Model to Reduce the Risk of Tuberculosis Transmission through Tissue, Mask and Sosa Pocket Addition into DOTS System Completeness in Medan, Province of North Sumatera 2017

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Abstract. Prevalence of Tuberculosis in North Sumatera Province in 2013 was 200 per 100,000 population. Case Detection Rate in Medan in 2012 was 89.42 %, higher than national target of 70%. Reducing the risk of transmission requires specific action to destroy the bacteria inside the sputum, can be obtained through mask usage, disposing sputum in the tissues and soaking them into SOSA pocket containing 5% klorofen (4-kloro-alfa-fenilokresol). This study aimed to compare the risk of TB transmission between intervention and non-intervention group in using SOSA pocket. The population all new TB patients with smear-positive who came to health center with highest pulmonary TB in Medan. The sample taken purposively 30 patients for intervention group which the SOSA pocket and 30 patients for non-intervention group which only mask. The design was a quasi-experiment using post-test only design with control. The risk of transmission was measured using the questionnaire after two-months application. The results presented significant reductions of transmission risk between intervention and non-intervention groups based on gender, age, education, occupation, Directly Observed Treatment (DOT) providers’ role, sputum disposing habit and the potential of transmitter source (p<0.05). The health center are expected to educate TB patients using SOSA pocket to terminate TB transmission.

1. Introduction
Tuberculosis (TB) is an infectious disease which has been a serious threat to global society health [1, 2, 3]. Case Detection Rate (CDR) in Medan city in 2012 was 89.42 %, higher than national target of 70% [4]. The bacteria in droplet nuclei produced by patients were a potential source of transmission [5]. But this can be prevented through mask usage and throw second-hand tissue or mask on the SOSA pocket containing five per cents klorofen.

Pulmonary TB incidence keeps increasing, and Indonesia position as endemic country raised up from the fifth rank in 2015 to the second rank in 2016. TB treatment package in Directly Observed Treatment Short-course (DOTS) programme for all this time included sputum test and provided Anti Tuberculosis (AT) medicine for six months. Effective and efficient termination of transmission chain is necessary to support TB problem solving, through education and mask and tissue usage.

Mycobacterium tuberculosis as the agent of pulmonary TB is straight or slightly curved bacille-shape, non-spore and non-capsule bacteria. Source of transmission is pulmonary TB patient with
smear-positive who are able to transmit the disease to surroundings mainly people who make close contact with the patient. The bacteria was spread in the open air in droplet nuclei (aerosols) form when coughing or sneezing.

Coughing is advantageous to M. tuberculosis as a means of spreading to new hosts. It is possible that the cough reflex in tuberculosis is triggered more frequently than is physiologically required for protecting and clearing the airway [6].

In a household contact study enrolling 96 sputum culture-positive index TB cases and their 442 contacts, contacts of patients with TB who produced high aerosols (less than ten Colony-Forming Unit/CFU) were more likely to have a new infection compared with contacts from low-aerosol (one to nine CFU) and aerosol-negative cases (69 %, 25 %, and 30 %, respectively; p = 0.009) [7].

A retrospective cohort study in 2016 of 85 patients with smear-positive TB and their 369 household contacts in Kampala, Uganda also indicated on the increased risk of TB progression amongst contacts of high-aerosol case-patients [8]. Consequently, feasible actions must be determined to prevent the spread of the aerosols containing the bacteria.

One of the primary prevention efforts is to terminate the transmission chain of pulmonary TB so there will be no more new case of TB. This effort can be obtained by preventing TB bacteria in its initial source which is pulmonary TB patient’s sputum from entering the new host through the droplet nuclei. Mask, which is usually used to cover almost all facial area, become a tool to prevent droplet nuclei of pulmonary TB patient. A tissue is an alternative tool to clean up hands and another body parts. SOSA pocket was basically a place for the gadget to keep it water-resisted, which was modified to be a five-per-cents-klorofen-containing place for second-hand tissue and mask disposal of the smear-positive pulmonary TB patient. Klorofen was used for its ability to destroy the tubercle bacillus in sputum. Ref. [9] found that no growth of tubercle bacilli could be obtained after sputum had been mixed with klorofen in two and a half per cents dilution for half an hour.

Experiments by Ref.[10] carried out on the disinfection of sludge with klorofen, formol, copper sulphate, and chlorine. One of the results, after treatment for one week, was that the tubercle bacilli in Imhoff-tank sludge from purification plant Tb.R.I (an activated-sludge plant; with a dry-matter content of six and a fifth per cents) were killed by a half percent klorofen. 10 A preliminary report by Ref. [11] resumed a series of experiment using antiformin, carbolic acid and klorofen. They reported that klorofen and various quantities of carbolic acid have been added to pure sodium hypochlorite and smaller percentages of these disinfectants will destroy the tubercule bacillus.

Klorofen itself is a derivate of phenol (carbolic acid) group of disinfectant. It is a solution of cresol in saponified vegetable oil. In a test run by Ref. [12], phenol was found to be extremely effective in all the tests done. It produced at least a 5-log10 reduction (maximum level of detection) in suspension and a 4-log10 reduction of the test organism when dried on the surfaces of steel disks. The tuberculocidal activity was not affected by the presence of sputum. Ref. [13] also reported that phenol at five percents for one minute (tube technique) or for ten minutes (slide technique) was effective in decontaminating sputum smears from M. tuberculosis [13].

Fig 1. Both front and back side of SOSA pocket.

This study aimed to compare transmission risk of TB in intervention and non-intervention group to access the efficacy of intervention model with SOSA pocket.
2. Materials and Method

2.1. Materials
The design of this study was a quasi-experiment using post-test only design with control. In this study, free masks, tissues, and SOSA pockets (formerly were waterproof gadget covers) containing five per cents klorofen [see Figure 1 and 2] were given to intervention group.

2.2. Methods
The SOSA pockets were used until the patients were declared as smear-negative. Free masks and tissues only were given to non-intervention group based on TB department staff’s instruction in the health center. The term “SOSA” pocket stood for the authors’ name combination, “SOrimuda-SyArifah”. The model of this pocket is still in process of accessing its patent right. In this pocket, the function notification was attached, which was to destroy pulmonary TB bacteria in masks and tissues. Besides, there were also some messages attached for the patients related to their disease, which was not to forget taking the medicine, because if so, the TB bacteria would be resistant and the disease becomes worse (multidrug resistant, MDR-TB), the medication period would be longer, and the side effect would be more severe.

There was also message attached to the patient to use mask and tissue every time, and soak them in SOSA pocket after use. The direction of refilling this pocket was also given, started by filling the klorofen solution into the pocket, putting second-hand masks and tissues in the pocket until fulfilling the solution inside the pocket, then taking them out of the pocket into a plastic bag, throwing the plastic bag in the rubbish bin, and refilling the pocket for the next use, and keep using this pocket until the patient being declared smear-negative by examination in the health centre.

The population was all new TB patients with smear-positive who came to health centre health with highest pulmonary TB visitation rate in Medan City, which were Teladan, Johor, Helvetia, and Pasar Merah. The sample was taken purposively which were new TB patients with smear-positive who sought for medication in those health center until the sample size was fulfilled. Sample size was 30 patients for intervention group which the SOSA pocket was given and 30 patients for non-intervention group which only mask was given and the numbers had been statistically normal distributed. The interview with a questionnaire was conducted to both intervention and non-intervention group. The questionnaire had been tested and measured and the result gave the value of reliability (>0.05) and validity (<0.05).

The transmission risk was measured by scoring the answers given by the respondents in both intervention and non-intervention group. Independent variables were categorical measures of the patient’s characteristics (age, gender, education, occupation), Directly Observed Treatment (DOT) providers’ role, sputum disposing habit, and potential of transmitter source. While the dependent variable was measured by using a questionnaire to obtain the transmission risk using ratio scale based on the scoring result of respondents’ answers. Then data was described and being tested by means comparing test of t-independent and Mann-Whitney test from each independent to dependent variable on both groups.

For the purpose of clear understanding, the potential of transmitter source variable was defined as a group of actions which were supportive to the mode of TB transmission, such as non-compliance with the treatment, mode of the mouth covering, and dealing with post-usage mouth-covering things. Complying the treatment, using recommended mode of the mouth covering (e.g tissue or mask), and safe dealing with post-usage mouth-covering things would be low-categorized; otherwise, they would be high-categorized.

2.3. Ethical considerations
The intervention and the questionnaire were approved by Faculty of Nursing University of North Sumatera by an ethical clearance no. 12225/VI/SP/2017. The field staff approached eligible individuals in the locations of study and explained the procedures and benefits of this study in understandable sentences. This study was also approved by Medan City Health Office. A written informed consent was obtained from each of all participants prior to the interview.
3. Result and Discussion

It was found in the intervention group that the highest proportions were in the group of male (76.7 %), ≤ 42 years of age (53.3 %), high education (66.7 %) and employed (70.0 %). While in the non-intervention group, the highest proportions were in the group of male (56.7 %), both ≤ 42 and >42 years of age (50.0 %), high education (80.0 %), and employed (70.0 %) (Table 1).

| Table 1. Distribution of TB Patients based on their characteristics |
|---------------------------------------------------------------|
| Characteristics | Intervention | Non-Intervention |
|-----------------|--------------|-----------------|
|                 | f  | %  | f  | %  |
| Gender          |    |    |    |    |
| Male            | 23 | 76.7 | 17 | 56.7 |
| Female          | 7  | 23.3 | 13 | 43.3 |
| Age (years old) |    |    |    |    |
| ≤ 42            | 16 | 53.3 | 15 | 50.0 |
| > 42            | 14 | 46.7 | 15 | 50.0 |
| Education       |    |    |    |    |
| Low             | 10 | 33.3 | 6  | 20.0 |
| High            | 20 | 66.7 | 24 | 80.0 |
| Occupation      |    |    |    |    |
| Unemployed      | 9  | 30.0 | 9  | 30.0 |
| Employed        | 21 | 70.0 | 21 | 70.0 |

The DOT providers’ role in the intervention group was at the highest proportion in good role category of 24 patients (80.0 %). While in non-intervention group, the highest proportion was in not-good role category of 20 patients (66.7 %) (Table 2).

| Table 2. Distribution of TB Patients based on their DOT Providers’ Role, Sputum Disposing Habit, Potential of Transmitter Source |
|----------------------------------------------------------------------------------------------------------------------------|
| Distribution | Quality | Intervention | Non-Intervention |
|--------------|---------|--------------|------------------|
|              |         | f  | %  | f  | %  |
| DOT          | Good    | 24 | 80.0 | 10 | 33.3 |
| Providers’ role | Not-good | 6  | 20.0 | 20 | 66.7 |
| Sputum       | Good    | 23 | 76.7 | 1  | 3.3  |
| Disposing Habit | Not-good | 7  | 23.3 | 29 | 96.7 |
| Potential of Transmitter | Low    | 22 | 73.3 | 6  | 20.0 |
| Source       | High    | 8  | 26.7 | 24 | 80.0 |

Based on the sputum disposing habit, we obtained the highest proportion of the intervention group which was in good habit category of 23 patients (76.7 %). While in the non-intervention group, the highest proportion was in not-good habit category of 29 patients (96.7 %) (Table 2). Based on the potential of transmitter source, we obtained the highest proportion of the intervention group which was in a low category of 22 patients (73.3 %). While in the non-intervention group, the highest proportion was in a high category of 24 patients (80.0 %) (Table 2). The bivariate analysis gave the result of significant reduction of transmission risk in intervention group compared to non-intervention group based on gender (male, p= 0.0075; female, p= 0.0005), age (≤ 42 years old, p= 0.0015; >42 years old, p= 0.005), education (low, p=0.045; high, p=0.000), occupation (unemployed, p=0.000; employed, p=0.004) (Table 3).
We refer to the intervention group was significantly lower than in non-intervention group (p=0.0) (Table 4).

Table 3. Difference in TB Risk Transmissions based on Characteristics

| Characteristics | Test Groups | Meansa | SDsa | p   | 95% CI | Medians (min-max)* |
|----------------|-------------|--------|------|-----|--------|-------------------|
| Gender         | Male        | Intervention (n=23) | 8.7  | 5.6 | 0.0    | -7.1 – (-0.8)     |
|                | Female      | Intervention (n=7)  | 6.3  | 3.3 | 0.0    | 5(3-11)           |
|                |             | Non-Intervention (n=13) | 14.3 | 3.7 | 0.0    | 14(5-19)          |
| Age (Years old)| ≤ 42        | Intervention (n=16) | 7.1  | 4.9 | 0.0    | 5(1-19)           |
|                | > 42        | Non-Intervention (n=15) | 12.7 | 3.5 | 0.0    | 13(5-17)          |
|                |             | Intervention (n=14) | 9.3  | 5.3 | 0.0    | -8.3 – (-1.2)     |
|                |             | Non-Intervention (n=15) | 14.1 | 3.9 | 0.0    | -10.1 – 0.8       |
| Education      | Low         | Intervention (n=10) | 10.2 | 5.6 | 0.0    | -11.4 – (-4.1)    |
|                |             | Non-Intervention (n=6) | 14.8 | 3.4 | 0.0    | -13.6 – 14.9      |
|                | High        | Intervention (n=20) | 13.0 | 3.7 | 0.0    | 14(5-19)          |
| Occupation     | Unemploye d | Intervention (n=9)  | 6.6  | 4.1 | 0.0    | -7.1 – (-1.1)     |
|                | Employed    | Non-Intervention (n=9) | 14.3 | 3.2 | 0.0    | -8.3 – (-1.2)     |
|                |             | Intervention (n=21) | 8.8  | 5.5 | 0.0    | -7.1 – (-1.1)     |
|                |             | Non-Intervention (n=21) | 12.9 | 3.9 | 0.0    | 5(1-19)           |

a) means and SD are not accurate enough as central tendency in abnormal distributed data. Hence, the medians (min-max) are provided as the substitution.

There was a significant reduction of transmission risk based on DOT providers’ role in the intervention group compared to the non-intervention group (p=0.0) (Table 4).

Table 4. Difference in TB Risk Transmissions based on PMO’s Role, Sputum Disposing Habit, Potential of Transmitter Source

| Difference in TB Risk Transmissions | Test Groups | Meansa | SDsa | p   | Medians (min-max)* |
|-------------------------------------|-------------|--------|------|-----|-------------------|
| PMO’s Role                          | Intervention | 1.7    | 2.1  | 0.0 | 1 (0 – 6)         |
|                                     | Non-Intervention | 4.8    | 2.4  | 0.0 | 5.5 (0 – 7)       |
| Sputum Disposing Habit              | Intervention | 1.1    | 1.0  | 0.0 | 1 (0-4)           |
|                                     | Non-Intervention | 3.0    | 0.7  | 0.0 | 3 (0-4)           |
| Potential of Transmitter Source     | Intervention | 1.4    | 1.3  | 0.0 | 1 (0-4)           |
|                                     | Non-Intervention | 3.2    | 1.1  | 0.0 | 3 (0-5)           |

a) means and SD are not accurate enough as central tendency in abnormal distributed data. Hence, the medians (min-max) are provided as the substitution.

The habit of disposing of sputum in the intervention group was also significantly lower than in the non-intervention group (p=0.0) (Table 4). Similarly, the potential of transmitter source in intervention group was significantly lower than non-intervention group (p=0.0) (Table 4).

The risk of TB transmission is highly influenced by daily TB patients’ habit and cough etiquettes. We are aware that global health authorities and agencies do not recommend covering mouth/nose using bare hands when coughing as the bacteria will collect on the hands and from which they can easily be transmitted to others. But the most common daily fact is that many people do not even cover their mouth/nose when coughing or sneezing. Moreover, previous findings reported that history of contact
with a known TB patient was one of many factors of TB transmission [14]. The lack of good habits as early protection when being exposed to contact of known TB patient was obviously risky in the scheme of TB transmission. Major findings in this study include: (a) reduction of transmission risk was found based on characteristics, DOT providers’ role, sputum disposing habit, and the potential of transmitter source, and (b) model of intervention with SOSA pocket gained its role in reducing the transmission risk.

Model of intervention in this study appeared to be the development based on daily cough etiquette in society. In their result background, Ref. [15] stated that the definition of respiratory hygiene/cough etiquette of covering mouth and nose with the arm, sleeve, or elbow had been added as a new maneuver soon after the Severe Acute Respiratory Syndrome (SARS) and Avian Influenza (AI) outbreaks. This maneuver is inconsistently recommended in written publications of global health authorities. While no general consensus exists regarding the best description of the respiratory hygiene/cough etiquette among some health agencies, it appears that: “cover your mouth and nose with a tissue when you cough or sneeze. Dispose of the used tissue in a rubbish can. If you don’t have a tissue, cough or sneeze into your elbow or sleeve, not in your hands” is the most acceptable recommendation. Although the result indicated that all of the manoeuvres do not block droplets expelled as aerosol when coughing and still permit direct, indirect, and/or airborne transmission of some diseases including TB, but their study challenged for new procedures that effectively block cough bioaerosol to interrupt the chain of transmission and spread of Infectious Respiratory Disease (IRD) [15].

In this study, our model of intervention had been developed considering such condition mentioned in the previous result. As the result indicated, the similarity in dominant characteristics found both in TB patients of intervention and non-intervention groups, as shown in Table 1, giving an indication that patients’ characteristics in this study design were proportionally not significant with the TB occurrence itself, regarding the focus of this study which is the comparison between two groups of TB patients. The characteristics comparison between the two groups indicated that male, high education and employed were among the dominant categories. While the age group shares non-significant differences among the categories. WHO reported that characteristics of TB incidence in Indonesia by 2016 were higher in males (698,000 in estimated total; range 424,000-972,000) than females (323,000 in estimated total; range 196,000-449,000). By age group, WHO reported that estimated incidence in >14 years old group (961,000; range 584,000-1,340,000) was higher than 0-14 years old group (60,000; range 36,000-83,000) [1]. Similarly, Ref. [16] found that male category was among variables associated with pulmonary tuberculosis in Germany (n = 568, 66.4 %) [16].

In another hand, a report by Depkes RI (Indonesian Department of Health) based on 2013 Basic Health Research mentioned that TB prevalence was higher in >45 years of age group compared to the other age groups. By the education aspect, it was found that the higher the educational level, the lower the prevalence was. By the occupational aspect, it was found that the highest prevalence was in the unemployed group [17].

Some other studies may perform various result based on TB characteristics. But, we have no doubt that each measure of the characteristics holds a role in TB transmission risk. Ref. [18] found that age (Odds Ratio/OR = 0.473, p = 0.018) and gender (OR=1.613, p=0.027) were included in the risk factors influencing adult pulmonary TB in Indonesia.

In their study in Uganda, Ref. [19] reported that based on their characteristics, the TB patients were highest in age group of <40 years (296 patients; 81.1 %), female (207 patients; 56.7 %), un/self-employed (110 patients; 64.0 %), and in primary education (110 patients; 30.1 %). These findings, especially in terms of age and gender, sometimes were found different with another study. Dhanaraj, et al. (2015) reported that in their research in a metropolitan city of South India, those in the age group of 55 years and above had a very high prevalence of smear-positive pulmonary TB estimated at 470 (95 % Confidence Interval/CI 338–601), for culture positive pulmonary TB 527 (95 % CI 388–666) and for bacteriologically positive pulmonary TB 722 (95 % CI 605–942). A consistently significantly higher prevalence was observed amongst males when compared to females for smear, culture and bacteriologically positive pulmonary TB across all age groups. However, in the age group >65 years, there was an observed decrease in prevalence which was relatively more for smear positive as compared to both culture and bacteriologically positive disease [20].
These were similar (except for gender) with Ref. [21] who mentioned in their study in China that amongst household contacts, the elder people (aged above 65 years old) (Adjusted Odds Ratio/AOR 4.96, p<0.05) and men (AOR 1.52, p<0.05) were most likely to be diagnosed TB.

Regarding the source of infection, Ref. [22] mentioned in their result that the risk of infection from household and community sources increased from birth until 20 years of age [22]. While from the transmission mode point of view, Ref. [5] mentioned that young children and infants, having both recent exposures by nature and a higher risk of rapid progression, can act as sentinel populations for ongoing transmission, but rarely contribute to ongoing transmission, owing to their decreased infectiousness. In older populations, incident tuberculosis is a less reliable measure of ongoing transmission because of difficulties in identifying the timing of infection and distinguishing between reactivation of latent infection and early active disease [5].

In more specific explanation of the age group categories, Ref. [23] found that young age was among factors related to the individual for tuberculosis. Children with primary infection before two years or after ten years of age were at increased risk for disease development. The highest risk for TB-related mortality following primary infection occurred during infancy. The risk declined to one per cent between one and four years of age, before rising to more than two percent from 15 to 25 years of age [23]. Regarding age and education categories, Ref. [24] explained in their result of multiple logistic regression in Croatian population that the lowest level of education (OR=3.44, 95 % CI 1.39-8.50) and unemployment (OR=2.69, 95 % CI 1.18-6.16) were among significant factors for pulmonary tuberculosis [24].

Proportionally, our study reported that there was a significant difference between intervention and non-intervention groups based on DOT providers’ role. A good role was dominant in the intervention group while not-good role was dominant in the non-intervention group. This was supported by the statistic test result which performed a significant reduction of transmission risk scores in intervention group compared to the non-intervention group.

The similar results were also found in variables of disposing of sputum habit and potential of transmitter source. These were closely related to the interventions themselves, as before interventions were given, both groups respectively accepted counseling about sputum disposing habit. However, in the intervention group where SOSA pockets were given, there were also messages attached to the pockets which always could be read by the patients. These messages could influence aspect of sputum disposing habit in order to reduce the transmission risk. The Proportion of good habit was dominant in the intervention group, while not-good habit was dominant in the non-intervention group. Statistical test results indeed supported these proportion differences, which indicated a significant reduction of transmission risk scores in the intervention group compared to the non-intervention group.

Some supportive findings were found regarding to disposing of sputum habit. Ref. [25] found that disposing sputum in any place (p=0.016) is one of factors influencing the transmission risk of pulmonary TB. Safe sputum disposal had also been the study focus of Singh, et al. (2016) amongst pulmonary TB patients from Northern India. Safe sputum disposal was practiced by 46.4 % of the study subjects. More females (70.4 %) than males (39.2 %) disposed sputum safely, as did more subjects of literate than illiterate (categories used for education variable) subjects (n=150, 57.5 % vs. n=46, 28.6 %). The difference in the proportion observed was found to be statistically highly significant (p < 0.001) in those categories [26].

DOTS program can not be separated from the role of DOT providers. In this study they were mainly from the family member or relatives. Their roles, whether good or not-good, are always important in determining TB treatment success rates. When they were compared to DOT provided by a non-family member, previous study in Gujarat, India, reported that they also achieved similar treatment success rates [27].

In the aspect of the potential of transmitter source, as defined before in the previous part of this study, many findings supported the need of low-categorized habits. Ref. [28] mentioned in their result that habit of not using mask was one of the risk factors of TB infection (OR=2.01 ; 95 %CI 0.7 – 5.3), beside the absence of sunlight at workplace and exposure to dust at work place. In terms of treatment compliance, Ref. [29] in their mixed-method study in urban Zambia reported that in total, 31 patients (ten per cents) had previously been noncompliant, ranging from pausing treatment for a week to completely abandoning treatment (Lost to Follow-up/LTFU).
There was no evidence of an association between non-compliance and sex, age, education, profession, Human Immunodeficiency Virus/HIV, seeking alternative health care, stigma, or financial constraints. Patients’ difficulties with time/distance to be at/reach the clinic indicated a possible association with a higher risk of non-compliance (OR 0.52; 95% CI 0.25, 1.10, p=0.086) [29]. The results of this study also challenged for more advanced studies to evaluate the safety and efficacy of the model of intervention. Another alternative forms of this model may be found in the future in order to make it easier and convenient to use and applied.

4. Conclusion
The characteristics of the intervention and the non-intervention groups were respectively similar, which were dominant in male patients, with high education, and employed, except in age group category which almost share the same proportion. However, good DOT provider’s roles, good sputum disposing habit, and the low potential of transmitter source were more dominant in the intervention group compared to the non-intervention group. The intervention group which SOSA pockets were given show significantly lower TB transmission risk compared to the group which SOSA pockets were not given. These results could become an indicator to recommend SOSA pocket into DOTS program as a solution to reduce the risk of TB transmission and lower the TB incidence.

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