IMPROVING IDENTIFICATION OF INPATIENT SEPSIS AFTER ADMISSION

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Background

Early sepsis identification in the hospital can improve outcomes with early resuscitation and antibiotic administration. While ~80% of sepsis is identified early in the emergency room or on admission, identification of additional transitions to sepsis physiology during inpatient stays is an important safety metric, with clinical care guidelines audited according to Joint Commission(JC) SEP-1 standards. To improve patient safety and monitor consistency of care for a potential deadly condition, PCCI, in collaboration with Parkland Health & Hospital System, tested and trained a locally derived model and compared the model against available alternatives for a trigger of decision support alerts.

Aims

- Develop a clinical predictive model to predict inpatient sepsis not being treated on admission with antibiotics
- Implement the model as clinical decision support as a popup Best Practice Alert (BPA) for Inpatient medicine service line with tailored content for the primary physician team and primary RN

Methods

Retrospective Model Development
Training, testing and validation cohorts of inpatient admissions for select medicine service lines were extracted and selected based on meeting Joint Commission Sepsis billing criteria with sepsis ICD10-CM codes being flagged as 'Not Present on Admission' and not receiving antibiotics from the recommended antibiotics list within the first 12 hours of admission from 2017-2018. Data sets were collected for clinical predictive features from 24-hour time periods before the first antibiotic administration or the discharge date when no antibiotics were delivered. Models were trained using logistic regression, XGBoost and ANN algorithms in R(v 3.5) and the DataRobot platforms. Data required to develop and evaluate the model include individual/admission level data, MRN, admissions, discharge, transfers, treatment teams, patient locations, payer type, demographics, prior admission ICD10 codes for prior 2 years, vital flowsheets, laboratory result data, medication administration and charge data.

Production Silent Validation
The model was implemented using API access to clinical data accessed every 15 minutes using API data in Isthmus^{SM} (a HIPAA compliant cloud computing environment). To verify that performance was maintained in the production data extraction environment and timeframes, the model was implemented and run in a "silent-mode" during 2019. Planned implementation in January 2020 was interrupted by the COVID19 pandemic planning, and performance was re-evaluated for performance with a higher prevalence of viral pneumonia.

Clinical Workflow

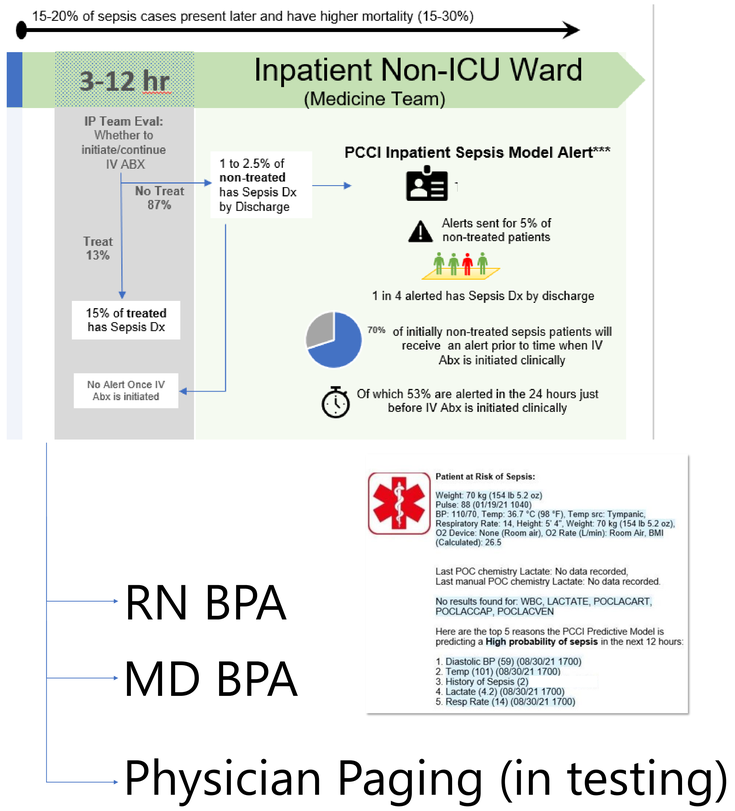


Figure 1. Schematic patient flow and workflow of the clinical decision support for inpatient medicine sepsis detection

Results

Model Performance Statistics

Metric	Model Green	Model Purple
Threshold	40	0.89
Accuracy (TP+TN/All)	0.84	0.85
Precision (PPV) (TP/TP+FP)	0.31	0.34
Sensitivity (TPR) (TP/TP+FN)	0.54	0.57

Table 1.

Model performance was compared in the same patient encounters against available retrospective data for an EHR-based model. The locally-trained model had superior performance characteristics on selected key metrics of sensitivity and PPV. Although both models performed above minimal target PPV of 14%, the local model fired on average 19 hours before typical antibiotic administration compared to 1.5 hours for the EHR model. The Governance committee selected the local model.

Pilot Performance

Two pilot units were selected by the project team on wards principally housing Hospitalist patients.

In first 8 weeks of Pilot:
- 42 patients were above selected threshold
- 27 Highs Alerts Fired, 15 Medication Suppressed
  - 35% Medication Alert Suppression
- 18 True Sepsis
  - 5 septic shock, 3 severe sepsis, 10 general sepsis
- 13/27 True Sepsis (BPA)
- Precision: 32.5% ~1 True sepsis patient per 3 alerts
- Sensitivity : 48.5% Percent of Sepsis patients identified

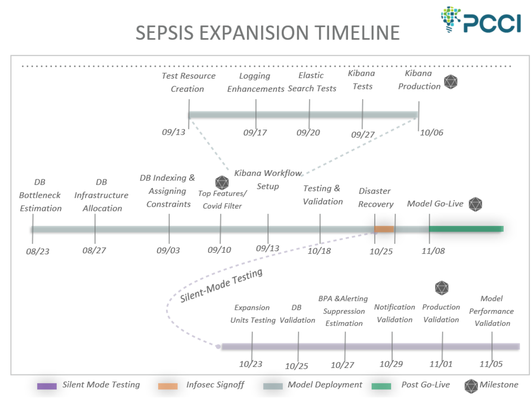
Based on acceptable performance of the model during the 8-week pilot phase, the care model was approved to expand to 8 additional hospital wards in October 2021 after the next major EPIC EHR Upgrade. Upon chart review, a small percentage of the false positive alerts were found to be in COVID19 patients. Retrospective reporting showed that in admissions with COVID19 PCR testing, empiric antibiotics were added typically after a mean of 10 days (range:8-30) from the initial test result.

Planned enhancements to be tested prior to the upgrade include a filter to suppress alerts during the first 10 days after a positive COVID19 result, adding the top 5 clinical predictors to the BPA display for clinical transparency and forwarding a page to the first-call provider for the physician team.

Conclusions

- Patient monitoring for sepsis developing in the hospital is effective. Detecting half of sepsis not being treated without antibiotics
- Medication filtering reduced unnecessary alerts 35%
- Training on the administration of antibiotics allows for the model to alert on average 19 hours before routine antibiotic administration
- Suppression of alerting within 10 days of a positive COVID19 test allows for expansion in a setting of a possible rising autumn COVID burden

Next Steps



- Expand sepsis coverage to all medicine teams
- Interface alerts with automated paging system
- Monitor model performance, user acceptance and safety metrics with governance committee of Nursing, Physician and Informatics teams
- Evaluate role of Sepsis coordinator to help improve bundle compliance

Acknowledgement

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