Sepsis Insight and Management Platform (SIMPL): Utilizing Comorbidity Subgroups For Enhanced ICU Patient Care

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- 1. Medical Dashboard
- 2. About the group
- 3. GitHub Repository



ABSTRACT

Sepsis is the leading cause of deaths in the ICU, highlighting a significant deficiency in the incorporation of medical history in current sepsis care protocols. Working with stakeholders, along with building upon the insights from Zador et al. (2019), which challenges the current diagnostic system, we decided to create a comprehensive sepsis risk assessment dashboard that capitalizes on our new insights relating to comorbidity, or disease composition.

VISUALIZATIONS



Selected Vitals Signs (based on UCSD Health):

- Blood Pressure - Temperature (°F)
- White Blood Cell Count - Heart Rate
- Respiratory Rate Oxygen saturation

Sepsis is diagnosed when the presence of two or more positive Systemic Inflammatory Response Syndrome (SIRS) criteria, which are as follows:

- Temperature > 100.9°F or 96.8°F
- Heart Rate > 90 bpm
- Respiratory Rate > 20 bpm
- White Blood Cell Count > 12,000 or < 4,000 or 10% bands
- + With suspected Source of Infections.

STATISTICAL ANALYSIS

Patient Group Analysis Cardiopulmonary Group Likelihood: 83% Our automated analysis is 83% confident this patient belongs in the Cardiopulmonary subgroup. This is taken into account for our sepsis risk analysis.

Latent Class Analysis (LCA): A clustering model for multivariate discrete data

- Age (16+)
- Admission Types (Elective, Emergency)
- 30 Elixhauser Comorbidity Index

By choosing the lowest AIC and BIC, 7 latent groups are identified.

- Cardiopulmonary
- Complicated diabetics
- Cardiac
- Uncomplicated diabetics
- Young

- Hepatic/addiction - UNKNOWN

Select a Disease: Congestive Heart Failure This patient is in the Cardiopulmonary group, and the following comorbidities have been found to be highly correlated with congestive heart failure: - Cardiac Arrhythmias - Valvular Disease - Hypertension - Chronic Pulmonary Conditions - Complicated Diabetes - Renal Failure Coagulopathy

Logistic Regression: A statistical model for predicting categorical variables dependency on other variables

The statistical association ($P \le 0.01$) between various diseases within specific groups, allowing us to efficiently inform healthcare professionals about potential comorbidities in patients based on their group classifications.

DASHBOARD INFO

The dashboard incorporates HTML, Tailwind CSS, JavaScript, and Tableau.

- Simple and quick view of important Just In Time information
- Dynamic visualization of relevant vitals and subgroup data

MACHINE LEARNING

Random Forest Classifier Features:

- 1. Vital signs: temperature, blood pressure, heart rate, oxygen level, respiratory rate
- 2. Comorbidity groups to which the patients belong
- 3. Number of readmissions, Hours in the Hospital per Admission, Age

The model predicts the sepsis risk score category for each patient and assigns a color-coded flag based on the predicted score range.

Color Flags Explanation:

- RED: Severe Risk indicates that patients need consistent and immediate attention. SOFA score between [12, 24] inclusive
- YELLOW: Mid Risk suggests that patients require regular monitoring and potential intervention. SOFA score between [5,11] inclusive
- GREEN: Low Risk signifies that patients are currently stable but should continue to be observed for any changes. SOFA score between [0, 4] inclusive

Our model, while not highly accurate at approximately 60 - 80% per subgroup, is designed to be explainable, allowing doctors to understand the basis for each prediction.

Sepsis Risk Alert

Red Flag - Severe Risk

This patient has been identified as at severe risk for developing sepsis.

According to our Random Forest Classifier-based machine learning algorithm, this patient has been classified as having a high (red flag) risk of developing sepsis. This classification is based on an analysis of the patient's vital signs (temperature, blood pressure, heart rate, oxygen level, respiratory rate) and existing comorbidities, along with factors such as number of readmissions, hours in the hospital per admission, and age. The predicted SOFA score range for this category is between 12 and 24, inclusive.

Immediate and consistent attention is required. Please initiate emergency procedures, conduct a comprehensive review of the patient's medical records, and prepare for potential intensive care intervention. This condition demands prompt action to prevent critical outcomes.

SOFA Score

Measurement					
	0	1	2	3	4
Respiration	Normal	<400	<300	<200	<100
PaO ₂ /FiO ₂ ,				(with respiratory	(with respiratory
mmHg				support)	support)
Coagulation	Normal	<150	<100	<50	<20
Platelets					
x10 ³ /mm ³					
Liver	Normal	1.2-1.9	2.0-5.9	6.0-11.9	>12.0
Bilirubin, mg/dL		(20-32)	(33-101)	(102-204)	(<204)
(μmol/l)					
Cardiovascular	Normal	MAP<70	Dopamine <u><</u> 5 or	Dopamine >5 or	Dopamine >15 or
Hypotension		mmHg	dobutamine (any	epinephrine ≤0.1 or	epinephrine >0.1 or
			dose)**	norepinephrine <0.1	norepinephrine >0.1
Central Nervous	Normal	13-14	10-12	6-9	<6
System					
Glasgow Coma					
Score					
Renal	Normal	1.2-1.9	2.0-3.4	3.5-4.9	>5.0
Creatinine,		(110-170)	(171-299)	(300-440)	(>440)
mg/dL (µmol/l)				or <500 mL/day	or <200 mL/day
or					
Urine output					

RESULTS

Organ System,

With the model using the general UCSD Health Protocol using just vitals:

- Sepsis Model (All Patients): 50%
- With the model using general UCSD Health Protocol using vitals + comorbidity:
- Subgroup Specific Model: 60-80%