Non-invasive wireless near-infrared device provides reliable diagnosis of bladder dysfunction

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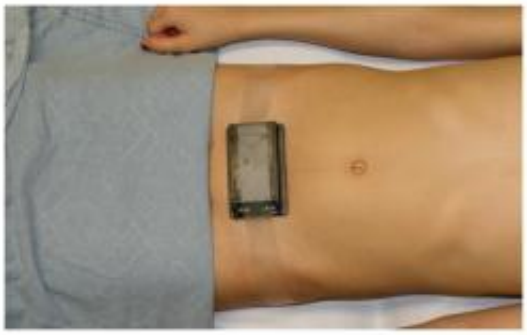

A laser-powered instrument's fiber optic cable and emitter detector interface attached over the bladder of a child; and a self-contained led-powered device positioned for bladder monitoring.

(Medical Xpress) -- A cell phone-sized, wireless near-infrared device is as reliable as the current "gold standard" invasive tests in determining bladder disease, according to a study by researchers at the University of British Columbia, Vancouver Coastal Health and the Child & Family Research Institute (CFRI).

The new physiologic information gathered through near-infrared spectroscopy (NIRS) could also advance treatment that tackles the root causes of urinary incontinence, says the research team.

Published in the current issue of the *International Journal of Spectroscopy*, the study is the first to use NIRS to investigate bladder disease in children.

In this study of 37 healthy and symptomatic adults and children, a wireless NIRS device is placed on the skin over the bladder and held in place by a strap. Software measures the differences in the amount of light shone through the skin to – and returning from – the bladder wall. The data provides researchers with a measure of changing hemoglobin concentration and the levels of oxygen and volume in the blood.

The research team found consistent patterns of normal oxygen availability and blood supply in the bladder muscle of healthy subjects during urination. Meanwhile, the patterns in children with symptoms due to voiding problems were quite different and matched patterns seen when blood flow or oxygen supply is inadequate for normal muscle function.

“Currently, diagnosing bladder dysfunction usually requires an invasive test that involves urethral and rectal catheter insertion to measure bladder pressure and urine output – a stressful and painful procedure that provides a limited amount of physiologic information,” says lead author Dr. Andrew Macnab, a pediatrics and urology professor at UBC and Head of the NIRS study group at the Bladder Care Centre at UBC Hospital.

“Our study shows that near-infrared spectroscopy – a non-toxic and non-invasive method using light shone through the skin to monitor the microcirculation of the bladder – can detect changes in bladder physiology that are proving characteristic for specific causes of voiding dysfunction” says Macnab, a senior scientist at CFRI.

A previous study led by Macnab demonstrated the accuracy of non-

invasive NIRS in diagnosing men with difficulty passing urine due to possible prostatic enlargement compared to current invasive tests. Inclusion of children in the latest study further validates the merits of extending NIRS monitoring to children.

“Both adults and children like the device, and patients can be in a room remote from the researcher when they pass urine for the test, as the device can either store the data or transmit the results wirelessly to a computer in the next room. NIRS definitely constitutes a disruptive technology in the field of urology,” says co-author Dr. Lynn Stothers, a urology professor at UBC and director of research at the Bladder Care Centre at UBC Hospital.

“We found it particularly useful in studies involving children; its small size and ease of application generated no anxiety, didn’t limit the participants’ movement or their ability to empty their bladder; and NIRS definitely constitutes a disruptive technology in the field of urology,” says co-author Dr. Kourosh Afshar, an urologist at BC Children’s Hospital and an assistant professor at UBC.

Urinary incontinence is a stigmatized and under-treated condition and often erroneously regarded as a “normal” part of early childhood and aging or a symptom of many other diseases.

One third of men and women aged 30-70 experience loss of bladder control that negatively impacts their quality of life over one million patients seek physician consults for this every year in the U.S. alone. It also affects 53 per cent of all long-term-care residents, 25 per cent of middle-aged women and 15 per cent of all men 60 years and older.

“Current treatment options for incontinence focus on managing symptoms because little is known about the physiology of voiding dysfunction,” says Macnab. “NIRS could help us determine whether

blood flow in the bladder muscle is a root cause of incontinence and in turn develop new therapeutics to cure these conditions."

NIRS was originally used by a team of UBC and B.C. Children's Hospital scientists led by Macnab to develop a new way to monitor the adequacy of oxygen delivery to the brain during heart bypass surgery. A device capable of monitoring changes in oxygenation and blood flow in the bladder muscle was later developed and patented through UBC's Industry Liaison Office.

The team's most recent study using spectroscopy won the prize for best research in female urology at the recent American Urological Association annual meeting. Macnab says the research team is currently exploring the use of wireless NIRS to investigate bladder function in patients with spinal cord injury, and long-term monitoring as a way to improve the quality of life in patients with urinary incontinence due to a range of problems.

More information: Near-Infrared Spectroscopy of the Bladder: New Parameters for Evaluating Voiding Dysfunction, *International Journal of Spectroscopy* Volume 2011 (2011), Article ID 814179, 8 pages. doi:10.1155/2011/814179

Abstract
We describe innovative methodology for monitoring alterations in bladder oxygenation and haemodynamics in humans using near-infrared spectroscopy (NIRS). Concentrations of the chromophores oxygenated (O2Hb) and deoxygenated (HHb) haemoglobin and their sum (total haemoglobin) differ during bladder contraction in health and disease. A wireless device that incorporates three paired light emitting diodes (wavelengths 760 and 850 nanometers) and silicon photodiode detector collects data transcutaneously (10 Hz) with the emitter/detector over the bladder during spontaneous bladder emptying. Data analysis indicates

comparable patterns of change in chromophore concentration in healthy children and adults (positive trend during voiding, predominantly due to elevated O2Hb), but different changes in symptomatic subjects with characteristic chromophore patterns identified for voiding dysfunction due to specific pathophysiologies: bladder outlet obstruction (males), overactive bladder (females), and nonneurogenic dysfunction (children). Comparison with NIRS muscle data suggests altered bladder haemodynamics and/or oxygenation may underlie voiding dysfunction offering new insight into the causal physiology.

Provided by University of British Columbia