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The Effect of a Care Bundle on the Rate of Blood Culture Contamination in a General ICU

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Abstract: Background/Objectives: A blood culture (BC) care bundle is aimed at decreasing BC contamination rate. This study examined prospectively the effect of a care bundle on BC contamination rates in a high workload ICU. **Methods:** We performed a before-after study in a general ICU, from January 2018 to May 2019. Blood culture sets were classified as positive, contaminated, indeterminate and negative. We used bivariate and interrupted time series analysis to assess the effect of the intervention and factors associated with contamination rates. **Results:** During the study, a total of 4236 BC vials were collected. BC Contamination rate decreased significantly after the intervention from 6.2% to 1.3%. Incidence rate of contaminated BC sets was significantly lower in the POST phase: 0.461 vs 0.154 BC sets per 100 ICU bed-days. Overall compliance with the BC care bundle increased from 3.4% to 96.9%. **Conclusions:** The care bundle was effective in reducing BC contamination and improving several quality indicators in our setting. The indeterminate BC rate is an important problem, and we suggest that it should be included in BC quality indicators. : The BC care bundle implementation was effective in reducing BC contamination rate, although its long-term effect was not assessed.

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1. Introduction

According to the 2022-23 European Centre for Disease Prevention and Control (ECDC) Point Prevalent Study, bloodstream infections (BSI) represent almost 18.0% of all healthcare-associated infections (HAI) in Intensive Care Units (ICU) across Europe [1]. It is therefore important that BSIs be diagnosed accurately.

Although novel, non-culture, methods for the detection of bacteraemia are evolving, blood cultures (BC) remain the gold standard against which all new methods are compared [2,3]. Timely and accurate reporting of microbiologic data from positive BCs improves clinical outcomes and reduces healthcare costs [4]. In fact, obtaining BCs before antibiotic administration is one of five elements of the "Hour-1 Bundle for initial resuscitation for sepsis and septic shock" [5]. Thus, BCs are among the most frequently performed and clinically important tests in microbiology. Unfortunately, contamination of BCs is a frequent problem, with reported rates ranging from 0.8% to 30% depending on the setting and other factors [6,7]. Blood culture contamination has multiple unwanted effects, such as additional unnecessary testing (i.e. to confirm the presence and to investigate the origin of the spurious BSI), increased antimicrobial exposure and inappropriate hospital admissions, leading to increased laboratory workload and healthcare cost [8,9]. Several interventions to reduce BCs contamination are supported by evidence, e.g. appropriate selection and preparation of venipuncture site, sterile technique during venipuncture and inoculation of blood in

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the BC vials, collection of appropriate blood volume and expedited transport to the laboratory [8,10]. Although there are relatively few studies on BC collection care bundles, they are suggested as a quality improvement intervention [11-14]. While the effectiveness of some care bundles, e.g. central venous catheter insertion and prevention, has been repeatedly confirmed in practice [15], Greece ranks above the 75th percentile of the EU/EE countries with 69.4 BC sets drawn per 1000 patient-days [16]. The success of care bundles is, at least in part, context-dependent, and requirements in terms of organizational culture and staffing are probably critical to successful care bundle implementation [17,18].Therefore, we designed this study to examine prospectively the effect of the implementation of a relevant care bundle on BCs contamination rates in our setting which was a high workload ICU, with high rates of BCs and limited experience on the implementation of care bundles..

2. Results

2.1. Patient Characteristics

2.2. Blood Culture Information

2.3. Contaminated and Indeterminate Blood Cultures

There were 314/1763 (17.8%) positive BC sets and 61/443 (13.8%) positive solitary BC vials. Of the 114 BC sets with a common commensal (5.2% of all BC sets), 36 (1.6%) were classified as CBC and 78 (3.5%) as IBC (see Table 2). Contamination rate decreased significantly after the intervention from 6.2% (29/464) to 1.3% (7/525), [Chi-square 16.98, p<0.0001, relative risk=0.21 (95% confidence interval 0.09-0.47)]. The proportion of indeterminate BC sets was also significantly lower in the POST phase [PRE 65/1210 (5.2%) vs 15/996 (1.5%), relative risk=0.28 (95% confidence interval 0.16-0.50), chi-square 21.93, p<0.001]. The contamination rate by pooling CBC and IBC sets, again it was lower for the POST phase [PRE 92/1210 (7.6%) vs 22/996 (2.2%), relative risk=0.28 (95% CI 0.17-0.50), chi-square 32.44 p<0.0001].

The duration of the study was relatively short for a robust interrupted time series analysis (ITS). However, a preliminary ITS analysis which included CBC and IBC sets, showed that there was a significant change in trend after the implementation of the intervention (from 1.38 to 0.47, difference -0.91, 95% CI -1.46 to -0.36, Figure 1). Supremum Wald test confirmed the presence of a change point in the series (p=6.03 x 10-9).

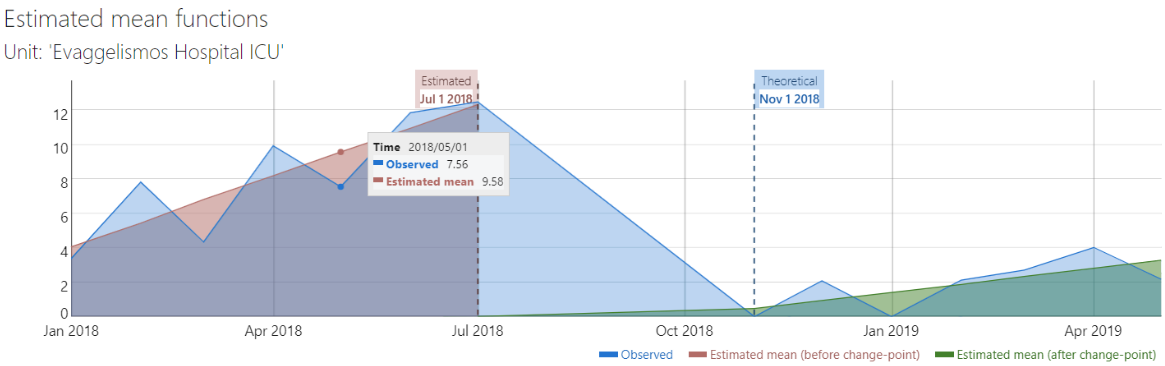

Figure 1. Interrupted time series analysis of contamination rate (including both CBC and IBC sets).

The incidence rate of CBC sets was significantly lower in the POST phase: 0.461 vs 0.154 BC sets per 100 ICU bed-days (Rate difference = -0,307, 95% confidence interval = -0.527 to -0,086). Indeterminate BC incidence rate was also significantly lower in the POST phase:1.00 vs 0.330 (Rate difference = -0.671, 95% confidence interval = -0.996 to -0.347).

Overall, CBC and IBC sets represented respectively 7.4% (36/489) and 16.0% (78/489) of BC sets yielding any microorganism (pathogen or commensal). The proportion of CBC sets was significantly lower in the POST phase: 29/308 (9.4%) vs 7/181 (3.9%), Chi-square 5.14, p=0.023. Similarly, the

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proportion of IBC sets was also lower in the POST phase: 63/308 (20.4%) vs 15/181 (8.3%), Chi-square 12.59, p=0.0004.

2.4. Quality Indicators

2.5. Care bundle Compliance

2.6. Factors Associated with BC Contamination

3. Discussion

4. Materials and Methods

4.1. Setting

4.2. Study Design

4.3. Inclusion / Exclusion Criteria

4.4. Data collection

4.5. Intervention: Care Bundle Implementation

4.6. Definitions and Outcomes

4.7. Statistical Analysis

5. Conclusions

The implementation of a BC care bundle was associated with a significant improvement in the BC contamination indicators as well as with improvement in almost all other BC collection quality indicators. It is noted that the poor baseline BC collection practices in the study ICU, suggests that this effect should not be expected across all settings. An important finding was the large number of indeterminate BC sets, which is associated with the respective proportion of single-set BC. Indeterminate BC sets may have an equal or a larger impact than CBC sets, and we suggest that they should be included in the BC collection quality indicators

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1,Table S1 – Table S8.

Author Contributions: Conceptualization, M.S., F.V. and A.K.; methodology, F.V., M.S.; software, M.S.; validation, M.S., and F.V.; formal analysis, M.S; investigation, F.V., X.X., P-M.V.; data curation, F.V., and P-M.V.; writing—original draft preparation, F.V.; writing—review and editing, M.S.; supervision, A.K. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Patient consent was waived because the study was part of a quality improvement initiative and only routinely generated data were collected.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to legal restrictions.

Conflicts of Interest: The authors declare no conflicts of interest.

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