Ice-water (cold stress) immersion testing

**Description**

Trauma-induced cold intolerance (cold sensitivity) is characterised by pain, stiffness, altered sensibility, or colour change associated with cold exposure (Campbell and Kay 1998), and is common after nerve injury or surgery (Irwin et al 1997). The Immersion in Cold water Evaluation (ICE) is a cold stress test administered through a standardised protocol where the hand is immersed in cold water and the examiner monitors the pain response and re-warming (Traynor and MacDermid 2008).

**Test description:** The patient is allowed to acclimatise for 15 minutes in a room with temperature of 20° to 22° C. The hand digits are then immersed in 12° C water for 5 minutes, followed by a 10-minute re-warming period for a total test duration of 30 minutes. Pain is reported using the Numeric Rating Scale (NRS) just prior to and after immersion, and at the end of the test. Skin surface temperature is measured before and after immersion, and at the end of the recovery period. The ICE can be repeated for the unaffected or less affected limb for better comparison. Variations of this protocol at different temperatures or timing have been used in clinical studies prior to establishment of reliable protocols.

**Instruments:** Infrared skin thermometer, pool thermometer, stopwatch, insulated water container, and ice water.

**Interpretation:** Failure of temperature and pain scores to return to baseline after ICE indicates cold intolerance. The complete test description is available at http://www.youtube.com/watch?v=ktvjsqbfUUM

**Reliability and validity:** The reliability of digital skin temperature measurement is excellent with test-retest intraclass correlation coefficients (ICC) ranging from 0.81 to 0.86 in healthy subjects (Traynor and MacDermid 2008). Intra-rater ICCs of 0.79 to 0.82 have also been reported in patients with complex regional pain syndrome and in healthy control subjects (Packham et al 2012). Subjective reporting of cold intolerance (ie, using NRS) is also well supported (Traynor 2008, MacDermid et al 2009, Maxwell and Sterling 2013) but only moderately correlated.

**Commentary**

Cold responses are altered in many clinical conditions, such as whiplash-associated disorders, complex regional pain syndrome, and hand vibration syndrome (Harada 2002, Sterling et al 2003; Maxwell and Sterling 2013, Packham et al 2012). Cold intolerance can also be idiopathic, such as occurs with Raynaud’s phenomenon. There are multiple reasons and methods for assessing response to cold and no single method has been shown to be superior.

**Benefits for clinicians:** In comparison to costly quantitative sensory testing, this test presents a reliable, feasible, and economical choice for clinicians.

**Limitations:** The ICE is not tolerated by all patients and its value in comparison to cold pain threshold testing is not known. Test results may be impacted by seasonal temperature variations, gender, smoking, and alcohol intake. Contraindications include open wounds/ulcers on the digits, and digital arterial disease.

**References**