Attacking Panic Attacks

Project carried out by a multidisciplinary team of six engineering students

What are Panic Disorders?

Anxiety disorders that causes **unexpected and intense periods of fear**

Accompanied by physical symptoms such as chest pain, heart palpitations shortness of breath, dizziness, or abdominal distress

Quantifiably measured with the **Panic Disorder Severity Scale (PDSS)**

Why do we Care?

4.7%

of U.S. adults experience panic disorder at some time in their lives

2.7% of US adults and 2.3% of US adolescents

had panic disorder in the past year

What's the Problem?

People are currently trained to practice mindfulness techniques such as Cognitive Behavioral Therapy (CBT)

But during the **shock of a panic attack**, people are **frozen** and these exercises are difficult to remember and effectively implement

Therefore, current treatment strategies are insufficient real-time solutions

Need Statement

A way to receive real-time feedback during panic attacks for individuals with panic disorders to reduce their Panic Disorder Severity Scale (PDSS) score.

How are Panic Disorders currently treated?

Psychological Therapy

Cognitive Behavioral Therapy (CBT)

Distress Tolerance

Exposure Therapy

Pharmaceuticals

Antidepressants (SSRIs and SNRIs)

CNS Depressants (Benzodiazepines)

Mood Stabilizers

Self-Help and Management

Lifestyle Changes

Education

Support Groups

No Real-Time Feedback

Current treatment strategies focus primarily on **long-term symptom management** and prevention,

but...

there is **no method** for reducing acute symptoms **during a panic attack.**

PushinP Mechanism of Action

Apple Watch sensors detect spikes in **heart rate (HR)** and a decrease in **heart rate variability (HRV)** not correlated to **movement**

↓

Alert through haptic buzzing

↓

Balloon breathing walkthrough

↓

Weekly reporting of PDSS Score

PushinP Technical Specifications

Detection Algorithm

↑ Heart Rate + ↓ HRV + ↓ Motion = Panic Attack

Heart Rate (HR)

Beats per minute (bpm): PPG

- In panic: rapid increase (+20 pbm, 100–160+ bpm)

  (Taylor et al., 1986; McGinnis et al., 2022)
- Immediate fight-or-flight response

HRV

Variation btwn heartbeats (ms): PPG

- In panic: decreases (low HRV, ≤ 20ms) (Princella et al., 2025)
- Reflects reduced relaxation & stress control

Motion

Physical activity (g): IMU

- In panic: acceleration ≤ 0.2g (Hildebrand et al., 2017)
- Shows behavioral reaction to stress independent of exercise

De-risking steps taken

Can off-the-shelf wearable sensors detect panic attacks accurately enough to trigger a clinically meaningful intervention?

Technical risk

Can Apple Watch sensors detect a panic attack?

Clinical risk

Will the intervention actually reduce symptoms?

Physiological Panic Signature

- HR spike ≥ 20 bpm **via PPG sensor**
- HRV ≤ 20 ms **via PPG sensor and SDNN calculation** (O'Grady and al., 2024)
- Wrist acceleration ≤ 0.2 g **via IMU**
- Combined threshold confirms panic, not physical exertion (Friedman, 1998)

CBT-Guided Breathing Module

- Guided breathing interventions are first-line CBT tools for panic disorder
- Triggered within ≤30 s of event detection
- On-screen balloon breathing replaces high-load memory tasks
- Haptic alert initiates calm engagement
- User can dismiss at any time, preserving autonomy

De-risking steps outcome

What was achieved: coding phase

- Application was coded on XCode in Swift programming language
- Using PPG and IMU sensors
- CBT breathing module was implemented
- Fully functional simulation
- Apple Watch purchased

What needs to be done: testing phase

- Uploading the application to the Apple Watch (Apple Developer account)
- Wearing the watch to have signals inputs and report PA detection
- Assess reduction of the PDSS score through weekly testing

Regulatory Plan

Clinical Claim

PDSS score reduction

- ➔ 10–39% PDSS score reduction over consistent use = “minimally improved” (Furukawa et al., 2009)

Device classification

FDA approval for **Class II Software as a Medical Device (SaMD)**

- ➔ Not a general wellness device; exceeds FDA's low-risk wellness policy threshold

Pathway to market

De Novo pathway

- ➔ No sufficiently similar predicate device exists for panic-specific real-time detection + CBT
- ➔ Comparable cleared devices: Freespira (K180173), Daylight by Big Health (K233872)

How does concept address existing gaps?

Gap	Solution
Detection-Action Latency Users often realize they are having an attack too late to stop it	**Automated Triggering** Uses HR/sensor fusion to detect spikes and alert the user via haptics before the attack peaks
High Cognitive Load Panic makes it hard to remember complex CBT exercises	**Guided Intervention** Replaces "memory-based" coping with "instruction-based" breathing visuals and prompts
Subjective Reporting Bias Doctors rely on vague patient memories to adjust treatments	**Objective Data Logging** Pairs physiological data with quick PDSS reporting for an accurate clinical history

PushinP Analysis

Are these the *best* indicators?

↑ Heart Rate + ↓ HRV + ↓ Motion = Panic Attack

What if user is pacing during panic?

However, without motion sensing, abnormal HR and HRV could mean anything

Does false detection matter? → could just practice breathing

Device Classification
FDA approval for Class II software as a medical device (SaMD)

Clinical Claim
Reduces PDSS scores over time; not a general wellness device

Pathway to Market
Likely De novo pathway (no predicate device)

High risk

High effort

Slow

Wellness Device
Already no diagnostic claim
Remove PDSS reduction claim

→

Class II De Novo
Run pilot study
Refine app and algorithm

Next Steps ?

The problem is an important one, and one needs care, we just need to improve how we tackle it

Can we work with this? YES

Future Plans:

- Improved combination of inputs & analysis (e.g. GPS, behavioral habits, time-of-day context, direct user feedback)
- Multiple feedbacks (e.g. haptic distraction, breathing exercises)
- Multiple breathing techniques
- Slidebar adjustment for sensor threshold
- Own hardware

We strive to reduce stress around us and reduce the PDSS scores!

Resources

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Thank You!

Questions?