# Evaluating Predictive Analytics to Support Suicide-Risk Surveillance of Inpatients

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## TAKE-HOME

- **Dynamic clinical changes contain useful short-term signal, but rare-event precision is too low for automated alerting.**
- **The more promising application is interpretable surveillance that strengthens clinical situational awareness.**

## BACKGROUND & AIM

**Can routinely collected inpatient data identify changing short-term suicide risk — and which signals are useful for operational monitoring?**

We were asked to integrate clinical data & administrative data, engineer dynamic indicators, and predict a suicidality-related STRIDES event within the subsequent 24 hours.

**Measures: AUROC • precision/recall • feature importance • subgroup performance**

## FOUR COHORTS

**23,316**

inpatients, June 2016 – Dec 2024

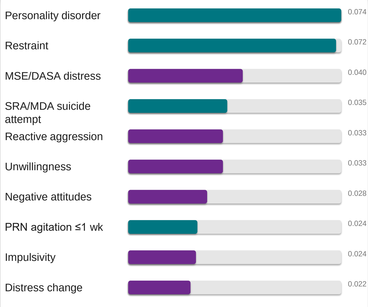
| | |
|---|---|
| **168** **Suicidality** (180 observations) | **471** **Self-harm only** |
| **584** SSH (suicidality or self harm); **shifted reference time** | **22,677** **No** SSH-related STRIDES |

## DATA → FEATURES → MODEL

| | |
|---|---|
| **21 warehouse views** | hospitalization • diagnoses • SRA/MDA • MSE (mental status exam) • DASA (aggression assessment) • sleep • medication • demographics |
| **58 candidate indicators** | levels • history • recent changes • contextual variables |
| **Random forest** | four-class Model 1 + binary Model 2 |
| **24-hour horizon** | suicidality-related event vs comparator observations |

## SELECTED PREDICTIVE SIGNALS

**Model 1 feature importance (selected top features)**



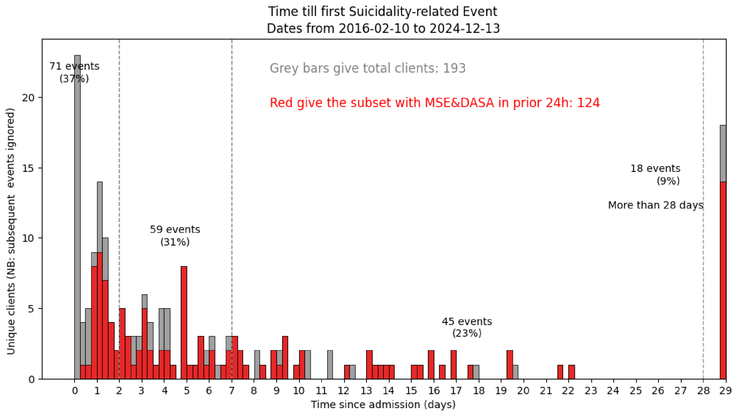

***Prior STRIDES self-harm*** *ranked highest in Model 1 initially, but sensitivity analysis showed that its importance was partly driven by cohort construction; removing prior-event/restraint variables changed AUROC by <1 percentage point.*

***MSE/DASA distress*** *is a composite count of indicators of psychological and behavioural distress, including agitation, aggression, negative affect, disorganized thinking, and perceptual disturbances, offset by indicators of normal or positive functioning.*

*Disclaimer: Not a validated clinical prediction tool.*

## WHEN DID FIRST EVENTS OCCUR?

**Many first events occurred early after admission**




*Grey: all clients (n=193). Red: subset with MSE & DASA in the prior 24 h (n=124). Subsequent events ignored.*
*MSE: Mental Status Examination. DASA: Dynamic Appraisal of Situation Aggression*

**Transition-of-care signal: the first ~36 hours are important; MSE/DASA data are generally available from ~18 hours after admission.**

## MODEL PERFORMANCE

| **0.83** | **0.89** |
|---|---|
| **Model 1 AUROC** | **Model 2 AUROC** |

**At ~90% recall** **precision falls to single digits**

→ most alerts would be false positives in a deployment-like class balance.

**Yet >20% of event observations appeared comparatively easy to identify, at >80% model precision.**

## WHY AUROC WASN'T ENOUGH

**Rare-event problem**

A model can rank cases well overall (high AUROC) and still generate too many false positives when the event is uncommon. For a clinical alert, precision–recall therefore matters more than discrimination alone.

**Operational conclusion: do not deploy the present model as an automated imminent-suicide alert.**

## EQUITY CHECK

**Test-set performance by race and gender**

| Group | Accuracy | Precision | Recall | F1 |
|---|---|---|---|---|
| White | .795 | .511 | .829 | .633 |
| Other race | .853 | .595 | .825 | .691 |
| Man | .870 | .609 | .812 | .696 |
| Woman | .782 | .486 | .831 | .614 |
| Other gender | .732 | .607 | 1.000 | .756 |

*Recall was similar for White versus other-race groups and for men vs women; subgroup sample sizes differ, so this is a performance check rather than proof of equity.*

## FROM PREDICTION TO SURVEILLANCE

**A dashboard can help without assigning an "imminent suicidality" classification.**

- Show 4 to 6 interpretable contributors for each client.
- Link every signal to its source MSE, DASA, SRA or medication record.
- Emphasize baseline-aware change, not just absolute level.
- Support team annotations and disagreement.
- Use the model to surface information — not to replace clinical risk assessment.

## EXAMPLE PER-CLIENT SIGNALS

1. **Personality disorder + PRN for agitation in past week**
2. **New MSE: negative attitudes + reactive aggression**
3. **SRA: suicide attempt + DASA: distress**
4. **Antidepressant started in past fortnight + reactive aggression**

## LESSONS LEARNED

- Dynamic MSE/DASA indicators were substantially more informative than demographic characteristics.
- Strong discrimination does not guarantee operational usefulness in a low-prevalence setting.
- The model is better suited to interpretable surveillance signals than automated alerts.
- Early admission is an important monitoring window, but time-since-admission itself had low model importance.
- Feature creation took seconds per client on a standard CAMH laptop, supporting technical feasibility.

## NEXT STEPS

**Prototype & test surveillance concepts prospectively with clinicians before considering any escalation workflow.**

**Focus on clinically actionable change, provenance, team interpretation and unintended equity effects.**

**Indigenous clients are an important population for future equity-focused evaluation.**

## ACKNOWLEDGEMENTS & NOTES

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- CAMH Suicide Prevention Expert Group (SPEG),
- Data & Insights Team, and
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**Project period**

**September 2024 – October 2025**

**Why this matters**

**The work connects data & technology with patient safety and advancement of care: using existing clinical data to make changing risk more visible without overclaiming what prediction can do.**

CAMH is situated on lands occupied by First Nations for millennia. Toronto is covered by the Toronto Purchase, Treaty No. 13 of 1805 with the Mississaugas of the Credit, and is home to diverse First Nations, Inuit and Métis peoples. CAMH is committed to reconciliation.

**GLOSSARY**

- **AUROC** Area Under the Receiver Operating Characteristic Curve
- **CAMH** Centre for Addiction and Mental Health
- **CQuIPS** Centre for Quality Improvement and Patient Safety
- **DASA** Dynamic Appraisal of Situational Aggression (routine nurse-completed assessment)
- **F1** Harmonic mean of precision and recall
- **MDA** Multidisciplinary Assessment (performed in CAMH's emergency department)
- **MSE** Mental Status Examination
- **PRN** Pro Re Nata ('as needed' medication)
- **SRA** Suicide Risk Assessment
- **SSH** Suicidality or Self-Harm (abbreviation specific to this QI project).
- **STRIDES** Systematic Tracking & Review of Incidents: Disclosure for the Enhancement of Safety (The CAMH incident-reporting system)