Postnatal screening for congenital heart disease:
Clinical findings, Pulsoxymetry, Echocardiography
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Background and Aims
Congenital heart defects (CHD) are the most common congenital malformations. Echocardiography performed by a pediatric cardiologist is regarded as the gold standard, detecting even small cardiovascular defects. The primary objective of newborn screening is the pre-symptomatic identification of life-threatening CHD in order to achieve a timely diagnosis before collapse or death occurs.

Patients and Method
Supported by the government of Hessen, and in written informed consent of the parents, screening echocardiograms (ECHO) were offered for a period of eleven years for all babies who were born between August 1, 2007 and November 30, 2018 at the Marienhospital in Darmstadt (MHD). An experienced pediatric cardiologist performed the echocardiograms using a 10 MHz transducer within the first days (median: 20 hours) of neonatal life. In this study, the results were compared with those obtained from clinical examinations (CLIN) and pulse oximetry (SpO2 under 95%) (OXI).

Results
13830 newborns were examined. In all, 596 cases were diagnosed with CHD (52% male and 48% female neonates). This corresponds to an incidence of 45.7 per 1000 and included 16 critical, life-threatening CHD (1.2 per 1000) (with the necessity of a surgical intervention in the first year of life), 160 hemodynamically significant (12.3 per 1000), 411 minor VSD (31.5 per 1000) and 9 other defects. If only the critical and hemodynamically significant heart defects (176 out of 13096) are taken into consideration, this results in an incidence of 1.35 per 1000. An abnormal heart murmur was able to be heard (by auscultation) in 221 cases, of which 94 had a CHD. Under the prerequisite of a 100% detection of CHD by ECHO, the sensitivity of the test is 15%. With regard to critical CHD, the sensitivity of CLIN was 44%. For 144 neonates, OXI was performed in the 2nd to 3rd hour of life with a SpO2 < 95%. 17 of these neonates had a CHD. In four cases there was a cyanotic heart defect detected. The sensitivity of OXI with regard to all of the diagnosed CHD was only 3% in this study design. In 128 cases the result of OXI was false positive (specificity 99%). With regard to critical CHD, the sensitivity of OXI was 38%. The sensitivity of CLIN and OXI together was 63% (critical CHD). The main advantage of OXI in this study design was the early detection of four class-dependent cyanotic heart failure (Triangular atrial with pulmonary atresia (3), D-TGA (2)). According to the flow-chart an immediate ECHO resulted in a therapy and transportation to a heart centre without delay. On the other hand OXI failed to diagnose two critical coarctations. Regarding the life threatening CHD in neonatal period the sensitivity of OXI was 57%.

Discussion
A finding within normal limits in antenatal tests is the prerequisite for a delivery at MHD. Therefore, it is not surprising that no single case of CHD was diagnosed antenatally in this study design.

The earliest moment for recognizing the hemodynamic impact of a CHD is when the umbilical cord is cut. As a rule, symptoms commence with the closure of the ductus arteriosus in the event of a critical CHD. The ductus arteriosus closes on the day of delivery or on the first day of life for the neonates examined here. In a considerably lower percentage of neonates, the ductus arteriosus was still open on the second, third day of life or later.

The task that pediatric cardiologists will have to resolve in the future comprise of being able to securely rule out CHD, early diagnostic clarification, provision of competent advice to the parents, timely therapy planning and the implementation and complete detection and scientific clarification of cardiologic syndromes. Therefore an ECHO is essential. On the other hand ECHO has been classified as being too cost- and personnel-intensive. Calculating the costs with the data of this study and the medical fee schedule (in Germany GGA): With 700000 babies born every year in Germany CLIN accounts for 15 million Euro per year. OXI will raise the yearly costs by an additional 0.2 million Euro. To avoid missed diagnoses of CHD with ECHO a further 50 million Euro has to be calculated. These costs should be compared to the lifelong additional costs resulting from complications caused by a considerable delay in diagnosis.

Conclusions
This is the first study to prospectively compare the three postnatal screening methods in a large number of consecutive newborns. The advantages and limitations of OXI as an additional screening tool could be demonstrated. ECHO is expensive and personnel-intensive, but the only strategy to rule out missed diagnoses of CHD.

The author declares that he has no conflict of interests.