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SOWANS E-TB Application Innovation on Quality of Life and Medication Compliance in MDR-TB Patients

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Abstract

***Background**: Tuberculosis (TB) is a direct infectious disease caused by Mycobacterium Tuberculosis. WHO reported that during 2014 – 2016, almost 89% of the world's population suffered from TB. Furthermore, the 2017 WHO report showed that there were 14 countries in the world that experienced a double burden of TB such as sensitive TB, MDR-TB and TB/HIV. WHO estimates that there are 23,000 cases of MDR/RR in Indonesia. **Purpose**: The general aim of this research is to determine the effectiveness of the telemedicine system on the quality of life and medication adherence of MDR-TB patients. Creation of the SOWANS E-TBS telemedicine system in the form of an application and website that helps treat MDR-TB patients. **Methods**: This research method is quasi experimental. Where a treatment group and a control group will be formed. The treatment group will be given the E-TB SOWANS application. Then compared with the control group. Both groups will be given quality of life questionnaires and medication adherence before and after treatment. **Results**: The distribution of MDR TB patients based on the intervention and control groups showed that 20 MDR TB patients received treatment (53.6%), while the number of patients in the control group was 18 people (47.4%). MDR TB patients based on treatment compliance showed that MDR TB patients who had non-adherence to treatment were 11 (28.9%) patients, and those who were adherent to treatment. **Conclusion**: Based on the research results and discussion by referring back to the problem formulation and hypothesis, it can be concluded that there is an influence of the E-TBCS application innovation on the quality of life of MDR-TB patients. Current advances in technology 4.0 can help improve the quality of life of MDR-TB patients.*

Keywords: *Application; Telemedicine; Counseling; SOWANS; Tuberculosis*

1. Introduction

Background provides the state of the art of the study and consists of an adequate background, the previous researches and significance of the study to show the scientific merit or novelties of the paper. Avoid the use of literature review or a summary of the results. The purpose of the study should be stated at the end of the introduction section. Tuberculosis (TB) is a direct infectious disease caused by Mycobacterium Tuberculosis. Until now, TB is still a world health problem. There were 442,000 TB cases recorded in the program, of which there were an estimated 8,600-15,000 MDR/RR TB cases, (estimated 2.4% of new cases and 13% of previously treated TB patients)(Van Gurp et al., 2019). TB – MDR is TB that is resistant to fifampicin and isoniazid, the two most powerful anti-TB agents; it requires treatment with the RR-TB regimen and also requires treatment with second-line drugs (Benson Ncube et al., 2023a). With the increasing use of Xpert MTB/RIF for the concurrent detection of TB and rifampicin resistance, more and more cases of RR-TB (without further testing for isoniazid resistance) are being detected and notified (Nsengiyumva et al., 2018).

Extensively drug-resistant TB (XDR-TB) is defined as MDR-TB plus resistance to at least one drug in both of the most important drug classes in MDR-TB regimens fluoroquinolones and second-line injectable agents (amikacin, capreomycin or kanamycin) (Shokri et al., 2023). The diagnosis of Drug-Resistant TB is confirmed based on the M, tuberculosis susceptibility test using either conventional methods using solid media or liquid media, or using rapid test methods with GeneXpert or with LPA Central Sulawesi Province had a Case Detection Rate (CDR) for TB in 2018 of 417/100,000 people suffering from TB of all types. Of all districts/cities in Central Sulawesi Province, the highest TB cases were found in Palu City with 693 cases (Alipanah et al., 2018). Where 467 cases were new cases of

BTA+. Tuberculosis treatment affects the quality of life of TB patients. TB patients who receive complete and regular treatment will have good treatment results, thus affecting the patient's quality of life (Falzon et al., 2019). A prospective study was conducted during three stages of treatment, namely the initial period of treatment, the intensive period, and the final period of treatment, and patients who completed treatment regularly showed quality of life scores that continued to increase (Assaye et al., 2023). This shows that there is an association between treatment adherence and the patient's quality of life (Campbell et al., 2021).

Quality of Life is an individual's perception of their position in life according to the cultural context and values in which they live and in relation to life goals, hopes, standards and concerns (Paniagua-Saldarriaga et al., 2021). This is a broad concept that influences a person's physical health, psychological state, level of dependency, social relationships, personal beliefs and their relationship with future desires for their environment (Fadaizadeh et al., 2018). Health Related Quality of Life (HRQoL) is defined as health status and is viewed as an increasingly complex continuum of patient outcomes, including biological/physiological factors, symptoms, function, general health perception and overall well-being or quality of life (Chowdhury & Chakraborty, 2017).

Counseling is a form of psychotherapy used to help TB patients, especially MDR-TB, to overcome the problems they face. Counseling is a process where someone who is experiencing difficulties is helped to feel and then act in a way that is more satisfying to him, through interaction with someone who is not involved, namely the counselor (B. Ncube et al., 2020). The counselor provides information and reactions to encourage clients to develop behavior to relate more effectively to themselves and the environment (Huang et al., 2019). A systematic review suggests that telemedicine can overcome many of the challenges of providing health care services to rural and remote areas (Velen et al., 2022). Telemedicine involves the use of medical information exchanged from one site to another through electronic means to improve health (Mehrian et al., 2020).

The development of a telemedicine system for treating TB disease has been developed in several countries, such as Ukraine (Maimaitiming et al., 2023). Telemedicine networks enable electronic document exchange, storage and tracking, direct communication between doctors and patients, and epidemiological monitoring. Desktop video conferencing is used, and the software provides support for DICOM Images (http://www.e-works.com). The network web portal (http://www.itub.dn.ua) allows access to video conferencing(Benson Ncube et al., 2023b).

2. Materials And Methods

Research design

This research method is quasi experimental. Where a treatment group and a control group will be formed. The treatment group will be given the SOWANS E-TB application. Then compared with the control group. Both groups will be given quality of life questionnaires and medication adherence before and after treatment(Blackstone & Hauck, 2022).

Setting and samples

The population of research respondents is in the Palu city area. The sampling technique will be carried out randomly in each cluster of Community Health Center areas. The total population of pulmonary TB sufferers in Palu City is 693 cases with 467 new cases, so the estimated calculation of MDR-TB patients in new cases is 467 x 2.4% = 11 cases. And the estimate for old MDR-TB patients is 226 x 13% = 29 cases. Total 11 + 29 = 40 cases. The research sample consisted of 20 respondents in the treatment group and 20 respondents in the control group. Research inclusion criteria include: MDR TB patients, Willing to take part in research and can use or have a family that can use a smartphone and internet connection. Research exclusion criteria include: The patient dies and patients cannot take part in the study until it is completed (Pathak & Das, 2021).

3. Results and Discussion

Univariate Analysis

Based on the research results, the characteristics of the respondents were obtained in table 1.

Table 1. Respondent Characteristics

Characteristics	N	Percentage (%)
Age (years)		
Age 26-35 **years**	12	31,6
Age 36-45 **years**	8	21,1
Age 46-55 **years**	11	28,9
Age ≥55 **years**	7	18,4

Gender		
Female	20	52,6
Male	18	47,4
Level of education		
Not attending school	4	10,5
Elementary school	7	18,4
Junior high school	5	13,2
Senior High School	11	28,9
Diploma	5	13,2
Bachelor	6	15,8
Work		
Work	18	47,4
Doesn't work	20	52,6

Table 1 shows that the majority of respondents were aged 26-35 years (31.6%), female (52.6%), high school/equivalent education level (28.9%), and unemployed (52.6%). %).

Table 2. Distribution of Quality of Life of MDR TB Patients in the Intervention Group and Control Group Pretest and Posttest

Domain 1 (Physical Health)		
Intervention Group	Pre-test	Post-test
Mean	55,25	65,05
Standard Deviation	11,6	3,6
Median	56	63
Maximum	88	69
Minimum	38	56
Control Group	Pre-test	Post-test
Mean	52,61	53,39
Standard Deviation	10,05	9,4
Median	50	50
Maximum	88	69
Minimum	38	38

Domain 2 (Psychological Condition)		
Intervention Group	Pre-test	Post-test
Mean	56,95	68,35
Standard Deviation	9,09	3,4
Median	56	69
Maximum	75	75
Minimum	44	56
Control Group	Pre-test	Post-test
Mean	58,7	62,28
Standard Deviation	12,6	3,4

Domain 3 (Social Relationships)		
Intervention Group	Pre-test	Post-test
Mean	56,9	74,6
Standard Deviation	11,9	6,4
Median	56	75
Maximum	81	81
Minimum	31	50
Control Group	Pre-test	Post-test
Mean	58,2	57,2
Standard Deviation	12,3	14,5
Median	56	56
Maximum	81	75

Minimum	31	13

Table 2 shows the average score in the physical health domain in the two research groups, where the intervention group at the pretest showed an average result of 55.25 with a standard deviation of 11.6. Meanwhile, the posttest had a mean value of 65.05 with a standard deviation of 3.6. The control group showed that the average score of patients in domain 1 at the pretest was 52.61 with a standard deviation of 10.05. The posttest results show an average value of 53.39 with a standard deviation of 9.4.

The average score in the psychological condition domain in the two research groups, where the intervention group at the pretest showed an average result of 56.95 with a standard deviation of 9.09. Meanwhile, the posttest showed an average result of 68.35 with a standard deviation of 3.4. The results of the control group showed an average score at pretest of 58.7 with a standard deviation of 12.6. Meanwhile, the posttest showed an average value of 62.28 with a standard deviation of 3.4.

The mean score in the social relations domain in the two research groups, where the mean score for the pretest intervention group showed a result of 56.9 with a standard deviation of 11.9. The mean value at posttest was 74.6 with a standard deviation value of 6.4. The results in the control group show a mean value of 58.2 with a standard deviation of 12.3. The average posttest score showed a result of 57.2 with a standard deviation of 14.5.

The mean score in the environmental condition's domain in both research groups, the intervention group at pretest showed an average score of 61.1 with a standard deviation of 8.5. The posttest score showed a result of 75.8 with a standard deviation of 5.4. The results for the control group showed that the mean value was 60.4 with a standard deviation of 12.5. Meanwhile, during the posttest, the mean value was 65.7 with a standard deviation of 10.3.

Table 3. Distribution of Adherence to Medication in MDR TB Patients

Medication Adherence	Pre-test	%	Post-test	%
Interven**tion Group**				
Obedient	13	65	18	90
Not obey	7	35	2	20
Control Group				
Obedient	12	60	13	65
Not obey	**6**	**40**	**5**	35

Table 3 shows that the majority of respondents in the treatment group were compliant in taking medication at pretest (65%) and at posttest (90%). Meanwhile, in the control group, most respondents adhered to taking medication (60%) and during the posttest (65%).

Bivariate Analysis

Before carrying out bivariate analysis, a data normality test was first carried out. The normality test uses the Kolmogorov Smirnov statistical test.

Table 4. Pretest Normality Test Results for Quality of Life in MDR TB Patients

Quality of Life Domain	Group		
	Intervention Sig value	Control Sig value	Note
Domain 1	0,029	0,202	Abnormal
Domain 2	0,179	0,027	Abnormal
Domain 3	0,087	0,077	Abnormal
Domain 4	0,314	0,024	Abnormal

Table 4 shows that the results of the normality test for the quality of life of pretest respondents are not normally distributed. Thus, the parametric t-dependent test cannot be used. Bivariate analysis will use a non-parametric statistical test, namely the Mann Whitney test.

Table 5. Post-test Normality Test Results for Quality of Life in MDR TB Patients

Quality of Life Domain	Group		
	Intervention	Control	Note

	Sig value	Sig value	
Domain 1	0,001	0,028	Abnormal
Domain 2	0,001	0,276	Abnormal
Domain 3	0,001	0,002	Abnormal
Domain 4	0,001	0,529	Abnormal

Table 5. shows that the results of the normality test for the quality of life of posttest respondents are not normally distributed. Thus, the parametric t-dependent test cannot be used. Bivariate analysis will use a non-parametric statistical test, namely the Mann Whitney test.

Table 6. Average Normality Test Results for Medication Adherence in MDR TB Patients

Medication Adherence	**Group**		Note
	Intervention Sig value	Control Sig value	
Pre-test	0,607	0,104	Normal
Post-test	0,001	0,832	Abnormal

Table 6. shows that the results of the posttest medication adherence normality test are not normally distributed. Thus, the parametric t-independent test cannot be used. Bivariate analysis will use a non-parametric statistical test, namely the Wilcoxon test. Next, a bivariate analysis was carried out on the research results as follows.

Table 7. Mann Whitney Post-test Results Intervention group and Quality of Life Control for MDR TB Patients

Difference Test	**Significance value**	**Note**
Intervention and Control	0,001	Significance

Table 7. shows the statistical test results of $p = 0.001$ ($p < 0.05$), so it can be concluded that there is an influence of the E-TBC application on the quality of life of MDR TB patients.

Table 8. Wilcoxon Test Results for Medication Adherence in MDR TB Patients

Difference Test between 2 paired groups	**Significance**	**Note**
Compliance with taking medication	0,001	Significance

Table 8. shows the statistical test results of $p = 0.001$ ($p < 0.05$), so it can be concluded that there is an influence of the E-TBC application on compliance with taking medication in MDR TB patients.

This research is a Quasi Experimental type of research with a randomized pretest and posttest control group design. The distribution of MDR TB patients based on the intervention and control groups showed that 20 MDR TB patients received treatment (53.6%), while the number of patients in the control group was 18 people (47.4%).

MDR TB patients based on treatment compliance showed that MDR TB patients who had non-adherence to treatment were 11 (28.9%) patients, and those who were adherent to treatment were 27 patients. Defines patient compliance as "the extent to which patient behavior is in accordance with the provisions given by health professionals". The patient may not comply with the objectives or may simply forget or misunderstand the instructions given. Compliance comes from the word "obey" which means obedient, obedient, disciplined (Idrus & Sunarno, 2015). Compliance is the level of behavior of sufferers in taking treatment, for example in determining healthy living habits and treatment decisions(Pappalardo et al., 2021). In treatment, a person is said to be disobedient if the person neglects his or her obligations to seek treatment, which can result in obstruction of healing. The results of this study are in accordance research that the use of teleconsultation by counselors via the video directly observed therapy (VDOT) system is feasible and acceptable (Idrus & Sunarno, 2022), with increased compliance and high quality of life for patients. The median duration of VDOT use was 5.5 months (range 1-11). Compliance was similar in San Diego (93%) and Tijuana (96%). Compared to face-to-face meetings, 92% preferred VDOT, 81% found VDOT more confidential, 89% never/rarely had problems recording video, and 100% would recommend VDOT to others. Seven (13%) participants were returned to DOT directly and six (12%) additional participants lost their phones, were damaged, or stolen (Alvarez-Risco et al., 2021).

The results of different tests show that there is a difference in the quality of life of MDR TB patients in the control and treatment groups using the ETBC SOWANS application. This is consistent with several previous studies reviewing the effects of this technology on TB treatment adherence and patient

outcomes. The research results are able to provide information that can be used to improve TB control strategies. Through the use of information technology in the form of applications, better results will be achieved in health service compliance with the National Health Program and patient compliance with the treatment and cure of diseases. Several studies have reported the effects of digital interventions, including video-observed therapy (VOT) and treatment monitoring (MM), to support the treatment of active TB(Iqbal, 2020). Two observational studies of VOT reported comparable treatment completion rates when compared with face-to-face DOT. MM increased the chance of cure in one observational study. Around the world, patients and healthcare providers are increasingly using mobile devices to communicate. Therefore, it is important to understand how technology can be best used to provide patient-centered treatment support and allocate resources more wisely. Data from ongoing and future studies, including non-inferiority studies, pragmatic trials, and cost-effectiveness analyses, will help optimize practical approaches(Dheda et al., 2022). This could include targeting different entry points on underexplored behavioral change pathways, and combining multiple technologies to improve their impact on TB treatment adherence and patient quality of life. This is in accordance shows that the evidence base from research on digital technology targeting TB is slowly starting to develop. Although there is interest in the use of digital technology to improve care for TB sufferers, reported impacts vary and evidence from implementation studies is limited. Certain digital technologies can support TB treatment efforts while reducing patient and provider costs, as well as patient discomfort(Bhaskar et al., 2020).

The results of this study differ from study with a larger number of respondents, namely 3,074 patients, 2686 (87%) of whom were included in the intention-to-treat population. 1909 (71%) of 2686 patients were men, 777 (29%) were women, and the median age was 44 years (IQR 29–58). At 18 months from treatment initiation, using multiple imputation for missing outcomes, 239 (16% [geometric mean cluster-level proportion]) of 1,388 patients in the control group and 224 (16%) of 1,298 intervention groups had an event of the primary composite outcome (289 [62%] of 463 loss to follow-up during treatment and 42 [9%] recurrence of tuberculosis) (Bowsher et al., 2021). The intervention had no effect on the risk of the primary composite outcome (adjusted risk ratio 1·01, 95% CI 0.73–1·40). The digital treatment monitoring intervention showed no impact on negative patient behavior such as loss to follow-up during treatment, tuberculosis recurrence, death, and treatment failure (Fadaizadeh et al., 2020). There was failure to change patient management following identification of medication nonadherence at monthly reviews. This may occur due to a lack of timely compliance data, and due to failure to change management after discovery of non-compliance at monthly reviews (Khan et al., 2022). Rather than performing monthly adherence assessments (Shokri et al., 2023), more frequent review of adherence data by healthcare personnel and initiation of intensive management to assist patients who have adherence problems may be necessary to reduce loss to follow-up(Bashshur et al., 2019).

Better understanding of adherence patterns and their association with adverse outcomes, coupled with more timely review of adherence data and increased implementation of different treatments may be necessary. Especially in larger populations. Further research on a larger sample is needed to confirm the effectiveness of the E-TBCS system (Li et al., 2020).

Implication and limitations

Obstacles Research involving TB patients often involves monitoring or intervening with individuals who may be at high risk or vulnerable. This requires researchers to adhere to strict ethical guidelines to protect patients' rights, privacy and welfare. Sometimes, the available data may be limited and can affect the accuracy of research results and make conclusions more difficult. Selection bias can arise if the sample of TB patients used is not representative of the wider population.

4. Conclusion

Based on the research results and discussion by referring back to the problem formulation and hypothesis, it can be concluded that there is an influence of the SOWAN E-TB application innovation on the quality of life of MDR-TB patients. Current advances in technology 4.0 can help improve the quality of life of MDR-TB patients.

Apart from that, this research also shows the influence of the innovative SOWAN E-TB application on medication adherence for MDR-TB patients. Application technology can make it easier for patients to communicate with counselors at any time. This is very helpful in assisting patients to increase motivation to take medication.

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Author contribution

All authors (AS, BC, SGN) contributed to the completion of this paper providing significant contributions throughout the development of the manuscript, including conception, design, data analysis, writing, and revision.

Conflict of interest

There is no conflict of interest in this study.

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