Development of an Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) Method for Measurement of Urine Iodine & Assessment of Iodine Status in Subclinical Hypothyroidism

K Jones¹, J Rogers¹, A DeLloyd², DA Rees³, M Ludgate², C Evans¹

¹Medical Biochemistry & Immunology, University Hospital of Wales, Cardiff, UK
²Thyroid Research Group, Institute for Molecular & Experimental Medicine, School of Medicine, Cardiff University, UK
³Cardiovascular & Metabolism Research Group, Institute for Molecular & Experimental Medicine, Cardiff University, UK

Introduction
- Iodine (I) is a component of thyroid hormones thyroxine (T4) and triiodothyronine (figure 1)
- Iodine deficiency may lead to reduced thyroid hormone production & consequences including goitre, hypothyroidism, foetal abnormalities, mental retardation & susceptibility to iodine-induced hyperthyroidism¹
- A recent study suggests the UK may be iodine deficient², indicating the need for further research
- Population iodine status can be assessed by measurement of urine iodine¹, for which ICP-MS is the gold standard method³

Aims
1. To develop & validate a method for measurement of urine iodine by ICP-MS
2. To apply this method to a local population with subclinical hypothyroidism

Methods
ICP-MS
Analysis was carried out on an Agilent 7700x ICP-MS with autosampler and integrated sample introduction system. Helium gas (5mL/min) was used in the collision cell and iodine was monitored at m/z 127. Aqueous iodine standards 0-1000µg/L (0-7800nmol/L) (Inorganic Ventures) were used for calibration. Standards, samples and quality control material were diluted 1 in 20 in diluent (1% TMAH, 0.01% Triton-X). Quality control material consisted of Seronorm Urine Level 2 (Alere Ltd) and urine pools (3 levels) prepared in house. The laboratory enrolled in the CDC EQUIP (Ensuring the Quality of Urinary Iodine Procedures) EQA scheme.

Subclinical hypothyroidism study
Spot urines were collected from 203 individuals (20-71 years (median 54.5 years), 75% female, 90% Caucasian) enrolled in a local study on subclinical hypothyroidism (selection criteria TSH 5-10mU/L, fT4 within reference range). Ethical approval was granted for this study. Participants had repeat thyroid function (TSH & fT4) at the time of urine collection.

Method Validation
- Linearity
  - Standard curves were linear with a correlation coefficient consistently >0.999 (figure 2)
  - Dilution of urine iodine was linear over the range 1–2527 µg/L
- Accuracy
  - No carryover was observed during analysis of blank samples following the top standard (1000 µg/L) or urine samples (>2500 µg/L)
- Sensitivity
  - LLOD 2 µg/L (17 nmol/L)
  - LLOQ 1 µg/L (8 nmol/L)
- Recovery
  - Table 2: Recovery of iodine in urine

Iodine status in subclinical hypothyroidism
- The population median urine iodine concentration was 94 µg/L (0.73 µmol/L), consistent with mild iodine deficiency¹
- A wide range of iodine excretion was observed: 8–3341 µg/L (0.06–26.33 µmol/L)
- No correlation was observed between urine iodine and TSH (figure 4) or free T4

Summary
- An ICP-MS method for urine iodine has been successfully developed and validated
- Application of this method revealed mild iodine deficiency in a local study population
- Urine iodine does not correlate with TSH or fT4 in this population

References

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