College of Engineering

R&D Expo

University of North Texas

SENIOR DESIGN

Spring 2026

COLLEGE OF ENGINEERING
Department of Biomedical Engineering

Senior Design Abstracts
Spring 2026

Smart Compression Sleeve

Team Members

Alikhan Daya
Fizzah Fasih
Louis Ly
Serena Lopez

External Sponsors/Mentors

N/A

Internal Sponsors/Mentors

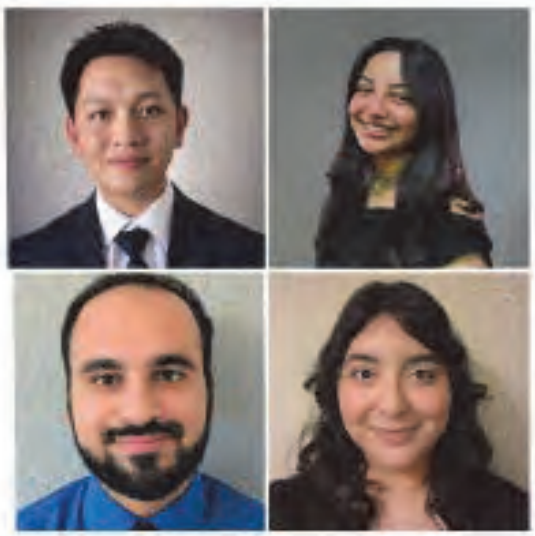
Dr. Neda Habibi

The University of North Texas Biomedical Engineering Department

Abstract

Soft tissue injuries are extremely common and tend to occur in your muscles, tendons, and ligaments oftentimes from overuse or injury. They affect a big population of people from athletes to manual labor workers of all ages, constituting nearly 30% of all work injuries per the BLS. They often present as sprains, strains, and contusions, with more serious injuries presenting as tendonitis and bursitis. A common method of treating this type of injury is a compression sleeve. Compression sleeves work by pressing down on the injured area to increase blood flow in the vessels while preventing the buildup of fluid. Other ways to treat such injuries may involve heating or icing the injured area.

Our solution combines heating, compression, and biomarker monitoring to promote healing and prevent further injury. With user-choosable compression of up to 20 mmHg, temperature settings operating up to 43 °C, as well as inflammation and muscle oxygenation sensing, our device is completely customizable to the customer.



We would like to extend our gratitude to Dr. Habibi, Dr. Shi, Nicole Berry, and Neil Chinn for their support and guidance on this project.

Scalable Niche-Mimicking Bioreactor for Stem Cell Biomanufacturing

Team Members

Nelly Juarez Carrillo
Cristina Campuzano
Angel Dougan
Michell Rodriguez

External Sponsors/Mentors

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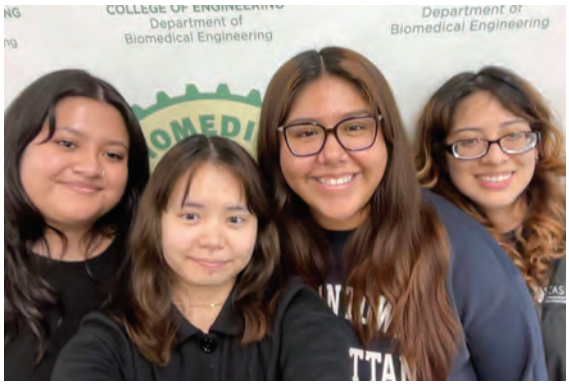
Internal Sponsors/Mentors

Dr. Yong Yang

Abstract

Stem Cells hold great potential to transform regenerative therapies, disease modeling, and even cosmeceutical applications. However, realizing the potential is restricted by the need for large cell quantities and the high production cost. Conventional two-dimensional multilayered culture systems fail to recapitulate in vivo environment, causing a loss of stemness, while commercial bioreactors expose cells to high shear stress, adversely affecting cell viability and function. To address these challenges, a dynamic bioreactor was developed. The bioreactor is comprised of multiple cell culture cartridges, each featuring a stretchable membrane sandwiched between soft hydrogels, which are electrospun with nanofibers to mimic in vivo environment. In addition to continuous perfusion of culture medium, cyclic, uniaxial mechanical stretching was applied to the cartridges to regulate cell behavior. Computational simulation was conducted to optimize flow dynamics within the bioreactor. Immunofluorescence assay exhibited larger cell spreading and higher proliferation rate on stiff hydrogels (80kPa) compared to soft hydrogels (1kPa). Yet, gene expression analysis showed upregulated stemness on soft hydrogels. This device offers a promising approach to bridge the gap between large-scale production, cell functionality, and cost efficiency.



We would like to acknowledge Dr. Yong Yang, Sachin Kaluarachchi, Ryan Ghandour, and Benjamin Hu for all their help and support throughout this project.

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CLUBKICKS: A Gait Assistance Device for Clubfoot

CLUBKICKS

Team Members

Julio Saucedo
Savanah Chavarria
Alejandro Castro
Chelsea Danko

External Sponsors/Mentors

N/A

Internal Sponsors/Mentors

Dr. Amir Jafari

Abstract

Clubkicks is an active gait assistance device for clubfoot. Clubfoot is a congenital foot deformity that is characterized most commonly by the foot turning inward and downward (C.A.V.E. tendencies). While clinical techniques like the Ponseti Method correct the foot through a series of casting phases, post-clinical retention methods serve as passive positional retention, effectively immobilizing the foot position, without providing any active gait correction.

Clubkicks aims to improve the quality of life for those afflicted by clubfoot by providing daily-use orthopedic shoe that utilizes an elastic system that pulls the foot out and up during a user's swing phase, accompanied by an integrated ankle-foot orthosis that maintains proper foot structure and a double rocker sole that facilitates a more efficient heel-to-toe transition. We aim to bridge the gap between static bracing and functional mobility to encourage compliance and promote optimal gait kinematics.

Acknowledgements: Alejandro Padilla Gonzalez, Dr. Amir Jafari, Dr. Xiaodan Shi, Nicole Berry, Neil Chinn, Marco Zavala, Ramzi Aouadi, Biomedical Engineering, Mechanical Engineering, & Material Science Department.

Cooling Vest for Canines

Team Members

Kaustubh Gurnani
Patrick Overton
Eduardo Ochoa
Luis Assad

External Sponsors/Mentors

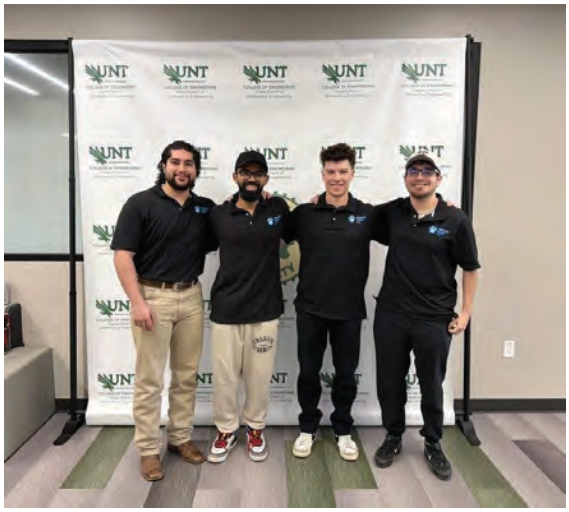
Kseniya Parsons

Internal Sponsors/Mentors

Dr. Tsz Yan Clement Chan

Abstract

Physical exertion, especially in hot climates, is a major cause of heat-related illness in canines. Although dogs rely on panting for cooling, this mechanism is inefficient. Existing products mainly use evaporative cooling, which provides only short-term relief and requires frequent soaking, making performance dependent on weather conditions. This project addresses these limitations by developing two sustainable cooling harness systems designed to provide more reliable temperature regulation and comfort.
Prototype I is a five-layer harness composed of a UV-reflective outer shell, spacer mesh, phase change material (PCM) packs, polyurethane laminate (PUL), and an inner lining. Together, these layers reduce heat absorption, improve airflow, manage moisture, and enhance comfort. The PCM packs, made from lauric acid and stearic acid, act as a thermal battery by absorbing heat.
Prototype II uses a closed fluid circulation system to deliver more uniform cooling. A DC water pump, powered by a 3S Li-ion battery pack, circulates cold water through silicone tubing placed along key heat-exchange zones on the dog's back and torso.



Acknowledgements: Kseniya Parsons, Dr. Xiaodan Shi, Nicole Berry, Dr. Tsz Yan Clement Chan, Neil Chinn

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DinoFloDx: Paper Based Microfluidic Device for Bacterial Detection in Diarrhea

DinoFloDx

Team Members

James Escobar
Gurushayraam Venkatesan
Benjamin Marin
Isaiah Torres

External Sponsors/Mentors

Dr. John Peffer (Sponsor)
Dr. Sara Peffer (Sponsor)

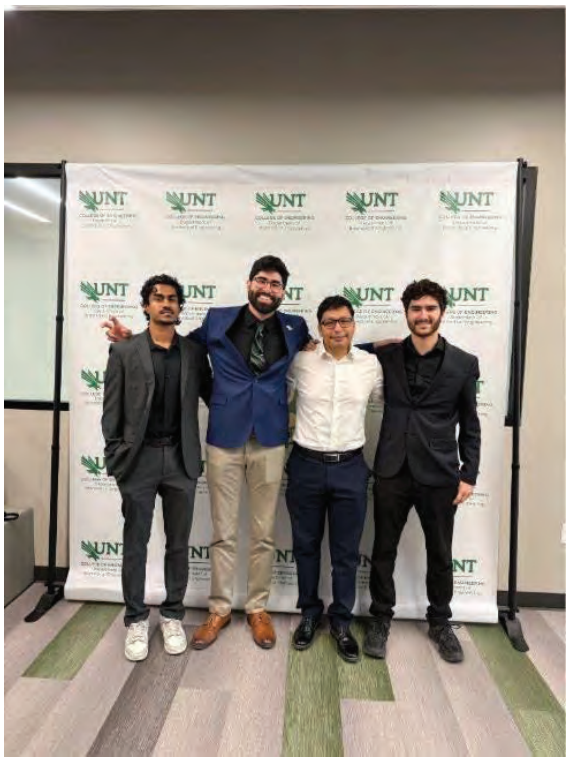
Internal Sponsors/Mentors

Biomedical Engineering Department
Brian Meckes (Mentor)

Abstract

Worldwide, diarrhea affects and estimated 1.7 billion children aged between the ages of 5 and 9 every year. Our device is an accessible testing device for professional healthcare use that can be sold for less than $30 for a kit and requires no external equipment. Our device tests for the three bacteria responsible for 80% of bacterial diarrhea cases; Salmonella, Shigella, and Campylobacter. This allows health providers to ensure appropriate treatment is provided.
The device uses a paper-based lateral flow immunoassay system where antibodies attach to surface proteins of bacteria and render them visible to the naked eye with the use of gold nanoparticles.

Our device's components, which include conjugate pads, nitrocellulose paper, gold nanoparticles, and a cassette to hold the device in place, are inexpensive to source and manufacture. In addition, the device will consolidate testing for all three bacteria, reducing waste, cost, and carbon footprint. With our innovative technology, we strive to innovate the next generation of affordable rapid testing.



Special thanks to Nicole Berry, Neil Cornelius Chinn, Dr. Neda Habibi, Dr. Xiaodan Shi, Dr. Brain Meckes, Biomedical Engineering Department, and Dr. John and Sara Peffer.

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Smart Pill Dispenser for Geriatric Patients

Team Members

Deeba Dinarvand
Maria Celeste Becerra
Giselle Mata
Steven Medrano

External Sponsors/Mentors

N/A

Internal Sponsors/Mentors

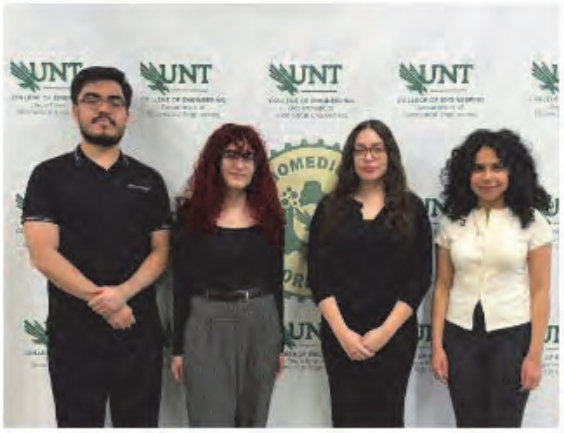
Dr. Youngwook Won
Nicole Berry

Abstract

Medication non-adherence refers to any deviation from the medication plan set by the physician for the patient. Non-adherence is especially seen in geriatric patients, often due to polypharmacy, emotional distress, cognitive barriers, and physical limitations. These challenges can lead to missed doses and incorrect medication intake, causing adverse effects such as disease progression, increased hospitalization, and even mortality.

Current pill storage systems often require manual organization and rely heavily on patient recall and memory, posing significant challenges for older adults. The EmergeRX smart pill dispenser is designed specifically for geriatric patients to simplify medication management with ease and minimal effort. The device features four compartments capable of accommodating various pill shapes and sizes, along with integrated visual and audio alerts to support timely dosing. It also offers bilingual functionality in English and Spanish to enhance accessibility.

In addition, the accompanying software enables caregivers and family members to remotely monitor medication adherence and manage dosing schedules in real time, improving both patient safety and overall care coordination.



We would like to acknowledge Cristina Campuzano for proposing the idea that insipired this project. We would also like to acknowledge Dr. Won, Dr. Shi, Nicole Berry, and Neil Chinn for their continued support and feedback throughout the year.

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The Perfusion Index "PI" Wearable Device

Team Members

Oscar Palacios
Monica Leanos
Habiba Elsayed
Joaquin Salinas

External Sponsors/Mentors

The RealTime Group:
Noah Sudduth
Cooper Woods

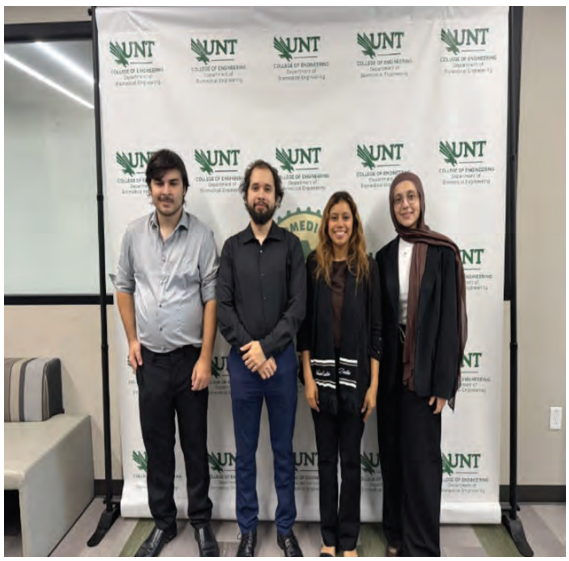
Internal Sponsors/Mentors

Dr. Fateme Esmailie (Sponser)

Abstract

Throughout the years, chemotherapy has been used as the main way to fight for survival for cancer. While recommended, it is not without its own risks and drawbacks during treatments. These effects include pain, bodily disorder, or advancements in their current conditions that may affect their movements/responses towards certain stimuli. With the help of our sponsor, The RealTime Group, We in Hartonik have created our own wearable perfusion index device that monitors the blood flow in patients who undergo chemotherapy. Its primary purpose is to act as an early warning for severe conditions such as Chemotherapy-Induced Peripheral Neuropathy (CIPN).

Its construction is modeled around proper security, comfort, and longevity. The design allows it to be worn and operated for up to four hours before needing to recharge from its use. Our device utilizes a raspberry Pi that utilizes python code and converters for power regulation. Being powered by a 3.7V lithium-ion battery that connects to the sensor, the max301 at the index finger that received the data. Then data is processed through our code to be displayed onto the LCD screen selected to showcase the data in a graph format. Allowing for an almost instant update as to the patient's current condition while they are uninterrupted doing their daily life.



We would like to thank both the BMEN department from the University of North Texas; Fateme Esmailie and The Realtime Group for both funding, providing assistance, understand of the necessary equipment to allow to create our Perfusion index Design prototype.

STRYDR Smart Sock: Fall Prevention and Diagnostics Aid Device for the Elderly

Team Members

Laura De Cesero
Ernest Ndjibu
Alyssa Galindo
Princess Amah

External Sponsors/Mentors

Mr. Curtis Rhodes
UNT Health Fort Worth

Internal Sponsors/Mentors

The University of North Texas
Department of Biomedical Engineering
Dr. Lin Li

Abstract

Falls among the elderly population represent a major public health challenge, often resulting in injuries, immobility, and increased mortality risk. Current fall prevention devices, both wearable and non-wearable, have primarily focused on gait correction and monitoring, but often lack discreetness and long-term usability.

Our STRYDR Smart Sock is designed to provide physical therapists with a discreet, wearable device for extended monitoring (6+ hours). The rechargeable, battery-powered system integrates force-sensing resistors (FSRs), an inertial measurement unit (IMU), and ultra-wideband (UWB) sensors embedded in a comfortable insole to capture the patient's walking patterns, speed, and stride length. Data is stored and processed through a compact circuitry unit located at ankle height within the sock. Arduino IDE is used for data acquisition and transmission, while MATLAB enables processing and visualization on the physician's device, creating a user-friendly interface that displays both graphical trends and numerical values.

By combining extended monitoring with a discreet design, the STRYDR Smart Sock enables medical-grade assessment from the comfort of the user's home, supporting early intervention, and improving quality of life in the elderly population.

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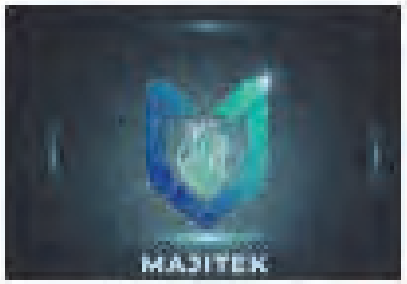


Majitek Solutions: Thermal Fall Mitigation Vest

Team Members

Jaxon Rait
Joanna Thrirunilathu
Merlin Chandy
Muhaned Almenayan

External Sponsors/Mentors

N/A

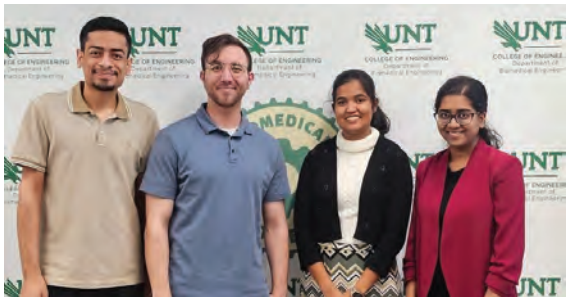
Internal Sponsors/Mentors

Dr. Vijay Vaidyanathan
Omar Cavazos

Abstract

Falls are a major cause of injury among adults aged 65 and older, often leading to fractures, head trauma, and long-term mobility problems.

The Thermal Fall Mitigation Vest is a wearable safety device designed to reduce such injuries by combining advanced sensors and rapid protection technology. It uses three strategically placed accelerometers to continuously monitor body motion and detect sudden movements exceeding 2–3 g, indicating a fall. When a fall is detected, a CO_2 canister rapidly inflates an integrated airbag within 100 milliseconds, cushioning critical areas such as the neck and hips. The vest is lightweight, comfortable, and breathable, allowing elderly users to wear it throughout the day. Its reusable design, with replaceable CO_2 cartridges and resettable airbags, makes it a practical, cost-effective solution that enhances both safety and independence for older adults.



We would like to acknowledge and thank Dr. Vijay Vaidyanathan for serving as our academic advisor.

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MEDMIST

Team Members

Becca Cataline
Mariah Mukes
Adedolapo Adeyankinnu
Davida Osagie

External Sponsors/Mentors

John Houston

Internal Sponsors/Mentors

Dr. Moo-yeal Lee

Abstract

A laryngoscopy is a procedure used to visually examine the larynx (voice box) and other surrounding areas of the throat. This is an uncomfortable procedure for patients. The lidocaine drip is a common solution on the market used to numb the area alleviating this discomfort. Airkor created UltraEzAir, a nebulizer to vaporize the lidocaine into a finer mist than the drip, which coats the upper airway evenly. This device, however, produces a lot of plastic waste per use.

Our MedMist nebulizer is a redesign of the current device and a solution to overall waste reduction. This design will reduce production cost as well as the cost for the patients while reducing medical waste in the environment. Our device would make use of a piezo electric transducer which would be in direct contact with the lidocaine medication like the original UltraEzAir device, however, the hard plastic chamber used previously is replaced with a soft medical grade PET chamber to reduce waste per use.

Our group would like to acknowledge John Houston, our sponsor, and Dr. Moo-yeal Lee for their unwavering support, guidance and encouragement through the duration of this project.

DAWL Indwelling Urinary Catheter

Team Members

Mariam Athumani
Georgia Doan
Skylar Latimore
Diane Williams

External Sponsors/Mentors

N/A

Internal Sponsors/Mentors

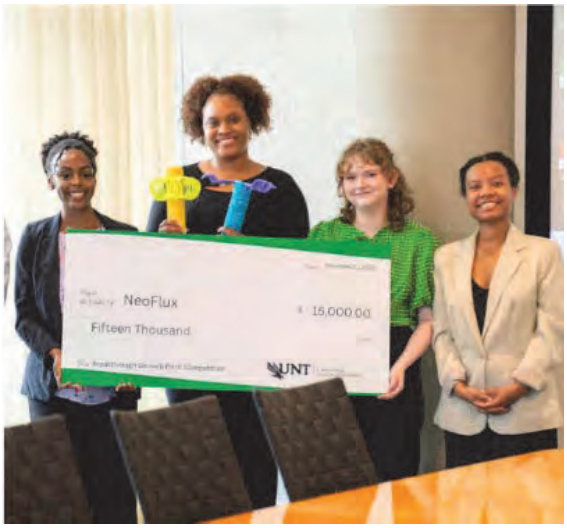
The University of North Texas Biomedical Engineering Department

Dr. Huaxiao "Adam" Yang

Abstract

While the global demand for long-term urinary catheters is increasing, the technology remains substantially stagnant. No significant improvements have been made to the standard Foley option since it was first invented nearly one hundred years ago. Furthermore, many women have a need for long-term urinary catheterization, yet a catheter has never been made with women's comfort in mind.

Our DAWL catheter features a novel petal-like design to secure it inside the bladder while minimizing contact with the most sensitive areas of the bladder. This feature allows our product to be more lightweight and comfortable than the traditional Foley Catheter. Additionally, DAWL features a chitosan coating that provides the catheter with superior antimicrobial properties. Together, these design choices target the two main shortcomings of the Foley catheter, discomfort and infection risk, in a single device. NeoFlux aims to reach beyond what has been tolerated, and deliver the standard of care that women deserve.



We would like to acknowledge Dr. Melanie Ecker, Dr. Neda Habibi, Dr. Yong Yang, Nicole Berry, and Dr. Xiaodan Shi for their continued help and support.

An In Vitro Human Head Phantom

Team Members

MacKenzie Moore
Jaden Coston
Marjorie Mendoza
James McKinley

External Sponsors/Mentors

N/A

Internal Sponsors/Mentors

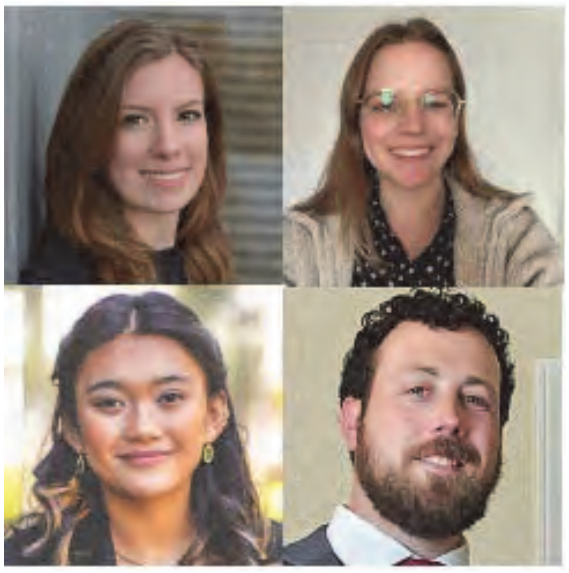
Dr. Fateme Esmailie

Abstract

medical applications, including cochlear cooling for the prevention of hearing loss. Currently, such testing is primarily performed using animal models (e.g., rats) and human cadavers; however, both approaches have significant limitations. Rats lack the anatomical fidelity of the human head, including appropriate size and the correct location of blood flow as a thermoregulatory heat source. Cadavers possess accurate human anatomy but do not exhibit active blood circulation. As a result, these testing methods introduce inaccuracies because they fail to replicate the thermal behavior of a living human head.

To address these limitations, we propose the development of an in vitro human head phantom that replicates the thermal properties of cranial tissues and incorporates fluid flow through the carotid artery using a controlled flow loop. In this work, computed tomography (CT) images and three-dimensional (3D) modeling software were used to generate anatomical models. These models will be used to fabricate the components of the final human head phantom from materials selected to match the thermal conductivities of the corresponding biological tissues.

The ultimate goal of this project is to create an in vitro human head phantom that accurately mimics the thermal behavior of a real human head. This phantom will provide a reliable testing platform for researchers and medical device manufacturers and serve as an effective teaching tool for educational institutions.



We would like to give a huge thank you to Dr. Esmailie, Bailey McCorkendale, and the Thermal Fluid Assisted Medicine Lab for all of their help and support!

SoreShield Patch

Team Members

Emily Hesselgesser
Jazlyn Rodriguez
Jaqueline Gandara
Gabriela Guillen

External Sponsors/Mentors

N/A

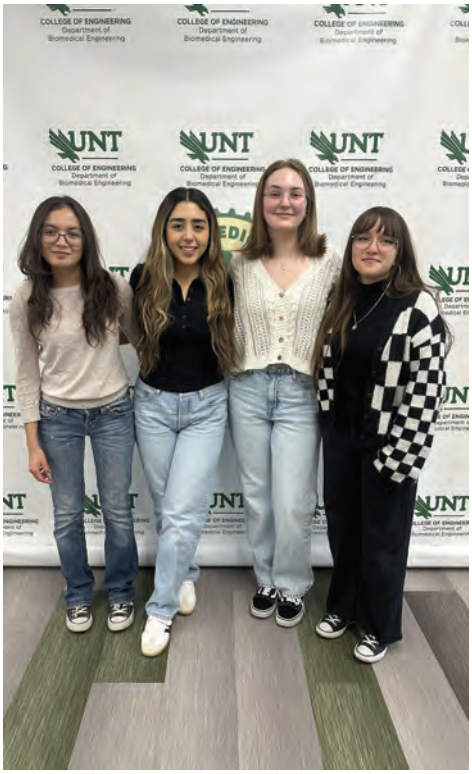
Internal Sponsors/Mentors

Dr. Melanie Ecker

Abstract

Pressure ulcers, or bed sores, are a prevalent issue amongst the elderly in long-term care facilities and patients in intensive care units. Pressure ulcers are areas of skin breakdown due to prolonged pressure, typically over a bony prominence, which causes tissue ischemia leading to tissue damage. Pressure is the main cause of pressure ulcers, but the process of skin breakdown can be made faster by increasing the temperature and humidity of the skin. Current solutions for pressure ulcer prevention involve nursing intervention, which can be time-consuming and inefficient.

Our project, the SoreShield Patch, aims to reduce the number of pressure ulcer cases by sensing pressure, temperature, and humidity to anticipate a heightened risk of pressure ulcer formation. This will help ease the burden of nurses and care providers by alerting them when they need to check on patients. The device will feature a two-layered patch, the first layer is an adhesive to stick the patch to the skin, and the second is a dressing to cover the integrated temperature/humidity sensor and pressure sensor. The patch will be connected to a reusable housing via a disposable wire. The housing will hold the rechargeable battery and PCB. The device will alert nurses or care providers when an increased risk of ulcer formation has been detected.



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