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Sweat Sensor for Non-Invasive Glucose Measurement

MAY 7TH, 2021 CONN HASTINGS DIAGNOSTICS, MEDICINE

Researchers at the University of California San Diego have developed a sweat sensor that measures glucose levels on the skin and converts those readings into accurate blood sugar estimates. As glucose levels in sweat can vary from person to person, the sensor incorporates algorithms that personalize the measurement for each user, requiring finger-prick calibration once or twice each month.

Although glucose levels in sweat correlate loosely with blood glucose levels, there are significant levels of variability from person to person. The levels of glucose in sweat tend to be much lower than that in the blood, and rates of sweating can also affect the measurements.

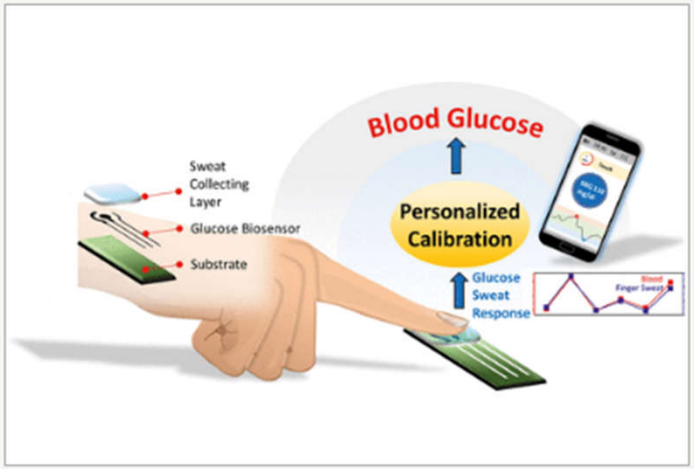
Consequently, a 'one size fits all' approach to sweat glucose testing clearly isn't as accurate as it could be. To address this, these researchers have developed a device that can provide a personalized measurement for each patient. A user simply places their finger on the sensor for a period of 1 minute to collect enough sweat to test.

The sensor consists of a polyvinyl alcohol hydrogel which absorbs the sweat. The gel lies over an electrochemical sensor, which detects and measures the amount of glucose present through an enzymatic reaction that creates an electrical charge. Collected data are interpreted using an algorithm that corrects the reading for each user based on a monthly finger prick calibration.

So far, the device has been tested in a small number of volunteers and could accurately predict blood glucose levels before and after a meal with over 95% accuracy.

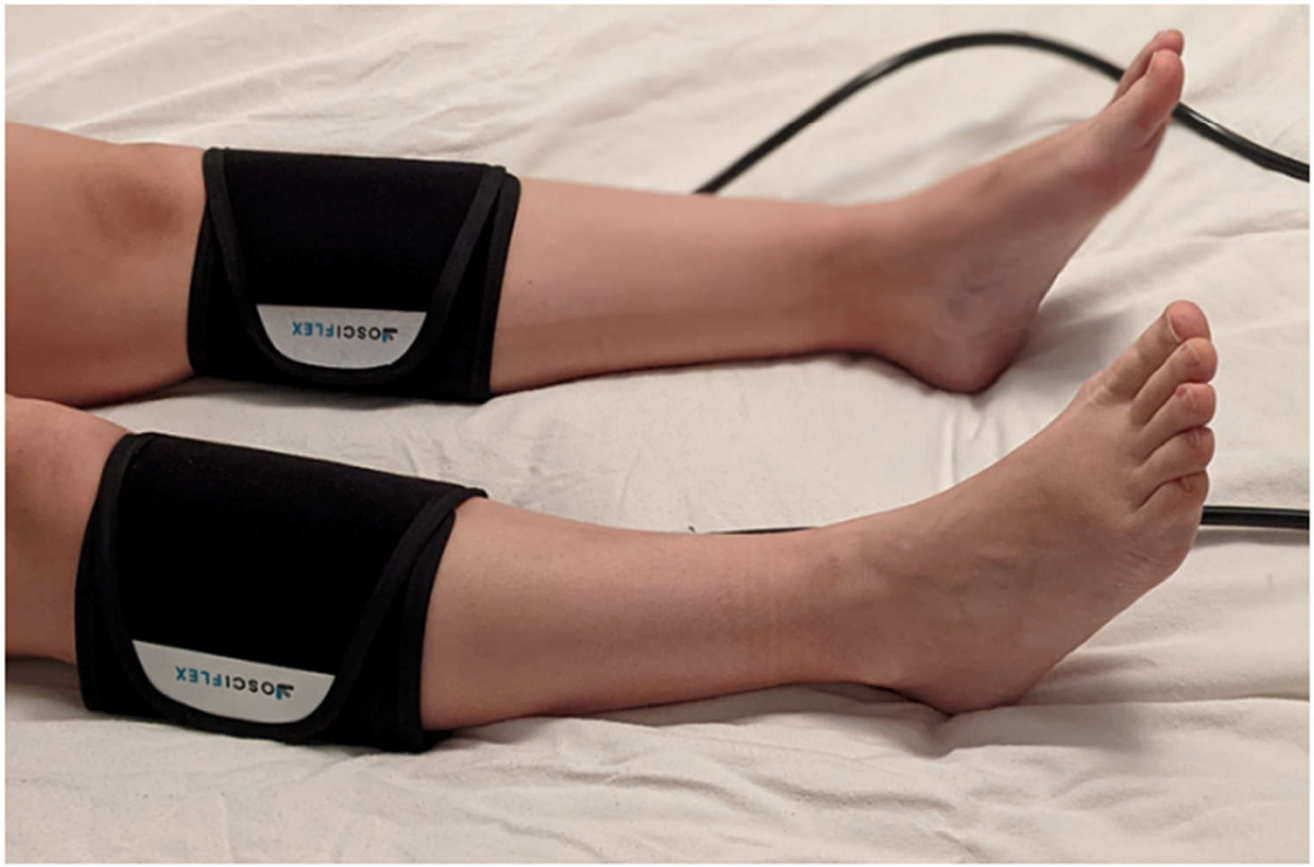
Abstract

Diabetes prevalence has been rising exponentially, increasing the need for reliable noninvasive approaches for glucose monitoring. Different biofluids have been explored recently for replacing current blood finger-stick glucose strips with noninvasive painless sensing devices. While sweat has received considerable attention, there are mixed reports on correlating the sweat results with blood glucose levels. Here, we demonstrate a new rapid and reliable approach that combines a simple touch-based fingertip sweat electrochemical sensor with a new algorithm that addresses for personal variations toward the accurate estimate of blood glucose concentrations. The new painless and simple glucose self-testing protocol leverages the fast sweat rate on the fingertip for rapid assays of natural perspiration, without any sweat stimulation, along with the personalized sweat-response-to-blood concentration translation. A reliable estimate of the blood glucose sensing concentrations can thus be realized through a simple one-time personal precalibration. Such system training leads to a substantially improved accuracy with a Pearson correlation coefficient higher than 0.95, along with an overall mean absolute relative difference of 7.79%, with 100% paired points residing in the A + B region of the Clarke error grid. The speed and simplicity of the touch-based blood-free fingertip sweat assay, and the elimination of periodic blood calibrations, should lead to frequent self-testing of glucose and enhanced patient compliance toward the improved management of diabetes.



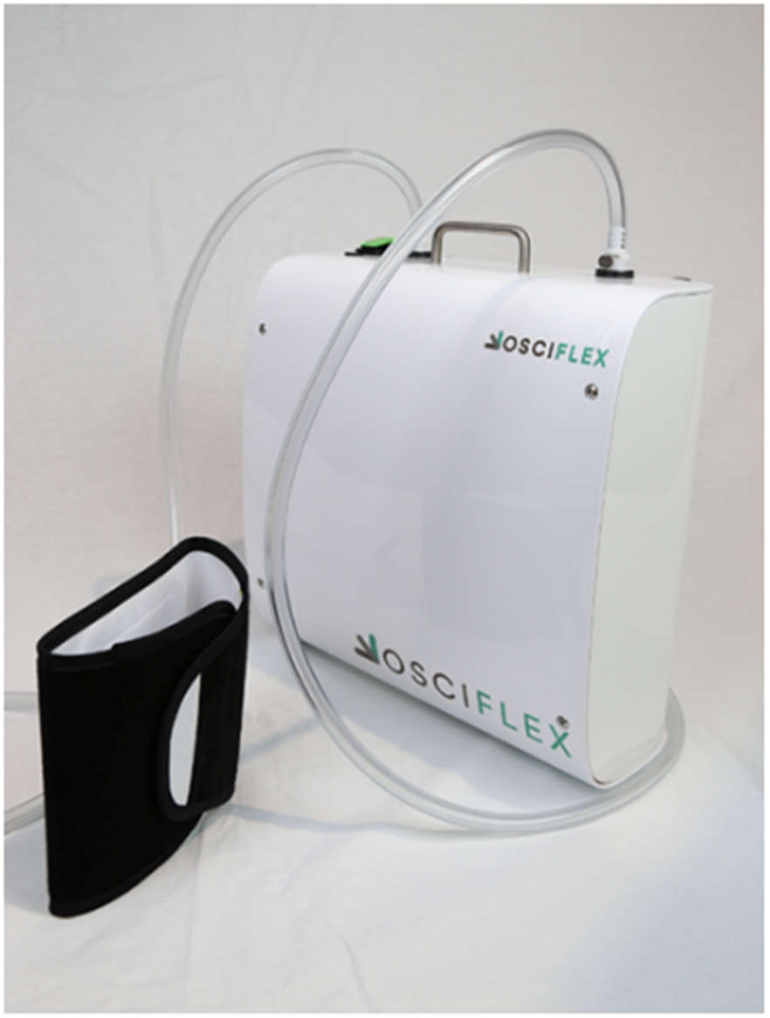
Rapid Compression Device to Prevent Deep Vein Thrombosis

APRIL 13TH, 2021 CONN HASTINGS CARDIOLOGY, GERIATRICS, MEDICINE, SURGERY, VASCULAR SURGERY



Researchers at Penn Medicine have developed a wearable sleeve that provides rapid pulsatile compression, and aims to mimic the compression our calf muscles experience during walking. The technology, being commercialized by Osciflex, a spin out from Penn Medicine, is intended to prevent deep vein thrombosis in patients who are bed-bound for long periods of time.

The researchers behind this new device studied the gene expression involved in deep vein thrombosis, and found that the genetic basis for healthy blood flow can become dysregulated by long periods of inactivity. "We began to look at venous valves and their gene expression compared to lymphatic valves," said Mark Kahn, a researcher involved in the project "We got to understand something that wasn't well understood: Venous valves were the point of origin for a lot of pathologies."



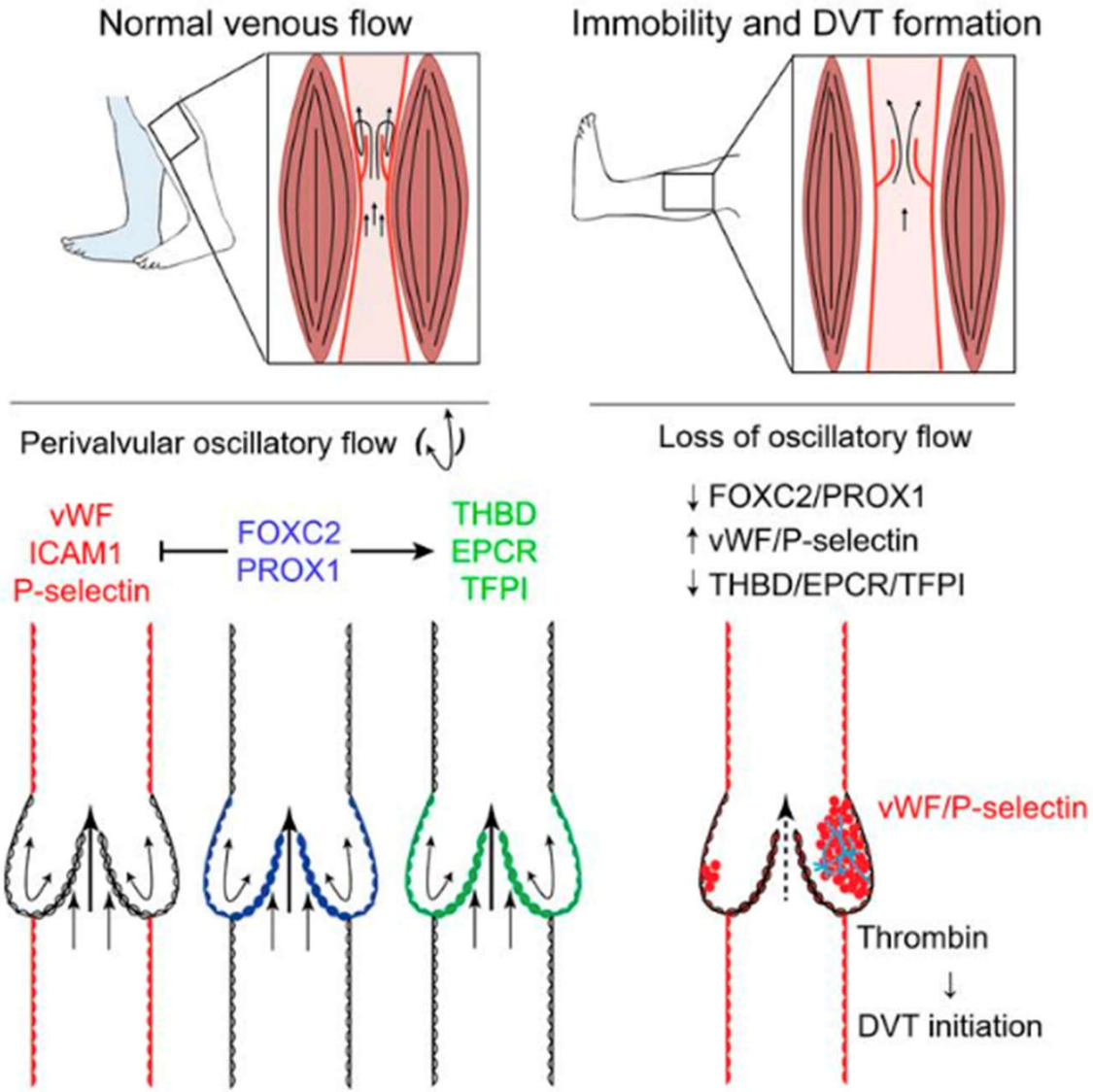
According to the researchers, currently used mechanical cuffs aren't effective enough to prevent clot formation at venous valves. "They all functioned in a way that moved blood forward but didn't have an effect on the valves that we thought was critical," said John Welsh, another researcher involved in the project.

Their solution is the Oscipulse, and is intended to mimic the rapid compression that occurs during walking. The researchers claim that it can help to maintain healthy blood flow more effectively than mechanical cuffs. "It's more like a quick tap, a fluid wave similar to the way things would behave during something like walking," said Kahn.

Introducing OsciFlex

Venous blood clots form specifically at the valves, and genetic prevention of clots at these sites requires pulses of reversing flow of blood that current mechanical therapy devices like intermittent compression and foot pumps don't create.

Direct imaging of human blood flow in response to passive movements has identified that simultaneous foot flexion and compression at specific intervals creates optimal blood flow patterns.


Normal venous flow
Immobility and DVT formation
Perivalvular oscillatory flow
Loss of oscillatory flow
↓ FOXC2/PROX1
↑ vWF/P-selectin
↓ THBD/EPCR/TFPI
vWF
ICAM1
P-selectin
FOXC2
PROX1
THBD
EPCR
TFPI
vWF/P-selectin
Thrombin
↓
DVT initiation

NIRVANA Test Rapidly Identifies and Sequences COVID-19 Viral Variants

APRIL 5TH, 2021 CONN HASTINGS MEDICINE, PUBLIC HEALTH

Researchers at the Salk Institute in California, working with outside collaborators, have developed a COVID-19 test that can rapidly identify and sequence the causative virus, helping to track new variants. The test, called "nanopore sequencing of isothermal rapid viral amplification for near real-time analysis," (NIRVANA), can also simultaneously test for other viruses, such as influenza, that may cause similar symptoms.

As SARS-CoV-2 continues to mutate, health authorities are increasingly concerned about new variants being more dangerous, more transmissible, and more difficult to treat or vaccinate against. At present, a PCR test is required to spot SARS-CoV-2 and then additional genetic sequencing is needed to identify the viral variant, which requires bulky and expensive lab equipment. This new technology aims to combine these results in just one test, which is small and portable.

"This is a virus detection and surveillance method that doesn't require an expensive infrastructure like other approaches," said Juan Carlos Izpisua Belmonte, a researcher involved in the study, via a Salk press release. "We can accomplish with one portable test the same thing that others are using two or three different tests, with different machines, to do."

The approach is called isothermal recombinase polymerase amplification (RPA). It uses proteins to separate and copy DNA strands in as little as 20 minutes, which is different from PCR, which requires temperature cycling to achieve the same thing. The technology also involves a technique called real-time nanopore sequencing, and it allows the researchers to sequence regions of the virus that are prone to mutation, helping them to track variants. Additionally, the test can assess samples for other viruses, such as influenza.

"We quickly realized that we could use this technique to not only detect SARS-CoV-2, but other viruses at the same time," said Mo Li, another researcher involved in the study. "We can easily adapt it to tackle another pathogen, even something new and emergent."

A small portable field test incorporates the technology, and can analyze 96 samples at a time. It could be useful for rapid screening in airports or schools. "The pandemic has provided two important lessons: first, test widely and quickly, and second, know your variants. Our NIRVANA method provides a promising solution to these two challenges not only for the current pandemic but also for possible future ones," added Izpisua Belmonte.

Summary

Background

Strategies for monitoring the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection are crucial for combating the pandemic. Detection and mutation surveillance of SARS-CoV-2 and other respiratory viruses require separate and complex workflows that rely on highly specialized facilities, personnel, and reagents. To date, no method can rapidly diagnose multiple viral infections and determine variants in a high-throughput manner.

Methods

We describe a method for multiplex isothermal amplification-based sequencing and real-time analysis of multiple viral genomes, termed nanopore sequencing of isothermal rapid viral amplification for near real-time analysis (NIRVANA). It can simultaneously detect SARS-CoV-2, influenza A, human adenovirus, and human coronavirus and monitor mutations for up to 96 samples in real time.

Findings

NIRVANA showed high sensitivity and specificity for SARS-CoV-2 in 70 clinical samples with a detection limit of 20 viral RNA copies per µL of extracted nucleic acid. It also detected the influenza A co-infection in two samples. The variant analysis results of SARS-CoV-2-positive samples mirror the epidemiology of coronavirus disease 2019 (COVID-19). Additionally, NIRVANA could simultaneously detect SARS-CoV-2 and pepper mild mottle virus (PMMoV) (an omnipresent virus and water-quality indicator) in municipal wastewater samples.

Conclusions

NIRVANA provides high-confidence detection of both SARS-CoV-2 and other respiratory viruses and mutation surveillance of SARS-CoV-2 on the fly. We expect it to offer a promising solution for rapid field-deployable detection and mutational surveillance of pandemic viruses.


THANKS FOR YOUR ATTENTION !