NeuroLens

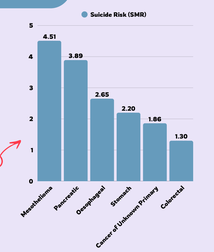
Invisible Care. Visible Change

To reduce stress and anxiety in real-time by integrating physiological feedback (cortisol levels) with adaptive vagus nerve stimulation (tVNS), guided audio, and emotional support tools tailored for cancer patients post-chemotherapy.

THE PROBLEM: WHY STRESS NEEDS SMARTER SOLUTIONS

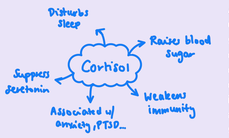
While survival rates for cancer patients have steadily improved, the psychological and emotional aftermath of diagnosis and treatment remains deeply under-addressed. Many cancer survivors continue to experience high levels of anxiety, cognitive fog, and depression long after their treatment ends. Research shows that up to 27% of cancer patients suffer from depression, with 20% experiencing anxiety. Additionally, 35–40% meet the diagnostic criteria for psychiatric disorders. These issues persist across the full cancer journey - regardless of stage or treatment phase - yet psychological support is often inconsistently provided or completely overlooked. The COVID-19 pandemic further exacerbated this crisis by isolating patients during long and emotionally taxing hospital stays, creating a deeper burden on mental health.

Some cancers carry a far higher psychological toll than others. For example, patients with mesothelioma are more than four times more likely to die by suicide than the general population. Pancreatic and oesophageal cancers also show suicide risks nearly three times higher than average. Even among more common cancers like colorectal or stomach cancer, suicide risk remains significantly elevated. This data is very disheartening. It highlights the fact that, for many cancer patients, the emotional trauma of illness can be just as devastating - and deadly - as the physical symptoms themselves.



Estimated increases in suicide rate compared with the general population according to tumour type

Figure 1. Adapted diagram of estimated increases in suicide rate compared with the general population according to tumour type. Adapted from Fernando, Asanga. "PubMed Central." "Mental health needs in cancer – a call for change", 30 Jul 2021, https://pmc.ncbi.nlm.nih.gov/articles/PMC10540782/. Accessed 23 June 2025



A key biological link between chronic stress and emotional breakdown lies in the hormone cortisol. Cortisol is the body's primary stress hormone. In short bursts, it plays an adaptive role - raising blood sugar for energy, sharpening attention, and aiding tissue repair. However, when cortisol levels remain elevated over time - as they often do in cancer survivors facing long-term stress - the effects are damaging. Chronically high cortisol disrupts nearly every major bodily system. It weakens immunity, disturbs digestion and sleep, increases blood pressure, suppresses serotonin (a mood regulator), and impairs memory and focus. It is also strongly associated with depression, anxiety, PTSD, and physical ailments like heart disease and ulcers. In this context, cortisol isn't just a stress marker - it's a warning signal that mind and body are under attack.

This is where smarter, more integrated health technology is urgently needed. Cancer survivors don't just need medication or periodic mental health check-ins—they need daily, adaptive support. **This is the promise of Neurolens**: a wearable smart glasses system designed to detect rising stress and respond in real-time. By using advanced biosensors to track cortisol and other physiological indicators of stress, Neurolens identifies emotional distress before it escalates. Through transcutaneous vagus nerve stimulation (tVNS), it stimulates the vagal nerve helping to reduce anxiety and improve mental clarity. Combined with bone-conduction audio delivering guided meditation or supportive coaching, the device supports not just stress relief, but emotional empowerment.

The reality is clear: the psychological consequences of cancer are measurable, biologically impactful, and (too often) fatal. But they are also manageable, especially with the right tools. Neurolens represents a shift from reactive care to proactive healing, an approach that understands stress as a treatable condition, and wellbeing as a continuous process. For millions of cancer survivors, such innovation could mean the difference between just surviving and truly living.

NOVELTY AND VISION: WHAT MAKES NEUROLENS DIFFERENT

Traditional VNS involves surgical implantation of a device to stimulate the vagus nerve. While effective, it carries risks such as breathing issues, irregular heart rhythm, and also has surgical complications. NeuroLens, using transcutaneous VNS (tVNS), avoids surgery by delivering gentle electrical stimulation through the skin, offering a safer, less invasive alternative. Compared to pharmacological therapy, NeuroLens also prevents fewer side effects and a lower risk of dependency.

NeuroLens cleverly integrates advanced neuromodulation technology into standard-looking eyeglasses, ensuring discretion and comfort. It uses AgCl (silver chloride) adhesive electrodes placed behind the ears, targeting the auricular branch of the vagus nerve. These pads are extended from the soft silicone arms of the glasses, making the design aesthetically appealing, minimalistic and wearable all day. Being non-invasive, it doesn't require surgery or intrusive procedures, making it ideal for daily use with minimal disruption to lifestyle.

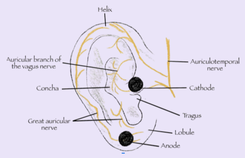


Figure 2. Low Level Tragus Stimulation (LLTS) diagram. MDPI. "Vagus Nerve Stimulation and Its Cardioprotective Abilities: A Systematic Review." MDPI, 21 February 2023, https://www.mdpi.com/2077-0383/12/5/1717.

SOCIAL ACCEPTABILITY: Built for the Real World

One of the main reasons of NeuroLens works so well in everyday life is that it does not look like a medical device. Unlike bulky or clinically looking wearables that might make the user feel self-conscious, NeuroLens blends in with regular glasses, reducing stigma and making people feel more comfortable wearing it in public. This discrete design encourages daily use without drawing attention, which is especially important for individuals managing mental health conditions or recovering from trauma. Feedback from early users highlights how the familiar appearance helped them stick with it long term, something that's often a challenge with more obvious medical tech

Visually, showing a side-by-side comparison of traditional medical devices versus NeuroLens could help reinforce just how subtle and wearable it is. Including real quotes from users or prototype testers in a "thought bubble" format would add a more relatable, personal feel to the product story. These perspectives not only humanize the technology but also show that people from different walks of life—whether recovering patients or high-stress professionals—can find it helpful without feeling labeled or exposed. That kind of social acceptability is what makes NeuroLens practical beyond just the clinical setting.

SCIENTIFIC + TECHNOLOGICAL APPROACH: How NeuroLens Works

The vagus nerve is a key part of the parasympathetic nervous system, which controls many of the body's automatic functions related to rest, recovery, and emotional regulation. When this system is activated, it helps the body slow down - reducing heart rate, calming breathing, and restoring balance across major systems. This makes the vagus nerve a powerful target for therapeutic stimulation, especially in individuals struggling with stress, anxiety, or emotional instability.

Transcutaneous vagus nerve stimulation (tVNS) is a non-invasive method that stimulates the vagus nerve through the skin, triggering brain regions involved in mood and anxiety regulation. It has been shown to improve emotional well-being and reduce stress without the risks associated with invasive procedures. In contrast, traditional vagus nerve stimulation (VNS), which requires surgical implantation, carries risks such as breathing disturbances, irregular heart rhythms, and complications from the procedure itself. tVNS avoids these issues, making it a safer, more publicly accepted option for daily use.

Our device, Neurolens, harnesses this technology in a wearable and discreet form. By using AgCl (silver chloride) adhesive electrodes positioned behind the ear near the tragus, the device delivers gentle and targeted stimulation to the auricular branch of the vagus nerve. This region was chosen for its reliability, anatomical accessibility, and compatibility with a stable glasses form factor. The stimulation pads are integrated into the soft silicone arms of the glasses, providing continuous contact without sacrificing comfort or aesthetics.

While research continues into the most effective regions for vagus nerve stimulation, the tragus remains one of the most practical and well-supported locations for non-invasive use. Our design embraces this approach to ensure consistency and user comfort, while enabling real-time interventions based on biometric feedback.

Paired with biosensors that monitor cortisol and other stress indicators, Neurolens does more than just track stress - it actively helps the body respond to it. By combining stimulation, sensing, and AI-guided support in a sleek, user-friendly package, our device empowers cancer survivors to regain emotional balance, reduce anxiety, and enhance their quality of life.

Strengths of tVNS	Weaknesses of tVNS
Non-invasive: No surgery required, unlike implanted VNS devices.	Variable efficacy: Response rates vary across individuals and conditions.
Fewer side effects: Generally better tolerated than pharmacological treatments.	Limited long-term data: Few high-quality studies on long-term safety and efficacy.
Home-use potential: Some tVNS devices are portable and suitable for self-administration	Mechanism not fully understood: Biological mechanisms still under investigation.
Wide therapeutic potential: Studied for depression, epilepsy, migraine, anxiety, tinnitus, PTSD, and more.	Placebo effect possible: Some benefits may be due to placebo, complicating interpretation of results.
Low risk of dependency: Unlike some medications, there's minimal risk of addiction or tolerance.	Requires adherence: Daily or regular use may be needed for benefit.

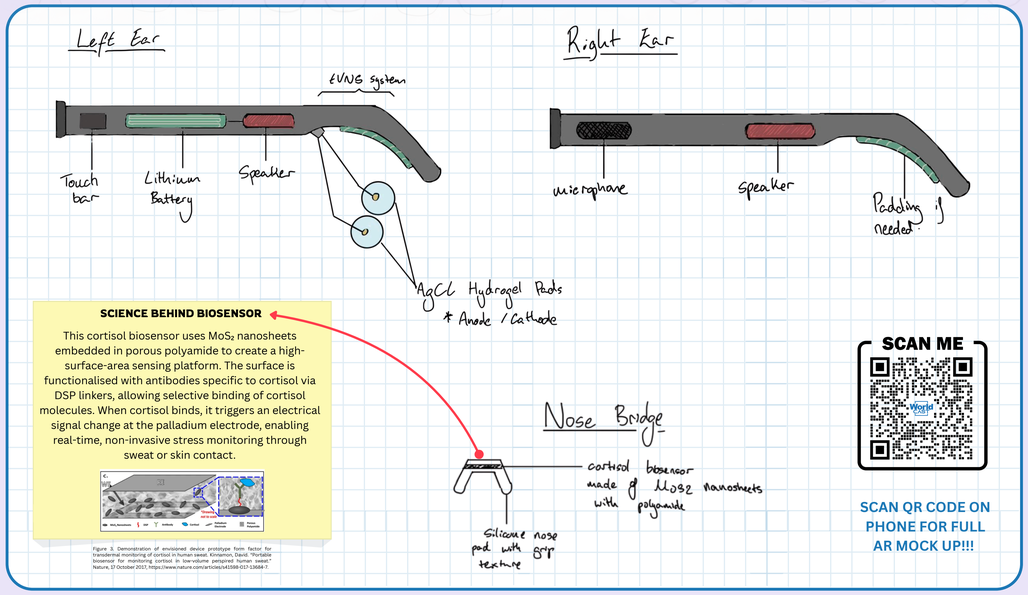
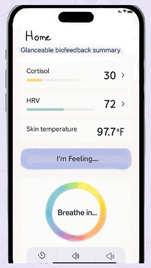


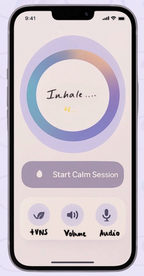
Figure 3. Demonstration of envisioned device prototype form factor for transdermal monitoring of cortisol in human sweat. Kinsman, David. "Portable biosensor for monitoring cortisol in low-volume perspired human sweat." Nature, 17 October 2017, https://www.nature.com/articles/s41598-017-13684-7

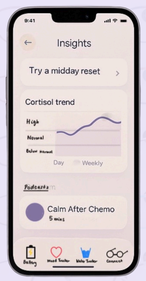
APP MOCKUPS

App Overview: Supporting Post-Chemotherapy Wellbeing

The Neurolens companion app is designed to work seamlessly with the smart glasses system to support stress relief, emotional regulation, and mental clarity in cancer patients recovering from chemotherapy. This mock up demonstrates how the interface helps users engage with biofeedback, guided therapy, and emotional check-ins in a calming, intuitive way.







Key Features:

Biofeedback Dashboard
The home screen provides a real-time summary of key indicators: **cortisol levels**, **HRV (heart rate variability)**, and **skin temperature** all of which reflect the user's stress state. This helps users build awareness of their physiological patterns.

Touch-Activated TVNS Sessions
The app allows users to start **tVNS sessions** directly or via the touch bar on the glasses. These sessions activate calming neural pathways, helping reduce anxiety and physical symptoms of stress.

Mood Journaling + Voice Notes
Users can describe how they're feeling using text or voice. The app offers **sentiment analysis** and prompts emotional check-ins that are **correlated with biometric data** to support mental clarity and reflection.

Therapeutic Audio Content
Bone conduction speakers in the glasses deliver **AI-guided emotional coaching**, meditative exercises, and therapeutic audio tailored to user needs - all controllable through the app.

Calm Session Interface
A simplified breathing ring and live session screen guide the user through calming routines, supported by **haptic prompts** and audio, enhancing emotional regulation on the go.

Insights and Trends
The app includes a visual trends section, comparing **cortisol levels with self-reported mood**, helping users understand what affects their emotional and physiological state.

This app is not a generic wellness tool - it is specifically created for **cancer survivors** dealing with ongoing emotional strain, cognitive fog, and heightened vulnerability to stress. By translating biometric data into guided actions, the Neurolens system supports recovery with **compassionate, intelligent design**. It empowers users to regain emotional balance, improve quality of life, and feel more in control of their mental health journey.

TEAM

Lead Researcher: Chiwenimnwo Wamadi :Biology, Chemistry, Maths, EPQ
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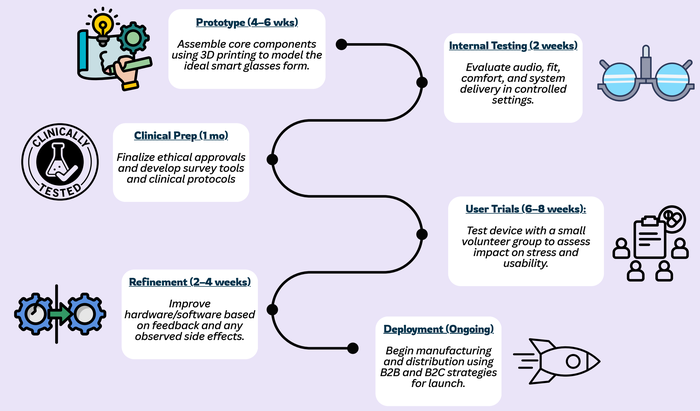
User Experience & Ethics Lead: Syed Muhammad Ridwan Miah :Biology, Chemistry, Psychology

TESTING & EFFICACY: Does it work?

"IMPLEMENTATION TIMELINE"



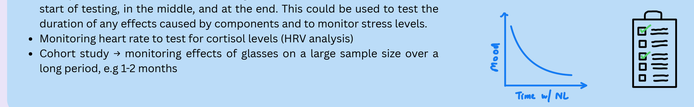
TESTING FOR EFFICACY:

Clinical involvement is an essential part of testing the effectiveness of the glasses:

- tVNS safety monitoring
- Mood/stress assessment
- Ethics

Examples that can be used:

- Surveys are sent out to volunteers at regular intervals. This could occur at the start of testing, in the middle, and at the end. This could be used to test the duration of any effects caused by components and to monitor stress levels.
- Monitoring heart rate to test for cortisol levels (HRV analysis)
- Cohort study → monitoring effects of glasses on a large sample size over a long period, e.g 1-2 months



AFFORDABILITY & AVAILABILITY: Built for the Real World

Component	Approx Cost	Size	Availability	Battery Impact	Data Syncing
AgCl hydrogel pads	£10 - £30 for a pair	Ear fit	Medium → medical supply	Very low	N/A
MoS2 sensor with polyamide	£15 - £60 depending on quality	Nose bridge chip	Low - Medium	Very low	Requires MCU
Lithium Battery (3.7V - 4.2V)	£5 - £19	18mm in diameter, 65mm in length	High availability	Main power source of the glasses	Supports BLE/IoT
Silicone nose pads	£2 - £5	Standard fit	High	N/A	N/A
Microphone	£1.50 – £5.50	Fits in right arm	High	Relatively low	Bluetooth
Speaker	£6 - £20	Compact	High	Low	Audio drivers
Touch Bar	£4 – £9	Slim	Medium	Low - Medium	Bluetooth
tVNS	Medical grade: £350 - £600	A mini PCB is needed	Medium	Relatively high	Controlled by a MCU

Note: All components are commercially available, wearable-ready, and selected for size, safety, and integration potential. Only tVNS current is safety-limited (1–5 mA).

A basic MVP with essential functionality (biosensing and tVNS) could be built for around £300–£350, while a more advanced, clinical-grade prototype with precision circuitry and medical-standard stimulation may reach £600–£650. The most significant cost factor is the tVNS system itself, but even with that, Neurolens remains excellent value when compared to similar technologies on the market.

- Fisher Wallace Stimulator – £400–£500
- Apollo Neuro – £300–£350
- Muse S Headband – ~£300
- Healy Resonance – £1,000+
- Whoop Band – £200–£300 (with ongoing subscription)

Unlike these products, Neurolens uniquely combines cortisol tracking, vagus nerve stimulation, and AI-guided emotional support in one discreet, wearable form. With no need for subscriptions and a specific focus on post-chemo cancer survivors, it offers strong clinical potential at a competitive cost. It also aligns well with NHS priorities for digital mental health tools and early, non-pharmacological intervention.

References

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