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Journal of Physiotherapy and Medical Technology

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The works must be unpublished and refer to topics of surgery, physical exercise, physiotherapeutic treatment, thermotherapy, muscular physiology program, ultrasound, rehabilitation, augmented reality, articulated prosthesis and other topics related to Medicine and Health Sciences.

Presentation of Content

As first article we present, *Heart failure prediction: Exploratory analysis and modeling with XGBoost and deep neural networks*, by GUDIÑO-OCHOA, Alberto, OCHOA-ORNELAS, Raquel, URIBE-TOSCANO, Sofia and CUEVAS-CHÁVEZ, Jorge Ivan, with adscription in the Tecnológico Nacional de México - Instituto Tecnológico de Ciudad Guzmán and Universidad de Guadalajara, as second article we present, *Artificial intelligence in the prevention of respiratory distress syndrome*, by PÉREZ-ESCAMILLA, Javier, MENDOZA-GUZMÁN, Lorena, CRUZ-GUERRERO, René and PÉREZ-BATISTA, Mario, with adscription in the Tecnológico Nacional de México / ITS del Occidente del Estado de Hidalgo and Tecnológico Nacional de México / ITS del Oriente del Estado de Hidalgo, as third article we present, *Biomarkers and genetic polymorphisms present in sudden cardiac death,* by GONZÁLEZ-GARCÍA, Arcelia, GONZÁLEZ-MARTÍNEZ, Lilia and ÁLVAREZ-GONZÁLEZ, Patricia Montserrath, with secondment at the Universidad Autónoma de Zacatecas, as last article we present, *Minimal dental intervention in children with cerebral palsy (Case Report)*, by MARTÍNEZ ORTIZ Rosa María, GARCÍA GONZÁLES Arcelia, RAMOS-GONZÁLEZ Elsy Janeth and HERNANDEZ-SALAS Claudia, on secondment at the Universidad Autónoma de Zacatecas.

Content

Article **Journal of Physiotherapy and Medical Technology**
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Heart failure prediction: Exploratory analysis and modeling with XGBoost and deep neural networks

Predicción de enfermedades cardíacas: análisis exploratorio y modelado con XGBoost y redes neuronales profundas

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Abstract

Heart failure, a leading cause of global mortality, affects over 26 million individuals, contributing to approximately 17.9 million deaths annually representing 31% of all causes of death, as reported by the WHO. Early anticipation of this condition is paramount. Automated algorithms for early prediction of heart diseases, including machine learning models deployed in medical applications, have been extensively explored. This study scrutinizes data from 918 patients, some with a history of heart failure, drawn from diverse locations, encompassing Cleveland, Hungary, Switzerland, and Long Beach VA. The investigation centers on assessing predictive capability using XGBoost and deep neural networks in a sequential model. Results unveil promising precision—up to 88.04% and 88.58%, respectively—in forecasting future instances of heart diseases. Emphasizing the efficacy of these models, their potential as a valuable tool for medical professionals enabling early detection of this critical ailment is underscored. These findings underscore the significance of early prevention of heart diseases, potentially enhancing global health through advanced artificial intelligence techniques.

XGBoost, Heart disease prediction, Deep neural network

Resumen

La insuficiencia cardíaca, una de las principales causas de muerte a nivel mundial, afecta a más de 26 millones de personas y contribuye a aproximadamente 17.9 millones de fallecimientos anuales, representando el 31% de todas las causas de muerte según la OMS. La anticipación temprana de esta condición es vital. Se han explorado algoritmos automatizados para la predicción temprana de enfermedades cardíacas, incluyendo modelos de aprendizaje automático implementados en aplicaciones médicas. Este estudio analiza datos de 918 pacientes, algunos con historial de insuficiencia cardíaca, provenientes de observaciones en diferentes localidades, incluyendo Cleveland, Hungría, Suiza y Long Beach VA. La investigación se enfoca en evaluar la capacidad predictiva mediante el uso de XGBoost y redes neuronales profundas en un modelo secuencial. Los resultados revelan una precisión prometedora: hasta un 88.04% y 88.58%, respectivamente, en la predicción de futuros casos de enfermedades cardíacas. Destacando la efectividad de estos modelos, se plantea su potencial como herramienta valiosa para los profesionales médicos, permitiendo la detección precoz de esta enfermedad crítica. Estos hallazgos resaltan la importancia de la prevención temprana de enfermedades cardíacas para mejorar significativamente la salud a nivel global a tráves de técnicas avanzadas de inteligencia artificial.

XGBoost, Predicción de enfermedad cardiaca, Red neuronal profunda

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Introduction

In the expansive realm of medical data and the burgeoning field of data science and analysis, innovative efforts by startups have undertaken the formidable task of creating predictive markers for impending diseases (Leung et al., 2020). Among these conditions, cardiovascular diseases (CVDs) stand out, claiming a staggering 17.9 million lives annually, representing a significant 31% of global mortality (Levy et al., 2017). Within this landscape, heart failure emerges as a prevalent consequence of CVDs (Reddy et al., 2021).

Individuals grappling with cardiovascular ailments or teetering on the edge of escalated cardiovascular risk, often linked to factors like hypertension, diabetes, hyperlipidemia, or existing medical conditions, require early identification and adept management (Kullo et al., 2010). Herein lies the potential of machine learning models to offer their guidance (Louridi et al., 2021). This technological synergy not only seeks to automate a natural conundrum but also to illuminate forthcoming challenges, all driven by the formidable capacities of artificial intelligence techniques (Lv et al., 2021; Chang et al., 2022).

Previous research showcases the integration of machine learning models with medical information systems to predict heart failure or other diseases using patient-collected data. Effective models based on decision trees, Naive Bayes, Random Forest, logistic regression, and Support Vector Machines (SVM) have achieved a maximum accuracy of 88% (Alotaibi, 2019; Mansur Huang et al., 2021; Kedia et al., 2022). Data normalization and preprocessing are pivotal for enhancing model accuracy (Wang, 2021). Hyperparameter optimization techniques such as TPOT and Random Forest have achieved the highest accuracy of 97.52% (Valarmathi et al., 2021). The application of deep neural networks, such as Recurrent Neural Networks (RNN), has been instrumental in predicting the risk and onset of heart failure, achieving an 82% accuracy, demonstrating their efficacy in predictive modeling using electronic medical records (Rasmy et al., 2018). Even models based on Multilayer Perceptron have reached an 88% accuracy (Awan et al., 2019; Lee et al., 2020).

People with cardiovascular diseases or those at high cardiovascular risk (due to factors such as hypertension, diabetes, hyperlipidemia, or existing diseases) require early detection and management, wherein machine learning models play a crucial role. Moreover, with environmental deterioration, these factors may lead to an increase in heart failure cases in the future. Neglecting the issue of heart failure could inevitably result in fatalities (Kim et al., 2021).

Four out of 5 CVD-related deaths emanate from heart attacks and strokes, with a third occurring prematurely among individuals under 70 years (Jagannathan et al., 2019). Heart failure, often an outcome of CVDs, serves as a focal point, addressed through a dataset encompassing 11 features pivotal in predicting cardiac diseases. For the current study, a dataset amalgamating five previously independent datasets: Cleveland (303 observations), Hungarian (294 observations), Swiss (123 observations), Long Beach VA (200 observations), and Stalog (270 observations), aggregated to a total of 1190 observations, identified 272 instances of duplications, culminating in a refined set of 918 observations.

This comprehensive dataset, available on Kaggle (fedesoriano, 2021), stands as the most extensive compilation in cardiovascular disease research to date. Table 1 presents a description of the pathological information collected. Among the most notable data from studies with a similar focus are 5 risk factors (body mass index, systolic blood pressure, high-density lipoprotein cholesterol, current smoking, and diabetes) and the incidence of cardiovascular diseases and death from any cause through Cox regression analysis (Global Cardiovascular Risk Consortium, 2023).; this study contemplates three of these primary factors.

This research's focus lies in implementing an Exploratory Data Analysis (EDA) to comprehend the dataset, preprocessing pathological information through standardization, and proceeding with the implementation of advanced machine learning techniques via XGBoost. The optimization of hyperparameters using the GridSearch method will be followed by evaluating prediction metrics with patients' pathological information, presenting an acceptable model for the future prediction of patients who might develop early-stage cardiac diseases.

Additionally, a comparison and evaluation of a Deep Neural Network (DNN) optimized to ascertain its accuracy in future classifications will provide valuable insights into AI-based predictive models for medical diagnoses.

Parameter	Description	Type
Age	Years	Patient`s age
Sex	patient's sex	M: Male, F: Female
Chest Pain Type	type of chest pain	TA: Typical Angina, ATA: Atypical Angina, NAP: Non-Anginal Pain, ASY: Asymptomatic
Resting Blood Pressure	resting blood pressure	mmHg
Cholesterol	serum cholesterol	mm/dl
Fasting Blood Sugar	fasting blood sugar level	1: if Fasting Blood Sugar > 120 mg/dl, 0: otherwise
Resting ECG	resting electrocardiogram results	Normal: Normal, ST: ST-T wave abnormality (T wave inversions and/or ST elevation or depression > 0.05 mV), LVH: probable or definite left ventricular hypertrophy by Estes' criteria
Maximum Heart Rate	maximum heart rate achieved	Numeric value between 60 and 202
Exercise-Induced Angina	exercise-induced angina	Y: Yes, N: No
Oldpeak	oldpeak = ST	Numeric value measured in depression
ST Slope	the slope of the peak exercise ST segment	Up: upsloping, Flat: flat, down: downsloping
Heart Disease	output class	1: heart disease, 0: Normal

Table 1 Information and description of the dataset.

XGBoost in Predictions of Cardiac Diseases

XGBoost, a machine learning technique, harnesses the ensemble method to merge multiple weak decision tree models, crafting a more robust and accurate model. Grounded in decision trees, known for their shallow depth and slightly superior performance to random predictions, XGBoost employs boosting to sequentially train trees, each rectifying the errors of the previous model (Chen et al., 2015).

Optimization in XGBoost revolves around an objective function balancing model loss and complexity. This technique utilizes a loss function to evaluate prediction accuracy, offering advantages like high performance, computational efficiency, and control over overfitting through regularization (Nielsen et al., 2016). For log-loss classification, the objective function is expressed by equation (1), where various parameters assess model predictions and regularization hyperparameters (Nielsen et al., 2016).

$$\text{Classificaction} = \sum_{\text{i}=1}^{\text{n}} (y_i \log(p_i) + (1 - y_i) \log(1 - p_i)) + \gamma\text{T} + \frac{1}{2}\lambda \sum_{j=1}^{T} \omega_j^2 \quad (1)$$

where: y_i represents the actual labels, p_i or y_i denote the model predictions, T stands for the number of tree leaves, ω_j^2 signifies the square of the weight assigned to each tree leaf, and λ as well as γ represent regularization hyperparameters.

In the classification of cardiac diseases, XGBoost has exhibited high performance in various scoring metrics using logistic regression (Nalluri et al., 2020). With optimized hyperparameters using OPTUNA, it achieved accuracies of 94.7%, 89.3%, and 88.5% in classifying distinct cardiac disease datasets (Srinivas et al., 2022). Additionally, Bayesian optimization combined with encoding techniques reached 91.8% accuracy in predicting heart disease in clinical settings (Budholiya et al., 2022). Utilizing feature selection via information gain and a hybrid Smote-Enn algorithm for imbalanced datasets in cardiac disease prediction attained 93.44% accuracy with XGBoost (Yang et al., 2022). Moreover, this model has demonstrated reliability in assessing cardiovascular disease risk in patients with type 2 diabetes mellitus (Athanasiou et al., 2020).

Deep Neural Networks (DNNs)

Deep or Dense Neural Networks (DNNs) consist of interconnected layers, where each neuron in one layer connects to all neurons in the subsequent layer, creating a densely connected network. Apart from input and output layers, hidden layers perform data transformation operations; activation functions are derived from neurons in a hidden layer by considering weighted inputs from neurons in preceding layers (Nazari et al., 2021).

Common examples of activation functions include Rectified Linear Unit (ReLU), sigmoid, hyperbolic tangent, among others (Ding et al., 2018). This algorithm is considered a deep and automatic learning method, adjusting neuron connection weights and biases during training by minimizing loss functions. Regularization techniques like Dropout, L1, L2 are employed in DNNs to prevent overfitting and enhance generalization (Cogswell et al., 2015). The key formula is presented in the following equation (2).

$$\text{Output} = \sigma\left(\sum_{i=1}^{n} \omega_i \cdot x_i + b\right) \quad (2)$$

where: x_i represents inputs, ω_i denotes the weights associated with each input, b stands for bias, and σ represents the activation function. DNNs possess the capability to learn intricate relationships within nonlinear data and automatically extract features (Zeng et al., 2014). Achieving up to 90% accuracy in predicting cardiac diseases has been accomplished using an enhanced Sparse Autoencoder (SAE) integrated with neural networks (Mienye et al., 2020). Assessment of metrics across epochs during DNN training has demonstrated a classification accuracy ranging between 80-90% (Ramprakash et al., 2020).

Exploratory Data Analysis (EDA)

During the phase of understanding the dataset, an Exploratory Data Analysis (EDA) was performed using Python-based tools. This aimed to uncover trends, relationships, and distributions within the data through statistical methods. Specifically, it delved into patient information, distinguishing between individuals with cardiac ailments and those deemed healthy. Additionally, it sought to offer a medical perspective by examining pertinent characteristics within patients' pathological data, such as clinical studies, age, and gender.

Among the 918 patients in the dataset, 508 were diagnosed with heart failure, while 410 did not exhibit such conditions. Figure 1 depicts bar graphs showcasing a nearly balanced distribution between healthy patients and those affected by cardiac disease. The median age of patients diagnosed with heart disease was 57, whereas individuals without heart disease showed a slightly younger median age of 51.

Previous similar clinical analyses found a comparable average age of 54.4 years (Global Cardiovascular Risk Consortium, 2023). The breakdown is nearly 90.2% male patients and 9.8% female patients in the dataset. Figure 2 showcases the prevalence of cardiac disease among these genders. Remarkably, among the 725 male patients, 63.2% have been diagnosed with cardiac disease. In contrast, among females, the diagnosis reveals that one in every four females has been diagnosed with a cardiac condition.

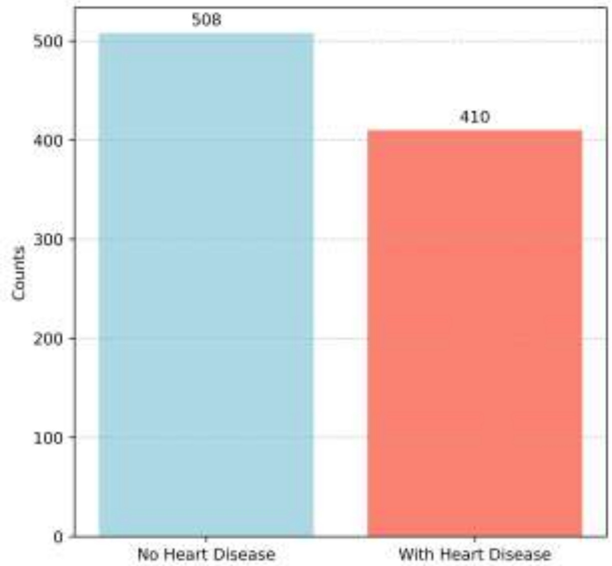

Figure 1 Total number of healthy patients and patients with heart disease.

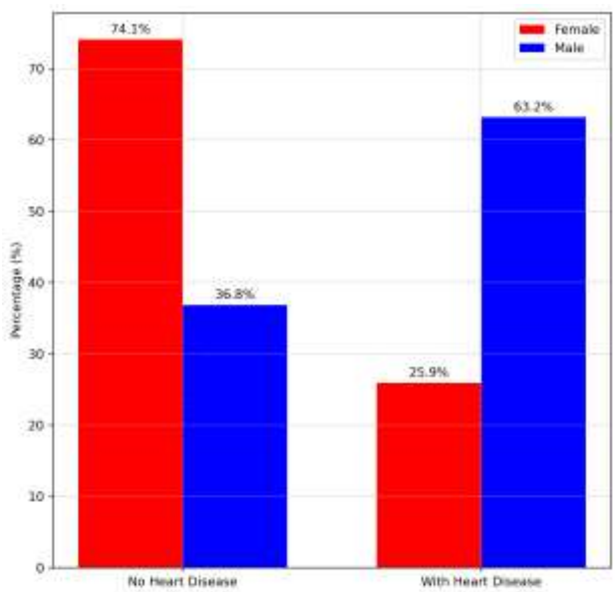

Figure 2 Percentage of patients and prevalence of heart disease among men and women.

Figure 3 displays boxplots depicting distinct age distributions among patients with and without heart disease.

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Among those diagnosed with heart disease, the boxplot indicates a narrower age range, mainly spanning from 51 to 62 years, with most patients falling within this interval. Notably, there are a few younger outliers below the lower whisker in this group. In contrast, patients without heart disease show a slightly broader age spectrum, evenly distributed without outliers. Many individuals in this category fall within the age range of 43 to 57 years, representing a relatively younger population.

Additionally, within Figure 3, the boxplots for Systolic Blood Pressure exhibit similar distributions between the groups. Both sets show upper and lower outliers, with most patients' blood pressure ranging from 120 to 145 mmHg. The median blood pressure remains consistent at approximately 130 mmHg for both patient cohorts. These data reveal the relationship highlighted in previous medical studies, linking severe increases in blood pressure directly to higher risks of developing heart failure.

The progression from hypertension to heart failure is complex and multifaceted. Therefore, while it elevates the risk of heart failure, not everyone with hypertension develops it. It would be challenging to determine heart failure solely based on hypertension, but it significantly increases the risk (Di Palo et al., 2020).

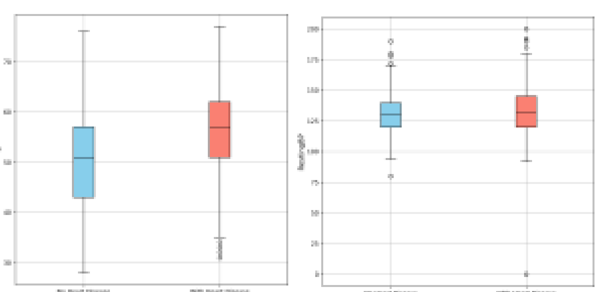

Figure 3 Boxplots depicting age distributions (left) and Systolic Blood Pressure (right).

In Figure 4, the distribution of cholesterol levels appears right-skewed, particularly within patients with cardiac conditions where numerous observations show missing cholesterol levels, marked as 0. On the other hand, among healthy patients, a median of 225 is evident within a range spanning approximately 200 to 275, displaying several outliers, as depicted in the boxplots.

However, it is well-established that lower levels of cholesterol could be detrimental to patients with Heart Failure. This could happen due to treatment for hypercholesterolemia with statins, which might pose risks for Heart Failure patients as they decrease Coenzyme Q10 concentrations. This concentration is vital in the respiratory reactions of cardiac myofibrils and mitochondria. Hence, it's not uncommon to find atypical or very low cholesterol levels in patients with heart failure (Charach et al., 2023).

Also, within the same Figure, it's noticeable that patients without heart disease exhibit the potential for higher maximum heart rates compared to patients with heart disease. The median heart rate among patients without heart disease stands at 150 beats per minute, contrasting with a median of 126 beats per minute among those with heart disease. Hypercholesterolemia is the primary risk factor leading to ischemic heart disease (a significant cause of heart failure). Chronotropic incompetence, a phenomenon common in heart failure with preserved ejection fraction (HFpEF), is linked to impaired aerobic capacity. Consequently, patients with heart failure struggle to achieve a higher maximum heart rate (Sarma et al., 2020).

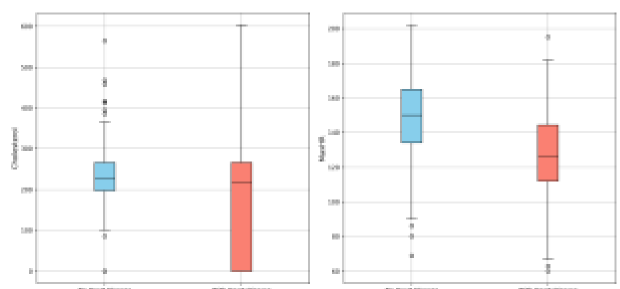

Figure 4 Boxplots illustrating cholesterol distribution (left) and maximum heart rate achieved (right).

In Figure 5, the boxplots distinctly illustrate the disparity in ST segment depression distribution between the two patient cohorts. Among those diagnosed with heart disease, there's a noticeably wider variability in ST depression, with several markedly larger outliers. Most patients in this category exhibit ST depressions ranging from 0 to 2 mm, centered around a median value of 1.2 mm.

Clinical investigations have demonstrated the association of ST segment depression in the initial ECG during atrial fibrillation with clinical outcomes.

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The primary endpoint was heart failure: cardiac death or hospitalization due to heart failure. The prevalence of ST segment depression was 25.4%; the incidence rate of the composite endpoint of heart failure was significantly higher in patients with ST segment depression compared to those without (5.3% vs. 3.6% per patient-year, logarithmic range P < 0.01). Additionally, ST segment depression was an independent predictor for the composite endpoint of heart failure (hazard ratio 1.23, 95% confidence interval: 1.03–1.49, P = 0.03) (Kawaji et al., 2023).

The patients within the heart disease subset of the Kaggle dataset seem to fall within this range, suggesting a potential clinical relevance like the relationship between ST segment depression and heart failure outcomes.

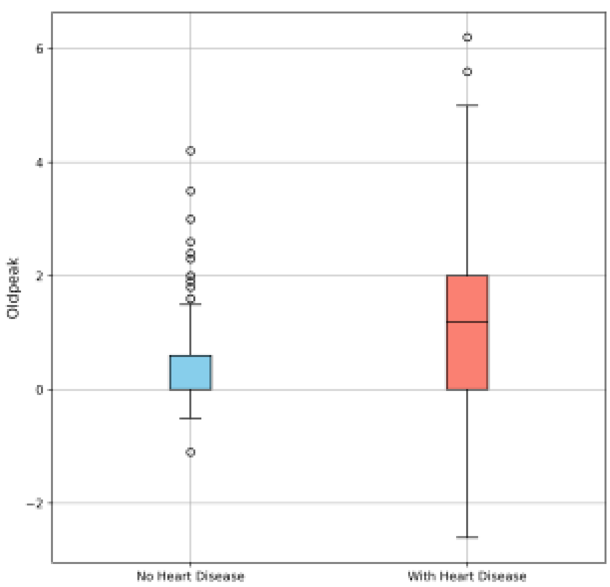

Figure 5 Boxplots illustrating oldpeak ST among individuals with and without heart disease.

Conversely, among patients without heart disease, the range of ST depression is comparatively narrower, spanning from 0 to 0.6 mm, with a median ST depression value of 0 mm. However, it's important to note that the distribution in this group displays a higher degree of skewness overall.

In Figure 6, it's evident that among patients diagnosed with diabetes, approximately 80% exhibit concurrent heart disease. This observation is grounded in the inherent relationship between heart failure and diabetes mellitus, representing substantial morbidity and mortality worldwide.

Furthermore, these chronic conditions can coexist and influence each other: among diabetic adults (> 64 years), a reported prevalence of heart failure stands at 22%. Patients with heart failure carry an increased risk of developing diabetes mellitus, and conversely, patients with diabetes mellitus have a higher likelihood of developing heart failure (Kallas et al., 2023).

Additionally, the graphic on the left side illustrates a notably heightened prevalence of heart disease, exceeding 85%, among patients experiencing exercise-induced angina. However, exercise-induced vasospastic angina represents a relatively uncommon clinical scenario characterized by the onset of chest symptoms during exertion due to coronary vasospasm. Unless a positive provocation test is achieved, diagnosing this can be challenging, potentially resulting in adverse cardiac events, including myocardial infarction, ventricular arrhythmia, and sudden cardiac arrest. A definitive diagnosis of vasospastic angina often poses a challenge because these spasms tend to be transient, and many coronary spasm events are asymptomatic (Tamura et al., 2018).

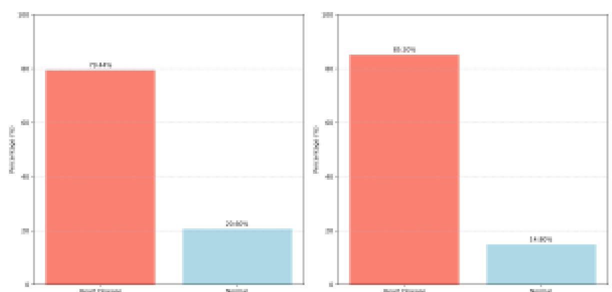

Figure 6 Prevalence depicted as percentages of patients with heart disease and healthy individuals among those with diabetes (left) and exercise-induced angina (right).

Exploring the categories of characteristics reveals a variability in the types of resting electrocardiogram results, as depicted in Figure 7. The distribution is as follows: 552 patients with normal ECG, accounting for 56.1% of the sample; 178 patients exhibiting ST-T wave abnormalities, representing 23%; and 188 patients showing probable or definite left ventricular hypertrophy according to Estes' criteria, making up 20.9% of the dataset.

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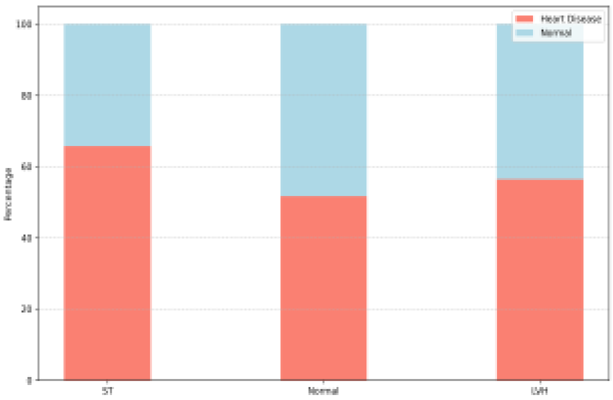

Figure 7 Prevalence of heart disease categorized by resting ECG.

Analyzing the resting ECG test outcomes reveals that over 65% of patients diagnosed with heart disease exhibit ST-T wave abnormalities in their ECG readings, marking the highest proportion among the different groups.

Studies focusing on resting electrocardiographic results have shown similarities in ST-T wave abnormalities and probable or definite left ventricular hypertrophy according to the Romhilt-Estes criteria (Aghamohammadi et al., 2019).

Three-quarters (75%) of the dataset, totaling 460 patients, exhibit a flat slope of the peak exercise ST segment. Additionally, 395 patients (15.4%) showcase an upward ST segment slope, while 63 patients (2.6%) display a downward ST segment slope. Remarkably, patients with a flat or downward ST segment slope during exercise present the highest prevalence of cardiovascular disease at 82.8% and 77.8%, respectively, as shown in Figure 8 (Aghamohammadi et al., 2019).

This relationship is similar to the findings where patients with ST segment depression were older and had more comorbidities than those without. The higher risk was observed in the horizontal or downward ST segment depression, but not in the upward depression. Moreover, among 40 patients exhibiting this pattern, 19 are at risk of a heart attack, with 3 of these 19 patients being women and 16 men. Out of these, 16 patients experience level 4 chest pain (Asymptomatic), 2 of whom have atypical angina, and only one has typical angina. Hence, it's notable that asymptomatic chest pain is also more prevalent in this research.

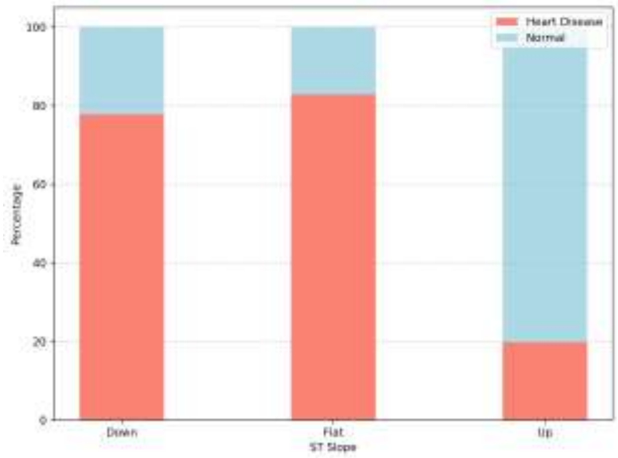

Figure 8 Prevalence of heart disease categorized by ST Slope.

The predominant type of chest pain noted is asymptomatic, observed in a total of 496 patients, constituting 77.2% of cases. Following this, non-anginal pain is reported in 203 patients, accounting for 14.2%, with atypical angina observed in 173 patients, representing 4.7% of the cohort. Lastly, 46 patients present with typical angina, comprising 3.9% of the dataset.

Figure 9 demonstrates that among individuals diagnosed with heart disease, asymptomatic chest pain prevails, exceeding 77%. Additionally, the incidence of heart disease is notably higher in men compared to women, occurring at a ratio of nearly 9 to 1 among patients diagnosed with cardiovascular conditions.

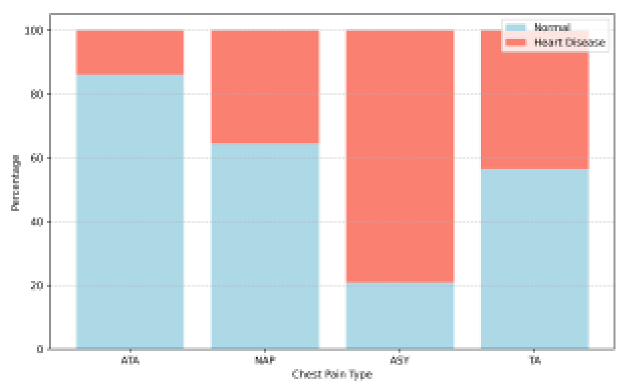

Figure 9 Prevalence of chest pain among individuals diagnosed with heart disease and those without heart issues.

Figure 10 illustrates the correlations and scatterplots, revealing significant associations within the dataset. Heart disease exhibits the strongest positive correlation with OldPeak (correlation = 0.4) and the most robust negative correlation with MaxHR (correlation = -0.4).

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Additionally, a moderately strong relationship of -0.38 exists between Age and MaxHR, indicating that as age increases, heart rate tends to decrease.

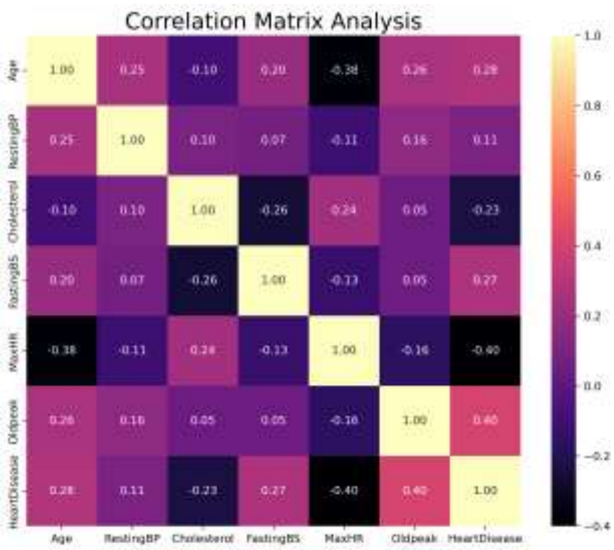

Figure 10 Correlation Matrix Analysis

Data Preprocessing and Classification Parameters with XGBoost and Deep Neural Networks

Preprocessing stands as a fundamental phase preceding model training. Within this study, numerical attributes undergo standardization, involving the removal of mean and scaling to unit variance. Meanwhile, categorical attributes are subjected to one-hot encoding, essential for the accurate interpretation of categorical data by the machine learning model.

Standardization, although not universally mandated, is widely considered a best practice in model training. Its application ensures uniformity in feature scaling, aiding model convergence and performance. On the other hand, one-hot encoding transforms categorical variables into a binary format, allowing the model to effectively comprehend categorical information.

The implementation of StandardScaler in sklearn operates under the assumption that the data, represented by variable, might not adhere strictly to a Gaussian distribution. However, it orchestrates transformations to align the distribution to a mean value of 0 and a standard deviation of 1. In other words, given a feature vector x, it modifies the values as follows:

$$Y_i = \frac{x_i - \mu(\vec{x})}{\sigma(\vec{x})} \quad (1)$$

where: x_i is the i-th element of the original feature vector $(\vec{x})$, $\mu(\vec{x})$ is the mean of the feature vector, and $\sigma(\vec{x})$ is the standard deviation of the feature vector.

Results and discussion

The XGBoost model was trained using 70% of preprocessed data as the training set (642 patients) and the remaining 30% as the test set (276 patients). The GridSearchCV technique was employed to fine-tune hyperparameters, focusing on binary logistic classification to distinguish patients prone to heart disease from healthy individuals.

Optimal hyperparameters for the XGBoost algorithm are presented in Table 2, highlighting the use of regularization via alpha and lambda to prevent overfitting during data classification.

Noteworthy are the performance metrics obtained from the classification report, demonstrating an 88.04% precision in the test set. Additionally, a 90% recall was achieved in identifying patients with heart disease. Table 3 details precision, recall, f1-score, and support values for the binary classification.

Parameter	Value	Description
Learning_rate	0.05	Controls the contribution of each tree to the model.
n_estimators	200	Specifies the number of trees used in the model.
objective	'binary: logistic'	binary classification
max_depth	3	Maximum depth of each tree, limiting the number of splits in each tree.
reg_alpha	1	avoid overfitting
reg_lambda	0.1	control overfitting

Table 2 XGBoost best hyperparameters with Gridsearch.

Condition	Precision	Recall	F1-Score	Support
0: Normal	0.88	0.85	0.86	123
1: Heart disease	0.88	0.90	0.89	153

Table 3 Classification report with XGBoost-GridSearchCV

The confusion matrix in Figure 11 illustrates 105 accurate predictions for healthy patients and 138 correct predictions for those diagnosed with heart disease.

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However, there are 18 false negatives where healthy patients were misclassified as having a heart condition, along with 15 false positives, indicating patients with heart disease incorrectly classified as healthy or normal.

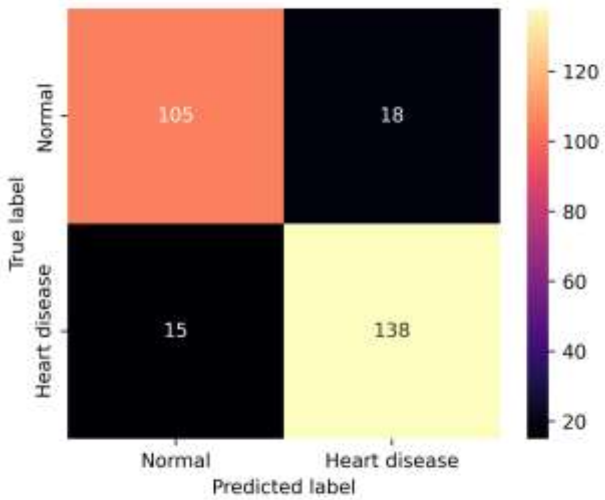

Figure 11 Confusion Matrix depicting results from the XGBoost classifier.

Furthermore, the implemented DNN model is based on a sequential model imported from the Keras library. The test set was split into 20%, with the remaining 80% designated for training. Within this 80%, an additional 25% was set aside to form the validation set. Thus, 60% of the total data is allocated to training, 20% to testing, and the remaining 20% to validation. Table 4 details the parameters and characteristics of the neural network.

Parameter	Value	Description
Layers (Dense)	Four layers, one serving as input and one as output.	Controlling the contribution of each layer to the model's predictive capacity.
Activation fucntion	‘ReLU’ is applied in the model's intermediate layers, while 'sigmoid' is used in the final layer.	'Sigmoid' is commonly employed in binary classification tasks to obtain probabilities between 0 and 1.
Regularization (L1)	0.001 for second layer and 0.0001 for third layer of dense neurons.	Aimed at constraining the weights to mitigate overfitting.
Dropout	0.5, 0.5, 0.25	Dropout layers are employed after each dense layer with dropout rates set at 0.5, 0.5, and 0.25, sequentially, to alleviate overfitting by randomly deactivating a fraction of neurons during training.

Table 4 Architecture of DNN

The optimizer employed during training was 'adam' due to its stochastic gradient descent characteristics. Binary cross-entropy loss function was utilized, deemed suitable for this classification problem. The evaluation metric utilized to assess the model during training was 'accuracy'.

The model was trained on the training data for 300 epochs with a batch size of 32. Simultaneously, validation was conducted during training to monitor performance and prevent overfitting. Figure 12 illustrates the model's performance, showcasing a slight discrepancy between the error rates of the training and validation sets.

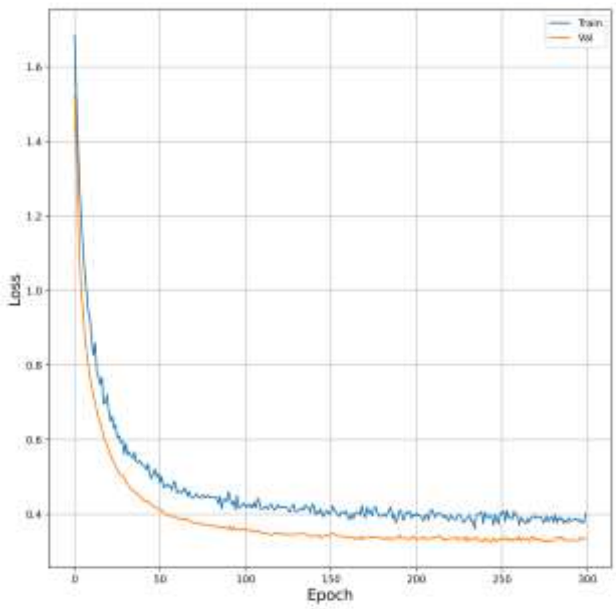

Figure 12 DNN Model Loss with Training and Validation Data.

The evaluation displayed an 88.58% accuracy across both datasets, as depicted in Figure 13. Detailed scoring metrics can be found in the classification report provided in Table 5. Comparatively, the DNN model surpasses XGBoost in terms of recall and f1-score, achieving an 88% and 87% detection rate for healthy patients, respectively. Moreover, it showcases significant precision at 91% for patients with heart disease and achieves an f1-score of 90%.

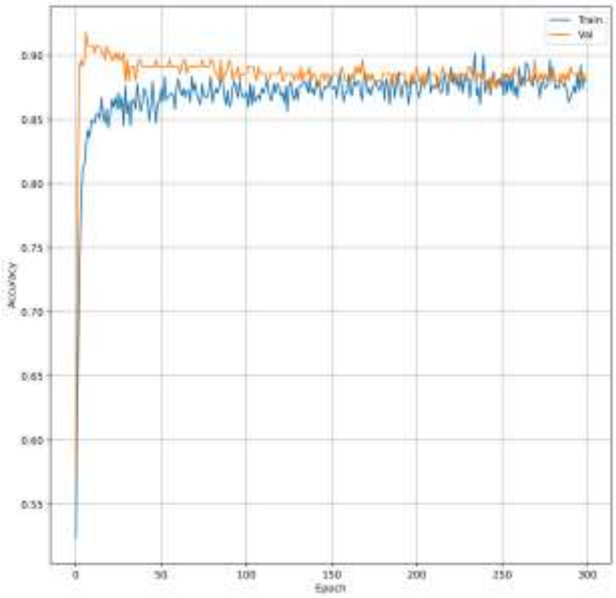

Figure 13 Model Accuracy During Training with Training and Validation Data

Condition	Precision	Recall	F1-Score	Support
0: Normal	0.85	0.88	0.87	77
1: Heart disease	0.91	0.89	0.90	153

Table 5 Classification Report for the DNN Model

The classification using DNN demonstrates a slight superiority compared to the XGBoost model. In this case, Figure 14 shows 68 accurate predictions for healthy patients and 95 correct predictions for those diagnosed with heart disease. However, only 12 false positives and 9 false negatives were detected.

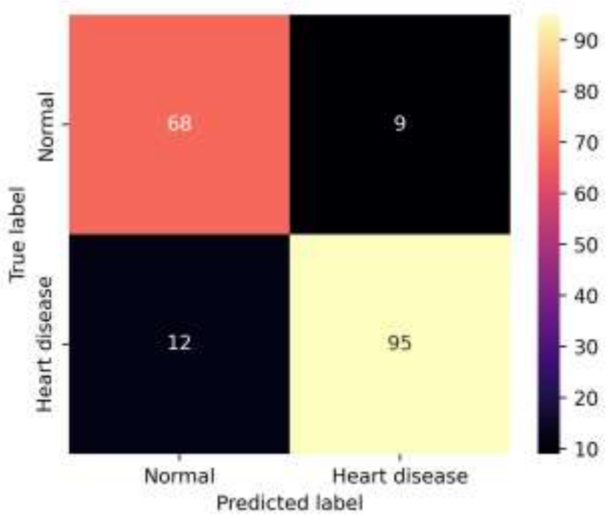

Figure 14 Confusion Matrix illustrating results from the DNN Classifier

The ROC curve metrics in Figure 15 demonstrate a value of 0.885 for the DNN and 0.878 for the XGBoost, with the DNN having the value closest to the true positive prediction.

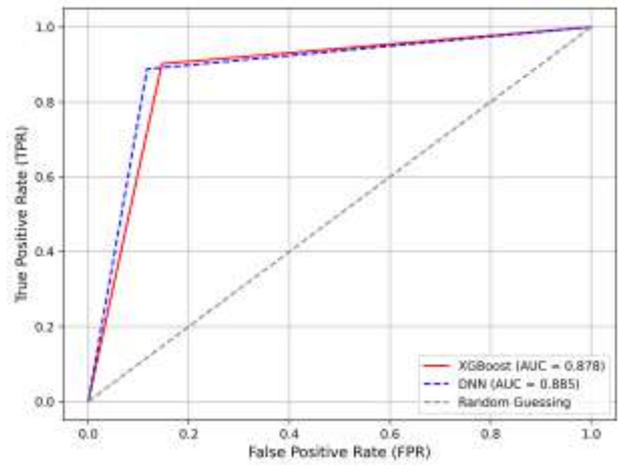

Figure 15 ROC Curves Comparison between the DNN and XGBoost Models.

The obtained results showcase significant metrics in Figure 16 concerning the detection of cardiac diseases. The XGBoost model demonstrates superior recall performance at 90.2% compared to the DNN's 88.79%. This signifies the XGBoost's efficacy in capturing most actual cardiac disease cases. Specifically, within this balanced patient dataset, the preprocessing and classification techniques employed by both XGBoost and DNN are on par or even surpassing other methodologies (Srinivas et al., 2022). Missing a positive case could have severe health consequences for the patient, underscoring the criticality of maximizing recall. Notably, the precision remains similar between both models at 88%.

This precision is crucial to prevent misdiagnosis, averting unnecessary treatments or undue stress for the patient. Finally, the DNN achieves a superior F1-score of 90.05%. As a harmonic mean between precision and recall, it emphasizes the precise identification of positive cases and the minimization of false positives compared to XGBoost.

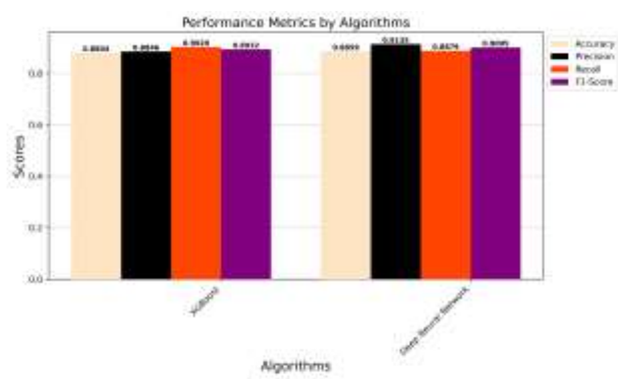

Figure 16 Performance Metrics by Algorithms between the DNN and XGBoost Models

Conclusions

The proposed models utilizing machine learning classifiers for cardiac disease detection were rigorously compared between DNN and XGBoost, leveraging the best hyperparameters obtained through Gridsearch. While both models demonstrated comparable precision, XGBoost exhibited superior recall at 90.2%, whereas DNN showcased stronger classification and F1-score metrics at 90%. These findings underscore the potential of machine learning in refining disease detection, especially in a cardiac context.

This study benefited significantly from a specific dataset, unveiling critical medical insights such as the correlation between certain parameters—like diabetes—and increased risk of cardiac illness. Moreover, the prevalence of chest pain, particularly among asymptomatic patients and those experiencing exercise-induced angina, proved crucial in identifying potential cardiac issues. The methodology's strength lay in meticulous data preprocessing, where numeric values and categorical classifications based on clinical and pathological test types were pivotal in enhancing both XGBoost and DNN classifications.

Looking ahead, this research paves the way for further investigations, potentially integrating additional datasets or exploring hybrid models amalgamating the strengths of various machine learning techniques. Moreover, the models' potential generalizability beyond this specific dataset merits consideration, exploring adaptations required for diverse populations.

The findings presented here hold promise for revolutionizing early detection strategies for cardiac diseases, offering profound implications for improved patient care and healthcare management. This work contributes to advancing the field, introducing novel methodologies and insights that may drive future breakthroughs in cardiac disease detection and management.

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Artificial intelligence in the prevention of respiratory distress syndrome

Inteligencia artificial en la prevención de síndrome de dificultad respiratoria

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Abstract

Malformations in fetal development affect the health of the product and the mother. Preventing illnesses during gestation, allows for a healthy and dignified life at birth. Data from INEGI in its report on Fetal Death Statistics (EFD) 2022, show that in Mexico there is an average of 72.2 fetal deaths per 100,000 women of childbearing age. Of these deaths, 25,041 deaths were registered during the year 2022. 5950 deaths correspond to gestational disorders, respiratory or cardiovascular disorders and congenital malformations. Lung defects result in induced abortion or Respiratory Distress Syndrome (RDS). RDS can be prevented by clinical studies and radiological criteria. Identification of abnormal developments using digital analysis of lung images during pregnancy can help identify a defect. We propose ONE classification tool using deep learning in a multiclass categorization of bronchopulmonary sequestration, cystic malformations and diaphragmatic hernia, where there is a risk of defect appreciation and thus misjudgment leading to complications or death. Resulting in a model accuracy of 88.88%, out of a set of 42 two-dimensional sonograms.

Malformation, Fetal lung, Artificial Intelligence

Resumen

Las malformaciones en el desarrollo fetal, afectan a la salud del producto y la madre. La prevención de padecimientos durante la gestación, permite que al nacer se tenga una vida digna y saludable. Datos del INEGI en su informe de Estadísticas de Defunciones Fetales (EFD) 2022, muestran que en México hay un promedio de 72.2 muertes fetales por cada 100,000 mujeres en edad fértil. De esas muertes, 25,041 defunciones fueron registradas durante el año 2022. 5950 decesos corresponden a trastornos en la gestación, trastornos respiratorios o cardiovasculares y malformaciones congénitas. Los defectos pulmonares, resultan en aborto inducido o en el Síndrome de Dificultad Respiratoria, RDS del inglés de Respiratory Distress Syndrome. RDS puede prevenirse por medio de estudios clínicos y criterios radiológicos. La identificación de desarrollos anormales usando el análisis digital de imágenes de pulmones durante el embarazo, puede ayudar a identificar un defecto. Proponemos una herramienta de clasificación usando aprendizaje profundo en una categorización multiclase de secuestro broncopulmonar, malformaciones quísticas y hernia diafragmática, donde existe riesgo de apreciación del defecto y por ello una valoración errada que lleve a complicaciones o el fallecimiento. Resultando en una exactitud del modelo de 88.88%, de un conjunto de 42 sonogramas bidimensionales.

Malformación, Pulmón Fetal, Inteligencia Artificial

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Introducción

The health of the population is a concern in recent years for developing countries, as it has positioned itself as an incident factor in human, economic and social development. It is important for medical centers and health institutes to strengthen technological tools to support medical diagnosis in a fast and non-intrusive way. It is especially important to bring non-invasive diagnostic services closer to vulnerable and low-income populations. Therefore, computer vision techniques in conjunction with machine learning tools, strengthen the task of health personnel to mitigate the risks arising from a condition. Respiratory Distress Syndrome (RDS) is a condition that can be prevented by analyzing the Fetal Pulmonary Maturity (FPM) study within the gestational development period. The search for safe methods, which do not threaten the health of the product and the mother, is presented as an opportunity for research in the face of traditional procedures.

Ultrasound is a medical tool that has the advantage of being a non-invasive and safe method that supports health personnel in the detection of anomalies. The FPM study is applied to images in JPEG format, where the differentiation of tissue and the week of gestation enables the physician to make a diagnosis of pulmonary development, allowing to assess whether there is any organ or tissue involvement. 15 million infants are born each year with a deficiency. A group of these are premature infants in gestational stages of up to 37 weeks of the recommended 40 weeks. 45% of all deaths of infants under 5 years of age, between 60% to 80%, are premature infants, according to data from the World Health Organization (WHO) in the "WHO recommendations for the care of premature or low birth weight infants", highlighting that the highest mortality is due to respiratory deficiencies. (World Health Organization, 2022)

In Mexico, according to data from the National Institute of Statistics and Geography, INEGI, the statistics of deaths in the fetal stage has a rate of 6.7 women of childbearing age per 10,000, where in the year 2021 a total of 23,000.00 deaths were registered, of which 2,016 are due to respiratory problems (National Institute of Statistics and Geography, 2022).

The number of deaths may be higher than those reported, considering that the report does not specify deaths due to malformation located in one or both lungs and/or resulting in induced abortion or RDS. The prevention of RDS can be supported by clinical studies and/or radiological criteria. Clinical analysis is an invasive method that relies on the levels of lecithin/sphingomyelin contained in the amniotic fluid, representing a low risk of serious complications derived from the extraction, but not zero. Radiological analysis, on the other hand, is a non-invasive method where the physician performs an assessment of fetal lung development by means of lung ultrasound.

If there is any doubt in the diagnosis by radiological method, the clinical method is applied or both, if the health personnel consider so. The problem with ultrasound diagnosis lies in the ability to identify aspects of the image analyzed, such as shape, size, among others. Misdiagnosis by visual means may result in medication that puts the life of the fetus at risk. The criteria of the WHO and the Pan American Health Organization focus on promoting diagnosis by non-invasive methods for health care in pregnant women.

The WHO considers the prevention of fetal and maternal health to be a focus of attention in the countries of the Americas. In order to mitigate risks and reduce deaths, it has established that ultrasound is the method that can meet the challenge. Being a method that can be improved and together with other radiology services be key in early detection (Pan American Health Organization, 2015).

Congenital malformations affect intrauterine life, for the correct diagnosis non-invasive techniques are required, this is where the ultrasound study can facilitate monitoring and care. An expert has the ability to find deficiencies in body parts, such as damage to the nervous system, spina bifida, gastroschisis and microcephaly to mention a few. In addition to fetal deficiencies, it highlights the importance of medical follow-up, where prevention in the early stages of development is easier (Espinosa Arreaga & Lucio Aldaz, 2020).

The prevention of pulmonary complications in newborns is a focus of attention in neonatal mortality, caused by pulmonary surfactant deficiency.

Therefore, non-invasive techniques present the opportunity to predict respiratory morbidity, so the evaluation of pulmonary maturity has shown that an algorithm can predict the occurrence of RDS, respiratory deficiency syndrome (Albinagorta Olórtegui, 2022).

The terms used to describe the human body, where health experts and anatomists use imaginary planes that cut or section the anatomical position, can be roughly categorized as: coronal, sagittal and transverse. They are detailed in subtypes specific to a localized area. Table 1 describes the sub-planes that can be used for precise sectioning (Kenhub, 2023). Figure 1 shows an example of the body planes. Figure 2 and Figure 3 show examples of transverse and sagittal plane ultrasound scans.

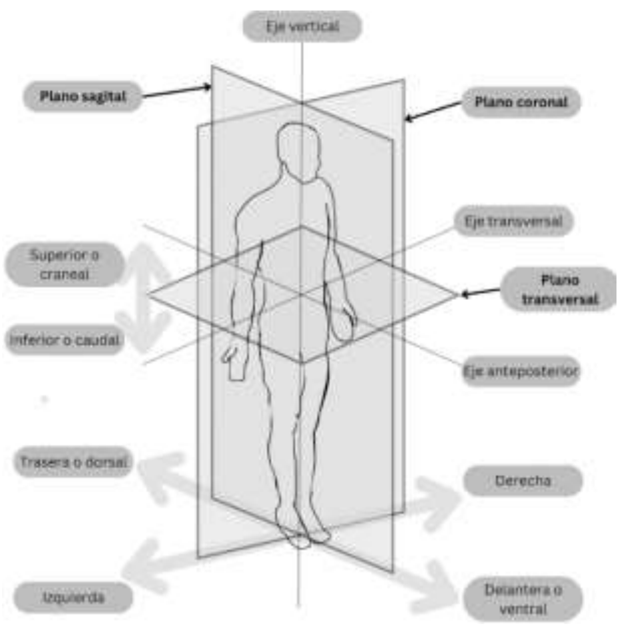

Figure 1 Anatomical planes
Own Creation

Here the planes become relevant when used in ultrasound studies and the interpretation of the sonogram or ultrasound, since the position is relative to the plane and in reverse order to the medical staff.

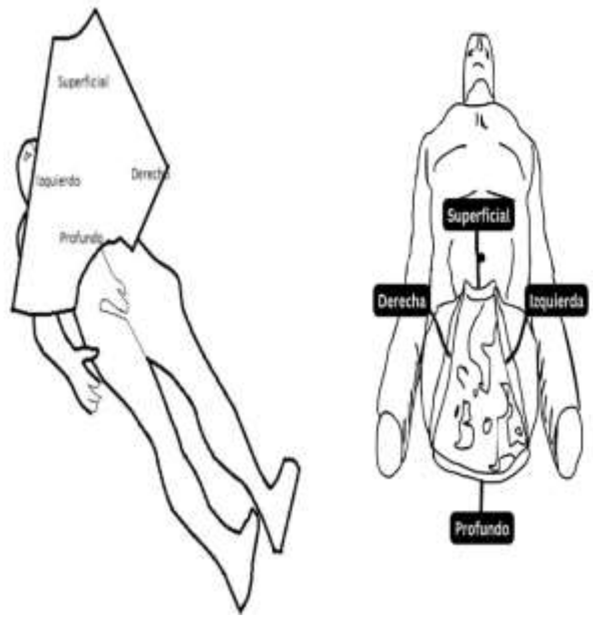

Figure 2 Cross section
Own Creation

The image is interpreted with the assumption that it is positioned below the patient and will be viewed upward from the patient's feet. The graphic shows the abdomen of the patient, the reverse of the medical staff view is displayed, the left side shows the right side of the patient while the right side shows the left side of the patient. The upper part shows the front region of the abdomen and the lower part shows the posterior region of the abdomen.

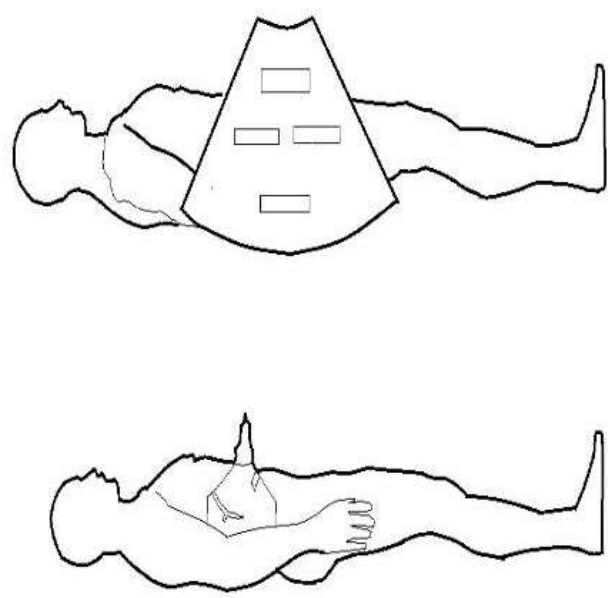

Figure 3 Longitudinal section
Own Creation

In longitudinal sections, the upper part represents the head and the lower part represents the posterior part of the body. The left side of the image shows the part closest to the front of the abdomen, while the right side shows the far side.

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This is similar to looking at slices through a patient from the right side.

	Anatomical planes
Anterior	In front of or in front of
Posterior	To the rear of or behind
Ventral	To the front of the bod
Dorsal	Toward the back of the body
Distal	Away or farther than another from the trunk or the point of origin of this one
Proximal	Closer to the trunk or toward the trunk, or to the point of origin of this
Middle	Midline of the body
Medial	Towards the midline
Lateral	Away from or away from the midline
Superior	Towards the top of the head
Lower	Towards the feet
External	Towards the surface, superficial
Internal	Away or away from the surface, deep
Frontal	Toward the anterior portion of the brain
Occipital	Toward the posterior portion of the brain
Coronal plane	Vertical plane dividing the body into anterior and posterior
Sagittal plane	Vertical plane that divides the body into left and right
Transverse plane	Horizontal plane dividing the body into superior and inferior

Table 1 Type of anatomical planes

The different planes that can be used to obtain a reference and image of the human body are described.

Ultrasound is a sound wave test. It allows an exploration of the internal organs of the human body, it is also called ultrasound or sonography. It is used to monitor fetal health during the gestation period. In addition, it is an efficient support to diagnose soft tissues, such as glands and blood vessels. It also serves as a support for other invasive procedures (Biblioteca Nacional de Medicina, 2023).

The echo occurs when a sound hits a reflective surface, so the resulting vibration returns to the focus. Several effects occur: reflection, which is when the wave travels through a given acoustic impedance of the medium; acoustic interface, which is the relationship between the two media; acoustic impedance, which is the resistance to the passage of waves through a fabric; propagation velocity, where impedance is directly related to the density of the medium; acoustic shadow, which is the sound that is totally reflected.

Refraction, which is the sound that changes direction upon contact with the reflecting medium; attenuation, which is the loss of energy of the signal; ultrasound beam, which is the damping of the wave by means of divergences and dispersion. The resolution of an ultrasound scanner is determined in axial and lateral type, depending on the ability to produce two different and distinguishable echoes between two structures or interfaces close to each other (Segura-Grau et al., 2013).

Ultrasound modes allow analysis of aspects during gestation, depending on the type diverse information can be obtained. A-mode is an ultrasound modality that is used to represent the amplitude of ultrasonic waves as a function of time, the horizontal axis represents time, while the vertical axis represents the amplitude of the ultrasonic waves, commonly used to obtain accurate measurements of distances and depths of structures. B-mode, also known as B-mode ultrasonography, is a medical imaging technique that uses ultrasound waves to generate real-time images of internal body structures.

Here, two-dimensional images depicting tissue anatomy are obtained. Mode C, also known as "contrast mode," is used to enhance the visualization of certain structures or areas within the body, where the use of ultrasound contrast agents improves the quality of the images obtained. The Doppler mode is based on the change in frequency of sound waves reflected by a moving object, in this case, blood cells in the bloodstream. A color code is used to represent the direction and speed of blood flow. For example, red may indicate blood flow toward the transducer, while blue may indicate blood flow away from the transducer. It allows clinicians to visualize the distribution of blood flow in real time. (Standen, 2022).

Ultrasound is a medical tool that has the advantage of being a non-invasive and safe method that supports health personnel in the detection of anomalies. The study is used on images in DICOM or JPEG format, where the differentiation of tissue and the week of gestation, enables the physician to make a diagnosis of the development of organs and the fetus in general.

This project proposes the development and implementation of a software application that allows health personnel to process a neonatal lung ultrasound, apply artificial vision techniques and obtain a characterization of the percentage of soft mass in development. Thus, to obtain a classification and labeling of the image to support the diagnosis or search for lung malformations resulting in RDS or miscarriage.

Background

During the gestational period, malformation of non-functional bronchial tissue, called Bronchopulmonary Sequestration (BRS), may occur. Routine morphologic ultrasound at 20 weeks makes early detection of the condition possible. It is a mass that is described as a non-utilitarian tissue, which does not connect with the tracheobronchial tree and is connected by means of an aberrant system artery, originating from the descending aorta. It is an anomalous development of the pulmonary artery, which can drain systemically.

This portion of additional pulmonary parenchyma is considered to be a solid, hyperechogenic, homogeneous mass occupying the pulmonary lower lobe. Figure 4 illustrates BRS Although it is considered a benign lung tumor, the criteria of size, growth rate, degree of cardiac or pulmonary compression, existence of hydrothorax or fetal heart failure. Physically, the evaluation of the tissue is based on maximum diameter in length, transverse and antero-posterior multiplied by 0.52 and divided by the cephalic circumference. Thus an index greater than 1 is of high risk, while one less than 1 has to be involute and can be treated after birth. (Cruz-Martínez & Ordorica-Flores, 2019).

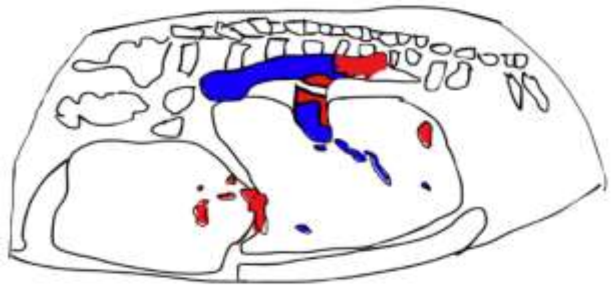

Figure 4 Sagittal cut ultrasound of fetal thorax. The image shows the solid mass corresponding to SBR, connected to the abdominal aorta
Source: https://www.scielo.org.mx/img/revistas/gom/v87n2//0300-9041-gom-87-02-116-gf1.png

During fetal lung development, lesions can be generated that are part of a group of anomalies based on dysplasia in the embryonic formation of the pulmonary tree, Figure 5. Among these is the adenoid cystic pulmonary malformation (ACM), where the classification is based on lung cysts ranging from two centimeters in single cysts, cysts smaller than one centimeter, and micro-cysts. Medical diagnosis is based on fetal lung morphologic assessment. An important feature of diagnostic differentiation between bronchopulmonary sequestration, bronchogenic cysts and diaphragmatic hernia is whether a nutritional vessel is present. A differential study to determine the condition is required. In ACM iit is characteristic that there is no irrigation connection. The evolution of the cysts triggers the phenomenon of hydrops and eventually fetal death (Vega, et al., 2015).

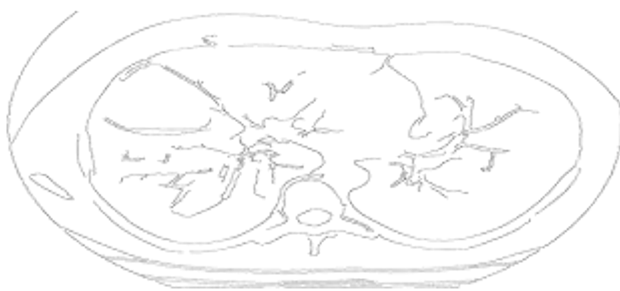

Figura 5 Ultrasound shows a macrocystic
Source: https://www.chop.edu/conditions-diseases/congenital-cystic-adenomatoid-malformation-ccam

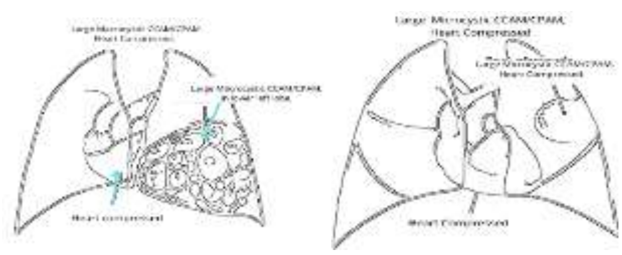

Figura 6 *Congenital cystic adenomatoid malformation (CCAM) is a benign lung lesion that appears before birth as a cyst or mass in the chest*
Source: https://www.chop.edu/conditions-diseases/congenital-cystic-adenomatoid-malformation-ccam. In those cases

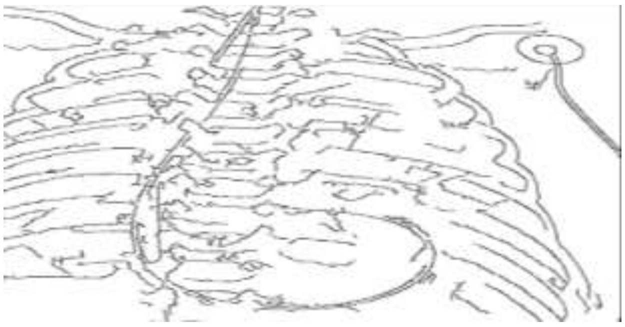

Figure 7 Plain chest x-ray of a patient with congenital diaphragmatic hernia. Hydro Aerial images of intestinal loops in the left hemithorax with deviation of the mediastinal structures to the right side were observed. The nasogastric tube shows that the stomach is in the chest
Source: https://enfermeria.top/apuntes/pediatria/hernia-diafragmatica-congenita/

Among the studies for lung maturity are the traditional ones, such as: a) lamellar body count, b) lecithin/sphingomyelin ratio, c) presence of phosphatidylglycerol, d) optical density of lamellar bodies and e) foam stability index (Clements test). The QuantusFLM ultrasound method is a tool that uses digital image pre-processing techniques to extract textural features and machine learning algorithms to predict the risk of respiratory morbidity. In practice, the traditional amniotic fluid procedure (b) and the sonogram procedure obtain the best clinical results (Zuñiga Vico, Gila Sánchez, & Hurtado Sánchez).

Pando García (2020) performed a quantitative study of the QuantusFLM method to predict MPF using the metrics of accuracy, specificity, sensitivity and negative predictive value, obtaining 87%, 86%, 91% and 98%. The invariance in ultrasound acquisition (position, illumination, shadows, resolution), allows the extraction of image texture features in a region of interest (ROI). In this ROI it will correspond to the fetal lung tissue. Once similarities of the inputs can be detected, a classifier can be trained for the task of PFM detection.

(Hernández Sancho & Rojas Maruri, 2020), who medically treat a pulmonary sequestration, make the diagnosis by means of ultrasound techniques, in this case echocardiography. Through visual analysis, they identify aortic stenosis and moderate aortic coarctation, with dilatation of the left atrium.

Through observations in the sonogram, they were able to predict the risk of intralobar RBS with basal cysts of one to two cm (AML), in addition to the presence of an aberrant aortic nutritional vessel of supra celiac origin in the abdominal aorta. The correct identification of the parts allowed an adequate intervention.

Deep learning, a vector-based technique, is based on a point in geometric space. The inputs are converted into an initial vector space and there is a target vector space. Geometric transformations are performed by the processing layers on the input data. The geometric complexity increases between layers, but is decomposed into simple transformations. That is, the input space is mapped into the target space, point by point. The process is parameterized by the synaptic weights, directly related to the performance of the model. The differentiation of each plane allows us to learn its parameters. A widely used optimization technique is the gradient descent, being a smooth and continuous decomposition. Deep learning models are machines for decomposing high-dimensional data manifolds (Collet, 2017).

Computer vision is a set of image processing and pattern recognition techniques, artificial intelligence and computer graphics. The input is based on digital images, the objective is to obtain information through descriptions based on feature extraction. The output of the process is the understanding of the scene. It can focus on tasks such as enhancement or recognition, being dependent on computational technology.(Wiley & Lucas, 2018).

For classification tasks categorical data consist of discrete labels, when working in machine learning, it is usually necessary to convert these categories into numerical values before entering them into a model. One-hot encoding, a common technique used to represent categorical variables, is represented as a binary vector, where only one element is set to one (1), indicating the presence of the category. Most encoded vectors will consist of zeros, resulting in a large amount of wasted memory. The sparse representation of categorical data, aims to address this inefficiency by using an integer index to represent each class. (Brownlee, 3 Ways to Encode Categorical Variables for Deep Learning, 2020).

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Deep learning models require tuning, so "Categorical accuracy" is a metric that measures the accuracy of predictions by calculating the fraction of correctly classified samples in the training dataset. "Value Categorical Accuracy" is used during the validation phase of training, it measures the accuracy of model predictions on a separate validation dataset, which is not used for training. This helps you evaluate how well the model generalizes to new and unseen data (Brownlee, How to Use Metrics for Deep Learning with Keras in Python, 2020). "Loss", and "Value Loss", help determine how performance changes over epochs and support diagnosing any problems with learning (Stefania, 2023).

The "Sensitivity" and "Specificity" values are the ratio of positive and negative classification per class. In AUC, sensitivity and specificity are related distributions, where the overlapping areas between them indicate the model's ability to discriminate (Brownlee, Sensitivity Analysis of Dataset Size vs. Model Performance, 2021).

Models in deep learning, are shown in Figure 8, Figure 9, Figure 10, Figure 11 and Figure 12 AlexNet

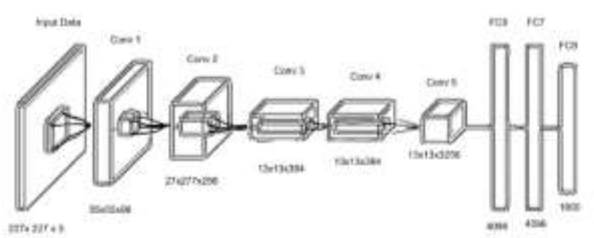

Figure 8 AlexNet model architecture
Source: https://www.mdpi.com/2072-4292/9/8/848/htm?ref=https://githubhelp.com

The model uses five convolutional stages, then flatten the vector resulting for classification.

Figure 9 VGG16 Architecture
Source: https://www.academia.edu/download/68916518/IRJET_V8I3564.pdf.

The Visual Geometry Group 16 model is more compact than Alexnet, the dense layers are used for classification.

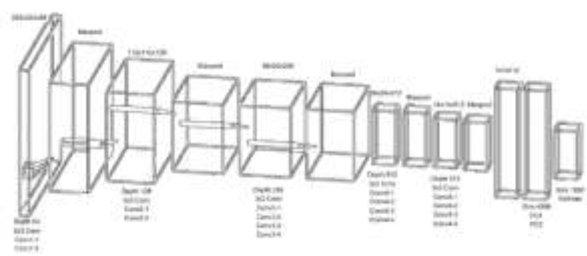

Figure 10 VGG19 Architecture
Source: https://cdn.techscience.cn/uploads/attached/file/20201030/20201030055352_36147.pdf.

Unlike some architectures that use filters of different sizes, Visual Geometry Group 19 uses 3x3 filters in all convolutional layers. This provides uniformity and simplicity in the architecture.

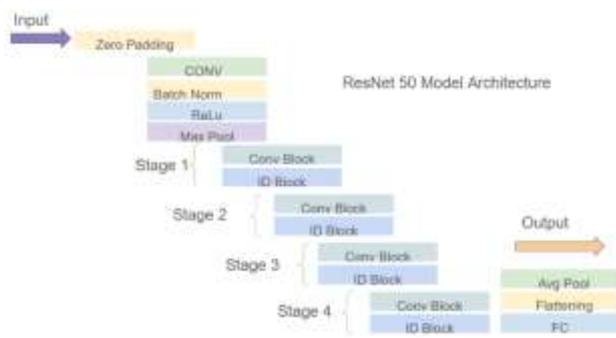

Figure 11 RESNET 50 Architecture
Source: https://cdn.techscience.cn/uploads/attached/file/20201030/20201030055352_36147.pdf

The distinguishing feature of ResNet is the use of residual blocks that allow layers to learn identity functions, which facilitates the training of much deeper networks. ResNet-50 specifically has 50 layers in total, including convolutional, clustering and fully connected layers.

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Inception V3

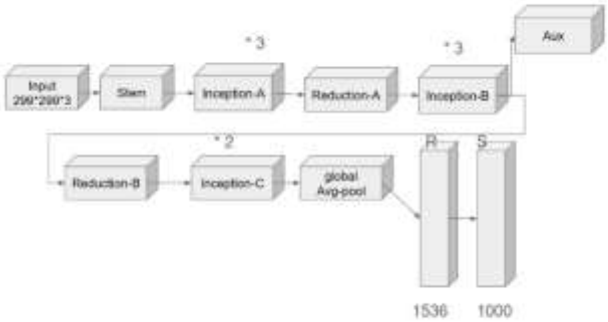

Figure 12 Inception V3
Source: https://medium.com/@AnasBrital98/inception-v3-cnn-architecture-explained-691cfb7bba08.

Known as GoogLeNet, the Inception architecture is characterized by the use of "Inception" blocks containing multiple convolutions of different kernel sizes. These blocks allow the network to capture patterns of different spatial scales in parallel, thus enhancing the network's ability to learn more complex and richer representations.

Methodology

A quantitative review of several neural networks was performed, using Tensorflow and transfer learning techniques. The objective is the classification of three medical diagnoses that, without attention, can lead to fetal death or RDS. Automated feature extraction functions are used, in conjunction with preset techniques for taking radiographs, on an ROI as the object of study. It focuses on the detection of abnormal conditions in the MPF. The three conditions to be treated are: BRS, AQM and diaphragmatic hernia (DH). Figure 13 illustrates the process.

Identify aspects of ultrasound: through documentary research, aspects of the anatomical planes and cuts used in the cases reported in the literature were identified. In addition, the acquired knowledge of the ultrasound acquisition methods and technical details of the operation of the machines that generate the sonograms were expanded.

Image selection: the criteria used to select the sonograms that are part of the research are: presence of any condition associated with the three diagnoses mentioned; the type of anatomical plane, either in axial or longitudinal section.

The size of the image, minimum 96 dpi and 24 bits of color in at least 100x100 pixels.Using the web scraping technique, images were located and selected for investigation. The use of the sonograms obtained is academic in scope.

Input preprocessing: The inputs were transformed into arrays of 227 by 227 pixels and three color channels. Finally, an image normalization process was performed.

Categorization: a multiclass categorization technique (one-hot encoding) was implemented on the dataset in order to use classification, resulting in three encodings: 0 0 1 = DH, 0 1 0 =AQM, and 0 0 1 = BRS.

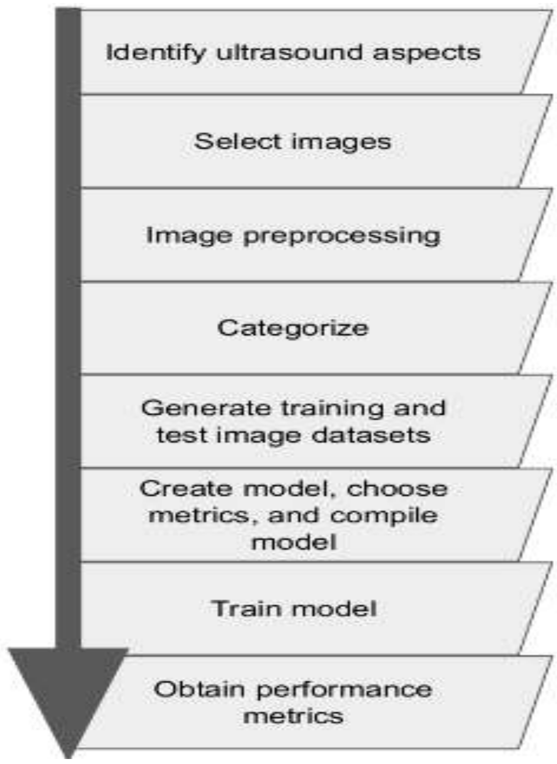

Figure 13 Implementation process, own creation. It starts with the collection strategy, image selection, image pre-processing, class categorization, creating the necessary sets, establishing the model, compiling the model and obtaining the necessary metrics.

Training and test set: the indices of each sonogram were randomized using s and with the Scikit-learn library the training and test set was created in a ratio of 80%-20%.

Create model, select metrics and compile model: using TensorFlow and Keras software via Transfer Learning, several AlexNet deep network models were implemented: a) using all pre-processing layers, b) with brightness and contrast pre-processing and c) without pre-processing, whose optimization setup is stochastic gradient descent method based on adaptive "adam" estimation. The metrics selected for training and validation are shown in Table 2.

Training	Validation
Categorical Accuracy	Value Categorical Accuracy
Loss (Categorical cross entropy)	Value Loss
AUC (Area Under Curve)	
Sensitivity	
Sensitivity	

Table 2 Model metrics.Training and validation metrics help fine-tune the model

Training model: For training, 1000 epochs were used, using a subsampling of 8 and derived from the fact that there are few images, the test set was used in order to avoid overtraining.

Performance metrics: Finally, the prediction of all models was run to obtain the metrics, which are shown in the results section.

Results

Obtain Performance metrics: Finally, the model prediction was run to obtain the metrics, which are shown in the results section. The macro performance of the model, using variants in the preprocessing are shown in Table 3.

Model	Categorial Accuracy	AUC
Alexnet	88.89%	88.87%
EfficientNetB0	55.50%	77.22%
DenseNet121	55.56%	81.48%
InceptionResNetV3	55.55%	56.84%
Resnet 50	55.56	61.73%

Table 3 Performance metrics

The result for each model was made with the same parameters for the training and same training and test dataset..

The set of images during the investigation is illustrated in Figure 14. The sonograms were obtained by web scraping and are intended for academic purposes.

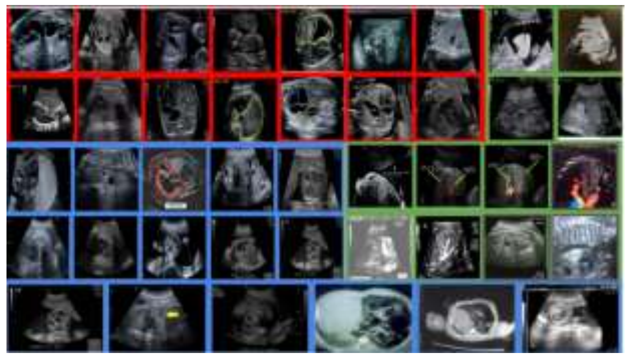

Figure 14 Data set

On the left, diaphragmatic hernia. In the center, adenoid cystic pulmonary malformation. On the right, bronchopulmonary sequestration. The sonograms that were selected contain the pulmonary lesion.

AlexNet, without preprocessing, was trained for 1000 epochs, where the monitoring graph was obtained, which is illustrated in Figure 15. The best result obtained was 88.88% categorical accuracy and an area under the curve value of 90.43%. Table 4 shows the results obtained.

Metric	With Layers	Contrast	Without pre processing
Categorical Accuracy	55.56%	77.77%	88.88%
Pre - processing layers	Rotation= (-0.2,0.3) Flip= Horizontal and Vertical Brightness = [-0.8, 0.8] Translation= Higher=0.2, Anchor= 0.2	Contrast=[0.1, 0.4] Brightness = [-0.8, 0.8]	NA

Tabla 4 Alexnet with and without processing layers

The pre-processing layers did not support a better result. The highest accuracy is obtained with the model without processing.

The values during training are shown in Figure 15. Performance metrics were captured for 1000 epochs.

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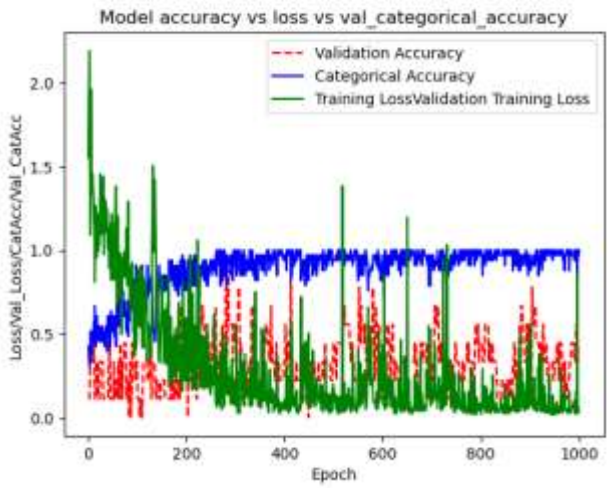

Figure 15 Plot of categorical accuracy versus categorical accuracy value versus loss

At epoch 378 it obtained its best performance (88.88%). Subsequent iterations no longer reflect further learning.

Metric	Precision	Recall	F1 Score	Support
DH	1.0	1.0	1.0	5
AQM	1.0	0.80	0.89	1
BRS	0.75	1.0	0.86	3
micro Avg	0.89	0.89	0.90	9
micro Avg	0.92	0.93	0.92	9
weighted Avg	0.89	0.89	0.89	9
samples Avg	0.89	0.89	0.89	9
For DH precision 1.0				
For AQM Precision 1.0				
For BRS 0.75				
Macro Precision 0.92				

Table 5 Macro, weighted and macro results

The values obtained can be assumed that the model discriminates moderately well.

The confusion matrix of the model is shown in Figure 16.

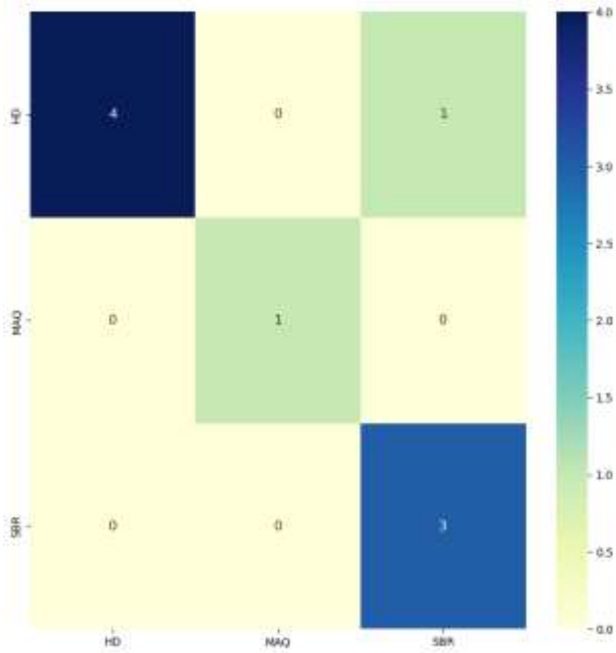

Figure 16 Confusion matrix

Illustrates the classification of each condition in the prediction.

The ModelCheckpoint method of the Keras callbacks class was used to save the synaptic weights, depending on the best performance of the categorical accuracy value. It can also be used to stop the training early, if the performance on the validation set starts to degrade.

For model prediction, the images shown in Figure 16 were used. Each of the sonograms belongs to a class, in this case a categorical value.

Figure 16 Test set. Each image belongs to a class: 0 0 1 = DH, 0 1 0 =AQM, 0 0 1 1 = BRS. All elements were classified correctly

A comparison of the results in the proposed method and a QuantusFLM diagnostic method is given in Table 6.

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Metric	AlexNet without pre processing	QuantusFLM
Macro Precision	92.00%	1.0
Accuracy	88.89%	NA
AUC (Area under curve)	88.27%	NA
Specificity	94.44%	86.00%
Sensibility	88.89%	91%

Table 6 Comparative to Metrics of QuantumFLM

The results obtained have values close to those of the quantumFLM method.

Conclusions

According to (Vega, et al., 2015), to discriminate between SBR, MAQ and HD, a differential study is required. Therefore, the work contributes to facilitating the identification of the condition, for rapid treatment. Being a non-invasive method, ultrasound becomes relevant as a means for diagnosis comparable to other invasive methods according to (Zuñiga Vico, Gila Sánchez, & Hurtado Sánchez).

The underpinning of the performance of the proposed model, is given that each sonogram contains the features that the network is able to perceive to discriminate between each condition, as anticipated by (Wiley & Lucas, 2018). The different options of the pre-processing, showed no better result than the model without pre-processing. This characteristic may be associated with the fact that the devices that generate the sonograms already make adjustments such as contrast and brightness. The specific techniques for sonogram capture are beyond the scope of this work.

In Figure 15, the plot shows instability in training, since it is not a smoothed line and that the optimizer used in training is "adam" as anticipated by (Collet, 2017). One of the causes is that the size of the training data is small and may not represent all the input data. The variation in the image may be derived from the input decomposition, since it is an unsupervised process. In example, if the input vector is decomposed and matched with the target vector, another input is not matched. For this the categorical accuracy value metric, supports in visualizing how the neural network is performing on the validation data and checking for over-fitting.

An over-fit model performs well on the training data, but poorly on the validation data. In general it implies that the neural network, at some epochs over fits and at other epochs under fits for both sets. The best result is not necessarily the one with the highest accuracy, but according to Table 4, it would be the one that best discriminates between classes and is not over-fitted.

Ultrasound mode B helps to obtain a two-dimensional sonogram, doppler mode helps to identify blood vessels. The latter is useful to detect cystic malformations and bronchopulmonary sequestration. How to take the sonogram is not covered in this publication. It will be dealt with in a later investigation.

The AUC value obtained reflects the ability of the model to discriminate between classes. However, in this proposal, we work under the assumption that there is suspicion of disease. Therefore, we do not deal with cases where no condition is present. This will be addressed in another paper.

Validation metrics are useful so that the model can be adjusted, Keras tools make it easier to keep the training supervised. It is useful to consider a value to monitor the performance of the model on the training data and guide the optimization process. Adjustments, such as pre-processing layers, can improve performance. Augmentation of the data will not in all cases give the best result, but it comes close. The goal is to increase the categorical accuracy during training by adjusting the model parameters, either in subsampling, or by re-arranging the ensemble.

The use of the model is recommended to support specialists in the medical area and for didactic use.

The difficulty of obtaining sonograms is based on two aspects: a) data protection and privacy laws, b) the difficulty of associating with health institutions. The first raises the challenges of data use and limitations. The second focuses on project time, budget availability, lack of personnel and initiative to participate.

Acknowledgments

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Article

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Biomarkers and genetic polymorphisms present in sudden cardiac death

Biomarcadores y polimorfismos genéticos presentes en muerte súbita cardíaca

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Abstract

Sudden death (SD) represents a significant public health problem on a global scale. It is defined as occurring from natural causes in a previously asymptomatic individual or an individual with a known but stable medical condition, and is characterized by a short time interval, less than 60 minutes, between the onset of symptoms and death. It is also characterized by a short time interval, less than 60 minutes, between the onset of symptoms and death. This phenomenon is not exclusive to certain sectors of the population, and frequently manifests itself in adults and the elderly, both with and without a history of cardiac pathologies. Accordingly, it is necessary to have effective diagnostic and preventive tools, among which blood biomarkers stand out. In particular, troponin T and I are the most specific and sensitive in the identification of cardiac damage. In addition, mention should be made of the significant influence of genetic factors in the development of diseases associated with sudden death.

Sudden Death, Biomarkers, Genetic Polymorphisms

Resumen

La muerte súbita (MS) representa un significativo problema en el ámbito de la salud pública a escala global. Se define como aquella que sucede por causas naturales en un individuo previamente asintomático o con una condición médica conocida pero estable; asimismo, se caracteriza por un intervalo temporal breve, inferior a 60 minutos, entre el inicio de los síntomas y el deceso. Este fenómeno no es exclusivo a determinados sectores poblacionales, manifestándose con frecuencia en adultos y ancianos, tanto con cómo sin antecedentes de patologías cardíacas. De acuerdo con lo anterior, es necesario disponer de herramientas diagnósticas y preventivas efectivas, entre las que destacan los biomarcadores sanguíneos. En particular, la troponina T e I como los más específicos y sensibles en la identificación de daño cardíaco. Además, mencionar la influencia significativa de los factores genéticos en el desarrollo de enfermedades asociadas con la muerte súbita.

Muerte Súbita, Biomarcadores, Polimorfismos Genéticos

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Introduction

Sudden death (SD) is a significant global public health problem. It is defined as occurring from natural causes in a previously asymptomatic individual or an individual with a known but stable medical condition, and is characterised by a short time interval of less than 60 minutes between the onset of symptoms and death.[4]

This phenomenon is not exclusive to certain population groups and occurs frequently in adults and the elderly, both with and without a history of cardiac pathology. Sudden cardiac death (SCD) has a circadian distribution, with a prominent peak between 7 and 11 a.m. and a lower peak in the evening hours. In addition, its incidence is most pronounced at 6 months of age and between 45 and 65 years of age.[2]

The causes of SCD are diverse, ranging from infiltrative diseases, cardiovascular accidents, massive pulmonary embolisms, to excessive psychological and physical stress, chest trauma and electrolyte disturbances. Although neuromuscular diseases such as Friedreich's ataxia or Steinert's disease may also be involved, in most cases there is a previous predisposing cardiac pathology, such as ischaemic heart disease or other cardiomyopathy.[3]

The worldwide incidence of SCD is between 4 and 5 million cases per year, making it the third leading cause of death globally. Thus, genetic defects associated with ion channels have been identified that can trigger SCD, highlighting the importance of characterising genes linked to sodium, potassium and calcium channels for accurate diagnosis.

This characterisation not only benefits the patient, but also allows relatives to avoid fatal consequences; these come from predisposed genetic variants. [1]

Furthermore, in the field of diagnosis and prognosis, cardiac biomarkers emerge as crucial tools. These biological, biochemical, anthropometric or physiological indicators not only facilitate the identification of physiological or pathological processes, but also guide therapeutic decisions, highlighting their relevance in the comprehensive approach to cardiac diseases. [5]

Among the preventive measures, it is advisable not to smoke, to take care of the type of diet, weight, physical exercise and cardiac check-up as indicated by the doctor, in this way, it will be possible to detect and prevent alterations that may trigger an episode of sudden death. It is also important to avoid the use of class I antiarrhythmic drugs, as there is an increase in mortality due to sudden death in post-infarction patients treated with these drugs.[6]

Methodology

The research methodology is descriptive and information will be collected from electronic and bibliographic sources: research articles, review articles, theses, dissertations and books on the topic in question.

The population under investigation will comprise adult individuals, both men and women, aged 18 and over. Cases where the cause of death was sudden cardiac death will be considered, excluding the presence of other identifiable causes during the autopsy that justify the death. Preference will be given to cases with a lapse of no more than 12 hours from the time of death.

On the other hand, a questionnaire will be carried out, where the following information will be collected:

– Autopsy number and date of autopsy.
– Age
– Sex (M or F)
– Size
– Weight

– Cadaveric signs observed
a) Pallor
b) Stiffness
c) Lividity
d) Site of observation

– Site of recovery of the body
e) Public road
f) Address
g) Office
h) Hospital
i) Other site (specify)

– Remarks

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In forensic autopsies with a diagnosis of sudden death, 10 ml of blood shall be obtained by cardiac puncture of the left ventricle and/or superior vena cava, following the conventional procedures of the general autopsy protocol.

– Five ml shall be placed with a syringe in a tube without anticoagulant (red cap) and allowed to stand upright in the refrigerator at 4-5 C. The other 5 ml shall be placed in a tube without anticoagulant (red cap) and allowed to stand in the refrigerator at 4-5 C.

– The remaining 5 ml shall be placed in a tube with EDTA (purple stopper) and gently shaken and left in an upright position in the refrigerator at 4-5°C.

The tubes shall be identified by collecting the following data:

– Date
– Autopsy number
– Sex (M or F)
– Initials of the corpse (beginning with the first name and ending with the surname. It will have a hyphen between both) (e.g. Juan Enrique Delgado Correa: JE-DC).

Results

Cardiac biomarkers (Figure 1) are important in the prognosis and diagnosis of cardiac diseases and are used as therapeutic guidelines.

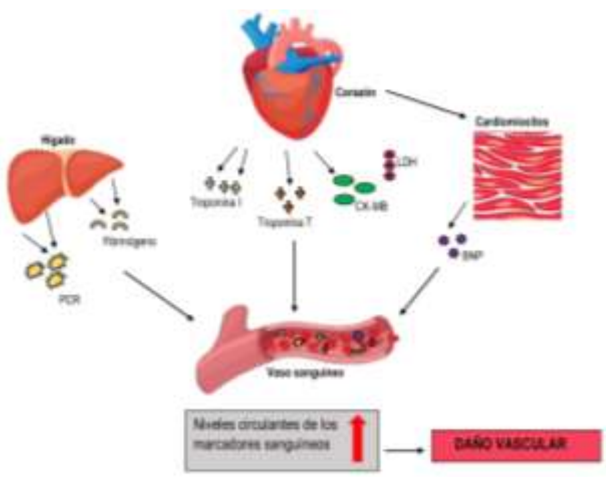

Figure 1 Origin of some blood markers that predict and diagnose cardiovascular risk

The ideal biomarker should be specific, sensitive, predictive, rapid and inexpensive, stable in vivo and in vitro, non-invasive and of sufficient preclinical and clinical relevance to modify decisions regarding the pathological process in which it is applied. Troponins would be the ideal biomarker in your case due to their high specificity and low invasiveness, as well as the speed with which the results are known (approximately 20 minutes if performed on equipment that works by electrochemiluminescence). In normal patients, the presence of troponins should not be identified, as long as values of less than 0.04 ng/ml troponin T and less than 0.1 ng/ml troponin I are present, the patient does not have cardiac irregularities.

Cardiac troponins are released in response to cardiac necrosis. When there is injury to cardiac tissue, the dying cells release several types of troponins into the blood. The most important are troponin I and T, which are specific to the heart and undetectable in healthy people. Their concentration increases within 3-4 hours after injury and can remain elevated for 10-14 days. They are recommended to diagnose acute myocardial infarction and acute coronary syndromes, however, their elevation may be due to other factors (Table 1).

Otras causas de elevación de Troponina en suero

Fiebre reumática aguda
Amiloidosis
Trauma cardíaco
Cardiotoxicidad por quimioterapia
Insuficiecia renal terminal
Enfermedad de Pompe
Hipotiroidismo
Embolismo pulmonar
Sepsis

Table 1 Non-ischemic causes of elevated serum troponin

In addition, there are other types of specific blood enzyme markers such as: creatine kinase (CK-total and CK-MB) is an enzyme that is generated in different parts of the body CK-MB originates in the heart and is therefore the marker of choice. CK-MB increases 3-6 hours after the onset of symptoms and the peak level is reached at 12-24 hours. As for total CK, it rises within 3-6 hours after the onset of acute coronary event symptoms and reaches a peak value between 18-30 hours and returns to normal by the third or fourth day.

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On the other hand, cardiomyopathies are considered to be Mendelian disorders over generations. Without exception, the various cardiomyopathies and primary electrical disorders are genetically heterogeneous, i.e. mutations in different genes can lead to the same clinical manifestation of the disease. In addition, there is considerable allelic heterogeneity, because many different mutations within each gene cause the disease.

Cardiac channelopathies are a group of clinical-electrocardiographic cardiac syndromes that affect the molecular constitution of the proteins that form the sarcoplasmic membrane channels of cardiomyocytes (sarcolemma) or of the intracellular sarcoplasmic reticulum (the main intracellular calcium store), caused by genetic mutations or by acquired causes (especially autoimmune) leading to alterations in transmembrane ion exchange involving sodium, potassium and calcium, resulting in dysfunction of these membranes (Table 2).

Irregularidades en los canales iónicos y sus consecuencias

Canal iónico	Gen	Subunidad afectada/ligando	Enfermedad
Canales de sodio:			
$Na_v1.5$	SCN5A	α	Síndrome de QT largo, bloqueo cardiaco familiar progresivo tipo I, síndrome de Brugada
Canales de calcio:			
RyR2	RYR2	α	Taquicardia ventricular catecolaminérgica polimórfica, displasia ventricular derecha arritmogénica tipo 2
Canales de potasio:			
KCNQ1/KVLQT1	KCNQ1	α	Síndrome de QT largo (tipo 1) autosómica dominante (Romano-Ward), síndrome de QT largo (tipo 1) autosómico recesivo con sordera (Jervell-Lange-Nielsen)
HERG/KCNH2	KCNH2	α	Síndrome de QT largo (tipo 2)
Kir2.1/IRK/KCNJ2	KCNJ2	α	Síndrome de QT largo (tipo 7) con malformaciones características (síndrome de Andersen)
KCNE1/MinK/ISK	KCNE1	β	Síndrome de QT largo (tipo 5) autosómico dominante (Romano-Ward), síndrome de QT largo (tipo 1) autosómico con sordera (Jervell-Lange-Nielsen)
KCNE2/MiRP1	KCNE2	β	Síndrome de QT largo (tipo 6)

Table 2 Cardiac diseases related to ion channel abnormalities

Furthermore, it was observed that 15-20% of sudden cardiac deaths are due to mutations in the SCN5A, KCNQ1, KCNH2, KCNE2, KCNE3 and RyR2 genes, which are associated with primary arrhythmogenic disorders.

Conclusions

Due to widespread misinformation, there is a mistaken belief that those who participate in physical activity or who are considered healthy are exempt from cardiac disorders.

However, anyone is susceptible to heart failure, cardiac arrest or even sudden cardiac death, especially if they have triggering polymorphisms and are exposed to external factors such as stress, poor dietary habits or ingestion of harmful substances, among others.
Preventing sudden cardiac death is feasible if the general population undergoes regular medical check-ups, not limiting this practice only to those with a history, previous diagnosis or family members with the same pathologies.

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Minimal dental intervention in children with cerebral palsy (Case Report)

Mínima intervención dental en niños con parálisis cerebral (Caso Clínico)

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Abstract

Goals: Identify the types of cerebral palsy in children and know what the dental care protocols are for patients with cerebral palsy.” Under the philosophy of minimal intervention Level: State, National and International. 2015-2023. Presentation of a Clinical Case, attended under the philosophy of Minimum dental intervention. Methodology: It is a bibliographic review, in articles and meta-analysis, through the following search engines: Google academic, Scielo. The Prisma methodology was used. Original sources in languages: English, Spanish from indexed magazines consulted in databases. Subject reviews, systematic reviews, meta-reviews were included analysis, studies, observations, care guide. Contribution: Create awareness among caregivers and parents of children with cerebral palsy, about early dental care in children, in addition to improving brushing techniques under the minimal dental intervention philosophy, “Prevention is better than cure”

Minimal dental intervention, Cerebral palsy

Resumen

Objetivos: Identificar los tipos de parálisis cerebral en niños y conocer cuáles son los Protocolos de atención dental en pacientes con paralisis cerebral ”. Bajo la filosofía de mínima intervención Nivel: Estatal, Nacional e Internacional. 2015-2023. Presentación de un Caso Clínico, atendido bajo la filosofía de Mínima intervención dental, Metodología: Es una revisión bibliográfica, en artículos y metaanálisis, a través de los siguientes buscadores: Google académico, Scielo. Se utilizó la metodología Prisma. Fuentes originales en los idiomas: inglés, español de revistas indezadas consultadas en bases de datos. Se incluyeron revisiones de tema, revisiones sistemáticas, meta-analisis, estudios observaciones guía de atención. Contribución: Crear conciencia entre los cuidadores y padres de familia en niños con parálisis cerebral, sobre la atención dental en niños a temprana, además de mejorar las técnicas de cepillado bajo la filosofía mínima intervención dental, “Prevenir es mejor que Curar”

Mínima intervención dental, Parálisis cerebral

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Introduction

In Zacatecas, cerebral palsy is a public health problem and, therefore, of obligatory attention by governmental health authorities. Cerebral palsy involves, in principle, parents who must be made aware of the need for care, rehabilitation, improvement of the quality of life and social insertion of minors who, even today, remain hidden, hidden and abandoned in their homes as "lumps", sometimes as a result of extreme poverty, but also due to ignorance and social and family rejection.

For its part, the health authorities find it difficult or even impossible to provide sufficient care for these minors, which has motivated organisations such as APAC Zacatecas to carry out different activities with the aim of obtaining resources that will allow them to care for children who, according to scientific and technological advances, are susceptible to rehabilitation.

For some families it is difficult to accept that one of their members has a severe problema severe problem, so they require not only material support but also psychological support in order to accept a child who has psychological support for the acceptance of a child in this highly vulnerable condition.

Cerebral palsy is a heterogeneous group of non-progressive diseases caused by chronic brain damage caused by chronic brain injuries, which originate in the prenatal, perinatal or early perinatal period, perinatal, or in the first years of life. There are 4 main subtypes: spastic, athetoid, ataxic and mixed, The disorder can range from fine motor dyscontrol or severe limb stiffness.

The health care of persons with special needs requires specialised knowledge as well as increased requires specialised knowledge as well as increased dexterity, attention, adaptive and accommodative measures beyond what is considered routine.

Prevention of the most common oral diseases in these children is necessary Children with Cerebral Palsy, dental care, care is complicated by the involuntary movements, in addition to their involuntary movements, in addition to their systemic condition, aesthetic complications, and impediments conditions that contribute to an inadequate deterioration of facial growth, in addition to the facial growth as well as the development of diseases such as caries, paradontoparathy and malocclusion, dental malocclusions, sialorrhea, dental erosion, temporomandibular disorders, among others temporomandibular disorders, among others.

For this reason, the aim is to design protocols for care under the philosophy of Minimum Intervention.

Justification

It is an important public health problem, in addition to the fact that family members are treatment at a systemic level, leaving aside the state of oral health, together with a lack of knowledge on the part of the patient.

This is added to the lack of knowledge on the part of caregivers about preventive measures for oral health care of the oral cavity. A complete set of extracted teeth was mounted on the phantom head, stained with a thin layer of salt.

The teeth were stained with a thin layer of saliva on the labial surfaces and stained with a developer solution stained with developer solution.

The duration of tooth brushing was set at 2 minutes. The efficacy of biofilm removal was evaluated in terms of the differences in the percentage of staining of the staining of the developer solution before and after using the electronic toothbrush, using an image analyser image analyser software. Quantitative data analysis was performed using SPSS (paired t-test; $p<0.01$). Results. The image software analyser software analyser showed staining percentages with developer solution of 59.35 % (±15.13) in the pretest and 38.48% (±20.08) at post-test. Statistical Analyses revealed a significant difference significant difference in the removal of staining developer solution from the teeth using the device.

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Conclusions of this study were: The toothbrush-mounted robotic arm is an effective and innovative and effective instrument that is effective in removing dental biofilm on the tooth surfaces of the tooth surfaces of the wheelchair patient.

Another article from 1 November 2021 was analysed, this one was based on constraint-induced movement therapy for the constraint-induced movement therapy for cerebral palsy: its methodology was a video trial using a video. The aim of this multisite, factorial randomised controlled trial of the multisite randomised controlled trial of the Children's Arm and Hand Movement Project for Children with Hemiparesis (CHAMP), we compared 2 doses and 2 types of constraint-induced movement therapy (CIMT). (CIMT) with the usual treatment as usual. (UCT).

Whose methods were as follows, CHAMP randomly assigned 118 children aged 2-8 years with hemiparetic cerebral palsy to one of 5 treatments with assessments at baseline, end of treatment, and end of treatment hemiparetic cerebral palsy to one of 5 treatments with assessments at baseline, at the end of treatment and 6 months post-treatment and 6 months post-treatment. The primary blinded outcomes were, assessment of the helping hand; Peabody motor development scales, second edition; visuomotor integration; and quality testing of upper extremity skills.

Upper Limb Dissociated Movement skills test. Parents rated functioning on the Activities of Daily Living Scale of the Paediatric Disability Assessment Inventory-Adaptive Test. Disabilities Assessment Inventory-Computer Adaptive Test and the Child's Motor Activity Record how often. Analyses focused on blinded and blinded scores from parent reports and gains per parent reports and rank-ordered gains on all measures.

Findings varied in terms of statistical significance when individual blind outcomes were analysed Individual blinded outcomes, parent reports and rank-ordered earnings were analysed rank order. Consistently, high-dose CIMT, irrespective of the type of restraint, produced a pattern of type of restraint, produced a pattern of greater short- and long-term gains (1.7% probability of occurrence by chance alone).

Probability of occurrence by chance alone) and significant gains in visuomotor integration and movement visuomotor integration and dissociated movement at 6 months. O'Brien's rank-order analyses revealed that high-dose CIMT produced significantly greater improvement than moderate- or significantly greater than moderate dose or UCT. All CIMT groups improved significantly more in parent-reported functioning, compared to the parent-reported functioning compared to UCT. Children on UCT also showed objective gains (e.g., 48% exceeded the smallest detectable auxiliary hand assessment change, compared to UCT) smallest detectable auxiliary hand change, compared to 71% of high-dose CIMT at the end of treatment) end of treatment).

The conclusions from this therapy (CHAMP), provides novel, though complex, findings, with most of the individual blinded results falling below the age-standard significance below statistical significance for group differences, high-dose CIMT consistently produced the best results

Consistently produced the greatest improvements at both time points unexpected finding concerns changes in UCT, towards higher doses, with better results compared to previous reports results compared to previous reports.

One hundred and seventy-three studies were included in this review. Children with cerebral palsy have an increased risk of dental caries and untreated tooth decay. Higher osmolality of saliva is an important factor contributing to increased dental caries dental caries. Individuals with cerebral palsy are more likely to experience tooth wear and bruxism. Children have a poor quality of life related to oral health.

There is a high unmet need for oral health care in this group group. There is no suggested plan for the prevention of poor oral health for this group. A high number of included research-related studies are conducted in low- and middle-income countries in low- and middle-income countries, care should be taken when applying the results outside of this context results outside of this context. There is a lack of research conducted in people with cerebral palsy, aged 18 years and older.

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Conclusion

There is an increased risk of poor oral health in people with cerebral palsy and there is a high unmet need for oral health carea high unmet need for dental care in this group. This study highlights the need for further research to focus on adults with cerebral palsy and to understand the outcomes of oral health care in adults with cerebral palsy and to understand the outcomes of oral health care in the context of the settings.

The authors recommend the inclusion of classification systems and the integration of disability-inclusive language in future studies Another study is worth mentioning: Influence of autonomy and frequency of brushing on oral hygiene in institutionalised people with cerebral palsy.

Bizarra MF (1), Luis HS (1), Bernardo M (1) (1) Faculty of Dentistry, University of Lisbon, Lisbon, Portugal.

Dentistry, University of Lisbon, Lisbon, Portugal Objective: To assess the influence of institutionalisation type and number of years, type of institutionalisation, type and number of years, dependence and frequency of brushing, on dental hygiene in on dental hygiene in individuals with cerebral palsy:

An observational study was developed after approval by the was developed after approval by the Ethics Committee of the Faculty of Dentistry of the University of Lisbon, Portugal of the University of Lisbon, institutional and parental/guardian authorisation. Data collection data collection was done by analysis of medical records, in terms of type of cerebral palsy (CP), dependence and frequency of brushing, years of institutionalisation and type (regimen). (CP), dependence and frequency of brushing, years of institutionalisation and type (daily regime and/or home care) daily regime and/or home care).

– To assess the effectiveness of toothbrushing, the Oral Hygiene Index Simplified (OHI-S) was used.

Simplified Oral Hygiene Index (OHI-S) was used. The inclusion criteria were to be adolescents or adults who attended or lived in institutions with more than 3 persons with PC.

Data were analysed using IBM SPSS Statistics 25 (Statistical Package for the Social Sciences) using the Kruskal Statistical Package for the Social Sciences) using the Kruskal Wallis and Forward Stepwise method for linear regression tests linear regression tests.

Results: Of the 30 institutions evaluated Our misión To improve the oral health and quality of life of people with disabilities and disadvantage and to advocate for equitable disadvantaged and to advocate for equitable oral health care outcomes for the most disadvantaged.

Our mission, to improve the oral health and quality of life of people with disabilities and disadvantage and to advocate for equitable oral health care outcomes for people with disabilities and disadvantages and to advocate for equitable oral health care outcomes for people with special for people with special health care needs. Promote positive attitudes and behaviours towards disability and oral health within the profession through advocacy and profession through advocacy and education and the communitywith The objective of this study was to investigate the relationship between functional classification systems, the Functional functional classification systems, the Manual Ability Classification System (MACS), the Manual Ability

Relationship between the Manual Ability Classification System (MACS), the Gross Motor Function Classification System (GMFCS), and the Gross Motor Function Classification System (GMFCS).

Function Classification System (GMFCS) and functional status (WeeFIM) in children with spastic cerebral palsy spastic cerebral palsyRelationship between gross motor function and the function, activity and participation components of the function, activity and participation components of the International Classification of Functioning in children with spastic cerebral palsy.

This study aimed to assess the relationship between gross motor function, measured using the Gross Motor Function Measure (GMFM), the Gross Motor Function Classification System (GMFCS), the Gross Motor Function Classification System (GMFCS), the Manual Ability Classification System (MACS) and the Manual Ability Classification System (MACS) and the Functional Independence Measure for Children (WeeFIM), and the Function, Activity and the Function, Activity and Participation components of the International Classification of Functioning, Disability and Health (ICFHD).

Functioning, Disability and Health-Child and Youth Check List (ICF-CY) components in children with spastic cerebral palsy (CP). [Subjects and Methods] Seventy-seven children with spastic cerebral palsy participated in the study cerebral palsy participated in the study.

The GMFM, GMFCS, MACS, and WeeFIM were administered in their entirety to patients without orthoses or mobility aids. The ICF-CY was used to assess the degree of disability and health. [Results] The ICF Activity and Participation component score had a significantly strong correlation with GMFM scores correlated significantly with the GMFM, GMFCS, MACS, WeeFIM and ICF Function component scores.

Function. [Conclusion] When establishing a treatment plan for children with spastic CP, should take into account the physical abilities of the children and their limitation in activity, performance and participation, which would be measured by the Functional Profiles of children with cerebral palsy in Jordan of children with cerebral palsy in Jordan based on the association between gross motor function and gross motor function and manual dexterity. Nihad A Almasri1, et al. (2022).

Background: Cerebral palsy (CP) is the most common cause of physical disability in childhood physical disability in childhood. A major challenge in providing effective services to children with CP is the heterogeneity of the medical condition cerebral palsy is the heterogeneity of the medical condition.

It is expected that the categorisation of children into homogeneous groups based on functional profiles is expected to improve service planning is expected to improve service planning. The objectives of this study were (1) to describe the functional profiles of children with cerebral palsy based on the Gross Motor Function Classification Gross Motor Function Classification System-Expanded and Revised (GMFCS-E & R) and the

Objective:

To identify the types of cerebral palsy in children and to know what the protocols for dental care in patients with cerebral palsy are dental care in patients with cerebral palsy". Under the philosophy of minimum Level: State, National and International. 2015-2023

Methodology

It is a literature review, in articles and meta-analysis, through the following search engines: Google Scholar, Scielo. The Prisma methodology was used. Original sources in the following languages: English, Spanish, from journals consulted in databases. We included topic reviews, systematic reviews, meta-analyses, studies, observations and guidelines reviews, systematic reviews, meta-analyses, studies, observations, care guidelines. Descriptors: Health Care and Network of Care for the Disabled Person Inclusion criteria: Documents where dental care for patients with where dental care in patients with cerebral palsy in preschool children is reported preschool children. Dental care protocols under the minimum intervention philosophy in patients with cerebral patients with cerebral palsy. Search strategies: books, website documents, governmental resolutions and national surveys, published between 2016-2023.

Systematic reviews, meta-analyses, case-control and experimental. Material was organised according to context: state, national, international. Subjects considered children keywords were: children with cerebral palsy, dental care. Websites, government regulation, surveys. Using Boolean AND, OR or NOT indicators.

Exclusion criteria: documents prior to the year 2016, adult patients and patients with Down's syndrome, autism and other disabilities, among others.

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Results

18 articles were consulted, in peer-reviewed journals, 4 degree theses in different countries, as can be seen in the following table different countries as can be seen in Figure 1.

They were grouped as follows: articles on parents' and caregivers' knowledge of oral health care and caregivers' knowledge about oral care in children with cerebral palsy.

Experimental study, design of a toothbrush-mounted robotic arm for wheelchair-bound patients in wheelchairs. In Malaysia. In addition, 2 clinical cases were presented, one of a girl with cerebral palsy and the other an ankyloglossia of a child with cerebral palsy cerebral palsy. In addition to 4 meta-analyses on oral health care strategies for children with cerebral palsy, 4 meta-analyses on oral health care strategies for children with cerebral palsy were presented in children with cerebral palsy, as well as the design of a dental care programme for children with cerebral palsy children with cerebral palsy. In addition 2 epidemiological studies on: main oral health problems in children with cerebral palsy oral health problems in children with cerebral palsy and a study of the ceo index in this type of patients.

Different types of sample ranging from 37 to 150 study subjects, different methodologies in each study methodologies in each study. Surveys addressed to parents and caregivers who take care of these children with cerebral children with cerebral palsy.

At the Faculty of Dentistry, University of Teknology UniversitiTeknologi MARA, Sungai Buloh, Malaysia; Lee B. H. (2017).) Faculty of Information Science and Engineering and Engineering, University of Management and Sciences, Shah Alam, Shah Alam, designed the and evaluation of a toothbrush-mounted robotic arm for wheelchair-bound patients in wheelchair patients Al-Bayaty FH, Ahmad MS (Almasri, N. A., , S. H., & et al. (2018).

The aim of this research was, to fabricate a robotic arm mounted on a toothbrush which is toothbrush that is connected to a wheelchair and evaluate its effectiveness in removing dental biofilm dental biofilm.

The methods they used, was to build a robotic arm mounted on a toothbrush. Two hydraulic motors (DC motor), timer and an electronic toothbrush were purchased. They were assembled and attached to the side of the dental chair.

Acknowledgement

Thanks are due to the educational authorities of the kindergarten where the child with cerebral palsy was examined and cared for, as well as to the parents.

Discussion

The patient should be kept in the centre of the chair with arms and legs as close to the body as posible as close to the body as possible. Cushions, flotation devices, trunk and limb cushions can be used, trunk and limb cushions can be used to control involuntary movements and comfort the patient comfort the patient. The patient should be semi-sitting to reduce swallowing difficulty swallowing; if the patient has a wheelchair and prefers to be cared for there, this can and should be done be done. It is advisable to schedule appointments in the morning when the patient is not fatigued.

It is advisable to schedule appointments in the morning when the patient is not fatigued, and to use mouth openers and digital wedges always held in place with dental floss.

It is important to link the patient to preventive and individualised treatment programmes, including modifications to toothbrushes, toothbrush holders, toothpaste including modifications to brushes, floss holders, anti-plaque rinses and diet, where posible 24. Lopez-Santacruz (2019).

Conclusion

The authors consulted in this review recommend the inclusion of classification systems and the integration of disability-inclusive language in future studies, in addition to classifying the type of paralysis presented by the child. According to the characteristics, a protocol will be proposed for each situation. Promote oral health in caregivers and parents, involve more family members in order to avoid fatigue and exhaustion on the part of the main caregivers, promote oral hygiene, toothbrushes, toothpaste, toothpaste, toothbrushes, toothpaste, toothpaste, toothpaste and toothpaste oral hygiene, toothbrushes, toothpaste according to the size and age of the child with cerebral palsy the old adage that says at the bottom: "PREVENTION IS BETTER THAN CURE". In these patients it is essential to carry it out. Clearly explain the results obtained and the possibilities for improvement.

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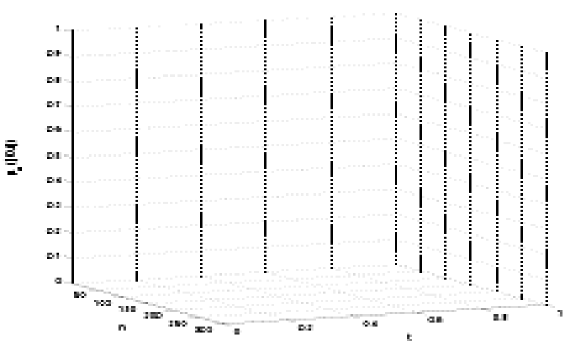

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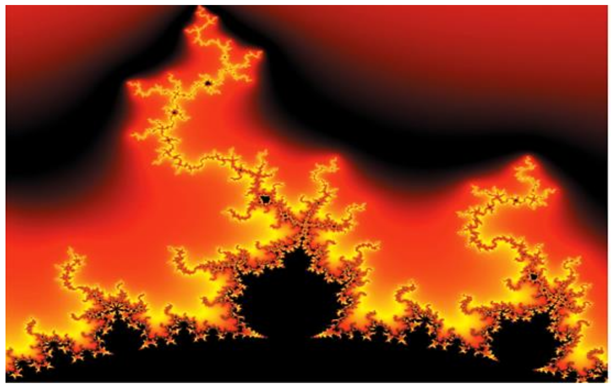

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