

# Detection of Suicide-Related Emergencies among Children using Real-world Clinical Data

Brain and Behavior Research Foundation

Meet the Scientist Webinar

March 12<sup>th</sup>, 2024

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## Research Support



## Community Partners



# Disclosures and Acknowledgments





UCLA Health Newsroom

## Talk Structure

Setting the challenge

Current efforts

Ongoing challenges

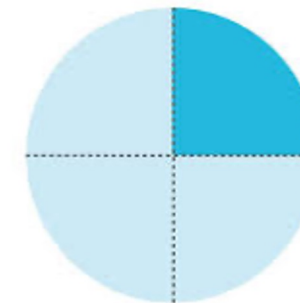
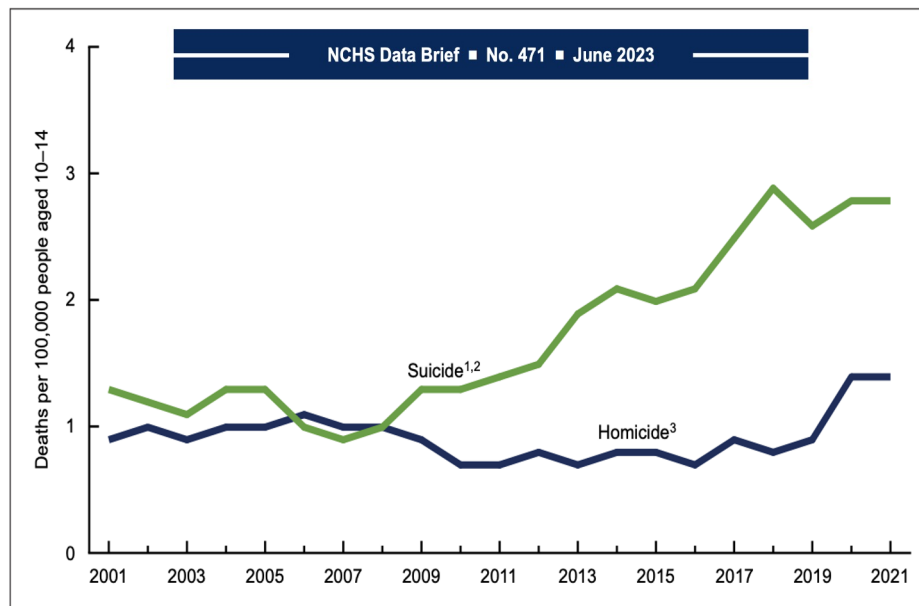
Roadmap ahead

Takeaways



Suicide is a leading cause of death of young people

Figure 2. Suicide and homicide death rates among people aged 10–14: United States, 2001–2021



One quarter of young people who die, die from suicide

1 in 13 U.S. high school students report having made a suicide attempt



Centers for Disease Control and Prevention

AAP-AACAP-CHA Declaration of a National Emergency in Child and Adolescent Mental Health

U.S. adults  
(94%) believe  
that suicide  
can be  
prevented at  
least  
sometimes.

[suicidepreventionnow.org](http://suicidepreventionnow.org)



## 5 Action Steps for Helping Someone in Emotional Pain



### ASK

“Are you thinking about killing yourself?”



### KEEP THEM SAFE

Reduce access to lethal items or places.



### BE THERE

Listen carefully and acknowledge their feelings.



### HELP THEM CONNECT

Call or text the 988 Suicide & Crisis Lifeline number (988).



### STAY CONNECTED

Follow up and stay in touch after a crisis.



[nimh.nih.gov/suicideprevention](http://nimh.nih.gov/suicideprevention)

Suicide death  
is only a  
portion of the  
problem



California Healthcare Foundation



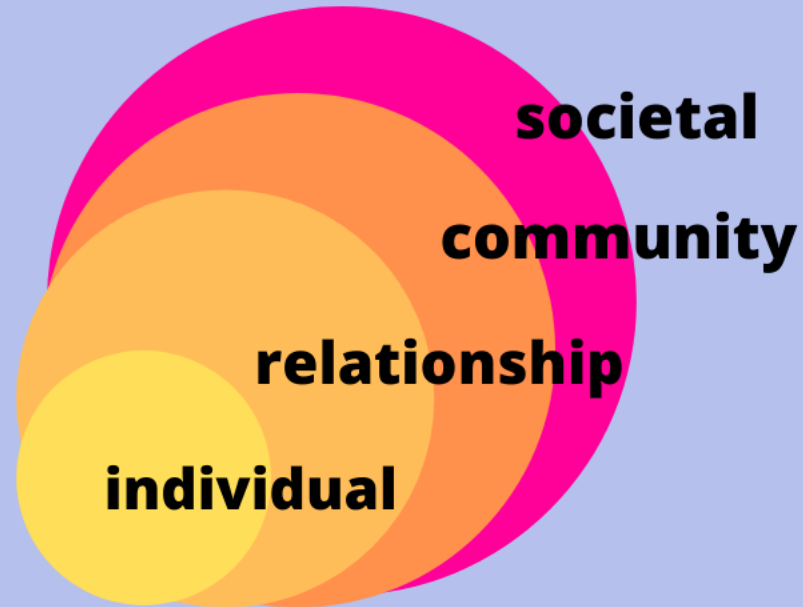
Johns Hopkins Medicine



Suicide  
Prevention  
RESOURCE FOR ACTION



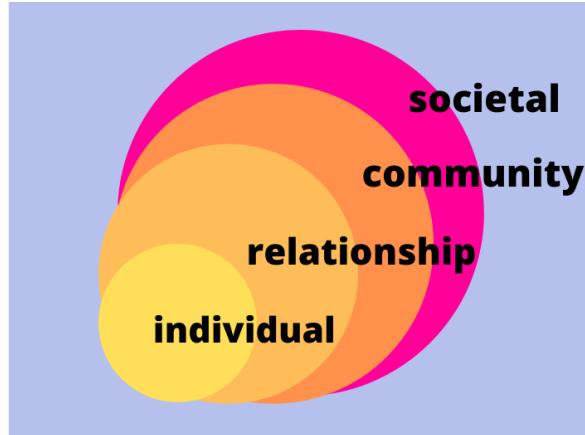
# THE SOCIOECOLOGICAL MODEL OF SUICIDE PREVENTION



**Action 1. Activate a broad-based public health response to  
suicide**

1.2 Empower every individual and organization to play a role  
in suicide prevention





The Guardian

# Pathways to preventing suicide in children differ from adults



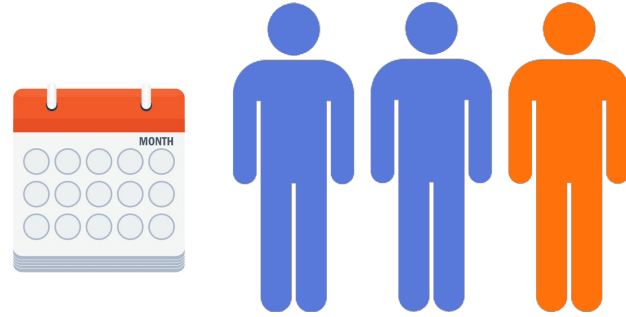


Healthcare visits are a key point of suicide prevention





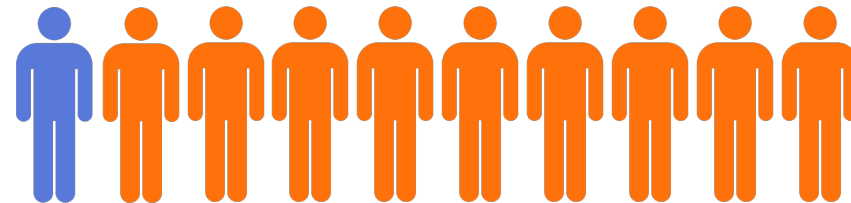
Most young people who die by suicide have had a recent health care visit



**One in three** (42%) young people who dies of suicide had a health care visit in the **month** before death



iStock photo



and nearly **nine in ten** (88%) had a visit within the **prior year**



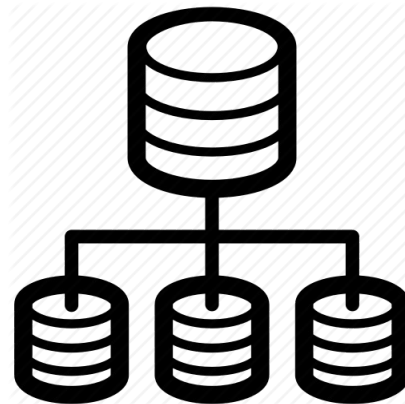
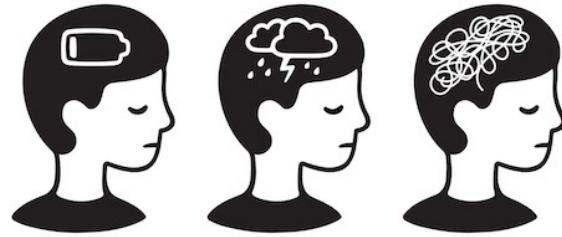
## Challenge

How do we maximize the chance that providers will deliver evidence-based care that has the highest chance of reducing risk of suicide?

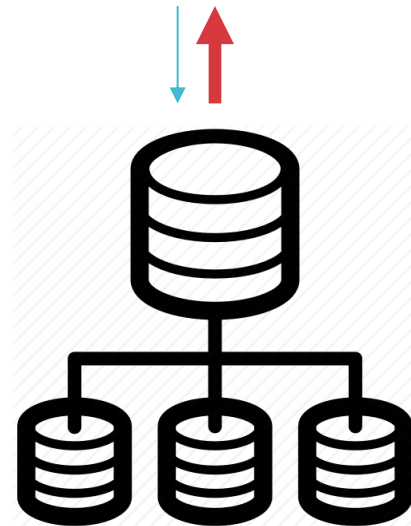
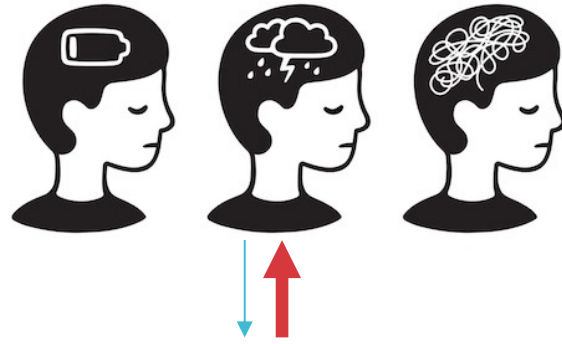
Personalized  
medicine:  
moving from  
risk prediction  
to patient-  
centered care



Each health  
care visit  
generates  
data



Does that  
data help the  
patient?





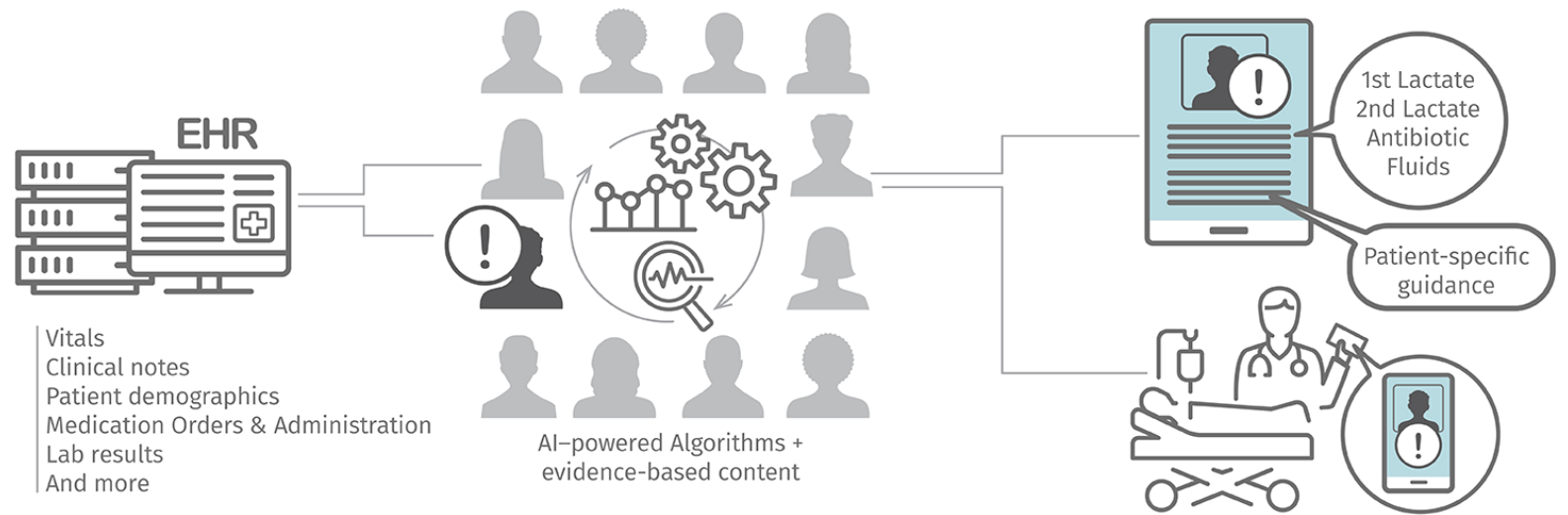
# Fundamental theorem of informatics



Helpful  
guidance or  
harm?



# Example of decision support: Sepsis



Senti7 Sepsis Monitor





## Five Rights

Right Information

Right Person

Right Format

Right Channel

Right Time



# Decision support: already in your search engine



suicide prevention



Images

News

Videos

Shopping

Books

Maps

Flights

Finance

About 716,000,000 results (0.41 seconds)

## Help is available

Speak with someone today

### 988 Suicide and Crisis Lifeline

Hours: Available 24 hours. Languages: English, Spanish. [Learn more](#)

# 988



Call



Chat



Official Website

**SMS:** 988

[Feedback](#)

## Connect with people you trust

From [International Association for Suicide Prevention](#) · [Learn more](#)

If you're struggling, it's okay to share your feelings. To start, you could copy one of these pre-written messages and send it to a trusted contact.

### Reach out

When you get a chance can you contact me? I feel really alone and suicidal, and could use some support.

### Contact a loved one

I don't want to die, but I don't know how to live. Talking with you may help me feel safe. Are you free to talk?

### Express your feelings

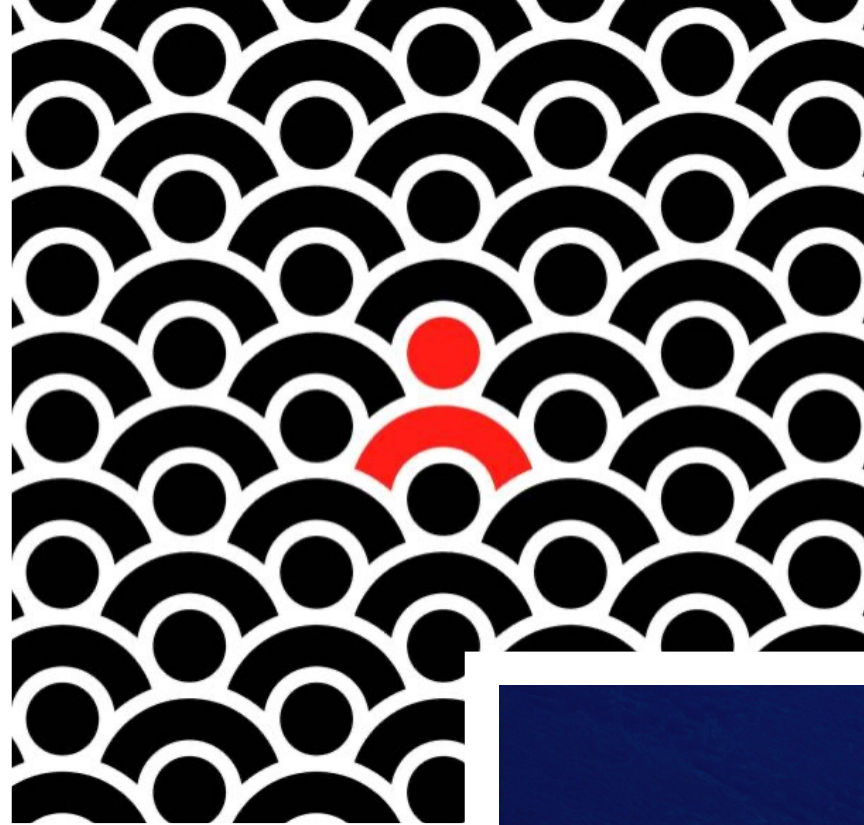
This is really hard for me to say but I'm having painful thoughts and it might help to talk. Are you free?



For informational purposes only. Consult your local medical authority for advice.

[Feedback](#)

# A journey through current research



- Right Information
- Right Person
- Right Format
- Right Channel
- Right Time



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# Mental Health Service Use Before and After a Suicidal Crisis Among Children and Adolescents in a United States National Medicaid Sample (Doupnik, *Academic Pediatrics*, 2021)

Examined Medicaid data from >90,000 ED visits

Less than 50% of children (6 to 17) who are seen in the ED for a mental health crisis and discharged receive mental health follow-up within 30 days.

If a child was not seen by a mental health provider 30 days prior to the ED visit, their chances of a new mental follow-up 30 days later was only 25%

Bottom line: **Children with mental health emergencies are unlikely to connect with specialty care.**



# Prevalence and Correlates of Suicide and Nonsuicidal Self-Injury in Children – A Systematic Review and Meta-analysis (Liu, *JAMA Psychiatry*, 2022)

Reviewed 58 studies with over 626 million children

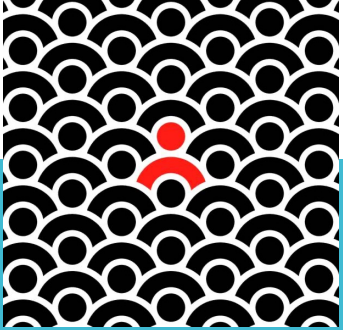
Focused on preadolescent children (<13)

Preadolescents experience suicidal thoughts (15.1%), suicide attempts (2.6%), and nonsuicidal self-injury (6.2%)

Male children were more likely to have SITBs in pre-adolescence compared with adolescence.

ADHD and depression emerged as strongest correlates of self-injurious thoughts and behaviors

Bottom line: ***Children* experience self-injurious thoughts and behaviors, and risk factors differ between children and teens**



# Issues in Developing a Surveillance Case Definition for Nonfatal Suicide Attempt and Intentional Self-harm Using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) Coded Data (Hedegaard, *National Health Statistics Reports*, 2018)

## Technical Notes

### ICD-9-CM and ICD-10-CM codes for suicide and self-inflicted injury

The ICD-9-CM and ICD-10-CM codes for suicide and self-inflicted injury are detailed in [Tables I](#) and [II](#), respectively.

**Table I. ICD-9-CM codes for suicide and self-inflicted injury**

Code	Description
E950.0	Suicide and self-inflicted poisoning by analgesics, antipyretics, and antirheumatics
E950.1	Suicide and self-inflicted poisoning by barbiturates
E950.2	Suicide and self-inflicted poisoning by other sedatives and hypnotics
E950.3	Suicide and self-inflicted poisoning by tranquilizers and other psychotropic agents
E950.4	Suicide and self-inflicted poisoning by other specified drugs and medicinal substances
E950.5	Suicide and self-inflicted poisoning by unspecified drug or medicinal substance
E950.6	Suicide and self-inflicted poisoning by agricultural and horticultural chemical and pharmaceutical preparations other than plant foods and fertilizers
E950.7	Suicide and self-inflicted poisoning by corrosive and caustic substances
E950.8	Suicide and self-inflicted poisoning by arsenic and its compounds
E950.9	Suicide and self-inflicted poisoning by other and unspecified solid and liquid substances
E951.0	Suicide and self-inflicted poisoning by gas distributed by pipeline
E951.1	Suicide and self-inflicted poisoning by liquefied petroleum gas distributed in mobile containers
E951.8	Suicide and self-inflicted poisoning by other utility gas

Bottom line: **Diagnostic and billing codes are assigned during each medical visit, but there are several reasons these codes may not reflect all visits for suicide and self-harm**

## Accuracy of ICD-10-CM encounter diagnoses from health records for identifying self-harm events (Simon, *JAMIA*, 2022)

Assessment of accuracy of ICD-10-CM codes to identify self-harm events and poisonings

Individuals with frequent suicidal ideation and an injury event

Blinded review of full-text clinical records found documentation of self-harm intent in 254 (89.1%) of those originally coded as self-harm, 24 (28.2%) of those coded as undetermined, 24 (7.9%) of those coded as accidental, and 48 (11.0%) of those without coding of intent.

Bottom line: **Among persons with frequent suicidal ideation and an injury, most receive a self-harm related code**

## Suicidal and Self-harm Presentations to Emergency Departments: The Challenges of Identification through Diagnostic Codes and Presenting Complaints (Sveticic, *Health Information Management Journal*, 2019)

Australian study of 2540 mental health ED visits among adults

ICD codes had very low sensitivity in detecting suicide attempts (18.7%), NSSI (38.5%), and suicidal ideation (42.3%)

Bias: ICD codes detected higher percentage of Indigenous persons and NSSI among female presenters

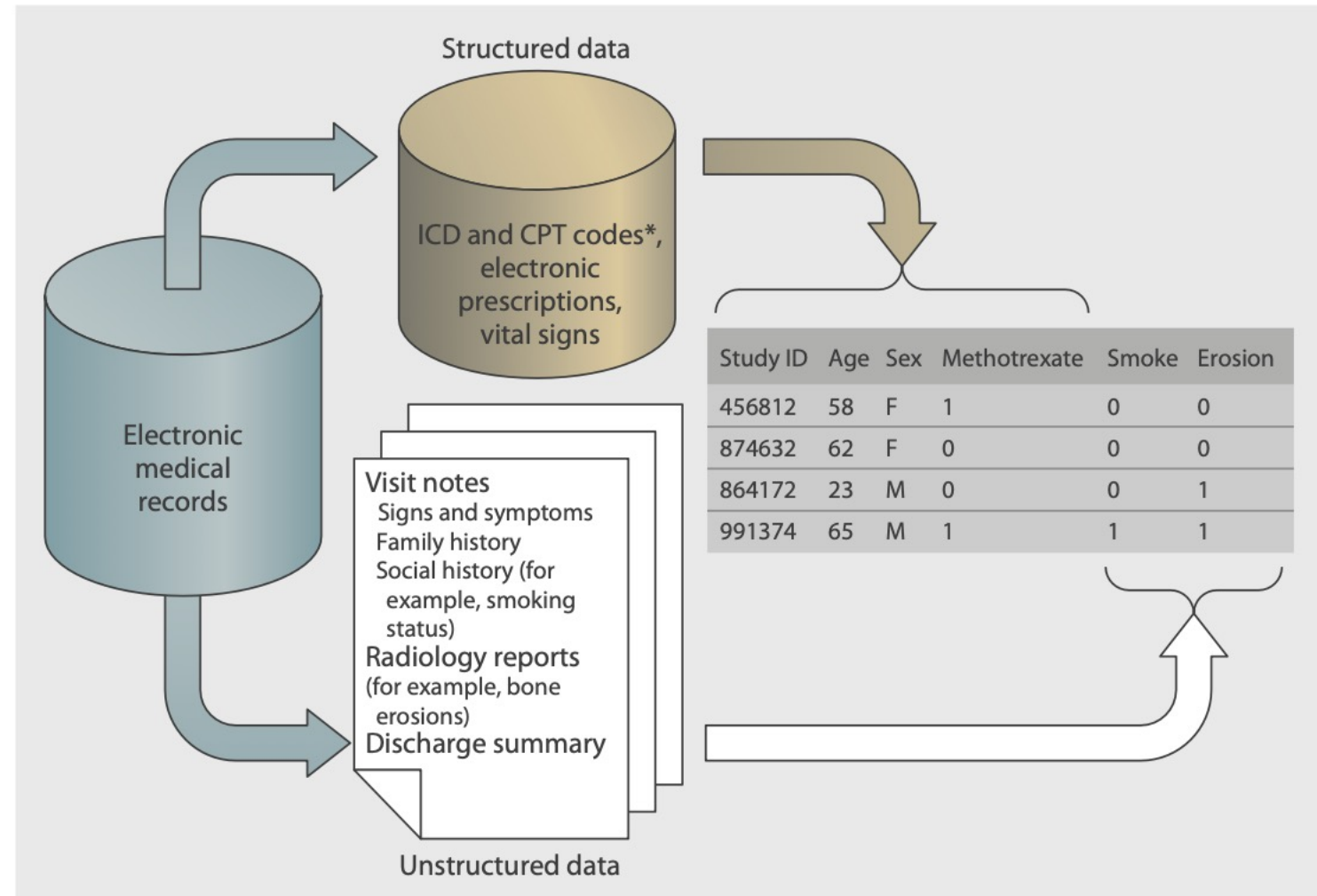
Bottom line: **Suicide and self-harm presentations may be undercounted in ED datasets and should be 'used with caution'**



Liao et al (2015)

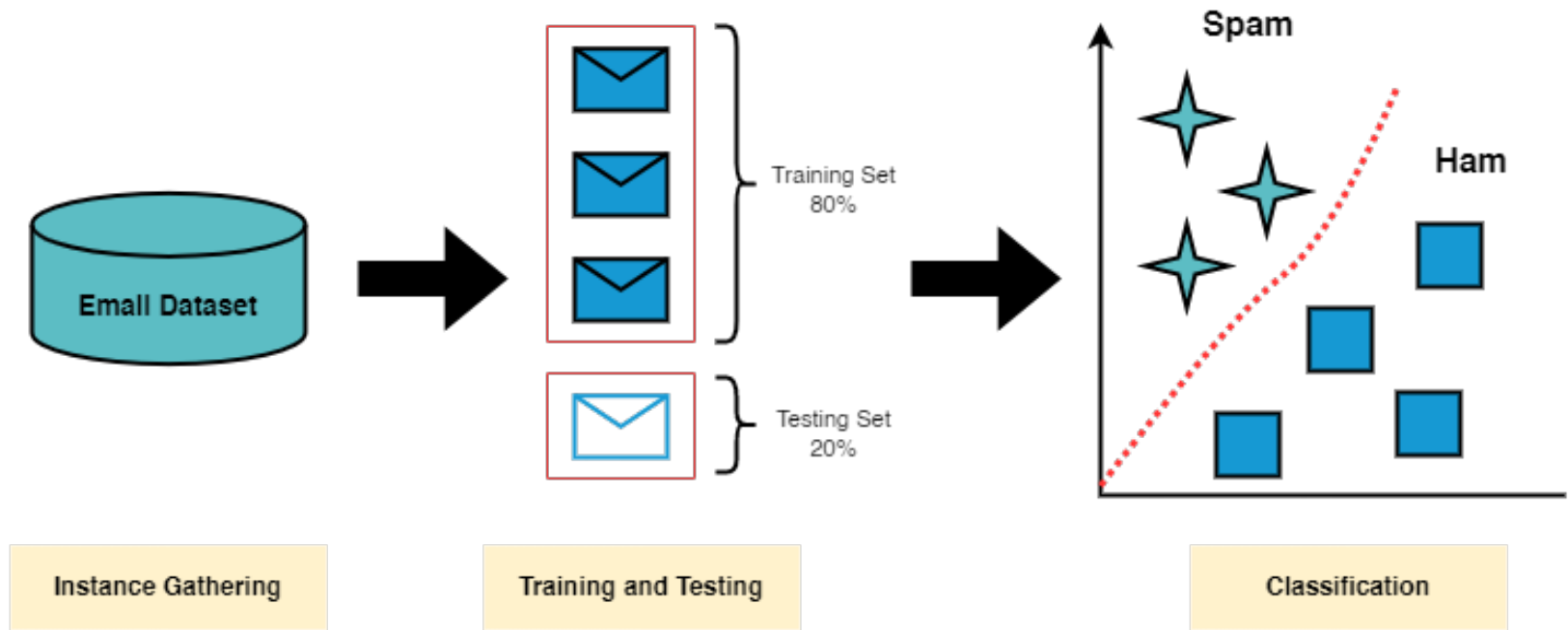
## Development of phenotype algorithms using electronic medical records and incorporating natural language processing

Katherine P Liao,<sup>1,2</sup> Tianxi Cai,<sup>3</sup> Guergana K Savova,<sup>4</sup> Shawn N Murphy,<sup>5</sup> Elizabeth W Karlson,<sup>1,2</sup> Ashwin N Ananthakrishnan,<sup>6</sup> Vivian S Gainer,<sup>7</sup> Stanley Y Shaw,<sup>2,8</sup> Zongqi Xia,<sup>2,9</sup> Peter Szolovits,<sup>10</sup> Susanne Churchill,<sup>2</sup> Isaac Kohane<sup>2,5</sup>



Bottom Line: Phenotype algorithms use EHR data to detect patients with specific diseases and outcomes

# Machine Learning: A useful tool for detection problems



Original Paper

# Assessing Detection of Children With Suicide-Related Emergencies: Evaluation and Development of Computable Phenotyping Approaches

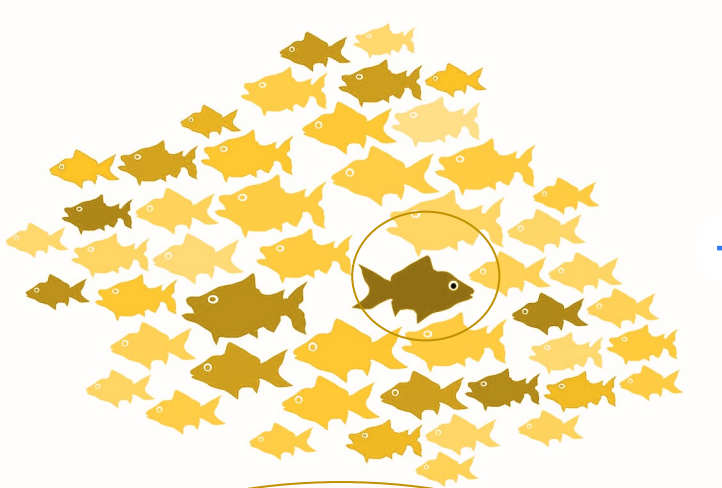
Juliet Beni Edgcomb<sup>1,2</sup>, MD, PhD; Chi-hong Tseng<sup>3</sup>, PhD; Mengtong Pan<sup>3</sup>, BA, BS; Alexandra Klomhaus<sup>3</sup>, PhD; Bonnie T Zima<sup>1,2</sup>, MPH, MD

<sup>1</sup>Mental Health Informatics and Data Science (MINDS) Hub, Center for Community Health, Semel Institute for Neuroscience and Human Behavior, University of California Los Angeles, Los Angeles, CA, United States

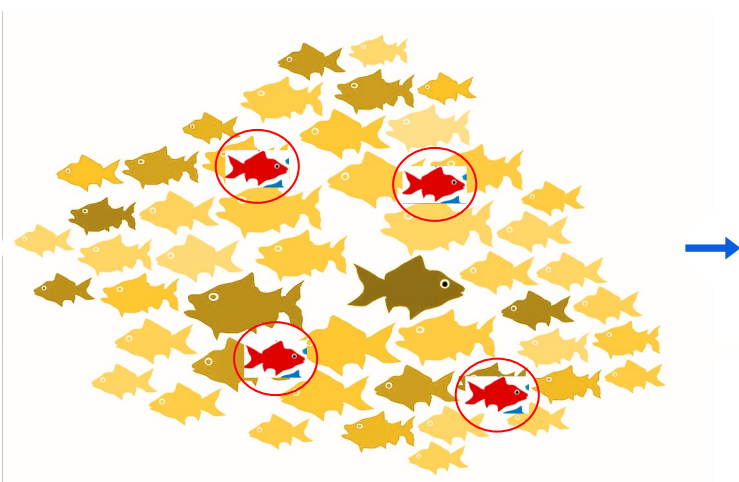
<sup>2</sup>Department of Psychiatry, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, United States

<sup>3</sup>Department of Medicine Statistics Core, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, United States





+



## Child Suicidality EHR Phenotyping (CSEP) Study

How might detection of SITB in children be more accurate and equitable?



**Shorter term:** What does improved detection mean for prediction and prevention of suicide?

Who is being missed?  
(and why?)

**Longer term:** How do we adapt informatics (research methods and clinical tools) for child mental health?



How are self-injurious thoughts and behaviors (SITB) behaviors currently detected in EHR datasets?



## Pilot (N=600 children)

Compared detection

1. 'Gold standard' manual chart review
2. Existing methods
  - ICD-10-CM related to suicide
  - Chief complaint related to suicide
3. Structured data classifiers
  - ICD-based (suicide, any MH)
  - Non-ICD-based (e.g., meds, labs)
  - All data elements

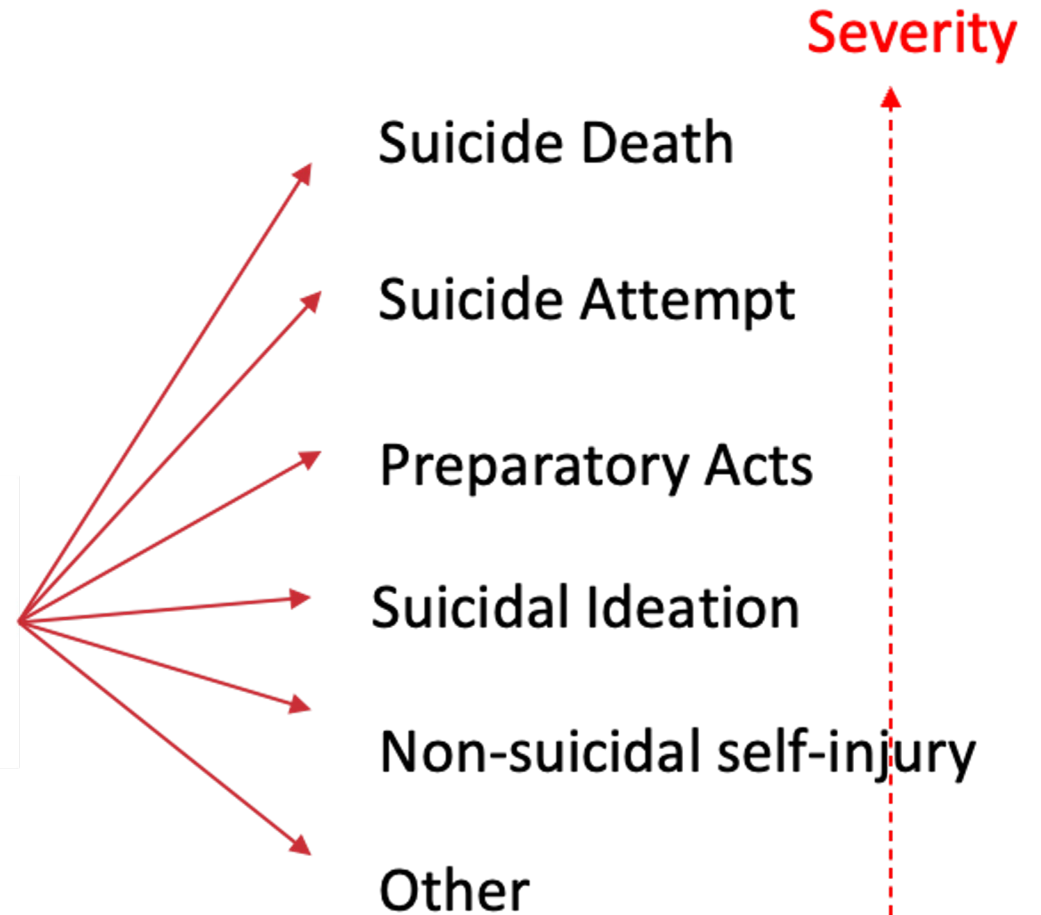
## Gold Standard:

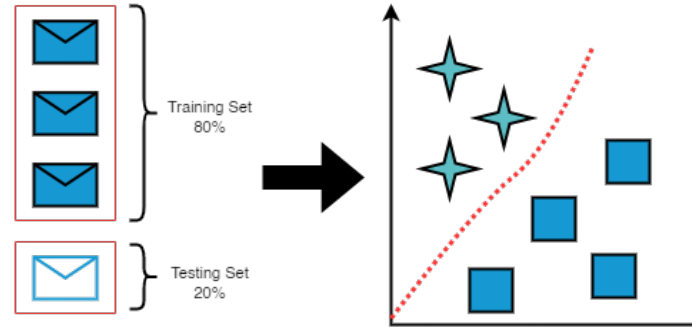
ED Visit  
Notes



**Columbia Classification Algorithm of Suicide Assessment (C-CASA): Classification of Suicidal Events in the FDA's Pediatric Suicidal Risk Analysis of Antidepressants**

Kelly Posner, Ph.D., Maria A. Oquendo, M.D., Madelyn Gould, Ph.D., M.P.H., Barbara Stanley, Ph.D., and Mark Davies, M.P.H.

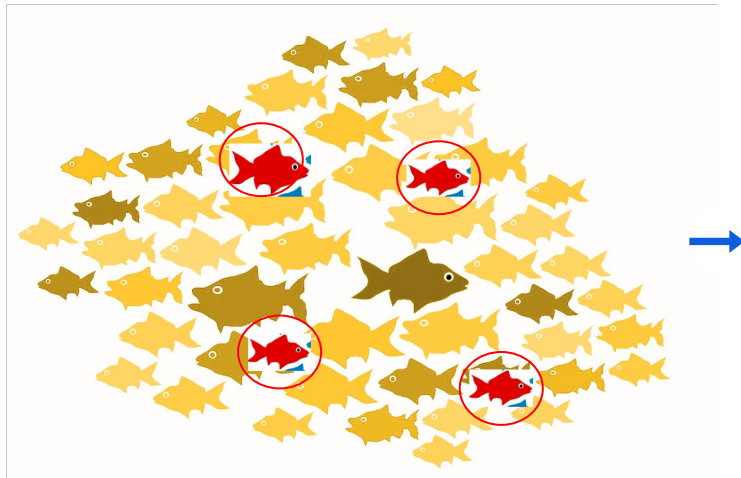




## Key findings:

- ICD-10-CM codes and chief complaint were imperfect at detecting children with suicide-related visits.
- Machine learning-based approaches were more sensitive.
- \*Not all children were detected equally – boys and younger children (10-12) were less likely to be detected correctly

# Study expansion



Who is being missed?  
(and why?)

## Child Suicidality EHR Phenotyping (CSEP) Study

How might detection of  
SITB in children be more  
accurate and equitable?

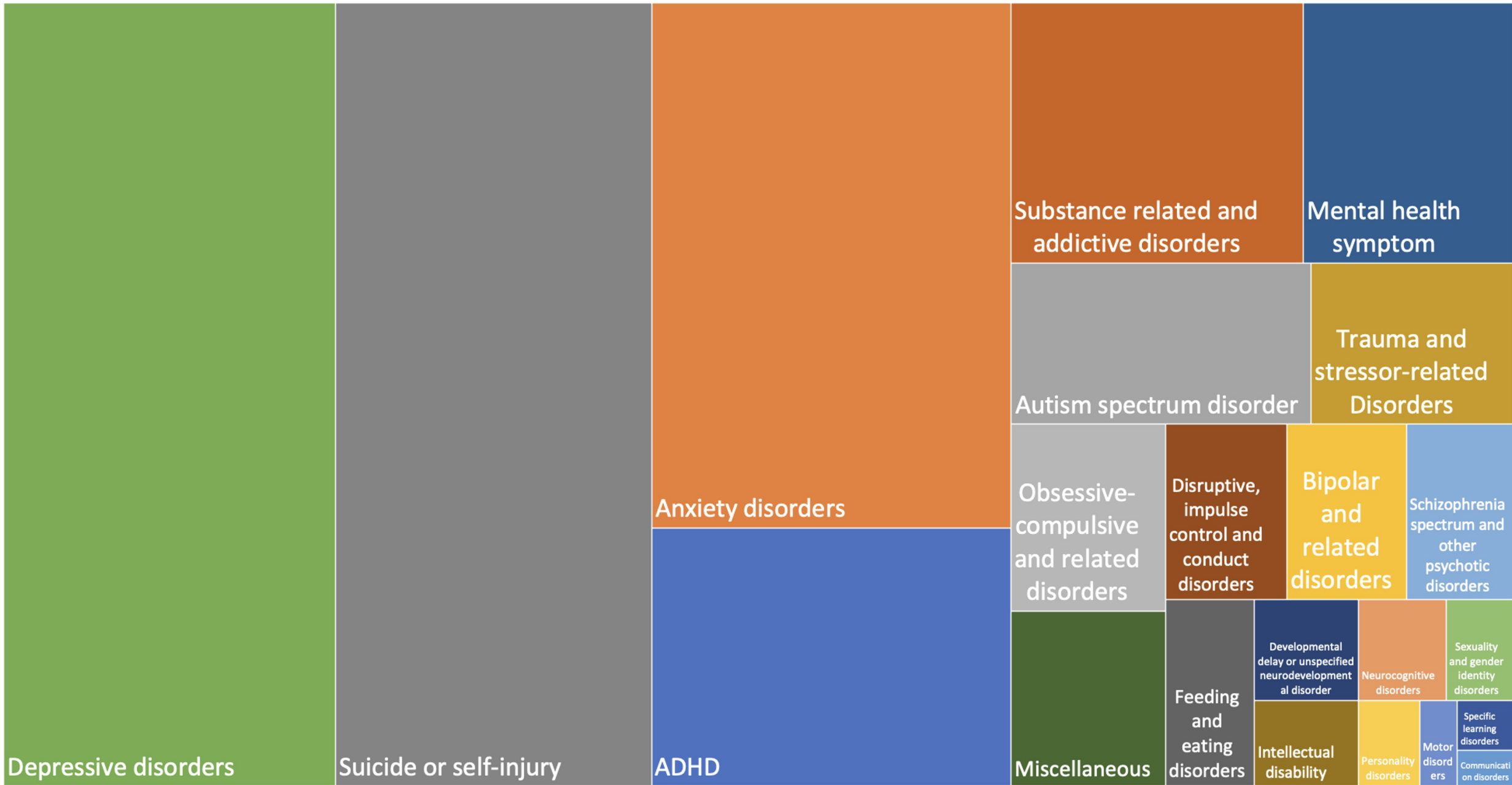
**N=3,000**

# Tree Map of ED Visit Diagnoses for Children (6-12 years old)





# Tree Map of ED Visit Diagnoses for Adolescents (13-17 years old)



# Comparing classifiers

(1) ICD-10-CM and chief complaint

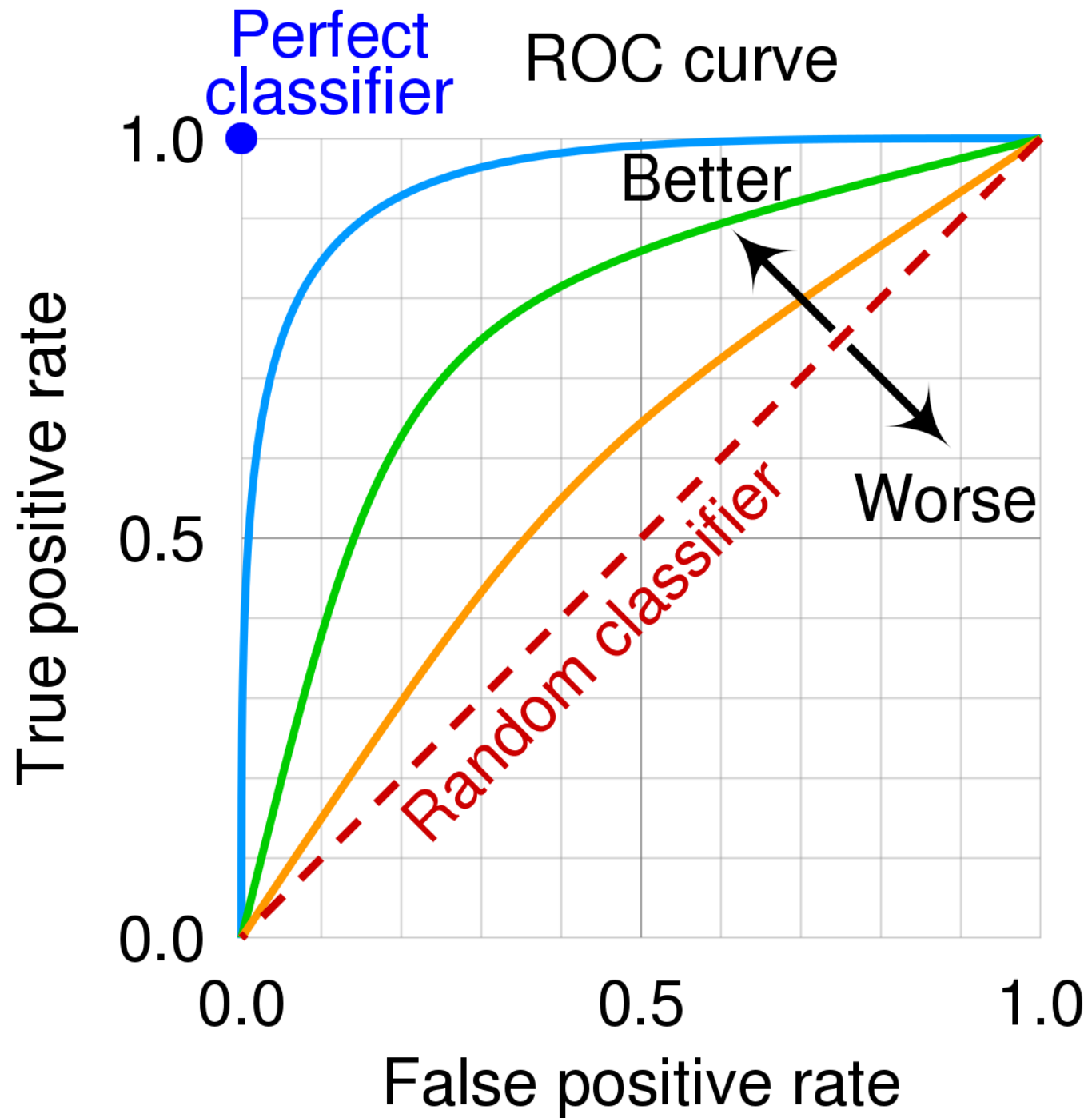
Existing standard

(2) All structured data elements

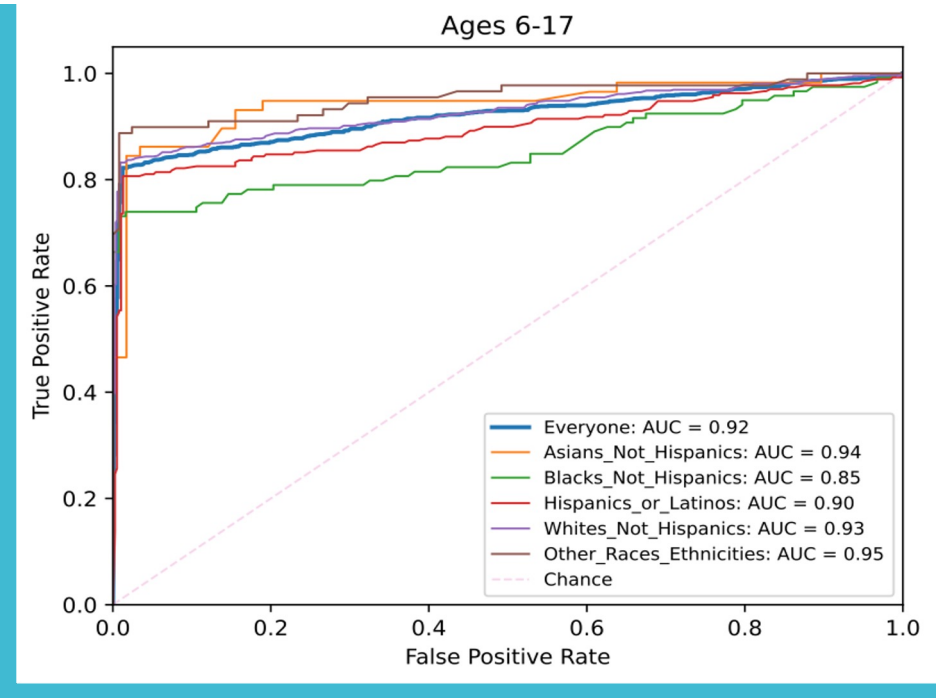
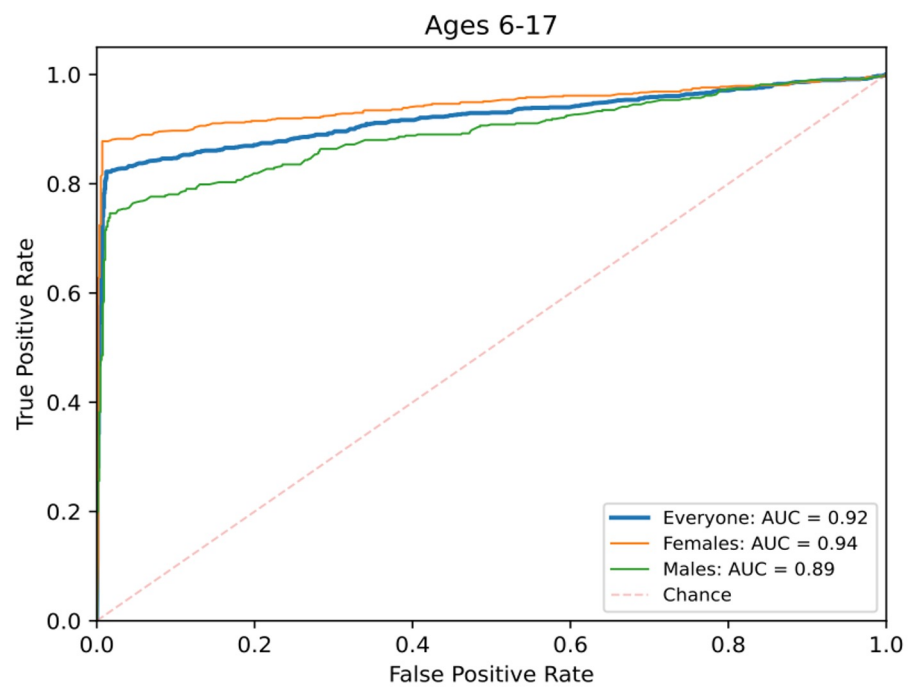
ML-based approach

Sample is 2702 MH-related ED visits by unique children 6-17yo.

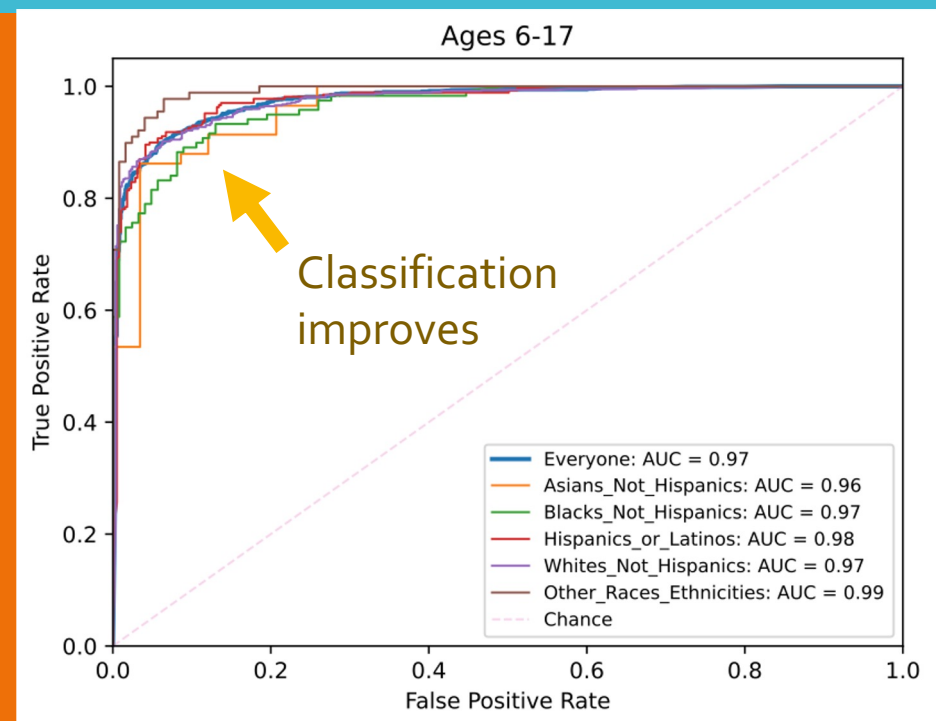
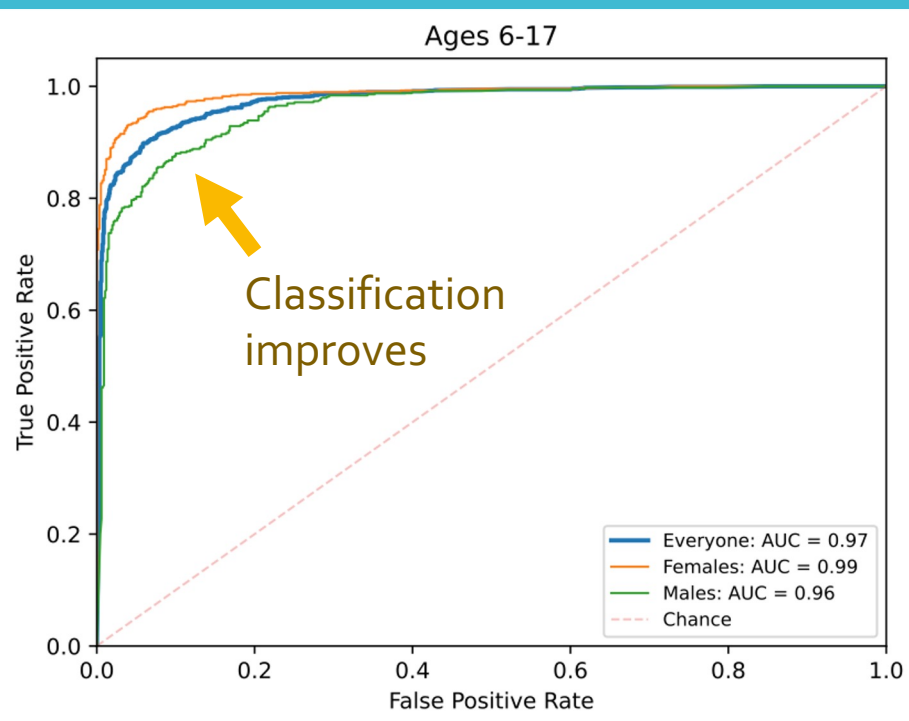
Random forest, nested 10-fold cross-validation with grid search for hyperparameter optimization, implemented in Python Scikit-learn.



# Preliminary Data



OLD

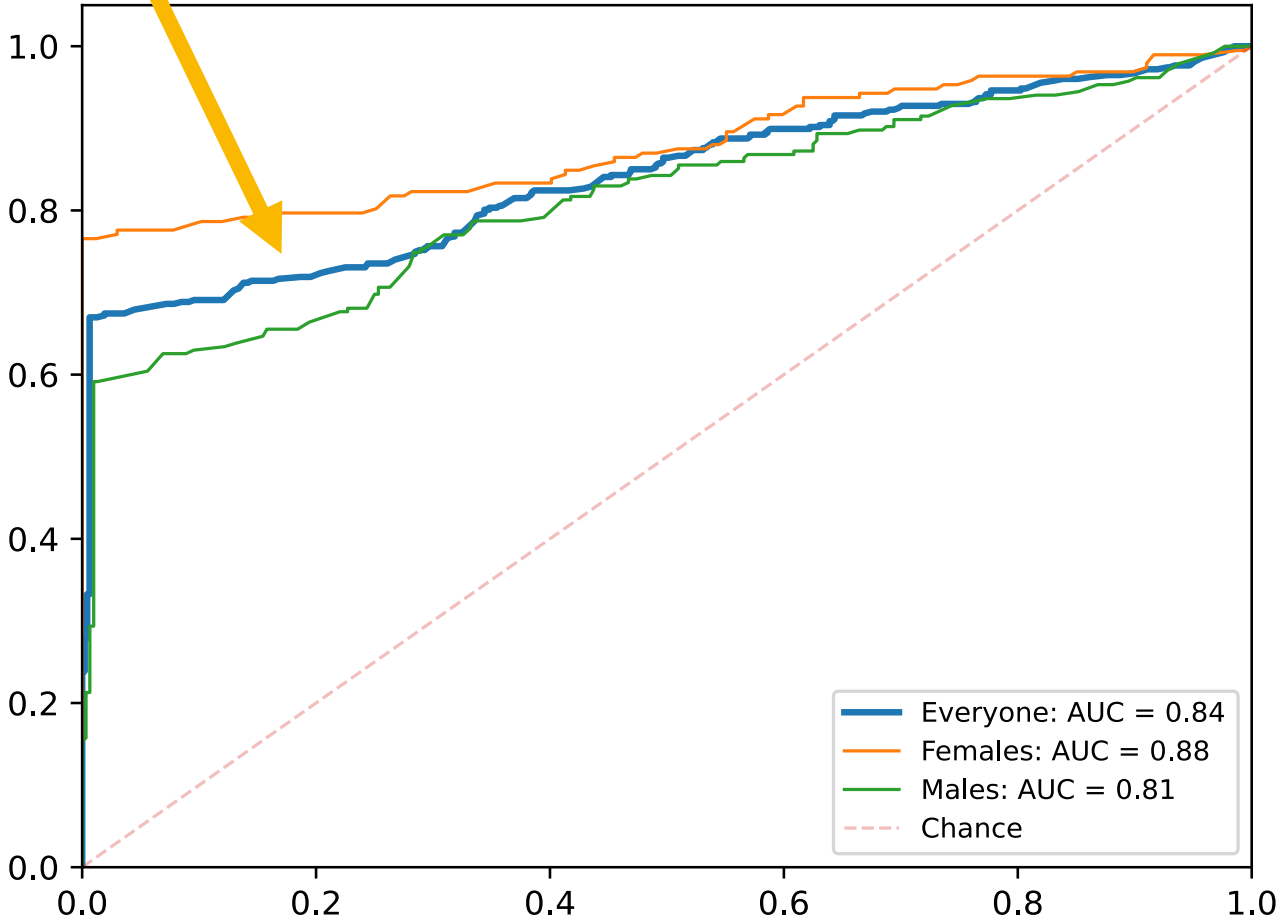


NEW

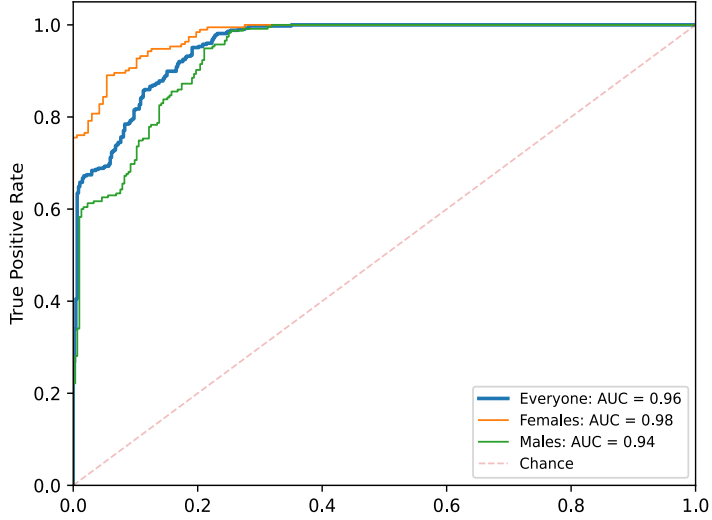
# Preliminary Data

Children

Ages 6-12



Ages 6-12



**Bottom Line:**  
Existing methods imperfectly detect youth with suicide-related ED visits, and some youth are at high risk of being missed.

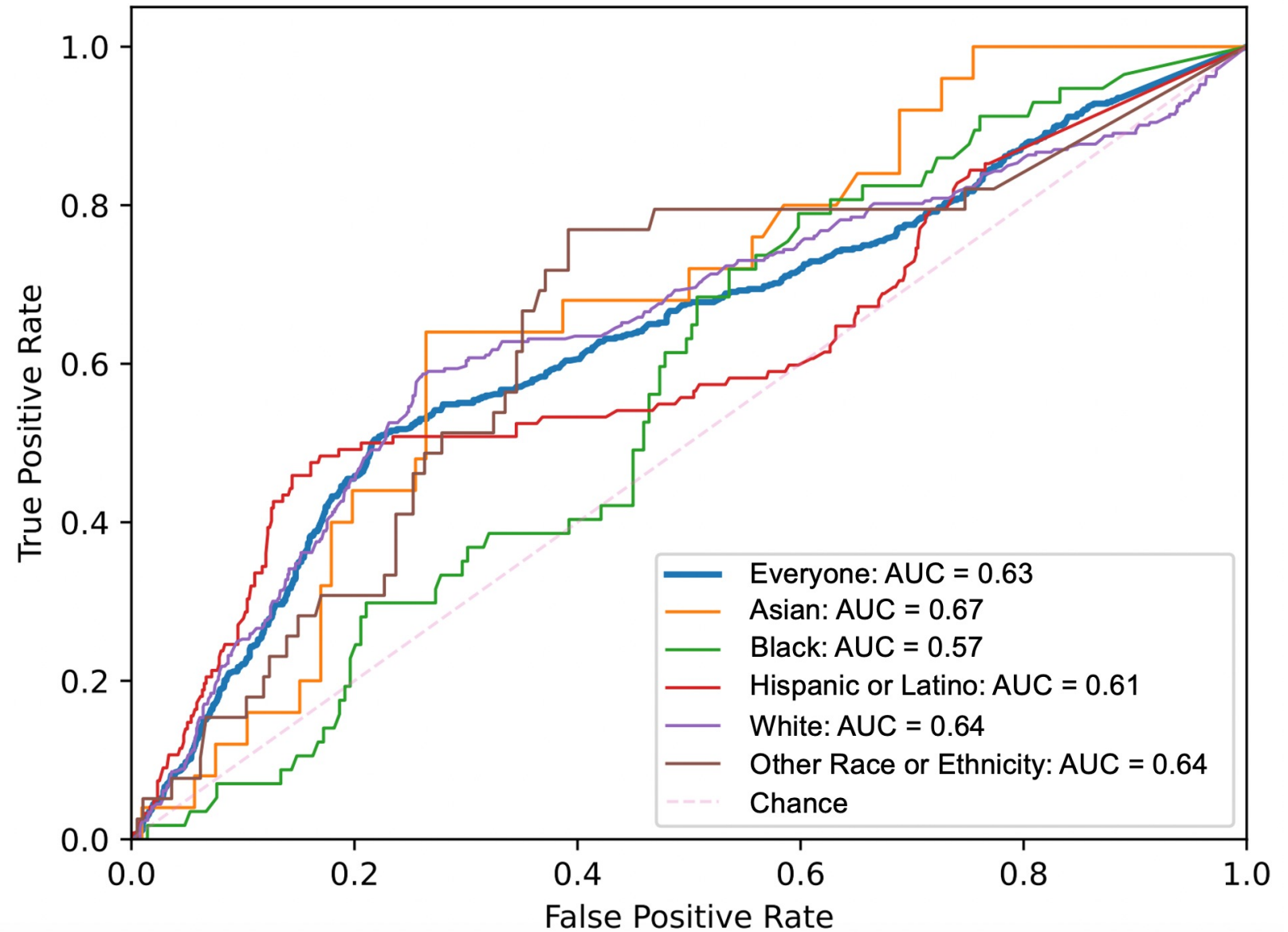


# Preliminary Data

Ages 6-17

N=2702

Existing case surveillance methods may miss non-suicidal self-injury (NSSI)



# Do clinical notes help detection?

Using weak supervision and deep learning to classify clinical notes for identification of current suicidal ideation (Cusick, *JAD Reports*, 2021)

Identification of suicidal behavior among psychiatrically hospitalized adolescents using natural language processing and machine learning of electronic health records (Carson, *PloS ONE*, 2019)

Identifying suicidal adolescents from mental health records using natural language processing (Velupillai, *Studies in Health Technology Informatics*, 2019)

Reason and history

Results of the physical examination

Assessment, diagnosis, actions decided

Personnummer	850322 41 09 25
AK	Majnczab/IV
Nuv sjd	Somnaren -R4 op pat för accomega.i. Står sedan den p Cortone 25 mg 1/2 tabl x 3.
Aktuellt	Pat blev för fem dagar sedan förkyld med svava och hosta samt feber. Fördublade på Cortone-dosen till 25 mg 1 x 3. Inkommer nu då hon idag på morgonen uppmätte en temp på 38,5°. Har för övrigt bra. Hostan har minskat, men svava kvarstår.
Status	Dullt och opåverkad. God muskelkraft. 120/80.
Åtta	Reenliggsfrött.
Hörs	Regelbunden rtm. Erevens 72/min. Inga blåsljud.
Hörsita	Auskulteras EKG u a.
Stygur	
Leb	SR 14 mm. Bp 143/91. Vita 5/7. Hb 137. K 7,6. glukos 7,9 krenturin 0,7. Utslutstatus är u a.
Styg	Pulm: Inga infiltrat. Status post throraxfrakt.
Svullm, Stygård	38-grad feber som är opåverkad. Inga ett hypofysadnom. Korrisompositivitet. Inkommer nu akut p g i fem dygn senare på temp omkring 38° och idag på morgonen temp 38,5°. Har fördublat sin Cortone-dos till 25 mg 1 x 3. Har kontakt med dr Saw Eriksson, som är bekant. Vi bestämmer att pat skall stå kvar i den fördublade Cortone-dosen. Inhämtas på pc. Vi nå hem. Uppmanas att återkomma om feber kvarstår eller stigra till och svagdomar är borta. Är sjukaktiv i om den 31/7 -85.
856326 41 09 25	Pat har haft feber omkring 38° och stått ungefär 1 x 3 dubbel Cortone-dos 25 mg x 3 med 5 varliga fall 12,5 mg x 1 till nu. Inga förändringar i status. Inkommer nu akut på pc. Inhämtas på pc. Vi nå hem. Uppmanas att återkomma om feber kvarstår eller stigra till och svagdomar är borta. Är sjukaktiv i om den 31/7 -85.

Note from visit

Short note

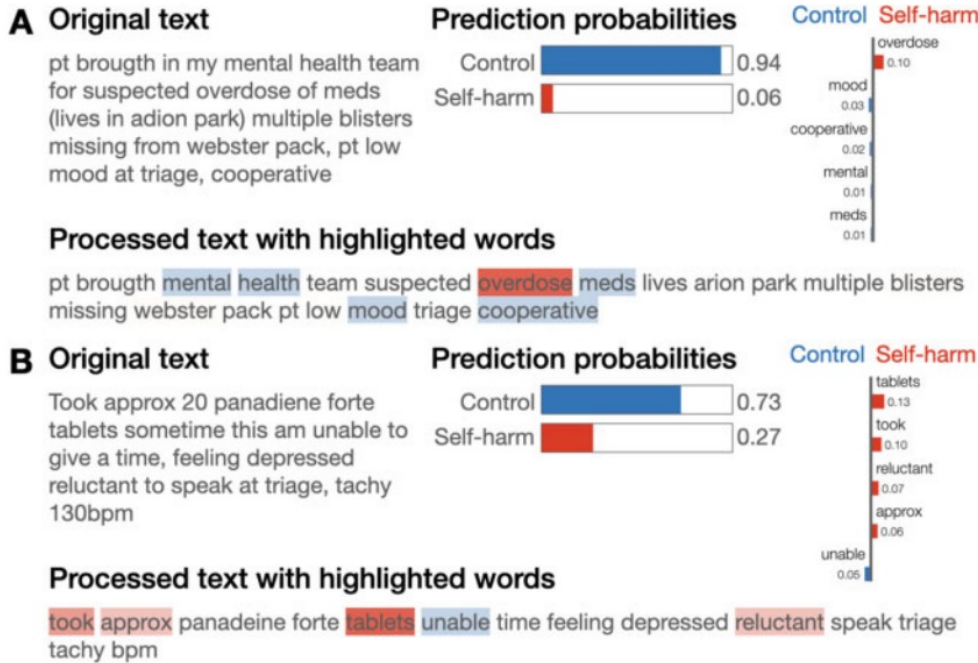
Improving ascertainment of suicidal ideation and suicide attempt with natural language processing (Bejan, *Scientific Reports*, 2022)

Bottom Line: Notes likely help with detection, yes, but challenges remain, and head-to-head comparisons of new and existing methods are scarce.

# Detection of Self-harm and Suicidal Ideation in Emergency Department Triage Notes (Rozova, *JAMIA*, 2021)

Aimed to develop an automated system for detection of self-harm presentations directly from ED triage notes

Used Natural Language Processing from 477k free-text notes



**Figure 5.** (A, B) Illustration of triage notes annotated as SH and misclassified as Controls (false negatives). The bars on the left show the predicted probability of each class. Horizontal bar plot provides the weights of five most important features. On the bottom, these words are highlighted in the text.

Bottom line: Machine learning 'dramatically' outperformed keyword-based searches

## Talk Structure

Setting the challenge

Current efforts

Ongoing challenges

Roadmap ahead

Takeaways

# Challenges

Stacked deck: Algorithmic fairness

Moving target: Childhood development

Leaky pipeline: Good software  $\neq$  good care

Slippery slope: Ethics of health data use



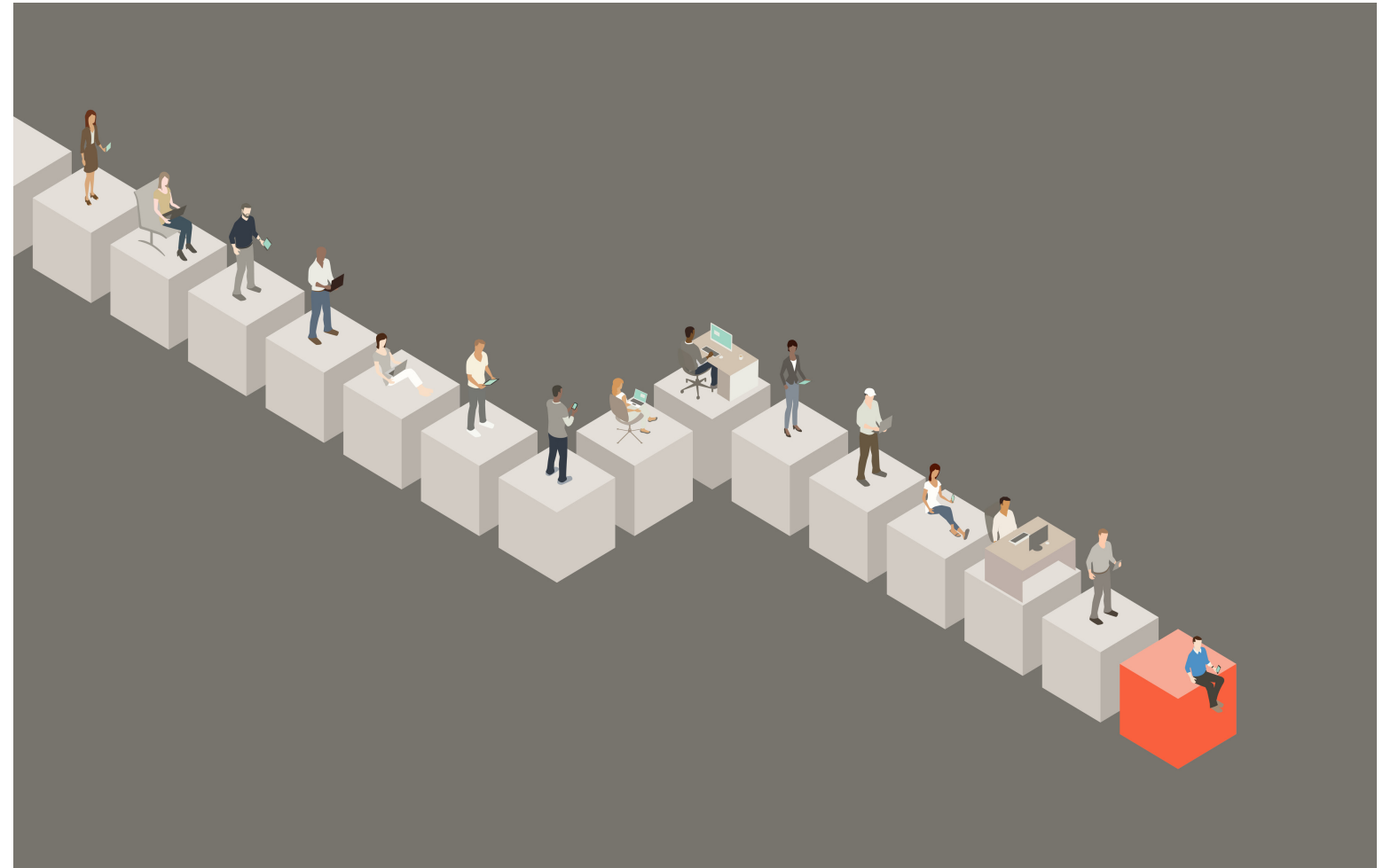
# Algorithmic Fairness



# Moving Target



# Leaky Pipeline





# Slippery Slope



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## Smarter algorithms

Larger datasets, better communication between health systems

Natural language processing rapidly evolves

Generative AI and large language models emerge in this area



## Adaptable medical record software

Flex appearance of medical record to providers and patients

Delivery of guidance directly to patients (portals)

Opportunity for patients to correct and add information





## Community perspectives

Increased awareness of integrating perspectives of families and stakeholders

Understand what providers want, what parents want, what children and adolescents want (infrequently the same)



# Data from the *real-world*

Health data from outside of the health setting

- Smartphone and digital trace data

- Social media

- Internet browser and search data

Thinking beyond doctor-patient

- Nursing interventions

- Involuntary mental health detainment



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# Takeaways

- Suicide is a highly prevalent condition for personalized medicine offers hope
- Clinical decision support may bolster person-centered care by delivering personalized recommendations to patients and providers
- Detection of need may be inaccurate or biased, and children are a moving target with special considerations
- Better detection of healthcare visits related to suicide refines precision and capacity to intervene early

# Thank you

- UCLA Mental Health Informatics and Data Science (MINDS) Hub
  - Kristen Choi, RN, PhD
  - Chrislie Ponce, BA BS
  - Elyse Tascione, MA
  - Alanna Montero, BS
  - Bonnie Zima, MD MPH
- UCLA Department of Medicine Statistics Core
  - Alex Klomhaus, PhD
  - Joshua J. Lee, BS
  - Angshuman Saha, PhD
  - Chi-hong Tseng, PhD
- CTSI Biomedical Informatics Program
  - Amanda Do, MS
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<https://cch.ucla.edu/minds/>



Q&A

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<https://cch.ucla.edu/minds/>