Infants and Emergency Department Patients at Highest Risk for Blood Culture Contamination

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| Challenge | **Contaminated blood cultures result in unplanned health care reutilization, unnecessary antibiotic exposure and excess health care spending. The rates and risk factors of blood culture contamination (BCC) across age groups in children are not well understood.** |
| Existing Evidence | BCC leads to unnecessary healthcare utilization, including extra laboratory testing, imaging, emergency department encounters, hospital admissions, prolonged length of stay and unnecessary antibiotic exposure, with a profound impact on healthcare costs, estimated to be $5-7.5 billion annually in the United States. Unnecessary antimicrobial exposure contributes to resistance, infections such as C. difficile, immune dysregulation, intestinal dysbiosis, and increased risk of chronic diseases, including obesity and inflammatory bowel disease. The American Hospital Association benchmark for BCC is <1% of cultures. |
| Target Population | Pediatric patients of KPNC with blood cultures obtained from 2014-2022 in outpatient and hospital settings. |
| Exposure | Contaminated blood culture  |
| Key Findings | **Younger patient age and ED nurse draws were risk factors for contamination. Patients age 29-90 days have a BCC rate of 5.4%. Phlebotomists have lower odds of contamination than ER nurses for all ages and lower odds of contamination than inpatients nurses for patients older than 1 year.** Compared with cultures from children age 5 to 12 years, younger age groups had significantly higher odds of BCC, with patients age 29 to 90 days having the highest odds (OR: 5.66; 95% CI: 4.64-6.91). Compared with phlebotomists, ER collectors had higher odds of contamination (OR: 2.79; 95% CI: 2.47-3.15). Inpatient nurses had lower odds of contamination overall (OR: 0.83; 95% CI: 0.70-1.00, p-value=0.047), however, this is due to lower odds of contamination in infants only. Contrast analyses by collector across age group, and by age group across collector were conducted to examine potential interactions between age group and collector. Among phlebotomists, the odds of contamination were higher for younger patients compared with those age 5 to 12 years. Specifically, the odds were highest for newborns age 0 to 28 days (OR=10.5; 95% CI: 7.04-15.68) and age 29 to 90 days (OR=13.26 95% CI: 8.73-20.16). Similarly, ER collectors had higher odds of contamination in younger age groups compared with patients age 5 to 12 years, with the highest odds in patients age 0-28 days (OR=3.94; 95% CI: 2.98-5.20) and 29 to 90 days (OR=4.68; 95% CI: 3.64-6.02). Inpatient nurse collectors had lower odds of contamination in patients age 0 to 28 days, non-significant odds of contamination across older infants, and highest odds of contamination of patients age 1 to 18. Stratified by age group, ER collectors had significantly higher odds of contamination than phlebotomists for all ages with odds ratios ranging from 2.02 to 7.63. Inpatient nurses had lower odds of contamination in the 0 to 28 day age group (OR=0.36 95% CI; 0.28-0.46), no difference in odds in patients age 29 to 90 days or 91 days to 1 year, and significantly higher odds of contamination in patients older than 1 year.  |
| Resulting Action | **Consider targeted training for infant blood draws, particularly for phlebotomists and ER nurses, and increasing phlebotomy staffing for blood culture draws.**  We identified quality improvement opportunities via training and staffing changes to improve the accuracy and reliability of blood cultures, which will improve patient care and resource utilization. We have also laid the groundwork for analyzing the cost of reutilization associated with contaminated blood cultures.  |
| Additional Recommendations | Manuscript in final stages of preparation for submission to high-impact medical journal |
| Implementation Tools | Training courses and increased phlebotomy blood culture draws  |
| Implementation Measurement | Follow up data analysis of blood culture contamination  |
| Reference |

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|   **Table 1. Contamination Rates by Patient Age, Collector, and Clinical Location**

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| --- | --- | --- | --- | --- | --- | --- |
| **Patient Age**  | **Contaminants**  | **True Positives**  | **Total Positive Cultures**  | **Total Blood cultures**  | **Contamination Rate: Positive Cultures**  | **Contamination Rate: Total Cultures**  |
| 0-28 days  | 407  | 229  | 636  | 20,507  | 64.0%  | 2.0%  |
| 29-90 days  | 286  | 150  | 436  | 53,17  | 65.6%  | 5.4%  |
| 90 days to 1 year  | 219  | 185  | 404  | 80,98  | 54.2%  | 2.7%  |
| 1 to 3 years  | 256  | 120  | 376  | 13,885  | 68.1%  | 1.8%  |
| 3 to 5 years  | 113  | 90  | 203  | 7,675  | 55.7%  | 1.5%  |
| 5 to 12 years  | 156  | 292  | 448  | 16,845  | 34.8%  | 0.9%  |
| 12 to 17 years  | 157  | 379  | 536  | 17,621  | 29.3%  | 0.9%  |
| Total  | 1,594  | 1,445  | 3,039  | 89,948  | 52.5%  | 1.8%  |
|   |   |   |   |   |   |   |
| **Collector**  | **Contaminants**  | **True Positives**  | **Total Positive Cultures**  | **Total Blood cultures**  | **Contamination Rate: Positive Cultures**  | **Contamination Rate: Total Cultures**  |
| Nurse  | 257  | 239  | 496  | 18,965  | 51.8%  | 1.4%  |
| Phlebotomist  | 477  | 590  | 1,067  | 41,604  | 44.7%  | 1.1%  |
| ER Nurse  | 856  | 599  | 1,455  | 28,801  | 58.8%  | 3.0%  |
| Other  | 4  | 17  | 21  | 578  | 19.0%  | 0.7%  |
| Total  | 1,594  | 1,445  | 3,039  | 89,948  | 52.5%  | 1.8%  |
|   |   |   |   |   |   |   |
| **Clinical Location**  | **Contaminants**  | **True Positives**  | **Total Positive Cultures**  | **Total Blood cultures**  | **Contamination Rate: Positive Cultures**  | **Contamination Rate: Total Cultures**  |
| Outpatient  |  143   |  239   |  382   |  22,409   | 37.4%  | 0.6%  |
| Emergency Dept  |  1,109   |  756   |  1,865   |  42,749   | 59.5%  | 2.6%  |
| Observation  |  28   |  22   |  50   |  1,029   | 56.0%  | 2.7%  |
| Inpatient  |  314   |  428   |  742   |  23,761   | 42.3%  | 1.3%  |
| Total  |  1,594   |  1,445   |  3,039   |  89,948   | 52.5%  | 1.8%  |

**Table 2. Odds of Contamination from Mixed Methods Multivariable Logistic Regression**  |
| **Characteristic**  | **OR**  | **95% CI**  | **p-value**  |
| **Patient Age**  |    |    |    |
|      5 to 12 Years (Reference)  | —  | —  |   |
|     0 to 28 Days  | 3.53  | 2.88, 4.33  | <0.001  |
|     29 to 90 Days  | 5.66  | 4.64, 6.91  | <0.001  |
|     91 Days to 1 Year  | 2.83  | 2.30, 3.49  | <0.001  |
|     1 to 3 Years  | 1.97  | 1.61, 2.41  | <0.001  |
|     3 to 5 Years  | 1.61  | 1.26, 2.05  | <0.001  |
|     12 to 18 Years  | 0.88  | 0.70, 1.10  | 0.3  |

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