BAYESIAN HEALTH

Enabling Intelligent Care Augmentation at the Bedside

BAYESIAN'S ADAPTIVE AI APPLIED TO SEPSIS

Sepsis has been hard to solve in a sustained way because it is a "needle in a haystack"

- **Early detection is challenging but crucial**
- **Inaccurate results lead to low provider adoption**
- **Low quality alerts lead to fatigue**
- **Lack infrastructure for learning, improving over time**

Solving for sepsis is a crucial step in improving quality and patient safety—and it's achievable by leveraging Bayesian's platform.

Bayesian's platform leverages state-of-the-art, adaptive artificial intelligence, machine learning and behavior change science strategies to:

1. **Surface actionable & timely critical insights** amplifying a caregiver's capacity to evaluate and mediate risk
2. **Provide precise, patient-specific insights** in the EMR that empower proactive provider decision-making
3. **Continually optimize for performance**, provider use and outcomes that reduce mortality and morbidity

BAYESIAN INSIGHTS

Based on decades of research in the field, Bayesian's adaptive AI alerts providers of potential critical events, amplifying a caregiver's capacity to evaluate and mediate risk across the entire patient population. Contrasted against a typical BPA, Bayesian's flags are 300-700% more precise, resulting in fewer false alarms, reduced alarm fatigue and increased provider trust.

PRECISE
Patient-specific, targeted

TIMELY
Flags arrive with clinically meaningful lead time

RELIABLE
Rigorously tested, proven

SAFE
Structured to reduce bias and false flags

ACTIONABLE
Context accompanies every flag for transparency

CHALLENGES WITH CURRENTLY DEPLOYED MODELS

Unlike other approaches for clinical decision support (CDS), Bayesian's approach to modeling risk does not employ a static, rule-based logic framework to generate alerts. It also doesn't employ single, large, monolithic deep learning models due to their lack of transparency.

While these models have shown significant success in imaging applications, their use in analyzing multimodal health data has lagged.

Multimodal data have many more sources of noise and bias, and learning from it requires exponentially more highly-curated datasets that are rarely available. In the presence of limited data, it is much easier for these models to learn spurious, nonsensical correlations that are not actionable for the frontline clinicians.

Additionally, performance for these models is much more likely to deteriorate as they are moved from the site where it was originally developed to other sites.

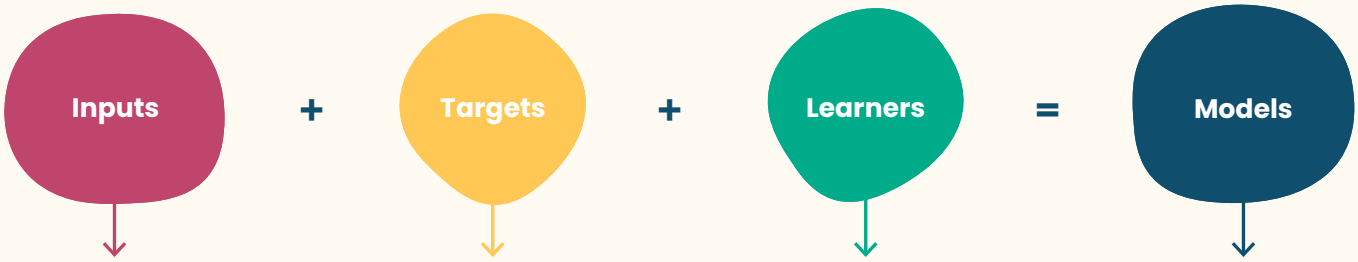
Further, due to the "black box" nature of deep learning models, meaning that their architecture and learning models are closed and difficult to interrogate, it is harder for frontline users to build trust with it.

Likewise, traditional BPAs have resulted in provider alarm fatigue, due to a lack of model precision and sensitivity. This is because the models deployed use limited inputs, incomplete targets such as billing codes and simple learners. Contrasted against a typical BPA, the flags are 300-700% more precise, resulting in fewer false alarms, reduced alarm fatigue, and increased trust.

BAYESIAN'S PRECISE, TIMELY, AND RELIABLE FLAGS

Bayesian's state-of-the-art machine learning strategies enable the platform to adapt to the heterogeneity in population and symptom profile common in sepsis, reducing false alerts, empowering proactive treatment and driving contiuous improvement.

1. Ingests and leverages structured and unstructured data;
2. Has a flexible framework for ingesting new sources; and
3. Uses best-in-class target identification algorithms and learners to create accurate, precise, and specific models.



Structured and unstructured data; can incorporate new data sources

Uses high quality clinical-grade phenotypes

Learner uses multiple strategies (inc. problem-specific) to tackle data complexity and unique clinical areas

Resulting models are accurate, precise and actionable

This framework is backed by 24 patents and peer reviewed publications in leading technical and clinical journals, such as:

1. A targeted real-time early warning score (TREWScore) for septic shock
2. Comparison of Automated Sepsis Identification Methods and Electronic Health Record-based Sepsis Phenotyping
3. Scalable Joint Models for Reliable Uncertainty-Aware Event Prediction

A DEEP DIVE ON BAYESIAN'S FLAGS

Patient with Sepsis

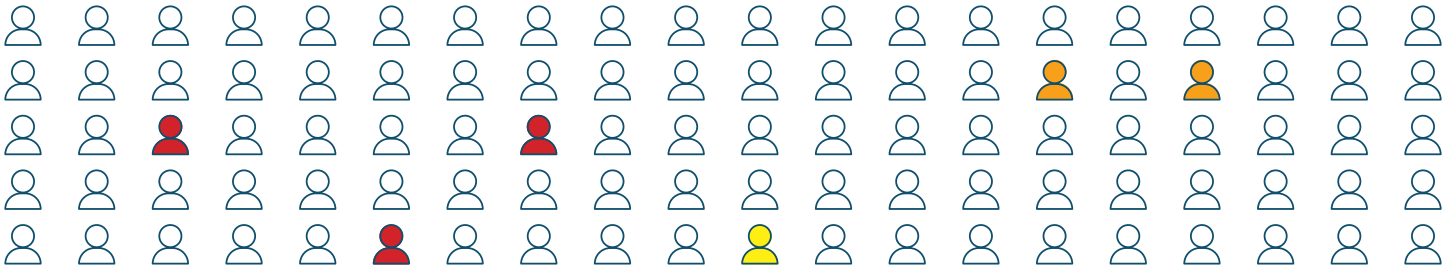
Patient developing Sepsis

Patient likely to have Sepsis

Alerted/flagged patient

What does this look like in practice?

In a typical population of 100 patients, there are six patients who are at various stages of developing sepsis.

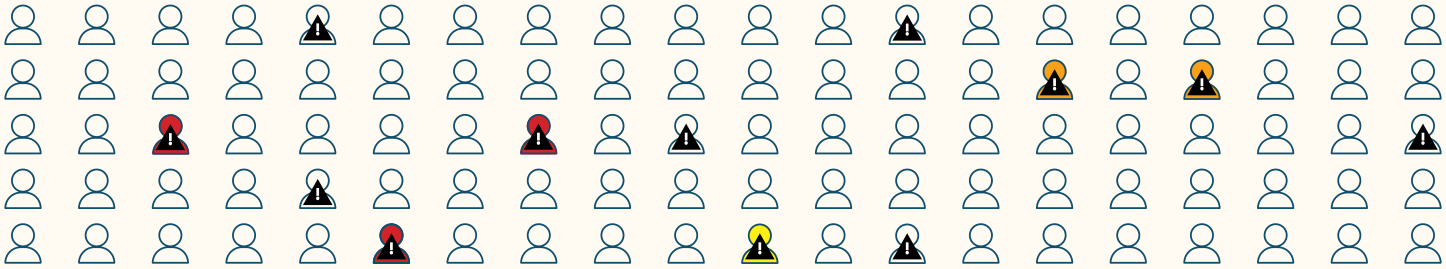


To catch only the two most severe patients, Epic would alarm on 40 patients.
That means 38 false alarms, even while missing the patients developing sepsis (0.63 AUC).

EPIC

IN CONTRAST, BAYESIAN WOULD FLAG ONLY 12 TOTAL PATIENTS, CATCHING THOSE AT RISK OF DEVELOPING SEPSIS, IN ADDITION TO THOSE ALREADY WITH SEPSIS (0.97 AUC).

BAYESIAN



Because Bayesian's models are also tuned for timeliness, the platform is able to catch cases of sepsis significantly earlier, allowing a provider the ability to intervene and provide critical care earlier. Each flag is also accompanied by context so that a provider can see the clinical indicators that lead to each flag, helping them to make better decisions, faster. The insights also guide providers to actionable next steps, and help ensure compliance with 3- and 6-hour sepsis bundles.

PROVIDER, PATIENT, & SYSTEM VALUE

Increases provider effectiveness, efficiency

- Second set of eyes and ears for provider; enables reliable care coordination
- Complete clinical context accompanies flags so provider can quickly do case review and make faster care decisions
- Workflow guides nurse/provider assessment and tracks compliance with 3-hour and 6-hour sepsis bundles
- Platform sits within the EMR so experience is seamless (more time at the bedside)

Improves outcomes, provides financial ROI

- Significantly reduces mortality
- Increases ability to treat sepsis before it develops
- Reduces readmissions, length of stay, days on supportive therapies
- Improves patient experience
- Increases compliance with sepsis bundle; reduces penalties

BAYESIAN'S END-TO-END PERFORMANCE OPTIMIZATION PROGRAM SECURES BUY-IN, ADOPTION, AND CONTINUED ENGAGEMENT—AND ENABLES THE PLATFORM TO PROVIDE SUSTAINED RESULTS—THROUGH:

1. Site-specific launch service

Stakeholder alignment on goals & success metrics; deep clinical discovery process; and site specific rollout

2. Performance monitoring engine

Multi-level monitoring and analysis, from tracking key metrics to automated case abstraction to enable scalable, efficient case review for QI and coding

3. Gap identification & optimization support

Find and implement actionable improvement strategies such as targeted education; ways to optimize and refine bundles; methods to improve billing & coding

RESULTS FROM THE BAYESIAN PLATFORM APPLIED TO SEPSIS*:

In July 2022, Bayesian and Johns Hopkins University released three large, prospective multisite cohort studies using data from 643,350 patients (13,663 with sepsis) across five hospitals in both academic and community-based hospital settings with 2,000+ providers using Bayesian's sepsis module over a prolonged sustained period of 2.5 years.

This research shows accurate early detection (1 in 3 cases were physician confirmed) at high sensitivity (82%) and significant lead time (5.7 hours earlier), high provider adoption (89%), and associated significant reductions in sepsis mortality by 19%

lead time
5.7 hours
earlier treatment for sepsis

sensitivity
82%
High sensitivity of sepsis cases identified

adoption
89%
sustained frontline user adoption

mortality
19%
relative reduction in sepsis mortality

Adams, Henry, Saria et al. Nature Medicine, 2022

BAYESIAN HEALTH HELPS HEALTH SYSTEMS UNLOCK CLINICAL AND FINANCIAL OUTCOMES AT SCALE
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