24 Hour Patterns of Vital Signs as Predictors of Blood Infection in Pediatric Burn Patients

Munoz, E.M., M.Acc.; Weber, J., R.N., C.I.C.; Lydon, M., R.N., B.S. ; Uygun, K., Ph.D.; Sheridan, R., M.D.

Shriners Hospitals for Children – Boston, Boston, MA; Massachusetts General Hospital, Boston, MA

BACKGROUND

Hypermetabolism of both burn injury and infection are difficult to distinguish. Infection is a leader of death and hospital costs.

An Exemplar of Patient Burden

Blood Draws
- Need for more manpower and trauma for patients without CVLs

Time Lag
- 3 days to speciation

Too Little Too Late
- Delays in treatment increase risk of death

Added Costs
- Financial and physical, longer hospitalization

A timely and accurate predictor of infection is paramount.

METHODS

In a retrospective study, we performed data mining on 100 pediatric burn patients, with an average 659 distinct time-points, and 3 blood cultures per patient, on pediatric burn patients admitted to Shriners Hospital for Children – Boston (SHC) Acute Care Unit (ACU).

RESULTS

Using a combination of vital signs to predict infection yields 95% sensitivity, 94% specificity and accuracy within 24 hours.

Corollary to vital sign analyses, we organized infectious agents by prevalence and healthcare-associated infections.

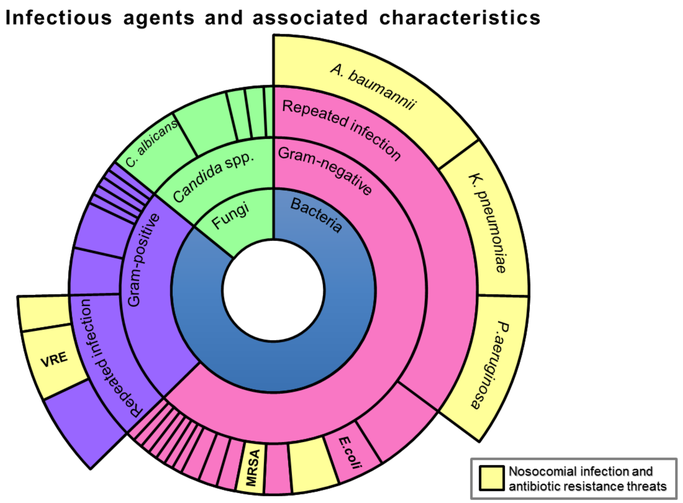

Figure 1. Infectious agents and associated characteristics

The most common infectious agents are characterized as both gram-negative bacteria and nosocomial infections.

Table 1. Predictive Measures Using 1 or more MAP dips and 2 or more fever spikes or 2 or more HR spikes in 24 hours

Using 1 ≤ MAP Dips and 2 ≤ Fever Spikes or 2 ≤ HR spikes in 24 hours				
	T = 0 to 24 hours			
Predictive Metric	Fever Spike Only	MAP Dip Only	HR Spike Only	Combination
True Positive Rate (Sensitivity)	68%	58%	92%	95%
True Negative Rate (Specificity)	94%	71%	41%	94%
Positive Predictive Value (Precision)	90%	59%	54%	92%
Negative Predictive Value	80%	69%	88%	96%
False Positive Rate	6%	29%	59%	6%
False Negative Rate	32%	42%	8%	5%
False Discovery Rate	10%	41%	46%	8%
Accuracy	83%	65%	63%	94%
F1 Score	78%	59%	68%	94%
Informedness	0.63	0.28	0.33	0.89
Markedness	0.70	0.29	0.41	0.88
Matthews Correlation Coefficient (MC	0.66	0.29	0.37	0.89

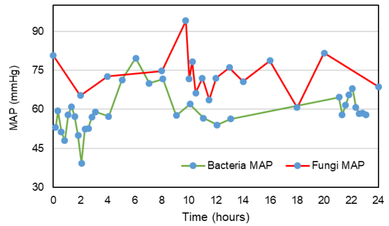

Figure 2. Vital Sign Patterns Show Difference in Infection Type within 24 hours

Individual patient charts show bacteremia patients exhibit more MAP dips and overall hypotensive events when compared to fungal infection.

MAIN FINDINGS

When compared to negative blood culture patients, positive blood culture patients:
- Had higher average temperatures and higher HR in 24 hours
- Had more fever spikes, more HR spikes, and more MAP dips in 24 hours

When compared to fungemia patients, bacteremia patients:
- Had more MAP dips within 24 hours

When compared to GPB, other infectious organisms (GNB and fungi):
- Had more fever spikes and HR spikes in 24 hours

DISCUSSION

Dynamic analysis of time-trends in vital signs have the potential to predict blood infection before the culture results are available. The study found that patients with blood infection have more fever spikes, HR spikes, and MAP dips. Additionally, the type of infectious organism may be predicted based on time-trends in vital signs. Timely and accurate prediction of blood infection can improve clinical care, patient outcomes, and lower healthcare costs.

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Poster, J., B.A.; Chu, C., B.S.

REFERNCES
CDC. (2019). Antibiotic resistance threats in the United States.

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