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Screening for Congenital Critical Heart Disease in Neonates Using Pulse Oximetry, Hospital Femap Ciudad Juarez

Hugo Salvador, Staines Orozco, Rafael Mauricio Marrufo, Edgardo Aarón Briceño Hidalgo, and Victoria Isabel Alcantara Moreno

Objective

The objective is to detect cases of newborns at risk of congenital critical heart disease, through neonatal cardiac screening tests using the instrument called "pulse oximeter" manufactured by Masimo SET.

Abstract

Objective. *The objective of this research was to detect cases of newborns at risk of congenital critical heart disease through neonatal cardiac screening tests using the instrument called "pulse oximeter" manufactured by Masimo SET, as part of the collaboration between the Newborn Foundation, the Autonomous University of Ciudad Juarez and the Autonomous University of Queretaro.* ***Method.*** *A total of 547 newborns were screened from December 2019 to March 2021 at Femap Hospital (Ciudad Juarez, Mexico), following the Newborn Foundation algorithm to detect arterial oxygen saturation (SpO2) in the right hand and foot; a saturation lower than 95% would be an indicator of heart disease risk.* **Results.** *Four risky cases of congenital critical heart disease were detected Using the pulse oximeter, referred to as a gold standard test (echocardiography). After the procedure, one case was confirmed positive by the specialist. With the data obtained, correlations and statistical associations were calculated using variables of SpO2 (dependent), height, weight, and age in hours of the newborn (independent). A positive correlation between hand SpO2 and foot SpO2 values was confirmed. Finally, SpO2 prediction graphs were obtained, where it was observed that the age in hours and the weight of the newborn (independent variables) influence the SpO2 variable, showing these maximum and minimum values.*

"A positive correlation between hand SpO2 and foot SpO2 values was confirmed."

Keywords

Congenital critical heart disease, pulse oximetry, cardiology screening, newborn, Ciudad Juárez, SpO2

Introduction

Congenital heart disease

Congenital critical heart disease (CCHD) is a lesion in the neonatal heart that requires early detection, surgical intervention, or cardiac catheterization within the first year of life for survival.(1,2)

Various types of congenital heart disease are classified as critical. Bruno & Havranek(2) named seven types whose attention is of great importance to reduce mortality: hypoplastic left ventricular syndrome, pulmonary atresia, tetralogy of Fallot, total anomalous pulmonary venous return, transposition of the great vessels, tricuspid atresia and patent ductus arteriosus. According to the authors, the incidence of congenital heart disease worldwide is 8 per 1000 live births in the case of CCHD. A study in Mexico,(3) mentioned that between 15,000 to 18,000 newborns with a cardiac malformation are expected annually, this being estimated according to the incidence shown in other countries.

"Authors say that [congenital] heart defects cause between 6% to 10% of pediatric deaths, representing 20% to 40% of deaths from malformations and 30% of prenatal deaths."

Congenital heart disease represents a significant medical and social problem, as mentioned by Ramirez-Escobar et al. (4); authors say that these heart defects cause between 6% to 10% of pediatric deaths, representing 20% to 40% of deaths from malformations and 30% of prenatal deaths. Extrapolating such data to the adult, Vázquez-Antona et al.(3) mentions that, from a population made up of 3483 adults confirmed with congenital heart disease, 25.6% of them were diagnosed in adulthood, indicating that the most important diseases were atrial septal defect, ventricular septal defect, and patent ductus arteriosus. The foregoing denotes a vital problem of the sub-diagnosis of congenital heart disease.

Screening for congenital heart disease

Screening is the procedure to obtain an early diagnosis, which is applied to the entire population. A screening must meet the criteria of Wilson and Junger to be viable as a public health policy, that is, that there is an effective treatment; that there is a high incidence of the pathology; that there is an adequate cost-benefit ratio and that it is cheap, sensitive and specific.(5)

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The most common malformations are congenital heart disease, with an incidence of 1%, causing a mortality prevalence between 6% to 8% of children under one year of age. Between 2004 and 2011, 1732 children under one year died from congenital heart disease, according to data from the Secretariat of Health in Mexico.(5)

Cardiac screening allows the detection of cardiac malformations without being invasive, giving way to a simple and fast procedure. Del Mar Meseguer & Carvajal Chinchilla6 conducted a prospective study between August 2014 and January 2015 at the Calderon Guardia Hospital in Costa Rica. Researchers performed 899 screenings, resulting in 4 positive cases to which an echocardiogram was performed as a confirmatory test, of which a diagnosis of congenital heart disease was demonstrated in two of the patients previously indicated as positive. Del Mar and Carvajal concluded that early detection of congenital critical disease is vital to avoid possible sequelae and mortality.

In 2011, Secretary's Advisory Committee on Heritable Disorders in Newborns and Children (SACHDNC) recommended screening for heart disease in all newborns to detect structural abnormalities promptly.(4) Previously, Granelli et al. (7) conducted a study in Switzerland where they studied 39,821 newborns, concluding that pulse oximetry is a technique capable of improving the detection rate of congenital critical heart disease of the ductus arteriosus in 92% of the cases and that this procedure is also profitable in the long run. Riede et al. (8) individually conducted a study in Germany, where 41,455 newborns were evaluated. With the use of pulse oximetry, authors reported a sensitivity of 77% and a specificity of 99% for the detection of CCHD, with a positive predictive value of 25.93% and a negative predictive value of 99.9%.

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A pulse oximeter is an instrument used to perform neonatal cardiac screening. Until 2019, Peña-Juarez et al. (9) reported that only two models were approved by the Food and Drugs Administration (FDA): the Masimo SET oximeter ® and the Covidien Nellcor oximeter ®. According to the author, other models, such as ChoiceMMed ® have reported lower sensitivity values than Masimo SET because of his study conducted at the Hospital General de Occidente in Zapopan, Jalisco, Mexico.

It is also mentioned in a study published in Germany that pulse oximetry as screening offers 77.7% of sensitivity and 99.9% of specificity; also, positive and negative predictive values of 25.93% and 99.9%, respectively.(5)

In a study on the effectiveness of screening for CCHD, a congenital heart disease detection rate of 91% was reported, compared to that of 89% when pulse oximetry was not used, but rather physical examination. A sensitivity of 90.9% and 81.8%, and a specificity of 99.9% and 98.2% of pulse oximetry and physical examination, respectively, were determined.(10)

In the study of Valderrama & Hernández (11) , postnatal echocardiography is described as the gold standard, which shows a sensitivity of 100% and a specificity of 89%. This may vary according to the training of health professionals in this area.

Need for the application of screening in Ciudad Juarez.

According to the data collected by the National Institute of Statistics and Geography (INEGI, for its acronym in Spanish), in 2020, 12,020 births were registered in Ciudad Juárez, Mexico, making a total population of 1,512,450 habitants. However, there is no certified data on congenital heart disease's incidence and prevalence rates locally or nationally.(12)

Between April 1992 and April 1999, Muñoz-Orozco13 obtained and identified, from the records of the Hospital General de Zona No. 6 of the (IMSS) of Ciudad Juarez, 102 cases of patients diagnosed with CCHD from 3 days of life until 51 years old. This would imply an incidence of 14 to 15 new CCHD diagnoses per year in this health unit alone.

In a clinic of congenital cardiopathies for children and adults from the IMSS hospitals system in México City, data was obtained from 3,483 confirmed cases of CCHD between the years 2011 and 2016, where 12.3% were patients under two years of age, 22.05% from 2.1 to 6 years, 21.27% from 6.1 to 10 years, 18.20% from 10.1 to 17 years and 25.64% over 17.1 years old. The late diagnosis of CCHD (from 2.1 years old and above) was 3,036 patients. In addition, the incidence of CCHD would be 696 to 697 new diagnoses per year. (14)

According to the demographic analysis of Márquez-González et al. 14, the prevalence of CCHD varies depending on the health center that treats them, as seen with the data collected in Ciudad Juarez, compared to that collected in Mexico City.

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Year	Newborns	Projected CCHD cases
2021	21,710	From 130 to 174
2020	15,421	From 93 to 123
2019	22,149	From 133 to 177

Table 1: Projection of possible cases of newborns with critical congenital heart disease in Ciudad Juarez by year

Source: own elaboration

According to Torres-Cosme et al. (15), between 1998 and 2013 in Mexico, approximately 41,717,421 births were registered, of which 50,759 (2.48%) died from some CCHD.

If the global incidence of CCHD reported by Quiroz et al. (16), which is 6 to 8 cases per 1000 live births, is taken, the cases of CCHD in Ciudad Juarez would range from 92.52 to 177.19 cases per year.

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Extrapolating the incidence values found in the bibliography, with births per year in Ciudad Juarez, it is possible to estimate general CCHD cases; however, Bouma & Mulder (17) refer that congenital heart diseases are the malformations that are most frequently underdiagnosed.

Materials and Method

Bioethical Committee approval

The protocol and execution of this research were approved by both the Bioethical Committee of the Autonomous University of Ciudad Juarez and the Board of Directors of Hospital Femap.

Research characteristics

This is cross-sectional, analytical, and exploratory research. The main unit of analysis is the newborn in apparent good health. Similarly, information is collected from the mother of the newborn. For the mother, the considered variables are sociodemographic (age and address) and clinical (type of delivery, primiparous pregnancy, weeks of gestation). Regarding newborns, the clinical variables are weight, height, sex, hours of life at the time of screening, and arterial oxygen saturation (SpO2) of the right hand and foot. Statistical analysis was done with a confidence interval of 95%.

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Pulse oximeter description

Two Masimo brand pulse oximeters, Model iSpO2 rx ®, were used as instruments to measure the percentage of SpO2, which received the CE mark and are currently available throughout Europe, Latin America, and most Asian Pacific countries. These instruments are certified to detect oxygenation even in the movement of the newborn and low perfusion.

Equipment setup

Setup was made according to the instructions issued by San Román et al. (18) and recommended by Newborn Foundation as described below:

Step 1. Assemble all the equipment: pulse oximeter and reading device.

Step 2. Connect and check the pulse oximeter cables.

Step 3. Place the YI (probes) sensor on the fixation band. The red mark indicates the light emitter. The light emitter and the detector must be placed in their respective gap in the band.

Step 4. Measurement in lower extremities:

On either baby's foot, position both probes opposite each other on the fleshy outer side of the foot.

Ensure no gaps exist between the probes and the baby's skin.

Step 5. SpO2 reading of the baby's foot is recorded when the quality of the reading is strong and stable.

Step 6. Measurement in upper extremities:

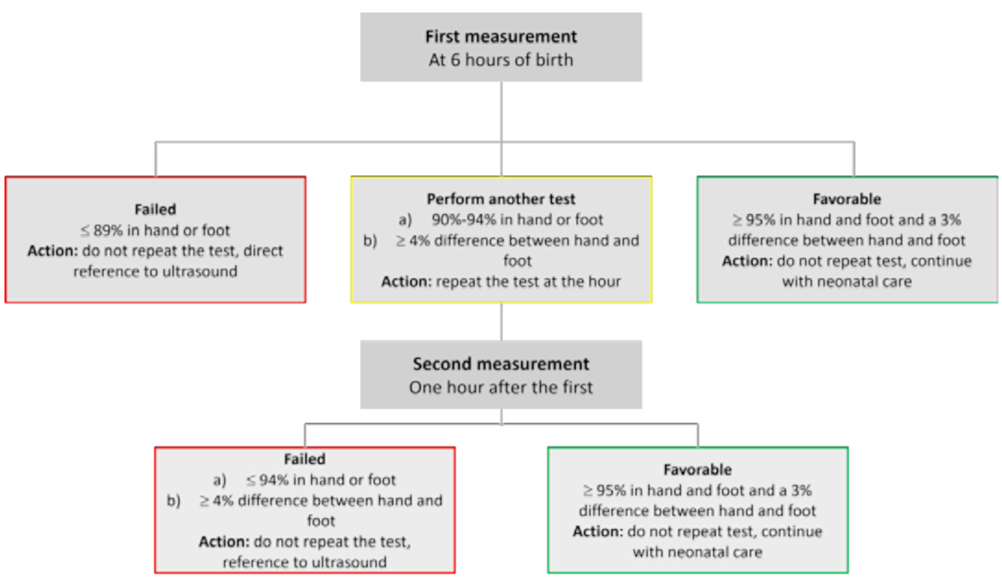

Figure 1: Algorithm description Source: own elaboration based on recommendations of the Newborn Foundation

Place the sensor in the baby's right hand, placing the opposite probes on the outer side of the hand. Make sure there are no gaps between the skin of the baby's hand and the sensors.

Step 7. SpO2 reading from the right hand is recorded when the quality of the reading is strong and stable.

Figure 2. Pulse oximeter Masimo model iSpO2 rx ®

Source: Masimo official website (19)

Interpretation of the readings

A satisfactory screening requires readings greater than or equal to 95% from both the hand and foot, with a difference of no more than 3%. These patients can be discharged home.

Readings in hand or foot indistinctly, between 90% and 94%, or with a difference greater than 3% between the two measurements, are considered failed and require a second one-hour screening from the present measurement. If the second screening yields similar results, it is considered a failure, and the responsible physician must be notified to continue with their evaluation as a risky case of CCHD; the newborn must not go home.

"Any confirmed hand or foot reading less than or equal to 89% indicates a failed screening and requires urgent notification to the treating physician as a risky case of CCHD; the newborn must not be discharged home."

Any confirmed hand or foot reading less than or equal to 89% indicates a failed screening and requires urgent notification to the treating physician as a risky case of CCHD; the newborn must not be discharged home. At the end of the measurement, data must be registered in the appropriate format for collection, which will be emptied into a digital database provided by the researchers.

Bioethical Considerations

When approaching the mother, the procedure and the expected benefit of the cardiac screening test were fully explained to her. Their authorization to carry out the procedure was requested, clarifying that it did not imply any risk to the newborn's health, except for any possible reaction to contact with the device's sensors. Through their signature, the mothers accepted that the procedure would be carried out, that they would be informed about its result, and that the data collected would be private and used for scientific research purposes.

Information analysis

From the sheets filled out by hand in the hospital, an emptying was made to a database in Excel format. Then, the database was exported to Stata 14 software to obtain descriptive and inferential statistics. The sociodemographic variables used were the mother's age and neighborhood of residence. Clinical variables for the mother were weeks of gestation, delivery or cesarean section, and primiparous. Regarding the newborn, clinical variables were hours elapsed since birth, weeks of gestation, SpO_2 values in the first measurement in the right hand and foot and, if required, second measurement of SpO_2 in the hand and right foot; weight (kilograms) and height (centimeters) data were also obtained as clinical variables from the newborn.

Descriptive statistics of the mother's sociodemographic data and the newborn's clinical data were obtained. Risky cases were identified according to the algorithm. Univariate logistic regression tests were performed to estimate the odds ratio of the newborn having heart disease (0= negative, 1=positive) according to the clinical variables. Univariate linear regressions were also performed with newborn pulse oximetry variables, taking SpO_2 values of the hand and foot from the second measurement as dependent variables.

Finally, predictions of SpO_2 values were obtained by using weight (kilograms), height (centimeters) and age (hours) of the newborn as independent variables.

"Based on our cases classified as risky through screening using the pulse oximeter and the algorithm recommended by the Newborn Foundation, the identified cases were referred to the Hospital Poliplaza Médica in Ciudad Juarez with a cardiologist for echocardiography to reveal diagnosis as positive or negative to CCHD."

Ultrasound as gold standard

Based on our cases classified as risky through screening using the pulse oximeter and the algorithm recommended by the Newborn Foundation, the identified cases were referred to the Hospital Poliplaza Médica in Ciudad Juarez with a cardiologist for echocardiography to reveal diagnosis as positive or negative to CCHD. To make it easier for the mother to attend, the cost of the procedure was set as free.

Adjustments implemented in our study due to the COVID-19 pandemic

At the beginning of the research project, the approach of the algorithm established the ability to carry out up to 3 repetitions of the screening test in the newborn. As of March 19, 2020, the arrival of the COVID-19 pandemic was decreed in Ciudad Juarez. The political and health authorities in Mexico decreed social distancing and quarantine policies to reduce the chances of transmission of the SARS-CoV-2 virus. Hospitals around the region also had to follow strict observations to reduce the risk of infections inside for patients and medical, administrative and assistance personnel. As a result of these policies, the length of stay of the mother and the newborn in the hospital was shortened, therefore, our algorithm had to be adapted to a maximum of two repetitions while data collection was done with the corresponding sanitary maneuvers. It was also observed during this period that the rate of births in the hospital decreased.

To adjust for this change, we were summoned by the hospital authorities to an informative workshop on the sanitary measures that would be carried out, such as sanitary control of entry and exit, maximum stay time of the patients and visits. On the other hand, a literature review was made to adapt the algorithm to maximum of two repetitions. (20)

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Results

General descriptive statistics

The average age of the mothers is 22.95 years, the youngest being 14 years and the oldest 43 years. 43% of the women were primiparous. It was also recognized that 33.13% of births by caesarean section. (Table 2)

There was a higher frequency of male births. On average, the newborns had 38.95 weeks of gestation with a minimum of 26 weeks and a maximum of 43 weeks. The average weight of the newborns was 3.193 kg with a minimum of 2.106 kg and a maximum of 4.7 kg. Regarding the size, an average of 51.709 cm with a minimum of 36 cm and a maximum of 60 cm. The screening was carried out at 19 hours after birth on average. (Table 3)

"There was a higher frequency of male births...Newborns generally have an acceptable level of arterial oxygen saturation, however, there were cases with unacceptable minimum values in the hand (74%, first measurement), foot (78%, first measurement), as well as minimum values not acceptable in second measurement."

Newborns generally have an acceptable level of arterial oxygen saturation, however, there were cases with unacceptable minimum values in the hand (74%, first measurement), foot (78%, first measurement), as well as minimum values not acceptable in second measurement. (Table 4)

Variable		Frecuency	Percentage		
Primiparous	Yes	175	43%		
	No	232	57%		
Total		407	100%		
Emergency cesarean	Yes	107	33.13%		
	No	216	66.87%		
Total		323	100%		
Variable	Mean	Standard deviation	Coefficient of variation	Mínimum	Maximum
Age (years)	22.9561	5.541	0.241	14	43

Table 2: Descriptive statistics from mothers (n=547)

Source: own data

Variable		Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Hours from birth to screening		19.119	9.545	0.499	3	60
Weight (kg)		3.193	0.495	0.155	2.106	4.7
Gestation weeks		38.959	1.715	0.044	26	43
Gender	Female	45.5	0.502	0.087	NA	NA
	Male	54.5	0.498	0.913	NA	NA
Height (cm)		51.709	3.507	0.067	36	60

Table 3: Descriptive statistics from newborns (n=547)

Source: own data

Variable	Observations (n)	SpO_2 mean (%)	Standard deviation (%)	Minimum (%)	Maximum (%)
First screening on right hand	544	97.075	2.020	74	100
First screening on right foot	543	97.206	2.001	78	100
Second screening on right hand	43	96.255	1.813	91	100
Second screening on right foot	43	96.511	1.894	89	99

Table 4: Percentage of arterial oxygen saturation (SpO2)

Source: own data

Independent variable	B_o coefficient	B_1 Coefficient	CI 95%		Adjusted R^2	p Value	Significative correlation
			Minimum	Maximum			
First screening on foot	43.766	0.548	0.476	0.620	29.33%	0.00	Yes
Second screening on hand	39.845	0.570	0.157	0.983	13.88%	0.008	Yes
Second screening on foot	58.489	0.375	-0.039	0.790	5.28%	0.075	No

Table 5: Linear regressions of the oxygen saturation values

Source: own data

Variable	Coefficient Bo	Coefficient B₁	IC 95% B₁		Adjusted R^2	p value	Significative correlation
			Min	Max			
Age of the mother (years)	97.434	-0.014	-0.051	0.023	0%	0.45	No
Gestation weeks	96.499	0.018	-0.103	0.141	0%	0.76	No
Weight of newborn (kilograms)	97.241	-0.022	-1.004	0.960	0%	0.96	No

Table 6: Linear regressions of the SpO2 value in the first measurement of the hand (dependent variable) and mother and newborn variables (independent variable)

Source: own data

Regression analysis

Table 5 shows the linear regression analysis between SpO2 values of the hand 1st measurement (dependent variable), 1st SpO2 values of foot (independent) and 2nd SpO2 values of hand and foot (independent).

In the previous analysis, the fact that arterial oxygen saturation values of the second measurement in the newborn's foot do not have a significant correlation with the values of the first measurement in the hand is considered a finding since the rest of the SpO2 values have correlation.

"The regression analysis showed that there is no statistically significant correlation between the SpO2 value and the variables of mother's age, weeks of gestation and newborn weight."

The regression analysis showed that there is no statistically significant correlation between the SpO2 value and the variables of mother's age, weeks of gestation and newborn weight.

Subsequently, SpO2 values from the second measurement were analyzed by using logistic regression to determine odds ratio of a positive result after the first measurement, as shown in the following table. (Table 7)

The odds ratio shows that the chances that the newborn will test positive for heart disease in the second measurement of SpO2 in his foot, after having been identified as positive in the first measurement by pulse oximetry are 27.85 greater than in children that were classified as negative in the first measurement (p=0.00).

"According to that, the possibility that the newborn is classified as risk of heart disease in the second measurement of SpO2 of his hand, are 214 times higher when the first measurement was also positive, compared to newborns that were initially classified as non-risky."

Dependent variable	Categories	n	Xi^2	Odds ratio	IC		P value	Sig
					Min	Max		
Positive on 2nd measurement (foot)	Positive	412	0.00	27.85	9.21	84.19	0.00	Yes
	Negative							
Positive on 2nd measurement (hand)	Positive	413	0.00	214.44	52.62	873.76	0.00	Yes
	Negative							

Table 7: Logistic univariate regression (first screening as independent variable)

Source: own data

According to that, the possibility that the newborn is classified as risk of heart disease in the second measurement of SpO2 of his hand, are 214 times higher when the first measurement was also positive, compared to newborns that were initially classified as non-risky (p=0.00).

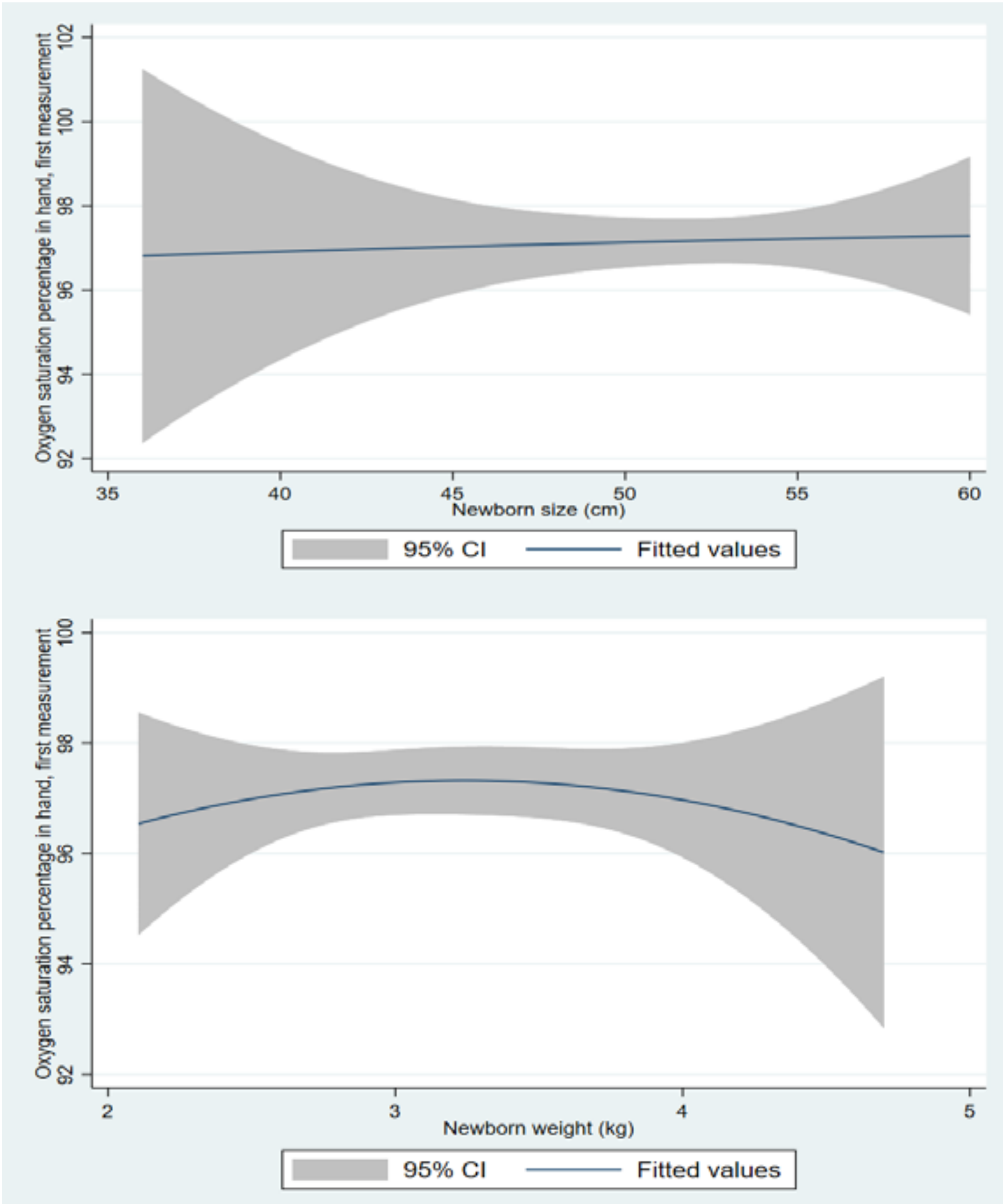
Oxygen arterial saturation predictions at the first measurement in hand

The prediction analysis using graphs was carried out to observe the behavior of the main variable (SpO2) compared to other variables, considering the ranges of acceptability (≥ 95%) and non-acceptability (<95%).

The SpO2 level of the newborn remains almost constant, in the ranges of 96.5% to 97.5% despite the differences in height, where the minimum was 36 cm and the maximum was 60 cm. Therefore, it can be argued through graphic evidence that height does not greatly influence the level of SpO2. (Graph 1)

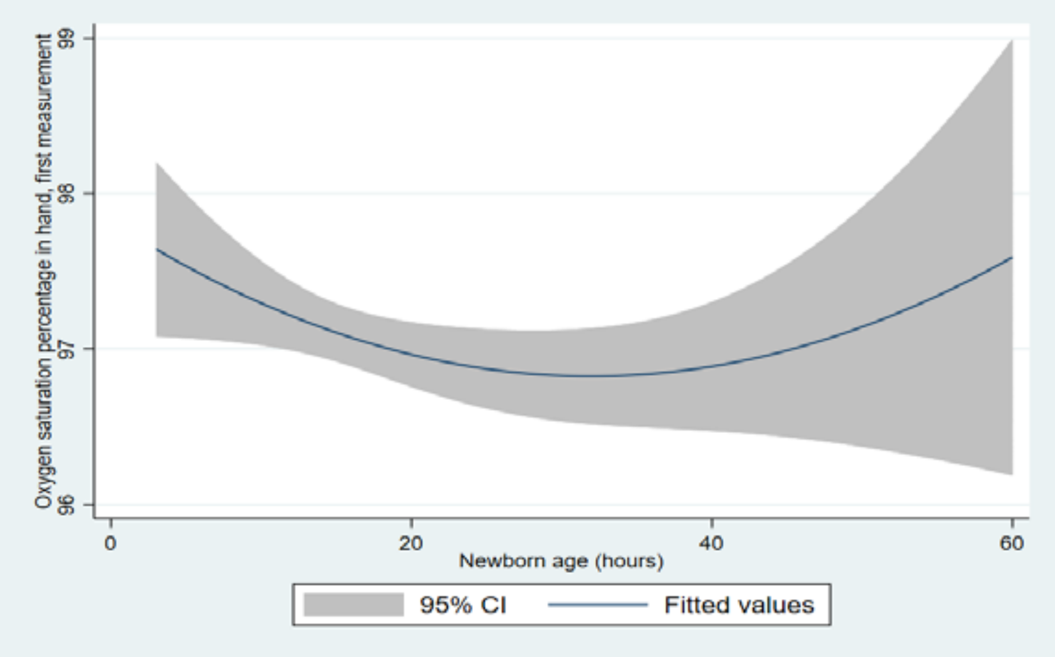
According to the graph, the weight range of newborns if from 2.1 to 4.7 kilograms. Both in the minimum and maximum weight values, the percentage of arterial oxygen saturation trends to decrease, while the maximum values are observed when the weight oscillates between 3 and 3.5 kg. (Graph 2)

The minimum and maximum values in hours of the newborns were 3 and 60 hours. According to the graph, if the screening is done during the first hours, the highest SpO2 values will be obtained; as the hours go by there is the possibility that the saturation percentage decreases, however, after 32 hours it is possible that if the screening is carried out, SpO2 values tend to increase. (Graph 3)



Graph 1 (top): SpO2 percentage according to the height (cm) of the newborn
Graph 2 (bottom): SpO2 percentage according to the weight (kilograms) of the newborn

Sources: own data



Graph 3: SpO2 percentage according to the age in hours of the newborn

Sources: own data

Regressions

Regression graphic shows that while SpO2 values from first screening go up, same happens with SpO2 values during the second screening. (Graph 4)

In this case, while values of SpO2 on first screening in foot have an increment, values of SpO2 on the second screening of hand have a decrement. (Graph 5)

Graphic shows a positive correlation between SpO2 values of hand and foot during their first measurement. It is observed a case of extreme low SpO2 value (74%). (Graph 6)

The first SpO2 measurement in hand has a positive correlation with the values obtained on the second SpO2 measurement in foot. Some values under 95% of saturation are observed, which were remitted to echography. (Graph 7)

Values of SpO2 for first and second measurement have a positive correlation according to fitted line. It is observed one value of SpO2 under 90%, which could be a critical case. (Graph 8)

Discussion

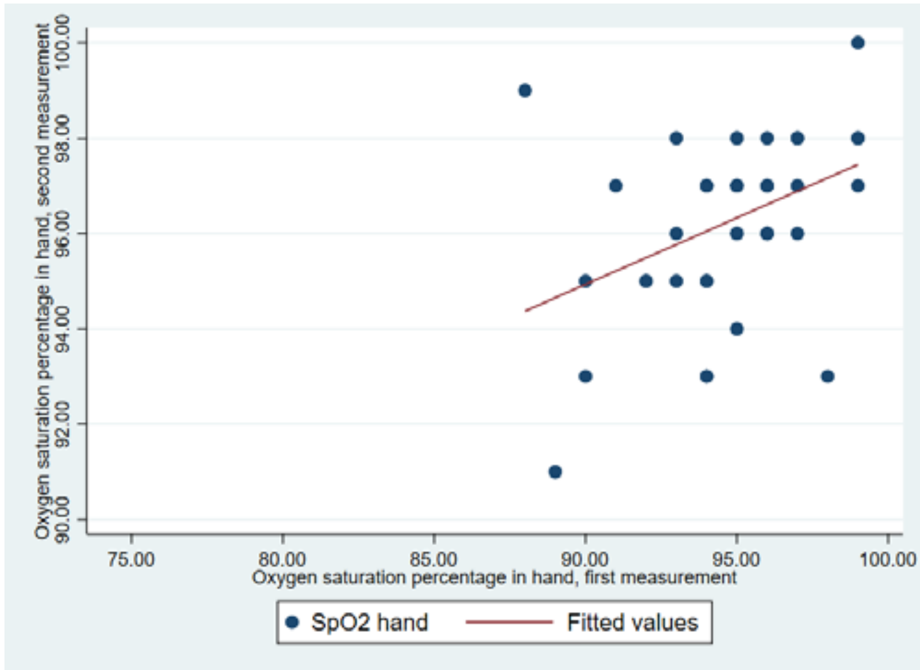
When the Masimo pulse oximeter was used as a cardiac screening instrument, the average time for hand and foot SpO2 measurement was 2.5 minutes. This data complies with one of the indicators of a good screening, that is, speed. The use of the instrument did not represent any economic cost, thus fulfilling another of the requests for screening. (5,21)

Regarding the efficiency of the instrument, it is verified with the gold standard test (echocardiogram). From four cases referred to this test, only two mothers responsibly went to request it; of these two cases, one was positive according to the cardiologist. In this sense, it can be commented that it is favorable for the parents of the newborn that the probability of a positive diagnosis is low, however, in terms of research this indicates that it is necessary to perform more pulse oximetry screening tests and refer suspected and non-suspected cases to echocardiography if sensitivity, specificity, true positive and true negative values are to be estimated, as was done by Thangaratinam et al (22). This task can be completed more quickly as screenings are carried out in hospitals with a higher frequency of births.

Care services provided by the Femap Hospital, although they are private, are inexpensive and are aimed at women who belong to a medium and medium-low socioeconomic level. Their average age was 22.95 years, which is in the age range with the highest frequency of mothers reported by INEGI in 2023 (20 to 24 years; 26.34%) (12). The birth rate in Chihuahua in 2021 was 54.6 per-1,000 women of reproductive age, so the official health services are in constant demand (12). Receiving information about the screening results is beneficial for mothers, and it is also necessary for them to receive guidance to maintain the health of the newborn, or to know procedures for care otherwise (23).

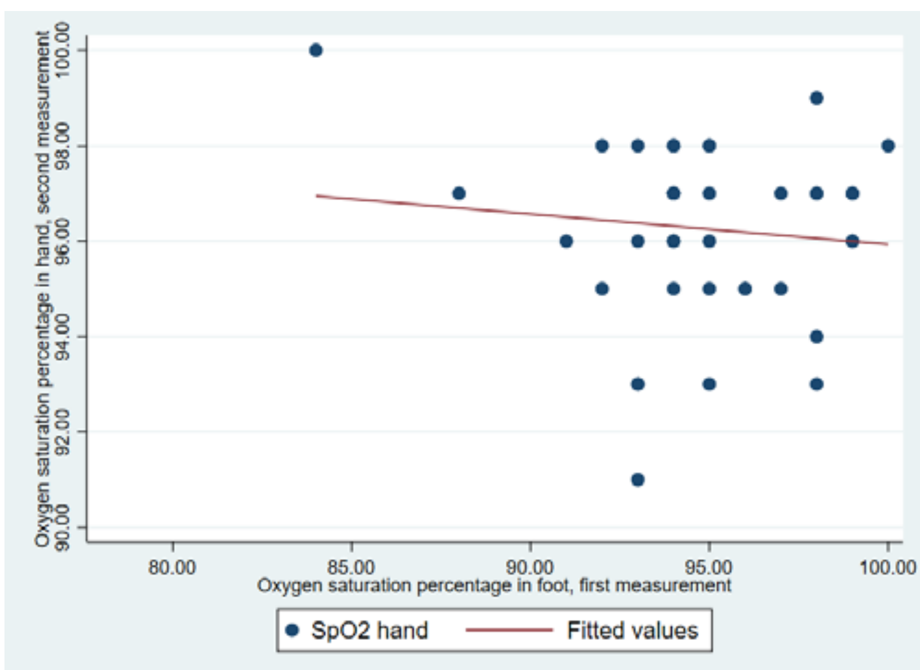
"The results of SpO2 values for foot and hand measurements using the pulse oximeter in the initial screening were satisfactory in the level of oxygenation (SpO2 ≥ 95%) in 504 of the 547 newborns, that is, 92% of the newborns. born was negative for risk of heart disease in the first screening."

The results of SpO2 values for foot and hand measurements using the pulse oximeter in the initial screening showed satisfactory oxygenation (SpO2 ≥ 95%) in 504 of the 547 newborns. That is, 92% of the newborns were negative for risk of heart disease at the first screening.



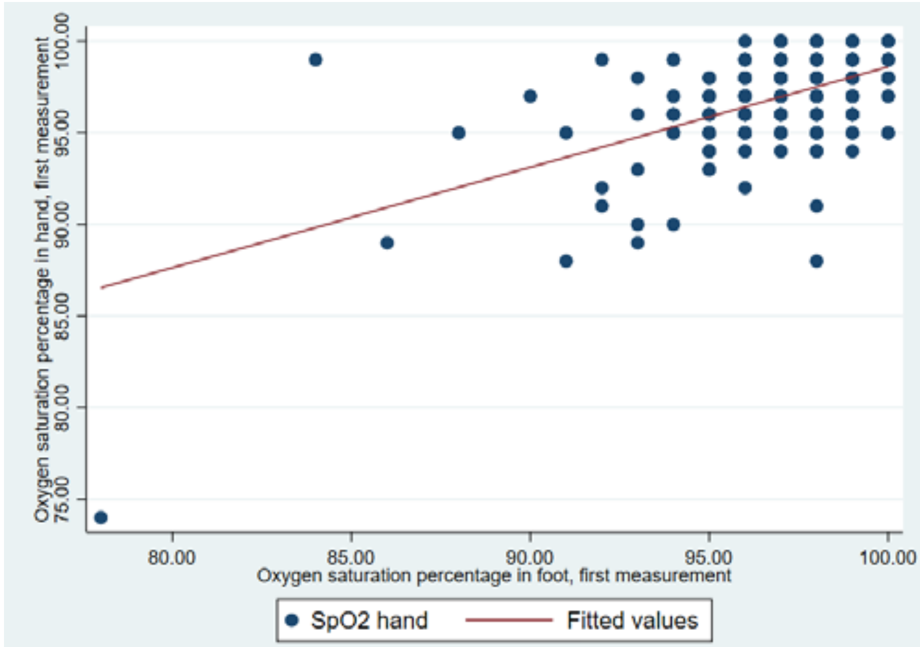
Graph 4: Linear regression of SpO2 hand second measurement (dependent) and SpO2 hand first measurement

Source: own data



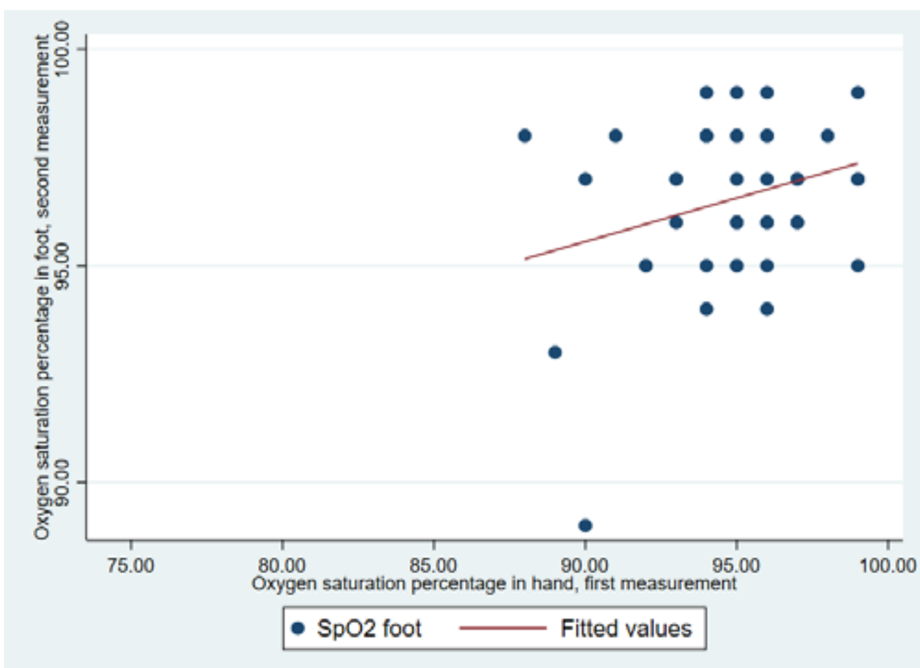
Graph 5: Linear regression of SpO2 hand second measurement (dependent) and SpO2 foot first measurement

Source: own data



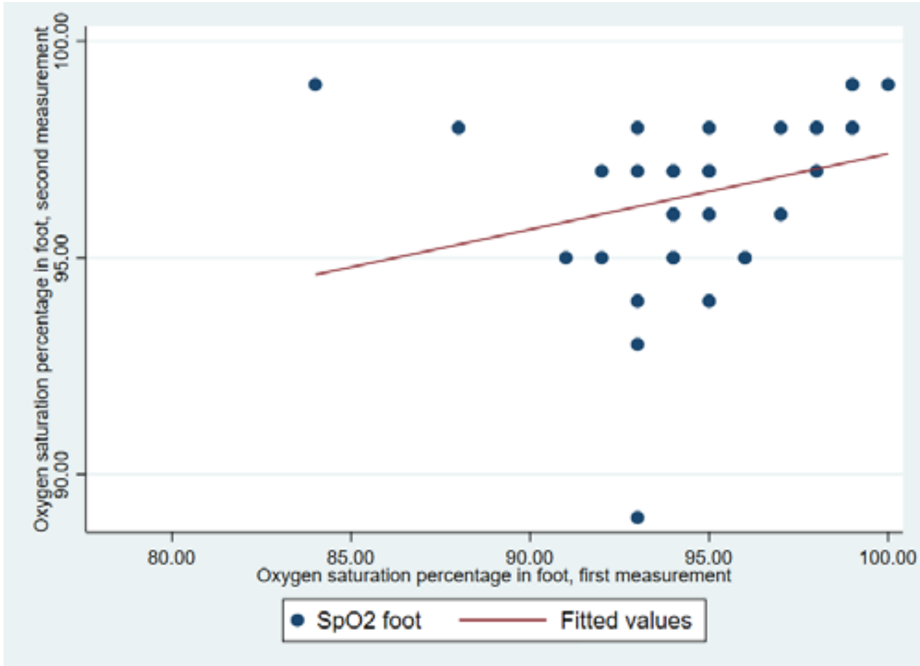
Graph 6: Linear regression of SpO2 hand first measurement (dependent) and SpO2 foot first measurement

Source: own data



Graph 7: Linear regression of SpO2 foot second measurement (dependent) and SpO2 hand first measurement

Source: own data



Graph 8: Linear regression of SpO2 foot second measurement (dependent) and SpO2 foot first measurement

Source: own data

In total, 43 newborns were referred for a second screening, and 4 of them were re-diagnosed as cases of risk for congenital critical heart disease. In this way, 91% of the newborns were discarded after the second screening thanks to the interpretation of data obtained with the pulse oximeter; For their part, San Román et al (18) discarded only 82% of newborns subjected to repeat screening (29/160). Finally, the calculated incidence of risky cases by pulse oximetry was 0.7%, which is close to that estimated by Bruno & Havranek (2), with an incidence of 0.8%, while that estimated by San Román et al (18), without reaching the echocardiography test, was 29/3007, that is, 0.9%. For their part, Del Mar and Carvajal (6) obtained 4 cases from 899 screenings (0.4%).

The results on the correlation between the oxygen saturation variables of hand and foot, confirm the findings of San Román (18), thus, the values detected by the pulse oximeter are consistent. In the case of this research in Femap, it was decided to expand the number of variables including weeks of gestation, weight and height of the newborn. Although the sample is relatively large, there were no approximations to a statistically significant correlation of these variables with those of arterial oxygen saturation. In this regard, Rosvik et al (24) reported a negative correlation also using a pulse oximeter, but with newborns weighing more than 2500 grams. When carrying out this procedure with our data, a negative B coefficient was also found for weight (-0.715), with a p value of 0.09, so the result is reliable at a 90% level, indicating that the lower the weight, the higher SpO2 percentage. In contrast, Laptook et al (25), were interested in SpO2 values in low-birth-weight newborns, recommending that further evaluations be made on saturation limit values, which, from this perspective, implies the need for further studies on the effects of SpO2 values somewhat less than 95%.

Although cardiac screening by pulse oximetry has proven to be effective, fast, and low-cost, it is necessary to multiply the number of hospitals in Mexico where it is routinely practiced, hence the need for hospitals to adhere to the Official Mexican Standard for this proof. If this is achieved, it would be necessary to supply hospitals with equipment and offer thorough training to clinical staff, but also the possibility of access to echocardiography tests would have to be expanded.

"Although cardiac screening by pulse oximetry has proven to be effective, fast, and low-cost, it is necessary to multiply the number of hospitals in Mexico where it is routinely practiced, hence the need for hospitals to adhere to the Official Mexican Standard for this proof."

For the measurement of SpO2 with the pulse oximeter, a condition of rest and tranquility of the newborn is required. It was observed that when the newborn was not calm, the SpO2 values were not quickly displayed on the digital readout, so the mother's collaboration is considered essential.

Finally, for the Health System in Mexico, the task remains of ensuring that hospitals responsibly assume the task of performing cardiac screening, for which they must have the necessary instruments, train the staff and know how to channel risk cases.

Conclusions

Newborn screening tests are a timely way to detect potential health risks. In the case of cardiac screening. An Official Mexican Standard was published for its rutinary implementation, so that health personnel and researchers have worked in a coordinated manner to achieve this in Mexico.

Using the results obtained locally at the Femap hospital in Ciudad Juarez, it can be stated that the pulse oximetry cardiac screening test meets the criteria of efficacy, speed, and low cost, as well as ease of obtaining data to identify risky cases (26). In this sense, the need arises to have more accessibility to gold standard tests when newborns with possible heart disease are detected.

"Using the results obtained locally at the Femap hospital in Ciudad Juarez, it can be stated that the pulse oximetry cardiac screening test meets the criteria of efficacy, speed, and low cost, as well as ease of obtaining data to identify risky cases."

Statistical analyes of data obtained with the pulse oximeter demonstrate the correlation between the main variables of arterial oxygen saturation in the foot and hand. It is possible to add more variables, both clinical and social, to know more about their association and correlation with SpO2 values. In the other hand, hospital authorities acquire the obligation of training their staff and accomplish the task of informing parents, ensuring that importance of screening is understood.

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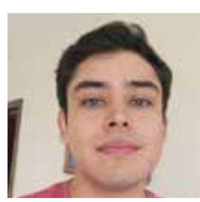

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