Institution: University of Glasgow

Unit of Assessment: Unit 1, Clinical Medicine

Title of case study: Development and use of new, improved UK child growth charts

1. Summary of the impact

Every child born in the UK receives a set of growth charts with their Personal Child Health Record. These charts have been developed and designed by Professor Charlotte Wright, University of Glasgow. Growth monitoring is fundamental for the assessment of health and the identification of growth abnormalities in children, and growth charts are used to interpret these measurements. The design of child growth charts and the instructions for their use influences perceptions of normality and drives screening activity for conditions such as failure to thrive or obesity. The newly developed UK child growth charts more accurately reflect healthy growth patterns than previous versions, and feature a range of design improvements and evidence-based, straightforward instructions for use. They have been endorsed by the key professional societies for child health and nutrition in the UK, and are being used by health professionals and parents throughout the UK, Ireland and New Zealand.

2. Underpinning research

Child growth charts allow growth data to be interpreted in the context of a child's age and gender. They are vital for health evaluation and medical diagnosis, but until recently, presented two problems. First, all the growth references in use before 2006 were based on small, unrepresentative samples of largely bottle-fed infants and thus could not be used as a standard of healthy growth. Second, few child growth charts anywhere in the world had undergone any formal evaluation of how they performed as clinical tools.

Professor Charlotte Wright, Professor of Community Child Health at the University of Glasgow (2001–present), has an established research record in the use, interpretation and validation of growth charts in child health, which she further developed on moving to Glasgow in October 2001. Here, Wright led research on the factors that affect weight gain or underlie failure to thrive in infancy,[1] and on the norms and limits for postnatal weight loss in newborns. The findings of this research have implications for the design and use of growth charts. Between 2006 and 2008, Wright participated in a joint Scientific Advisory Committee on Nutrition (SACN) and Royal College of Paediatrics and Child Health (RCPCH) group to evaluate the possible implementation of the World Health Organization (WHO) 2006 Child Growth Standard in the UK.

The WHO Standard was based on healthy breast-fed children from six countries (Brazil, Ghana, India, Norway, Oman and USA) and defined for the first time how all children aged 0–5 years should grow. Wright sought to determine how well the WHO Child Growth Standard matched data on UK child growth. Analyses undertaken by herself and by Drs Lakshman and Ong at Cambridge University revealed that UK children matched the WHO Standard well for length and height at all ages, but tended to become heavier than the standard by the end of the first year.[2] As this pattern seemed compatible with rising rates of obesity, the committee recommended adoption of the WHO standards from 2 weeks to 4 years as a means of applying a healthier standard of weight gain. Their findings also highlighted the need for better understanding and education about the correct use of child growth charts among health visitors, doctors and dieticians working with children.

In 2008, the Department of Health commissioned the RCPCH to design new early years child growth charts for the UK, based on the WHO Standard, with Wright as the academic lead of an expert panel, which included Tim Cole, Professor of Medical Statistics, University College London; Tony Williams, Reader in Child Nutrition, University of London; and Robert J Moy, Senior Lecturer in Community Child Health, University of Birmingham. Wright was involved in every element of the project, from commissioning the layout of the charts to writing and evaluating the charts and the extensive supporting educational material.

All previous UK child growth charts had artificially joined birth and postnatal weight data from

preterm and term children, which Wright had already shown to misrepresent growth around birth. Wright now explored how children born at different term gestations (37–42 weeks) grew in the neonatal period. This revealed that if birth weight for a child born at 37 weeks' gestation is plotted at 37, rather than 40, weeks, their growth rate appears to falter dramatically between birth and 12 days of age.[3] This research informed the guidance that birth weight for all term infants should be plotted at 'age zero' (40 weeks' gestation). Professor Cole and Wright also developed a new tool to predict adult height from a child's current height centile, which was added to the height charts.[5]

Wright and her team involved parents and health professionals in the process of designing and testing the charts and their accompanying information. Most child growth charts had not been assessed through any formal evaluation procedure for ease of use, accuracy and clarity. Wright was responsible for designing such an evaluation procedure for the new UK child growth charts. In this context, the new elements of the chart design were tested by groups of health staff using a range of different child growth scenarios and pre-plotted data. Dr Magda Sachs (NHS Salford) recorded the group discussion of the charts, while Wright analysed the quantitative data. These results prompted further refinements and changes to the chart design and instructions.[4] In parallel with the chart design and evaluation process, the group interacted with parents and health professionals to develop detailed instructions for use of the growth chart. This helped to identify and eliminate inconsistencies and ambiguities about chart use.[6]

After the pre-school charts had been published in 2009, the group went on to design charts for school-age children. These were based on pre-existing research, using both WHO and UK 1990 data. They also included new work undertaken by Wright, Cole and Prof Gary Butler (Consultant in paediatric and adolescent medicine and endocrinology, University College Hospital, London), which explored new ways of describing pubertal progression and assessing growth during puberty. Wright designed a new format BMI chart for use in children with special health needs which allows assessment of exceptionally overweight and underweight children. These charts were also evaluated and refined by Wright and her team using the approach described above.

3. References to the research

1. Wright CM *et al.* (2006) How does maternal and child feeding behavior relate to weight gain and failure to thrive? Data from a prospective birth cohort. *Pediatrics* 117, 1262–1269. doi:10.1542/peds.2005-1215
2. Wright CM *et al.* (2008) Implications of adopting the WHO 2006 Child Growth Standard in the UK: two prospective cohort studies. *Arch Dis Child.* 93, 566–569. doi:10.1136/adc.2007.126854
3. Cole TJ *et al.* (2012) Designing the new UK-WHO growth charts to enhance assessment of growth around birth. *Arch Dis Child Fetal Neonatal Ed.* 97, F219–F222 doi:10.1136/adc.2010.205864
4. Wright CM *et al*. (2012) Designing new UK-WHO growth charts: implications for health staff use and understanding of charts and growth monitoring. *Matern Child Nutr*. 8, 371–379. doi:10.1111/j.1740-8709.2010.00296.x
5. Cole TJ & Wright CM. (2011) A chart to predict adult height from a child's current height. *Ann Hum Biol*. 38, 662–668. doi:10.3109/03014460.2011.598189
6. Wright CM *et al*. (2010) Using the new UK-WHO growth charts. *BMJ* 340, c1140. doi:10.1136/bmj.c1140

4. Details of the impact

Growth charts are used universally in hospitals and baby clinics to monitor child health and are also important to parents seeking reassurance that their child is healthy and thriving. However, growth charts are complex clinical tools that can mislead as well as inform. Successful, accurate use of charts relies on robust design and unambiguous instructions for their use. Professor Wright's research has supported the adoption of the WHO Child Growth Standard (2006) in the UK. Moreover, it has initiated the development of improved Child Growth Charts for the UK, which are more comprehensible to health staff and parents. In addition, this work has provided improved professional guidance and training to health professionals involved in weighing and measuring

babies and children as well as identifying overweight and obesity.

Introduction of new child growth charts

The new early years child growth charts were launched in May 2009 (England)[a] and January 2010 (Scotland).[b] A set of A5 charts is currently distributed to those caring for every newborn in the UK through their Personal Child Health Record. The A4 clinical charts are also widely used in hospitals and primary care, with 500,000 copies distributed between April 2012 and April 2013.[c] In May 2012, charts for school-age children were launched.[d] By April 2013 around 300,000 copies had been distributed to NHS Trusts and Boards.[c] In June 2013 a specialist Childhood and Puberty Close Monitoring growth chart and a Body Mass Index (BMI) chart were published to complete the set.[e]

The UK child growth charts that have been developed by Wright have been endorsed by, the Department of Health in England,[a] the Scottish Government,[b] the Royal College of Nursing (where they have been incorporated into new guidance on measuring children)[f], the British Dietetic Association,[g] the National Child Birth Trust[h] and the Breast Feeding Network.[i] They are also being used internationally, to assess around 60,000 children born each year in New Zealand since 2010 and around 72,000 children born each year in Ireland since 2011.[j,k] The charts and associated educational material are free to download and there were over 162,000 visits to the RCPCH growth chart webpage in the year up to July 2013 alone. The charts can be printed locally and have also been used in developing countries, such as Pakistan.[l]

Improved information for parents

For the first time, the accompanying instructions for parent-held child growth charts were explicitly aimed at parents, and parent groups were actively involved in drafting them. These instructions inform a section on growth in 'Birth to Five' (2009), a publication by the UK Department of Health that was distributed to all new parents in England in the years 2009–2011, which is now available to download on the Department of Health website. The book is still provided freely in print and online from the public health departments of Wales and Northern Ireland.[m]

The new UK child growth charts differ substantially from previous charts in terms of their layout and graphic presentation. Discussion with focus groups of parents revealed that parents tend to expect all 'normal' children to grow close to the 50th centile line, so the new charts place less emphasis on the 50th centile and encourage parents to understand the wide range of normal stature. Moreover, parents often want to know how tall their child will be as an adult, and while doctors use parent's height to assess whether growth is within expected limits, the calculations required for this are complex and not always accurate. For this reason, the new charts incorporated a new scale for predicting adult height, designed by Wright and Cole, which is quicker to use and statistically more valid than previous methods.

Training of health professionals and improved clinical practice

The new guidance on completing RCPCH growth charts addressed the many aspects of the old charts that were poorly understood and inconsistently used by health visitors and paediatricians. In particular, Wright and colleagues had observed discrepancies in the plotting of varying gestation at birth and the assessment of puberty. As a result they were able to develop carefully worded, instructions, which were tested in parallel with the design, and which for the first time provided authoritative, evidence-based guidance on the use of charts and growth monitoring. Wright then led the development and evaluation of more detailed supporting educational materials, working with Eileen Birks (University of Northumbria) and Gary Butler (University College London Hospital).[n]

These have since been incorporated into e-learning packages for NHS staff that are currently in use throughout the UK.[o] Wright also organised and participated in a number of 'train the trainers' events in 2009–2010 mainly attended by Nurse trainers: three in London, four English regional events and four in Scotland. In 2010, the Royal College of Nursing issued guidance on standards for measuring children to nurses working with infants and young people in the acute care setting

children which reference the use of the new charts.[f]

Making chart use easier

The charts incorporate novel tools that are simple and accurate to use. Health staff have tended not to use BMI to assess whether a child is overweight as a matter of routine, as calculating BMI requires the use of a calculator and separate BMI charts. The new charts therefore have a BMI centile 'look-up' (designed by Cole) that allows the BMI centile to be identified without the need for extra calculation. The 2-18 charts also have a mid-parental height (average of father's and mother's height) calculator, designed previously by Wright, which avoid the need for complex calculation, as well as their new adult height predictor described above.

5. Sources to corroborate the impact

a. New UK-WHO Growth Charts – birth to 4 years.
b. Letter from the Deputy Director, Child and Maternal Health Division (Scotland) to all NHS Board Chief Executives introducing the Early Years Charts.
c. Print and distribution figures of all UK Growth Charts from April 2012 – April 2013, Harlow Printing Ltd., South Shields, Tyne & Wear, NE33 4PU.
d. Letter from the Director General Health & Social Care and Chief Executive NHS Scotland on the launch of the School Age Charts.
e. UK-WHO growth charts, Royal College of Paediatrics and Child Health [Prof Wright acknowledged under 'Additional information']
f. Royal College of Nursing guidance, 'Standards for the weighing of infants, children and young people in the acute health care setting' [Completion of RCPCH charts recommended, p10].
g. British Dietetic Association press release welcoming new charts.
h. National Childbirth Trust NCT endorsement in press release [See comment]
i. The Breastfeeding Network announcement welcomes the release of the new growth charts.
j. Chief Advisor, Child & Youth, Ministry of Health, New Zealand [book download – Growth charts, p.73]
k. Department of Health and Children, Ireland ['Note for the Record' confirming that the UK Charts will be used for full-term babies, infants and children from birth to 4 years in Ireland from 2011]; available on request.
l. Statement by a Resident in Paediatrics, Military Hospital, Rawalpindi, Pakistan [Request to use Growth Charts in their staff handbook]; available on request.
m. 'How will your child grow' Chapter 4, p.66. *In*, Birth to five (2009), Department of Health [Prof Wright acknowledged]
n. 'Education and training materials', Royal College of Paediatrics and Child Health website
o. e-Learning for packages for NHS staff (Module 8 – Growth & Nutrition): 08-07, Weighing and Measuring Infants and Children; 08_08, Growth Charts and their Interpretation