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Implementation of pre- and post-ductal oxygen saturation screening in babies born in a district general hospital

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KEY MESSAGES

What is already known on this topic

Pre-and post-ductal pulse oximetry has been shown to increase detection rates of critical congenital heart disease.

What this study adds

This quality improvement project looked at strategies to achieve universal screening in a district general hospital. A significant improvement was achieved over 12 months through a combination of IT changes, education, regular reinforcement, updates to handover sheets and case discussion.

How this study might affect research, practice or policy

A multi-disciplinary approach with open discussions and invitation for contribution was essential in achieving implementation. Through this screening a baby with hypoplastic left heart syndrome was identified and transferred to a cardiac surgery centre for urgent specialist management.

SUMMARY

Pre-and post-ductal pulse oximetry has moderate sensitivity and high specificity in detection of critical congenital heart disease – in this project we implement this screening tool in a district general hospital.

THE PROBLEM

Congenital heart defects (CHD) are the most common congenital anomaly and range from asymptomatic to lethal [1,2]. Early recognition is critical to prevent postnatal collapse as CHD account for nearly 10% of neonatal deaths [1].

At birth every newborn undergoes major physiological adaptation including the closure of the ductus arteriosus. In a structurally normal heart these changes are required for optimal oxygenation of peripheral tissues. However, closure of these shunts can be lethal in newborns with duct-dependent cardiac conditions. If detected early, prostaglandin infusion can be used to maintain patency of the ductus arteriosus until surgery is performed [3].

Antenatal ultrasound screening does not detect all structural heart defects, missing approximately half of cases [4,5] . Current UK screening committee guidelines offer all babies a newborn and infant physical examination (NIPE) [6]. However, this will still miss a further estimated 55% of cases [7].

Multiple studies including a Cochrane review have shown that pre- and post-ductal saturation screening in newborns increases the detection of critical CHD [8–10] and is generally acceptable to parents [11].

AIMS

1. Implement universal pre- and post-ductal saturation screening in babies born under the care of the West Suffolk maternity team (hospital and home births).
2. Evaluate the number of babies referred to the neonatal team for review due to abnormal screening.
3. Review any cases of CHD detected via screening.

MAKING A CASE FOR CHANGE

Following the death of two babies from congenital heart disease, the screening was driven by a paediatric consultant with support from Professor Ewer who led the PulseOx study [8]. Discussions at governance meetings and case presentations resulted in the formation of a multi-disciplinary team including doctors, midwives, and neonatal nurses.

YOUR IMPROVEMENTS

This quality improvement project began on 9th August 2021 and ended on 14th August 2022. During this period, 2886 pregnancies had routine antenatal care at West Suffolk Hospital and cardiac abnormalities were detected by ultrasound in 13 cases (prevalence 4.5 per 1000 babies screened).

The standard operating procedure for the care of babies born at our trust was updated to include a flowchart adapted from the PulseOx study (Figure 1) [8]. Initially screening was only offered to babies under midwifery care but this was updated in January 2022 to include all babies irrespective of location. Background work was undertaken with the IT team to allow recording of age, saturations, and escalation status within the electronic medical record.

In the first four weeks of the screening program a weekly average of 69% of babies had their pre- and post-ductal saturations recorded (Figure 2). Over the 53 weeks that this project was active, a variety of interventions were used to increase the proportion of newborns screened (Figure 2 & Table 1). As the priority was to improve screening rates, some of these took place in parallel. In view of this, it is difficult to assess the relative impact of each intervention. In the last four weeks of the project, an average of 95% of babies were screened. Indeed a significant run chart shift began on 11th April 2022 which is demonstrated by 17 consecutive weeks above the median (Figure 2).

Between 9th August 2021 and 14th August 2022 there were a total of 2186 live births (median 41, range 28-56 per week) and 1791 (81.9%) had saturation screening. Of these, 42 were referred to the neonatal team for review as a result of an abnormal screening result (23 babies escalated per 1000 babies screened) and 12 had normal repeat saturations. Amongst the remaining 30 babies, 29 (96.7%) were diagnosed with a non-cardiac problem and 19 (63.3%) required additional support for respiratory distress (Table 2).

An echocardiogram was requested and performed for one newborn. In this case the NIPE was normal, but saturations were low with a pre- post-ductal differential. The scan revealed hypoplastic left heart syndrome. Prostaglandin was started and the baby was transferred to a tertiary cardiac centre where they had surgery the following day. Therefore, our detection rate for CHD based on abnormal pulse oximetry results was 0.6 babies per 1000 babies screened.

LEARNING AND NEXT STEPS

Prior to the implementation, there were some concerns from both the midwifery and neonatal nurses about increased workload, additional training, and the cost of purchasing saturation monitors. The additional saturation monitors were purchased from maternity funds. Every midwife

was given standardised training to ensure competence and to illustrate the minimal time required to perform the potentially life-saving screening.

Initially, the need for screening was not recognised on continuously monitored babies on the neonatal unit. There was a preconception that a normal clinical examination excludes congenital cardiac defects. To overcome this, we shared data which showed that some newborns with normal antenatal scans, normal NIPE, and no concerns in the first days of life were at risk of sudden cardiac death. Importantly, some of these deaths are preventable through pre- and post-ductal saturation screening [8-10].

The two doctors in training leading the quality improvement project were working regularly on the postnatal and neonatal wards and identified key contacts in these areas. Regular informal conversations and focus groups with ward staff of all levels helped to elucidate barriers to the successful day-to-day implementation of the project. These discussions were crucial to identify small interventions which combined, had a significant impact. We feel that regular reinforcement was essential; this was largely led by the senior midwifery team who embedded this screening within their postnatal routines.

Feedback on the baby diagnosed with hypoplastic left heart syndrome was shared with the medical, neonatal, and midwifery teams to further reinforce the importance of screening. This was part of a programme of regular educational events which were particularly important for groups where there is significant staff turnover (e.g. junior paediatric doctors).

With the help of the Information and Quality Improvement Teams, data extraction from the electronic medical records was automated. Contemporaneous compliance data was regularly shared via e-mail by the team, including the lead consultant, to provide positive reinforcement.

Following the completion of this quality improvement project, screening levels of above 95% have been maintained over the following three months and pulse oximetry screening has now become the standard of care at our hospital. It is recognised that reaching 100% is a challenge, especially in a busy ward environment, in view of human factors. Work is ongoing to ensure that every baby is captured. We hope that adding the screening to the discharge checklist results in universal screening.

In our experience having a team with a clear united vision, utilising positive momentum through regular multi-disciplinary discussions, and provision of up-to-date feedback were fundamental to the success of this project. We hope that by sharing our experience, other hospitals may be able to implement pre- and post-ductal saturation screening to reduce neonatal morbidity and mortality.

CONFLICTS OF INTEREST

None

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FIGURES

Figure 1 – **Overview diagram of pulse oximetry screening.** Adaptation of the algorithm used for the screening program. Of note, references to specific places/roles at the hospital have been removed.

Figure 2 – **Pulse oximetry screening over time.** Run chart of the proportion of babies born under the care of the hospital who received saturation screening. Data points represent individual weeks (Monday-Sunday) over 53 weeks from 9th August 2021. Red line represents the median. The numbered interventions are detailed in Table 1.

TABLES

Table 1 – **Interventions used to increase the proportion of babies having pulse oximetry screening over time.** Numbers are in reference to Figure 2; of note, some interventions were carried out multiple times.

Intervention # (See Figure 2)	Target group	Description of intervention
1	Midwifery	**Raising awareness:** - Reminders via the midwifery staff Facebook group
2	Midwifery	**Raising awareness:** - Raising awareness and training as part of the midwifery "education week"
3	Neonatal Unit	**Raising awareness:** - Reminder emails - Posters on the staff notice board - "Education week" (as above)
4	Medical Staff	**Training medical staff:** - Presentations were given at induction for new junior doctors
5	Midwifery	**Engaging stakeholders:** - Presentation of the screening project and a case presentation was given at the obstetric governance meeting
6	IT/Infrastructure	**Recording pulse oximetry:** - Electronic medical records were updated to facilitate easier documentation on the Neonatal Unit
7	IT/Infrastructure	**Transitional care babies:** - Cot stickers were made for newborns on transitional care to remind staff when saturations were due to be measured
8	IT/Infrastructure	**Handover sheets:** - Midwifery handover sheets were updated to include whether pulse oximetry screening was outstanding

Table 2 – **(a) Diagnoses made and (b) respiratory support required in the 30 neonates admitted to the neonatal unit with abnormal pulse oximetry screening results.** Please note that some neonates had more than one diagnosis or required more than one type of respiratory support during their admission.

	Diagnosis	**Number of babies**
(a)	Suspected or confirmed neonatal sepsis	24
	Respiratory distress syndrome	6
	Transient tachypnoea of the newborn	2
	Persistent pulmonary hypertension of the newborn	1
	Prematurity	7
	Cardiac condition	1
	Genetic syndrome	2
(b)	**Respiratory support**	
	Low-flow nasal cannula oxygen	6
	High-flow nasal cannula oxygen	12
	Intubation and ventilation	3

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