Positive screening and carrier results for the England-wide universal newborn sickle cell screening programme by ethnicity and area for 2005–07

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ABSTRACT

Aims The overall aim of the new national newborn screening programme is to identify infants at risk of sickle cell disease to allow early detection and to minimise deaths and complications.

Methods Universal screening for sickle cell disease was introduced in England between September 2003 and July 2006. The 13 newborn laboratories each screen between 25 000 and 110 000 babies a year using the existing dried bloodspot cards. The specified conditions to be screened for include sickle cell anaemia (Hb SS), Hb SC disease, Hb S/β thalassaemia, Hb S/D Punjab and Hb S/βαthal. Data are reported on screening results by ethnic group and geographical area.

Results The prevalence of screen positive results across England is 1:2000. There is a 25-fold variation by geographical area. African babies make up 61% of all screen positive results despite representing only 4% of total births. Combined carrier rates vary widely by ethnicity, from 1.85 per 1000 (1:540) in ‘White British’ to 145 per 1000 (1:7) in ‘African’ babies. Refusal rates for screening show variation by ethnicity.

Conclusions These results provide useful information both about the frequency of these conditions and the carrier state and their geographic and ethnic distribution across England. This can be used to refine counselling information and are also useful to target and plan services and public information.

AIMS

The overall aim of the recently introduced national newborn screening programme is to identify infants at risk of sickle cell disease to allow early detection and to minimise deaths and complications through early treatment and care. Screening is now offered to all newborns irrespective of ethnicity at 5–8 days of age as part of the pre-existing newborn dried bloodspot screening programme; implementation was planned for Scotland in 2010. We report the frequency of suspected disease rates for different parts of the country and for the first time we report newborn carrier data broken down by ethnicity using the categories recorded on the dried bloodspot ( Guthrie) card. This is important information for those who have to counsel such families. The reported carrier rate for England as a whole is 15/1000. The frequency of diagnosis of sickle cell disease suggests that it should be given a higher priority in medical and nursing education and in NHS service planning and provision. The scale of need for genetic counselling arising from this programme is also emphasised.

METHODS

Screening for sickle cell disease was introduced in England between September 2003 and July 2006, building on the existing patchy screening arrangements which covered about 15% of England (in parts of London and the West Midlands).

The policy adopted by the National Screening Committee (NSC) was to introduce universal resident based screening of all infants using the bloodspot card and to discontinue catchment based cord blood samples.1 The newborn laboratory service providing the screening in England now consists of 13 centralised biochemistry newborn screening laboratories—each screening between 25 000 and 110 000 babies a year. For sickle cell screening, second line testing of all positive results is performed, either within the screening laboratory, or by a specialist haematology laboratory within the same hospital trust or elsewhere. Two methods of analysis are applied to all screen-positive results obtained from dried blood spot samples to ensure high specificity: either high performance liquid chromatography or iso-electric focussing (further details are included in our laboratory handbook).2 In addition to screening for sickle cell disease, these biochemistry laboratories perform newborn screening for phenylketonuria, congenital hypothyroidism, cystic fibrosis and medium chain acyl CoA dehydrogenase (MCADD).3

The screening programme specifies the conditions to be screened for and recommends specific methods to be used.2 The conditions screened for because of the potential benefit are: sickle cell anaemia (Hb SS), Hb SC disease, Hb S/β thalassaemia, Hb S/D Punjab and Hb S/βαthal. Hb S/β+ thalassaemia is also included as it needs to be distinguished from Hb SS and S/β or δβ thalassaemia although it is not in itself a condition for which there is proven benefit in screening. Currently the UK NSC does not support screening for β thalassaemia.

A detailed implementation plan was developed which included training of staff responsible for taking samples (predominantly midwives) and providing laboratory set-up costs, development of materials for parents, recruitment of counsellors and funding of laboratories as described elsewhere.4 5 Standards for the linked newborn and antenatal programme6 and for the overall bloodspot programme3 are available in various publications.

The NSC supported the recommendation by the programme that, in line with pre-existing practice in areas already undertaking newborn screening, carriers of the main haemoglobins including S, C,
Parents with specific haemoglobin variants (S, C, D and E) are therefore reported to be unlikely to be clinically important but have genetic relevance.9 It is important to know the distinction between the S carrier status (which is clinically healthy) and the difference between carrier state and disease, the latter being offered to ensure parents understand that their child is not affected.7 8 Carriers of the common haemoglobin variants are carriers often want to know this information. Recently published work has suggested that some beta thalassaemia carriers may be detected by their low levels of Hb A at birth.10

Demographic data are recorded on the blood spot card by the midwife who takes the sample, including ethnic data selected from a table printed on the back of the card. This ethnic data field is not completed in all cases and has not been available from one laboratory for the period reported here.

Data are collected from all laboratories, checked and discussed with the providing laboratory to keep inconsistencies to a minimum. The data are used to assist in planning counselling and clinical services and to inform antenatal prevalence estimates and local screening policy and service planning. The time period of the data collections is the two financial years of 2005/06 and 2006/2007.

RESULTS

The prevalence of screening results indicating likely sickle cell disease (screen positive results) varies widely (table 1). It ranges from 3 per 1000 in South East London (ie, about 1.530 babies have a screen positive result) to 0.12 per 1000 in Cumbria and Lancashire—a 25-fold variation in prevalence. Within London the prevalence is highest in South East London at 3/1000 and lowest in North West London at 1/1000. Other areas with higher rates of 0.4–0.5/1000 include Leicester and Northants, Bedfordshire, Birmingham, Essex and Greater Manchester. Overall babies recorded as Black African make up 61% of all the sickle cell disease suspected results despite representing only 4% of total births. Overall screen positive disease prevalence rate is 1.2000 for England.5

Figure 1 shows that combined carrier rates also vary widely by ethnicity from 1.85 per 1000 (1:540) in those babies recorded as ‘White British’ to 145 per 1000 (1:7) for ‘Black African’ babies. Figure 2, showing refusal rates for screening, shows that several populations such as the ‘any other white background’ (1:940), ‘Black Caribbean’ (1:840) and ‘not stated’ (1:830) populations appear to have a significantly higher rate of refusal of screening than the ‘White British’ (1:3150) category with CIs not overlapping the ‘White British’ category. Overall about 300 refusals are documented each year, and for these cases a blank

### Table 1 Rates of significant conditions* by strategic health authorities†: April 2005 to March 2007

| County          | Rate per 1000 babies screened | No. of babies screened |
|-----------------|-------------------------------|------------------------|
| County Durham and Tees Valley | † <5 | 23228 |
| Don't know      | † <5 | 29641 |
| Hampshire and Isle of Wight | † <5 | 23134 |
| North and East Yorkshire and Northern Lincolnshire | † <5 | 32781 |
| South West Peninsula | † <5 | 31073 |
| Surrey and Sussex | † <5 | 58190 |
| Trent           | † <5 | 58814 |
| Dorset and Somerset | 0 | 15931 |
| Cumbria and Lancashire | 0.12 | 42632 |
| Norfolk, Suffolk and Cambridgeshire | 0.12 | 41945 |
| Cheshire and Merseyside | 0.14 | 56655 |
| Coventry, Warwickshire, Herefordshire and Worcestershire | 0.14 | 35355 |
| Shropshire and Staffordshire | 0.15 | 33400 |
| Northumberland, Tyne and Wear | 0.19 | 26093 |
| Avon, Gloucestershire and Wiltshire | 0.23 | 43516 |
| Thames Valley | 0.24 | 24701 |
| Kent and Medway | 0.25 | 39764 |
| South Yorkshire | 0.26 | 30881 |
| West Yorkshire | 0.32 | 55954 |
| Greater Manchester | 0.38 | 70211 |
| Essex           | 0.39 | 38610 |
| Birmingham and the Black Country | 0.43 | 65150 |
| Bedford and Hertfordshire | 0.44 | 43239 |
| Leicestershire, Northamptonshire and Rutland | 0.53 | 38062 |
| London North West | 0.99 | 55514 |
| London South West | 1.25 | 39044 |
| London North Central | 1.41 | 38231 |
| London North East | 2.18 | 55050 |
| London South East | 3.05 | 51815 |
| England         | 0.54 | 651 | 1198614 |

Note that Portsmouth provided data from April 2006 and Oxford from July 2006.

** Significant conditions comprise the following results: FS, FSC, FS other and FE (F, foetal haemoglobin; S, S haemoglobin; C, C haemoglobin; E, E haemoglobin).
† Pre July 2006.
‡ Sample too small.

Figure 1 Carrier rates by ethnic category: April 2005 to March 2007.
Figure 2 Refusal rates per 1000 babies screened: April 2005 to March 2007.

card is sent to the laboratory to ensure that this information is documented on all records so that a test may still be performed if clinical suspicion is raised or if the child subsequently becomes ill. Almost exclusively refusals are for screening for all five conditions and not specifically a refusal for sickle cell disease screening. To date, to our knowledge, none of these refusals have been babies already identified by antenatal screening as at high risk of being affected. For infants at a 1:4 or higher risk the clinical policy is to offer liquid blood sample testing in advance of the bloodspot screen which is still offered (see page 4 of the programme laboratory handbook).

Table 2 shows that different ethnic groups have different patterns of carrier rates, with haemoglobin D being predominantly seen in the Indian and Pakistani populations and haemoglobin E seen in the Bangladeshi population.

CONCLUSION

These results from the newborn screening programme provide useful objective information, both about the frequency of these conditions and the carrier state and their variable geographic and ethnic distribution across England. They give ratios of conditions and carrier frequencies by ethnic group which can be used by the programme to refine counselling information for individuals and couples as recently recommended by Kai et al. They are also useful to target and plan services and public information.

The limitations of the data are that it is based on ethnicity data ascertained by midwives and recorded on the bloodspot card rather than on a detailed family origin questionnaire, and also that ethnic data were not recorded in about 13% of samples. Despite this, the overall pattern and distribution of disease and carrier rates expected is clearly shown. A second limitation of the data is that these are screening and not diagnostic results, but as reported elsewhere the screening methods used are highly specific and sensitive, and results are unlikely to be significantly changed when confirmatory tests are completed.

None of these limitations are likely to materially affect the main findings of the general prevalence of the condition—now about 1:2000 affected births in England: it is as common as cystic fibrosis. The significant contribution that the Black African, rather than the African-Caribbean population makes to the disease is of note. The data also show the significant burden that these conditions are likely to place on the London NHS.

Table 2 Carrier rates by ethnic category* and Hb type: April 2005 to March 2007

| Ethnicity                        | 0.00 | 0.50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| A - White British               |      |      |      |      |      |      |      |      |      |      |      |
| B - White Irish                 |      |      |      |      |      |      |      |      |      |      |      |
| C - Any other White background  |      |      |      |      |      |      |      |      |      |      |      |
| D - White and Black Caribbean   |      |      |      |      |      |      |      |      |      |      |      |
| E - White and Black African     |      |      |      |      |      |      |      |      |      |      |      |
| F - White and Asian             |      |      |      |      |      |      |      |      |      |      |      |
| G - Any other mixed background  |      |      |      |      |      |      |      |      |      |      |      |
| H - Indian                      |      |      |      |      |      |      |      |      |      |      |      |
| J - Pakistani                   |      |      |      |      |      |      |      |      |      |      |      |
| K - Bangladeshi                 |      |      |      |      |      |      |      |      |      |      |      |
| L - Any other Asian background  |      |      |      |      |      |      |      |      |      |      |      |
| M - Black Caribbean            |      |      |      |      |      |      |      |      |      |      |      |
| N - Black African               |      |      |      |      |      |      |      |      |      |      |      |
| P - Any other Black background  |      |      |      |      |      |      |      |      |      |      |      |
| S - Any other ethnic category   |      |      |      |      |      |      |      |      |      |      |      |
| Z - Not stated                  |      |      |      |      |      |      |      |      |      |      |      |
| **Total**                       |      |      |      |      |      |      |      |      |      |      |      |

*Ethnic category as it appears on the Guthrie card.
†Since there are many ‘D’ variants and characterisation may take some time, it is recommended that all ‘D’ variants with the characteristics of D Punjab (the only clinically significant variant) are assumed to be clinically significant and reported. DNA analysis or mass spectrometry can be used to elucidate the diagnosis.

Birmingham was unable to provide denominators by ethnic category due to variations in coding of ethnicity information and laboratory software constraints and their data has been taken out of this table. About 11% of all babies, 10% of carriers and approx 6% of all affected babies are tested in Birmingham. Note that Portsmouth provided data from April 2006 and Oxford from July 2006 only.

628 J Clin Pathol: first published as 10.1136/jcp.2010.077560 on 30 June 2010. Downloaded from http://jcp.bmj.com/ by guest. Protected by copyright.
In England, sickle cell disease is considerably more common than usually quoted, with a birth prevalence of 1:2000 (more common than cystic fibrosis—1:2500), and an S carrier rate of almost 1% in newborn babies.

There is wide (25-fold) geographical variation in the frequency of sickle cell disease. Most affected babies are in London and other large urban centres, but sickle cell disease is occurring in all parts of England, including areas where previously the disease was unreported and thought to be ‘not a problem here’.

For the first time reliable carrier rates by reported ethnicity give objective information by ethnic group to help those who counsel individuals and couples about their risk of sickle cell conditions. This includes the fact that 1:800 babies reported as ‘White British’ is a carrier of the S, C, D or E gene.

Collecting this ethnicity data has also been very valuable in showing variation by ethnicity in refusal rates, and this should continue to be monitored.

These objective figures should replace previous estimates of the scale of these conditions which are now out of date. They suggest that the management and care of haemoglobinopathies as a long term condition needs to move from its ‘orphan’ status into the mainstream of the NHS commissioning and clinical agenda as an important addition to the inequalities in healthcare agenda. The huge variation in the condition by ethnicity shown by these figures arguably explains why the condition has not received the attention it merits as the groups affected are often marginalised within UK society. A welcome recent development which may be helping to raise the profile of these conditions in the NHS is the establishment of an All Party Parliamentary group.

The other issue that these figures raise is the frequency of the carrier state and the ongoing challenge to record such information accurately, in primary care records, so that it is available when needed and repeat testing is avoided. In the case of S carrier status, this is important information for parents and children as sickling does occur, albeit rarely, under stress of deoxygenation such as during surgery, at high altitude and during extreme physical activity. This information is not solely relevant for reproductive reasons but also for clinical purposes such as during extreme physical activity.12 13 This information is not available for parents and children as sickling does occur, albeit rarely, under stress of deoxygenation such as during surgery, at high altitude and during extreme physical activity.12 13 This information is not solely relevant for reproductive reasons but also for clinical reasons, and in a child this latter point is the important issue.

We hope that by presenting objective information, which should be read alongside other information, the clinical community responsible for education of future clinicians and for developing services will act to support the obvious clinical needs shown, and will ensure that genetic issues are considered alongside clinical needs.14

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Competing interests None.

Contributors AS is a public health physician and has been Director for the Screening Programme since 2001. She has led on the development and implementation of the programme and data collection to support reporting on the programme. She has led on drafting the paper and editing the text. She is the guarantor of the paper. RL has been Clinical Data Coordinator for the programme since 2004 and has led on establishing the database, collating data and producing the tables and charts. He has commented on the text. JH has been a Laboratory Consultant to the Programme since 2003 and has led on developing a practical data return that laboratories can complete, liaising with laboratories and obtaining consent to provide the return. She has also led on writing the technical sections of the paper and commented on the text.

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Take-home messages

- In England, sickle cell disease is considerably more common than usually quoted, with a birth prevalence of 1:2000 (more common than cystic fibrosis—1:2500), and an S carrier rate of almost 1% in newborn babies.
- There is wide (25-fold) geographical variation in the frequency of sickle cell disease. Most affected babies are in London and other large urban centres, but sickle cell disease is occurring in all parts of England, including areas where previously the disease was unreported and thought to be ‘not a problem here’.
- For the first time reliable carrier rates by reported ethnicity give objective information by ethnic group to help those who counsel individuals and couples about their risk of sickle cell conditions. This includes the fact that 1:800 babies reported as ‘White British’ is a carrier of the S, C, D or E gene.
- Collecting this ethnicity data has also been very valuable in showing variation by ethnicity in refusal rates, and this should continue to be monitored.