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Development of an Early Detection Tool for Pneumonia in Toddlers with Ari Program Respiratory Rate Timer Based on the Internet of Things

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Abstract
Delays in establishing a diagnosis of pneumonia in toddlers can increase toddler morbidity and mortality. Early pneumonia detection tools are very necessary to be able to provide appropriate intervention. The objective is to develop an early-detection tool for pneumonia in toddlers using the ARI Programme Respiratory Rate Time based on the Internet of Things by calculating respiratory frequency and oxygen saturation. The research methods use Research and Development (R&D) was carried out on toddlers with cough complaints in the working area of the Grogol Health Center, Sukoharjo Regency from December 2023 to January 2024. The sample consisted of 100 toddlers who were selected using consecutive sampling. The dependent variables are respiratory frequency and oxygen saturation. The independent variables are ARI based on IoT, ARI Timer, and pulse oximeter. Other data is collected through observation sheets. Data were analyzed using independent t-test analysis using the SPSS version 26. The results of the validation test assessment by 6 experts obtained a total average score of 95.48% with very valid assessment criteria, which means the tool is suitable for use. The results of the Independent T-Test show that there is no difference between IoT-based ARI (Mean=39.28; SD=9.05) and Timer ARI (Mean±SD= 39.29±9.07), this result is not statistically significant (p=0.994) and does not exist. the difference between IoT-based ARI (Mean±SD= 94.90±2.55) and pulse oximeter (Mean±SD= 95.15±2.61), this result is not statistically significant (p=0.494). The conclusion is an ARI Programme Respiratory Rate Timer based on the Internet of Things tool can be developed for the early detection of pneumonia in toddlers and is suitable for use to determine the respiratory frequency and oxygen saturation in toddlers.

Keywords: Pneumonia, ARI based on IoT, Respiratory Frequency, Oxygen Saturation.

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1. INTRODUCTION

Acute Respiratory Infection (ARI), especially pneumonia, remains a major disease that is the main cause of morbidity and death in children (Kurniawan, Sutiningsih, & Martini, 2023). Pneumonia causes more than 5 million deaths each year in children under five in developing countries. The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) have warned that every 39 seconds, one child dies from pneumonia (Sudrajat, 2020). Typical symptoms of this disease include increased respiratory frequency and difficulty breathing due to sudden lung inflammation. Pneumonia is an inflammatory process in the alveoli of the lungs caused by microorganisms such as *Streptococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli*, *Haemophilus influenzae*, and *Pneumocystis jiroveci* (Sa'diyah et al., 2022). Pneumonia is an endemic disease that spreads in almost all developing countries and is a very important problem (Fatimah F, 2022).

The incidence of pneumonia cases in developing countries, such as Indonesia, reaches around 30% in children under five years of age, which is equivalent to 10-20 cases per 100 children per year, and this is accompanied by a significant mortality rate (Winarsih, Ikrawati, & Handayani, 2023). In 2018, estimates show that around 19,000 children died from pneumonia. The Ministry of Health of the Republic of Indonesia recorded in 2021 that as many as 5,386 (19.13%) toddlers died between the ages of 29 days to 11 months (post-neonatal), 2,506 (8.9%) toddlers died between the ages of 12 to 59 months, and pneumonia is the main cause of post-neonatal under-five deaths, reaching 14.5%. The Central Statistics Agency (BPS) reported that 42.83% of deaths under five in the age range 12-59 months were caused by parasitic infections, while pneumonia caused 5.05% of deaths, diarrhea 4.5%, drowning 0.05%, and other factors 47.41% (Hakim, & Febriana, 2023).

Central Java Province is in third place in terms of the highest number of pneumonia cases among children under five in Indonesia in the period 2013 to 2017 (Sari & Cahyati 2019; Sari & Ridza, 2021). In 2021, Central Java Province reported that 31% of under-five deaths were caused by pneumonia (Dinas Kesehatan Provinsi Jawa Tengah, 2022). In 2019, Sukoharjo Regency reported 22 deaths of children under five, of which 1 case was caused by pneumonia (Pemerintahan Kabupaten Sukoharjo, 2022). Pneumonia is the second most common disease suffered by toddlers after diarrhea in Sukoharjo Regency. In 2019, the prevalence of pneumonia cases reached 3.61%, or around 1,315 cases. In 2018, 991 cases were reported, in 2017 around 993 cases, and in 2016 around 556 cases. These data indicate that there was an increase in the number of cases reported in 2019 compared to previous years (Dinas Kesehatan Kabupaten Sukoharjo, 2020). Grogol Health Center, Sukoharjo Regency is one of the health centers that has a high average number of visits from sick toddlers, reaching 148 sick toddlers per month.

One of the strategies used in managing pneumonia cases is to apply the Integrated Management of Sick Toddlers (MTBS) approach through the Acute Respiratory Tract Infection Prevention and Control Program (P2P ISPA) (Siregar & Nugraha, 2020). Implementation of the IMCI strategy has helped accelerate the reduction in mortality due to respiratory diseases and also increased the benefits obtained through ISPA control strategies (Aryani, 2017). In the implementation of P2P ISPA, medical devices such as the ARI Sound Timer and Pulse Oximeter are needed to assist in early detection and diagnosis of pneumonia (Harahap, Priyatna, Figna, & Rambe, 2023).

The ARI Sound Timer can be used to detect abnormal respiratory symptoms in toddlers, while the pulse oximeter helps in measuring blood oxygen levels, which is important for assessing the severity of respiratory illnesses. ARI Sound Timer is the currently recommended method for measuring respiratory frequency by counting the number of breaths in one minute (Karlen et al., 2014). Pulse oximeter is a safe and precise non-invasive method for measuring the level of oxygen contained in the blood. This tool is indispensable for

measuring oxygen saturation in arterial hemoglobin and can help in detecting hypoxic conditions at an early stage, before they reach potentially fatal levels, and allows immediate assistance (Naufal & Rifa'i, 2021).

One of the main problems faced by the ISPA P2P program is early detection and management of pneumonia cases. The implementation of the IMCI approach in community health centers is still not optimal, and the capacity of staff to diagnose pneumonia is still low. The low level of commitment of community health center staff in carrying out respiratory frequency calculations and lower chest wall retraction (TDDK) examinations is also an obstacle. In addition, limited resources, such as program oumonperational funds and tools for early detection, are obstacles to implementing the program, especially at community health centers (Kementerian Kesehatan RI, 2022).

The ARI Respiratory Rate Timer Program Based on the Internet of Things can be connected to laptops and smartphones because it is connected to the internet network. The examination results database is stored in cloud software, making it easier for health workers to access it. In addition, the stored database can be directly printed as reporting data or research data to help determine policies related to the problem of treating pneumonia. The large benefits that can be felt from using this tool, made the author take up research entitled development of an early detection tool for pneumonia in toddlers with the ARI Program respiratory rate timer based on the Internet of things.

2. RESEARCH METHOD

This research design study uses the Research and Development (R&D) method because this research design will produce certain products. Researchers will develop an early detection tool for pneumonia in toddlers using Internet of Things technology, where this tool will measure respiratory frequency and oxygen saturation as a basis for diagnosing pneumonia. The sampling technique used in this research is non-probability sampling with a consecutive sampling technique.

The population used in this study were toddlers with cough complaints who visited the KIA Room at the Grogol Health Center, Sukoharjo Regency. The number of visits by sick toddlers during the January-September 2023 period reached 1,331 patients with an average monthly visit of 148 babies under five.

The sample in this study was 100 toddlers with cough complaints who visited the KIA Room at the Grogol Health Center, Sukoharjo Regency who met the inclusion and exclusion criteria. The independent variable in this research is the Early Detection Tool for Pneumonia in Toddlers with the ISPA Respiratory Rate Timer Program Based on the Internet of Things. The variables related to this research are Early Detection of Pneumonia in Toddlers Based on Respiratory Frequency and Oxygen Saturation. The sampling technique used in this research is non-probability sampling with consecutive sampling techniques.

Data collection techniques use primary data and secondary data. Primary data is data obtained directly from a respondent who is the research subject, which in this case is data on toddlers who have coughs, toddler age, number of breaths, and oxygen saturation. Secondary data for this research is data related to toddlers who have coughs at the Grogol Health Center, Sukoharjo Regency which is used in this research, such as information regarding birth weight.

This research instrument uses the ARI Program Respiratory Rate Timer based on the Internet of Things and respondent identity sheets. The ARI Program Respiratory Rate Timer based on the Internet of Things is a tool development that is used as an early detection tool for pneumonia in toddlers. This tool has the function of measuring a toddler's respiratory frequency for 60 seconds or one minute and measuring oxygen saturation to assess the

toddler's condition so that a diagnosis can be made according to the classification in the guidelines for integrated management of sick toddlers (MTBS).

The data analysis method uses univariate and bivariate analysis. Bivariate analysis was collected in the form of a frequency distribution table and mean ± standard deviation (SD). Next, the research results will be discussed using relevant theories and references. Bivariate statistical analysis that will be used is the independent t-test to test differences in mean respiratory frequency and oxygen saturation using different measuring instruments. The confidence level used is 95% with an alpha of 5%. This research has been carried out for ethical feasibility under number 1324/EA/KEPK/2023.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of respondents in large-scale trials of the ARI program respiratory rate timer tool based on the Internet of Things.

Characteristics	Category	Frequency	Percentage
Parents' Age	<20 years	2	2,0
	20-35 years	82	82,0
	>35 years	16	16,0
Total		100	100
Education	Elementary School	2	2,0
	Junior High School	27	27,0
	Senior High School	62	62,0
	College	9	9,0
Total		100	100
Child's Gender	Male	55	55,0
	Female	45	45,0
Total		100	100
Child’s Age	>12-24 months	25	25,0
	>24-36 months	23	23,0
	>36-48 months	26	26,0
	>48-59 months	26	26,0
Total		100	100

Table 1 displays the frequency distribution of respondents' characteristics in terms of parental age, namely the majority are in the 20 to 35-year age range, 82 people (82%). The majority of parents' last level of education was up to Senior High School (SMA) level, 62 people (62%). The characteristics of the children in terms of gender show that the majority are male, 55 children (55%), while the age of the children shows that the majority are aged between >36-48 months and >48-59 months, respectively 26 children (26%).

Data homogeneity and normality tests need to be carried out before carrying out a comparative analysis of the results of measurements of respiratory frequency and oxygen saturation in the control group using the ARI Timer and pulse oximeter, while the intervention group uses the ARI Program Respiratory Rate Timer based on the Internet of Things. The results of the data homogeneity test for the respiratory frequency variable in the control group and intervention group were p(0.994)>0.05, which means that the data is homogeneous. The results of the data homogeneity test for the oxygen saturation variable in the control group and intervention group were p(0.812)>0.05, which means that the data is homogeneous.

The results of the data normality test are p value> 0.05, which means that the data is normally distributed. The results of the data normality test in both groups show that the

sample standard deviation in each group is around the population standard deviation, which means it is normally distributed.

Table 2. A Comparison of the Use of the ARI Program Respiratory Rate Timer Tool Based on the Internet of Things with ARI Timer in Determining Respiratory Frequency.

Variable		Control	Intervention	p-*value*
Respiratory Frequency	Mean ± SD	39,29 ± 9,07	39,28 ± 9,05	0,994
	Min – Max	26,00 – 66,00	26,00 – 66,00	

Table 2 displays the results of data analysis on a large-scale trial of the Internet of Things-based ARI Program Respiratory Rate Timer tool using the Independent T-Test and obtained a p-value (0.994)>0.05. The p value> 0.05 means that the average measurement results on respiratory frequency in the control group (ARI Timer) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years.

Table 3. A comparison of the results of measuring oxygen saturation in the control group using a pulse oximeter and the intervention group using the ARI Program Respiratory Rate Timer based on the Internet of Things.

Variable		Control	Intervention	p-*value*
Oxygen Saturation	Mean ± SD	95,15 ± 2,61	94,90 ± 2,55	0,494
	Min - Max	88,00 – 99,00	89,00 – 99,00	

Table 3 displays the results of data analysis on a large-scale trial of the Internet of Things-Based ARI Program Respiratory Rate Timer tool using the Independent T-Test and obtained a p-value (0.494)>0.05. The p value> 0.05 means that the average measurement results on oxygen saturation in the control group (pulse oximeter) and the intervention group (ARI Program Respiratory Rate Timer Based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

Sensitivity and specificity analysis of respiratory frequency measurement using the Internet of Things-Based ARI Program respiratory rate timer compared to ARI timer

a. Recall (Sensitivity)

Recall is the ratio of true positive predictions compared to the total true positive data. The recall value can be seen in the following data calculations:

Table 4. Recall (Sensitivity)

Recall	**=**	**(TP) / (TP+FN)**
	=	43 / (43+1)
	=	43 / 44
	=	0,98
	=	98%

The results of calculating the recall value obtained a value of 98%, which means that the model or information system is accurate in identifying relevant items. This can indicate

that the model is very good at doing its job and can be relied on to identify relevant items very well.

b. Specificity

Specificity is the correctness of negative predictions compared to all negative data. The specificity value can be seen in the following data calculations:

Table 5. Specificity

Specificity	**=**	**(TN)/ (TN + FP)**
	=	56 / (56+0)
	=	56 / 56
	=	1
	=	100%

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results.

Analysis of Sensitivity and Specificity of Oxygen Saturation Measurement Using ARI Program Respiratory Rate Timer Based on Internet of Things Compared to Pulse Oximeter.

a. Recall (Sensitivity)

Recall is the ratio of true positive predictions compared to the total true positive data. The recall value can be seen in the following data calculations:

Table 6. Recall (Sensitivity)

Recall	=	(TP) / (TP+FN)
	=	16 / (16+0)
	=	16 / 16
	=	1
	=	100%

Table 6 The results of calculating the recall value obtained a value of 100%, which means that the model or information system is very accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well.

b. Specificity

Specificity is the correctness of negative predictions compared to all negative data. The specificity value can be seen in the following data calculations:

Table 7. Specificity

Specificity	=	(TN)/ (TN + FP)
	=	84 / (84+0)
	=	84 / 84
	=	1
	=	100%

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results.

DISCUSSION

1. Results of respiratory frequency measurement using the ARI program respiratory rate timer tool based on the Internet of Things

Pneumonia is an inflammatory condition of the lungs in which the air sinuses in the lungs fill with inflammatory fluid, and can involve the infiltration of inflammatory cells into the walls of the alveoli and the spaces between the lung tissue. Pneumonia is often an acute bacterial infection and is characterized by a sudden attack, symptoms of fever, chills, pain in the pleura area, difficulty breathing (*dyspnea*), rapid breathing (*tachypnea*), productive cough with red phlegm, and an increase in the number of white blood cells (*leukocytosis*) (Prabawa, 2016).

This research tests a tool that has been designed to measure respiratory frequency in toddlers, namely the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool uses an FSR sensor which is installed on the belt and functions to receive the pressure generated by breathing activity so that the respiratory frequency can be calculated. The test results of the ARI Program Respiratory Rate Timer tool based on the Internet of Things in measuring respiratory frequency showed that the measurement error value was less than 5%, namely 1.04% and the accuracy value reached 98.96%, meaning that the calibration value of the sensor sensitivity used in the tool was valid. used.

Based on data analysis from a comparison of measurement results using old and new equipment, the results show that the average measurement results on respiratory frequency in the control group (ARI Timer) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years.

The ARI Program Respiratory Rate Timer based on the Internet of Things has several advantages compared to previous tools, namely that the respiratory frequency calculation is carried out automatically by this tool. Previously, respiratory frequency calculations were done manually by looking at the movement or rise and fall of the toddler's stomach and assisted by the ARI Timer tool as a reminder of the time. Manual calculations are carried out for 60 seconds by officers, but in practice, officers only count for 30 seconds and then the results are multiplied by 2 to get a count of 60 seconds. This can increase the risk of errors or discrepancies in respiratory frequency calculation results. Errors in calculating respiratory frequency can result in incorrect diagnosis of pneumonia in toddlers resulting in inappropriate treatment of the disease.

The results of calculating respiratory frequency using the Internet of Things-based ARI Program Respiratory Rate Timer will appear automatically on the device's LCD screen. The results will be visible immediately without the need to calculate manually. Another advantage of this tool is that it is able to store examination result data in a database which can be accessed directly anytime and anywhere using a device (laptop or smartphone) because it is connected to the internet network. Different from previous tools, manual calculation results must be recorded on the patient's physical examination sheet and the results can only be seen when looking at the patient's medical record document.

The results of this research are in line with research that designs tools based on the Internet of Things so that the tools created can be connected to the internet. The use of Internet of Things-based technology will make it easier for users to access electronic equipment online via an internet connection using a smartphone. Users can do this whenever and wherever they want as long as the device is connected to the internet network. This

device can be accessed with internet services via an Android smartphone so that it can increase the level of energy efficiency and working hours. This Internet of Things-based technology is appropriate to apply because it makes it easier for officers to carry out this work (Efendi, 2018).

Another study designed a tool used to calculate respiratory frequency in toddlers using an application embedded in an Android smartphone. The advantages of this tool are the same as those of the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool can be accessed directly using a smartphone and is able to display measurement results that are more valid than the results of manually calculating respiratory frequency using ARI Timer. Calculation of respiratory frequency has many risks of error, such as the officer forgetting to calculate the sequence of numbers because it was done for 60 seconds or the officer only calculating the respiratory frequency for 30 seconds and then multiplying it by 2 to get the respiratory frequency result for 60 seconds (Karlen W, Gan H, 2014).

The results of research that has been carried out and compared with previous research proves that the ARI Program Respiratory Rate Timer based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years with an error percentage of 1.04% and an accuracy percentage value. 98.96%. These results make this tool accurate enough to be used to measure respiratory frequency in toddlers. Testing a tool with a percentage error value of no more than 5% indicates that the calibration value of the sensitivity of the sensor used on the tool is valid to use.

Detection is generally carried out by identifying signs of abnormality or abnormality in a disease. This approach aims to prevent more serious complications that can harm a person's personality. This step can help individuals develop healthy thoughts, feelings and behavior, so that their existence can be accepted and recognized in the social environment as an overall healthy individual (Setyoningrum & Mustiko, 2020). Early detection also plays a role as a preventive measure from an early stage against possible indications of disorders (Wijayanti, Purwaningsih, & Trimawati, 2019).

2. Results of measuring oxygen saturation using the ARI program respiratory rate timer tool based on the Internet of Things

This research tests a tool that has been designed to measure oxygen saturation in toddlers, namely the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool uses a MAX30100 sensor which is used to measure oxygen saturation. The test results of the ARI Program Respiratory Rate Timer tool based on the Internet of Things in measuring oxygen saturation showed that the measurement error value was less than 5%, namely 0.89, and the accuracy value reached 99.11%, meaning that the calibration value of the sensor sensitivity used in the tool was valid. used.

Pneumonia is an acute respiratory infection that affects lung tissue, especially the alveoli, and is usually characterized by symptoms such as coughing and difficulty breathing (Afriani & Oktavia, 2021). Pneumonia is a public health problem because it is one of the factors causing the high infant mortality rate in Indonesia (Riyanto & Megasari, 2021). Toddlers who experience pneumonia and do not immediately receive appropriate treatment are at risk of death. Pneumonia is an inflammatory condition of the lung tissue, which in children is often described as bronchopneumonia (Siregar, 2018). Symptoms of pneumonia are often characterized by indrawing of the chest wall, rough breathing sounds when the child takes a breath (stridor), and rapid breathing (Lutfah & Heryawan, 2017).

Based on data analysis from the comparison of measurement results using old and new equipment, the results show that the average measurement results on oxygen saturation in the control group (pulse oximeter) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program

Respiratory Rate Timer tool based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

The ARI Program Respiratory Rate Timer based on the Internet of Things has several advantages compared to previous tools, namely that the oxygen saturation calculation is carried out simultaneously with the calculation of the toddler's respiratory frequency so that the diagnosis of pneumonia in toddlers is made faster. Pneumonia can be detected as early as possible with this tool so that toddlers can get more appropriate and faster treatment before the toddler's condition gets worse. Accuracy and speed in establishing a diagnosis of pneumonia can help reduce the risk of morbidity and mortality in toddlers due to pneumonia. Previously, oxygen saturation calculations could only be done at referral sites. When an examination is carried out at the first health service facility such as a Community Health Center, health workers can only calculate the respiratory frequency of toddlers manually using the available tool, namely the ARI Timer. If the calculation results show that the toddler is experiencing rapid breathing (more than 40 times per minute for ages >12 months to less than 5 years), then they will be referred to the hospital for an oxygen saturation check to determine the classification of pneumonia the child is suffering from. This will take a long time because many procedures must be completed, which can increase the risk of morbidity and mortality due to pneumonia due to delays in treating the disease.

The results of oxygen saturation calculations using the Internet of Things-based ARI Program Respiratory Rate Timer will appear automatically on the device's LCD screen. The results will be visible immediately so that you can immediately make a diagnosis of pneumonia according to the predetermined classification. Another advantage of this tool is that it is able to store examination result data in a database which can be accessed directly anytime and anywhere using a device (laptop or smartphone) because it is connected to the internet network. Different from previous tools, the calculation results only appear on the monitor screen and must be recorded on the patient's physical examination sheet so that the results can only be seen when viewing the patient's medical record documents.

The results of this research are in line with research that designs tools based on the Internet of Things so that the tools created can be connected to the internet. The use of Internet of Things-based technology will make it easier for users to access electronic equipment online via an internet connection using a smartphone. Users can do this whenever and wherever they want as long as the device is connected to the internet network. This device can be accessed with internet services via an Android smartphone so that it can increase the level of energy efficiency and working hours. This Internet of Things-based technology is appropriate to apply because it makes it easier for officers to carry out this work (Efendi, 2018).

Another study designed a tool used to calculate oxygen saturation using an application embedded in an Android smartphone. The advantages of this tool are the same as those of the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool can be accessed directly using a smartphone and is capable of displaying valid measurement results. The pulse oximeter embedded in the application on the smartphone has high accuracy when compared to modern pulse oximeters and is very helpful in measuring oxygen saturation because it is easy to access anywhere and at any time (Nufal F, 2021).

The results of research that has been carried out and compared with previous research prove that the ARI Program Respiratory Rate Timer based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

3. Results of sensitivity and specificity analysis of respiratory frequency measurement using the ARI program respiratory rate timer based on the Internet of Things

Measuring respiratory frequency using the ARI Program Respiratory Rate Timer based on the Internet of Things has an accuracy value of up to 99%, which means that the tool has classification capabilities with a good level of accuracy. The results of calculating the precision value obtained a value of 100%, which means that the tool has a high level of accuracy in making measurements. This means that the measurement results obtained from this tool have no difference compared to previously determined reference or standard values.

The results of calculating the sensitivity value obtained a value of 98%, which means that the model or information system is accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well. The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results. The results of calculating the F1 Score value obtained a value of 99%, which means that the model has very good performance in classifying the data. Based on a scale of 0-1, the F1 Score value of 0.99 indicates that the model is able to achieve high accuracy and is able to balance precision and recall well.

4. Results of sensitivity and specificity analysis of oxygen saturation measurements using the ARI program respiratory rate timer based on the Internet of Things

Measuring oxygen saturation using the ARI Program Respiratory Rate Timer based on the Internet of Things has an accuracy value of 100%, which means that the tool has classification capabilities with a good level of accuracy. The results of calculating the precision value obtained a value of 100%, which means that the tool has a high level of accuracy in making measurements. This means that the measurement results obtained from this tool have no difference compared to previously determined reference or standard values. The results of calculating the sensitivity value obtained a value of 100%, which means that the model or information system is very accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well.

The IoT concept is applied where all machines are given an identifier in the form of an IP address and use the internet network as a communication medium to exchange data between each other. This allows machines to interact in various locations without the constraints of distance (Kumar, Tiwari, & Zymbler, 2019). Sistem ini didesain dengan menggunakan algoritma cerdas yang dapat membantu dalam memprediksi dan mendiagnosis kondisi pasien berdasarkan gejala dan informasi medis (Handoko, & Neneng, 2021).

Pneumonia is inflammation of the lungs caused by infection from various types of microorganisms. Symptoms of pneumonia include fever, chills, night sweats, chest pain, cough, shortness of breath, phlegm, and headache. These symptoms are similar to those of other respiratory illnesses, making an accurate diagnosis time-consuming and expensive (Abdjul & Herlina, 2020). As a result, doctors often have to perform several tests before making a diagnosis. To ensure patients suffering from pneumonia receive appropriate care and treatment, it is vital to have access to the ongoing expertise and knowledge of specialist physicians (Arani et al, 2019).

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results. The results of calculating the F1 Score value obtained a value of 100%, which means that the model has very good performance in

classifying the data. Based on a scale of 0-1, an F1 Score value of 1 indicates that the model can achieve high accuracy and can balance precision and recall well.

This research has achieved significant progress in developing an expert system for early detection of pneumonia, with a high level of accuracy in identifying pneumonia cases. This research underscores the potential of such systems in the healthcare sector, while highlighting the importance of continuously improving their performance. In addition to increasing medical knowledge, this research also has the potential to improve health care outcomes for the general public (Cahyanto, Zulkarnain, & Farida, 2023).

IoT is a concept that aims to utilize internet connectivity that remains continuously connected. This allows us to connect various machines, equipment, and other physical objects with networked sensors and actuators. In this way, we can collect data and control the performance of these devices automatically. The tool developed is capable of storing measurement results data, including patient identity and examination results data as a data source for reporting pneumonia cases (Ranjan, Rao, Kumar, & Sharma, 2023).

4. CONCLUSION

The conclusion of the research regarding the development of an early detection tool for pneumonia in toddlers with the ARI Program Respiratory Rate Timer based on the Internet of Things, namely the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be developed for early detection of pneumonia in toddlers based on the results of calculating respiratory frequency and oxygen saturation. This tool is suitable for use to determine respiratory frequency and oxygen saturation in toddlers with a validation value of 95.48%. This tool is valid for determining respiratory frequency with an accuracy percentage value of 98.96% and valid for determining oxygen saturation with an accuracy percentage value of 99.11%. So, the ARI Program Respiratory Rate Timer tool based on the Internet of Things has a sensitivity level of 98% and specificity of 100% for measuring respiratory frequency and has a level of sensitivity of 100% and specificity of 100% for measuring oxygen saturation.

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