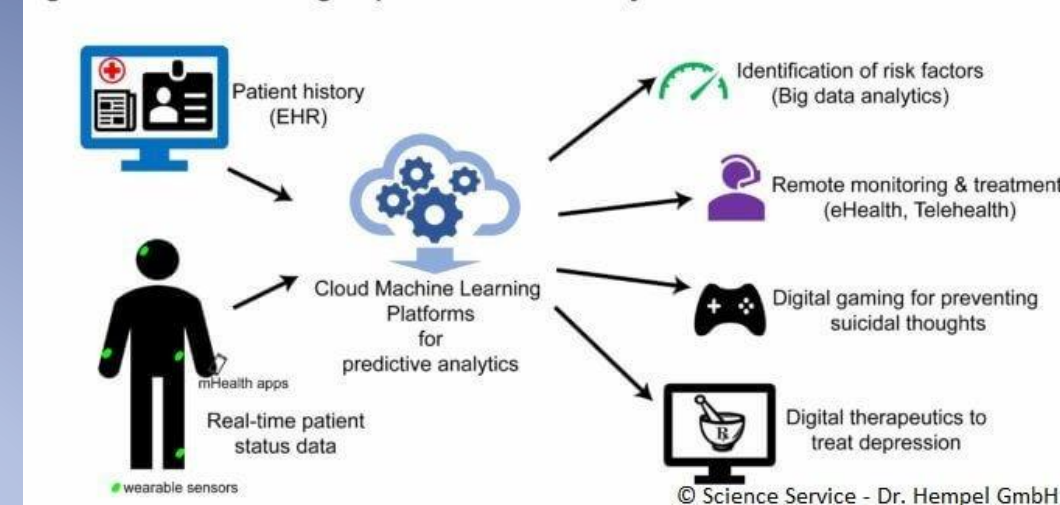


Figure 2. Workflow for digital prevention of death by suicide



Assessing and Managing Adolescent Suicidal Behavior: New Approaches

Brain & Behavior Research Foundation
 2020 Meet The Scientist Webinar Series
 David Brent, MD
 Tuesday, September 8th, 2020

Disclosures

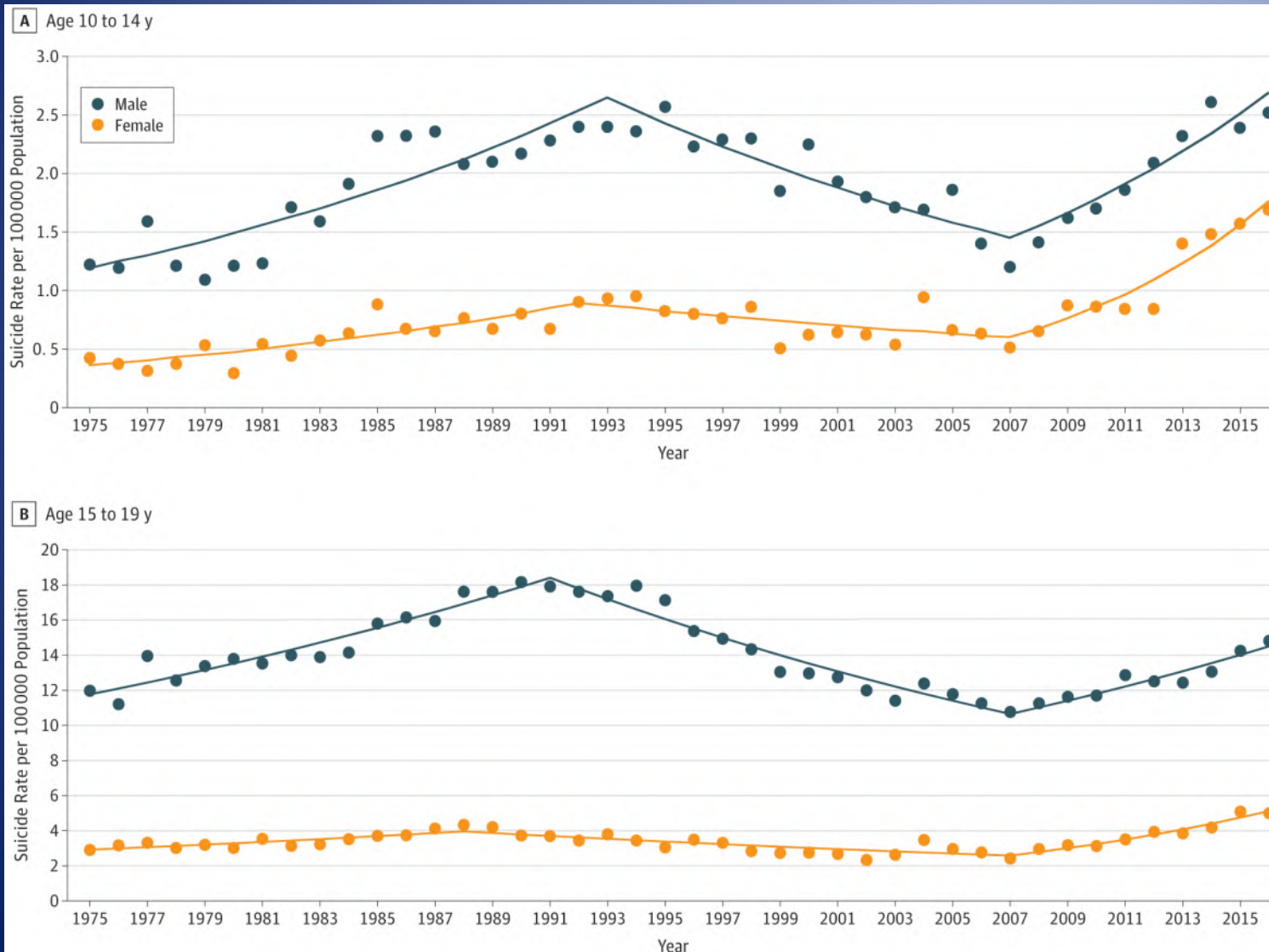
- Research funding: NIMH, AFSP, Once Upon A Time Foundation, Beckwith Foundation, Endowed Chair in Suicide Studies
- Clinical programmatic support: Commonwealth of Pennsylvania
- Royalties: UpToDate, eRT, Guilford Press
- Consultation: Healthwise
- Scientific Boards: Klingenstein Third Generation Foundation, AFSP

Objectives

The attendees will be able to describe:

- 1) Rationale for screening for suicide risk in in pediatric EDs and the advantages of using an adaptive screening tool.
- 2) Rationale, methods, and major findings of studies that apply machine learning to electronic health records in order to delineate suicidal risk.
- 3) How machine learning when applied to social media and to fMRI neural signatures of suicidal people illustrate the role of self-referential thinking in suicidal risk.
- 4) How to generate a safety plan, and how a brief inpatient intervention and a safety planning app can protect high risk youth against recurrent suicidal behavior

Challenges in the Prevention of Adolescent Suicide



- Hard to predict
- Most at-risk patients present in ED or primary care, not MH
- Assessment relies heavily on self-report
- Youth suicidal behavior is often **impulsive**: Need for detection of inflexions in suicidal behavior, and availability of **just-in-time** interventions

Two approaches to suicide prevention

Population Health

- **Prediction and identification**
- **Particularly important in primary care and emergency room settings**
- **Optimize match between needs and resources**

Individual differences

- **Alternatives to self-report**
- **Sensitive to fluctuations in suicidal risk in real time**
- **May lead to risk-triggered interventions**

Why Look for Patients at High-risk for Suicide in EDs?

- Youths who come to the ED are at increased risk for attempts:
 - 10.7% of those who die by suicide visited an ED within 2 weeks of death (Cerel et al., 2016)
- The reasons for coming to the ED are often risk factors for suicide
 - Somatic complaints
 - Chronic medical illness (e.g., asthma)
 - Assault
 - Head injury
 - Alcohol/drug intoxication (Grupp-Phelan et al., 2012; Borges et al., 2017)
 - Use of ED for primary care purposes (Slap et al., 1989; Wilson & Klein, 2000)

Why Would Screening for Suicide Risk Be Helpful in EDs?

High proportion of youth visit the ED at least once a year

- 19% visit ED at least once per year (US Dept HHS, 2013)

- Case-finding is important

- 33-50% of those seen in ED who screen positive for suicide risk do **not** present as suicidal (King et al., 2009; Ballard et al., 2017)

- 50% of teens who die by suicide are first attempters (Brent et al., 1988; Shaffer et al., 1996)

- Low proportion of suicides are in treatment at time of death (Brent et al., 1988, 1993; Shaffer et al., 1996)

EDs: Room for Improvement

- Only 38% of youthful suicide attempters seen in an ED had a psychiatric diagnosis (vs. studies that find that 80-90% have a diagnosis, suggesting inadequate assessment) (Bridge et al., 2015)
- Very low rate of assessment of availability of lethal agents and counseling (e.g., 15%; Betz et al., 2017)

Evidence that brief screening can be effective in case-finding

- Brief screens can identify youth at high suicidal risk (King et al., 2009; 2015; Horwitz et al., 2001; 2010; 2015; Grupp-Phelan, 2012).
- ASQ-5, most widely used screen (Ballard et al., 2017)
 - 53% of those who screened positive did not present for suicidal risk
 - In predicting return to the ED within 6 mos for suicide-related issues, 93% sensitive but only specificity of 43%.
 - In much larger sample with return to ED for suicidal risk (record review) as the outcome, 93% specificity, but 60% sensitivity for universal screen (DeVylder et al., 2019)
- Screening alone, though is inadequate without follow-up to link patients to aftercare (Miller et al., 2017; Inagaki et al., 2014)

Adaptive Screens for Suicidal Risk

- Currently, in ED-STARS, a study in 13 pediatric EDs (PIs King, Grupp-Phelan, Brent), we are working with Robert Gibbons to develop an adaptive screen.
 - Adaptive screen draws from a larger, more heterogenous item bank and presents different questions to different individuals conditional on previous responses.
 - Useful in assessing suicidal risk because it is multi-dimensional
 - Preliminary results in a prospective study of 2000 adolescents indicate that a 6-11 item screen can predict a suicide attempt within 3 months with $AUC=0.89$, in validation also had $AUC>0.8$.

Conclusions about screening in ED

- ED is a good place for screening because many high risk youth go there
- Many do not present as suicidal but if screened are positive
- Room for improvement in assessment and lethality counseling
- Brief screen needed, adaptive features desirable
- IAT may be helpful in non-suicidal group but requires further study
- If screen positive, need plan for further assessment, and a brief intervention providing resources and follow-up to encourage adherence with outpatient care

Machine learning and electronic health records



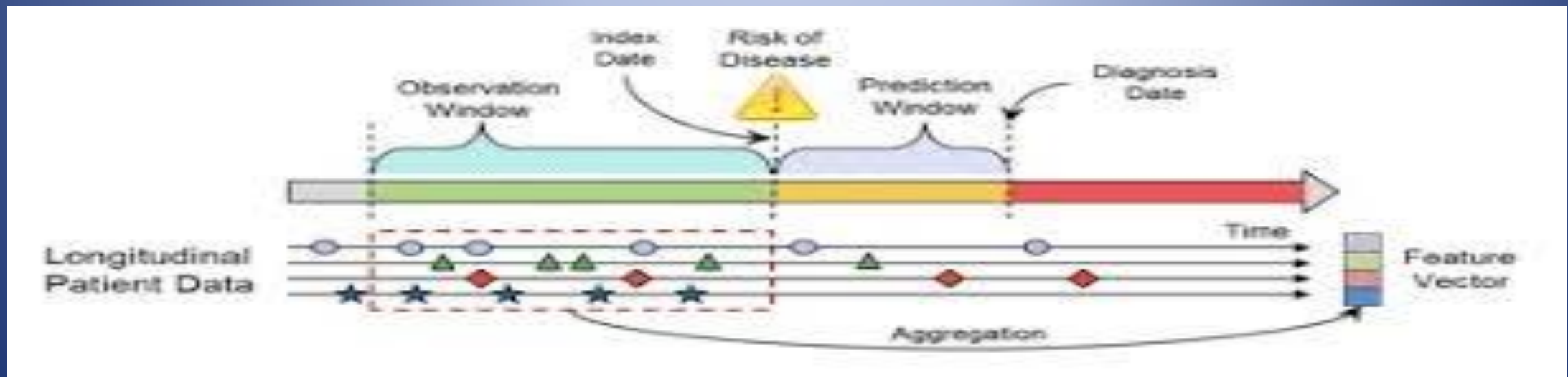
Neal Ryan, MD



Fuchiang "Rich" Tsui, PhD



Candice Biernesser, PhD



Machine Learning (ML)

- Machine learning modifies algorithms through feedback on performance designed to improve future performance.
- Advantage over standard linear multivariate techniques because ML can handle co-linear data.
- Advantageous for suicide risk prediction because suicide risk is multidimensional and consists of multiple variables that each make a small contribution to risk.
- Disadvantage is that the more “powerful” the machine learning technique, the less transparent the mechanism for decision-making.
- Consequently— better for prediction and classification than for mechanistic research designed to understand etiology

Machine Learning of EHRs (Simon et al., 2018)

- In 7 health systems: 2,960,929 patients with MH dx
- 10,275,853 specialty mental health visits
- 9,685,206 primary care visits
- 24,133 attempts, 1240 suicides
- In both specialty mental health and primary care settings, able to identify top 5%ile of risk= 43-48% of suicides and attempts within 90 days, with AUC's 0.83-0.85
- However, not informative about suicide risk for those without a mental hx diagnosis in the EMR.

Natural language processing (NLP) and suicide

- Use of NLP can identify suicidal ideators and attempters that were not given a diagnosis (Anderson et al., 2015; Haerian et al. 2012; Zhong et al., 2018)
 - Zhong et al., 2018– Of 196 women with suicidality in dx, 76% positive by NLP; of 486 who were negative, 30% were positive on NLP
- McCoy et al., 2015– “positive valence” identified in clinician notes predicts a lower risk of suicide (OR=0.70).

Methods: Beckwith Foundation Project

- Obtained medical records from 18 UPMC hospitals from January of 2007-December 2016.
- Case: ICD-9/10 dx of suicide attempt, with at least 2 years of records prior (at least narrative on record), no previous attempts → 5099
- Control— no diagnosis of suicide attempt, or death → 40139
- Data quality— reviewed 150 cases of suicide attempt— all were definite or probable attempts, only 1.2% of “controls” had evidence of SA in note.
- Used 8 types of machine learning with time windows ranging from 7-730 days.
- 70% of sample to develop algorithm and then validated on 30%

Results: Best ML approach was Extreme Gradient Boosting (EXGB) (Unpublished)

Time Window	AUC	Sensitivity	Specificity
<7 days	0.93	0.90	0.79
90 days	0.93	0.95	0.70

Strata	M	F	<35 yrs	>35 yrs	MA	Prev visit ED	Prev visit inpt	Race W	Race AA	Dep
AUC	0.94	0.92	0.91	0.94	0.88	0.92	0.99	0.93	0.91	0.88

Predictors of Suicide Attempt

Structural

Characteristic	OR
Male sex	1.3
White race	1.3
Age (15-24)	13.9
Medicaid	2.9

NLP

Characteristic	OR
Suicide attempt	2.3
Mood disorder	9.3
Sleep problem	3.5
Tattoo	2.8
Marital conflict	4.7
Imprisonment	2.2
Employed	0.1
Family support	0.29

Conclusions

- ML can result in accurate predictions of SA within narrow time window
- NLP (unstructured data) adds to accuracy of prediction above and beyond structured data ($p < .001$)
- Algorithm is robust to point of service, diagnosis, and demographics

Limitations

- Patients may have had visits in other health systems
- Accuracy of diagnostic coding
- If health care biases in access, could also result in a biased algorithm
- More complicated the algorithm, the more opaque and harder to explain to clinicians and patients
- Need to figure out how clinicians can use this algorithm
- Need for qualitative research with clinicians, patients, administrators, and ethicists about the best way to apply these algorithms

Machine learning of neural representations of suicide and emotion concepts identifies suicidal youth

Marcel Adam Just^{1*}, Lisa Pan², Vladimir L. Cherkassky¹, Dana L. McMakin³, Christine Cha⁴, Matthew K. Nock⁵ and David Brent²



Marcel Just, PhD



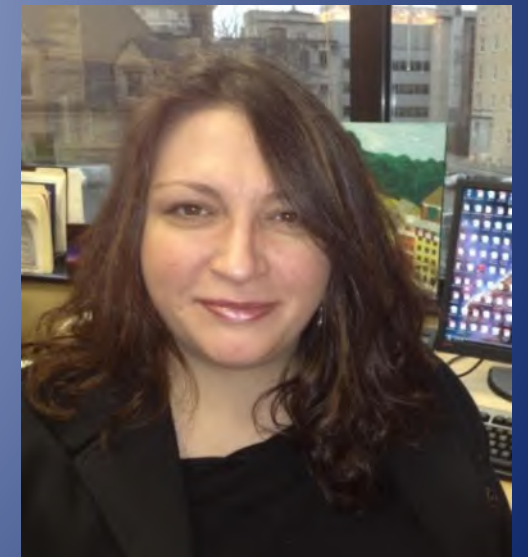
Matt Nock, PhD



Christine Cha, PhD



Dana McMakin, PhD



Lisa Pan, MD

Machine learning of neural signals of suicide and emotion-related words

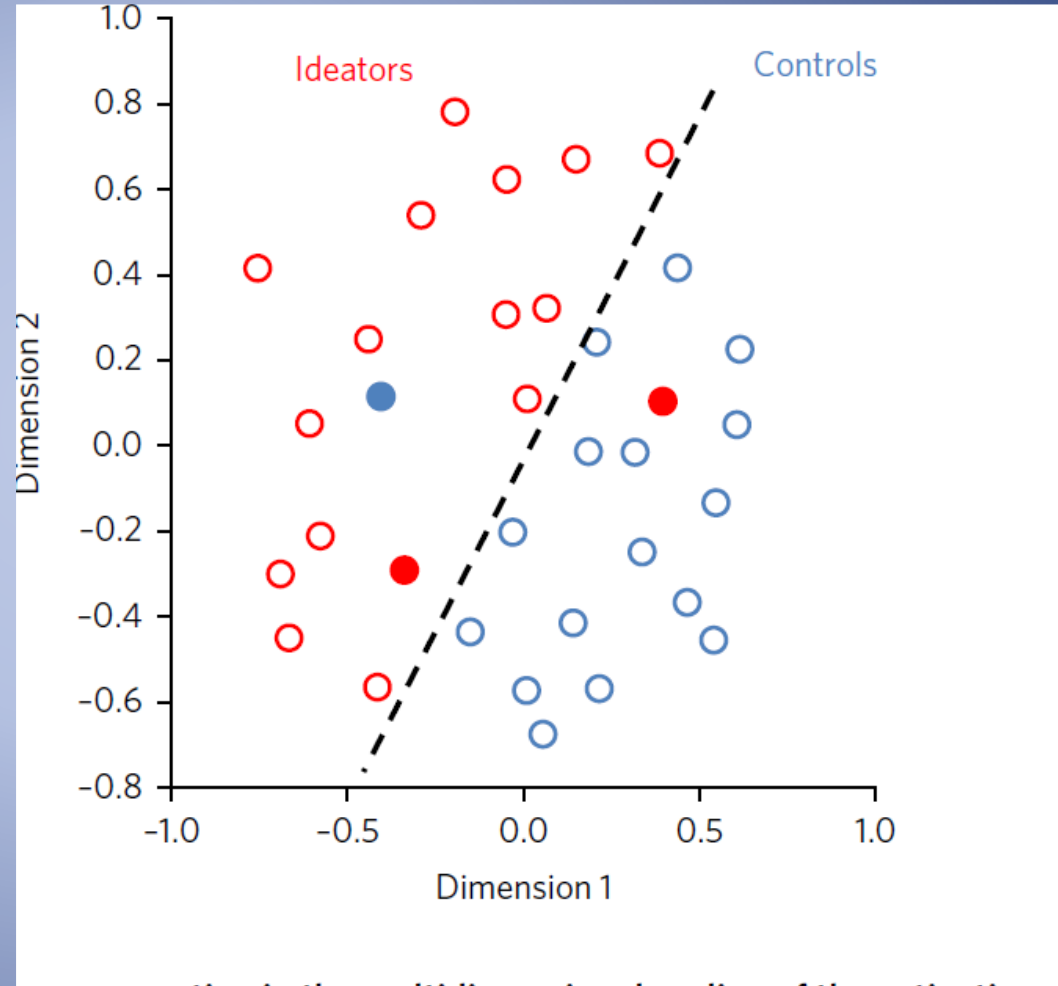
- 17 young adults with suicidal ideation and 17 healthy controls
- Second sample of 34 participants
- Had them think of a series of 30 words (10 related to suicide, 10 positive, 10 negative emotion valence).
- Used machine learning to discriminate activation patterns
- Tested if the machine learning classifier would:
 - Discriminate ideators from controls
 - Identify which ideators had a history of an attempt
 - Identify distinct emotion component signatures that discriminate between groups

List of 30 stimulus words

More 21 stimulus concepts		
Suicide	Positive	Negative
Apathy	Bliss	Boredom
Death	Carefree	Criticism
Desperate	Comfort	Cruelty
Distressed	Excellent	Evil
Fatal	Good	Gloom
Funeral	Innocent	Guilty
Hopeless	Kindness	Inferior
Lifeless	Praise	Terrible
Overdose	Superior	Trouble
Suicide	Vitality	Worried

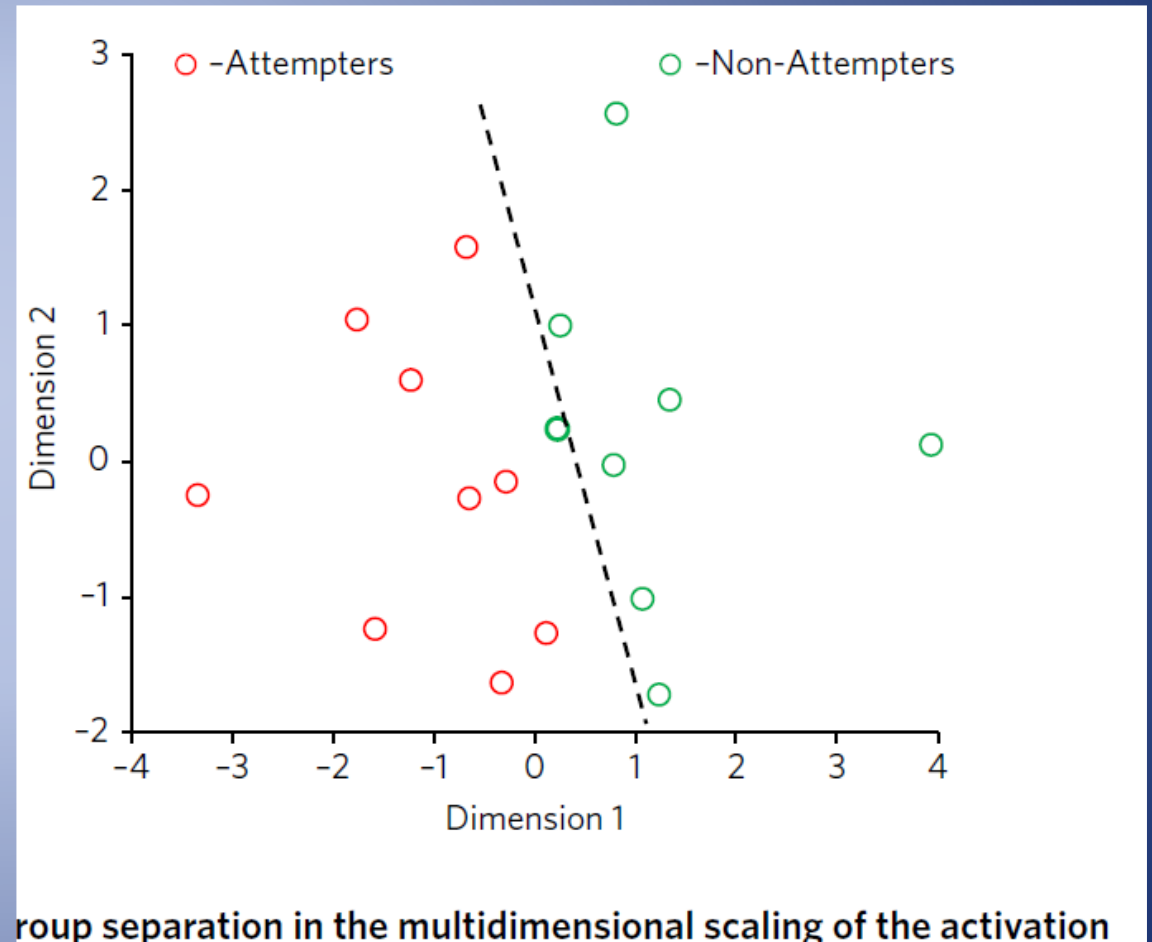
Separation of Ideators from Controls

- Able to discriminate ideators from controls (AUC=0.91).
- Words were: death, carefree, good, cruelty, praise, trouble in descending order
- AUC=0.94, after adjusting for anxiety, depression, ASR, CTQ
- If left half out, classification accuracy AUC=0.76
- Brain regions that discriminated: left superior medial frontal area, medial/frontal ACC, right middle temporal area, left inferior parietal area, left inferior frontal area

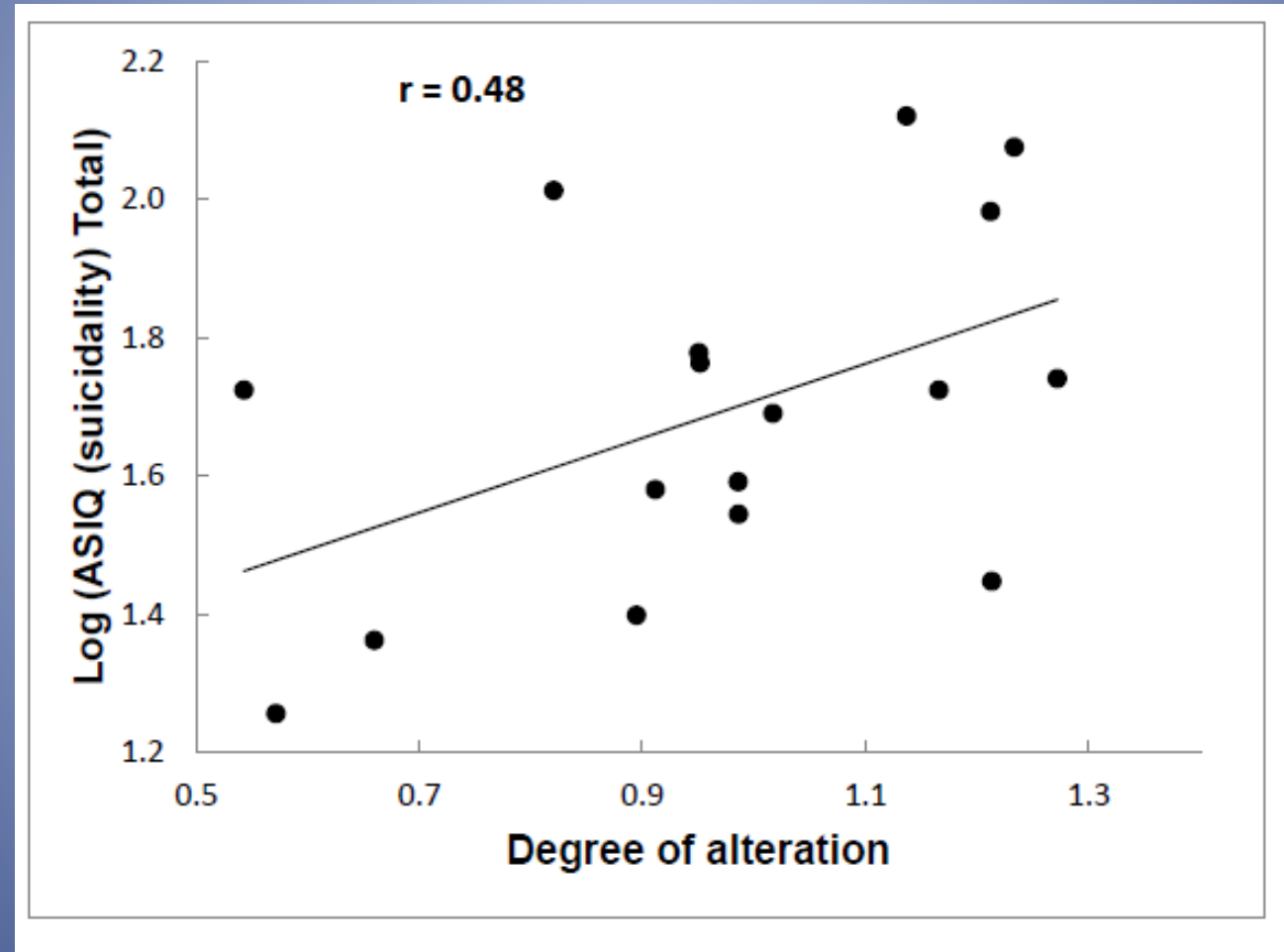


Ideators with a history of an attempt from those without such a history

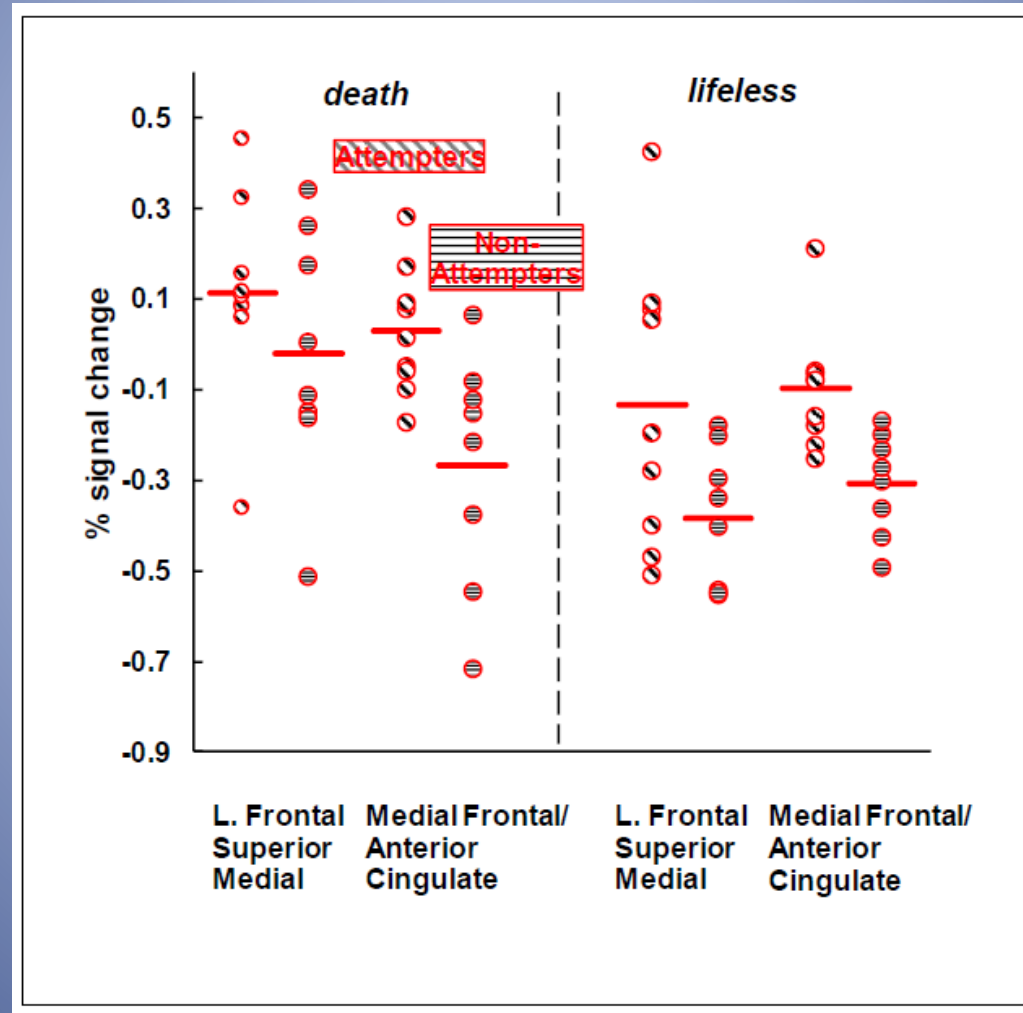
- Able to discriminate ideators with a history of an attempt from those without such a history (AUC=0.94)
- Best discriminating words: death, lifeless, carefree
- Discriminating regions: L superior medial frontal area, medial/frontal ACC, right middle temporal region



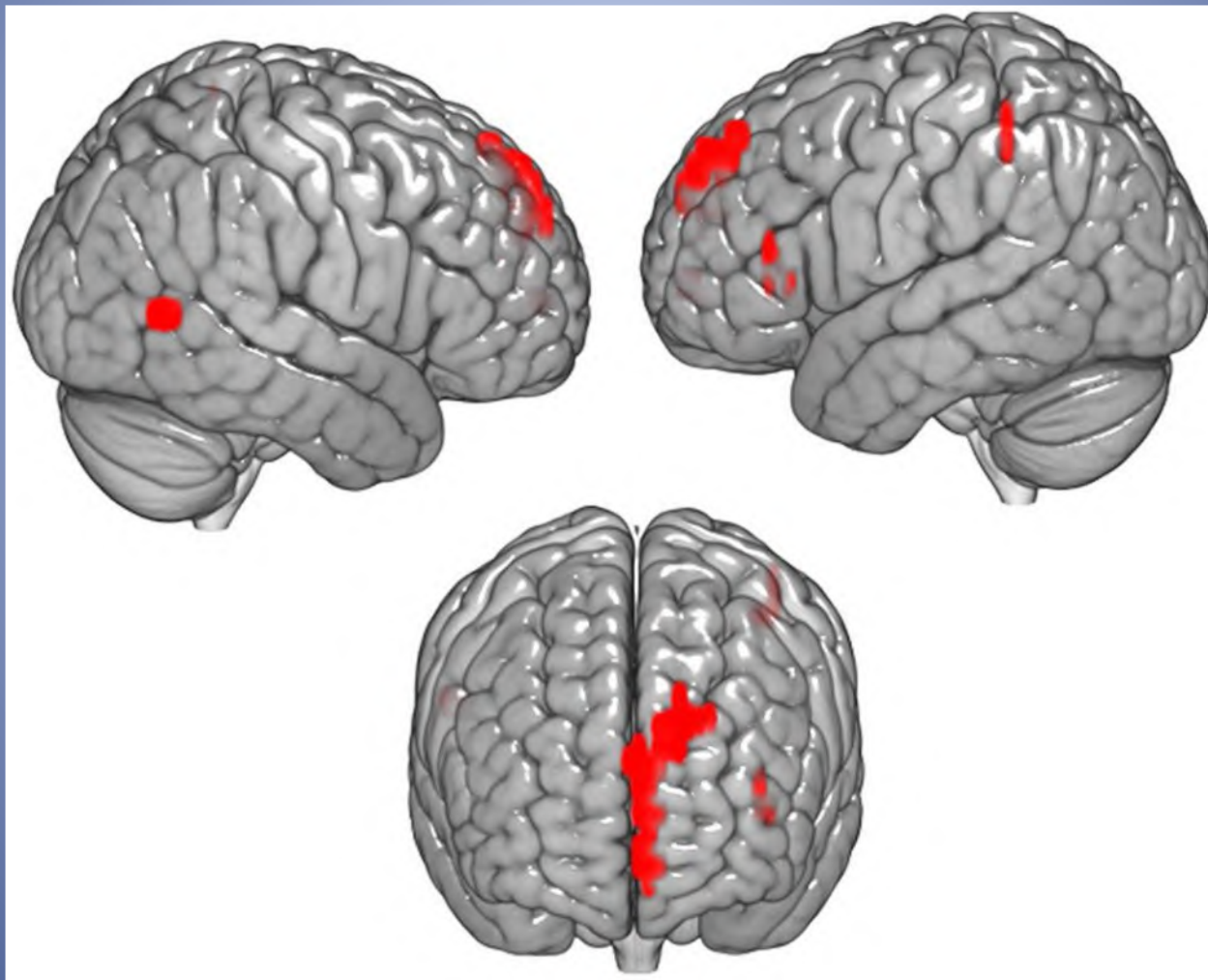
Correlation between degree of alteration of discriminating concepts and log (ASIQ) self-report of suicidal ideation in 17 ideators



Distributions of activation levels for 9 ideators with a suicide attempt and 8 ideators without such an attempt for two concepts in two locations



Machine learning of neural signatures of suicidal and emotional words (Just et al., 2017)



Limitations and future work

- Small sample, mostly female, high IQ
- Dependent on attention and cooperation
- Did not have psychiatric controls, although adjustment did not affect the algorithm, and were able to discriminate ideators with vs. without a history of an attempt
- Cross-sectional



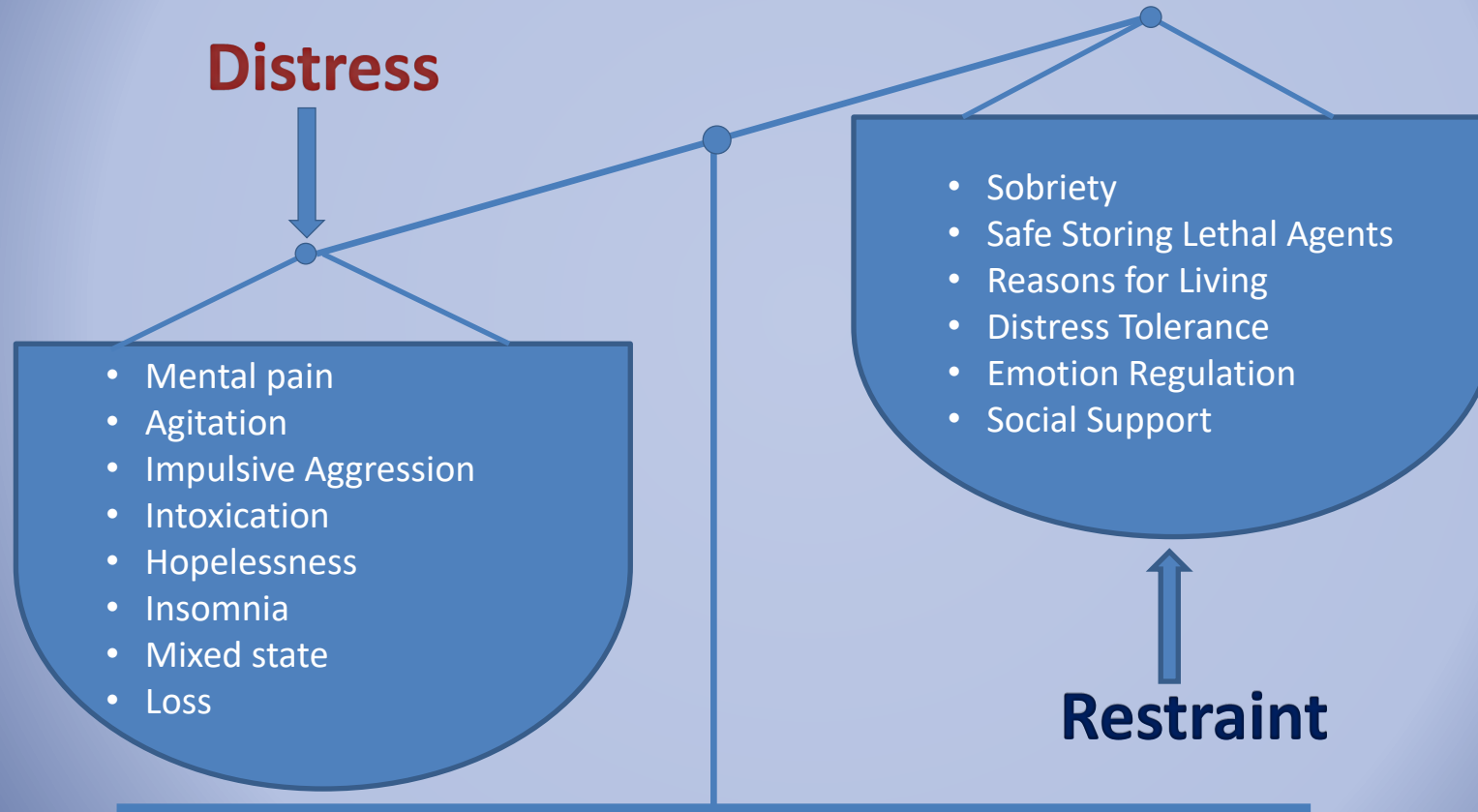
How to Build a Safety Plan for Suicidal Adolescents in 5 Steps

1. Orientation to Safety planning

- A safety plan is a structured set of responses designed to help the suicidal patient cope successfully with suicidal urges
- Safety planning aims to prevent the progression from urge to action.
- Since suicidal acts represent an imbalance between distress and restraint, safety plans should improve distress tolerance, decrease distress, or improve restraint.
- Youth suicidal behavior can come on quickly, so important to catch emotional distress before it becomes a crisis

Imminent Suicidal Risk

An Assessment of the Balance between Distress and Restraint



2. Identify triggers for suicidal behavior

- Triggers can be:
 - **Events**– discord, rejection, trauma, victimization, legal problems
 - **Emotions**– anxiety, depression, “distress,” anger, irritability
 - **Behaviors**– drinking, drugs, on-line postings, actions that can lead to disciplinary consequences
 - Or a series and combination of the above...
- Ask: **what happened that led you to want to make a suicide attempt?**
- Ask about **stressors, traumatic events, insomnia, intoxication, sexual/gender issues, peer victimization**

3. Avoid triggers and make the environment safe

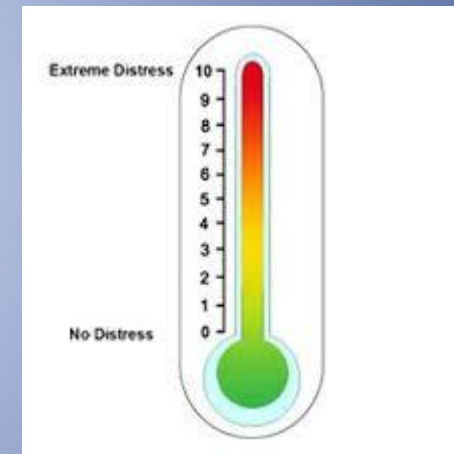
- Avoiding:
 - Interpersonal discord– avoid the person or get an agreement between two parties (parent and child) to table discussion of “hot issues.”
 - Cyberbullying– block victimizers, delete account
- Deal with Vulnerability factors– e.g., poor sleep, alcohol/drug use that can increase likelihood of acting on suicidal urges
- Make the environment safe (sharps, meds, weapons)

4a. How to cope with the trigger?

- Ask what has worked before?
- Self-talk
- Distraction
- Relaxation/Meditation
- Review Reasons for Living
- Use of Emotional Thermometer
- Pick one skill and practice it

4b. Plan to lower the emotional temperature.

- If 10 is “out of control” and 0 is calm and “in control,” let’s talk about what is the “hottest” you can get and still turn things around?
- How do we know when you are at that point, or just before?
- Come up with coping strategies for lowering temperature
- Daily practice in rating and coping



4c. Identification of interpersonal coping resources

- Peers can be helpful as distractors, but should not be used as therapists.
- Adults can provide support and help direct the youth to professional help if needed
 - Parental permission to include adults
 - Get buy-in of the adults and clarify expectations
 - Mobilization of adult support for suicidal patients shown to reduce mortality one decade later (King, 2019)

4d. Clinical and crisis contacts

- Therapist— need ground rules about when to call, coverage, what to do after hours.
 - Want to be available for coaching but promote patient's autonomy and reinforcing suicidal behavior as a coping mechanism
- Crisis line/text
- Mental health crisis services (mobile teams, emergency based)
- Police
- Try to use personal and interpersonal resources first, then these contacts

5. Collaborate with family and consider barriers

- Ask patient to explain plan to parents
 - Use example of trigger and how patient would use the plan to cope
- Get parental feedback
- Need for a truce
- Parental monitoring of risky behavior and suicidality
- Ask about confidence in plan, and what might increase or decrease it
- Ask both parents and patient what might get in the way of implementing the plan and problem-solve
- Removal/securing lethal agents— most families will agree to secure, but not remove firearms; also meds, chemicals, sharp

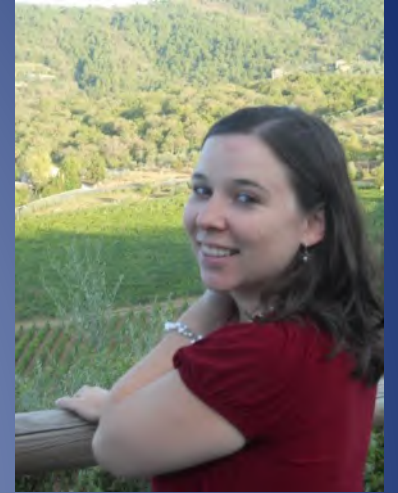
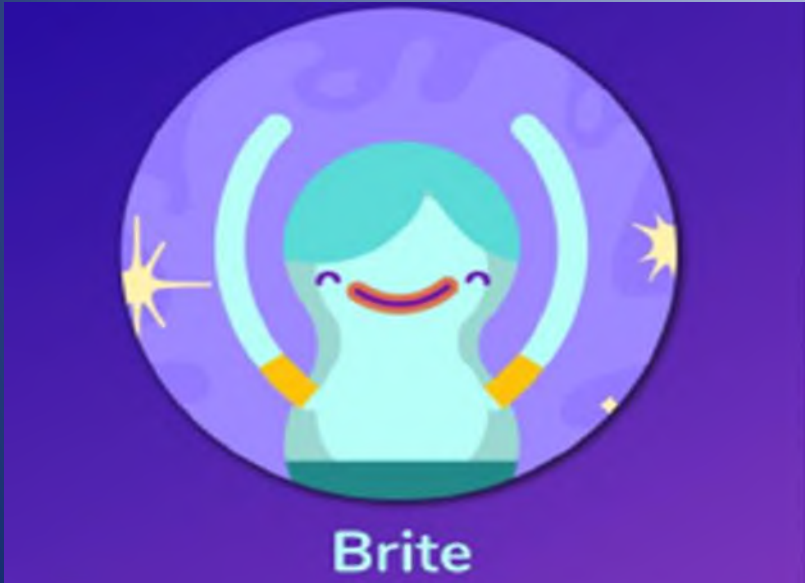
Reluctance to agree to use a safety plan

- **Don't want to promise 100% when not sure could keep that promise**
 - Can ask what % of assurance can they give
 - Try to reduce the time window of the safety plan
 - Ask what might help increase likelihood of adherence
- **Pattern of non-cooperation and oppositional behavior**
 - High parent-child discord
 - Refusal to engage in treatment
 - Might ask if they would agree to some components or a restricted time window
- **As part of general mental impairment or high environmental stress**
(high suicidal intent, mixed state, severe depression, substance abuse, home situation with neglect, abuse, domestic violence)

Review of Safety Plan in 5 Steps

1. Orient to safety planning
2. Identify triggers or warning signs for suicidality
3. Make the environment safe and avoiding triggers
4. Coping strategies
 - a. Emotion thermometer
 - b. Reasons for living
 - c. Other skills
 - d. Interpersonal resources
 - e. Professional resources
5. Review with family and identify potential barriers

Guide2Brite, Brite, and BritePath: A Suite of Suicide Prevention Apps



App developed by:
David Brent, Betsy Kennard, Candice Biernesser, Jamie Zelazny,
Tina Goldstein, and Stephanie Stepp

How a safety planning app can address these gaps

- Safety planning has been shown to **prevent suicide attempts**
 - Crisis response plan, N=99, 5% vs. 19%, HR= 0.24 (Bryan et al., 2017)
 - Safety Planning Intervention, N=1640 in 9 EDs, 3.0% v. 5.3%, HR=0.56
- Safety planning available in an app means that the safety plan is **readily available to the patient in real time**
- An app that can guide a clinician in building an effective safety plan could **greatly extend the use of safety planning beyond those of specialty-trained mental health practitioners.**
- Such an app could be used in **inpatient, outpatient, primary care, or ED settings**

What suicidal teens want in an app

- Security and discretion
- Personalization
- Suggestions for useful interventions
- Multiple methods for coping so can try a second if a first one doesn't work
- Daily reminders to use the app so that when a crisis comes, they are used to using it

Suicide prevention apps in the literature

- **iBobbly**– (Tighe et al.)– tested Aboriginal young adult youth in RCT– app is culturally sensitive, focuses on distress tolerance and emotion regulation– resulted in decreases in depression and distress but not ideation or behavior (N=61)
- **Virtual Hopekit** (Bush et al.) (N=138)– has reminders of reasons for living in pictorial form. Tested in military personnel, improved rated self-efficacy on coping but not measures of distress or suicidality
- **BlueIce** (Grist et al., 2016)– personalized mood monitoring and emotion regulation– tested in adolescents, promising in open trials
- **Brite** is the only app tested in adolescents with an RCT that had suicide attempt as its primary outcome

AS SAFE AS POSSIBLE (ASAP): AN INPATIENT INTERVENTION FOR SUICIDAL ADOLESCENTS



Betsy
Kennard, PsyD



Candice
Biernesser, LCSW,
MPH



Tina Goldstein, PhD

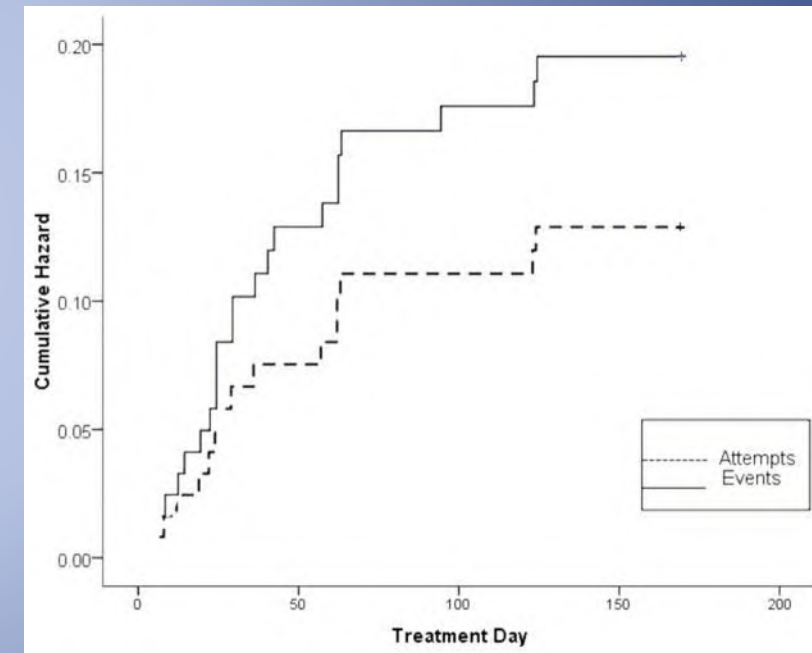
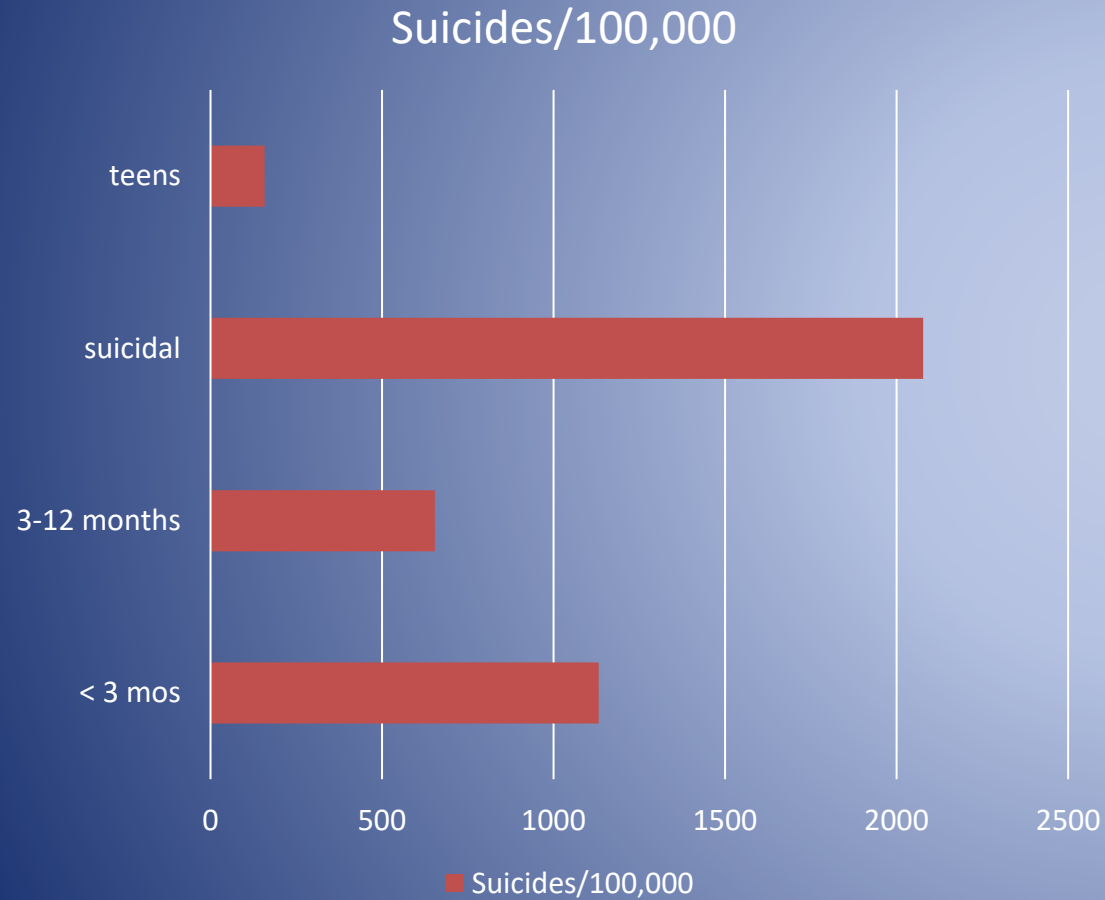


Antoine Douaihy, MD



Dana McMakin, PhD

Risk of Suicide Post-discharge from Psychiatric Hospital (Chung et al., 2017)



Elements of TAU and ASAP

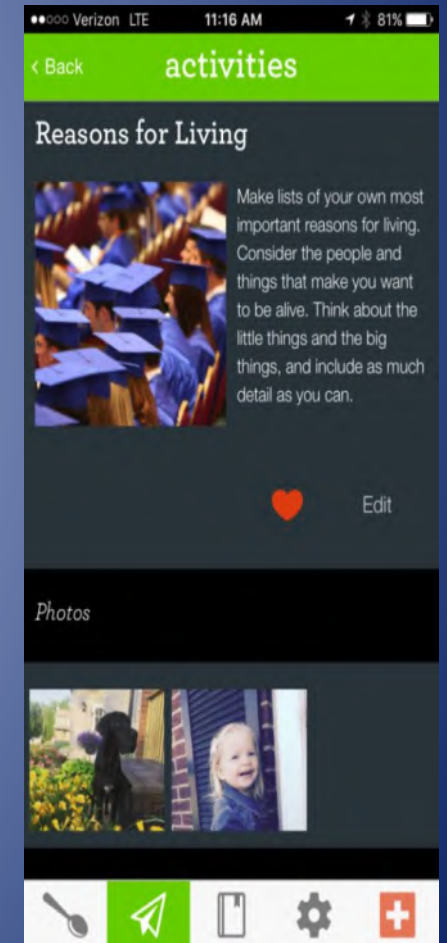
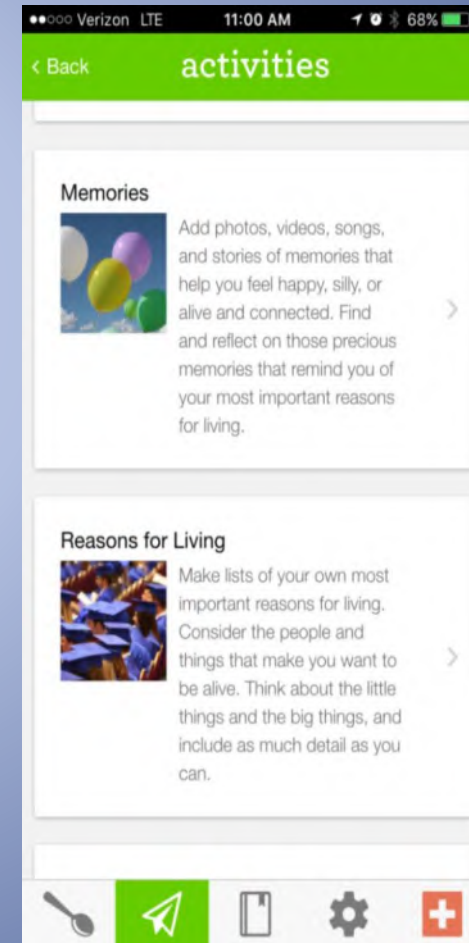
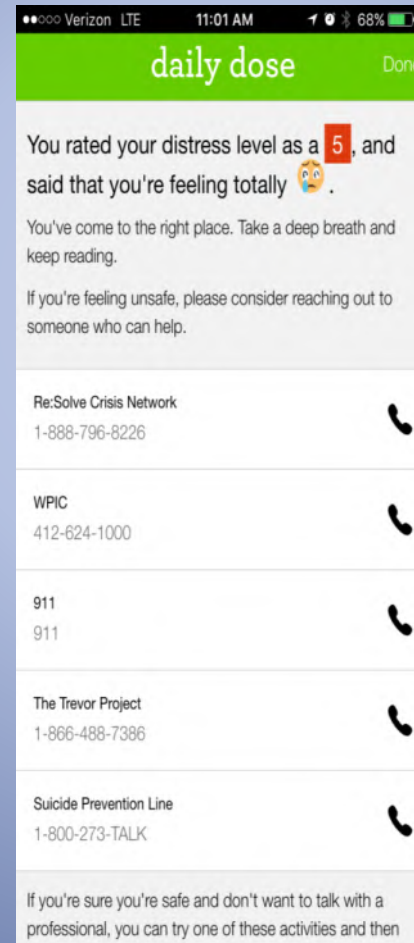
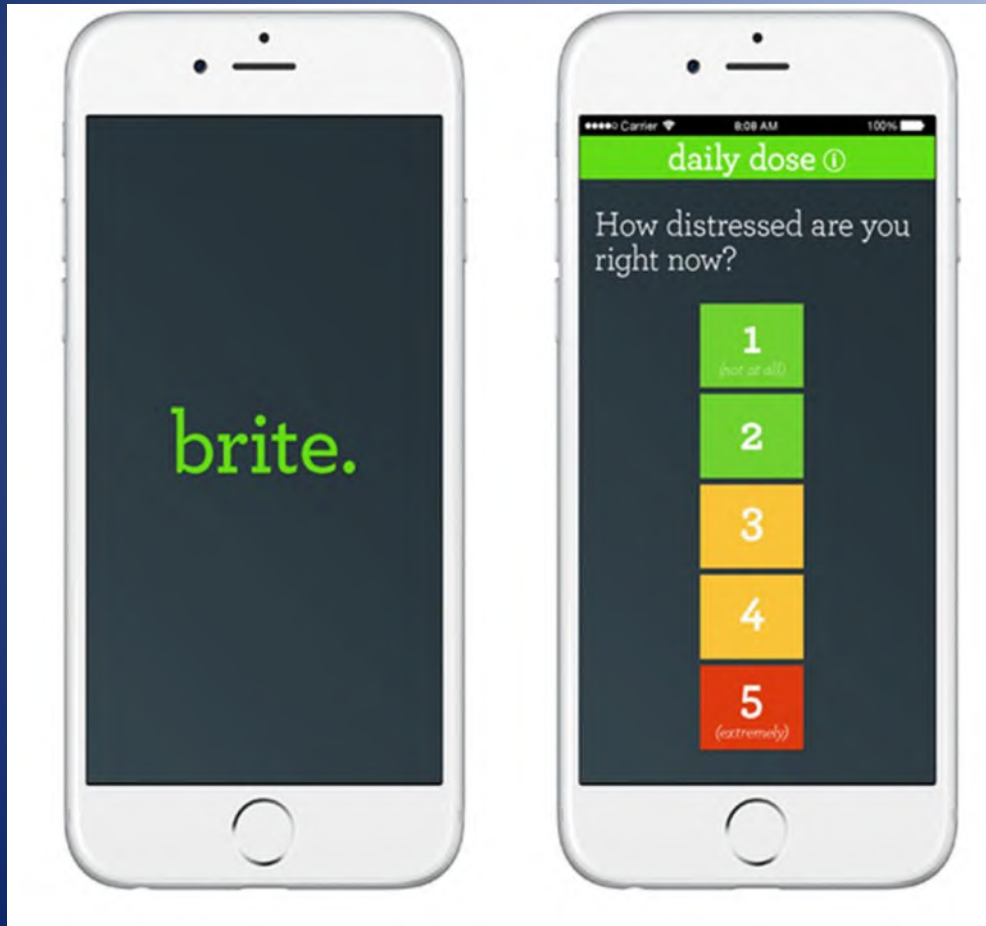
Treatment As Usual

- Inpatient
 - Standard safety plan
 - Skills groups
- Aftercare (often higher level of care followed by outpatient)

Added ASAP Components

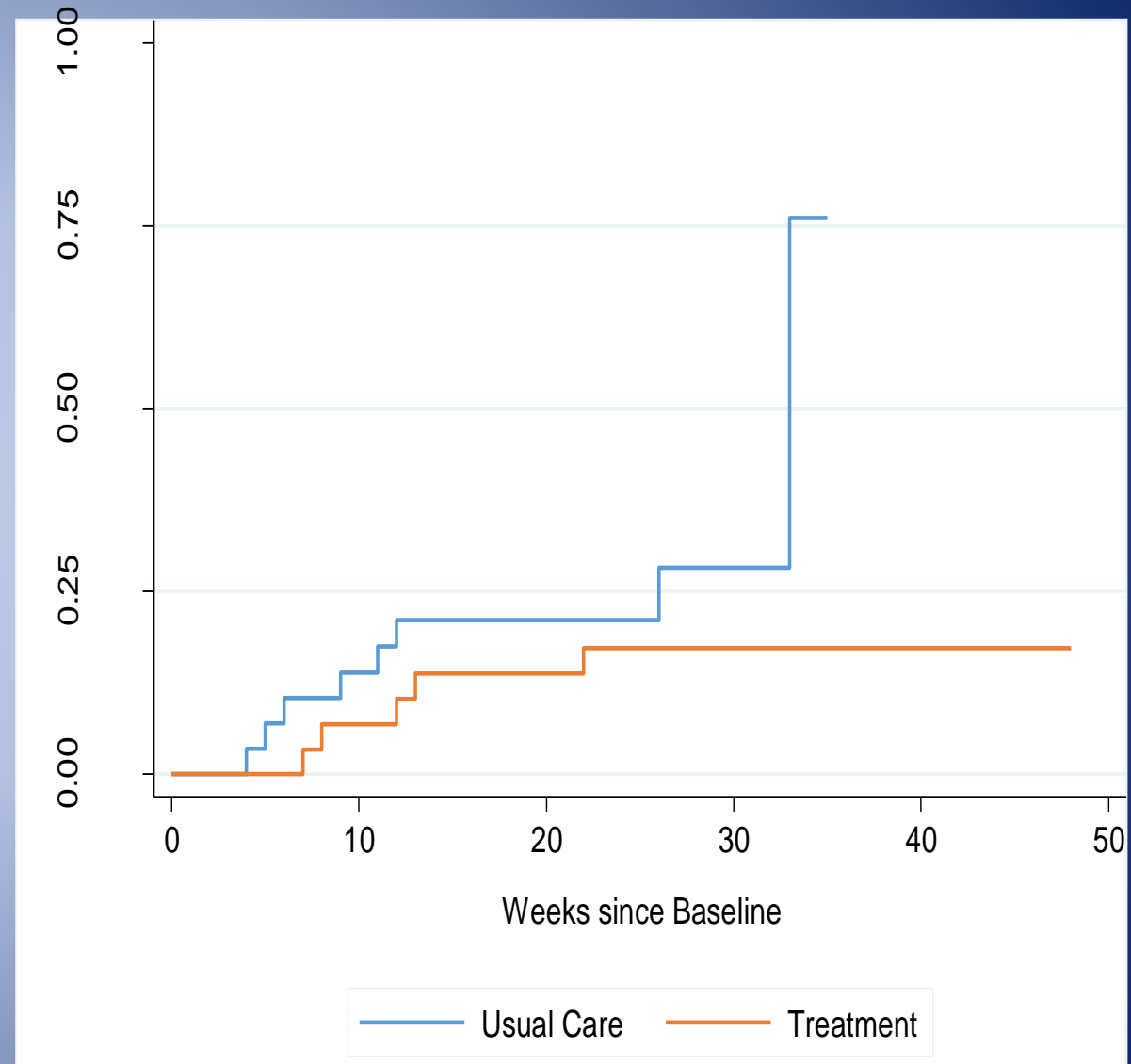
- Chain analysis
- Safety Plan
- Internal strategies
 - Interpersonal strategies
 - Clinical contact
- Distress Tolerance
- Emotion Regulation
- MI to encourage outpatient follow-up

- 2015-2017– developed second prototype and tested in an RCT—kids liked it better, but weak clinician interface



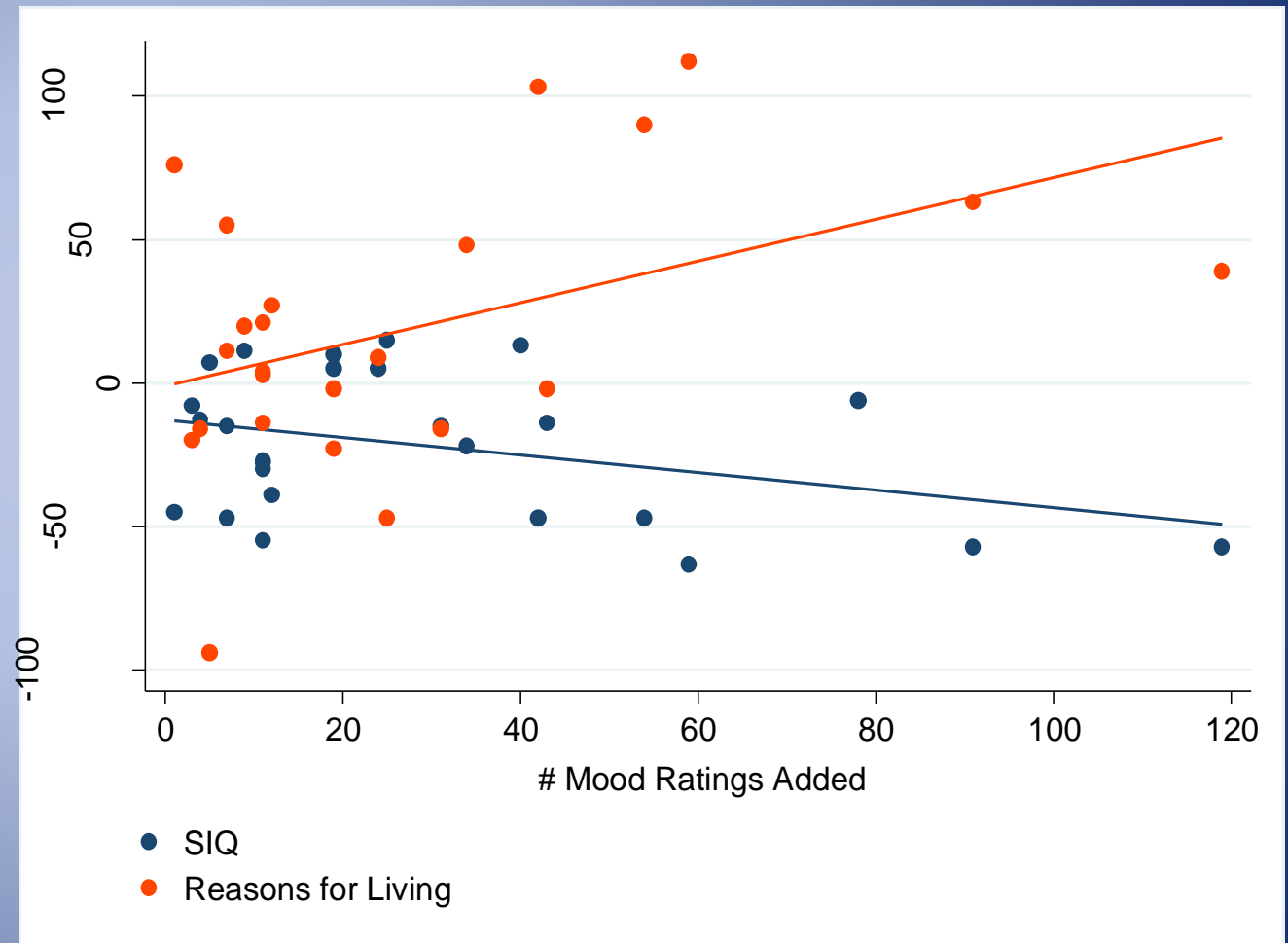
ASAP/Brite Clinical Trial

- 66 suicidal youth hospitalized either at WPIC or UTSW
- Randomized to ASAP/Brite + TAU vs. TAU alone
- ASAP— average of 3 sessions, around 2.7 hours
- Developed safety plan and personalized Brite intervention on patient's phone (using an iPad)
- At 6 months, rate of attempts 16% vs. 31%
- Significant effect in those with a history of a suicide attempt



App Use, Reasons for Living, and Suicidal Thinking

- The more frequent use of app (mood rating), the greater the reduction in suicidal ideation and the greater the increase in Reasons for Living.
- 70% used app at least once
- Avg. no times used app=28.7 (median=19)



SIQ = Suicidal Ideation Questionnaire

Found Monitoring Helpful

"I really liked how you check in with yourself, your temperature's rising and you don't even know it...I started doing it without even the app, it became natural to me."

Diversity of Content

"There's a lot of diversity in the app, which is helpful, because people's moods fluctuate!"

Reminded of Reasons to Live

"It just helped me to focus on the good things, especially when I felt a little bit suicidal and I wasn't really focusing on things that made me happy. Good things—the people in my life and my goals to become a nurse and help people"

Reducing Distress

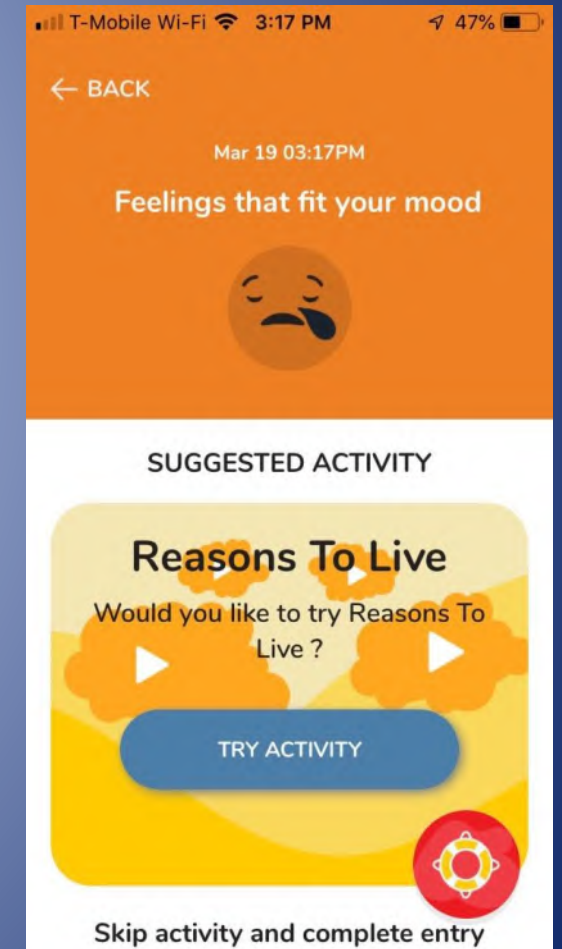
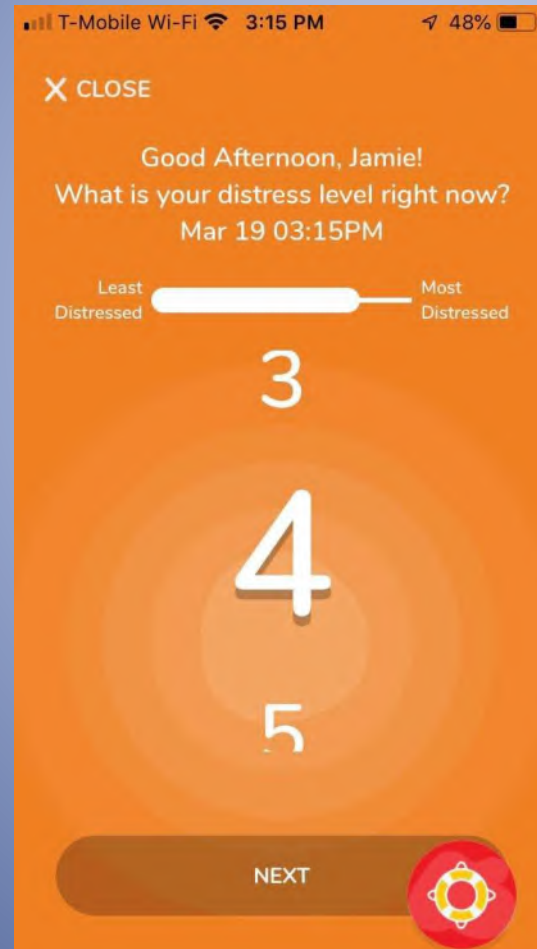
"I've used guided imagery...It's really helpful for me when I can't sleep or having a panic attack. It calms me down a lot."



Helpful in the Moment

"[Brite] was helpful, because it reminded you when you're in the moment you don't really think of that stuff. You can look on there and remind yourself that you can still be here."

- 2018-2019 On basis of experience we modified Brite and are now testing in a larger clinical trial



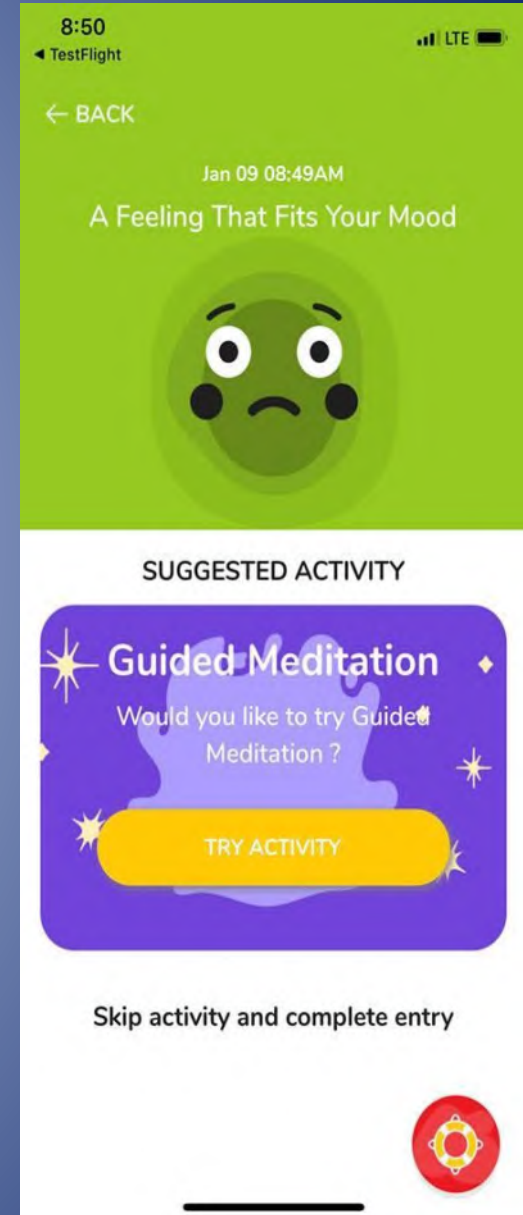
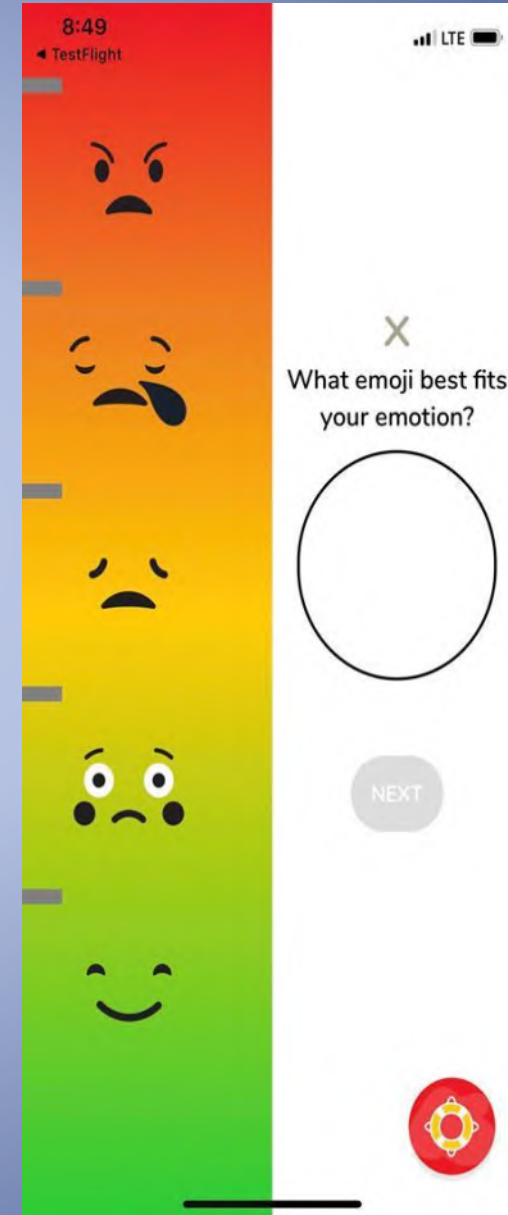
A Orientation to BRITE

Clinician will
guide
patient
through
steps to
populate
safety
planning
app



Welcome to Guide 2 Brite

B
Tracking
distress
using the
emotional
therm-
ometer




C

Creation of safety plan in BRITE

Carrier 2:44 PM

← BACK REASONS TO LIVE





You have the power to choose to remain alive

This space holds your most important reasons for staying alive


Edit

People that are important to me



12:51 LTE

← BACK SAFETY PLAN




Don't Give up. Every day is a new day to recreate yourself

This space holds the skills you will need for daily use and when you are having a rough time.

Edit

I can stay calm by



12:50 LTE

← BACK SAFETY PLAN

I can stay well by

I can cope with stress by

To make my environment safe, I will

12:51 LTE

← BACK SAFETY PLAN

Reaching Out

Call or text your chosen people below when you need to chat with someone.

Mom
123-456-7890

Dad
121-456-7890

Brother
221-456-7890


Professional Help

Call your chosen professionals when you need to chat with someone

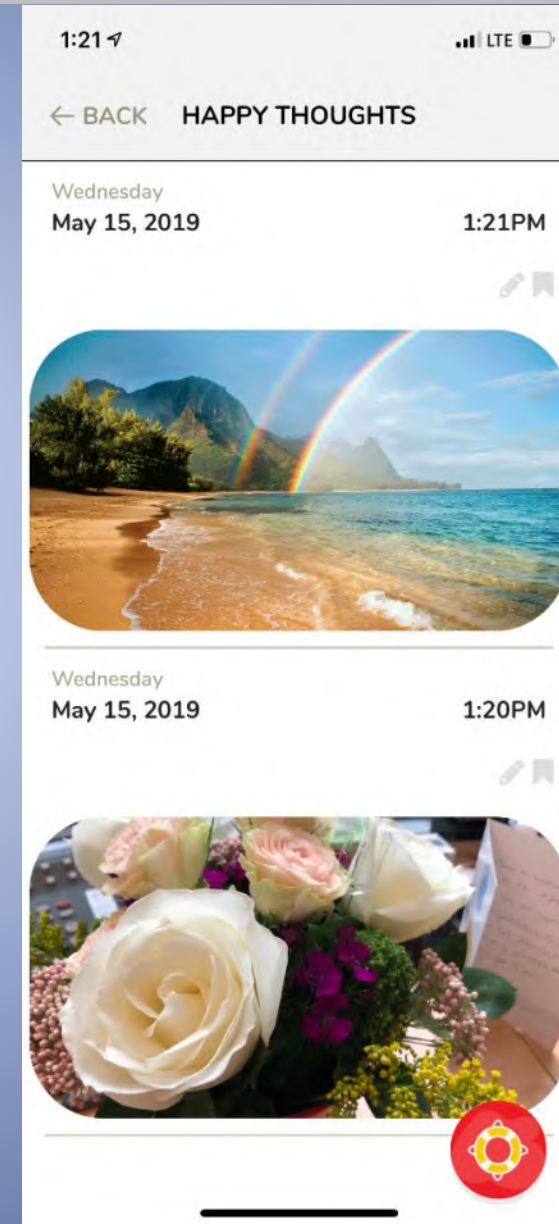
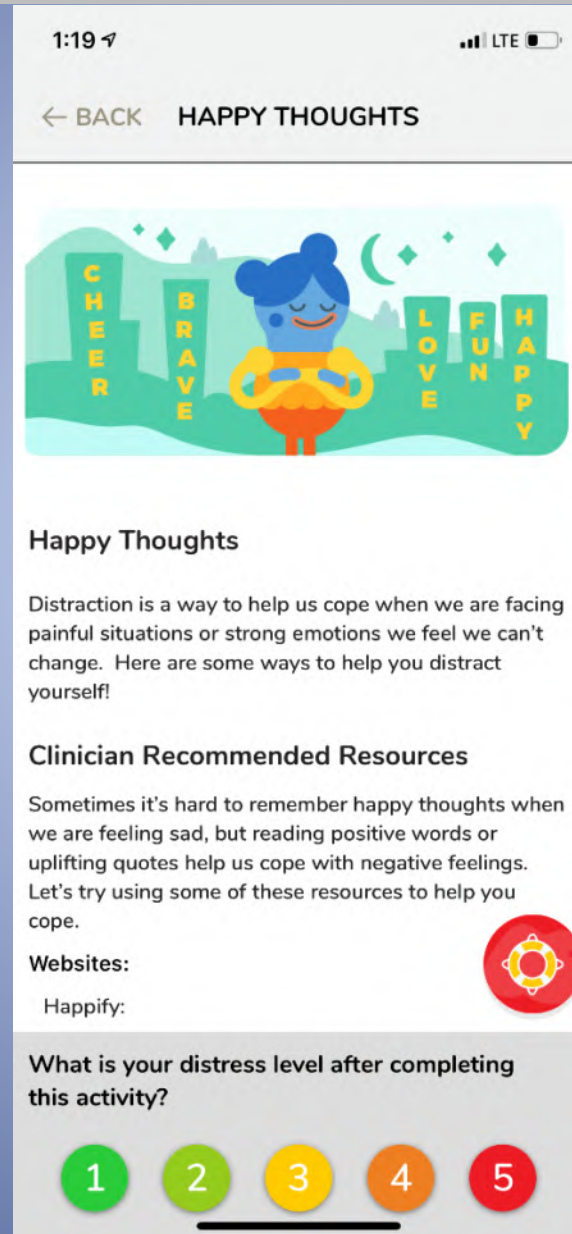
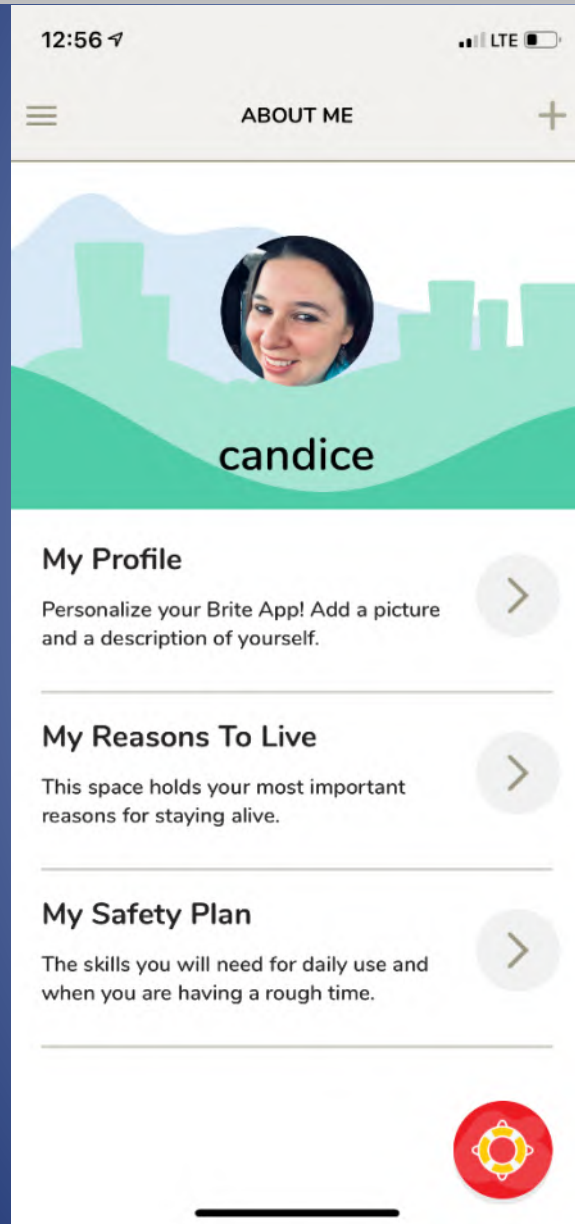
Therapist
800-000-0000

UPMC Phsychiatry
800-000-0000

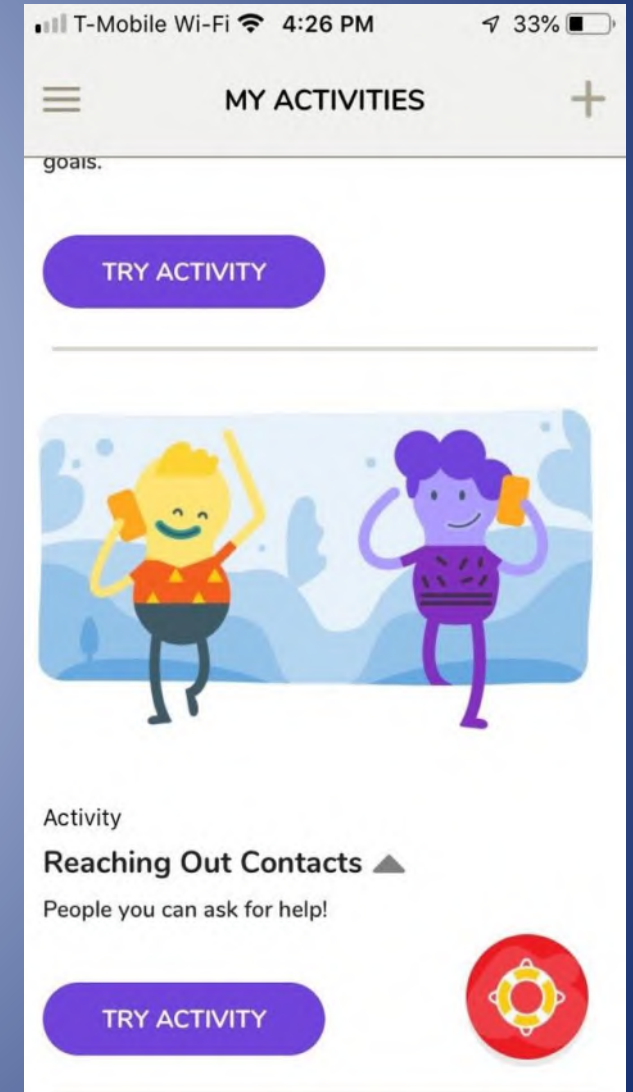
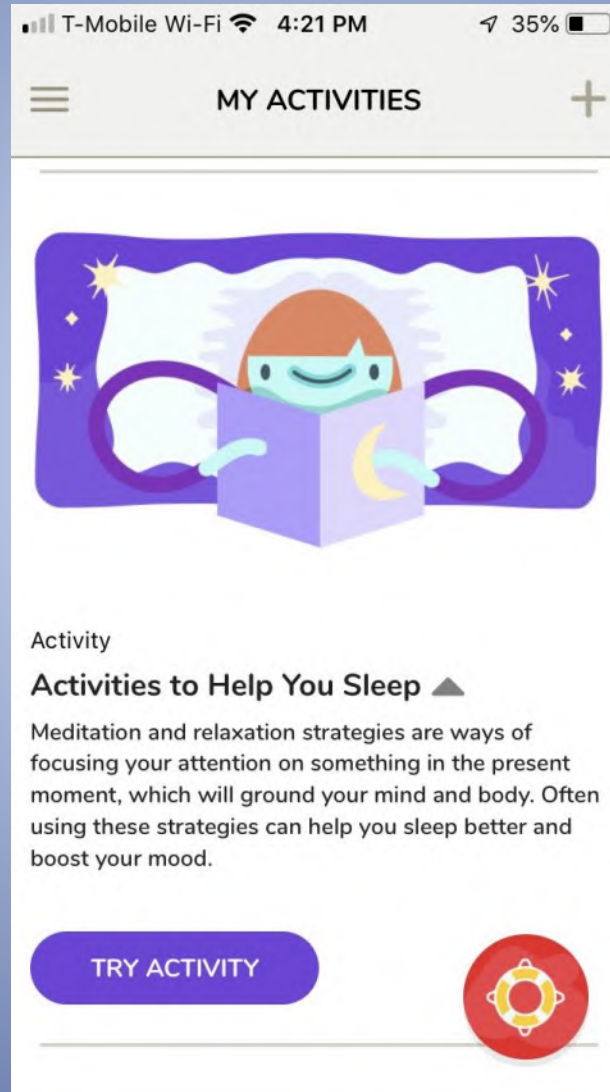
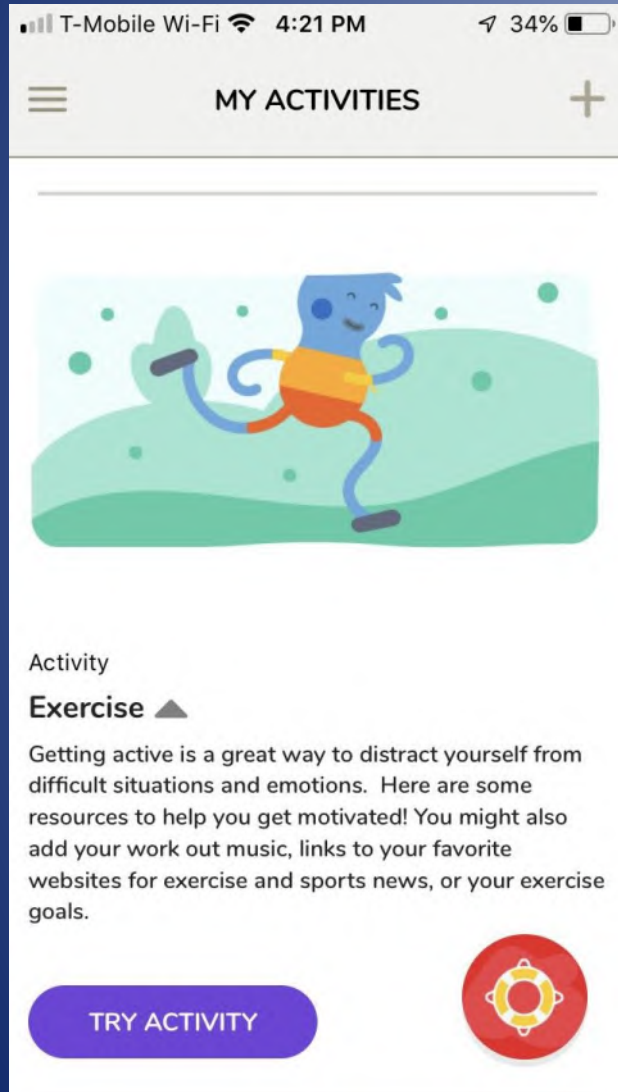
Emergency Room
800-000-0000



D Personalize app content & practice using app



Brite – New Design



Potential population health impact

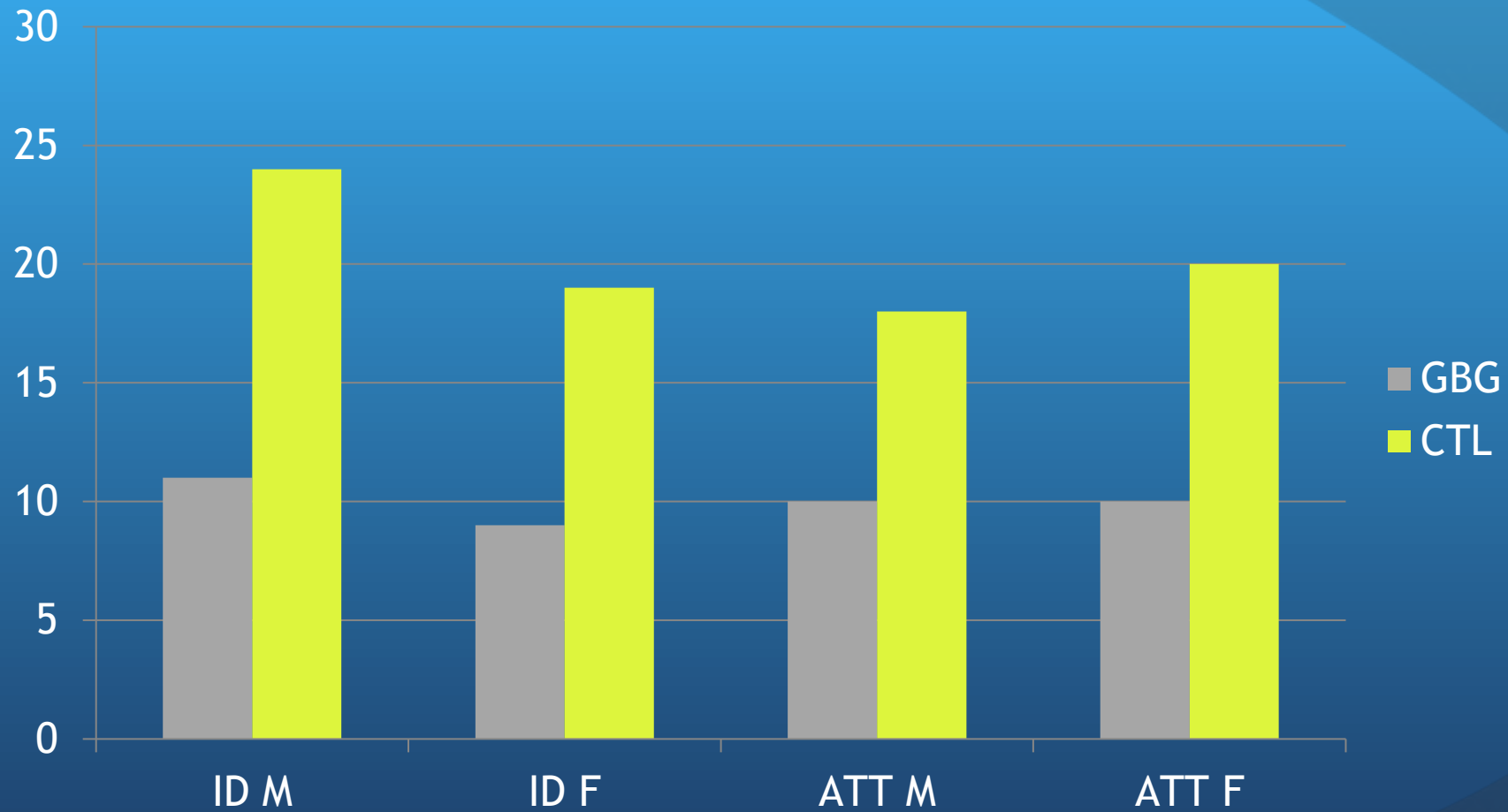
- Decrease suicide attempts in high risk patients
- Potentially decrease unnecessary re-admissions and visits to the ED
- In a large enough population, could decrease rate of suicide
- Increase pool of clinicians capable of making a competent safety plan
- For more detailed demonstration, please see:

<https://pitt.zoom.us/rec/share/wv5aloyt6UdJetbH9h7eW7AZIaHZX6a81SkbqaUlnkaphvZRL2ZFhFLuLOi2I3wm?startTime=1585775250000>

There are evidence-based methods for reducing suicidal behavior

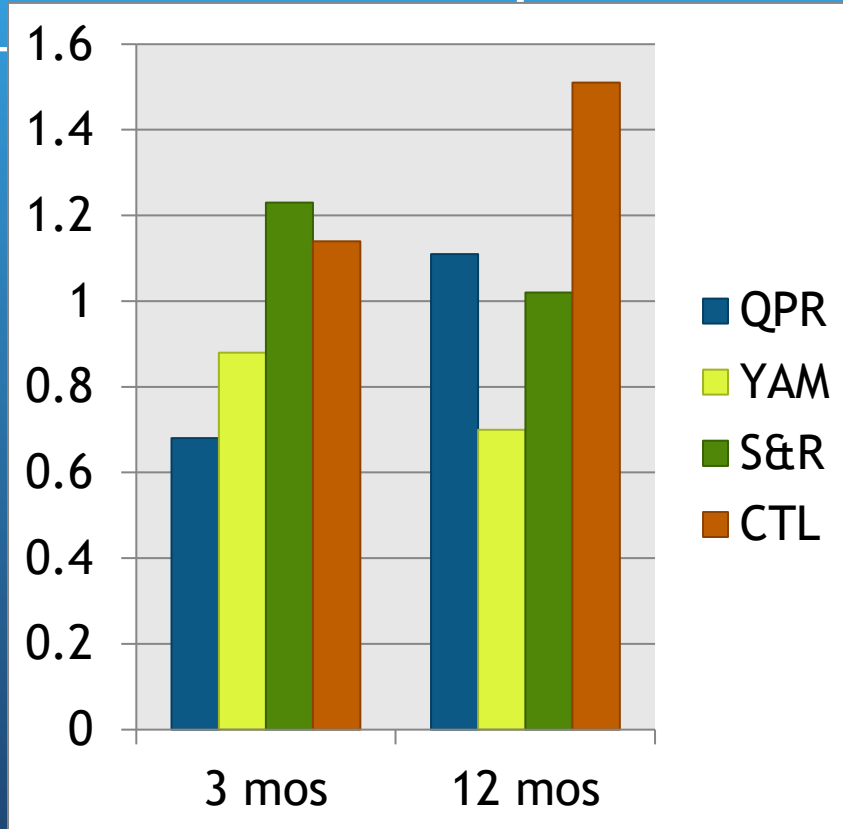
- School-based interventions—Good Behavior Game; Youth Aware of Mental Health
- Augmenting family resilience—e.g., Family Check-up
- Brief interventions— Safety Planning
- Evidence-based treatments—CBT, DBT
- Improving quality and coordination of care
- Restriction of access to lethal agents

GBG Effects on Suicidal Ideation and Attempts (%) (Wilcox et al., 2008)

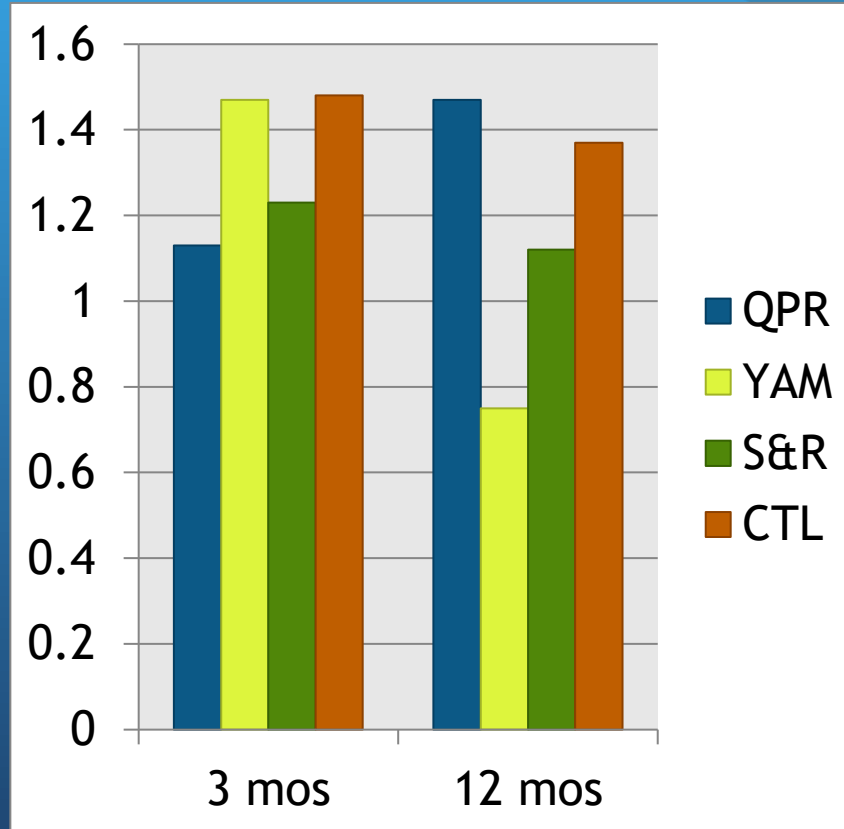


Suicidal Ideation and Attempts at 3 and 12 Months Post-intervention (%)*

Attempts



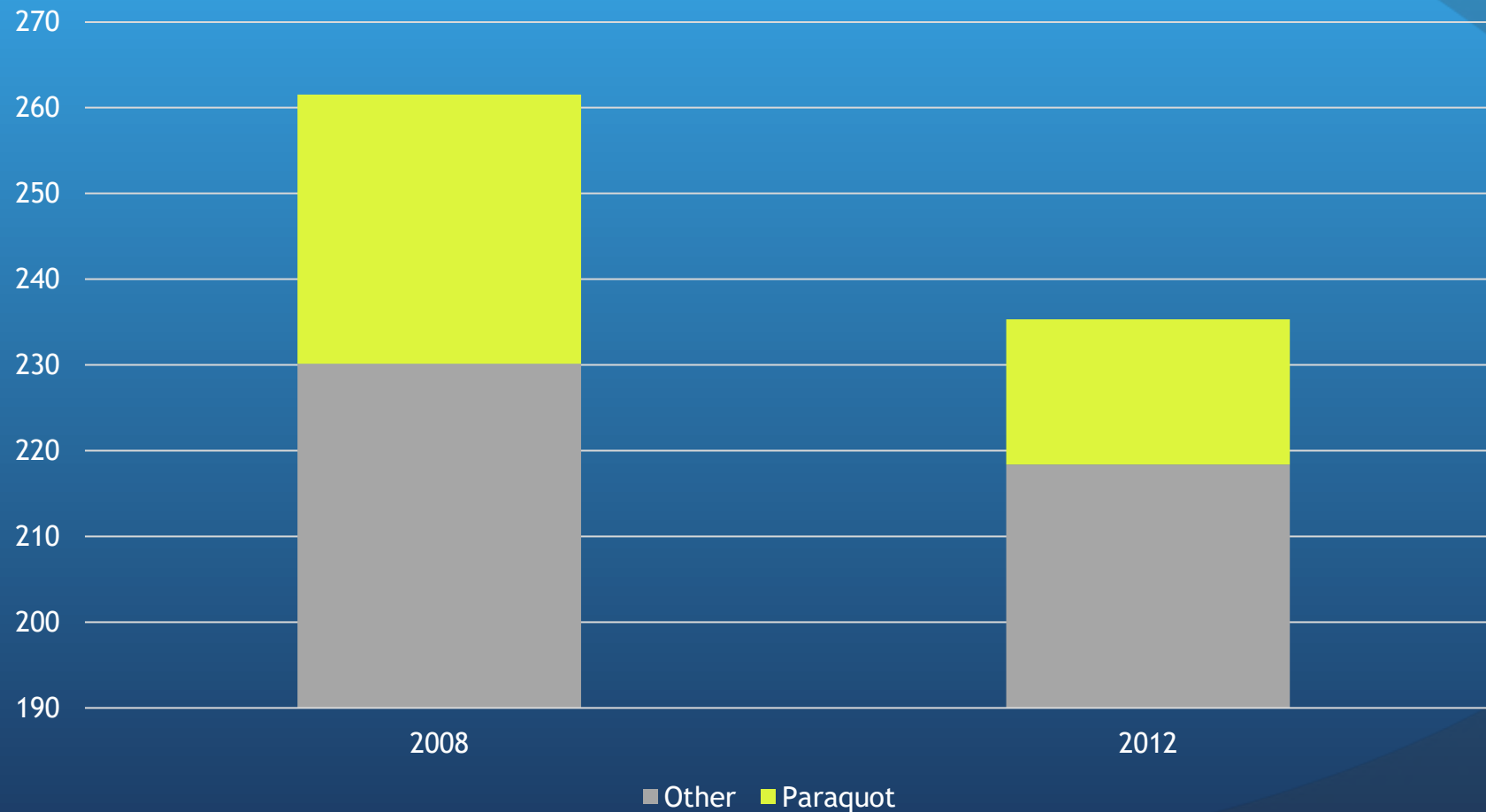
Ideation



*SELYE study: Wasserman et al., 2014

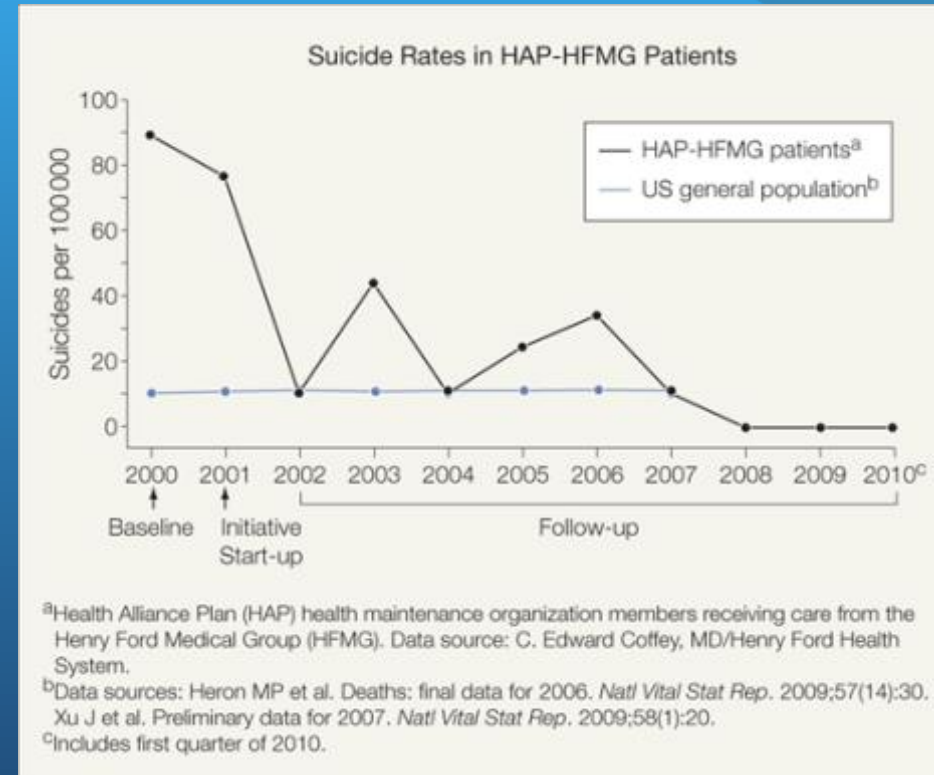
Intervention	Social Contextual Path	Individual Path	Suicide Effects
Familias Unidas, (Vidot et al., 2016)	Positive parenting, communication, monitoring	Reduced substance use, high risk sex, alcohol use	@30 months, decreased attempts In those with low parent-child connection
Family Check-Up, (Connell et al.,2016)	Increased parent child relationship quality, monitoring Reduced family conflict	Reduced antisocial behavior, depression, obesity	5-15 years, decreased ideation or attempt
Family Bereavement Program, (Sandler et al., 2016)	Positive Parenting, parent depression, alcoholism, grief disorder, coping efficacy	Coping, emotional expression, cortisol, internalizing, externalizing, self- esteem, grief	6-15 years 3-6 fold decrease in ideation or attempt

Decline in Suicides (per 10,000,000) in Korea after banning paraquat (Myung et al., 2015)



Systems Change: Henry Ford Hospital

- Consumer advisory group
- CBT training and in suicide risk
- Rapid access to care
- Assertive follow-up by phone of non-adherence
- Removal of lethal agents
- Support and education for families, patients, and staff



Hampton, 2010

Conclusion: There are some promising new ways forward

- Fanaticism is the belief that continuing to do the same thing will result in a different outcome OR we could try:
- Adaptive screening paired with an intervention in ED
- Machine learning of EMRs
- NLP of Social Media posts
- Neural correlates and feedback of suicidal thinking
- Brief inpatient intervention supported by an app to reduce suicide attempts

