



Non-invasive Urodynamics and Detrusor Oxygenation Using Near Infrared Spectroscopy

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INTRODUCTION: Modern clinical near infrared spectroscopy (NIRS) is a non-invasive means of monitoring changes in concentrations of mixed arterial/venous oxygenated (HbO₂) and de-oxygenated hemoglobin (Hb) akin to pulse oximetry but without the need for pulsatility and with 30 times greater depth of interrogation. NIRS devices are commercially available and typically use several wavelengths of low intensity infrared light transmitted to the tissue surface via a fiber optic bundle, and detected with a photodiode array mounted on the skin's surface. The ratio of emitted light intensity to detected light intensity is used to derive absolute changes in hemoglobin concentrations. Since the absolute tissue volume being sampled is unknown, NIRS measures absolute changes in concentration relative to an unknown initial concentration.

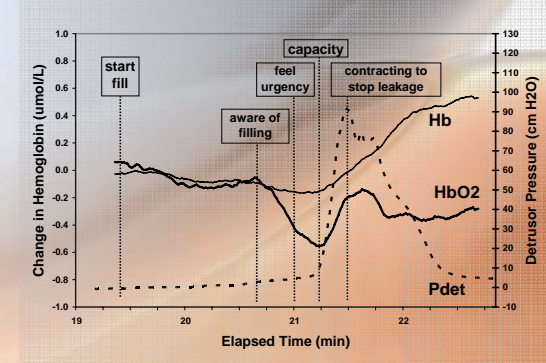
Originally intended as a bedside brain monitor, we explored its usage as a bladder monitor.

METHODS: Ten males aged 55 to 82 years and 10 females aged 30 to 67 years presenting with complaints of frequency, urgency, neurogenic bladder, obstruction, and overflow incontinence underwent routine cystometrograms with simultaneous NIRS data collection.

The optodes of a NIRO-300 (Hamamatsu Photonics KK, Hamamatsu City, Japan) were placed at 40mm separation on the intact skin of the abdomen over the transverse midline of the bladder. Measurements of abdominal pressure (Pabd), detrusor pressure (Pdet) and vesical pressure (Pves) together with NIRS Cyt were collected simultaneously at 6Hz intervals. Two filling cystometrograms and pressure flows with EMG were completed per patient.

Data collection began with an empty bladder and continued through both filling with sterile saline, via infusion pump, and voluntary emptying. Event markers recorded the subject's declared moments of first sensation of filling, first urgency, full capacity, and being finished voiding.

Results: There were highly significant correlations ($p < 0.05$ for $r > 0.095$) between all NIRS and all standard pressure transducer readings: HbO₂ vs Pabd $r = -0.57$, HbO₂ vs Pves $r = -0.64$, HbO₂ vs Pdet $r = -0.55$, and Hb vs Pabd $r = -0.62$, Hb vs Pves $r = -0.46$, Hb vs Pdet $r = -0.34$. High pressures are related to low hemoglobin concentrations.



Example of detrusor over activity, urgency incontinence, high contraction pressure, and obstruction in a supine 55 year old male with reduced flow, urinary frequency, and post-void dribbling.

Conclusions: NIRS showed significant patterns of change during filling and voiding thereby implying it may be a useful tool in the urodynamic setting.