Peer reviewed article

# Pulse oximetry screening for congenital heart defects in Switzerland: Most but not all maternity units screen their neonates

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## Summary

*Questions:* In Switzerland, the screening of neonates for congenital heart defects (CHD) by using pulse oximetry (PO) on the first day of life was recommended in 2005. We assessed the current practice of Swiss maternity units regarding PO screening to define the actual screening rate in Switzerland and to detect possible difficulties in the implementation of this screening.

*Methods:* This descriptive study was conducted by means of a standardized questionnaire that was sent to all Swiss maternity units.

*Results:* The response rate was 100%. 76% of the units perform regular PO screening and, on the basis of the number of births for 2007, this means that 85% of newborns in Switzerland undergo screening. Although units which do not perform PO screening include every category of maternity unit, the screening is performed to a significantly lower extent in birthing centres than in hospitals ($p$ <0.001). The number of unscreened neonates was 5398 within small units (<1000 births per year) while it was 6137 within large units (>1000 births per year). The main reasons for not performing PO screening are financial factors and the belief that clinical signs are sufficient for the detection of CHD.

*Conclusions:* Greater effort is needed to implement a nationwide PO screening program for CHD. Special attention should be paid to birthing centres given their limited capacity to treat newborns with critical CHD.

*Key words: congenital heart defects; echocardiography; pulse oximetry; screening; neonate; recommendations*

## Introduction

Congenital heart defects (CHD) are the most frequent congenital malformation, with an incidence of 6 to 8 per 1000 live births. Nowadays, even complex CHD can be treated with the appropriate surgical or catheter intervention. Timely recognition is crucial for a good outcome, but can be challenging in neonates because of an initial lack of specific clinical signs. Ductus-dependent CHD, such as hypoplastic left heart syndrome or transposition of the great arteries, may be clinically recognizable only after spontaneous closure of the arterial duct. This is followed by a rapid progression of severe low cardiac output and/or cyanosis and deterioration of the patient. As severe cardiovascular compromise is related significantly to mortality and prolonged ventilation [1], timely detection prior to closure of the duct in this population is important. Patients with right-to-left shunting, which is either intracardiac or at the level of the patent arterial duct, have a decreased postductal oxygen saturation. This can be measured by pulse oximetry (PO) on the patient's feet. PO screening has been shown to be effective in the detection of CHD with a high specificity of over 99% and a sensitivity of 72% to 77% [2–4].

On the basis of this evidence, the Swiss Society of Neonatology and the Swiss Society of Paediatric Cardiology recommended, in 2005, that all neonates born in Switzerland should be screened on their first day of life by using transcutaneous PO on a foot. If the saturation is below 95%, the guidelines outlined in figure 1 should then be fol-

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**List of abbreviations**

| | |
|---|---|
| CHD | congenital heart defects |
| PO | pulse oximetry |

lowed. According to these guidelines, patients satisfying certain criteria should receive an echocardiography exam to find out if they have CHD. The official journal of the Swiss Paediatric Society published these recommendations in 2005 [5], in order to notify as many maternity units as possible. The chairwoman of the Swiss Association of Midwives was also informed of these recommendations.

Different studies have recently defined (or are still investigating) the specificity and sensitivity of this screening in larger populations as well as its cost effectiveness [3, 4, 6, 7]. The intention of this survey was not to demonstrate the effectiveness of PO screening. In contrast, our aim was to evaluate the current acceptance and the practicability of the implementation of PO screening, as judged by the maternity units.

Our hypothesis was that most maternity units in Switzerland followed the recommendations, and that no adaptations to the screening protocol had been made.

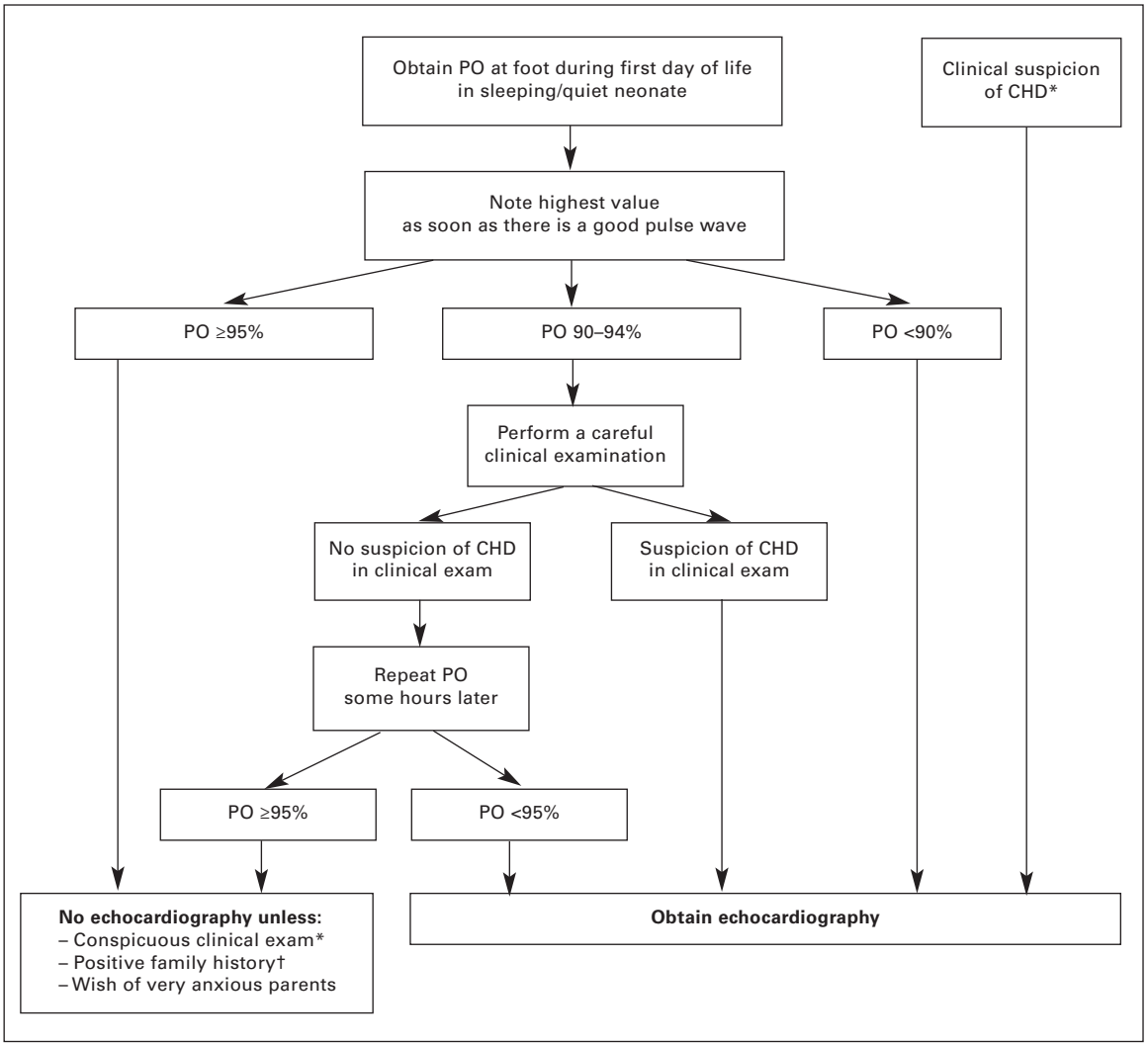


**Figure 1**

Flowchart of the recommendations for pulse oximetry (PO) screening in neonates (adapted from Arlettaz et al. [5]).
* Suspicious cardiac clinical examination; syndrome with dysmorphism or multiple congenital malformations.
† Congenital heart disease in first-degree relative; maternal diabetes; maternal drug or alcohol abuse; confirmed prenatal diagnosis of CHD.

## Methods

### Data acquisition

In summer 2008, a structured questionnaire was sent to all 136 registered maternity units in Switzerland. The head of each maternity unit was asked to answer the following questions:

– In your centre, do you carry out pulse oximetry screening in accordance with the recommendations of the Swiss Society of Neonatology, Paediatrics, and Paediatric Cardiology?
– Did you have to adapt the protocol?

The questionnaire was translated into the three main official languages of Switzerland. If there was no reply after two weeks, a reminder was sent via e-mail, and in the absence of a reaction after four weeks, the centre was contacted by phone, with the questionnaire being sent again, if necessary.

### Data analysis

The results were set against the total number of newborns per centre in 2007. These numbers were obtained from the annual birth-statistics report, based on declarations submitted by the maternity units themselves [8].

In order to assess the influence of the size of the associated paediatric unit on the screening rates, we grouped the maternity units into three categories according to the level of paediatrics training available at this associated centre: (1) maternity units associated with terti-

ary care centres for paediatrics, (2) maternity units with secondary or primary care centres for paediatrics, and (3) maternity units without paediatric units, such as small regional hospitals or private services. The categories were adopted from the official grouping of paediatric units drawn up by the Swiss Medical Association [9].

To compare screening rates with regard to the kind of maternity unit, we categorised the latter as follows: (1) birthing centres ("Geburtshäuser"), (2) private hospitals, and (3) public hospitals.

The screening rates were also compared against the size of the maternity units. For this purpose, we classified the maternity units as follows: (1) very small units with 100 or fewer births per year in 2007, (2) small units with over 100 to 500 births per year, (3) medium-sized units with over 500 to 1000 births per year, and (4) large units with over 1000 births per year.

The allocation of the maternity units to a language region was performed on the basis of the main official language spoken in the locality in question, so as to highlight potential differences between these regions.

The statements given by maternity units for not adopting PO screening were summarised under general headings. When multiple answers were given, all the statements were noted.

The data collected from the units was analysed by means of descriptive statistics. Comparisons were made using the chi-square test. Logistic regression analysis was used to test for possible interactions between different variables. For that purpose we employed the answer to the PO screening question as the dependent variable and the existence of a paediatric unit, the size (over 100 vs 100 or fewer births a year), and the kind of obstetric unit (hospital vs birthing centre) as covariates.

*P*-values <0.05 were considered significant. SPSS version 16.0 for Windows was employed for statistical analysis.

## Results

The response rate to the questionnaire was 100% within 10 weeks.

Of the 136 maternity units approached, 103 (76%) actually perform the screening as recommended. Scaling this figure according to the number of births per maternity unit in 2007 gives the result that 85% of all neonates born in Switzerland are screened.

In maternity units linked to a paediatric unit, the percentage of hospitals performing PO screening is significantly higher than in maternity units without a paediatric unit ($p = 0.019$). There is no significant difference in the screening rates for tertiary and secondary or primary paediatric care centres ($p = 0.061$).

When the maternity units are categorised according to their obstetric facilities, a lower level of screening is found in birthing centres than in obstetric units in hospitals (15% vs 86%, respectively; $p < 0.001$). Private hospitals have the highest rate of regular PO screening of all categories (fig. 2), but the screening rates at private and public hospitals do not differ significantly ($p = 0.125$).

As is shown in figure 3, maternity units with 100 or fewer births a year screen significantly less than maternity units with more than 100 births per year ($p < 0.001$). However, the largest Swiss birth clinic, with nearly 4000 births per year, does not perform the screening – being the only Swiss perinatal centre not to do so. Screening rates in the three categories of centre with over 100 births per year do not differ significantly from each other ($p = 0.169$). If these data are looked at from a more infant-based view, the number of un-

**Figure 2**

Screening rate by category of maternity unit; n = 136 (birthing centre: n = 20; private hospital: n = 24; public hospital: n = 92). Percentage (indexed on the left) of units with regular PO screening (white) and without (grey).

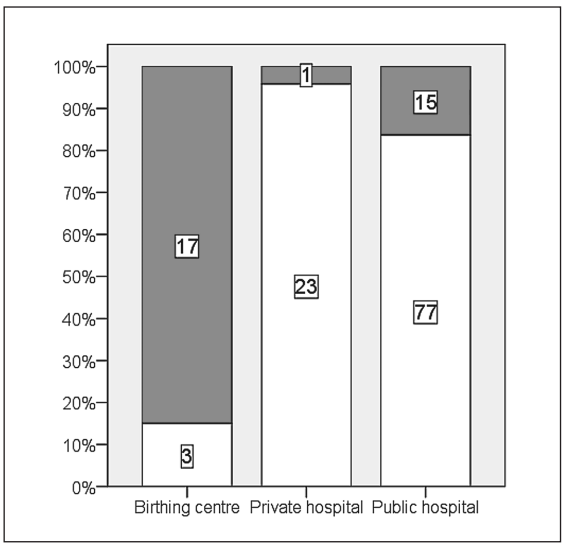


**Figure 3**

Screening rate by size of maternity unit (n = 136). Percentage (indexed on the left) of units with regular PO screening (white) and without (grey). Size is categorised as very small (<=100 births/year; n = 25), small (>100–500 births/year; n = 49), medium-sized (>500–1000 births/year; n = 44), and large (>1000 births/year; n = 18).

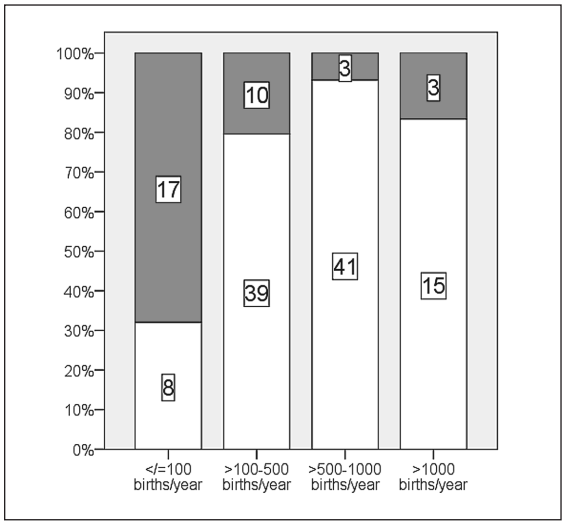

**Table 1**

Reasons for not performing pulse oximetry (PO) screening. Answers given by the 33 out of 136 maternity units who do not perform PO screening. Multiple answers possible.

| Stated reasons | Number of maternity units |
|---|---|
| Financial factors, costs | 14 |
| Clinical presentation is sufficient to detect CHD | 11 |
| No in-house guidelines available | 4 |
| Recommendations are not evidence-based | 2 |
| We will have adopted screening by the end of 2008 | 2 |
| No answer given | 4 |

screened neonates was 5398 for the 30 birth places with less than 1000 births per year while it was 6137 in the 3 birth places with more than 1000 births per year.

With regard to the three language regions, we found that all maternity units in the Italian-speaking (southern) part of Switzerland perform the screening, whereas screening rates in the German-speaking part and the French-speaking part are lower (100%, 77.2% and 64.3%, respectively). These screening rates do not, however, differ significantly from each other ($p = 0.113$).

The category of the maternity unit (i.e., hospital vs birthing centre) was the only independent variable that produced significant results in a univariate analysis, as was shown by a logistic regression analysis of the three subdivisions (i.e., the size of the paediatric unit, and the size and category of maternity unit).

The most commonly given reasons for not carrying out the screening are financial factors and the belief that clinical signs are sufficient for detecting CHD (table 1). A third of maternity units that do not perform the screening (11/33) state that they do not own a pulse oximeter and/or they cannot afford one. All but two of these are birthing centres and are very small (median 20, range 3 to 91 births per year in 2007). All maternity units performing the screening followed the recommendations without any modifications.

## Discussion

This survey is based on a standardised questionnaire and showed an excellent rate of return. It provides a representative overview of the current opinion and practice of all Swiss maternity units with regard to PO screening. The results of this survey provide a sound basis for discussing possible further measures to be taken to promote the spread of PO screening in Switzerland. Furthermore, it has the potential to provide other countries that are planning to implement a screening program with a list of the problems that were encountered in the implementation of the screening program in Switzerland. This should help these other countries anticipate and, therefore, prevent similar problems.

The benefit of PO screening is still a subject of controversy. Sendelbach et al. [6] found no additional benefit of PO screening when prenatal ultrasound, close clinical observation during the first few hours, and physical examination were used. In contrast, de-Wahl Granelli et al. [4] found a higher sensitivity with the combination of examination and oximetry screening than with either of the methods individually. Similar findings have been reported by Meberg et al. [3]. In a national Norwegian study they also found a trend for fewer critical heart defects to be missed and detected after discharge in the population undergoing PO screening [10]. As most maternity units in Switzerland use rooming-in and do not have the space or staff to closely observe all newborns, we strongly believe that neonates born in Switzerland do indeed benefit from PO screening. Increasing numbers of newborns are discharged sooner after delivery and this trend may further increase the benefit of PO screening, as clinical signs of CHD may not yet be present by the time of the physical examination if the arterial duct is still open. The potential detection of patients with very early potentially severe pulmonary disease and infection with subclinical or subtle symptoms is an additional advantage of the screening [3].

The estimated screening rate of 85% of all newborns in our study population is similar to recently published data of 75% to 86% from studies in other countries [3, 7]. The variability of the screening rates in different studies and countries can be explained by the rigidity of the respective recommendations and whether parental consent is required or not. Given that PO screening is recommended by all the sub-specialty societies in Switzerland, and since there is no additional charge for parents, a screening rate in excess of 90% ought to be expected.

A pulse oximeter unit forms part of the standard equipment of all maternity units in Switzerland [11], and an appropriate device can be purchased by any centre at a low cost. In our experience, PO can be used on a sleeping newborn and is not a time-consuming procedure. It will usually take no longer than five minutes to obtain an appropriate reading, and no additional staff are needed [4, 12]. As none of the maternity units made any modifications to the recommended screening procedure, it can be stated that this can be readily integrated in the clinical routine. Some smaller maternity units do not measure the transcutaneous saturation in order to avoid disturbing the neonate and upsetting or worrying the family with unnecessary tests. Although the psychosocial effects of PO screening among parents still have to be explored, the clear benefits of early detec-

tion of a potentially lethal CHD far outweigh any such concerns, so this approach cannot be supported. Furthermore, most of these maternity units are remote from tertiary care centres and do not employ a paediatrician. Neonates born in these places benefit most from the early recognition of critical CHD to ensure that they do not suffer delayed admission to a paediatric clinic.

A majority of patients with relevant CHD will be detected by a careful clinical examination performed within the first few days of life [2, 6]. The timing of the transition from fetal to postnatal circulation is highly variable, and the arterial duct may remain patent for more than 72 hours even in full-term infants [13]. Therefore, as many as 20–25% of newborns with a critical heart malformation may leave the maternity ward without the diagnosis being made [14–16]. This finding illustrates the inadequate sensitivity achieved by just using clinical examination to detect CHD. If CHD is recognised at a later stage, i.e., when a cardiovascular compromise occurs, the outcome following heart surgery has been shown to be worse [1]. PO performed in addition to the clinical examination has been shown to improve the detection rate of critical CHD [3, 4, 12, 17–19], and to detect CHD earlier [10].

Our plan for further improving the screening rate is as follows: maternity units not performing the screening are being approached directly in order to encourage the implementation of PO screening as part of their routine postnatal care. The results of this study have been presented to the chairwoman of the Swiss Association of Midwives and her help has been requested to improve the acceptability of PO in birthing centres. Low-volume maternity units, who stated financial factors as a reason for not screening, are being individually approached, and the possibilities of external funding are being discussed. Maternity units which do not have in-house guidelines are being provided with the relevant documentation and advised of the official recommendations.

The conclusions drawn from this survey are limited by the fact that data were collected retrospectively. The total screening rate of 85% might be slightly overestimated, because some neonates might have escaped from the screening although they were born in maternity units which stated that they perform regular PO screening. We did not assess how PO readings were obtained in the different maternity units nor which training the person performing the screening had obtained. Both these factors have been found to influence the reliability and therefore the sensibility of PO screening [20]. Another effect of the retrospective design is that values of PO results and concomitant diagnoses could not be obtained. Likewise, the number of neonates ineligible for screening, for example in the case of prenatal diagnosis of CHD or if immediate admission to a neonatal intensive care unit had been necessary, is not known either. No conclusion about the screening's impact on the detection rate of CHD can be deduced from the analysed data. However, this was not the aim of this study.

**Conclusion**

Three years after nationwide PO screening was recommended, most Swiss maternity units have implemented this screening in their current management protocol for neonates. The implementation of this protocol has not caused any significant difficulties. The current screening strategy has led to 85% of all neonates born in Switzerland being tested. The negative outlook of maternity units which do not perform the screening is not based on evidence but on structural and financial considerations. Further efforts are needed to convince all maternity units in Switzerland of the need for the screening. Special attention ought to be paid to smaller units and to birthing centres, given their limited range of available equipment and specially trained staff to treat neonates with CHD if needed.

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