Delaire

The 911 Flaw

When the Wrong Voice Costs Lives

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Table of Contents

Abstract

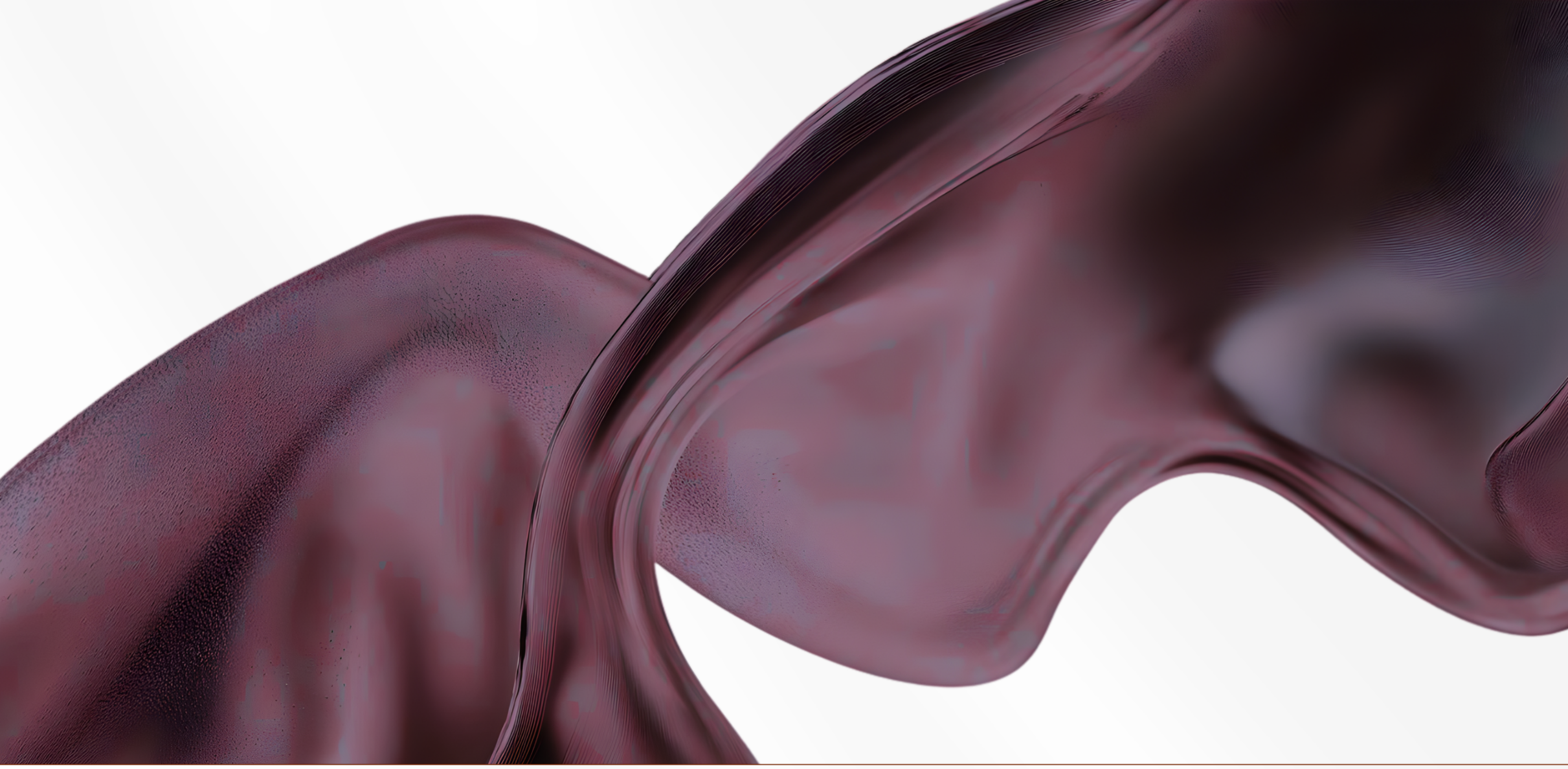
Emergency services worldwide are deploying AI voice systems in 911 dispatch centers based on efficiency metrics: speed, accuracy, cost reduction. These systems ignore the only variable that determines survival, whether the responder's voice regulates or dysregulates a caller's nervous system.

This paper introduces a methodological framework for measuring physiological responses to vocal tone. The research proposed here should have been conducted before AI deployment began.

Drawing on autonomic nervous system research and multiple theoretical frameworks including polyvagal theory, classical autonomic models, and limbic system neuroscience, we present the first framework for measuring vocal trust in crisis contexts: a composite measure of physiological, behavioral, and outcome-based indicators. We propose pilot studies measuring caller heart rate, biometric indicators, vocal stress markers, and survival outcomes.

Without this validation, emergency services are conducting a global experiment on millions of people during the most vulnerable moments of their lives.

Keywords: autonomic nervous system; voice prosody; vocal stress markers; crisis communication; AI voice systems; human-AI interaction; emergency dispatch; emotional regulation; physiological measurement; polyvagal theory



Introduction

Picture a 2 AM car crash. You're in the passenger seat. The driver is your best friend. They're not moving. Blood on the windshield. Your hands shake so violently you can barely unlock your phone. You dial 911.

A voice answers. Calm. Clear. Perfectly enunciated.

But something is wrong.

Your body knows before your brain does. The voice sounds right, but it feels wrong. The tone is flat where it should lift. The pacing is mechanical where it should breathe. Your nervous system is already in fight-or-flight. It registers this mismatch in milliseconds. Instead of calming down, your heart rate spikes higher. Your hands shake worse. You cannot think clearly enough to follow the CPR instructions being given to you.

The voice is artificial intelligence.

And in that crisis, the difference may kill you.

The Question No One Is Asking

Would you rather wait 20 minutes on hold for a human dispatcher, or get an AI voice assistant immediately? Most people say AI—until they hear it. Until they feel what happens in their nervous system when a synthetic voice tries to guide them through the worst moment of their life.

Cities deploying AI emergency response systems fail to understand that the brain does not process words during crisis (LeDoux, 1996). It is processing tone (Morales-Luque et al., 2025). And tone is survival.

Current Paradigm and Limitations

The neuroscience connecting certain voices to calm and others to panic is well established (Ethofer et al., 2006; Fruhholz et al., 2014; Porges, 2011, 2022, 2025). Decades of research in autonomic regulation, prosodic communication, and limbic-system processing demonstrate that vocal tone directly influences physiological state (Kogan et al., 2013; Morales-Luque et al., 2025).

Yet emergency-response systems have been optimized for efficiency, with speed, accuracy, and low cost positioned as the primary goals, over biological safety (International Academies of Emergency Dispatch (IAED) & National Association of State 911 Administrators (NASNA), 2023).

Current AI voice deployments ignore the human nervous system as a variable in survival outcomes.

Despite existing research, no framework translates these findings into operational standards for crisis communication. Before additional systems are deployed, controlled physiological studies must determine how voice tone, pacing, prosody, and other sonic variables affect caller regulation, compliance with instructions, and survival rates.

The objective is to align emergency communication with human neurobiology, establishing measurable safety benchmarks for AI voices before public deployment.

Current Deployment:
The Global Experiment

United States:
The $150M+ AI Emergency Voice Market

AI voice systems are being deployed in emergency response worldwide right now, but no published studies have examined their emotional impact on callers.

Aurelian ($14M Series A, 2025): Deployed in over a dozen 911 centers including Snohomish County, WA and Chattanooga, TN. Handles thousands of live non-emergency calls daily. Claims to save each dispatcher 3 hours per day by automating 74% of calls (Temkin, 2025). The system must distinguish emergency from non-emergency situations in real-time, and Aurelian's AI is "trained to recognize a real emergency and immediately transfer those calls to a human dispatcher" (Temkin, 2025), requiring prosodic and semantic analysis of callers who may already be in heightened autonomic states.

Prepared ($80M Series C, 2025): Partners with 1,000+ agencies in 49 states protecting nearly 100 million people. Provides real-time translation, automated triage, and "assistive call-taking" that reduced Spanish-language call processing by 66% (Prepared, 2025).

RapidSOS (HARMONY AI platform): Launched automated non-emergency call handling across multiple agencies. 82% of US 911 centers report critical understaffing, and AI is being positioned as the only scalable solution (Automation X AI, 2023).

Amazon Connect: Deployed in Charleston County, SC. Reduced non-emergency call volume by 36% in six months, but there is no available data on caller stress or survival outcomes (Watford, 2023).

United Kingdom:
NHS 111's AI Triage Experiments

The UK has been testing AI voice triage longer than the US.

Babylon Health + NHS 111 (2017-2018): Deployed AI chatbot triage for 1.2 million Londoners in north London boroughs. Patients were prompted to text symptoms to an AI instead of speaking to human operators. The pilot was controversial, and leading doctors called it "quite frightening," warning that "people who are ill want a person they can speak to" (Heather, 2017).

Europe: EENA's AI Emergency Services Initiative

The European Emergency Number Association (EENA) launched a 2024 special project testing AI applications across European public safety answering points (PSAPs). The focus: using AI to process "multiple streams of data almost instantly", such as caller location, audio from the call, and limited social media monitoring (Gizikis, 2024).

The pattern is global: AI is being optimized for efficiency, not emotional regulation.

UK NHS 111:
In December 2022,

only 1 in 5 calls

were answered within 60 seconds (Nuffield Trust, 2025).

2.9 million total

The Justification: A Staffing Crisis

Emergency services are collapsing under call volume and vacancy rates.

US 911 centers: 30%+ vacancy rates reported by 166 centers, dispatchers working 12-16 hour shifts. Research indicates that 911 telecommunicators experience PTSD symptoms at elevated rates, with symptom screening studies suggesting 18-24% meet clinical criteria compared to general population rates (International Academies of Emergency Dispatch (IAED) & National Association of State 911 Administrators (NASNA), 2023; Lilly & Pierce, 2013; Pierce & Lilly, 2012).

AI is being sold as the solution. But no one is measuring:

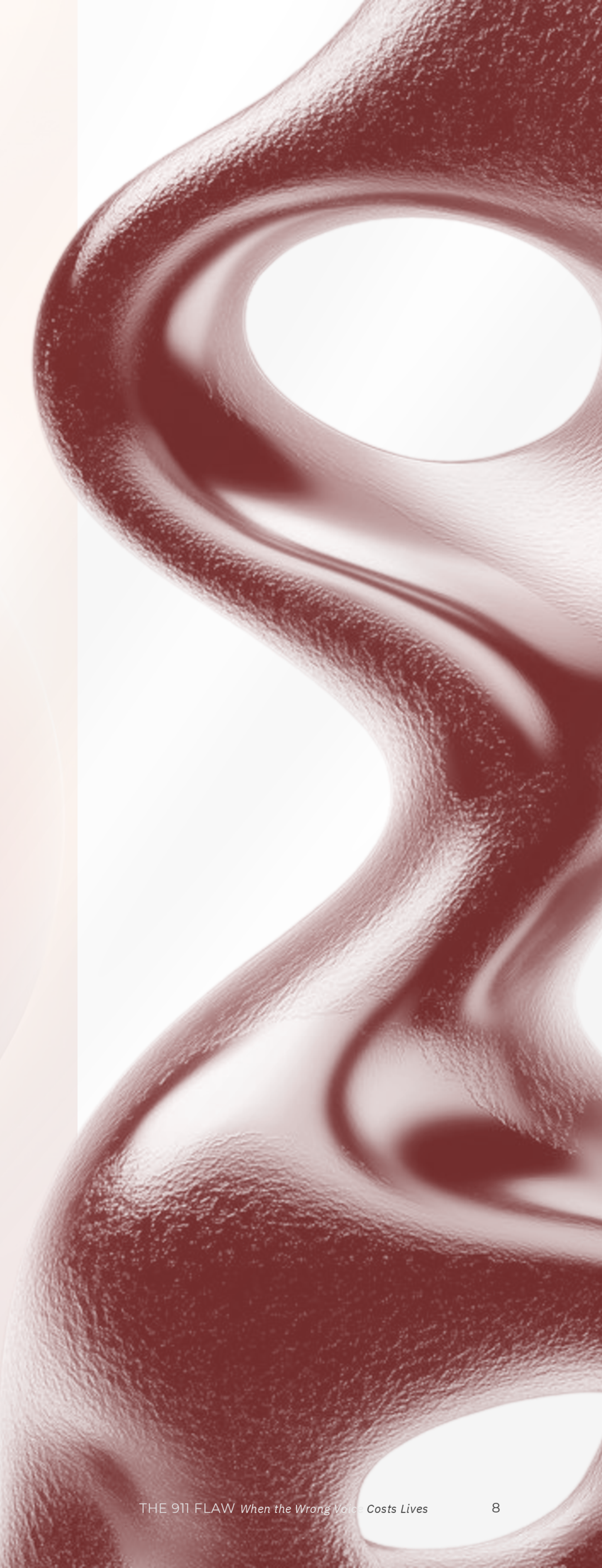
Does a caller trust an AI voice enough to follow lifesaving instructions?

And if the AI voice increases hesitation by even 30 seconds, what does that delay cost in survival rates?

Theoretical Framework: The Neuroscience of Crisis Communication

When a person calls 911, they are not in a rational state. The prefrontal cortex, the part of the brain responsible for logical thinking and executive control, is largely offline (Arnsten, 2009). In moments of acute stress, the brain shifts into limbic processing, the survival-oriented system that detects and responds to threat (Hermans et al., 2014).

In this state, people are not primarily processing words; they are responding to prosody, to the melody and rhythm of the voice, which creates emotional tone in speech (Paulmann & Kotz, 2008; Schirmer & Kotz, 2006).



Multiple Frameworks Converge on Voice-Emotion Regulation

This paper draws on Polyvagal Theory (Porges, 1995, 2011, 2022, 2025) as one explanatory framework, while acknowledging ongoing scientific debate about its neuroanatomical specifics (Grossman, 2023; Neuhuber & Berthoud, 2022).

However, the core argument, that voice prosody directly influences autonomic regulation and that AI emergency voices require physiological validation, stands independent of any single theoretical framework.

Interdisciplinary research supports the connection between voice and autonomic state:

01

Classical Autonomic Nervous System Models: The autonomic nervous system regulates involuntary physiological functions including heart rate, blood pressure, and respiration through sympathetic (arousal) and parasympathetic (calming) branches (Samuels & Szabadi, 2008). Vocal cues can trigger shifts between these states.

02

Limbic System and Amygdala Processing: The amygdala, a key structure in the limbic system, acts as a rapid threat-detection system, receiving sensory information, including vocal cues, faster than conscious processing centers (Fruhholz et al., 2014; LeDoux, 1996). Emotional prosody is processed through both subcortical (fast, automatic) and cortical (slower, evaluative) pathways, with the amygdala playing a central role in alerting autonomic and endocrine systems to arousing stimuli (Ethofer et al., 2006; Wildgruber et al., 2006).

According to Polyvagal Theory, specific prosodic features in the human voice are proposed to engage ventral vagal mechanisms associated with social engagement and the calming of defensive responses (Porges, 2011, 2022, 2025). The effects of vocal cues on autonomic regulation are well documented across several research traditions (Kogan et al., 2013; Mehr et al., 2016; Morales-Luque et al., 2025; Vickhoff et al., 2013).

03

Voice-ANS Coupling Research: Recent scoping reviews document that vocal activity modulates autonomic function through respiratory coupling, with slow-paced vocalizations increasing parasympathetic activity and emotional vocal challenges revealing context-dependent interactions between vocal output and autonomic responses (Morales-Luque et al., 2025).

Why Sound Bypasses Logic

Sound reaches the emotional centers of the brain before conscious reasoning occurs. A familiar song can transport a listener back to adolescence—to a first heartbreak, a summer night drive, or even a memory buried deep in the body. Suspenseful music in a film can elevate heart rate even without visual context. Sound activates emotion before cognition.

Sound does not ask for consent.

In moments of panic, when rational processing is impaired, the voice a caller hears does more than convey information. It signals to the nervous system whether safety or threat is present and determines whether the caller can stay regulated enough to respond and survive the next five minutes.

The Acoustic Properties of Safety

Several acoustic properties have been empirically linked to perceived safety and autonomic regulation.

Prosodic variation: Human voices naturally modulate in pitch and rhythm, creating a “melody” that signals attentiveness and empathy. Research on emotional speech demonstrates that prosodic features such as pitch contour and speech rate, as well as the rhythmic qualities of speech, directly influence autonomic arousal (Ethofer et al., 2006; Goudbeek & Scherer, 2010). AI voices often lack this variation, and therefore sound flat or mechanical. Many listeners find them discomforting because this lack of prosody contributes to the loss of “presence.”

Breathiness and vocal quality: Audible breath creates acoustic intimacy, signaling physical presence and emotional engagement (Kreiman & Sidtis, 2011). When speaking about emotions rather than facts, individuals exhibit lower pitch and reduced skin conductance, indicating decreased autonomic arousal (Matejka et al., 2013). AI voices don’t breathe.

Response latency: Humans pause before responding, creating a natural conversational rhythm that can mirror and regulate a caller’s emotional state (Porges, 2011). AI systems, however, often respond instantly or too quickly for a brain in panic to perceive as attuned or safe. Even when pauses are programmed in, without variation, the issue remains.

Vocal frequency with warmth: Lower-pitched voices (180-220 Hz for women, 85-180 Hz for men) can signal authority, but when a voice lacks warmth or misses prosodic “lift” at key moments, it registers as cold, not commanding (Fruhholz et al., 2014).

Limitations of Current AI Voice Systems

Current AI voice systems are optimized for accuracy, not emotion.

They can transcribe calls in real time, detect relevant keywords, and route emergencies to human dispatchers (Behravan et al., 2024; Prepared, 2025). But they cannot attune.

They cannot detect panic in a caller's voice and adjust their own prosody to match and then gradually slow it, guiding the caller out of hyperarousal. They cannot use breath as a cue for presence, where a human inhale signals, "I'm here with you." They cannot modulate pauses, allowing silence to do the work words cannot.

This is not merely a technological limitation; it is a design flaw, rooted in a fundamental misunderstanding of what crisis communication is.

Related Work

Research in adjacent fields highlights this gap.

A.

Voice Stress Analysis: Measuring the Wrong Direction

Existing research on voice and emergency dispatch focuses on analyzing incoming caller speech to detect stress and prioritize calls. Demenko & Jastrzebska (2012) demonstrated that emergency callers' pitch position increases under acute threat, and notably, that dispatcher instructions can lower a caller's pitch position even when the threat persists, providing early evidence that voice-mediated regulation occurs during real 911 calls. Machine learning models now classify caller emotional states from emergency recordings with 73-85% accuracy using mel-frequency cepstral coefficients (Chin et al., 2021).

However, these systems detect emotion in the caller's voice to help dispatchers respond appropriately. No research measures how the dispatcher's voice, whether human or synthetic, affects the caller's physiological state.

B. AI Voice Technology: Adjacent Solutions

Recent technical advances address related but distinct problems in emergency communication:

Speech reconstruction: Venkateshperumal et al. (2024) proposed using Large Language Models to reconstruct incomplete caller speech caused by packet loss and poor signal quality, improving what dispatchers hear from callers, but still not addressing how AI voices affect callers.

Peer-to-peer disaster communication: Behravan et al. (2024) developed multilingual voice-based social networks for disaster situations, focusing on message authenticity via blockchain rather than voice prosody's regulatory effects on listeners.

Voice ethics and harms: Hutiri et al. (2024) developed a comprehensive taxonomy of harms from speech generators, analyzing incidents including swatting attacks using synthetic voices. However, this research focuses on preventing malicious uses such as identity theft and deepfake generation, along with the spread of misinformation, rather than on measuring unintentional harm to people interacting with AI voices during legitimate use, especially in crisis states.

These works address voice-cloning ethics, such as preventing unauthorized replication of voices, or focus on the technical challenges in voice transmission. None examine whether synthetic voices in crisis contexts provide physiological safety or induce stress that could affect survival outcomes.

We have developed the necessary components but not integrated them.

Case Study: The Scarlett Johansson Principle

In 2024, Sam Altman (CEO of OpenAI) asked Scarlett Johansson twice to voice ChatGPT's new interface. She declined. OpenAI launched anyway with a voice called "Sky" so acoustically similar that Johansson's own friends couldn't tell the difference. She hired lawyers. OpenAI pulled the voice within days (New York Times, 2024).

Altman's only public comment? One word: *"her."*

He later clarified that he chose a voice he thought would be "comforting to people" (The Verge, 2024).

Not accurate. Not efficient. Comforting.

OpenAI risked massive legal liability to copy one specific celebrity voice. Consciously or not, they understood what emergency services are ignoring: certain voices hit specific acoustic markers that trigger biological responses. Those markers can be engineered.

Johansson's voice exhibits every prosodic marker of safety, including warm lower frequencies and controlled tempo and breath modulation, along with a textured vocal timbre often associated with embodied human presence.

OpenAI understood that her voice generates trust. They didn't understand why, and they didn't know how to engineer it ethically or measure whether it would work when someone's life depends on it.

Voice as Infrastructure

In the age of AI, your voice is more valuable than your logo.

Hollywood understands this. They cast voices the way they cast faces, knowing the wrong voice can sink a $200M film.

If tech companies are willing to risk lawsuits to access specific vocal properties, emergency services should be studying those same properties with scientific rigor.

The difference between a voice that calms and a voice that dysregulates isn't subjective. It's measurable biology. And when someone's life depends on it, biology decides survival.

The Cost of Getting It Wrong

Every second matters, and emergency medical dispatchers know this viscerally. They are trained to keep callers calm enough to follow instructions because panic kills.

The Compliance Problem

Research on 911 dispatchers reveals the occupational toll of constant voice modulation: dispatchers report higher rates of voice symptoms and score significantly higher on Voice Handicap Index measures than the general public, although clinical voice disorder diagnosis rates remain similar (Johns-Fiedler & van Mersbergen, 2015). The constant vocal load creates physical strain, with 54% reporting neck pain, 66% shoulder pain, and 13% throat pain from maintaining vocal control during high-stress calls. Dispatchers must constantly modulate their voices, raising pitch to signal urgency and lowering it to convey calm, while breathing audibly to signal presence.

AI voices don't do this. And when callers don't feel regulated by the voice on the other end, they:

- Struggle to convey accurate information (Tracy & Tracy, 1998)
- Fail to follow pre-arrival instructions (CPR, bleeding control, safe positioning)
- Disconnect prematurely because they don't trust the system (Adams et al., 2015)

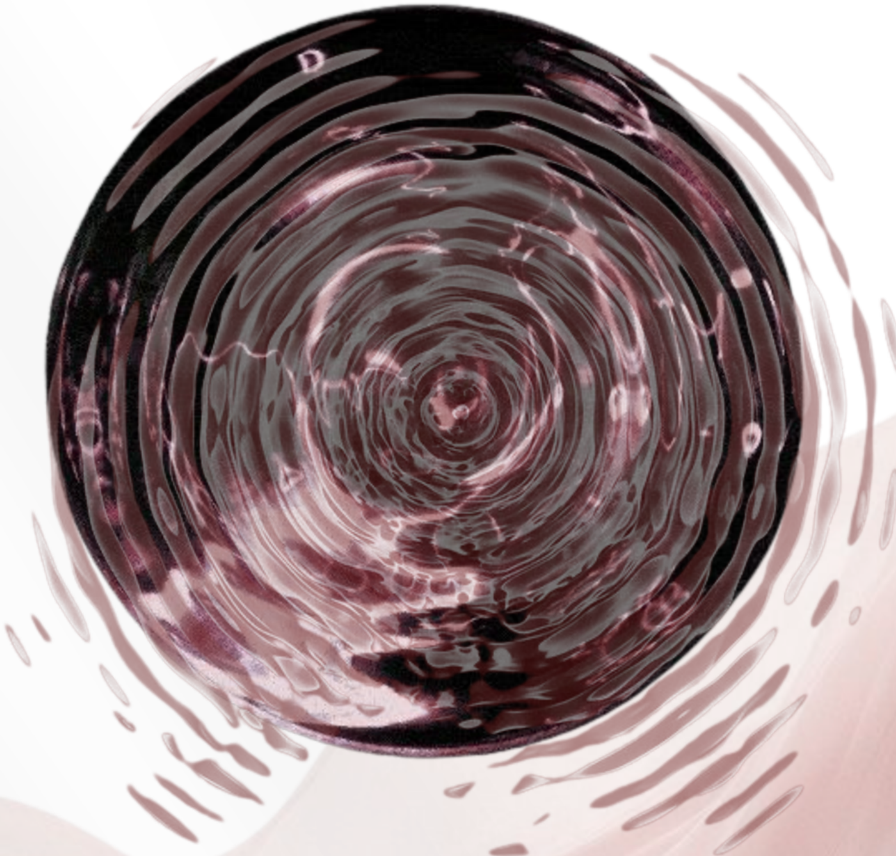
The 30-Second Problem

Research on emergency call outcomes consistently shows that delays in accurate information gathering increase mortality. Studies examining the relationship between CPR delay and survival demonstrate a dose-response relationship: each minute of delay reduces survival odds (Bircher et al., 2019; Nguyen et al., 2024).

For out-of-hospital cardiac arrest, survival rates drop significantly when CPR is delayed. Among 78,048 patients who received bystander CPR, survival was highest when CPR began within the first minute. Survival decreased progressively with each 2-minute delay (Nguyen et al., 2024).

Earlier research by Cummins et al. (1985) established that earlier CPR initiation significantly improves survival. The window is very narrow: CPR must start within 4–6 minutes of collapse and be followed by advanced life support within 10–12 minutes to be effective.

If an AI voice increases caller hesitation by even 15–30 seconds, callers pause, re-ask questions, or struggle to calm down, that delay may be fatal.



The Trust Erosion

Most concerning: once trust is broken, it does not reset. If someone calls 911 in a moment of desperation and encounters a voice that feels “wrong”, their brain encodes that 911 is not safe.

The next time they or someone in their community face an emergency, they may hesitate to call at all (Pierce & Lilly, 2012).

In consumer AI interaction, 70% of respondents said they would consider switching brands after just one frustrating AI-powered service experience, highlighting just how rapidly trust erodes (Acquire BPO, 2024). In customer experience, this deterioration leads to brand abandonment; in emergency response, it can mean the difference between life and death.

The Measurement Gap

Efficiency alone is an inadequate metric for human survival. This extends to mental health crisis lines, where callers in acute distress may now encounter synthetic voices before reaching humans. The stakes of voice-induced dysregulation in these contexts remain entirely unstudied.

Current benchmarks, like call processing time, accuracy, or routing performance, optimize operational throughput rather than physiological or psychological outcomes.

We should be measuring:

1. Biometric Validation

Heart rate variability (HRV): Measuring whether the caller's heart rate decreases or spikes during AI interaction. HRV provides insight into parasympathetic modulation and has been associated with emotion regulation (Appelhans, 2006; Morales-Luque et al., 2025).

Expanded biometric studies: In controlled simulations, a broader set of autonomic indicators could be collected, including skin conductance, respiration, pupil dilation, and facial EMG, to capture a comprehensive profile of voice-induced regulation. Although these measures are unlikely to be practical in live 911 environments, they remain valuable for establishing baseline responses to synthetic vs. human voices.

Vocal stress markers: Changes in the caller's voice pitch can indicate shifts in emotional state. Increases in pitch are associated with rising panic or arousal, while decreases in pitch and reduced skin conductance are linked to autonomic regulation (Laukka, 2005; Matejka et al., 2013).

Respiratory rate: Does the caller's breathing deepen and slow, or remain shallow and rapid? Respiratory patterns directly influence autonomic state through respiratory-cardiac coupling (Morales-Luque et al., 2025).

These are objective, measurable indicators of whether a voice is functioning as a regulatory agent.

2. Compliance Rates

Do callers follow CPR instructions as accurately with AI voices as with human dispatchers (Adams et al., 2015; Tracy & Tracy, 1998)?

Do they stay on the line longer or disconnect prematurely (Adams et al., 2015)?

Do they provide accurate address and victim status information on the first ask, or require multiple clarifications (Tracy & Tracy, 1998)?

3. Survival Outcomes

The gold standard should be A/B testing on real emergency calls which is ethically complex, but necessary.

Matched emergency scenarios (cardiac arrest, choking, severe bleeding).

Randomized to AI vs. human dispatch.

Measured outcomes: Time to successful intervention, survival rates, bystander CPR quality (Greif et al., 2024; Perkins et al., 2015).

Proposed Methodology: Research First, Deploy Intentionally

Automation in emergency response is already underway (Prepared, 2025; Temkin, 2025). Resistance is futile. Emergency services urgently need support. But deployment without validation is reckless. Broken data will break people. And without human data, technological innovation plateaus.

01 Phase: Biometric Pilot Studies (0–6 months)

Conduct controlled studies to establish baseline physiological and behavioral metrics and survival rates for synthetic vs. human dispatchers. These studies should measure caller autonomic regulation (HRV, respiration, vocal stress markers) and survival outcomes under matched conditions.

Goal: Identify quantifiable indicators of voice trust before further deployment.

Funding pathways: NIH Emergency Medicine, NSF HCI, state EMS budgets, private-sector matching.

02 Phase: Voice-Trust Standards (6-18 months)

Once data is available, establish measurable benchmarks for emergency AI voices:

- Minimum prosodic variation required (flat = dysregulating)
- Acceptable frequency ranges across demographics
- Response latency standards (instant = robotic; natural pacing = present)
- Breath-marker requirements (silence ≠ breath; synthesized breath cues = intimacy signal)

Develop open-standard testing protocols that are transparent and independently verifiable. These should serve as certification requirements for any emergency-response system before deployment.

03 Phase: The Hybrid Model (1-3 years)

Shift the thinking from “human OR AI” to “human WITH AI.”

Real-time prosodic modulation

- AI detects rising vocal pitch in caller → lowers own frequency, slows pacing
- Detects shallow rapid breathing. → introduces longer pauses, deeper rhythm
- Detects compliance hesitation → shifts from directive to collaborative tone

Voice continuity through dispatcher cloning

- AI voices trained on successful human dispatchers’ prosodic patterns
- Enables seamless handoff between AI → human → AI without disrupting caller’s trust
- Maintains acoustic consistency when dispatcher needs to override or step in
- Caller experiences one continuous voice relationship, not jarring speaker changes

Human monitoring + AI handling

- One dispatcher monitors 2-3 AI calls simultaneously via caller-biometric dashboards
- AI manages routine information gathering
- Human overrides immediately when stress escalates
- Human handles complex medical instructions, emotionally charged situations

Result:

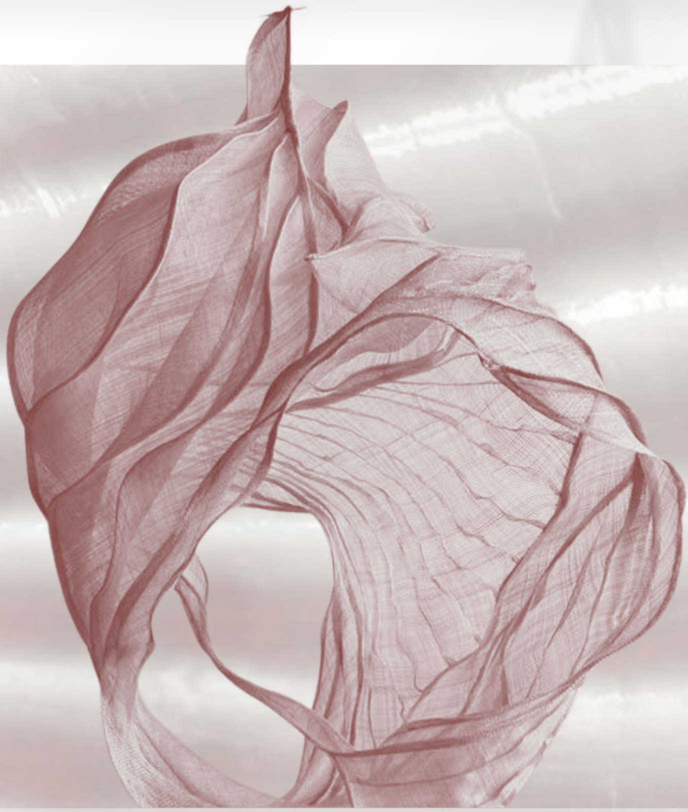
Dispatchers handle more volume without burning out. AI provides efficiency. Humans provide regulation.

04 Phase: Regulatory Framework (2-3 years)

Create standards requiring:

- Pre-deployment emotional impact testing
- Ongoing caller stress monitoring
- Mandatory reporting when AI fails to establish trust
- Regular audits comparing AI vs. human outcomes

Designing these standards for regulation will ensure that emotional safety is treated as a measurable performance metric rather than an afterthought.



We have crash test dummies for cars. We need voice trust tests for AI emergency systems.

Conclusion

We are building the sonic infrastructure of the future.
As AI voices become the primary interface for crisis response, we face a choice: build fast, or build right.

Although accuracy is essential, the human brain does not prioritize whether the AI transcribed an address correctly. It prioritizes whether the voice felt safe enough to elicit that information in the first place.

The Stakes

Over 1,000

agencies in 49 US states using AI emergency response (Prepared, 2025)

NHS 111

serving millions across UK with AI triage (NHS England, 2024)

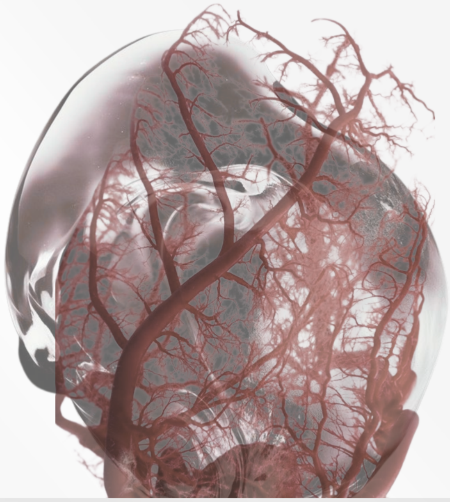
EENA pilot

programs deploying across European emergency services (Gizikis, 2024)

No published

studies on emotional impact of synthetic voices in crisis

Efficiency may save seconds, but design will save lives. The measure of a system built for humans must be human regulation itself.

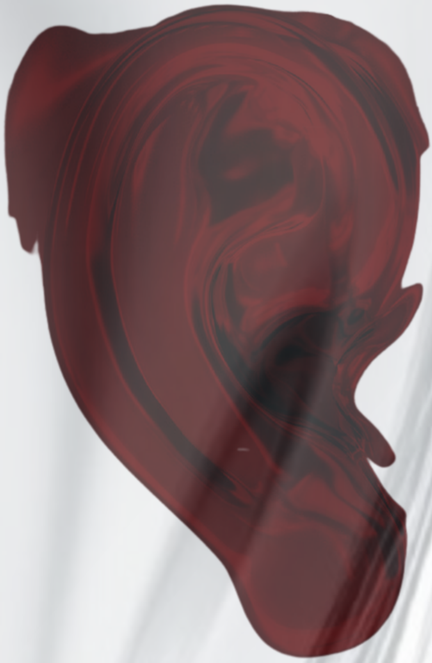


The Call to Action

Artificial intelligence is in motion. This is not a call to stop or slow it. It is a call to build it as if human life depends on it, because as we have shown today, it does.

Voice Safety Validation must become a pre-deployment standard for any system trusted with a human emergency. The neuroscience exists. The technology exists. The measurement tools exist.

We are building the foundation of a new world. What good is a machine that can speak like us if we do not understand how we listen?



About The Author

Jennalyn H. Ponraj is pioneering the study of vocal trust as measurable infrastructure and the design of voices for biological response, not just aesthetic preference.

She spent two decades making people feel through sound: a music career that began in her teens, performances in film and television, and as the voice behind global campaigns for some of the world's most recognizable brands including *Nike*, *Taco Bell*, *Kohl's*, *Victoria's Secret*, and *AAA* video games.

When two of the world's leading AI companies sought her voice for their systems, she recognized they were optimizing for the wrong variables.

She founded *Delaire*, a neuro-acoustic design lab developing Voice Architecture, frameworks that measure biological response to voice.

Her thesis: Voice equals trust. And trust is the new gatekeeper to adoption. If a voice fails to trigger the right biological response within 500 milliseconds, people will not trust the system, even if it works perfectly.

This paper presents the first biometric validation framework for AI emergency voices.

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from de l'air, "of the air."
Voice begins as breath. Breath is life

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