CHRONOLOGICAL AGE DETERMINATION FOR ADOPTED CHILDREN

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Introduction

This paper has been prepared as a submission to the Queensland Intercountry Adoption Unit regarding policy development for requests to amend a child's date of birth. The paper focuses on issues of chronological age determination and some psychological and social issues that emerge in relation to adoptive parents request for an amendment of a child's age. Although there is a strong delineation made between chronological (biological) and developmental age assessments, this paper does not specifically address the intricacies involved in developmental age assessments. Rather, the focus is on available tests and their validity for estimating chronological age.

1. There is a difference between chronological (biological) age and developmental age.

From the outset there should be clear recognition and acknowledgement that chronological (biological) age is a different consideration to developmental age and care needs to be exercised that the two are different issues and it is inappropriate to use developmental age assessments as a primary determinant to estimate chronological age. In short, the issue of chronological age is 'how old is the child?' rather than 'are they developing according to a particular chronological age?' In the latter situation there are an infinite number of variables and reasons why such development might not match a particular chronological age.

2. There is no definitive test for determining chronological age

There is no definitive test available (at this stage) that provides an accurate chronological age assessment for children. Therefore care must be taken when considering the base determinant measure that is used and against which other evidence is collected and related. There is, however, strong research evidence to support the use of a 'bone age' x-ray test to provide an initial estimation of chronological age and to which applicable other evidence can then be related. This additional evidence will be highly situational and individualistic – depending upon socio-economic background, ethnicity, race, nutrition etc. of the child – and may involve some relevant developmental assessments.

3. The use of a "bone age" x-ray tests

The most common test that is used as part of chronological age estimation is a "bone age" x-ray of the child's left hand and wrist which is then compared to x-rays of children with established ages in a textbook called 'Radiographic Atlas of Skeletal Development of the Hand and Wrist'. The standards in the Greulich and Pyle Atlas are derived from a study of healthy white middle-class children in the Cleveland area in the United States in the years 1931 to 1942. The study consisted of 6,879 hand radiographs from boys and girls. The ages ranged from 3 months to 16 years for girls and to 17 years for boys at the time of the radiographs. In the Greulich and Pyle Atlas a table is used to provide means and standard deviations for skeletal age[1]. At the time of its development Greulich and Pyle did not consider the estimation of chronological age as a potential use of their data and Atlas. Their original work was used to identify possible growth disorders, malformations and bone abnormalities.

A comparable test to Greulich and Pyle that is often used (especially in Britain) was developed by Tanner and Whitehouse. In this test each of the 20 bones in the hand is individually compared with a series of pictures of the ossific development of that particular bone.

There have been a number of comparative studies done on both the Greulich and Pyle and the Tanner and Whitehouse methods. Although there are some variations in the conclusions, these variations tend to involve reliability considerations and none of the studies have been dismissive of either method in terms of validity for estimating bone age. Rather they tend to advocate caution when using the tests. For example, in an audit conducted by King et al it was concluded that 'the Greulich and Pyle method gave similar reproducibility and was faster than the Tanner and Whitehouse method'.[2] Guimarey et al. concluded that 'the distribution of mean differences by age and method demonstrated that all deviations were encompassed into +/- 2 SD with no particular bias. In general terms, a good agreement was obtained between these two methods'.[3] A separate study by Milner et al involved comparisons of the two methods and they concluded that 'estimates made using the method of Greulich and Pyle were younger than those made using that of Tanner and Whitehouse'.[4]

There have been numerous (over 80) studies done on bone age testing and these raise some common questions in relation to its application to adopted children.

4. Does ethnicity affect outcomes of "bone age" tests?

Do the bone age test reference standards accurately reflect skeletal development in children and adolescents of European, African, Hispanic or Asian descent?

***Asian children*:** A study conducted by Ontell et al using the Greulich and Pyle Atlas to consider bone age in children of diverse ethnicity found that in 'Asian and white girls, bone age approximated chronological age throughout

childhood, with the only significant discrepancy being in adolescent white girls, in whom bone age exceeded chronological age by an average of 4 months…preadolescent Asian boys also showed significant delays in bone age, particularly in middle childhood, when bone age lagged behind chronological age by nearly 15 months…'.[5]

An extensive canvassing of available literature has revealed only one specific Asian conducted study. A longitudinal study conducted by Chen et al. between 1976 an 1979 on Malaysian children aged 12-28 months using the Greulich and Pyle atlas found that '83.4% of cases for males and 94.8% of cases for females matched within the +/- 6 months discrepancy range. For practical purposes therefore, our [Malaysian] population may use the Greulich and Pyle Atlas with a good degree of confidence'.[6]

Children of European and African Descent: A study by Loder et al on 841 children (452 boys and 389 girls – 461 black and 380 white children) concluded that the Greulich and Pyle atlas was not applicable to all children today, especially black girls who were skeletally advanced by 0.4 to 0.7 years except during middle childhood (4 – 8 years).[7]

Another study by Mora et al. focused on healthy American children of European and African descent born after the year 1980. Their findings were that '…variations in skeletal maturation in prepubertal children are greater than those reflected in the Greulich and Pyle atlas; prepubertal American children of European descent have significantly delayed skeletal maturation when compared with those of African descent; and postpubertal European-American males have significantly advanced skeletal maturation when compared to postpubertal African-American males.'[8]

Another study of central European children using the Greulich and Pyle method was conducted by Groell et al. who concluded that '…the differences between chronological and bone age were within the normal variations of skeletal maturation as reported by Greulich and Pyle. Our [Groell's et al.] data suggests that the reliability of bone age measurements increases with experience and that the Greulich and Pyle method may be used for central European children.'[9]

Work done by Schmeling et al. at the Institute of Legal Medicine of Berlin University Hospital is reported in a paper titled *"Effects of ethnicity on skeletal maturation: consequences for forensic age estimations".*[10] The abstract of that paper serves as a pertinent summary to the question of ethnicity on bone age measurements:

> *An x-ray of the hand is an important method in forensic science for estimation of the age of juvenile suspects with uncertain dates of birth. Relevant x-ray standards for evaluation of skeletal maturity are available for white US Americans as well as for North and Central Europeans. The applicability of these standards to members of ethnic groups different from the reference population has been the subject of controversial discussion. More than 80 publications were analyzed with a view of finding out whether*

skeletal maturation is affected by ethnic identity. It was concluded that skeletal maturation takes place in phases which are identically defined for all ethnic groups. Time related differences in passing those stages of skeletal maturation within the relevant age group appear to be unaffected by ethnic identity. It is the socio-economic status of the given population which is of decisive importance to the rate of ossification. The application of x-ray standards to individuals of a socio-economic status lower than that of the reference population usually leads to underestimation of the person's age.

5. Impact of nutrition on chronological development

Dr Kevin Osborn (Secretary, ACT Branch, Royal Australian and New Zealand College of Radiologists) testified to the Australian Senate Legal and Constitutional Legislation Committee on 2 March 2001 and when asked by Senator Cooney 'Is diet a factor [with assessing bone age] responded:

Very much so – nutrition is quite a big factor. Provided nutrition is adequate the standards are good. Where nutrition is significantly reduced, without doubt there will be delay in maturation. For any given chronological age the skeletal age will be younger than you expect. Nutrition will not cause increased maturation or early maturation. It will only make you tend to underestimate the chronological age rather than overestimate it.[11]

6. Reliability of other chronological age estimations

As well as the assessment of bone-age using either Greulich and Pyle or Tanner and Whitehouse methods, two other methods are often used to make a chronological age assessment.[12] These are:

Physical measurements: This is an examination of height and size of the person compared to reference tables, so called anthropometrical measurements. These examinations have been highly criticized because they do not take variations according to ethnicity, race, nutritional intake and socio-economic background into consideration. The reference tables are 35-40 years old and no longer correspond to the size of people living in Europe today and adolescents today are on average bigger than their parents. No country utilizes this method in isolation, however, a few such as Romania and Sweden use it in combination with other tests.

Dental age: Teeth appear at certain ages, e.g. the temporary teeth appear between 6 months and 2.5 years. Loss of temporary teeth is between 6-12 years old. The third molar is an exception. Different methods are used but it usually involves counting the number of primary or permanent teeth, the existence of wisdom teeth, and studying the mineralisation of the teeth. Critics such as the German Association of Forensic Medicine and researchers in Sweden, Finland, France and the USA state that the development of teeth depends on the environment, nutrition, as well as ethnicity and race. The dental examination is more precise than the anthropometrical examination, but it still does not provide an exact age.

7. Psychological and social considerations relating to chronological age change.

There are a number of psychological and social considerations that need to be taken into account when adoptive parents are seeking to have the chronological age of their child altered. To summarise these points, they are:

- Why change the age?
- Whose choice of a relevant age?
- Does the proposed change have significance in terms of school age?
- Are there social security issues (i.e. are there sinister motivations for the change)?
- What are the likely implications for siblings (both adopted and biological)?
- What are the potential implications of early onset puberty and growth spurts?
- Is the given age likely to present future issues of fertility for a female child?

The 'selection' of a new chronological age should not be the responsibility of the Intercountry Adoption Unit staff. The above points need to be considered as part of the evidence gathering by the adoptive parents and presented to the Intercountry Adoption Unit as a recommendation which can then be considered and negotiated with the primary focus on the well being and developmental considerations of the child.

Conclusion

This paper outlined some key issues involved in estimating chronological ages for children. Firstly, it clarified the important distinction between chronological and development age assessments. It then presented arguments that although there is no definitive test available, the bone age test (Greulich and Pyle) does have face validity as a starting point to which other evidence can be related. The relevance of ethnicity on bone age testing has been discounted, however, issues of socio-economic background and nutrition have been identified as factors that can influence both +/- the chronological age estimations made using bone age tests. The use of supplementary tests such as dental age and physical measurements was also discussed in terms of applicability as additional evidence to that gathered by bone age testing. Finally, a number of psychological and social considerations were raised.

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[1] Para 28 Federal magistrates Court of Australia, *Applicant Vfay v Minister for Immigration [2003] FMCA 289.*

[2] King DG, Steventon DM, O'Sullivan MP, Cook AM, Hornsby VP, Jefferson IG and King PR, *Reproducibility of bone ages when performed by radiology registrars: an audit of Tanner and Whitehouse II versus Greulich and Pyle methods*, British Journal of radiology, 1994, Sep: 67(801):848-51.

[3] Guimarey L, Moreno Morcillo A, Orazi V, and Lemos-Marini SH, *Validity of the use of a few hand-wrist bones for assessing bone age,* Journal of Pediatric Endocrinology Metab., 2003 Apr-

May;16(4):541-4.

[4] Milner GR, Levick RK and Kay R, *Assessment of bone age: a comparison of the Greulich and Pyle and the Tanner and Whitehouse methods,* Clinical Radiologist, 1986 Mar;37(2):119-21.

[5] Ontell FK, Ivanovic M, Ablin DS and Barlow TW, *American Journal of Roentgenology*, Vol.167, 1395-1398, 1996.

[6] Chen ST, Jee FC and Mohamed TB, *Bone age of Malaysian children aged 12 to 28 months,* Journal of the Singapore Pediatric Society, 1990;32(3-4):97-101.

[7] Loder RT, Estle DT, Morrison K, Eggleston D, Fish DN, Greenfield ML and Guire KE, *American Journal of Dis. Children,* 1993, dec:147(12):1329-33.

[8] Mora S., Ines Boechat M., Pietka E, Huang HK and Gilsanz V., 2001, *Pediatric Research,* Vol.50, No.5, pp.624-628.

[9] Groell R, Lindbichler F, Riepl T, Gherra L, Roposch A and Fotter R., *T The British Journal of Radiology,* 72(1999), 461-464.

[10] Schmeling A, Reisinger W, Loreck D, Vendira, Markus W and Geserick, *Effects of ethnicity in skeletal maturation: consequences for forensic age estimations* cited in para.37 Federal magistrates Court of Australia, *Applicant Vfay v Minister for Immigration [2003] FMCA 289.*

[11] Dr Kevin Osborn (Secretary, ACT Branch, Royal Australian and New Zealand College of Radiologists) testimony to the Australian Senate Legal and Constitutional Legislation Committee on 2 March 2001, Reference Crimes Amendment (Age Determination) Bill 2001.

[12] Halvorsen K., Separated Children in Europe Programme Workshop on Age Assessment and identification, Bucharest, 20-22 March 2003, p.7-8.