**Feasibility of pulse oximetry screening for critical congenital heart defects in homebirths**

**Cawsey MJ,1 Noble S,1 and Cross-Sudworth F,1 Ewer AK1,2**

1. Birmingham Women’s Hospital NHS Foundation Trust, Edgbaston, Birmingham UK.
2. School of Clinical and Experimental Medicine, University of Birmingham, Birmingham, UK

**Corresponding author:**

Prof A K Ewer

Neonatal Unit

Birmingham Women’s Hospital

Edgbaston

Birmingham

B15 2TG

Email: a.k.ewer@bham.ac.uk

Tel: +44 121 623 6631

Fax: +44 121 627 2749

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**Abstract**

Background: Pulse oximetry has been shown to be a valuable additional screening test for detecting critical congenital heart defects (CCHD) in newborns. The feasibility of homebirth screening by the attending midwife has not been reported previously.

Aim: Routine pulse oximetry screening of homebirths at 2 hours of age was introduced in a UK tertiary maternity service in January 2014. The process and outcomes were evaluated.

Methods: Retrospective review of the clinical record of all babies undergoing pulse oximetry screening performed following homebirths over a 16 month period was undertaken. The acceptability of screening among the homecare team (n=11) was also evaluated.

Results: Ninety babies underwent routine pulse oximetry screening within 2 hours following homebirth; 2 had a positive result and were admitted to the Neonatal Unit with significant respiratory illness.

Screening was acceptable and reassuring to midwives enabling prompt postnatal decision making and confirming normal transition without significantly increasing workload.

Conclusions: Early pulse oximetry screening for homebirths is both feasible and acceptable.

**Introduction**

Congenital Heart Defects (CHD) are the commonest congenital abnormalities and a leading cause of infant death in the developed world.1 The detection of babies with critical CHD (CCHD) before cardiovascular collapse continues to present difficulties and despite antenatal screening and postnatal examination a significant proportion are still missed.1 Pulse oximetry (PO) screening is a highly specific, moderately sensitive test for identifying babies with CCHD2 which is cost-effective,1 acceptable to both parents and staff3 and adds value to existing screening methods.1,4

PO screening is becoming increasingly utilised in both high and middle income countries and several, (including the USA) have introduced routine screening as national policy. 4 A National Screening Committee pilot study is currently underway across England to assess the feasibility and clinical impact of the introduction of PO screening.

To date, almost all PO screening studies and reports are from babies born in hospital. The rate of homebirths varies in high income countries. In the Netherlands, which has a relatively high homebirth rate (approximately 20%) a team has published a protocol for screening including homebirths but no outcome data have been reported.5 One study from Wisconsin USA reported screening of out-of-hospital births but the screening was undertaken a considerable time after the birth (mean age 40 hours) and following a separate visit by the midwife.6 We are unaware of any published reports of PO screening by the attending midwife.

In 2013, homebirths accounted for 2.3% of all births in England and Wales and this rate is increasing. The inclusion of homebirths in a PO screening programme is potentially difficult as there are a number of complicating factors – midwives are usually only with mother and baby for a short time (2 hours) following delivery, they can cover a wide geographical area and are not routinely equipped with pulse oximeters. Additionally, the pathway for further evaluation of the baby with a positive result is not clear.

Key specific concerns include - when should a homebirth be tested to ensure timely diagnosis without an increase in false positives? Who should undertake the test? What is the appropriate referral pathway following a positive test result?

As early PO screening may result in a slightly higher false positive rate2 and later screening may lead to more cases of CCHD presenting before screening takes place,4 the screening of homebirths presents a challenge.

Birmingham Women’s Hospital introduced routine PO screening in 2009 following completion of the PulseOx study7 and has continued to screen inborn babies since then using the same protocol.

Initially, babies delivered at home were offered screening on the day after birth, but this required the baby to attend the hospital and usually occurred after 24 hours of age. As a result of increasing number of homebirths and following the appointment of a nurse consultant with responsibility for the homebirth team (SN) we initiated a programme of screening homebirth babies at home in January 2014. No additional staff were employed; screening was undertaken by midwives and midwifery support workers attending the birth using the Masimo Rad 5v pulse oximeter (Masimo Corporation, Irvine, California). All staff received in house training by the team leader.

Homebirths underwent the same protocol as inborn babies7,8 except they were screened at approximately 2 hours of age as opposed to between 4 and 8 hours. The timing of the screen was a pragmatic decision, allowing the baby to be screened before the midwife left the home. Although it was possible that this may slightly increase the risk of false positive results, this was considered preferable to arranging a separate visit to carry out the screening.

All members of the homebirth team were trained to undertake screening and each homebirth pack included a pulse oximeter. Parents were given the same pre-delivery information regarding PO screening as inborn babies and verbal consent was taken by the midwife at the time of screening.

The main aims were to examine whether the introduction of the screen was feasible, whether the test was acceptable to the homebirth team and to evaluate outcomes, with particular emphasis on the number of babies requiring hospital admission.

**Methods**

A retrospective analysis of screening outcomes of all homebirths from January 2014 to May 2015 was undertaken using the electronic maternity data system. A more detailed review was undertaken of the babies who were admitted using case notes and the electronic neonatal record system to define the clinical course and final diagnosis.

To assess acceptability, a simple questionnaire was designed to gauge opinion on the key features of the homebirth screening programme which was then completed by all 11 members of the homebirth team. The questionnaire comprised 7 questions which were scored using a Likert scale of 1 (strongly agree) through to 5 (strongly disagree). The questions are listed in table 1.

**Results**

There were 90 homebirths during the study period. All were asymptomatic at the time of screening and therefore eligible to be screened. No parents declined screening. All babies underwent pulse oximetry screening according to the described protocol.7,8 Eighty-six (96%) had an initial negative screen (figure 1). Two babies had a borderline result and both underwent repeat screening 2 hours later which resulted in a negative screen (figure 1). Therefore, 88 (98% of total screened babies) had a final negative screen. Two babies (2%) had a positive result (figure 1). Both were admitted to NNU according to the protocol. Following admission, both had a confirmed diagnosis of congenital pneumonia (clinical signs, radiological confirmation and rise in CRP)8 requiring oxygen therapy for more than 24 hours and five days of IV antibiotics.

Three babies who became symptomatic after a negative screen were admitted to hospital. One was pyrexial (38.0oC) and was investigated and treated for suspected sepsis (antibiotics were stopped after 48 hours). The second had mild respiratory distress (tachypnoea, recession but no additional oxygen requirement) which settled within 12 hours; the third baby was admitted to another hospital with a final diagnosis of meningitis.

The results of the questionnaire gave a uniformly positive opinion of pulse oximetry screening (table 1).

**Discussion**

This is the first report of early PO screening in homebirths by the attending midwife and although the numbers of babies screened is low, our data demonstrate the feasibility and acceptability of such screening at home and suggest that the impact on the clinical service is not increased significantly.

Prior to initiating the screening programme the main concern was the potential for increased test positive results because of earlier screening (two hours compared with 4-8 hours for inborn babies).

Although the test positive rate was 2% compared with 0.8% in inborn babies,8 the cohort size was very small and both test positive babies were admitted to hospital with a significant respiratory illness which, in all likelihood would have resulted in hospital admission anyway. None of the babies had CCHD however in such a small, low-risk cohort this is not surprising.

Two babies had a borderline result and a Midwifery Support Worker stayed at the house for an extra 2 hours in order to repeat testing. This did not appear to have an impact on the homebirth workload and was not perceived to be a negative aspect of screening by the homebirth team.

Three babies were admitted after a negative screen; two had self-limiting problems and one had meningitis which is not a condition that PO screening is likely to identify.

The overall opinion of midwives was positive about screening and they were reassured by having an objective measure of oxygenation to add to the clinical assessment of the baby.

The introduction of pulse oximetry screening to babies born at home at 2 hours of age is feasible and although our numbers are very small it had minimal impact on working patterns and appears to be acceptable to the midwives responsible for homebirths.

**What is already known on this topic?**

* + Some critical congenital heart defects are missed by antenatal scanning and postnatal examination
	+ Pulse oximetry screening after birth improves detection of critical congenital heart disease
	+ There are no published data on early pulse oximetry screening in homebirths

**What this study adds**

* + Carrying out early pulse oximetry screening in homebirths is feasible
	+ PO screening is acceptable to the homebirth team
	+ Early screening at 2 hours of age did not impact significantly on clinical services

**Competing interest:** None declared

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**Author contributions**

MC collated the data, performed the initial analysis, wrote the first version of the manuscript and edited subsequent versions.
SN helped develop the homebirth screening protocol, led the screening team and edited the manuscript.

FCS assisted with data collection, analysis and edited the manuscript
AKE developed the protocol, edited and completed the final version of the manuscript.

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**Figure 1: Outcomes of PO screening in home birth babies:** 

**Table 1: Results from questionnaire given to Homebirth team (n=11)**

|  |  |
| --- | --- |
| **Question** | **Percentage stating “Strongly agree” or “Agree”** |
| Were you previously aware of PO screening? | 82% |
| Did you receive adequate training? | 91% |
| Is pulse oximetry screening a useful test? | 100% |
| Was home implementation of PO screening straightforward? | 91% |
| Carrying out the screen has no impact on working pattern? | 91% |
| Is the equipment provided appropriate? | 100% |
| Is the current referral pathway appropriate? | 73% |