and 31 March 2017.
Results: Among 60 243 blood culture sets drawn, 5591 isolates were obtained, of which 2303 were incident, 1929 were repeat positive and 1359 were contaminants. Overall annual rates of culturing, incident, repeat positive and contaminant isolates were 4832, 185, 155 and 109 per 100 000 population, respectively. During the 84-month study, there was an increase in the culturing rate that reached a plateau at 48 months (5403 cultures per 100 000 per year). The rate of both repeat isolates and contaminants increased linearly with an increasing culturing rate. However, the incident isolate rate reached an inflection point at a rate of approximately 5550 per 100 000 annually, at which point the increase in incident isolates per culture sample was diminished. At a culturing rate above 6123 per 100 000 per year, the number of repeat isolates exceeded that of incident isolates.
Conclusions: The determined incidence of BSI will increase with increased culturing in a population. Further studies are needed to explore optimal BSI culturing rates in other populations. **K.B. Laupland, Clin Microbiol Infect 2018;▪:1**

Introduction

Surveillance of bloodstream infection (BSI) is important for defining its epidemiology, for tracking trends in emerging and resistant pathogens, and for monitoring success of infection prevention and control programs [1]. The diagnosis of a BSI mandates that a specimen of blood be drawn, that it subsequently be cultured positive and that contamination be ruled out [2]. In surveillance, the detected occurrence of BSI will be related to the rate of culturing [3–5]. On the one hand, if too few cultures are drawn, then cases may not be detected and the occurrence of BSI will be underestimated. On the other hand, excessive culturing may identify limited additional cases and may risk a higher rate of contaminants with the associated adverse consequences of excess antibiotic treatment [6].

Few studies have investigated the relationship between culturing rates and incidence of BSI in nonselected populations [7,8]. The objective of this study was to investigate the relationship between culturing rates and BSI incidence in the western interior of British Columbia, Canada. We *a priori* hypothesized that higher culturing rates for BSI would be associated with an increased incidence of BSI but that a threshold may be met whereby the incremental benefit of added cases would be outweighed by repeat isolates and contaminants.

Methods

Study population and surveillance

An active population-based surveillance design was used. All blood cultures performed in the western interior region of British

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Columbia from 1 April 2010 to 31 March 2017 were included, as previously described [9]. The regional research ethics review board approved this study.

Laboratory procedures and definitions

All blood was cultured using the BacT/Alert 3D System (bioMérieux, Marcy l'Étoile, France) during the study duration. A blood culture set consisted of a single draw of 20 mL of blood divided into an aerobic/anaerobic bottle pair. Standard practice during this study period was to draw two sets of blood cultures from different sites. For the total number of cultures drawn, routine summary laboratory reports were obtained. Negative cultures were not available at the individual level. All positive blood cultures were independently reviewed case by case and were classified as contaminants or as BSI associated, as previously described [9]. Isolates associated with BSIs were further classified as incident when the first isolate per species per episode, or as repeat isolates when the same species was subsequently isolated during the same BSI episode [9].

Statistical analysis

Population-based estimates of blood culture sets drawn and resultant isolates obtained (incident positive, repeat positive and contaminant) were expressed as rates per 100 000 population using regional census data (https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-estimates). Linear spline analysis was used to identify statistically significant knots in the linear relationship between culture sets drawn and isolates obtained. Durbin's alternative test and the Ljung Box Q-test were used to examine for serial autocorrelation among adjacent data [10,11], and models were corrected for the presence of autocorrelation as required using the Cochrane-Orcutt methodology [12].

Modelled rates were reported as estimates with 95% confidence intervals. All statistical analyses were conducted by Stata 14.2 (StataCorp, College Station, TX, USA).

Results

A total of 60 243 blood culture sets were drawn and 5591 isolates were obtained, of which 2303 were incident, 1929 were repeat positive and 1359 were contaminant isolates, for rates of 4832, 185, 155 and 109 per 100 000 population, respectively.

The rate of culturing changed significantly with time (Fig. 1). There was an increase in culture incidence (Fig. 1(a)) during the first 4 years of the study (41.5; 95% confidence interval, 33.4 to 49.6 cultures per 100 000 per month; $p < 0.0001$) that reached a plateau at 48 months with 5403 cultures per 100 000 per year (subsequent increase 14.8; 95% confidence interval, 0 to 32.8 cultures per 100 000 per month; p 0.1). However, irrespective of this plateau in rate of cultures drawn, the rates of incident, repeat and contaminants all continued to increase through the duration of study period with no statistical change in rate at month 48 (Fig. 1(b–d)).

An increasing rate of culturing was associated with increasing rates of incident, repeat positive and contaminant isolates (Fig. 2). However, while the rate of both repeat isolates and contaminants increased linearly with an increasing culture rate, models suggested that the rate of incident isolates per culture set drawn decreased beyond a culture rate of 5550 culture sets drawn per 100 000 population per year (Fig. 2; p 0.08 for change in slope). In

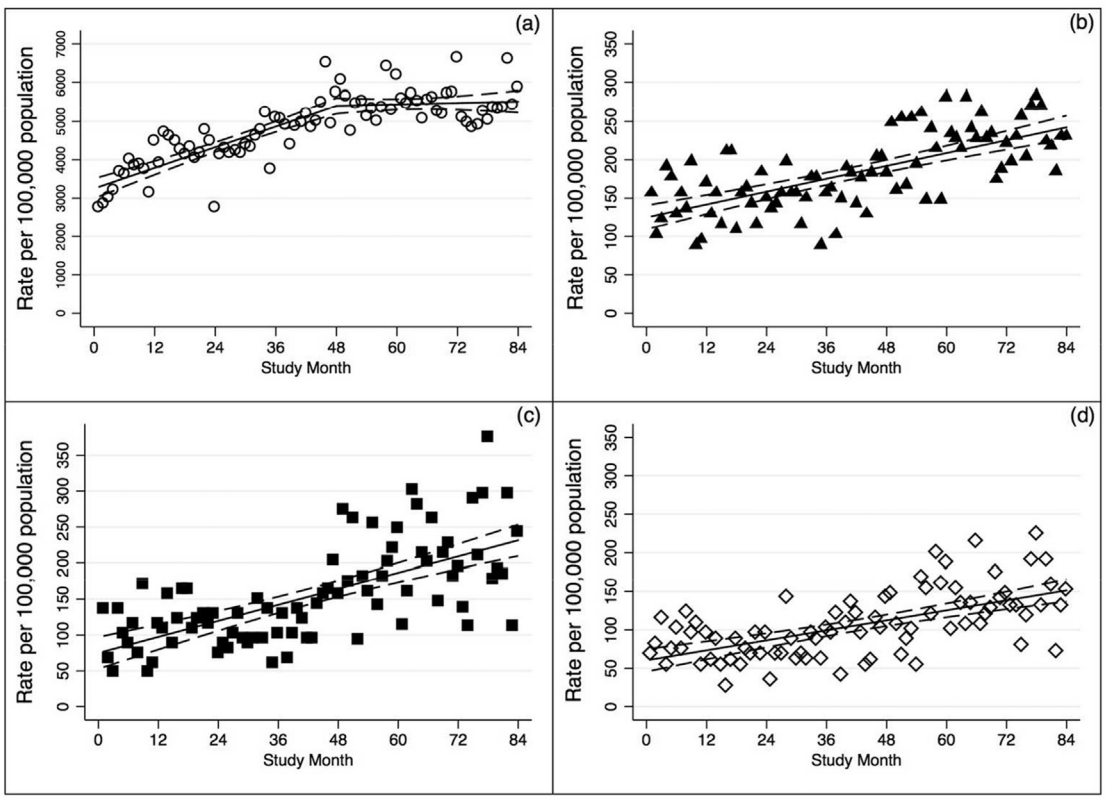

Fig. 1. Rate of culture sampling and positivity, western interior of British Columbia, April 2010 to March 2017. (a) Culture rates (circles). (b) Incident positive (triangles). (c) Repeat positive (squares). (d) Contaminants (diamonds).

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