ORIGINAL ARTICLE

Effectiveness of mirror-assisted screening device in aiding pharyngitis diagnosis and raising patients' awareness of rational antimicrobial use with related perceptions

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ABSTRACT

Antimicrobial drugs used for pharyngitis are prone to irrational use owing to ease of access to various sources and other risk factors. A mirror-assisted screening device (MASD) was developed to promote rational antimicrobial use, but it was not fully evaluated. This study aimed to assess the effectiveness of MASD in aiding the pharyngitis diagnosis and rational antimicrobial use of patients with pharyngitis and to elicit the perceptions of patients and healthcare providers about the use of MASD. A single-blinded, quasi-intervention study was conducted among Thai patients with pharyngitis attending primary care centers, called sub-district health promoting hospitals, in 10 provinces of three regions, i.e. the Eastern, Northern and North-eastern regions, during the 2019-2021 period. Eligible samples were conveniently allocated to an intervention group obtaining normal care plus MASD use or a control group receiving solely normal care. Patients in both groups completed a questionnaire pre- and post-interventions. All data were analyzed using descriptive statistics and a Chi-square test. The results showed that patients in the intervention and control groups (n = 2,031 and n = 235, respectively) were mostly female adults working in agricultural sectors in the North-eastern region. The rates of antimicrobial use in both groups were statistically different (17.0% vs. 24.7%, p = 0.004; RR 0.69, 95%CI [0.54, 0.88]); the relative risk reduction was 31.2%. Both groups had anticipated and intended needs for an antimicrobial and also requested it. They were mostly satisfied with MASD and willing to check their throat infections and antimicrobial use. The providers were also satisfied with and confident in using MASD to facilitate the diagnosis. Overall, MASD was effective as a pharyngitis diagnostic aid that helped patients raise their awareness of antimicrobial consumption. Further studies are required to evaluate the use of MASD in other primary care settings.

Keywords:
Mirror-assisted screening device, pharyngitis diagnosis, patient awareness, patient perception, rational antimicrobial use

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INTRODUCTION

Antimicrobials are drugs, chemicals or other substances that kill, inactivate or slow the growth of microbes, such as bacteria (antibacterials), viruses (antivirals) and fungi (antifungals). A subset of antimicrobials is called "antibiotics", which are compounds inhibiting the growth (bacteriostatic) or killing bacteria (bactericidal) and now become synonymous with "antibacterials".[1] It is important that antimicrobials should be appropriately utilized to treat infections. The irrational use of the drugs may bring about antimicrobial resistance, adverse drug events, higher treatment costs, prolonged hospital stay, or even death.[2] Antimicrobial resistance (AMR) has been a matter of great concern worldwide. The World Health Organization (WHO) reported in 2019 that AMR globally causes at least 700,000 deaths a year, including 230,000 deaths from multidrug-resistant tuberculosis. If no appropriate measure is implemented, the figure might increase to 10 million deaths per year by 2050.[3] In Thailand, AMR results in approximately 38,000 deaths annually with overall economic losses of 1,200 million USD.[4]

The use of antimicrobials has been targeted for rational drug use (RDU). According to WHO, the rational use of medicines requires that "patients receive medications appropriate to their clinical needs, in doses that meet their own individual requirements, for an adequate period of time, and at the lowest cost to them and their community".[5] This is generally known as "5 rights" – the right drug at the right dose by the right route at the right time for the right patient.[6] WHO has urged all member countries to promote RDU through rational drug policies, structures, evidence-based information, patient education and training for healthcare professionals.[7] As for Thailand, the Ministry of Public Health has started a national policy on RDU that includes some strategies, such as RDU hospital programs that focus on raising RDU awareness among health professionals, particularly prescribers, and promoting multidisciplinary teamwork.[8] Partly involved in this RDU movement is the national strategic plan on AMR that comprises antimicrobial stewardship programs, AMR prevention and control measures, antibiotic smart use, campaigns to enhance public knowledge and awareness of AMR and rational antimicrobial use, etc.[4,9] Although there are ongoing activities to promote RDU, irrational antimicrobial use still exists, especially in the case of upper respiratory infections and diarrhea for which antimicrobials are not usually required.[9]

Pharyngitis, commonly known as sore throat, is an upper respiratory infection (URI) that manifests as inflammation of the pharynx.[10] URIs, including pharyngitis, usually occur between late winter and early spring, but in Thailand, it takes place throughout the year as a common regional disease in every age group.[9] Most of these infections, or approximately 80% of cases, are a common cold caused by viruses, but the rest are bacterial and rarely fungal infections.[11] In general, viral causes are usually self-limiting and managed by symptomatic treatment. On the other hand, bacterial causes are usually supra-infections occurring after viral infections in the first few days; the infection of group A streptococcus (GAS) is the crucial one. Most bacterial infections are more severe and require antimicrobial therapy to eradicate the pathogens and prevent complications. However, a growing increase in AMR has alerted healthcare professionals to minimize antimicrobial use with rational approaches.[12] In practice, the differential diagnosis of viral and bacterial pharyngitis is quite a challenge by means of

patients' history with signs and symptoms. However, throat culture and rapid antigen detection tests are not routinely practical.[12]

Antimicrobials used for pharyngitis are often prone to irrational use, partly because people conveniently have access to the drugs through various sources, e.g. hospitals, pharmacies and other settings. Additionally, many people mostly lack knowledge and understanding of the drugs and they are unaware of the consequences of irrational antimicrobial use. For example, they misconceive that antimicrobials can cure a sore throat regardless of viral or bacterial infections and often request them from physicians.[13] As non-medical prescribers, especially Thai nurses, have been allowed to prescribe some antimicrobials at primary care centers, they might experience the same situation as physicians. This possibly leads to inappropriate prescribing practices, which merits an investigation.

To resolve the problem of irrational drug use, a screening tool called "mirror-assisted screening device" (MASD) was therefore developed to aid the pharyngitis diagnosis and enable patients to be aware of their throat infections and antimicrobial consumption. Its ultimate goal is to reduce unnecessary antibacterial use. MASD was initially devised by the International Health Policy Program (IHPP) and collaborators[14] and reproduced with permission by the Thai FDA and Drug System and Monitoring Center. Nevertheless, it was not fully assessed in patients with pharyngitis.

Less than 20% of all antimicrobials are utilized in hospitals, but the intensity of use is much higher in the community.[15] Many rational antimicrobial use (RAU) campaigns thus put emphasis on primary care centers, community pharmacies (drugstores) and villages. The primary care centers in Thai sub-districts are called "sub-district health promoting hospitals" (SHPHs), which are usually staffed by healthcare providers, i.e. nurses, public health technical officers, public health officers and dental hygienists; physicians from community hospitals occasionally visit affiliated SHPHs. As all SHPHs need to follow the RAU policy, it is worth exploring for RAU measures with the use of MASD. From an extensive literature search, no study has been previously conducted to assess the effects of MASD on any aspect. This study thus aimed to evaluate the effectiveness of MASD in aiding the pharyngitis diagnosis and rational antimicrobial use by patients with pharyngitis and to elicit the perceptions of the patients and healthcare providers about the use of MASD.

METHODS

A single-blinded, quasi-intervention study with non-randomization was conducted in Thai patients with pharyngitis (or sore throat) who attended SHPHs during the 2019-2021 period. It was a preliminary study of the antimicrobial use and resistance project approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group 1, Chulalongkorn University, Thailand (COA 191.1/2021). The study was designed based on real-world research concepts to mirror actual primary care settings and patient experiences[16] and the findings were reported according to the TREND reporting guidelines for nonrandomized or quasi-experimental study designs.[17]

Population and samples

Participants were included in the study if they were patients with pharyngitis (sore throat) who visited their SHPHs for the first time during the study period. They could be aged 1 month to 80 years and used the healthcare services at various SHPHs in 10 provinces of three regions, i.e. the Eastern region (Chachoengsao Province), Northern region (Chiang Rai, Nan, Phayao and Phrae Provinces) and North-eastern region (Roi Et, Srisaket, Sakon Nakhon,

Amnat Charoen and Ubon Ratchathani Provinces). The SHPHs were purposively selected, as their healthcare providers, i.e. nurses, public health technical officers, public health officers and dental hygienists, were previously trained for rational drug use and antimicrobial issues by the RAU team of Drug System Monitoring and Development Program. Additionally, patients were excluded if they were not willing to partake in the study or could not communicate in the Thai language.

The sample size of the study was determined based on the proportions of antimicrobial use of two groups using G*Power v.3.1.9.6 (Franz Faul, Kiel University, Germany) based on the equation: $N = 2 (Z_{\alpha/2} + Z_{\beta})^2 P (1 - P)/(P_1 - P_2)^2$, where $P = (P_1 + P_2)/2$. According to a pilot study conducted by the research team, the proportion of sore-throat patients with antimicrobials prescribed or suggested by healthcare providers was approximately 20% (P_1). It was envisaged by the research team that the proportion of sore-throat patients using antimicrobials after receiving MASD was approximately 10 – 15% (P_2), or 12.5% on average. As the marginal effect of MASD used was found in the pilot study, a patient ratio of 10:1 would be expectedly needed to differentiate the effectiveness of MASD in assisting with the pharyngitis diagnosis. With a significance level of 0.05 and a power of 80%, 1,935 and 194 patients were required for the intervention and control groups, respectively.

Study instruments

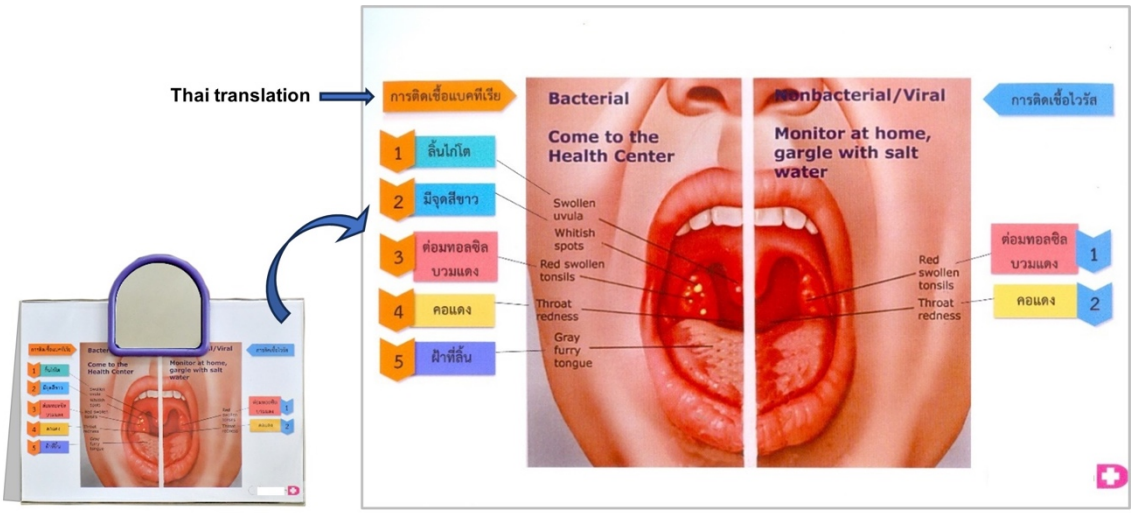

Figure 1. Mirror-assisted screening device (MASD) consisting of a mirror and information card with lesions translated into the Thai language as shown on the left- and right-hand sides of the picture

This study made use of two instruments: the mirror-assisted screening device (MASD) and questionnaires. The MASD was produced by Ligo Graphic and Design Company, Ltd. It consisted of a standing, tiny mirror and one information card with a Thai translation (Figure 1). It was utilized on a desk to distinguish the pathologic manifestation of the oropharynx between viral (or non-bacterial) and bacterial infections. If patients were bacterially infected, their tonsils as seen in the mirror would be red and swollen with whitish pus-like spots or patches.

Additionally, they also had fever, gray furry tongues and sore throats with no cough. The lymph glands in the neck were pea-size or larger, and tender to gentle pressure. Thus, they should visit SHPHs, or the primary care centers, to further investigate the bacterial infection and get an antimicrobial if required. In the case of viral infections or common colds, patients would have red and swollen tonsils, throat redness, sneezing, running nose, hoarseness and cough. As antimicrobials are not necessary for a viral sore throat, they should observe the symptoms and gargle with salt water. Lozenges or lemon and honey water are also useful to soothe irritated throats.

Two sets of questionnaires were constructed for patients and healthcare providers. Before elaborating the questionnaires, two types of needs, i.e. anticipated and intended requirements, should be first clarified. Anticipated needs (or stated needs) are those that are clearly identified or required for an antimicrobial, whereas intended needs are those that are determined to get one if they do not obtain any antimicrobials. The patient questionnaire contained two parts. Part 1 was patients' personal data (e.g. gender, age, occupation and highest education level). Part 2 was to draw out their perceptions of pre-interventions (i.e. anticipated need for an antimicrobial) and post-interventions, such as the outcome (question: Do you obtain an antimicrobial?), intended needs for an antimicrobial, satisfaction with the diagnosis and checking for throat infections. The answers to the queries were just "Yes or No", but some questions had an additional answer, namely "Not sure". The provider questionnaire was also composed of two parts: providers' characteristics and their perceptions. The characteristics consisted of gender, age, type of healthcare provider and workplace. Providers' perceptions included their satisfaction with the use of MASD, confidence in getting an accurate diagnosis when using MASD, and MASD's helpfulness and usefulness. They were asked to rate on a 5-point Likert scale, such as 1 = very dissatisfied (or very unconfident) to 5 = very satisfied (or very confident). Both questionnaires were checked for face validity, which is the extent to which the questions or items appear to measure as intended based on the inspection of peer researchers or experts.[18] The questionnaires were also piloted in a sample group and improved for actual data gathering.

Data collection

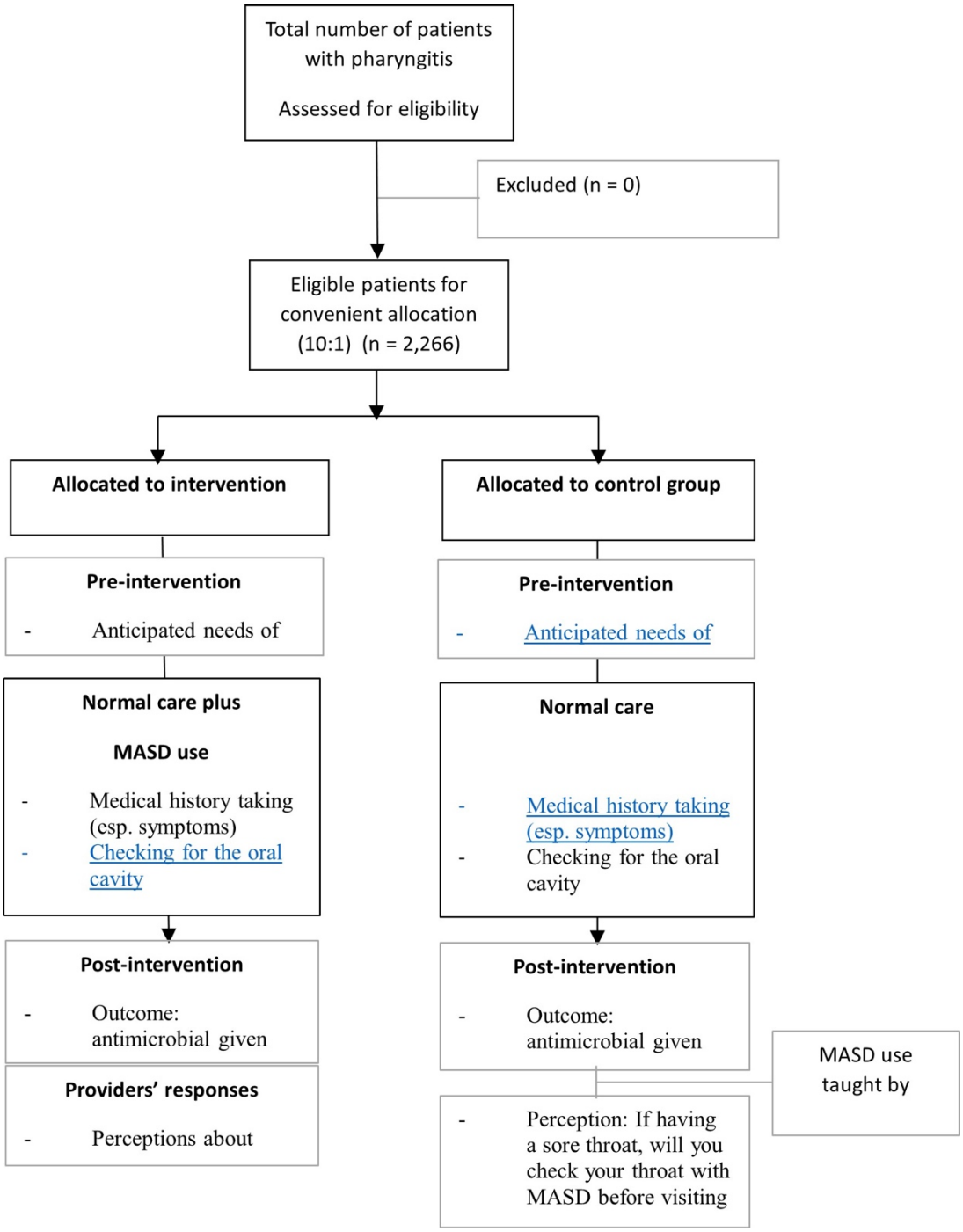

Figure 2. Study flow of participants in the study

A total of 2,266 patients with pharyngitis, as shown in the participant flow diagram (Figure 2), attended SHPHs in 10 provinces. As many SHPHs experienced a shortage of staff, patients coming to the hospitals possibly met one of the healthcare providers, i.e. a nurse, public health technical officer, public health officer, or dental hygienist, who was a trained researcher to offer interventions and gather data. Initially, all participants were asked to give verbal consent by asking whether they were willing to participate in the study and allowing them to see detailed

statements of the study. With the non-randomized process, they were then conveniently allocated to the intervention or control group at a ratio of 10:1. For instance, 55 eligible patients of an SHPH were assigned to an intervention (n = 50) or control group (n = 5) based on the healthcare services; no randomization was performed. Patients in the control group received normal care, i.e. medical history taking (especially symptoms), checking for the oral cavity and providing advice with pamphlets of pharyngitis. For patients in the intervention group, they obtained normal care plus MASD, i.e. patients being allowed to look at their own oral cavities using wooden tongue depressors with small torches (flashlights) in front of the MASD mirrors. For preschool or young children, their parents or guardians would help open their mouths using small wooden tongue depressors and check with MASD accordingly. If they were diagnosed with bacterial pharyngitis, they would get an antibiotic, or mainly amoxicillin, from the nurses who were permitted to prescribe certain medications. For other healthcare providers, permission for antimicrobial prescribing must be sought from the nurses. To collect data prior to the intervention, both patient groups were questioned about the anticipated need for an antimicrobial.

After the interventions, all patients were asked to complete the questionnaire by reporting the outcomes (i.e. whether to receive an antimicrobial) and relevant perceptions. If children or adult patients could not answer the queries for any reason, their parents, caregivers or relatives were allowed to respond on their behalf. For patients in the control group, they were then taught how to use MASD by the healthcare providers afterward and were requested to complete the last question like those in the intervention group, i.e. "If having a sore throat, will you check for your throat with MASD before visiting the SHPH?" At the end of the sessions, every participant received a pamphlet with an oral cavity picture and relevant information like the MASD's information card. They, however, needed to find a mirror and a torch (flashlight) themselves in order to examine their own throats at home. Moreover, healthcare providers were requested to fill out the questionnaire to express their views on the MASD application. All copies of patient and provider questionnaires were collated and returned to the research team for data analysis.

Statistical analysis

All data were entered into IBM SPSS v.29.0.0.0 (IBM Thailand Co., Ltd., Bangkok) and analyzed using descriptive statistics, i.e. frequency, percentage, mean and standard deviation. A Chi-square test was performed to determine whether there were differences in some categorical variables between the intervention and control groups, for example, antimicrobials given and requested from the healthcare providers. A relative risk with a 95% confidence interval and relative risk reduction was also calculated for the outcome of antimicrobial use. To further confirm the association of patients' characteristics and their perceptions, especially their anticipated needs and willingness to check for throat infections with MASD, another Chi-square test was separately performed. A significance level was set at 0.05.

RESULTS

Patients' characteristics, outcome and perceptions

In this study, 2,031 patients were in the intervention group and 235 patients in the control group as demonstrated in Table 1. Females outnumbered males in both groups, but the overall number was slightly different. Their ages mostly ranged from 31 to 50 years and the majority visited SHPHs in the North-eastern region (52.9% vs. 52.3%). They were mostly farmers working

in agricultural sectors (47% vs. 37.0%, p < 0.001) and educated only at the primary or secondary school levels (81.8% vs. 77.0%, p = 0.089).

Table 1. Patients' characteristics, outcome and perceptions of the intervention and control groups (total n = 2,266)

Data	Number of patients (%)		P-value
	Intervention group (n=2,031)	Control group (n=235)	
Patients' characteristics			
Gender			
Male	733 (36.1)	104 (44.3)	**0.014***
Female	1,298 (63.9)	131 (55.7)	
Age (years)			
≤ 20	351 (17.3)	44 (18.7)	0.057
21 – 30	297 (14.6)	33 (14.1)	
31 – 40	419 (20.6)	35 (14.9)	
41 – 50	434 (21.4)	43 (18.3)	
51 – 60	321 (15.8)	44 (18.7)	
≥ 61	209 (10.3)	36 (15.3)	
Sub-district health promoting hospital (SHPH) attended			
Eastern region	249 (12.3)	27 (11.5)	0.892
Northern region	707 (34.8)	85 (36.2)	
North-eastern region	1,075 (52.9)	123 (52.3)	
Occupation			
Unemployed	307 (15.1)	50 (21.3)	**<0.001***
Civil service/state enterprise	48 (2.4)	6 (2.5)	
Agriculture	955 (47.0)	87 (37.0)	
Private employee	332 (16.4)	42 (17.9)	
Business/merchant	133 (6.5)	17 (7.2)	
Others – students, retiree or monk	256 (12.6)	33 (14.1)	
Highest education level			
Uneducated	181 (8.9)	27 (11.5)	0.089
Primary or secondary school	1,662 (81.8)	181 (77.0)	
Vocational school	61 (3.0)	9 (3.8)	
Bachelor's degree or above	81 (4.0)	14 (6.0)	
Others: preschool children	46 (2.3)	4 (1.7)	
Patients' outcome and perceptions			
Pre-intervention			
You should receive an antimicrobial for the sore throat – *anticipated needs*			
No	507 (24.9)	83 (35.3)	**<0.001***
Yes	763 (37.6)	53 (22.6)	
Not sure	761 (37.5)	99 (42.1)	
Post-intervention			
1. **Outcome:** You obtained an antimicrobial: Yes	346 (17.0)	58 (24.7)	**0.004***
2. If not getting any antimicrobial, do you intend to go elsewhere to have one? – *intended needs*: Yes	235 (13.9) (*n=1685*)	23 (13.0) (*n=177*)	0.727
3. Do you request an antimicrobial from the healthcare provider during the session?: Yes	563 (27.7)	52 (22.1)	0.068

Data	Number of patients (%)		P-value
	Intervention group (n=2,031)	Control group (n=235)	
4. Are you satisfied with the diagnosis (viral or bacterial pharyngitis) with MASD use? (1=very dissatisfied to 5=very satisfied): mean (SD)	4.30 (0.62)	-	-
5. If having a sore throat, will you check for your throat with MASD before visiting the SHPH?			
No	83 (4.1)	45 (19.1)	**<0.001***
Yes	1,715 (84.4)	137 (58.3)	
Not sure	233 (11.5)	53 (22.6)	

* Statistical significance, p-value < 0.05

In Table 1, before the interventions, patients in both groups had anticipated needs for an antimicrobial, which were marginally different (37.6% vs. 22.6%, p<0.001). Nevertheless, there was a high proportion of patients uncertain about their need for the antimicrobial (37.5% vs. 42.1%). After the interventions, the proportion of patients receiving antimicrobials in the intervention group was different from that in the control group (17.0% vs. 24.7%, p = 0.004). The relative risk (RR) and relative risk reduction (RRR) results (data not shown in the table) also confirmed the MASD effectiveness by decreasing the antimicrobial use by 31.2%, i.e. RR 0.69, 95% CI [0.54, 0.88] and RRR 0.312. For those who did not obtain antimicrobials in both groups, they still had intended need by going elsewhere to fetch them (13.9% vs. 13.0%, p = 0.727). Participants in both groups did request an antibiotic from the healthcare providers during the sessions (27.7% vs. 22.1%, p = 0.068). Regarding MASD, the patients in the intervention group were mostly satisfied or very satisfied with the diagnosis, along with the MASD use (4.30±0.62). When both groups were queried if they were willing to check for their throat infections with MASD, patients in the intervention group would do more than those in the control group (84.4% vs. 58.3%, p < 0.001). Quite a number of them were, however, unsure about the throat screening (11.5% vs. 22.6%) for some reasons, e.g. inconvenience of using a mirror, difficulties in opening their mouths, eye problems due to old age, etc.

Considering patients' perceptions in detail, the demographic factors were typically involved. As demonstrated in Table 2, the patients' age, region of SHPH attended, occupation and educational background were significantly associated with their anticipated needs (all p-values < 0.05), except for the gender (p = 0.159). Patients aged 31-50, attending SHPHs in the North-eastern region, working in agricultural sectors (or mostly farmers) and educated at the primary or secondary school levels tended to need antimicrobials when they first experienced sore throats. Similarly, the demographic data were also associated with their willingness to check for throat infections with MASD (all p-value < 0.05), except for the educational background (p = 0.067) and the tendency of demographic factors was nearly the same as that of the anticipated needs.

Table 2. Associations of patients' demographic factors with anticipated needs and willingness to check for throat infections with MASD (n = 2,266)

Characteristic	Anticipated needs: number of patients (%)			P-value	Willingness to check for throat infections with MASD: number of patients (%)			P-value
	No (n=590)	Yes (n=816)	Not sure (n=860)		No (n=128)	Yes (n=1,852)	Not sure (n=286)	
Gender								
Male	210 (35.6)	288 (35.3)	339 (39.4)	0.159	64 (50.0)	651 (35.2)	122 (42.7)	**<0.001***
Female	380 (64.4)	528 (64.7)	521 (60.6)		64 (50.0)	**1,201 (64.8)**	164 (57.3)	
Age (years)								
≤ 20	86 (14.6)	150 (18.4)	159 (18.5)	**0.002***	19 (14.9)	327 (17.6)	49 (17.1)	**0.004***
21 – 30	86 (14.6)	132 (16.2)	112 (13.0)		9 (7.0)	283 (15.3)	38 (13.3)	
31 – 40	120 (20.3)	**190 (23.3)**	144 (16.8)		24 (18.8)	**366 (19.8)**	64 (22.4)	
41 – 50	136 (23.1)	**157 (19.2)**	184 (21.4)		25 (19.5)	**383 (20.7)**	69 (24.1)	
51 – 60	101 (17.1)	114 (14.0)	150 (17.4)		26 (20.3)	290 (15.6)	49 (17.1)	
≥ 61	61 (10.3)	73 (8.9)	111 (12.9)		25 (19.5)	203 (11.0)	17 (6.0)	
Sub-district health promoting hospital (SHPH) attended								
Eastern region	40 (6.8)	1 (0.1)	235 (27.3)	**<0.001***	10 (7.8)	195 (10.5)	71 (24.8)	**<0.001***
Northern region	182 (30.8)	319 (39.1)	291 (33.8)		52 (40.6)	621 (33.5)	119 (41.6)	
North-eastern region	368 (62.4)	**496 (60.8)**	334 (38.9)		66 (51.6)	**1,036 (56.0)**	96 (33.6)	
Occupation								
Unemployed	74 (12.5)	118 (14.5)	165 (19.2)	**<0.001***	19 (14.9)	288 (15.6)	50 (17.5)	**0.014***
Civil service/state enterprise	19 (3.2)	23 (2.8)	12 (1.4)		3 (2.3)	48 (2.6)	3 (1.1)	
Agriculture	272 (46.1)	**410 (50.2)**	360 (41.9)		55 (43.0)	**858 (46.3)**	129 (45.1)	
Private employee	93 (15.8)	106 (13.0)	175 (20.3)		21 (16.4)	289 (15.6)	64 (22.4)	
Business/merchant	57 (9.7)	56 (6.9)	37 (4.3)		16 (12.5)	121 (6.5)	13 (4.5)	
Others – students, retiree or monk	75 (12.7)	103 (12.6)	111 (12.9)		14 (10.9)	248 (13.4)	27 (9.4)	
Highest education level								
Uneducated	41 (6.9)	85 (10.4)	82 (9.5)	**<0.001***	10 (7.8)	157 (8.5)	41 (14.3)	0.067
Primary or secondary school	483 (81.9)	**658 (80.6)**	702 (81.6)		109 (85.2)	**1,514 (81.7)**	220 (76.9)	
Vocational school	22 (3.7)	23 (2.8)	25 (2.9)		1 (0.8)	59 (3.2)	10 (3.5)	
Bachelor's degree or above	38 (6.5)	36 (4.5)	21 (2.5)		5 (3.9)	82 (4.4)	8 (2.8)	
Others: preschool children	6 (1.0)	14 (1.7)	30 (3.5)		3 (2.3)	40 (2.2)	7 (2.5)	

* Statistical significance, p-value < 0.05

Providers' characteristics and perceptions about MASD

The characteristics and perceptions of healthcare providers are summarized in Table 3. Most healthcare providers in the study were female (87.8%) and their ages ranged from 31 – 50 years (69%). The majority of them were nurses (76.5%) and nearly half of them (49.8%) were based in the North-eastern region, similar to the patient population. As for their perceptions, they felt satisfied or very satisfied with the application of MASD (4.19±0.72) and were very confident in using it to reach an accurate diagnosis (4.29±0.66). In regard to MASD helpfulness, they reckoned that it enabled patients to accept the diagnosis, either viral or bacterial pharyngitis, and bring down the request for antimicrobials (4.08±0.70). However, they doubted the usefulness of MASD for patients at home in terms of boosting confidence, differentiation of pharyngitis, understanding the reason for use or no use of antimicrobials, knowledge improvement and aid in diagnosing pharyngitis (all with scores of 2 – 3). Regarding additional feedback, many of them pointed out some barriers to MASD use in children, older persons or those with mouth-opening problems. They also stated constrained budgets for providing patients with MASD and the lack of MASD suppliers; official suppliers were not available at the time of this study.

Table 3. Characteristics and perceptions of healthcare providers about the mirror-assisted screening device (n = 213)

Data	Number of healthcare providers (%)
Providers' characteristics	
Gender	
Male	26 (12.2)
Female	187 (87.8)
Age (years)	
20 – 30	43 (20.2)
31 – 40	65 (30.5)
40 – 50	82 (38.5)
50 – 60	22 (10.3)
Over 60	1 (0.5)
Healthcare provider: respondent	
Nurse	163 (76.5)
Public health technical officer	28 (13.1)
public health officers	21 (9.9)
Dental hygienist	1 (0.5)
Sub-district health promoting hospital (SHPH): workplace	
Eastern region	31 (14.5)
Northern region	76 (35.7)
North-eastern region	106 (49.8)
Providers' perceptions about MASD	**Mean (SD)**
1. You were satisfied with the use of MASD. (1=very dissatisfied to 5=very satisfied)	4.19 (0.72)
2. You were confident in getting an accurate diagnosis when using MASD. (1=very unconfident to 5=very confident)	4.29 (0.66)
3. You submitted MASD was helpful for patients to accept the diagnosis and reduce the request for antimicrobials. (1=very unhelpful to 5=very helpful)	4.08 (0.70)

Data	Number of healthcare providers (%)
4. You perceived the usefulness of MASD for patients: (1=not useful at all to 5=very useful)	
- Boost patient's confidence	3.31 (1.42)
- Differentiate viral and bacterial pharyngitis	2.55 (1.17)
- Understand the reason for use or no use of antimicrobials	2.39 (1.17)
- Use with other means to improve knowledge	3.26 (1.27)
- Aid in pharyngitis diagnosis	3.17 (1.27)

DISCUSSION

Patients' outcome and perceptions

This study was the first of its kind to evaluate the effectiveness of the mirror-assisted screening device (MASD) in patients with pharyngitis. The findings revealed the favorable effect of MASD on helping diagnose pharyngitis, whether it be viral or bacterial infection. Compared with the control group, patients using MASD in the intervention group tended to use fewer antimicrobials with a reduction of 31.2%. Despite using MASD, patients in both groups still had intended needs and requests for an antimicrobial. This implied that the tool did not directly promote patients' rational antimicrobial use. However, it did help patients raise their awareness of rational antimicrobial consumption, as evidenced by the statistical difference in checking for their throat infections when they experienced sore throats.

It should be noted that some demographic data of both groups, i.e. the gender and occupation, were statistically different at the outset ($p = 0.014$ and $p < 0.001$, respectively). The differences in the baseline data might partially affect patients' perceptions but had no effect on the interpretation of MASD effectiveness. As detailed in the Results, nearly all demographic factors were associated with the perceptions. This was partly comparable to the systematic review of Zanichelli et al., which found that young age, low income and low educational level were associated with the high rate of antibiotic use for upper respiratory tract infections.[19] The associations of demographic factors with the perceptions were probably concerned with an individual's health literacy that embraces relevant knowledge and awareness of antimicrobial use and resistance.[20]

The knowledge and awareness of patients and the public about rational antimicrobial use, e.g. why and how to use antibiotics appropriately, infection types and proper storage of antibiotics, were not investigated in this study. However, both issues are major contributing factors to inappropriate antimicrobial use.[15,21] Phuengpinit et al. reported patients' knowledge about antibiotic use for upper respiratory tract infections (URIs) is generally poor, especially among younger persons, those with junior high school certificates or those not receiving any antibiotic-related information.[13] Education interventions, e.g. antibiotic awareness campaigns and education via social media, are required to improve public knowledge and awareness of antibiotic use. Apart from that, patients with a lower level of antibiotic knowledge and awareness tend to perceive the necessity of antibiotics for treating various respiratory symptoms. Linder and his team also revealed that 39% of adult patients seeking care for URIs demand antibiotics to eradicate the infections.[22] The result of anticipated need is quite congruent with the present study, i.e. roughly 20 – 30%.

Pharyngitis often occurs in children as well as adults, and parents or caregivers are directly involved in infection management.[23] Tran et al. emphasized the importance of the knowledge, attitudes and behaviors of caregivers, especially mothers,

on the use of antibiotics in their children.[24] According to the systematic review of Shamim et al., more than half of parents (55.8%) expected antibiotics for their children during consultation for URIs.[25] As the present study allowed some parents or caregivers to express their opinions on the children's behalf, their expectations of antimicrobial use in terms of anticipated or intended need should be taken into account. Furthermore, school students in this study also expected some antimicrobials for their sore throats, probably due to their limited knowledge. As reported by Saengcharoen et al.[26], the knowledge and attitudes of Thai students toward antimicrobial use are quite concerning with alarming signs, i.e. taking an incomplete course of antimicrobial treatment (less than 5 days) and holding misconceptions about antimicrobial use for URIs. Accordingly, educational interventions that incorporate MASD as a screening tool could be introduced to them so as to improve their knowledge and awareness of antibiotic use.

Considering the application of MASD to enhance patient empowerment, patients in the invention group felt more content with it, compared with the control. This was probably because they were directly advised on how to use the device in order to confirm the pharyngitis diagnosis. Additionally, this also enabled most of them to be more willing to check for their throat infections at home before asking for help at SHPHs. Interestingly, a number of patients were unsure about the use of MASD, which was supported by the views of healthcare providers; MASD might not be easy to use or beneficial as expected. In fact, one way to make MASD more user-friendly is to upgrade it to an electronic form, or e-MASD, by connecting it to a hand-held application software or computer, including artificial intelligence (AI) in the future. In addition, it is useful to illustrate the oral cavity or throat on screen and save the picture for further investigation.

Providers' aspects and perceptions

Another factor associated with irrational antimicrobial use is the knowledge and awareness of healthcare practitioners.[15,27] As prescribers may be responsive to a patient's requests or expectations for antibiotic treatment[28], healthcare providers in this study might be partly influenced by patients to give them an antimicrobial. The exact incidence was undetectable. Since all healthcare professionals need to follow the rational antimicrobial use policy, they have to find some objective tools to help out with the strategic plan. It was no wonder that with the application of MASD, most of them felt satisfied and confident in getting an accurate pharyngitis diagnosis and agreed on its helpfulness. As it is a bit of a challenge for MASD use in children or people with difficulty opening their mouths, the providers still questioned its usefulness for patients at home. Nevertheless, it is essential to organize more educational and training interventions with or without MASD that target specific provider groups on antimicrobial use and resistance.

Limitations of the study.

This study simulated the real-world situation and thus lacked a certain degree of internal validity. In other words, the study did not strictly control confounding factors, such as the healthcare providers offering the interventions, patient age range, or random allocations. For everyday primary care, patients attending SHPHs may see any healthcare provider available at the time, or else book a particular practitioner beforehand. Since pharyngitis is a common illness, people may ask for help at their SHPHs. They probably have some previous knowledge and awareness of antimicrobial

use. However, the main objective of this study was to assess the effectiveness of MASD and patients' perceptions were just additional data to support it. Most importantly, the study could not determine the indicators of accuracy for the screening tool (MASD), i.e. sensitivity, specificity or likelihood ratios. The reason was that an objective measure, i.e. throat culture or rapid antigen detection test (RADT), could not be performed at SHPHs to verify whether pharyngitis was of viral or bacterial origin.

RECOMMENDATIONS

The mirror-assisted screening device (MASD) for pharyngitis could help patients reduce antimicrobial use to some extent by checking for throat infections. However, it could not promote rational drug use owing to the fact that the anticipated or intended need for antimicrobials still happened. Patients are more aware of rational antimicrobial consumption, especially viral pharyngitis that is unnecessarily treated with antimicrobials. Both patients and healthcare providers perceive the helpfulness of MASD in facilitating the pharyngitis diagnosis, but its usefulness at home is still questionable by some providers. Overall, MASD could be used by patients themselves or healthcare professionals to screen throat lesions or confirm the primary diagnosis of viral or bacterial pharyngitis. Further studies are also required for the MASD monitoring and evaluation, e.g. assessing the effectiveness of MASD in drugstores, nursing homes or other settings and some problems with solutions. As aforementioned, it is feasible to upgrade MASD to e-MASD in order to make it more applicable. This issue of e-MASD also merits further research. Moreover, the providers' training needs and training programs, together with patients' educational needs for rational antimicrobial use, should be evaluated.

AUTHOR CONTRIBUTIONS

S.W.: Supervision, Methodology, Formal analysis. Y.S.: Conceptualization, Methodology, Resources, Funding acquisition. S.P.: Project administration, Data curation, Writing-Original draft. W.W-W.: Formal analysis, Visualization, Writing-Reviewing and Editing.

ETHICAL CONSIDERATION

It was a preliminary study of the antimicrobial use and resistance project approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group 1, Chulalongkorn University, Thailand (COA 191.1/2021) on December 2, 2021.

CONFLICT OF INTEREST STATEMENT

We authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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