The pattern of growth in childhood is well known to paediatricians: the rapid and rapidly decelerating growth from the third trimester to the second year of life gives way to the steady and slowly decelerating growth of middle childhood (with the mid childhood growth spurt between ages 6 and 8), and the adolescent growth spurt. Possibly less well known is the mathematical division of these phases of growth into infancy, childhood, and puberty components, which correspond to three major control mechanisms.

Growth during fetal life and the first postnatal year is dependent on nutrition. Children born of low birth weight or starved in the first year of life fail to grow at an adequate rate and, if this continues for any length of time, incur a growth deficit which is irrecoverable. Children overfed in utero (infants of diabetic mothers) or shortly after birth become not only fat but also large.

The height which an individual achieves is determined largely by the rate of growth. A child destined to become a tall adult grows at a rate consistently rather greater than his third centile peer. It is now well recognised that growth rate is determined by the amplitude of pulsatile growth hormone secretion. What this means is that just as height velocity is a continuous variable, so also is growth hormone secretion. Thus the idea that there is a cut off value for either of these parameters which strictly defines normality is as illusory as seeking to define obesity or hypertension in terms of cut off values.

**Who needs tests?**

Thrivng is an active process and no child should be investigated for having previously failed to thrive, except insofar as an explanation may be available from what has gone before to explain short stature: investigations are not likely to prove helpful in any child currently growing at a normal rate. The answer, therefore, to who needs investigating is any child, regardless of the stature he or she has attained, who is not growing at a normal rate.

The definition of what constitutes a normal rate of growth has always caused paediatricians anxiety and it was for this reason that we promulgated some years ago the Middlesex height velocity chart, which is now available as a Perspex sheet designed to lie on the desk of physicians who look after children. The only children who should be candidates for tests of growth hormone secretion are those growing at a slow rate in middle childhood in whom other causes of failure to thrive have been excluded by clinical examination and/or screening investigations.

A pragmatic solution is to investigate immediately all children growing at a less than third centile velocity (with thereby a 97% chance of detecting an abnormality) and closely to follow up those growing at rates between the third and 25th centiles with a view to investigating them if such a growth rate persists into a second year; in this case the chance of normality is not 25% but 25% of 25% or 6.25%. Recent data fit these concepts well.

**What tests are available?**

Table 1 shows some of the tests that are regularly employed.
Figure 1 Association between growth hormone secretion and height velocity in 50 short prepubertal children. Growth hormone conversion factor 1 μg/l = 2 mU/l.

Table 2 The effect of employing cut off values to test results in 64 children

<table>
<thead>
<tr>
<th>Peak growth hormone responses to insulin induced hypoglycaemia (μg/l)</th>
<th>Height velocity score</th>
<th>Sensitivity in detecting true positive</th>
<th>Specificity in excluding true negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4</td>
<td>-0.8</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>&gt;5</td>
<td>0.8</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>&gt;5</td>
<td>-0.8</td>
<td>0.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Growth hormone conversion factor 1μg/l = 2 mU/l.

Performance of a test has an important influence on its result. Every test is designed to test the readily releasable pool of growth hormone that happens to be in the pituitary at the time the test is performed. If there has recently been a pulse of growth hormone secretion and the gland is empty, nothing will make it produce a further response. A high baseline value in a provocative test may presage a misleading result. In a patient in whom there is an abnormality of the control of growth hormone secretion (neurosecretory dysfunction), a pharmacological test may falsely suggest that growth hormone secretion is normal when in fact the pattern is grossly disorganised. Nutritional state is also important: in states of starvation (intrauterine growth retardation) growth hormone concentrations are high and responses to stimuli are blunted in obese children growing quite normally.

The second common situation in which tests may be misleading is in late puberty. The pubertal increase in growth hormone secretion requires an increase in sex steroid concentration and tests of growth hormone secretion done in patients over 11 years of age need very special consideration.

Finally, as indicated, many conditions that interfere with growth have secondary effects on growth hormone secretion. The correction of the basic abnormality (gluten free diet or removal of a child from an inclement emotional environment) will restore growth hormone secretion.

Who needs tests of growth hormone secretion? All this brings us back to what the point of such tests were in the first place. It is now abundantly clear both from the implication in figs 1 and 2 and from clinical practice that any child given growth hormone will grow more quickly. The amount of growth hormone that has to be given is determined by the pretreatment rate at which the children are growing (the most slowly growing, the most severely insufficient of growth hormone secretion will respond best), the dose of growth hormone used, and the condition being treated. The only reason for a test of growth hormone secretion is therefore to confirm that the problem lies in this area and not elsewhere; we have already seen that the tests do not achieve this result.

A plan for action
It will be clear that tests of growth hormone secretion are currently in a mess and we purpose the following scheme for the management of the short child seen in general paediatric practice:

1. Measure the child and the heights of his parents. In the absence of other indications:
2. Measure the child again after four months and calculate an annual growth velocity.
3. Plot the velocity on the Middlesex height velocity chart.
(4) If the velocity is way below the lower limit of normal (third centile), take immediate action.
(5) If the velocity is close to the lower limit of normality (third to 25th centile), follow up the child for a longer period of time.
(6) In cases of doubt, the paediatrician has the option of either giving the child growth hormone or seeking advice from a specialist centre.

In these days of cost consciousness, the latter is likely to be a cheaper option for the referring health district than the former.

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