Safety of the insulin tolerance test

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Concerns have been raised about the hazards of the insulin tolerance test (ITT), used to measure growth hormone secretion. In Glasgow, we continue to use this test, adhering to a strict protocol. A review of outcome over a 10 year period (1989–99), during which 550 ITTs were performed, was undertaken. No serious adverse events occurred; in particular, no child fitted or required intravenous glucose. Fewer tests were done during the latter five years, with a higher yield of growth hormone (GH) deficiency, reflecting our increasingly conservative approach to paediatric GH therapy during this period. We conclude that the ITT is safe and reliable in a paediatric setting provided that a strict procedure is followed.

In 1991, following several fatalities in the UK, the Department of Health issued a circular warning of the hazards of the insulin tolerance test (ITT), stating that: “the insulin tolerance test should not be used in children when only growth hormone reserve needs to be tested”. Since then many paediatric centres have abandoned the ITT as a means of assessing growth hormone (GH) reserve although it remains the standard diagnostic test for GH deficiency in adults, in view of its sensitivity and reproducibility. We have continued to use the ITT as our first line test, reserving the arginine test for children with epilepsy or cardiac disease and those under 5 years.

We have reviewed retrospectively our experience of performing ITTs over a 10 year period (1989–99), with particular attention paid to the last five years, during which a dedicated nurse specialist has been overseeing the tests. Our principal aim was to assess the safety of the ITT, defining the key morbidity measures as: (a) hypoglycaemia requiring emergency administration of intravenous glucose; (b) hypoglycaemic convulsions; and (c) death. We have also examined the timing of the glucose nadir following insulin administration as this has practical implications for oral glucose administration. Finally, in the light of a change in the pattern of GH prescribing in Scotland over the past 10 years, we have noted the annual number of ITTs performed.

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**METHODS**

The following strict ITT protocol was adhered to:

- **Child must be fasted overnight.**
- **Blood glucose must be >3.0 mmol/l at time −30 minutes and 0 minutes.**

- Oxygen, glucose, and hydrocortisone must be available.
- A doctor must be present for 45 minutes following insulin administration and a nurse specialist throughout. (Protocol since 1995, when an endocrine nurse specialist was appointed. During the first five years of the study period, endocrine tests were carried out on a paediatric inpatient ward by junior medical staff.)
- **Child must eat and remain on ward for one hour before cannula removal and discharge home.**
- **Administration of insulin.** An insulin concentration of 1 unit/ml is used and a dose of 0.15 units/kg is given (0.1 units/kg if panhypopituitarism is suspected). The doctor must sign for the insulin and the nurse must check the dosage.
- **Blood sampling.** Glucose and growth hormone concentrations are measured in 4 ml samples drawn at −30, 0, 15, 30, 60, 90, and 120 minutes. The rationale of the −30 minute sample is to capture any stress related GH surge, as this may be followed by a refractory period, giving the misleading interpretation of GH deficiency.
- **Management of hypoglycaemia.** If the blood glucose drops below 2.2 mmol/l and/or the child is symptomatic, 30–40 ml of dextrose is given intravenously, and blood glucose rechecked. Thereafter 50–100 mg hydrocortisone, followed by a 10% dextrose infusion at 0.1 ml/kg/min is given. A further dextrose bolus is administered only if blood glucose remains <6.0 mmol/l.

**Statistical analysis**

The relative risk of a future adverse event occurring as a result of the procedure, assuming that none had occurred to date, was calculated according to a simple formula, first described by Hanley in 1983, which states that:

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\text{upper limit of the 95% confidence interval of the probability of such an event (i.e. maximum risk)} = \frac{3}{n} \text{ (for } n > 30)\]

where n = number in series (i.e. number of past, uneventful procedures).

**Abbreviations:** GH, growth hormone; ITT, insulin tolerance test
RESULTS
A total of 550 ITTs were performed between 1989 and 1999. No serious adverse events occurred. In particular, no child lost consciousness, fainted, or required intravenous glucose following hypoglycaemia. The upper limit of the confidence interval for relative risk from the procedure is therefore 3/550 = 0.005 = 0.5%. Glucose profiles were documented for the 223 ITTs performed since 1995. The glucose nadir occurred at 15 minutes in 118 (53%) cases (range 0.6–2.2 mmol/l) and at 30 minutes in 105 (47%) cases (range 1.1–2.3 mmol/l). Between 1989 and 1992 the annual number of ITTs performed ranged from 57 to 77. During this period GH values of 10–20 mU/l were recorded in 27%. From 1993 to 1999, the annual number of ITTs performed decreased to 37–52 and the number of cases with GH values of 10–20 mU/l rose to 43%. Over the 10 year period GH values <10 mU/l were recorded in 14%. GH concentrations were >20 mU/l at time >30 minutes in 16%, indicating a normal GH response to stress, thus precluding GH deficiency.

DISCUSSION
In this assessment of the safety of the ITT in childhood we report no serious adverse events in the 550 cases studied. We acknowledge that this finding cannot preclude adverse events occurring in future patients but the probability, based on the numbers of patients studied, is, at most, 5 per thousand. Indeed no test that alters glucose homeostasis can be regarded as safe. Even the simple act of fasting a severely hypopituitary child may cause symptomatic hypoglycaemia. However, our experience indicates that the ITT is relatively safe provided that this endocrine investigation is carried out in a well resourced, specialised setting by experienced, competent medical staff, we consider that our endocrine day case service resulting from these changes, we have no doubt that the standard of day care is much improved. Moreover, in the light of the recent changes to the working practice of junior doctors, we have no experience of other agents, but it is well recognised that clonidine causes unpleasant symptoms such as drowsiness and hypotension which are not rapidly reversible. 10 In addition, clonidine has recently been shown to be associated with hypoglycaemia, although the mechanism of action is unclear.11 Glucagon administration causes nausea and vomiting,12 and may also result in hypoglycaemia by stimulating insulin release.14

Our observation that no child required intravenous dextrose in the treatment of hypoglycaemia emphasises that in virtually all cases oral glucose administration is all that is required. Indeed, fatalities associated with the ITT have involved the administration of large quantities of intravenous dextrose. There is no place for large quantities of either hypotonic (for example, 5%) or hypertonic (50%) dextrose in insulin induced hypoglycaemia. If necessary, the child should receive 0.5 g/kg of dextrose as a 10% solution, followed by 10% dextrose with 0.45% saline at maintenance rates.

In highlighting the favourable safety record of the ITT in our hospital we are not advocating the widespread reintroduction of this method of anterior pituitary function testing, especially in departments where relatively small numbers of children are involved. Indeed, given the controversies surrounding the selection of children for investigation and treatment of GH deficiency,15 we believe that the decision to embark on growth hormone stimulation testing should only be made by paediatricians who are experienced in paediatric endocrinology, and/or working in close collaboration with a regional centre.

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REFERENCES
thought it would be easy: basic guidelines for hospital management of asthma. How wrong I was.

Constructing clinical guidelines is one of the tasks I've taken on for my year in Oshakati Hospital as a RCPCH/VSO paediatric fellow. Not wanting to be just another for my year in Oshakati Hospital as a RCPCH/VSO paediatric fellow. Not to be defeated I modified my help? Surely the cost saving is minimal, and now we have several cartridge refills without the plastic delivery casing. Just how does that to keep the department in steady supply of plastic bottle spacers. It stock I considered it my duty to drink as much fizzy pop as was needed work, and a few nice papers showing the effectiveness of homemade coming. I could show inhaled salbutamol (and steroids) definitely ulised salbutamol in preference to adrenaline for acute attacks. How-

But asthma, that's got to be easier; so much research, so many consensus statements, so many professionally designed guidelines. The current in-house management for acute attacks relies on small doses of nebulised salbutamol with regular adrenaline. Metered dose inhalers are occasionally used for maintenance therapy when stocks of oral salbutamol run out but inhaled steroids are not used or even available (despite being on the Essential Drug List). Preventative therapy relies on theophylline and long courses of daily prednisolone. I set out to encourage the use of standardised regular doses of neb-ulised salbutamol in preference to adrenaline for acute attacks. How-

I'm starting to comprehend the questions that must be asked of every trial and intervention: Is this relevant to my target population? And is this acceptable by my target population?

I'm prescribing oral salbutamol occasionally, the patients are happier and the clinic sister is satisfied that my consultation times are approaching those of my colleagues (3 to 5 minutes maximum). Theophylline remains the mainstay of background control but at least prednisolone courses are shorter. I still battle on with my inhalers and leave without their plastic bottle. A paediatric nurse mother demonstrated to me that her child's inhaler worked much better when...