

Session #C02

Emerging Data-Driven Approaches in the Detection of Suicidal Ideation: Insights from a Digital Behavioral Health Platform

Amanda Brooks, LCSW, CADC
Director of Clinical Growth and Strategy
NeuroFlow



Faculty Disclosure

The presenters of this session currently have or have had the following relevant financial relationships (in any amount) during the past 12 months.

- Employee and equity shareholder, NeuroFlow



Conference Resources

Slides and handouts, shared by our conference presenters,
are available on the conference mobile app.

Learning Objectives

At the conclusion of this session, the participant will be able to:

- Understand the scale and scope of America's suicide crisis, with an emphasis on social vulnerability and widespread psychiatric shortages
- Assess the benefits and challenges of in-clinic screenings for suicidal ideation (SI)
- Evaluate the potential for asynchronous digital behavioral health (dBH) technologies to augment these approaches

Mental Health and Suicide Landscape

Suicide is a Public Health Crisis

- **3.5M** Americans made a suicide plan in 2021²
- **1.7M** attempted suicide²
- **>49K** U.S. suicides in 2022¹
- A leading cause of death for most age groups (*right, 2022 data*)³

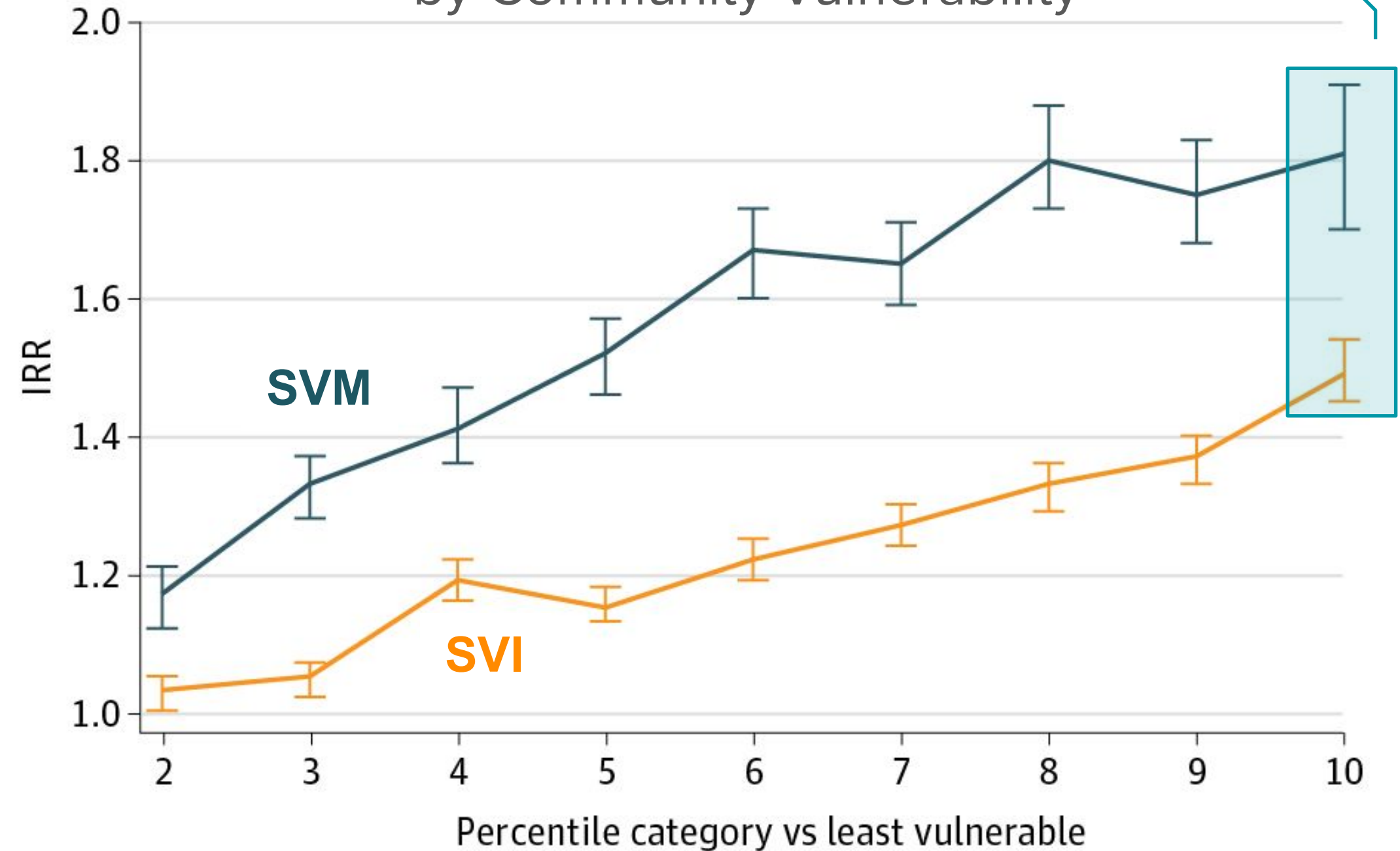
10 Leading Causes of Death, United States					
2022, Both sexes, All races, Ages 10-64					
10-14	15-24	25-34	35-44	45-54	55-64
Unintentional Injury 926	Unintentional Injury 14,669	Unintentional Injury 33,058	Unintentional Injury 36,972	Malignant Neoplasms 33,363	Malignant Neoplasms 105,133
Suicide 493	Homicide 6,262	Suicide 8,663	Diseases of Heart 12,258	Diseases of Heart 32,398	Diseases of Heart 85,733
Malignant Neoplasms 442	Suicide 6,040	Homicide 6,712	Malignant Neoplasms 11,177	Unintentional Injury 31,394	Unintentional Injury 34,017
Homicide 366	Malignant Neoplasms 1,421	Diseases of Heart 3,789	Suicide 8,185	COVID-19 9,628	COVID-19 24,252
Congenital Anomalies 205	Diseases of Heart 848	Malignant Neoplasms 3,641	Liver Disease 5,501	Liver Disease 9,401	Diabetes 17,410
Diseases of Heart 145	COVID-19 447	Liver Disease 1,786	Homicide 4,765	Suicide 7,781	Chronic Low Respiratory Diseases 17,138
COVID-19 69	Congenital Anomalies 412	COVID-19 1,640	COVID-19 3,841	Diabetes 7,364	Liver Disease 16,684
Chronic Low Respiratory Diseases 58	Diabetes 324	Diabetes 1,188	Diabetes 2,279	Cerebrovascular Diseases 5,563	Cerebrovascular Diseases 14,173
Cerebrovascular Diseases 55	Chronic Low Respiratory Diseases 197	Cerebrovascular Diseases 599	Cerebrovascular Diseases 2,150	Chronic Low Respiratory Diseases 2,987	Suicide 7,864
Influenza & Pneumonia 54	Influenza & Pneumonia 168	Complicated Pregnancy 591	Nephrotic Diseases 1,029	Homicide 2,740	Nephrotic Diseases 6,668

Marginalized populations are severely impacted

- **1 in 4** LGBTQ+ high-school students attempted suicide in the past year⁴
- **14%** of Black students attempted suicide in 2021, up from 8% in 2011⁴
- **>2X** risk of suicide attempts among girls and young women aged 10-24⁵
- **60%** of female high-school students experience persistent hopelessness⁴

Compared to our least vulnerable communities, our most vulnerable experience **56%** to **82%** greater suicide incidence

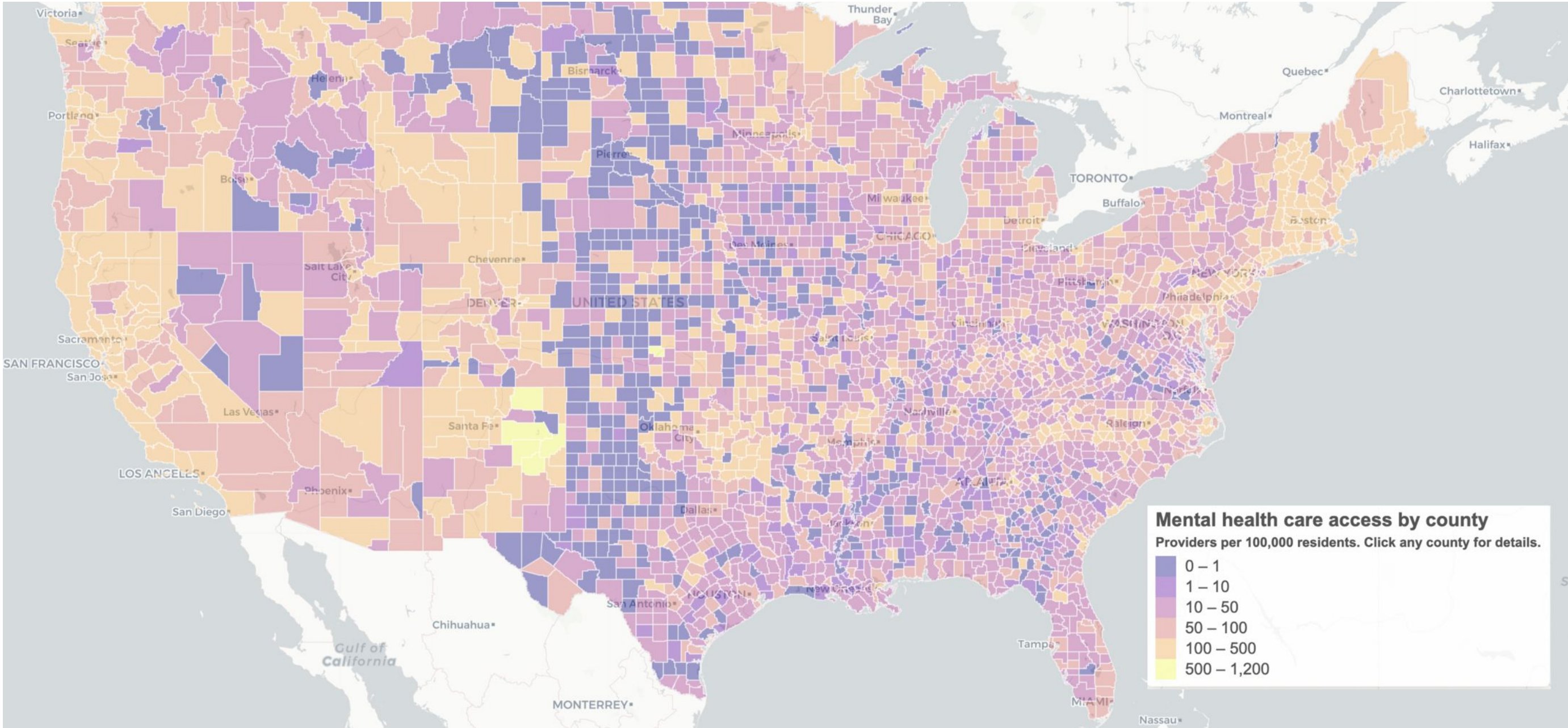
Suicide Incidence Rate Ratios (IRR),
by Community Vulnerability⁶



Devastating Data on Death-By-Suicide Is Just the Tip of the Iceberg



Despite this, mental health resources remain scarce, especially in rural America



“75% of rural counties across the country have no mental health providers or fewer than 50 per 100K people⁷.”

Even when care *is* utilized, assessing risk is extremely difficult

- **77%** of individuals who die by suicide have contact with primary care within 1 year of their death⁸
 - **45%** have contact within 1 month of their death⁹
 - **Nearly 30%** within the week before death¹⁰
- ~**50%** of those who died by suicide did **NOT** have a mental health diagnosis before death, limiting the reach of targeted interventions
- Rates nearly **2x** higher among individuals receiving mental health care

Only 20% of suicide decedents with known mental health disorder received treatment prior to death. There is a,

“Gap in prevention strategies: identifying individuals with mental disorders in mental health settings is insufficient”¹¹

Screening for Suicide

Challenges of suicide screening in primary care

- <50% of PCPs have been trained on assessment of suicide risk¹²
- 25% of GPs believe asking increases thoughts of self-harm¹²
- 50-60% of people will not disclose their SI or behaviors¹³
- Disclosures are lower when reported verbally vs online¹³

In a study of N=1818 adults presenting to an ED with psychiatric issues,

“Clinician’s assessment alone was little better than chance at predicting suicide attempts”

1 and 6 months post-discharge¹⁴

Current Screening Risks in Primary Care

- **PHQ-9** is one of the most utilized suicide screeners in primary care
 - PHQ-9 has a **0.69 specificity** for identifying suicidal ideation
 - Suicidal ideation goes undetected **84%** of the time when using the PHQ-9¹⁵
- Suicidal thoughts often episodic, with quick onset and short duration (1-3 hours on average)¹⁶
- Recent study identified 5 profiles of suicide risk¹⁷
 - Physical health problems profile was largest (31.7%) and increasing most rapidly
 - This profile showed lowest rates of disclosed suicidal intent (14.4%) and psychiatric diagnoses



Getty Images

National Initiatives



- Joint Commission National Patient Safety Goal 15.01.01
- American Academy of Pediatrics recommends universal screening 12+
- Colorado Zero Suicide (ECHO model)
- California Irwin Legislation

The challenge:

Existing frameworks are insufficient, particularly for our most marginalized communities

New approaches are needed to rapidly ID and support individuals in crisis, irrespective of when or where SI occurs

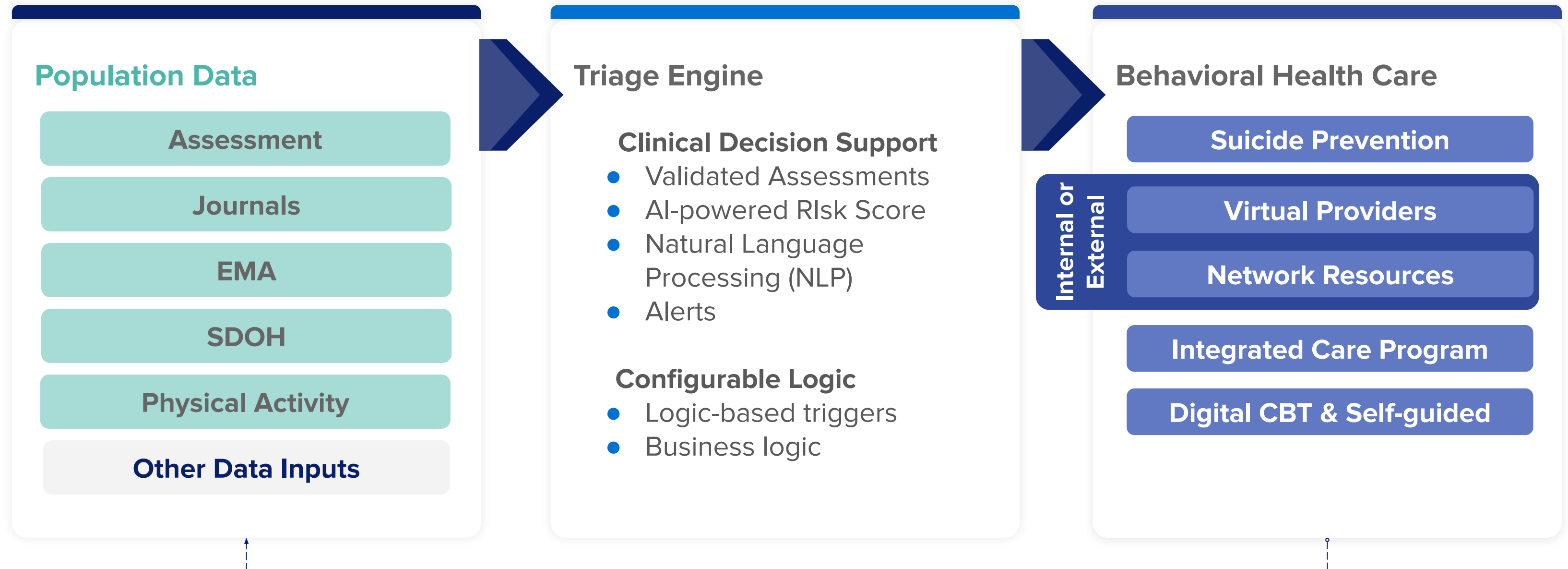
A high-tech, high-touch approach:

mHealth-enabled suicide prevention featuring asynchronous SI screenings can integrate with existing frameworks to surface risk that may otherwise remain undetected

This approach facilitates urgent crisis support and interventions from trained responders

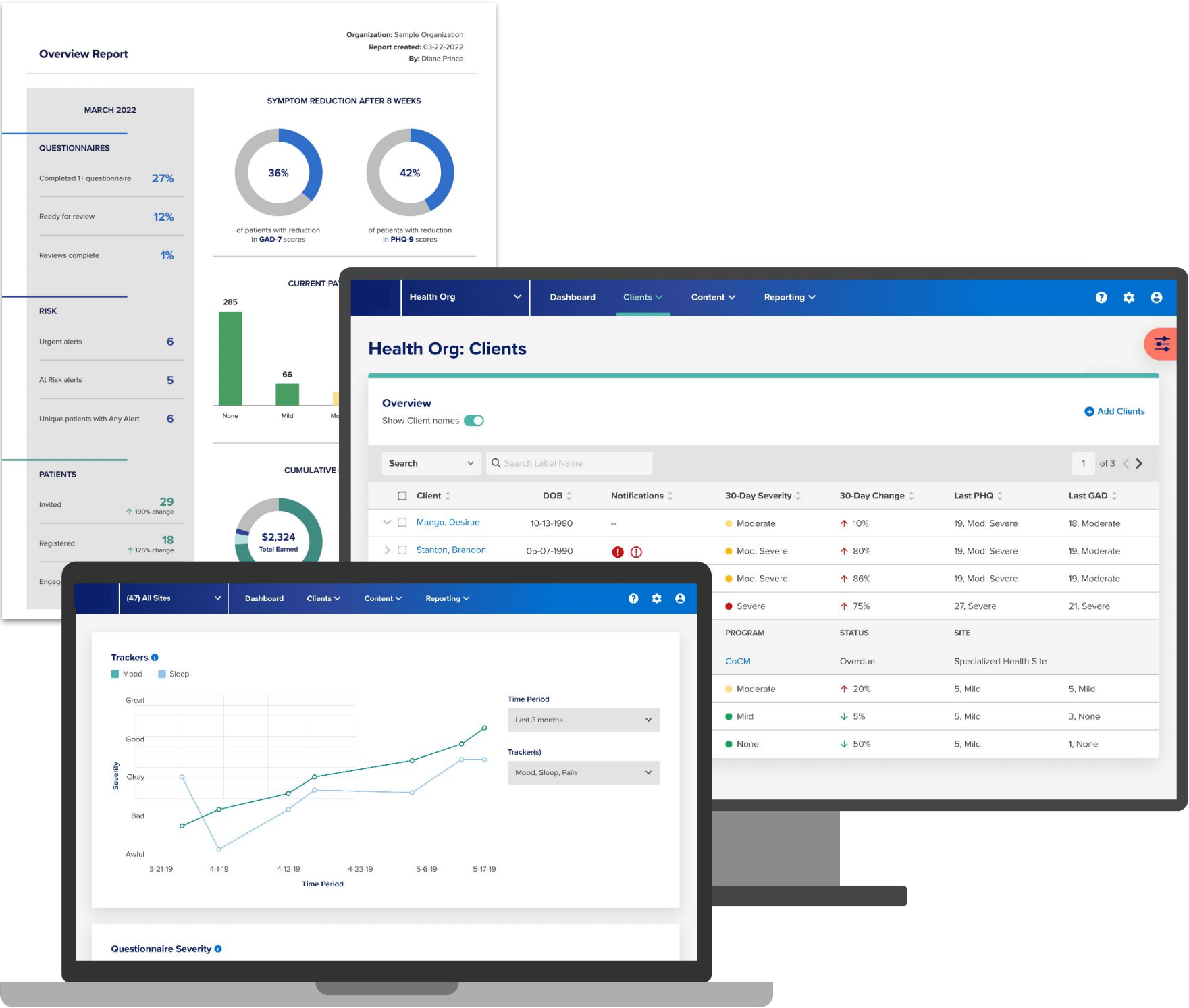
A High-tech, High-touch Approach

Leveraging population health data to support asynchronous suicide prevention



Ongoing monitoring keeps individuals supported at the right level as needs change

Data-driven tools and insights enhance patient continuity and clinical decision-making



Reporting on individual user trends enables clinical decision support and continuous, remote progress monitoring

At-Risk alerts minimize adverse events by immediately notifying care teams when users signal deteriorating conditions

Population level reporting monitors the impact of clinical interventions on quality of care while recognizing outliers requiring program adjustments

Personalized support in rising-risk situations

When an individual’s severity score starts to noticeably increase vs. their personal baseline, care teams are alerted and receive appropriate clinical suggestions. Individuals immediately receive resources and relevant content for their needs.



Response services provide critical support

365

days a year of coverage,
9am - 8pm ET

>50%

of people we call are successfully
reached and screened

33% avg. response rate for telehealth outreach

2

hours between time of alert and
outreach, on average

60%

of people who we have reached
have been connected with a
referral or resource

8%

of engaged, higher acuity
populations trigger an urgent alert

2% for general engaged populations

>50%

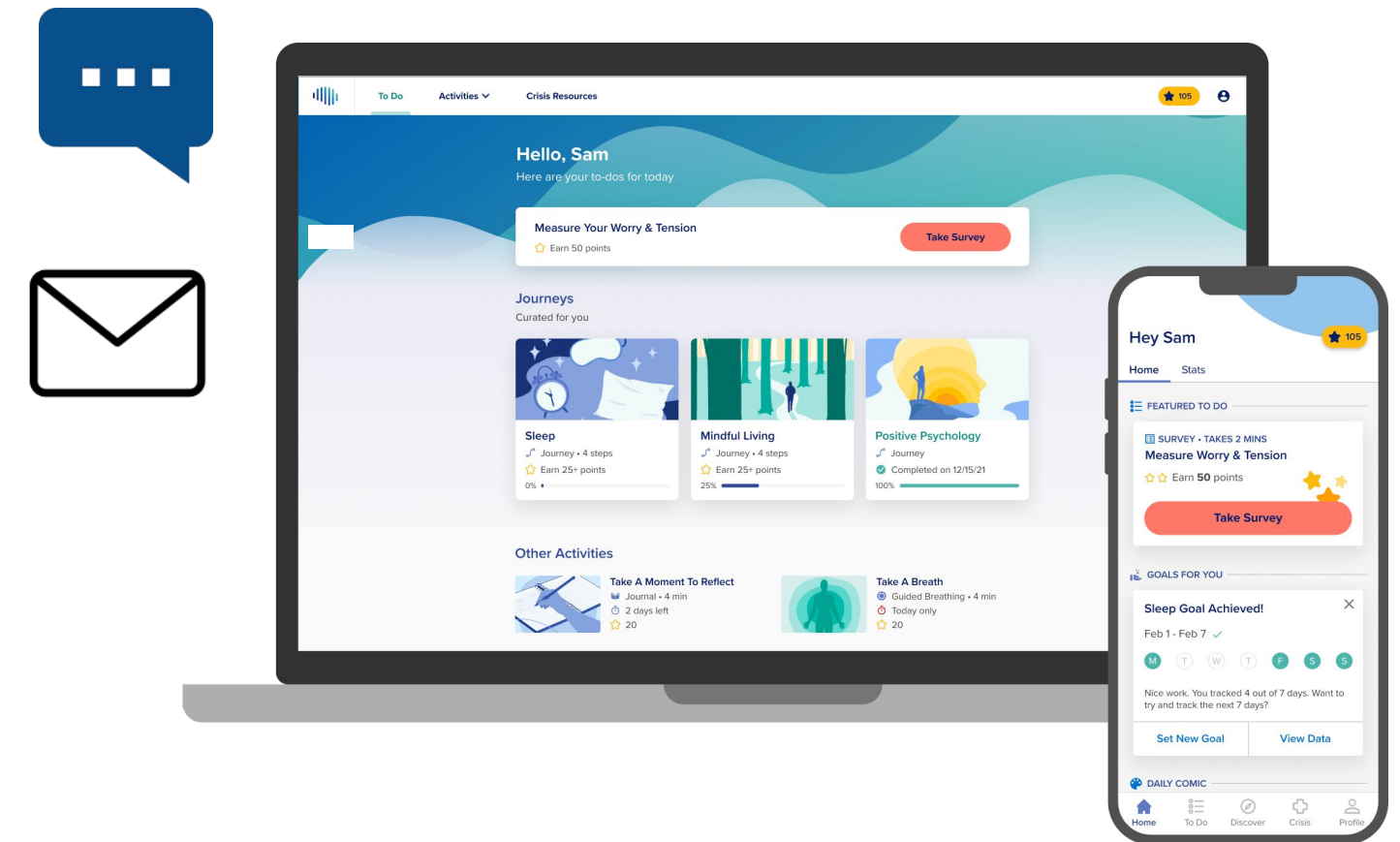
of people who receive our at-risk
email click to access resources

Study Results

STUDY 1

Tech-Enabled Suicide Prevention

- Review of mHealth-enabled suicide-prevention program across various healthcare providers, insurance payors, and employers from 4/22-3/23
- **N=10,099** patients were continuously monitored for new and emerging suicide risk using a three-pronged approach:
 - remote-administered assessments
 - natural language processing (NLP)
 - proprietary risk score*
- Patients had access to the platform's features and content, including psychoeducation and subjective-state tracking (e.g., mood, sleep, stress)



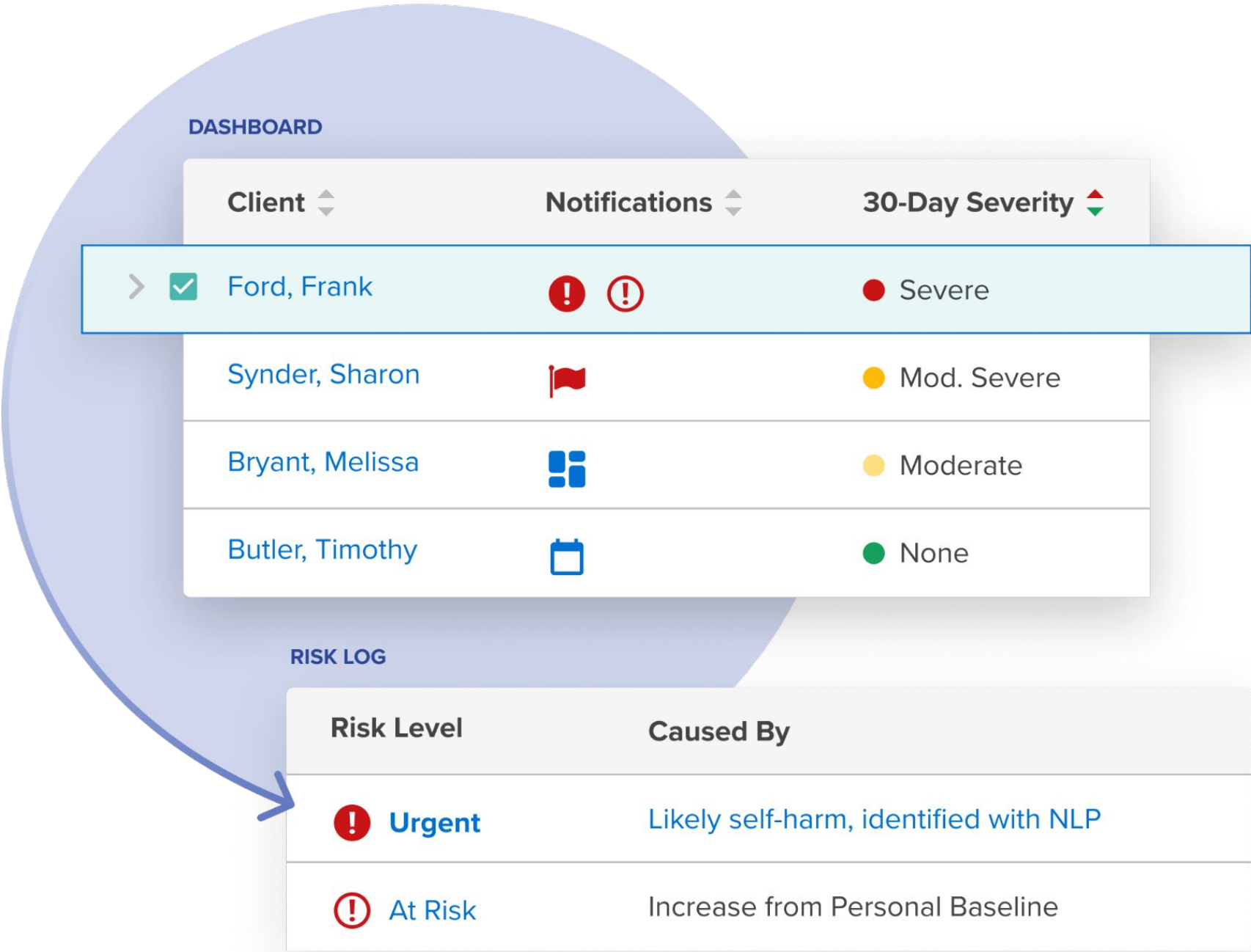
*Pardes et al., 2022. *Platform for Remote Assessment of Suicidal Ideation, Depression, and Anxiety: A Longitudinal Retrospective Study*. Innovations in Digital Health and Diagnostic Biomarkers

STUDY 1

Tech-Enabled Suicide Prevention

- **1165 urgent alerts** generated:
 - 787 patients generated 1139 assessment (PHQ-9, PHQ-2/9, or Edinburgh)
 - 20 patients generated 26 NLP alerts
- Responders administered C-SSRS for **333 patients** within 48 hours, leading to the following risk stratification:

		REASON FOR ALERT	
RISK LEVEL	PATIENTS	ASSESSMENT	NLP
Low	230	229	1
Moderate	81	79	2
High	22	21	1
TOTALS	333	329	4

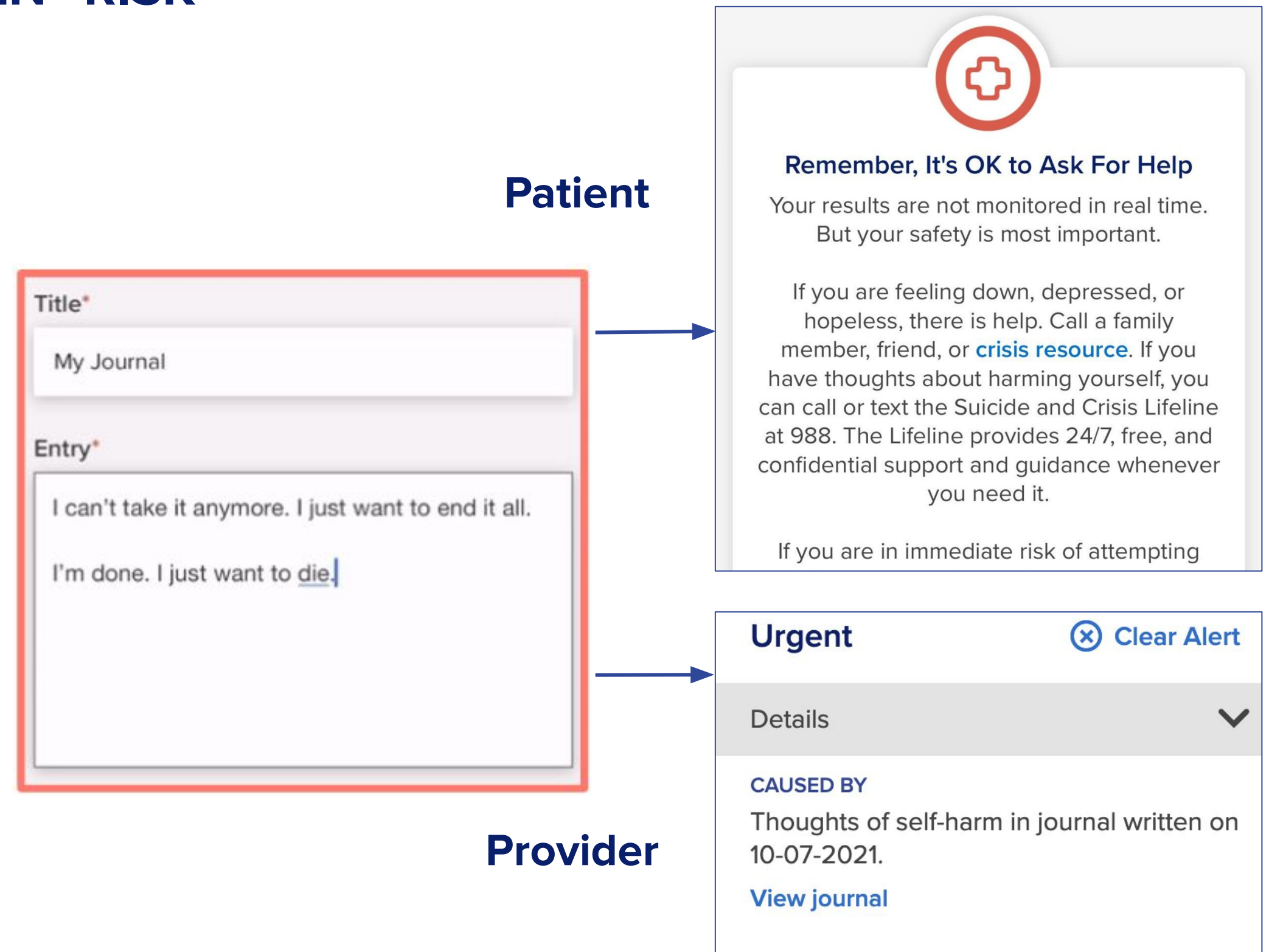


(top) automated caseload sorting prioritizes highest-risk patients in response coordinators’ dashboard; (bottom) risk log provides more information on cause of alert and links to further information

STUDY 2 – NLP TO SURFACE “HIDDEN” RISK

NLP in Action

- NLP analyzes free-text entries
- Our NLP algorithm identifies high-risk words
- and phrases related to suicide
- System processes user inputs asynchronously, enabling 24/7 monitoring

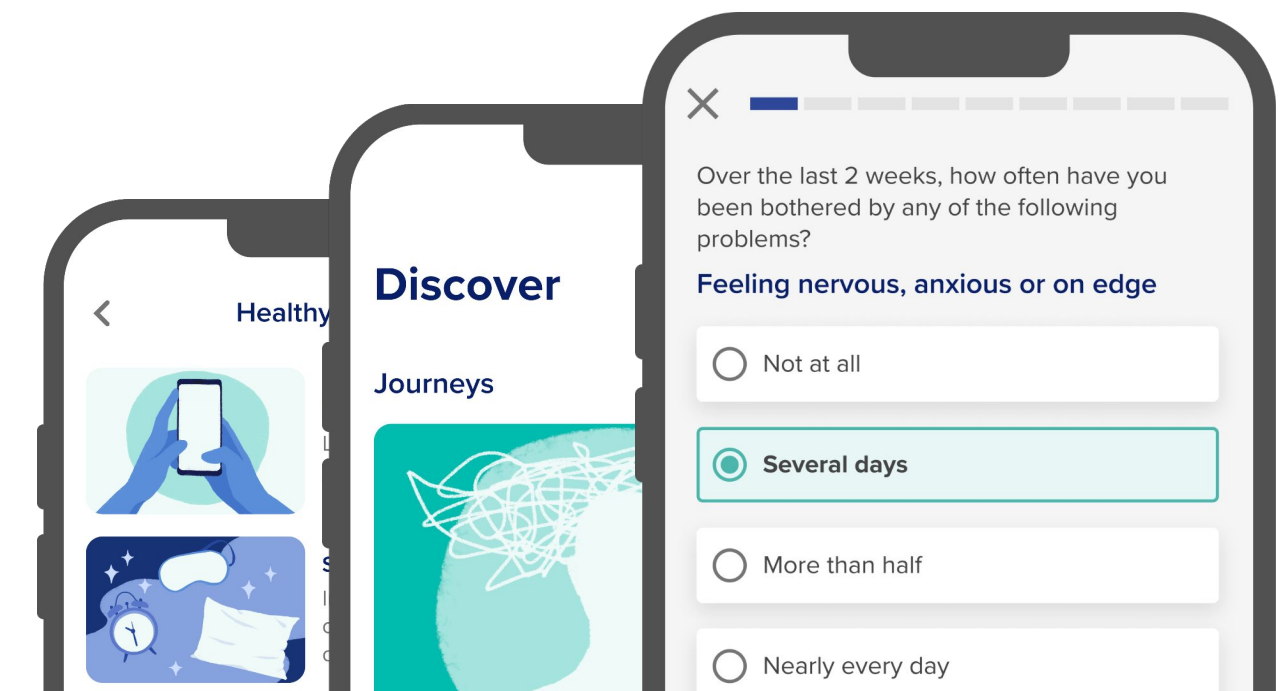


STUDY 2

NLP TO SURFACE “HIDDEN” RISK

Our Study 1 findings motivated a retrospective database study to analyze NLP alerts generated in various care settings between 1/20 and 8/23

- Of **N=425** patients who triggered an NLP alert for the first time while using the mHealth platform as a supplement for their care:
 - 177 complied with monthly PHQ-9 *and* responded >0 on most recent PHQ-9 question 9
 - 81 had fallen out of assessment compliance
 - 167 complied with monthly assessments *but* responded 0 on question 9
- Patients had access to the platform’s features and content, including psychoeducation and subjective-state tracking



Hartz et al., 2023 (in review): *Using Mobile App-driven NLP to Detect Suicidal Ideation and Prompt Urgent Interventions*. Innovations in Digital Health and Diagnostic Biomarkers

STUDY 2 – NLP TO SURFACE “HIDDEN” RISK

Asynchronous NLP and the fleeting nature of SI

Comparing most recent PHQ-9 scores of patients who complied with their monthly PHQ-9 tempo *and* triggered NLP alerts hints at the elusive nature of SI:

- Those who responded >0 on Q9 (N=177): mean=18.5 (**moderate-severe depression**), SD = 5.3
- Those who responded 0 on Q9 (N=167): mean = 8.4 (**mild depression**), SD = 5.9

└ Why *didn't* these patients endorse Q9 on their most recent assessments?

In a study of N=82 patients who attempted suicide, 39 reported ≤ 10 minutes between first current SI and attempt*, presenting clear challenges to monthly assessment tempos

It is possible that some of these patients experienced increased symptoms severity between assessments and *would have* endorsed Q9 at the time of their NLP alert generation; however, this remains an unanswered, and important, question

*Deissenheimer et al., 2009. *The Duration of the Suicidal Process: How Much Time is Left for Intervention between Consideration and Accomplishment of a Suicide Attempt?* J Clin Psych

STUDY 2 – NLP TO SURFACE “HIDDEN” RISK

NLP hints at the power of mHealth to deliver low-latency, data-driven care

- **58%** of patients who triggered an NLP alert had no assessment indicating risk of self-harm — **NLP is a safety net for these patients**
- **NLP is surfacing risk that traditional screening is missing** , while providing prompt high-touch intervention through alert systems, crisis outreach, and tailored referral paths
- Our findings raise questions about other ways that mHealth platforms can help address the fleeting nature of SI; e.g., through ecological momentary assessment of **subjective states**

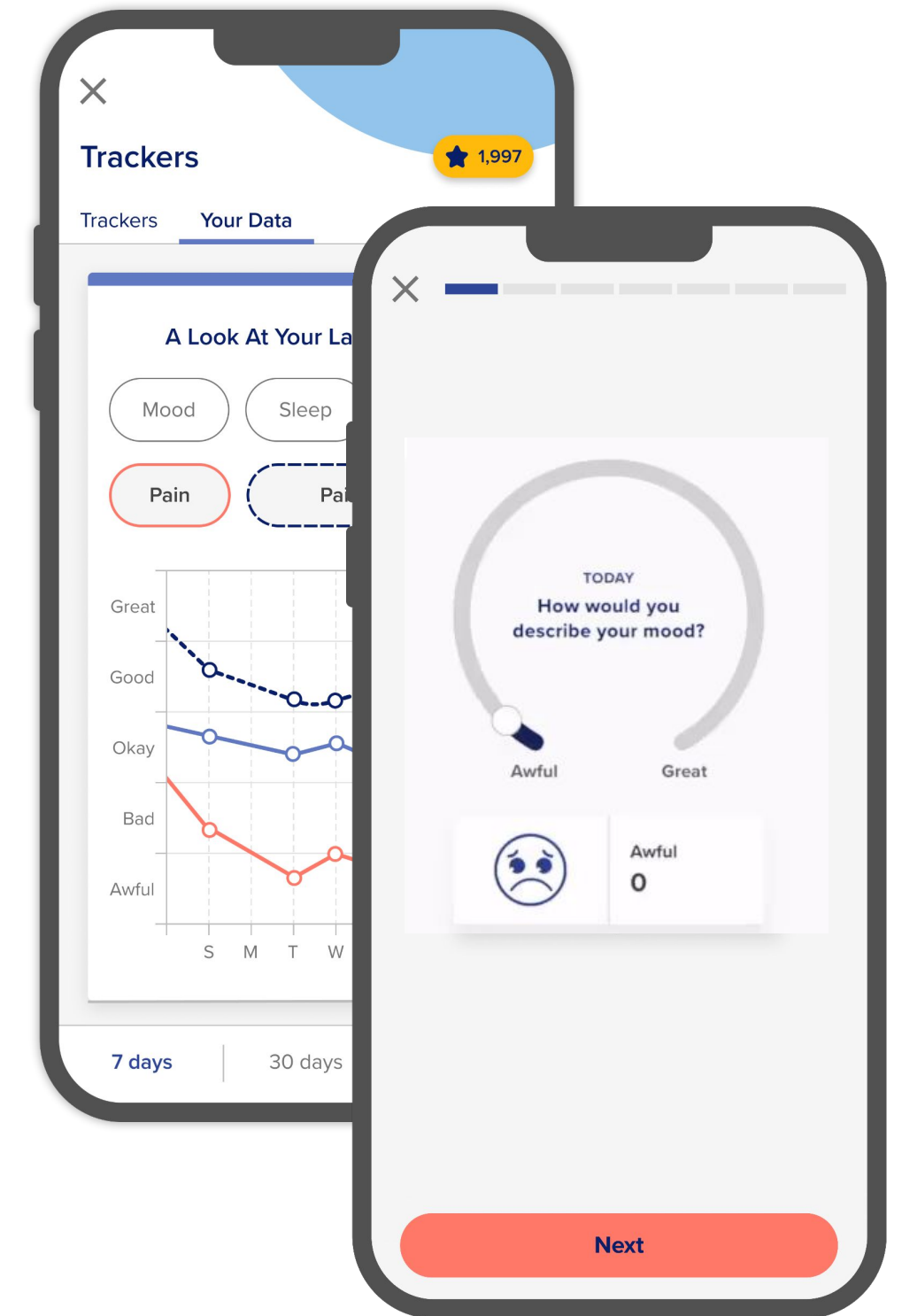
Read the full study:



STUDY 3

EMA TO PREDICT SUICIDAL IDEATION

- We collected **> 44,000 EMA self-reports** from N=16,268 patients on mood, sleep, stress, and pain using mHealth trackers (pictured).
- Tracker-to-PHQ9 ratio is **18-to-1**, allowing for monitoring between validated assessment delivery
- We analyzed EMA alongside responses to self-harm questions to develop a **predictive model of monthly SI risk**.



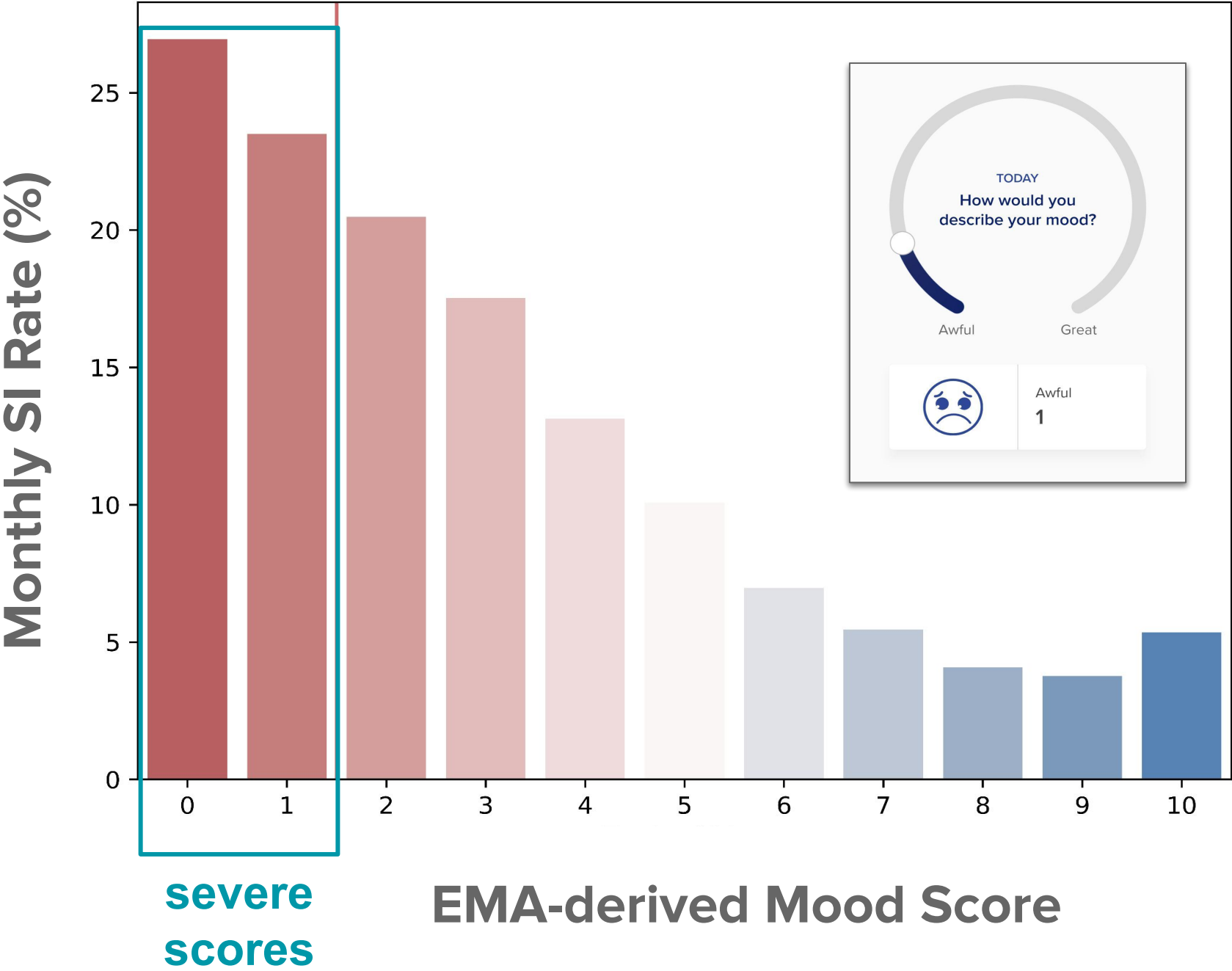
STUDY 3

EMA TO PREDICT SUICIDAL IDEATION

Mood predicts SI

- 30 day SI rate is significantly higher among patients who report severe negative mood (25.4%) vs non-severe mood (9.9%) ($X^2=725.5$, $p<.001$)
- Odds of expressing SI significantly increases for every 1-point drop in self-reported mood (95% CI Odds Ratio = [1.38-1.42]; $p<.001$)

Monthly SI Rates by Mood Score



STUDY 4

Remote Asynchronous Suicide Screening

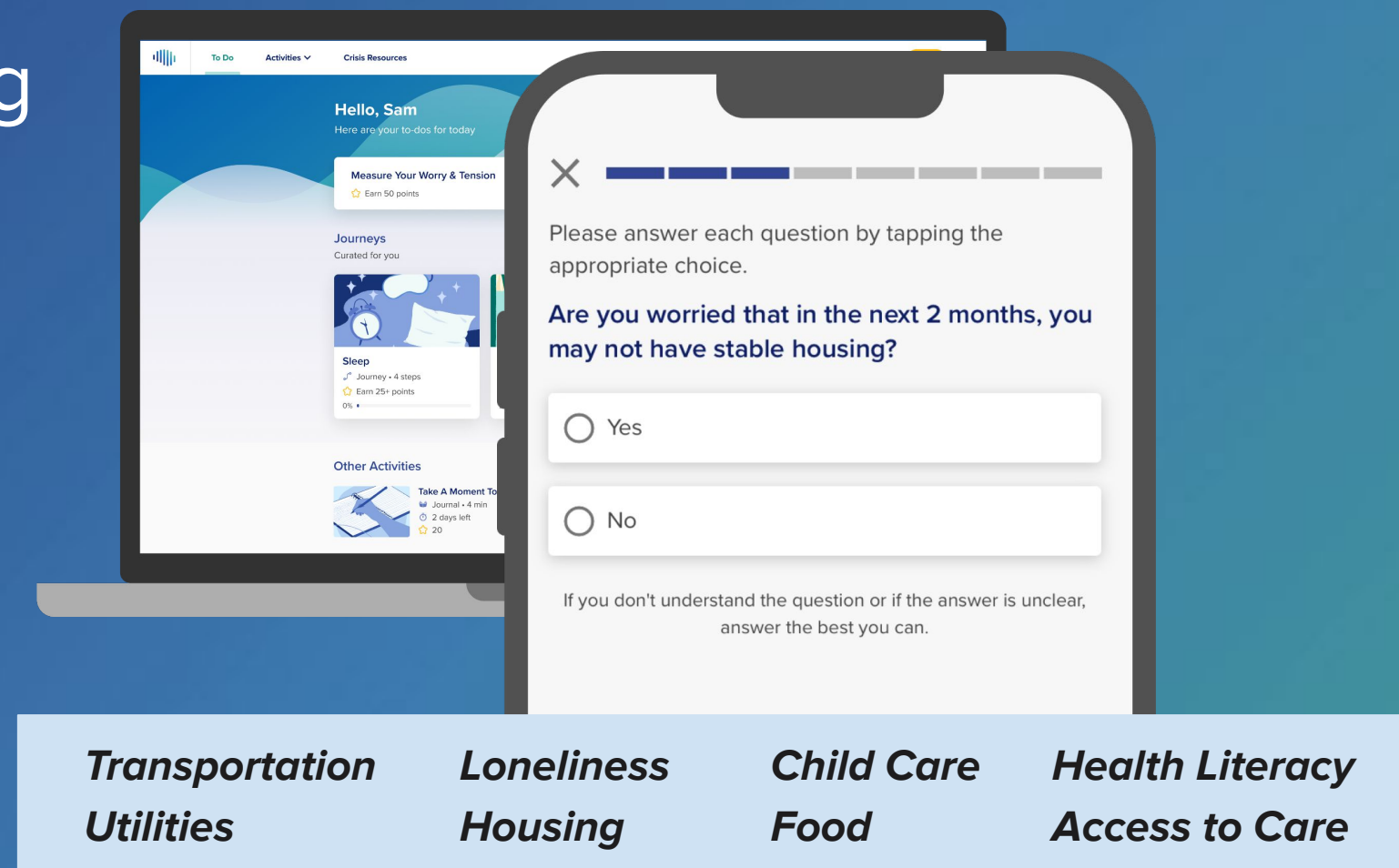
- Conducted ~ **16,000 remote suicide screenings** (ASQ, C-SSRS)
- **Reviewing protocols, procedures, and workflows** selected by behavioral health programs that opted-in for remote screening and alert management
- **First review** of utilizing remote, async suicide screening measures delivered by technology



SUMMARY

Tech-enabled suicide prevention: A high-tech, high-touch extension of evidence-based care

- Our studies demonstrate the potential for mHealth to integrate with various medical settings, augment risk stratification, and prompt life-saving interventions
- NLP and EMA can robustly complement existing approaches through the timely detection of “hidden” risk
- Importantly, mHealth holds great potential to democratize care in marginalized communities, where SDOH present barriers to care



Future Applications

Multilevel Modeling for Symptom Severity Prediction

- Developed multi-level models to predict PHQ-9 categories: **Probability of depression severity based on mood score**
- Model accounts for nested data structure (multiple reports per user)

For every mood tracker score **input** by a user, we can **output** the likelihood that they fall within a given PHQ-9 severity category:

Mood Tracker Score	0	1	2	3	4
None-Minimal (1)	0.033	0.047	0.068	0.097	0.137
Mild (2)	0.086	0.118	0.158	0.203	0.251
Moderate (3)	0.172	0.210	0.244	0.265	0.270
Moderately Severe (4)	0.306	0.309	0.292	0.259	0.217
Severe (5)	0.403	0.315	0.238	0.175	0.126

Multi-level Modeling for Symptom Severity Prediction

*For a user who tracks a zero for mood,
~ 88% chance of experiencing current
clinical depression symptoms*

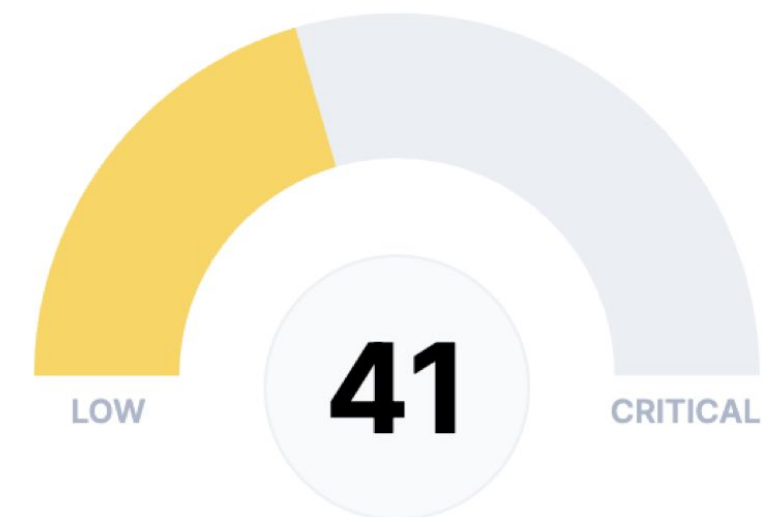
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COMBINING DATA SOURCES

Risk Modeling

- **ML models outperform** traditional clinical assessment (AUC 0.67 vs 0.77) (Nock et al., 2022)
- Combining **multiple data sources** offers comprehensive risk assessment and detects subtle changes:
 - **EHR and Claims:** Provide historical context through structured and unstructured data
 - **Self-reports:** Capture subjective state tracking
 - **Passive data collection:** Offers objective measures, such as digital phenotyping (e.g., smartphone use patterns, etc.)

Risk score



Current: **High Risk**

● Low ● Moderate ● High ● Very High ● Critical

References

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Session Evaluation

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