COVID-19 PORTABLE RESPIRATORY DIAGNOSTIC DEVICE

aReza Widianto Sudjud, bHana Nur Ramila, cArto Yuwono Soeroto, dTrio Adiono, eMuhammad Budi Kurniawan

ABSTRACT

Introduction: COVID-19 cases in Indonesia have been detected since March 2020 with continuously increasing numbers. Monitoring of non-severe COVID-19 cases undergoing self-isolation is a challenge due to the limited number of medical personnel and facilities. Respinos is a device designed to measure a patient’s respiratory rate, body temperature, and oxygen saturation connected to an online mobile application for telemedicine monitoring.

Objective: The purpose of this study was to assess the efficacy and barriers that patients might feel with the Respinos diagnostic device.

Methods: The study was a clinical trial with an intervention method performed on 97 patients with confirmed non-severe COVID-19 cases at Hasan Sadikin General Hospital from October to November 2021.

Results: The portable respiratory diagnostic device, Respinos, showed measurements of respiration rate, body temperature, and patient saturation that were relatively the same (p>0.05) with manual measurements both on periodic measurements (morning, afternoon, and evening) as well as the daily average.

Conclusion: Respinos can be considered a good monitoring tool for COVID-19 patients undergoing self-isolation as an aid for telemedicine.

Keywords: COVID-19, telemedicine, diagnostic tools, respinos.
RESUMO

Introdução: Os casos de COVID-19 na Indonésia foram detectados desde março de 2020 com números continuamente crescentes. A monitorização de casos não graves de COVID-19 em auto-isolamento é um desafio devido ao número limitado de pessoal e instalações médicas. Respinos é um dispositivo projetado para medir a frequência respiratória, temperatura corporal e saturação de oxigênio de um paciente conectado a um aplicativo móvel online para monitoramento por telemedicina.

Objetivo: O objetivo deste estudo foi avaliar a eficácia e as barreiras que os pacientes podem sentir com o dispositivo de diagnóstico Respinos.

Métodos: O estudo foi um ensaio clínico com método de intervenção realizado em 97 pacientes com casos confirmados de COVID-19 não graves no Hospital Geral Hasan Sadikin de outubro a novembro de 2021.

Resultados: O dispositivo portátil de diagnóstico respiratório, Respinos, mostrou medições de respiração frequência, temperatura corporal e saturação do paciente que foram relativamente iguais (p>0,05) com medições manuais tanto em medições periódicas (manhã, tarde e noite) quanto na média diária.

Conclusão: O Respinos pode ser considerado uma boa ferramenta de monitoramento para pacientes com COVID-19 em auto-isolamento como auxílio à telemedicina.


RESUMEN

Introducción: Se han detectado casos de COVID-19 en Indonesia desde marzo de 2020 y sus números aumentan continuamente. El seguimiento de los casos no graves de COVID-19 sometidos a autoaislamiento es un desafío debido al número limitado de personal e instalaciones médicas. Respinos es un dispositivo diseñado para medir la frecuencia respiratoria, la temperatura corporal y la saturación de oxígeno de un paciente conectado a una aplicación móvil en línea para monitoreo de telemedicina.

Objetivo: El propósito de este estudio fue evaluar la eficacia y las barreras que los pacientes podrían sentir con el dispositivo de diagnóstico Respinos.

Métodos: El estudio fue un ensayo clínico con un método de intervención realizado en 97 pacientes con casos confirmados de COVID-19 no graves en el Hospital General Hasan Sadikin de octubre a noviembre de 2021.

Resultados: El dispositivo portátil de diagnóstico respiratorio, Respinos, mostró mediciones de la respiración frecuencia, temperatura corporal y saturación del paciente que fueron relativamente iguales (p>0,05) con mediciones manuales tanto en mediciones periódicas (mañana, tarde y noche) como en el promedio diario.

Conclusión: Respinos puede considerarse una buena herramienta de seguimiento de pacientes con COVID-19 en autoaislamiento como ayuda para la telemedicina.

Palabras clave: COVID-19, telemedicina, herramientas de diagnóstico, respinos.
1 INTRODUCTION

COVID-19 cases in Indonesia have been detected since March 2020 and with continuously increasing numbers. Based on the available data, as of September 2, 2021, there are still 189,571 active cases of COVID-19, which include patients in the mild, moderate, severe and critical categories, who are undergoing self-isolation or hospitalized. The total number of confirmed COVID-19 cases is 4,100,138, with 3,776,891 cases recovering and 133,676 deaths.¹

COVID-19 pandemic has presented a challenging situation for health of general public. Patients with confirmed cases of COVID-19 might need a routine monitoring of vital function carried out at least 3 times a day or every change of doctor/nurse shift which includes the following parameters: respiration, temperature, pulse rate (beats per-minute/BPM), and peripheral oxygen saturation (SpO2) to detect any significant deterioration and avoid future complications. The monitoring process for patients in the ICU is assisted by special equipments, but the numbers are far fewer and limited when compared to non-ICU rooms which do might not have complete equipments hence monitoring is generally carried out manually by medical staffs who must interact directly with the patients. This increases the risk for the medical staffs, considering that there are many cases of medical staffs who are infected and even die. The Executive Board of the Indonesian Doctors Association in August 2021 reported that 640 doctors in Indonesia had died from COVID-19 and the Indonesian National Nurses Association reported that 373 nurses in Indonesia had died from Covid-19 in July 2021.²,³

With a very limited number of medical personnels and facilities, coupled with the difficulty of obtaining affordable and adequate equipment (some devices are still imported), it is quite a challenge to monitor patients with confirmed and suspected COVID-19. Therefore, a diagnostic device that can monitor health conditions, at least for the required parameters, which is practical to use, portable, at an affordable price, whose main purpose is to help medical staff to monitor remotely with accurate results as well as during direct examination is needed. Remote monitoring of COVID-19 patients does not only improve outcomes but also increases accuracy of electronic medical record due to its integration with online application and decreases the burden of medical staff. ⁴,⁵

This portable respiratory diagnostic device needs to be piloted to assess its efficacy and barriers that the patients may experience when used. It is necessary to assess whether the device is user-friendly and facilitates remote monitoring, whether the
obtained data is complete and accurate, as well as capturing the complaints that might occur either from the researchers and patients using this device. A clinical trial was conducted to improve the portable respiratory diagnostic device, Respinos.

2 MATERIALS AND METHODS

This study used a clinical trial design with intervention methods. Demographic data were used to assess the homogeneity of the study sample. If the data were not homogeneous, a re-sampling will be carried out if necessary. The research data were analyzed and presented in tabular forms according to the variables identified in the study. The research subjects were patients with confirmed COVID-19 through PCR swab of non-severe cases at Hasan Sadikin general hospital aged 18-60 years who were willing to take part in the study. Sampling was done using consecutive sampling technique. The research was conducted at Hasan Sadikin general hospital from October to November 2021.

The variables of this study included patient demographic characteristics, measurement of respiratory rate (times/minute), oxygen saturation (%), body temperature (°C), average respiration rate (times/minute), average oxygen saturation (%), and average body temperature (°C). For basic mode, monitoring includes measurement of respiratory rate, body temperature, and oxygen concentration three times a day (morning-afternoon-evening). The data collected were analyzed using statistical software (Microsoft® Excel 2019 and IBM SPSS 25.0) and is shown in a table.

3 RESULTS

The characteristics of study subjects were obtained based on age, sex, weight, height, body mass index (BMI), education, occupation, and race are presented in Table 1. The average age of the patients was 31.8 years, the majority of the patients were male (78.4%), the average BMI was 23.7 (normal), most patients had an associate degree (61.9%) and worked as a state civil servant (35.1%). We performed normality test based on the characteristics. Numerical data was tested with Shapiro-Wilks test because the number of data is less than 50. Table 1 describes the results of the normality test for the distribution of this study data which showed that the data was normally distributed (p>0.05)
Table 1. Characteristics of Study Subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Catagorical Data</th>
<th>Numerical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>76</td>
<td>78.4%</td>
</tr>
<tr>
<td>Female</td>
<td>21</td>
<td>21.6%</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational degree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate</td>
<td>60</td>
<td>61.9%</td>
</tr>
<tr>
<td>Bachelor</td>
<td>37</td>
<td>38.1%</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State civil servant</td>
<td>34</td>
<td>35.1%</td>
</tr>
<tr>
<td>Private sector employee</td>
<td>31</td>
<td>32.0%</td>
</tr>
<tr>
<td>Students</td>
<td>32</td>
<td>33.0%</td>
</tr>
</tbody>
</table>

source: developed by the authors

The results of measured respiratory rates between groups using Respinos and manual measurement showed relatively the same results (not significantly different) from the first to fifth day in the morning, afternoon, and evening measurements (Figure 1; p>0.05) and by average measurement per-day (Figure 2; p>0.05).

Figure 1. Comparison of Respiratory Rates between Respinos and Manual Measurement Group on Day 1 to 5 in the Morning, Afternoon and Night

source: developed by the authors
Measurement of body temperature in both showed relatively same results throughout the first to fifth day in the morning, afternoon, and evening measurements (Figure 3; p > 0.05) except in the morning of the fourth and fifth day where manual measurement showed a significantly higher temperature than Respinos. The daily average body temperature did not show a significant difference between the groups using Respinos and manual measurement (Figure 4; p > 0.05).
Figure 3. Comparison of Body Temperature between Respinos and Manual Measurement Group on Day 1 to 5 in the Morning, Afternoon and Night

source: developed by the authors

Figure 4. Comparison of the Average Body Temperature between Respinos and Manual Measurement Groups on Day 1 to 5

source: developed by the authors

The oxygen saturation of patients in the both groups did not show a significant difference on the first to fifth day in the morning, afternoon, and evening measurements (Figure 5; p>0.05). The average daily oxygen saturation between the two groups also showed relatively similar results on the first day to the fifth day (Figure 6; p>0.05).
Figure 5. Comparison of Oxygen Saturation between Respinos and Manual Measurement Group on Day 1 to 5 in the Morning, Afternoon and Night

Figure 6. Comparison of the Average Oxygen Saturation between Respinos and Manual Measurement Groups on Day 1 to 5

source: developed by the authors

4 DISCUSSION

This study was conducted on 97 adults of the Malay race aged 18 years and over. There was no difference in the age of the subjects between the two groups. This certainly describes the population infected with COVID-19 at Hasan Sadikin general hospital Bandung.
Measurement of respiratory rate with Respinos has no significant difference compared to manual measurement. In day-to-day measurements, it is expected that the variability of one measurement method with other measurement methods is small because the measurements are carried out sequentially in a close period of time. Measurements with Respinos detect expiratory airflow of study subjects while measurements of respiration manually assess the movement of the chest wall, especially during inspiration. These differences in observations may cause differences in the frequency of up to several breathing cycles, but statistically no significant differences were found.

Temperature measurement with Respinos has no significant difference compared to manual measurement. Temperature measurement using Respinos is quite accurate because the device uses a probe that is attached to the patient’s axillary. Therefore, the difference in temperature measurement between two groups is expected to be minimal and statistically insignificant.

Measurement of oxygen saturation with Respinos has no significant difference compared to ordinary manual oximetry. Oxygen saturation measurements using Respinos were performed consistently on the subject’s finger and showed accurate results.

The limitations of this study were the difference in the measurement time span between subjects hence it may cause measurement variations. This risk has been minimized by having measurements taken at the same time every day but it does not fully ensure that there is no variability between the two measurement time points. Another drawback is that respinos cannot be used in patients who are uncooperative or have decreased cognitive function.

5 CONCLUSIONS

The portable respiratory diagnostic device, Respinos, has shown measurements of respiratory rate, body temperature, and oxygen saturation which are relatively the same as manual measurements, both on periodic measurements (morning, afternoon, and evening) as well as daily averages. Respinos can be considered as a monitoring tool for COVID-19 patients undergoing self-isolation and aids as a telemedicine medium.
ACKNOWLEDGMENTS

The authors extend our gratitude to all patients participating in the study and every medical staff of Hasan Sadikin general hospital Bandung for their support.
REFERENCES


