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I don't want you to be only
a doctor but I also want you
to be a man
A quotation by His Royal Highness Prince Mahidol of Songkla

the clinical academia

Aim and Scope

Our journal is an opened access international journal devoted to peer-reviewed contributions dealing with clinical medicine and medical education from experimental to clinical aspects. Our journal publishes only high quality research, review and other types of original articles, technical and clinical reports every two months. Reviews of various global and Asian aspects will be solicited. Innovation or epidemiological aspects as well as health system research will be addressed. Rigorous systematic review and neglected tropical diseases are our priority

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message from the editor

Dear readers,

This issue of TCA is the second in this volume. As usual, interesting studies have been waiting for you to read. The first one is about the Macrolide resistance *Mycoplasma pneumoniae* and its clinical presentation. You will also have a chance to learn about helical tomotherapy planning for total marrow irradiation. In terms of emergency medicine, the new triage tool is mentioned in this issue. For medical education, there is an article regarding high and low fidelity simulation in the issue. Hope you like this issue of TCA as we do.

Enjoy!

Thammasorn Jeeraaumponwat, M.D., Ph.D.
Editor-in-Chief of The Clinical Academia

submission

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All accepted articles are classified into two main categories;
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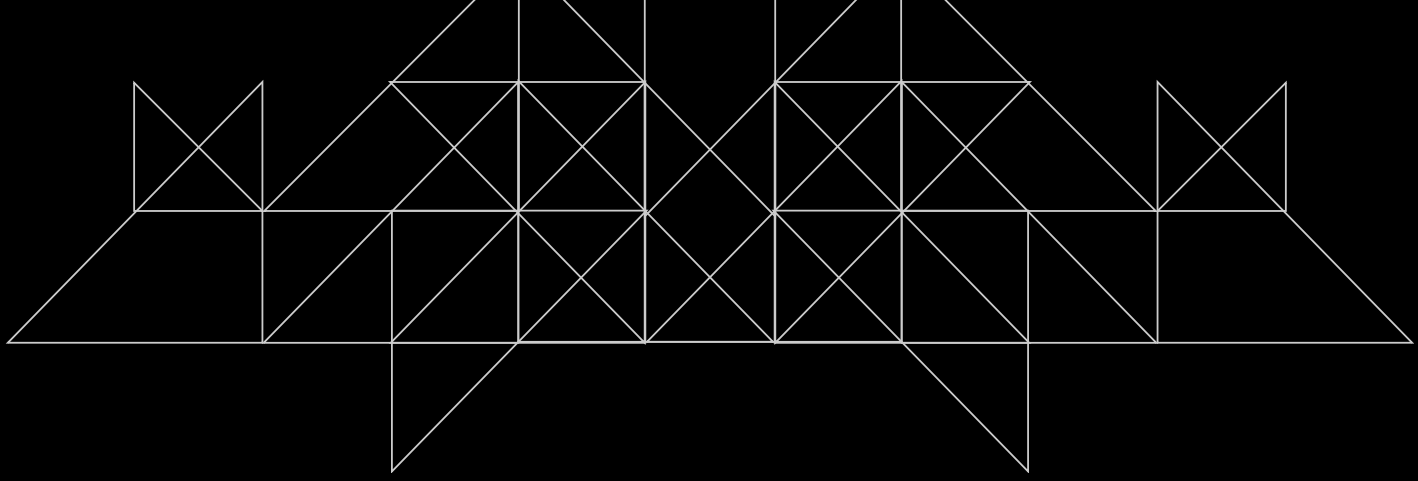
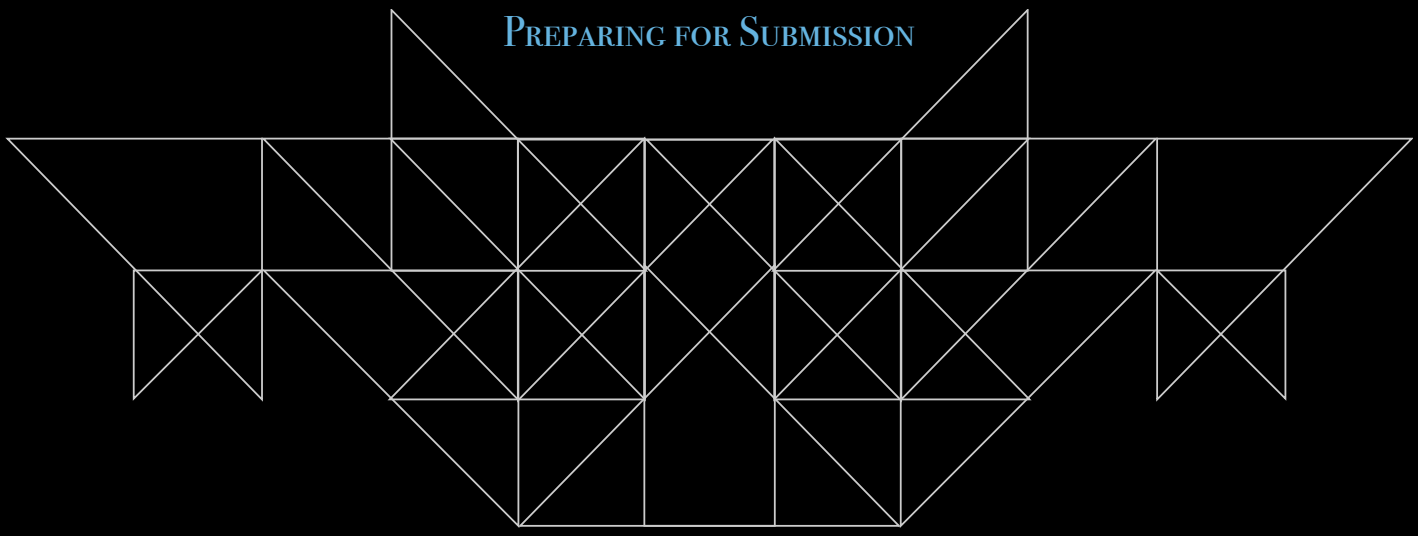
Email: theclinicalacademia@gmail.com
Telephone: (+66) 87 990 1035

Contents



International Committee of Medical Journal Editors (ICMJE)

Recommendation for Preparing for Submission



1. General Principles

The text of articles reporting original research is usually divided into Introduction, Methods, Results, and Discussion sections. This so-called "IMRAD" structure is not an arbitrary publication format but a reflection of the process of scientific discovery. Articles often need subheadings within these sections to further organize their content. Other types of articles, such as meta-analyses, may require different formats, while case reports, narrative reviews, and editorials may have less structured or unstructured formats.

Electronic formats have created opportunities for adding details or sections, layering information, cross-linking, or extracting portions of articles in electronic versions. Supplementary electronic-only material should be submitted and sent for peer review simultaneously with the primary manuscript.

2. Reporting Guidelines

Reporting guidelines have been developed for different study designs; examples include CONSORT for randomized trials, STROBE for observational studies, PRISMA for systematic reviews and meta-analyses, and STARD for studies of diagnostic accuracy. Journals are encouraged to ask authors to follow these guidelines because they help authors describe the study in enough detail for it to be evaluated by editors, reviewers, readers, and other researchers evaluating the medical literature. Authors of review manuscripts are encouraged to describe the methods used for locating, select¬ing, extracting, and synthesizing data; this is mandatory for systematic reviews. Good sources for reporting guidelines are the EQUATOR Network and the NLM's Research Reporting Guidelines and Initiatives.

3. Manuscript Sections

The following are general requirements for reporting within sections of all study designs and manuscript formats.

a. Title Page

General information about an article and its authors is presented on a manuscript title page and usually includes the article title, author information, any disclaimers, sources of support, word count, and sometimes the number of tables and figures.

Article title. The title provides a distilled description of the complete article and should include information that, along with the Abstract, will make electronic retrieval of the article sensitive and specific. Reporting guidelines recommend and some journals require that information about the study design be a part of the title (particularly important for randomized trials and systematic reviews and meta-analyses). Some journals require a short title, usually no more than 40 characters (including letters and spaces) on the title page or as a separate entry in an electronic submission system. Electronic submission systems may restrict the number of characters in the title.

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b. Abstract

Original research, systematic reviews, and meta-analyses require structured abstracts. The abstract should provide the context or background for the study and should state the study's purpose, basic procedures (selection of study participants, settings, measurements, analytical methods), main findings (giving specific effect sizes and their statistical and clinical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations, note important limitations, and not over-interpret findings. Clinical trial abstracts should include items that the CONSORT group has identified as essential. Funding sources should be listed separately after the Abstract to facilitate proper display and indexing for search retrieval by MEDLINE.

Because abstracts are the only substantive portion of the article indexed in many electronic databases, and the only portion many readers read, authors need to ensure that they accurately reflect the content of the article. Unfortunately, information in abstracts often differs from that in the text. Authors and editors should work in the process of revision and review to ensure that information is consistent in both places. The format required for structured abstracts differs from journal to journal, and some journals use more than one format; authors need to prepare their abstracts in the format specified by the journal they have chosen.

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registration number is available, authors list that number the first time they use a trial acronym to refer to the trial they are reporting or to other trials that they mention in the manuscript. If the data have been deposited in a public repository, authors should state at the end of the abstract the data set name, repository name and number.

c. Introduction

Provide a context or background for the study (that is, the nature of the problem and its significance). State the specific purpose or research objective of, or hypothesis tested by, the study or observation. Cite only directly pertinent references, and do not include data or conclusions from the work being reported.

d. Methods

The guiding principle of the Methods section should be clarity about how and why a study was done in a particular way. Methods section should aim to be sufficiently detailed such that others with access to the data would be able to reproduce the results. In general, the section should include only information that was available at the time the plan or protocol for the study was being written; all information obtained during the study belongs in the Results section. If an organization was paid or otherwise contracted to help conduct the research (examples include data collection and management), then this should be detailed in the methods.

The Methods section should include a statement indicating that the research was approved or exempted from the need for review by the responsible review committee (institutional or national). If no formal ethics committee is available, a statement indicating that the research was conducted according to the principles of the Declaration of Helsinki should be included.

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ii. Technical Information

Specify the study's main and secondary objectives–usually identified as primary and secondary outcomes. Identify methods, equipment (give the manufacturer's name and address in parentheses), and procedures in sufficient detail to allow others to reproduce the results. Give references to established methods, including statistical methods (see below); provide references and brief descriptions for methods that have been published but are not well-known; describe new or substantially modified methods, give the reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used, including generic name(s), dose(s), and route(s) of administration. Identify appropriate scientific names and gene names.

iii. Statistics

Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to judge its appropriateness for the study and to verify the reported results. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as P values, which fail to convey important information about effect size and precision of estimates. References for the design of the study and statistical methods should be to standard works when possible (with pages stated). Define statistical terms, abbreviations, and most symbols. Specify the statistical software package(s) and versions used. Distinguish prespecified from exploratory analyses, including subgroup analyses.

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Present your results in logical sequence in the text, tables, and figures, giving the main or most important findings first. Do not repeat all the data in the tables or figures in the text; emphasize or summarize only the most important observations. Provide data on all primary and secondary outcomes identified in the Methods Section. Extra or supplementary materials and technical details can be placed in an appendix where they will be accessible but will not interrupt the flow of the text, or they can be published solely in the electronic version of the journal.

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Separate reporting of data by demographic variables, such as age and sex, facilitate pooling of data for subgroups across studies and should be routine, unless there are compelling reasons not to stratify reporting, which should be explained.

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It is useful to begin the discussion by briefly summarizing the main findings, and explore possible mechanisms or explanations for these findings. Emphasize the new and important aspects of your study and put your finings in the context of the totality of the relevant evidence. State the limitations of your study, and explore the implications of your findings for future research and for clinical practice or policy. Do not repeat in detail data or other information given in other parts of the manuscript, such as in the Introduction or the Results section.

Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not adequately supported by the data. In particular, distinguish between clinical and statistical significance, and avoid making statements on economic benefits and costs unless the manuscript includes the appropriate economic data and analyses. Avoid claiming priority or alluding to work that has not been completed. State new hypotheses when warranted, but label them clearly.

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Authors should provide direct references to original research sources whenever possible. References should not be used by authors, editors, or peer reviewers to promote self-interests.Although references to review articles can be an efficient way to guide readers to a body of literature, review articles do not always reflect original work accurately. On the other hand, extensive lists of references to original work on a topic can use excessive space. Fewer references to key original papers often serve as well as more exhaustive lists, particularly since references can now be added to the electronic version of published papers, and since electronic literature searching allows readers to retrieve published literature efficiently.

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References should follow the standards summarized in the NLM's International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals: Sample References webpage and detailed in the

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Tables capture information concisely and display it efficiently; they also provide information at any desired level of detail and precision. Including data in tables rather than text frequently makes it possible to reduce the length of the text.

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Use only standard abbreviations; use of nonstandard abbreviations can be confusing to readers. Avoid abbreviations in the title of the manuscript. The spelled-out abbreviation followed by the abbreviation in parenthesis should be used on first mention unless the abbreviation is a standard unit of measurement.

Clinical relevance of macrolide-resistant *Mycoplasma pneumoniae* in respiratory tract infection

ORIGINAL ARTICLE

ORIGINAL ARTICLE BY

Uthumporn Panitanarak[1], Ph. D.; Anan Wattanathum[2], M.D.; Pornanan Domthong[3], M.D.

[1]Khon Kaen University, Thailand; [2]Phramongkutklao Hospital, Thailand; [3]Khon Kaen Hospital, Thailand.

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Correspondence to: Uthumporn Panitanarak; uthudo@kku.ac.th

ABSTRACT

OBJECTIVE

To assess the differences in clinical consequences between patients infected with macrolide-resistant *Mycoplasma pneumoniae* (MRMP) and macrolide-susceptible *Mycoplasma pneumoniae* (MSMP).

METHODS

One hundred and sixteen *M. pneumoniae* strains had been isolated from 1,100 patients with respiratory tract infection by real-time polymerase chain reaction (rt-PCR) assay from February 2012 to April 2015. We performed gene sequencing analysis to detect point mutations in 23S rRNA conferring resistant genotypes. Clinical characteristics and treatment outcomes of patients with MRMP and MSMP groups were compared.

RESULTS

There were 116 clinical isolates in which 31 of them were resistant to macrolide (26.7%). Most of MRMP strains harbored an A-to-G transition mutation at position 2063 in 23S rRNA genes, and only one of them harbored an A-to-G transition mutation at position 2064. Clinical data were completely available for 104 patients. There were 25 of them who had infected with MRMP (24.0%). Demographic data, clinical symptoms, leukocyte counts, and chest film findings of MRMP and MSMP groups were similar. The percentage of infected patients in the MRMP group, who had antibiotic exposure prior to 3 months, was higher than that of MSMP group (80% vs. 34.2%; P=0.001). The rate of changes from initially prescribed antibiotic therapy to levofloxacin was significantly higher in the MRMP group (40% vs. 0%; P=0.003). Moreover, the duration of symptom resolution after initiation of antibiotic therapy was also significantly longer in the MRMP group (6 days vs. 3 days; P=0.01).

CONCLUSION

History of antibiotic exposure was more common in patients infected with MRMP. The time of symptom resolution in MRMP patients was significantly longer.

INTRODUCTION

Mycoplasma pneumoniae is a common etiological agent of respiratory tract infection.[1] Although *M. pneumoniae* is not a life-threatening disease, there is an outbreak of the disease increases.[2-9] The prevalence of macrolide-resistant of the species could be ranging from as low as 3% in Germany,[2] 9.8% in France,[3] 13.2% in Japan,[6-7] 29.7% in Korea[8] to as high as 69% in China.[9] From 1998 to 2001, the report of out-patients with community-acquired pneumonia (CAP) in Southeast Asia showed that *M. pneumoniae* was the second prevalent pathogen, accounting for 29.6% of CAP cases while *Chlamydophila pneumoniae* (formerly *Chlamydia pneumoniae*) was the most common pathogen.[10]

The mechanism of drug resistance in *M. pneumoniae* is associated with mutations of 23S rRNA gene mutations detected by the complete sequence of the 23S rRNA by using real-time polymerase chain reaction (rt-PCR) as the following locations; A2063G, A2064G, A2063T, A1290G.[11] The resistance of *M. pneumoniae* to macrolides by A2063G, A2064G is associated with high-level macrolides resistance strain, while A2063T is associated with moderate-level resistance strain to macrolides. Based on the previous studies,[12-14] the phenotypic and genotypic characteristics were related, that is, if the mutation of genes is found, then microbiologic resistance to erythromycin, clarithromycin with the cut-off point of minimum inhibitory concentration is greater than 32 ug/ml.

Antimicrobial therapy with macrolides has widely used to treat respiratory tract infection caused by *M. pneumoniae*, the combination of antimicrobial therapy with macrolides and other antimicrobial agents in terms of empirical treatment have also used in patients who have been diagnosed with community-acquired pneumonia.[10,14] The purpose of this study was to assess the differences in clinical consequences between patients infected with macrolide-susceptible *M. pneumoniae* (MSMP), and those with macrolide-resistant *M. pneumoniae* (MRMP).

METHODS

STUDY DESIGN

This is a retrospective cohort study to compare clinical characteristics as well as the treatment outcomes in patients with MSMP and MRMP groups.

PATIENTS

Patients who had clinically suspected respiratory tract infection from February 2012 to April 2015, at Phramongkutklao Hospital, Bangkok Hospital, and Samitivej Hospital, Thailand were enrolled in this study. We excluded those who were pregnant and immunocompromised; patients with human immunodeficiency virus (HIV) infection, neutropenic patients, and patients receiving immunosuppressive agents or chemotherapy. The diagnosis was based on clinical signs and symptoms of respiratory tract infection including cough with or without phlegm, fever, dyspnea, pleuritic chest pain, or abnormal lung sounds. Investigation including complete blood count and a chest radiograph was performed. We collected the clinical characteristics and treatment outcomes of those patients. The study protocol was approved by the Ethics Committees at the Medical College of King Phramongkutklao. (R164q/55_Exp)

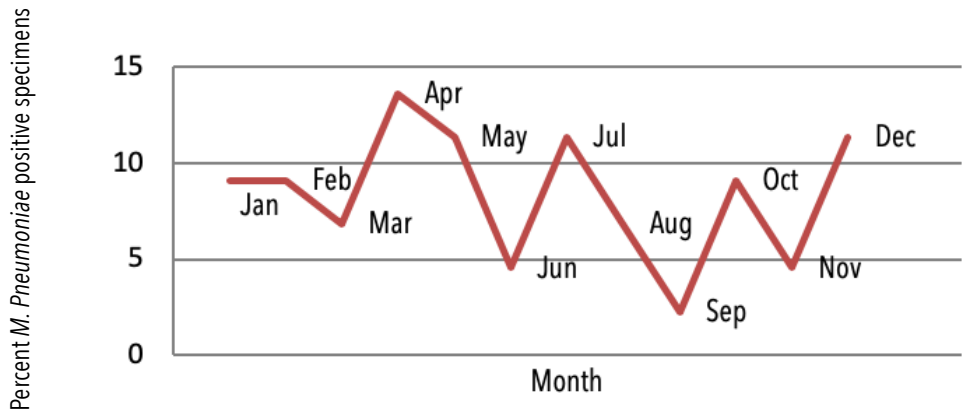

Figure 1. *M. pneumoniae* positive specimens detected by real-time PCR assay (February, 2012 to April, 2015)

DATA COLLECTION

A total of 1,100 nasopharyngeal swabs, throat swabs, or tracheal suction specimens were collected from patients having respiratory tract infection. *M. pneumoniae* isolates were identified by rt-PCR assays. DNA was extracted from respiratory tract specimens using a QIAamp Mini Kit according to the manufacturer's instructions. A search of mutations at sites 2063, 2064, and other sites in the *M. pneumoniae* 23S rRNA domain V gene region was performed using a direct sequencing method in samples with a positive PCR result. The mutations of 23S rRNA have been deposited in the Genbank sequence database and were assigned the accession number HM043729, HM043730, and HM043731. The clinical characteristics and treatment outcome of patients were retrospectively reviewed. Subgroup comparisons of those clinical data were conducted between patients infected with MSMP and MRMP.

STATISTICAL ANALYSIS

All numeric data were examined for their normality using the Kolmogorov-Smirnov test. The median and the interquartile range (IQR) were used for quantitative variables because of the non-normality data while number and percentage were used for qualitative variables. To assess the differences in frequency of qualitative variables either chi-square test or Fisher's exact test was applied where appropriate. We compare the baseline characteristics and treatment outcomes of patients with MSMP and MRMP. The statistical methods were verified, assuming a significance level of $P<0.05$ and a high significance level of $P<0.001$. Statistical analysis was carried out using the SPSS computer package version 13.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

One hundred and sixteen *M. pneumoniae* isolates were collected from 1,100 patients which were examined by using the rt-PCR assay. The epidemiology of respiratory tract infection from *M. pneumoniae* was 10.5% throughout the year. Those infections were slightly high during the winter season in Thailand from December to February,

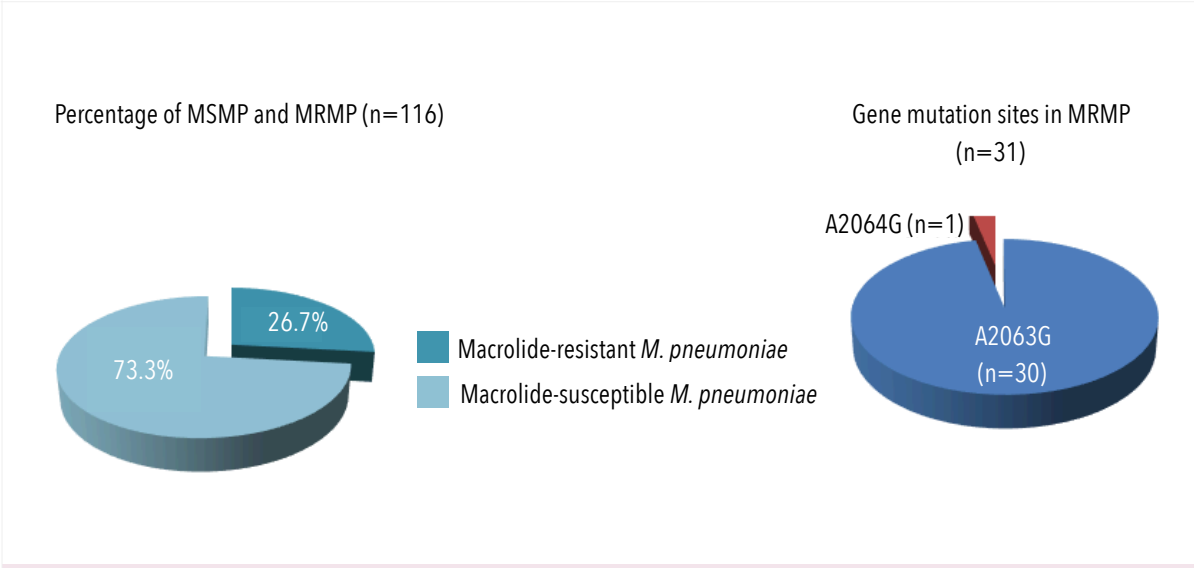

Figure 2. Macrolide-susceptible and macrolide-resistant M. pneumoniae with the point of gene mutation

illustrated in Figure 1. Then, the gene-sequencing analysis was performed to detect the point of gene mutation. Of 116 isolates, 31 (26.7%) were resistant to macrolide, illustrated in Figure 2. Among 31 macrolide-resistant strains, 30 had harbored an A-to-G transition mutation at position 2063 (A2063G) in 23S rRNA genes, and only one of them harbored an A-to-G transition mutation at position 2064 (A2064G).

When we determined the position of the gene mutation in specimens from 116 patients which relies on a database of Genbank, the sequences of base pairs in 2035 to 2085 were compared. The specimens of 30 patients and only one of them was changed to the base pairs from A to G at position 2063 and 2064; respectively, while in another location of base pairs were not changed. The locations without changing base pairs were represented by a dot symbol (.), illustrated in Figure 3.

Clinical data were completely available for 104 patients. The samples were divided into two groups, according to the pattern of susceptibility to macrolide, 25 of them (24.0%) had infected with MRMP, and 79 of them (76.0%) had infected with MSMP. Most of them were children and young adolescents. The median age of patients was 7.6 years and 7 years for patients infected with MRMP and MSMP; respectively. The proportion of males in the MRMP group is 0.60 and 0.44 in the MSMP group. The other demographic characteristics, clinical presentation, leukocyte counts, and chest radiological findings between MSMP and MRMP are illustrated in Table 1. In terms of demographic characteristics and clinical presentation, there was no statistically significant difference between both groups. Laboratory tests and chest radiography of the patients infected with MSMP and MRMP were presented in Table 2. We found no patients with pleural effusion and lymphadenopathy from chest radiological findings. In terms of clinical profiles and treatment outcome, the total febrile days and/or onset of respiratory tract symptoms before the diagnosis of a physician were not a significant

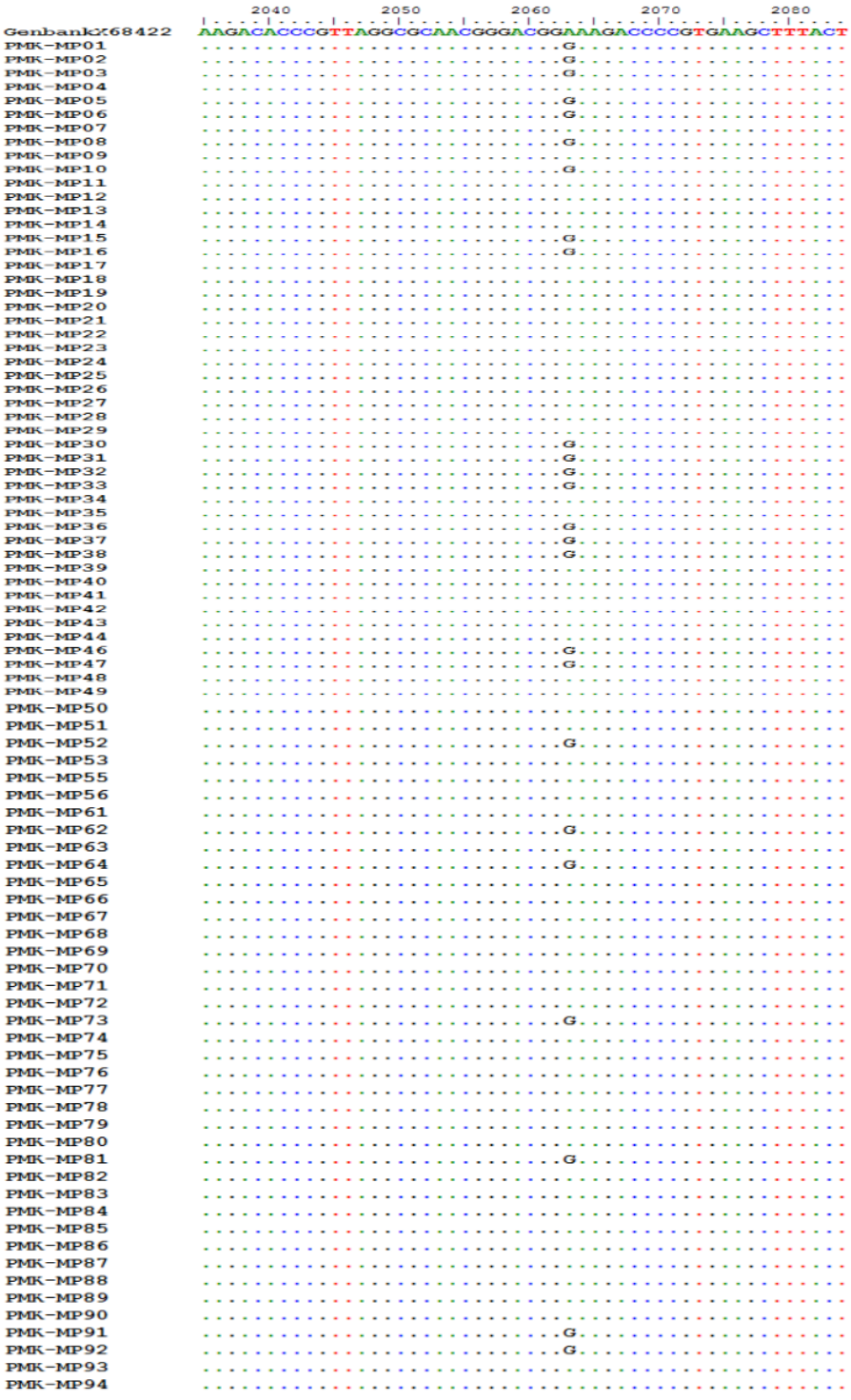

Figure 3. Identification of the point of gene mutation in 116 specimens when using the gene sequencing analysis.

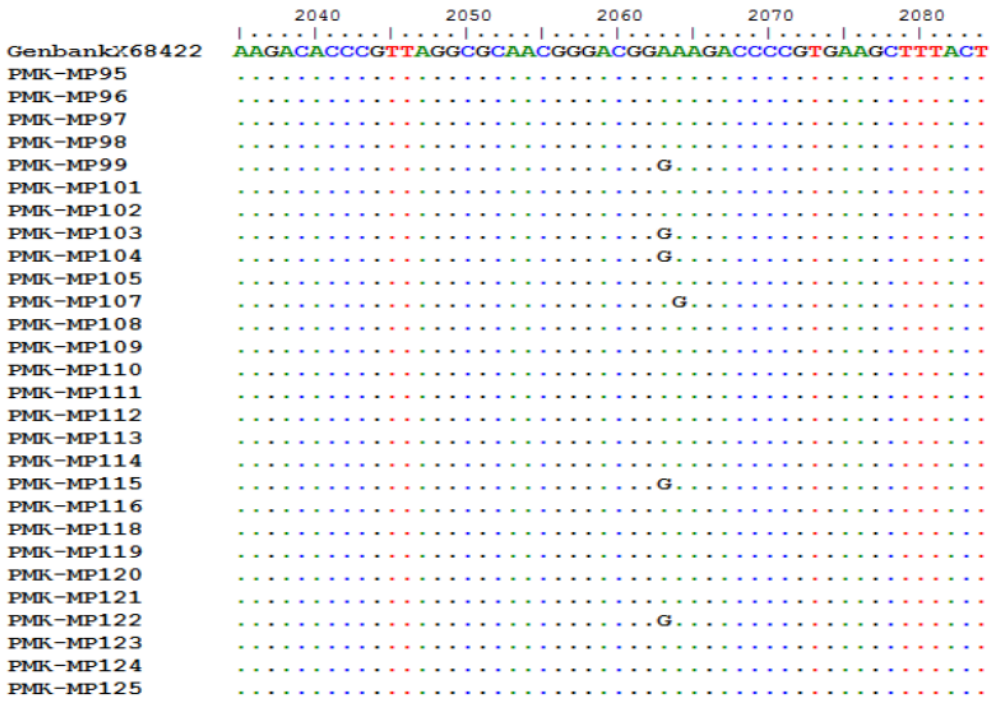

Figure 3. (Continue)

difference in the MSMP and MRMP group (4.3 days vs. 4.7 days; respectively: P=0.40). The percentage of infected patients in the MRMP group and having a history of antibiotic exposure before 3 months, was higher than in the MSMP group (80% vs. 34.2%: P= 0.001). The rate of hospital admission also was not a statistically significant difference (60.0% in the MRMP group vs. 72.2% in the MSMP group: P=0.65). However, 40% of patients with MRMP need to switch treatment from antimicrobial therapy to respiratory fluoroquinolone for clinical improvement such as fever, cough which was statistically significant difference comparing with MSMP group (P=0.003). The duration of symptom resolution time after initiation of antibiotic therapy was also significantly longer than that of MSMP group (6 days vs. 3 days; respectively: P=0.01). The clinical profiles and treatment outcomes were illustrated in Table 4.

DISCUSSION

In the past, the emergence of macrolide-resistant *M. pneumoniae* has been reported mainly in Asia, especially in the East of Asia such as Japan,[6-7] Korea,[8] China.[9] One previous study from China about the prevalence of macrolide-resistant *M. pneumoniae* in adult and adolescent patients with respiratory tract infection found a high rate of this infection (69.0%).[9] However, current resistance data for MRMP patients with respiratory tract infections are rarely found in Thailand. In this study, we found a high rate of resistance to

Table 1. Characteristics of the patients infected with macrolide-susceptible and macrolide-resistant.

Characteristic	MRMP group (N=25)	MSMP group (N=79)	P Value
Age–yr			0.19
Median	7.6	7.0	
Interquartile range	0.3 - 13.9	0.1 - 42.9	
Sex–no. (%)			0.21
Male	15 (60)	35 (44.3)	
History of previous exposure–no. (%)			
Any antibiotics exposure	20 (80)	27 (34.2)	0.001
Macrolides exposure	9 (45)	31 (39.2)	0.59
Clinical symptoms–no. (%)			
Cough	24 (96)	79 (100)	0.19
Sputum production	6 (24)	27 (34.2)	0.51
Dyspnea	2 (8)	0 (0)	0.26
Chest pain	0 (0)	0 (0)	>0.99
Total febrile day–days			0.40
Median	4.3	4.7	
Interquartile range	1-7	2-7	
Peak body temperature (°c)			0.54
Median	38.3	38.1	
Interquartile range	37.2-40	36.4-40.1	

Table 2. Laboratory and chest radiological findings of the patients.

Findings	MRMP group (N=25)	MSMP group (N=79)	P Value
White blood cell count–cells/mm^3			0.75
Median	8,600.8	8,698.5	
Interquartile range	3,690-15,290	4,610-13,370	
Neutrophil count–cells/mm^3			0.08
Median	62.4	71.2	
Interquartile range	40-83.8	48-90	
Lymphocyte count–cells/mm^3			0.16
Median	27.3	21.1	
Interquartile range	7.1-48.9	6-40	
Platelet count–1,000 cells/mm^3			0.005
Median	450.5	215.5	
Interquartile range	372-529	150-286	
Chest radiological findings–no. (%)			
Perihilar	5 (26.3)	26 (38.8)	0.44
Lobar consolidation	13 (68.4)	37 (55.2)	0.55
Perihilar and lobar consolidation	1 (5.3)	4 (6)	0.77

Table 3. Outcomes of the treatment

Outcome	MRMP group (N=25)	MSMP group (N=79)	P Value
Hospitalization–no. (%)	15 (60)	57 (72.2)	0.65
Change of the initially antibiotics to fluoroquinolones–no. (%)	10 (40)	0	0.003
Days of symptom resolution–day			0.01
Median	6	3	
Interquartile range	2–12	1–3	
30-day mortality–no. (%)	0	0	>0.99

macrolide (26.7%) for infected patients with *M. pneumoniae*. The reason might be due to the fact that antimicrobial therapy with over-the-counter administration is easier to access in Thailand than in the Western countries. Moreover, genetic predisposing may be associated factors with MRMP which is commonly found in Asia.

In real clinical practice, we can use various diagnostic methods for detecting these causative pathogens such as the rt-PCR assay, Mycoplasma IgG, and IgM. The infected rate of the present study was 10.5% which was lower than that of the previous study in Thailand1 as we only used one method for the diagnosis, the rt-PCR assay which yielded a sensitivity of 0.62, while the specificity was 0.96 to detect *M. pneumoniae* infection. In terms of epidemiology, we found this infection mostly during the winter season in Thailand, usually from December to February.

MRMP is strongly related to the mutations in 23S rRNA. Several potential transit mutations including A2063G and A2064G in the complete sequence of 23S rRNA were found; nevertheless, it was not found in other points of mutation (A2063T, and A1290G). A2063G was the most common point of mutation which resulting in moderate-level resistance to erythromycin (MIC more than 32 ug/ml). These results agree with the previous study from China.[12] The other points of mutation to determine macrolide-resistant strain were not detected. Moreover, we compare the characteristics and clinical data in both groups of patients, MRMP, and MSMP. The findings were not significantly different in terms of gender, age, and clinical symptoms. Febrile days during antimicrobial therapy were longer for patients infected with MRMP than those with MSMP infection. We also found that the duration of therapy and time to

resolution of symptoms was significantly longer for those patients, infected with macrolide-resistant strains. Macrolide-treated patients, infected with MRMP was no clinical improvement within 72 hours.

We suggest if respiratory tract infection patients do not have clinical improvement after the initial antimicrobial therapy, then physicians should consider the host factor and immune status. First, we ought to look for the complication from pneumonia; for example, lung abscess, parapneumonic effusion, and empyema thoracis. Secondly, the complication from treatment should be considered (drug fever, thrombophlebitis, and antibiotics associated diarrhea). Lastly, the pathogen itself especially the resistance strain should be in the differential diagnosis. This is the first report on MRMP and its clinical relevance in Thailand. However, the limitation of this study is that the dataset retrospectively collected from medical records might not be fully complete. To lessen the missing data, we also attempted to investigate more information from laboratory, radiological data, and electronic medical record. We suggest future studies should consider conducting more sample size or collect more data from multicenter to confirm our findings.

MRMP patients have had a history of antibiotic exposure to more than MSMP patients. The time of symptom resolution in MRMP patients was significantly longer than MSMP patients. Macrolide-treated patients who are infected with *M. pneumoniae* with no clinical improvement could be prescribed with levofloxacin as an alternative treatment.

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Helical tomotherapy planning for total marrow irradiation

ORIGINAL ARTICLE

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Chaiyaporn Sirichaichok; Wimrak Onchan, M.D.;
Somsak Wanwilairat

Chiang Mai University, Thailand.

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Correspondence to: Chaiyaporn Sirichaichok;
Chaiyaporn_siri@cmu.ac.th

ABSTRACT

OBJECTIVE

To evaluate plan quality of helical tomotherapy (HT) planning for total marrow irradiation (TMI) in rando phantom then verify dose by optically stimulated luminescence (OSL).

METHODS

Helical tomotherapy treatment planning for TMI in rando phantom was performed. Target areas included cranium bone, spine, pelvis, sternum, and ribs with expanded margin 5.00 mm for planning target volume (PTV). Organs at risk (OARs) for radiation were right eye, left eye, right lung, left lung, liver, right kidney, left kidney, heart, brain, and bowel. Prescribe dose for volume 95% (D95) of PTV≥12.00 Gy in 6 fractions. Dose verification by OSL in rando phantom position at the spine, sternum, and both lungs.

RESULTS

From TMI planning the D95 of PTV was 12.06 Gy and median dose (D50) of right eye, left eye, right lung, left lung, liver, right kidney, left kidney, heart, brain, and bowel were 7.09 Gy 5.23 Gy, 5.14 Gy, 5.94 Gy, 6.01 Gy, 5.97 Gy, 6.22 Gy, 5.12 Gy, 7.44 Gy, 10.03, and 7.09 Gy respectively. Results from the dose verification, % dose differences from planning compared with OSL dose at spine, sternum, right lung, and left lung were -5.54%, -4.19%, 0.08%, and -0.37% respectively.

CONCLUSION

Helical tomotherapy planning for TMI achieves target coverage of PTV and can reduce mean dose of OARs to 57.33% of prescribed dose. The dose verification of tomotherapy planning by OSL is convenient and high precision by mean dose difference 3.48%.

INTRODUCTION

Hematologic malignancy is a type of cancer caused from the abnormality of bone marrow cells or the lymph nodes that can be found in children, adults, and elders, especially in the patient with low immunity and children with genetic deficiency.[1] As the cancer cells spread from bone marrow over the body, the irradiation technique used is called total body irradiation (TBI), where the whole body is the target volume.[2] Radiation therapy, however, can both damage cancer cells and suppress immunity before processing stem cell transplantation, non-involved organs such as the lungs, eyes, liver, and kidneys receive unnecessary radiation dose.[2] As the technique of intensity-modulated radiation therapy (IMRT) has been developed, total marrow irradiation (TMI) to minimize the target volume to cover only the specific area and limits the radiation dose to the adjacent organs is proposed and it has been studied as the option of TBI.[3]

TMI is still not considered as a standard treatment for hematologic malignancy.[4] Its efficacy has been reported firstly in a rando phantom using helical tomotherapy (HT) with a fixed field width.[5] In this study, dose verification by thermoluminescent dosimeter was also performed to confirm the dose of radiation.[5] Later, its preferred clinical outcomes were also reported in three patients with acute myeloid leukemia compared with TBI.[3] In 2007, an experiment of TMI together with total lymphatic irradiation (TMLI) in six patients with multiple myeloma was performed to limit the radiation dose to the other organs, it found that TMI reduced up to 51% of radiation compared with TBI.[6] A larger phase I trial was conducted in 2009 with acute myeloid leukemia, acute lymphoblastic leukemia, non-Hodgkin's lymphoma, and multiple myeloma, it showed that TMI using helical tomotherapy was clinically feasible.[7] In term of the technique of TMI planning, HT and volumetric modulated arc therapy (VMAT) was performed on a phantom in 2016, it found that both planning systems can create high-quality plans for TMI, with HT resulting in superior Organs at risk (OARs) sparing.[8] However, the quality of TMI planning can be various depending on the technique use, machine parameters e.g.field width (FW), modulation factor (MF), pitch factor (PF), and experiences of the planner.[5] Verification of treatment planning is, thus, required to ensure safety. The present study aimed to describe the treatment planning using helical tomotherapy that is able to irradiate to the complex and large size cancer continuously for 160 cm long to assess its feasibility on a rando phantom while the verification of TMI plan was also performed using the optically stimulated luminescence (OSL).

METHODS

STUDY DESIGN AND SIMULATION

This is an experimental study to describe the treatment planning using helical tomotherapy (Hi-ART, Accuray, USA) to assess its feasibility on a rando phantom (The Phantom Laboratory, USA) with the verification of TMI plan using the OSL. This phantom has a similar structure to that of humans. It can be separated into 2.50 cm slab thickness. Four OSL (InLight nanoDot, Landauer, USA.) was attached in the rando phantom at the spine, sternum, left lung, and right lung. The 5.00 mm slice thickness. CT images data set was acquired and transfer to the contouring workstation

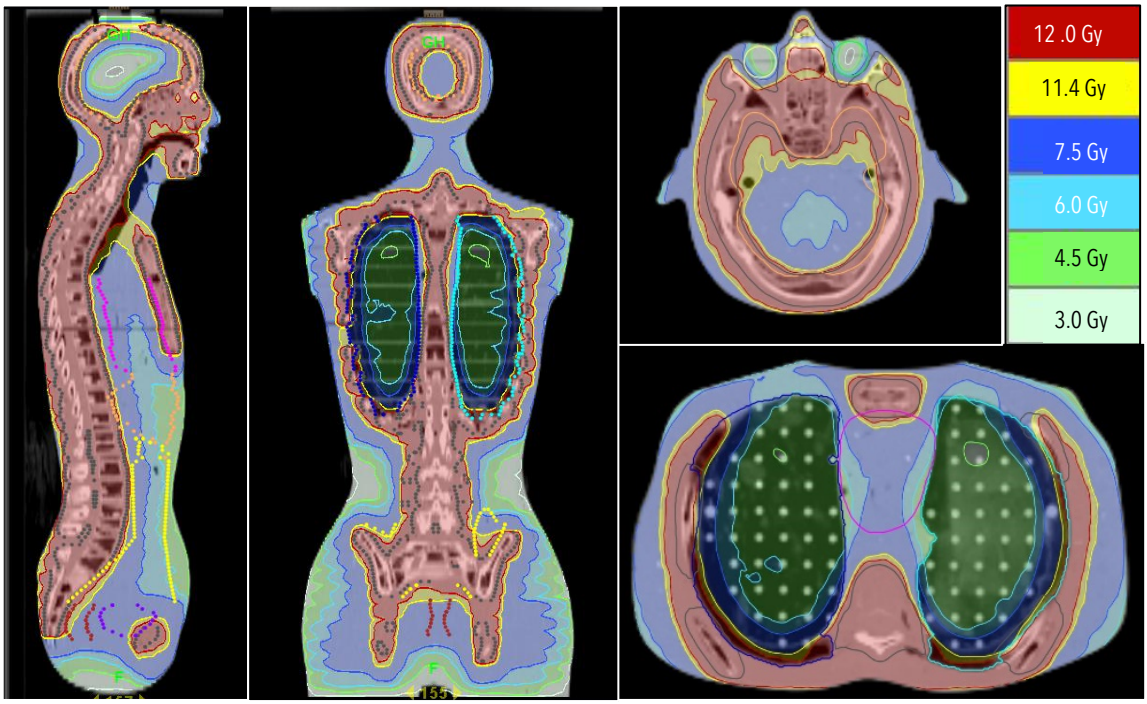

Figure 1. Dose distribution of helical tomotherapy planning for TMI in rando phantom.

(Oncentra Master Plan V.3.2., Nucletron). The present study was conducted at the Department of Radiology, Faculty of Medicine, Chiang Mai University, Thailand. It was conducted between August 2018 and November 2019.

STRUCTURE CONTOURING DOSE PRESCRIPTION

Gross tumor volume (GTV) is the total bones in the body. Planning target volume (PTV) is expanding GTV 5.00 mm on each side. OARs include lungs, eyes, kidneys, liver, heart, bowel, and brain. The prescription dose for volume 95% (D95) of PTV≥12.00 Gy in 6 fractions. For the OARs, following Marcantonini's study, the median dose (D50) of eyes, lungs, liver, heart, intestine, and brain should be lower than 6.00, 7.50, 7.50, 7.50, 8.00, 9.00, and 12.00 Gy respectively.[9]

HELICAL TOMOTHERAPY PLANNING

For helical tomotherapy planning using 6 MV photons, the machine parameters are dynamic jaw, field width=5.00 cm, modulation factor=2.50, and pitch factor=0.45. After the plan was compliant with the objective for PTV and OARs, the plan verification was processed. Verify the position of rando phantom before the irradiation by megavoltage computed tomography (MVCT) imaging. The plan was delivered for OSL dose measurement for three times. Thirty minutes after irradiation, the radiation dose from the sixteen OSL was readout.

ANALYSIS OF PLAN VERIFICATION

The percentage difference of radiation dose at each position in the rando phantom between the

Table 1. OARs dose from helical tomotherapy planning.

OARs	Constraint D_{50} (Gy)	Planning Dose (Gy)		
		D_{50}	D_{10}	D_{mean}
Brain	<12.00	10.03	12.48	9.30
Heart	<8.00	7.44	10.13	7.71
Right eye	<6.00	5.23	6.88	5.33
Left eye	<6.00	5.14	7.12	5.27
Right lung	<7.50	5.94	11.33	7.08
Left lung	<7.50	6.01	11.20	7.18
Right kidney	<7.50	6.22	9.27	7.08
Left kidney	<7.50	5.12	11.39	5.85
Liver	<7.50	5.97	8.72	6.45
Bowel	<9.00	7.09	11.00	7.49
Average				6.88

treatment planning calculation and OSL measurement using the equation shown in Box 1.

$$\%Dose\ difference = \frac{(Planning\ dose - Measure\ dose)}{Measure\ dose} \times 100$$

Box 1. Equation

RESULTS

Helical tomotherapy planning for TMI with the dynamic jaw, FW=5.00 cm, MF=2.50, and PF=0.45 use dose constraint of OARs, following the study of Marcantonini.[9] The obtained dose distribution in rando phantom is shown in Figure 1.

PLANNING DOSE AT THE TARGET VOLUME AND OARS

From dose-volume histogram (DVH) the D_{95}, D_{50}, dose received by 10% volume (D_{10}), mean dose (D_{mean}), and maximum dose (D_{max}) of PTV were 12.06 Gy, 12.64 Gy, 12.88 Gy, 12.60 Gy, and 14.35 Gy respectively. The volume received 110.00% of the prescription dose (V_{110}) and volume received

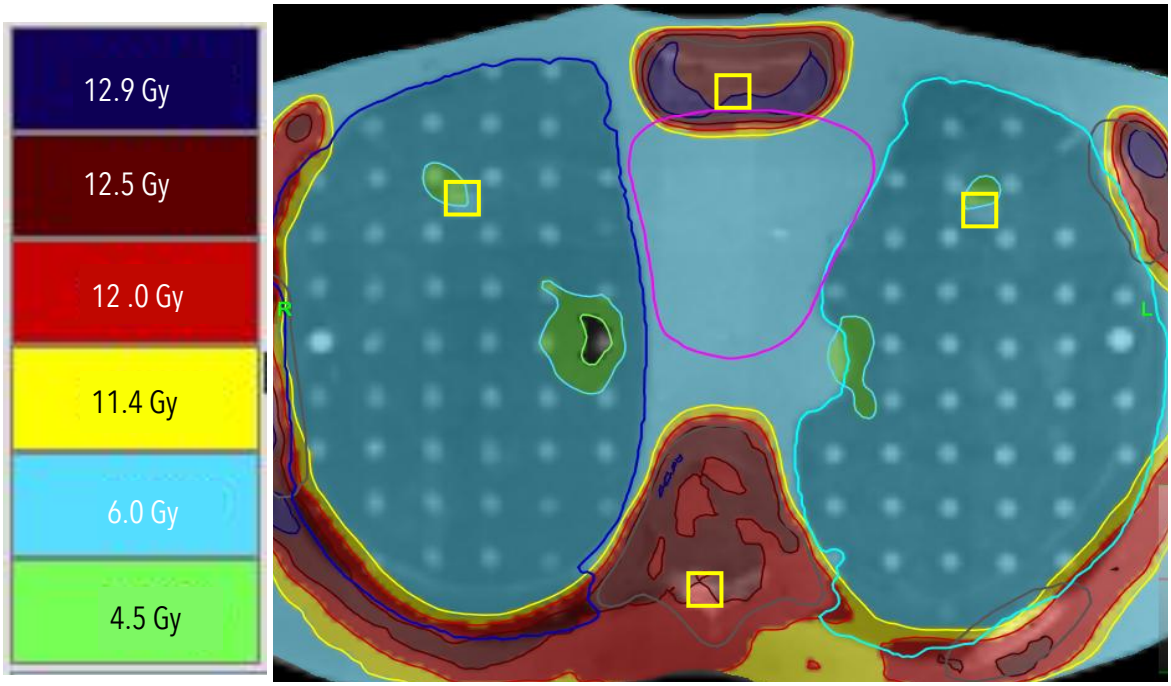

Figure 2. Dose distribution of helical tomotherapy planning for TMI in axial plane and the position of the four OSL in rando phantom.

93.00% of the prescription dose (V_{93}) of PTV were 1.80% and 99.08%, respectively. Planning dose at OARs, which include brain, heart, right and left eye, right and left lung, liver, and bowel are shown in Table 1.

PLANNING DOSE AT OSL

The calculation dose of helical tomotherapy planning for OSL position at spine, sternum, right lung, and left lung was 1253.00 cGy, 1293.67 cGy, 485.00 cGy, and 488.00 cGy respectively. Four OSL positions were shown in Figure 2.

MEASURED DOSE IN THE RANDO PHANTOM

OSL measured dose from the MVCT image procedure to verify the position of the rando phantom at the spine, sternum, right lung, and left lung was 1.80 cGy, 1.75 cGy, 1.80 cGy, and 1.65 cGy, respectively. The average of three times the dose measured with OSL from TMI plan delivery for 6 fractions at the spine, sternum, right lung, left lung were 1326.53, 1350.24, 484.63, and 489.83 cGy, respectively.

TMI PLANNING DOSE DEVIATION

The percentage difference between the planning calculation dose and OSL measured dose, at the spine, sternum, right lung, and left lung, were -5.54%, -4.19%, 0.08%, and -0.37%, respectively. The average difference was 3.48%.

DISCUSSION

This study on helical tomotherapy planning for TMI had the criteria D_{95} for PTV the same as that of the study by Schultheiss and Nalichowski.[6,8] The OARs

had the dose constraints following the study of Marcantonini as the international dose constraints for TMI is still unavailable.[9] The helical tomotherapy in the present study was created for TMI in the rando phantom, which was similar to the study of Nalichowski.[8] The machine parameters for optimizing were the same, except PF which was 0.450 while that of Nalichowski was 0.287. The D_{95}, D_{mean}, and D_{10} of PTV in our study and that of Nalichowski were similar; the differences were less than 1.00%. D_{max} in our study was 2.00% lower.[8]

Helical tomotherapy for TMI minimizes radiation dose at OARs when compared to prescription dose. Our study was able to reduce the average OARs radiation dose to 57.33% (6.88 Gy) of the prescription dose. Nalichowski used PF=0.287 which better reduced the average OARs radiation dose to 43.00% (5.16 Gy). The dosimetric parameters at the organs of the present study and that of Nalichowski were different as the rando phantom had no internal organs, except bones and lungs. Consequently, the drawing of organs contour and volume relied on the individual physician which affected the dosimetric parameters of each organ.

Average dose at the lung in this study was 7.13 Gy, which was higher than that of Nalichawski's study (6.77 Gy) but lower than that of Losert study which irradiated with 6 isocenter VMAT and lung dose was about 10.00 Gy.[8,10] TMI dose verification using OSL in our study showed the low percentage dose deviation at both lungs as it was in the low dose gradient area. There was a high percentage of deviation at the spine and sternum as the OSL were in the high dose gradient area. The average percentage of deviation was corresponding to the study of Yuen and lower than that of Welliver's study which was 4.48%.[11,12]

In conclusion, helical tomotherapy plan in the present study was able to provide a quality and effective plan for TMI D_{95}, D_{50}, and D_{mean} of PTV was deviate from the prescription dose less than 5.50% and was able to reduce the radiation dose to OARs, which were brain, heart, eyes, lungs, kidneys, and bowel to 57.33% of the prescription dose. TMI with helical tomotherapy minimized radiation dose to OARs in the rando phantom which mitigated the possibility of severe adverse effects such as pneumonia, cataract, and the chance of secondary cancer. OSL was considered suitable and convenient to use for HT planning for TMI verification as it is small and can measure radiation dose at different positions at the same time with the error at the low dose gradient less than 1.00%, and at the high dose gradient area was less than 6.00%.

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Reliability and validity of the revised triage sieve in daily emergency medical service situations

ORIGINAL ARTICLE

ORIGINAL ARTICLE BY

Ratrawee Pattanarattanamolee[1], M.D.;
Marturod Buranasakda[2], M.D.; Thanyaras Piyawatwela[1], R.N.

[1]Khon Kaen Hospital, Thailand; [2]Srinagarind Hospital, Thailand.

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Correspondence to: Ratrawee Pattanarattanamolee; ratrawee110@gmail.com

ABSTRACT

OBJECTIVE

To assess the reliability and the validity of the revised triage sieve in terms of a predictive performance regarding intrahospital death, hospital admission, and ESI.

METHODS

This study is a cross-section diagnostic study determining the reliability and diagnostic performance of the revised triage sieve for intrahospital death, hospital admission, and emergency severity index (ESI).

RESULTS

A total of 552 medical records were included. In terms of reliability, the inter-rater reliability was fair as the weight Kappa 0.54 (95% CI 0.49 to 0.59). The validity of the predictive performance regarding intrahospital death was relatively high (sensitivity 88.2%, 95% CI 63.6 to 98.5; specificity 80%, 95% CI 74.5 to 84.8; AUC 0.83, 95% CI 0.74 to 0.91). The high specificity was also found in hospital admission (80%, 95% CI 74.5 to 84.8) and hospital ESI (83.3%, 95%CI 79.0 to 87.0).

CONCLUSION

The revised triage sieve was one of the reliable and valid scene triage tools.

INTRODUCTION

Triage at the scene is performed initially in out-of-hospital trauma patients in the emergency medical service (EMS) system.[1] Its results would affect the decision of choosing the destination hospital and the emergency levels of transferring.[2–4] The Thai National Institute of Emergency Medicine has issued the criteria-based dispatch for phone triage.[5] Later, the emergency severity index (ESI) was created in 2000 to be used in the emergency room.[4] It is accepted to be the main triage because of its practicality, flexibility, and accuracy.[4,6–8] However, there is no standard scene triage tool as well as there is the evidence shows that the triage tool should be very specific to the scenarios and conditions.[9,10] Many triage tools have been used as scene triage, such as the Trauma index,[11] CRAMS scale,[12] Prehospital Index,[13] Advanced trauma life support field triage scheme,[14,15] The national advisory committee for aeronautics ,[16–18] Modified early warning score,[19] as well as the ESI was also used in the prehospital settings.[20] However, there is no reliable evidence confirmed which tool is superior as compared with one another on treatment outcomes.[21] In 2006, Robertson-steel[22] stated that the triage tool should be suitable and pragmatic for ambulance crew and EMS providers. The complicated triage tool, hence, should be refrained. Triage sieve was developed in 1995 as a part of the major incident medical management and support.[23] Triage sieve has been well known in its easy-to-use and has been adopted as a mass casualty triage for many years.[24,25] It was revised in 2012 to improve its accuracy.[26] The revised version was shown to have higher effectiveness in the military operation compared with that of the previous version.[27,28] The validity of its revised version, nonetheless, has never been assessed in daily EMS situations. Thus, the objective of this study was to assess the validity of the revised triage sieve in the daily emergency medical service situations.

METHODS

STUDY DESIGN

This study is a cross-section diagnostic study determining the reliability and diagnostic performance of the revised triage sieve for intrahospital death, hospital admission, and ESI.

MEDICAL RECORDS

The current study was conducted in an emergency medical service (EMS) system of four provinces in northeastern Thailand including Khon Kaen, Kalasin, Mahasarakham, and Roi-Et. Medical records of the EMS patients between January and August 2017 were reviewed and recorded. We excluded those with incomplete data and died on the scene. The intrahospital death was collected from patients' hospital records as well as the hospital admission. ESI was assessed by an emergency room nurse.

DATA COLLECTION

Aside from intrahospital mortality, hospital admission, and ESI, variables including sex, age, dispatch code, types of injury; trauma or non-trauma, as well as variables regarding the on-scene triage level done by EMS providers; Priority 1 (P1), Priority 2 (P2), and Priority 3 (P3) sieve were

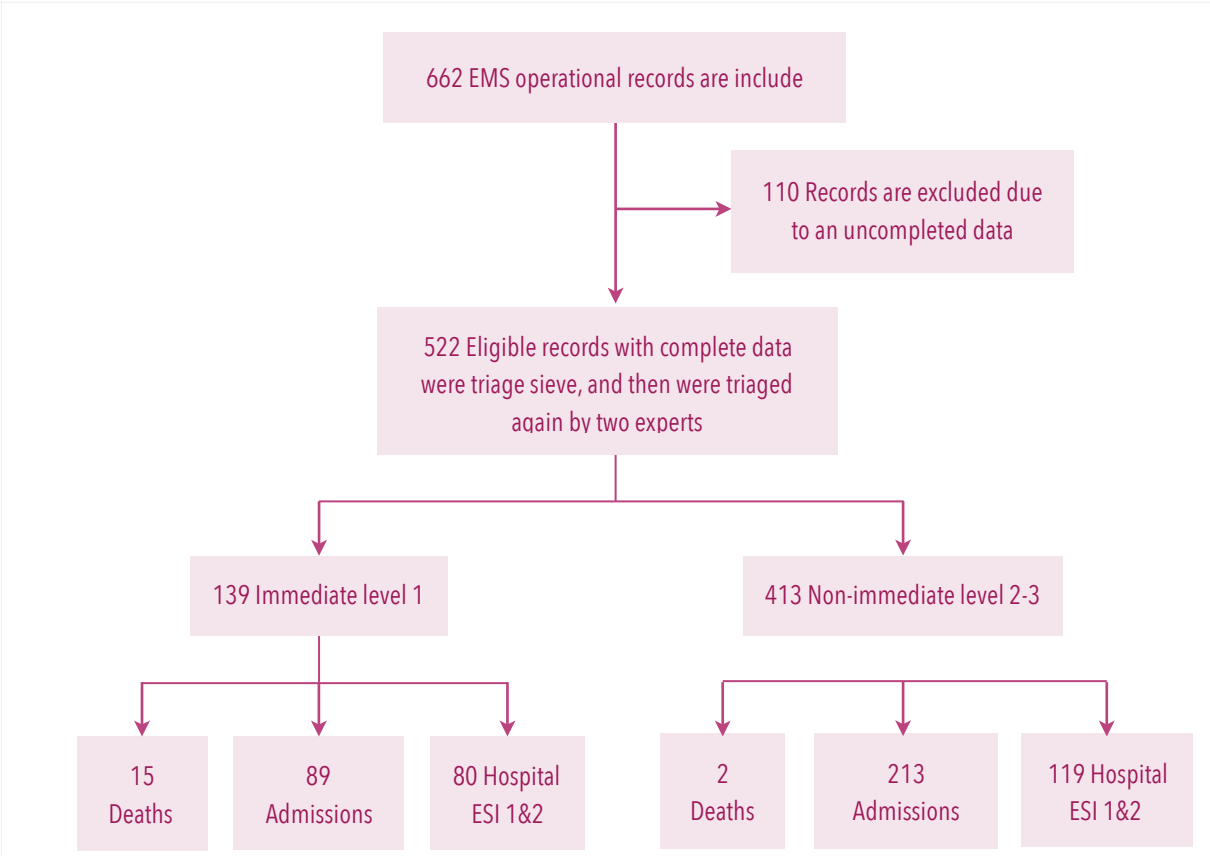

Figure 1. Patients

collected from recording documents; medical records and hospital records. All patients were divided into either immediate groups (P1) and non-immediate groups (P 2 and P3).

STATISTICAL ANALYSIS

All data were entered onto a spreadsheet, cleaned, and verified before the analysis. All characteristic data were analyzed by the Chi-square test, Mann-Whitney U test (continuous data), and Fisher exact test depending on the type of data. The calculated revised triage sieve was performed by two experienced paramedics. If there was some disagreement between them. the triage given in the medical records more would be accepted as the calculated revised triage sieve. The reliability of the revised triage sieve was calculated and presented in weight Kappa. For its validity, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratio (LR), accuracy, and area under the curve (AUC) together with its 95% confidence interval (CI) were also interpreted regarding the three outcomes; intrahospital death, hospital admission, ESI.

The sample size calculation is based on the sensitivity of our pilot study (N=60) which was 76%. Given 80% of power and 5% alpha error, the required sample would be at least 281. However, the study includes more than 600 patients for the best approximate of the results.

Table 1. Characteristics of the patients

Characteristic		Revised triage sieve		P-value
	Total (n=552)	Immediate (n=139)	Non-immediate (n=413)	
Male sex–no. (%)	311 (56.3)	87 (62.6)	224 (54.2)	0.086[a]
Age-years-no. (%)				0.015[a]
15 or younger	338 (61.2)	73 (52.5)	265 (64.2)	
60 or older	214 (38.8)	66 (47.5)	148 (35.8)	
Median (IQR)	52 (35-68)	59 (37-72)	50 (35-67)	0.023[b]
Dispatch code-no. (%)				<0.001[a]
Priority 1	150 (27.2)	79 (56.8)	71 (17.2)	
Priority 2	331 (60.0)	50 (36.0)	281 (68.0)	
Priority 3	71 (12.9)	10 (7.2)	61 (14.8)	
Trauma-no. (%)	156 (28.3)	40 (28.8)	116 (28.1)	0.876[a]
Intrahospital mortality-no. (%)	17 (3.1)	15 (10.8)	2 (0.5)	<0.001[c]
Hospital admission-no. (%)	302 (54.7)	89 (64.0)	213 (51.6)	0.011[a]
ESI level-no. (%)				<0.001[a]
1	86 (15.6)	43 (30.9)	43 (10.4)	
2	113 (20.5)	37 (26.6)	76 (18.4)	
3	193 (35.0)	41 (29.5)	152 (36.8)	
4	137 (24.8)	16 (11.5)	121 (29.3)	
5	23 (4.2)	2 (1.4)	21 (5.1)	

*Immediate(PO and P1), Non-immediate(P2 and P3), [a]Chi-square test, [b]Mann-Whitney U test, [c]Fisher exact test

Table 2. Matched levels of on-scene and calculated revised triage sieve

Priority	Calculated Revised triage sieve		
Revised triage sieve	**1**	**2**	**3**
		no. (%)	
1	73 (83.9)	46 (16.1)	20 (11.1)
2	9 (10.3)	196 (68.8)	56 (31.11)
3	5 (5.8)	43 (15.1)	104 (57.8)

RESULTS

There were 662 EMS patients included in the study; 110 patients were excluded due to incomplete data. In total, 552 were left in the analysis and were divided into two groups by the on-scene triage level (Figure 1). From Table 1 comparing the immediate and non-immediate groups, the former had a similar age range, a similar proportion of male sex, a similar types of injury, and similar hospital-admission rate (P>0.001). However, the intrahospital death and ESI were significantly different between the two groups (P<0.001).

The matched levels of the onsite and calculated revised triage sieve are presented in Table 2. The best-matched level is P1. Conversely, the percentage of matched level P2 and P3 is over 50%. Inter-rater reliability was described in the weight Kappa, which was 0.54 (95% CI 0.49 to 0.60).

Using the on-scene triage sieve to identify the immediacy of the patients and to prognose the intrahospital mortality, P1 yielded 88.2% sensitivity (95% CI 63.6 to 98.5), 76.8% specificity (95% CI 73.0 to 80.3), PPV 10.8% (95% CI 6.2 to 17.2), NPV 99.5% (95% CI 98.3 to 99.9), positive LR 3.8 (95% CI 3.0 to 4.8), negative LR 0.2 (95% CI 0.04 to 0.6), and Accuracy 77.2 (95% CI 73.4 to 80.6).

For hospital admission as the secondary outcome, P1 reported 29.5 % sensitivity (95% CI 24.4 to 35.0), 80.0% specificity (95% CI 74.5 to 84.8), PPV 64.0% (95% CI 55.5 to 72.0), NPV 48.4% (95% CI 43.5 to 53.4), positive LR 1.5 (1.1 to 2.0), negative LR 0.9 (95% CI 0.8 to 1.0), and Accuracy 52.4% (95% CI 48.1 to 56.6), and for ESI 1 and 2, P1 yielded 40.2% sensitivity (95% CI 33.3 to 47.4), 83.3% specificity (95% CI 79.0 to 87.0), PPV 57.6% (95% CI 48.9 to 65.9), NPV 71.2% (95% CI 66.6 to 75.5), positive LR 2.4 (95% CI 1.8 to 3.2), negative LR 0.7 (95% CI 0.6 to 0.8), and Accuracy 67.8 (95% CI 63.7 to 71.6). The AUC was demonstrated in figure 2. For intrahospital death, the AUC was significantly high as 0.83 (95% CI 0.7 to 0.9) while the AUC for hospital admission and ESI are o.6 (95%CI 0.5 to 0.6), and 0.6 (95% CI 0.6 to 0.7), respectively.

Table 3. Diagnostic performance of on-scene revised triage sieve at priority level 0 and 1 on each outcome

Revised triage sieve	Sensitivity	Specificity	PPV	NPV	LR+	LR-	Accuracy
Intrahospital death	88.2 (63.6 -98.5)	76.8 (73.0-80.3)	10.8 (6.2-17.2)	99.5 (98.3-99.9)	3.8 (3.0-4.8)	0.15 (0.04-0.56)	77.2 (73.4-80.6)
ESI (ESI 1 & 2)	40.2 (33.3-47.4)	83.3 (79.0- 87.0)	57.6 (48.9-65.9)	71.2 (66.6-75.5)	2.4 (1.8-3.2)	0.72 (0.63-0.81)	67.8 (63.7-71.6)
Admission	29.5 (24.4- 35.0)	80 (74.5-84.8)	64 (55.5-72.0)	48.4 (43.5-53.4)	1.5 (1.1-2.0)	0.88 (0.80-0.97)	52.4 (48.1-56.6)

DISCUSSION

PRINCIPAL FINDINGS

According to the finding, the revised triage sieve had moderate inter-rater reliability. The diagnostic performance of the revised triage sieve for intrahospital was high in sensitivity, good in specificity, PPV was quite low, NPV was high, the positive LR was small increase while the negative LR was moderate, and overall accuracy was fair. Notably, the AUC for intrahospital death was good. It seems that the revised triage sieve was able to rule in and rule out the intrahospital death, effectively. Besides, its high sensitivity and high NPV results in a low false negative. The low PPV can be explained by the low prevalence as 3.1% (95% CI 1.8 to 4.9). However, a negative LR power was higher than a positive LR, which indicated the suitability of this tool for ruling-out the diagnosis. In terms of hospital admission, the sensitivity was low but the specificity was good. Both PPV and NPV were fair. Either a positive or negative LR was small and rarely important. The AUC was interpreted as a fail level. Lastly, the overall accuracy is fair. It can be seen that the revised triage sieve was able to rule out the admission because of its high specificity. However, other parameters did not support the diagnostic performance of the tool. Next, for the ESI, the sensitivity was fair and the specificity was high. This supports its ability to rule out the ESI. PPV was quite high while PPV was fair. A positive LR was small as well as the negative LR was small and rarely important. Additionally, the AUC was interpreted as a poor level. It can be concluded that the diagnostic performance for ESI is unacceptable.

COMPARISONS WITH OTHER STUDIES

Due to a relatively small number of studies in this field, related studies are scarce. However, our findings are related to one study which reported the good specificity of this tool.[29] On the other hand, there is one study which indicated the triage sieve was inferior to identify a severe condition compared to other triage tools.[30]

STRENGTHS AND LIMITATIONS OF STUDY

The strength of this study was a multicenter study. It included 600 medical records to improve its quality. Second, this study applied several measurements to test the tool in different aspects.

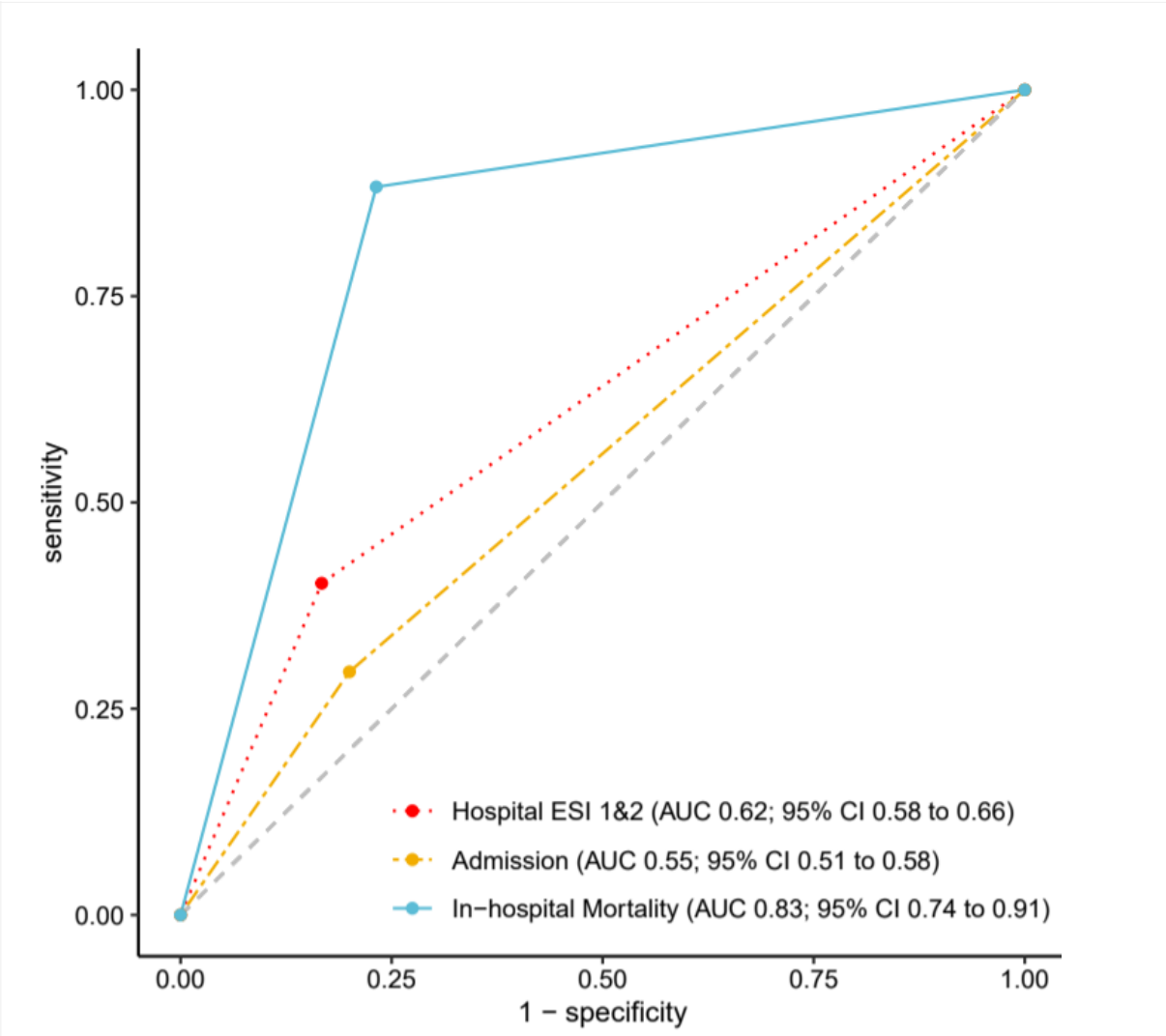

Figure 2. ROC curve of the immediate group

On the other hand, this study has some limitations. The number of medical records in the immediate group is less than the non-immediate group, which might affect the study to investigate the diagnostic performance in that group. Second, the prevalence of the intrahospital death was low which affected PPV as described above. Third, this study is an observational study that is difficult to control the confounding factor.

CONCLUSIONS AND POLICY IMPLICATIONS

The revised triage sieve was relatively reliable. It was useful to estimate the intrahospital death and hospital admission and ESI. Therefore, it was suitable to use as a scene triage in order to fill the gap of EMS service. However, further research should be conducted on a national scale to find out more regarding its reliability and validity.

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High and low fidelity simulation for clinical skill in paramedic students in resource limited settings

SYSTEMATIC REVIEW

ORIGINAL ARTICLE BY

Nantawan Tippayanate; Kiattisak Chaiprom; Ajchara Kamya; Chlollada Thornsao; Wipada Wijakkanalan; Nattida Aopasi; Kawisara Treemaneerat; Patthraporn Philatha

Mahasarakham University, Thailand

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Correspondence to: Nantawan Tippayanate; nokeworld@gmail.com

ABSTRACT

OBJECTIVE

To investigate and compare the effectiveness of high-fidelity simulation and low fidelity simulation.

METHODS

34 second-year paramedic students were randomly divided into eight groups: 17 students to the four experimental groups and the other 17 to the four control groups. Each group was assigned four scenarios of emergency from the same lecturer and the same instructor. The experimental groups received a high-fidelity simulator, a more advanced manikin that mimicked body mechanisms including pulse rates, a respiratory system, and a beating heart. They also had video-assisted instructor-facilitated debriefing. Meanwhile, the control groups received an evaluation during the training and then instructor-facilitated debriefing. Both experimental and control groups received their operation evaluation using a primary survey.

RESULTS

Thirtyfour paramedic students participated in the study (low fidelity, n=16; high fidelity, n=18). There was a significant improvement in posttest practice scores in assessment of the airway, disability and exposure. However, there was no statistically significant difference in score between low fidelity and high fidelity simulation sessions. Student opinions indicated that the experiential simulator sessions were more satisfying.

CONCLUSION

Both low fidelity and high fidelity simulation of faculty- facilitated educational offer a valuable learning experience. Future research is needed that address the long term effects of experiential learning in retention of knowledge and acquisition skills.

INTRODUCTION

Fidelity simulation training for paramedic students has had an increasingly important role for more than 20 years intending to develop their clinical skills to be effective for urgent situation with a limitation of training time and to give them relevant advice.[1,2] Fidelity simulation training is employed to instruct various medical practices including clinical examination, illness diagnoses, medical treatment procedures, and medical equipment use so students can perform those practices properly.[3] Advancement of hardware and software, simulation has become more realistic. Manikins used in a simulation have life-like body mechanisms such as pulse, respiratory system, and functioning pupils. They also have a basic ability to communicate. These sophisticated manikins are called high fidelity simulators.[4] Meanwhile, the less sophisticated manikins with limited simulated body mechanisms are called low fidelity simulators. When the latter is used, training is required to be evaluated with other criteria. Theoretically, the more realistic the simulation is, the better the learning outcome. However, it is found in various studies that gained knowledge and skills from high fidelity are not significantly different from that of low fidelity simulators.[5-7] However, most of the information is exclusively from the western countries while the evidence is relatively scarce in the resource- limited setting. The objective of this study was to compare the effectiveness of clinical learning outcome, self-confidence and satisfaction between the low fidelity simulation vs high fidelity simulation.

METHODS

STUDY DESIGN AND OVERSIGHT

This study employed quasi-experimental design with non-randomized intervention-control posttest only design to compare the results from the group trained with high fidelity simulation and the other group trained with low fidelity simulation. Both groups were given debriefing after the simulations. The low fidelity simulation took place in the skill lab, the faculty of Medicine, Mahasarakham University, Thailand and the high-fidelity simulation took place in the simulation unit, the faculty of nursing, Mahasarakham University, Thailand. The study period was from June 1, 2020 through July 31, 2020. The study was approved by the ethics committee of Mahasarakham University.

PARTICIPANTS

The participants were 34 second-year paramedic students of the academic year 2019 of Mahasarakham University, Thailand. They were divided into four groups regarding the students' preference. In each of these four groups; it was later divided into two small groups with a matched pretest score. At this stage, we had 8 small groups with 4-5 students per small group. These 8 small groups were assigned using block randomization with a block size of 2 to either high and low fidelity groups using.

PROCEDURES

All students were lectured regarding history taking and physical examination for 8 weeks at the Faculty of Medicine, Mahasarakham University. Later, they

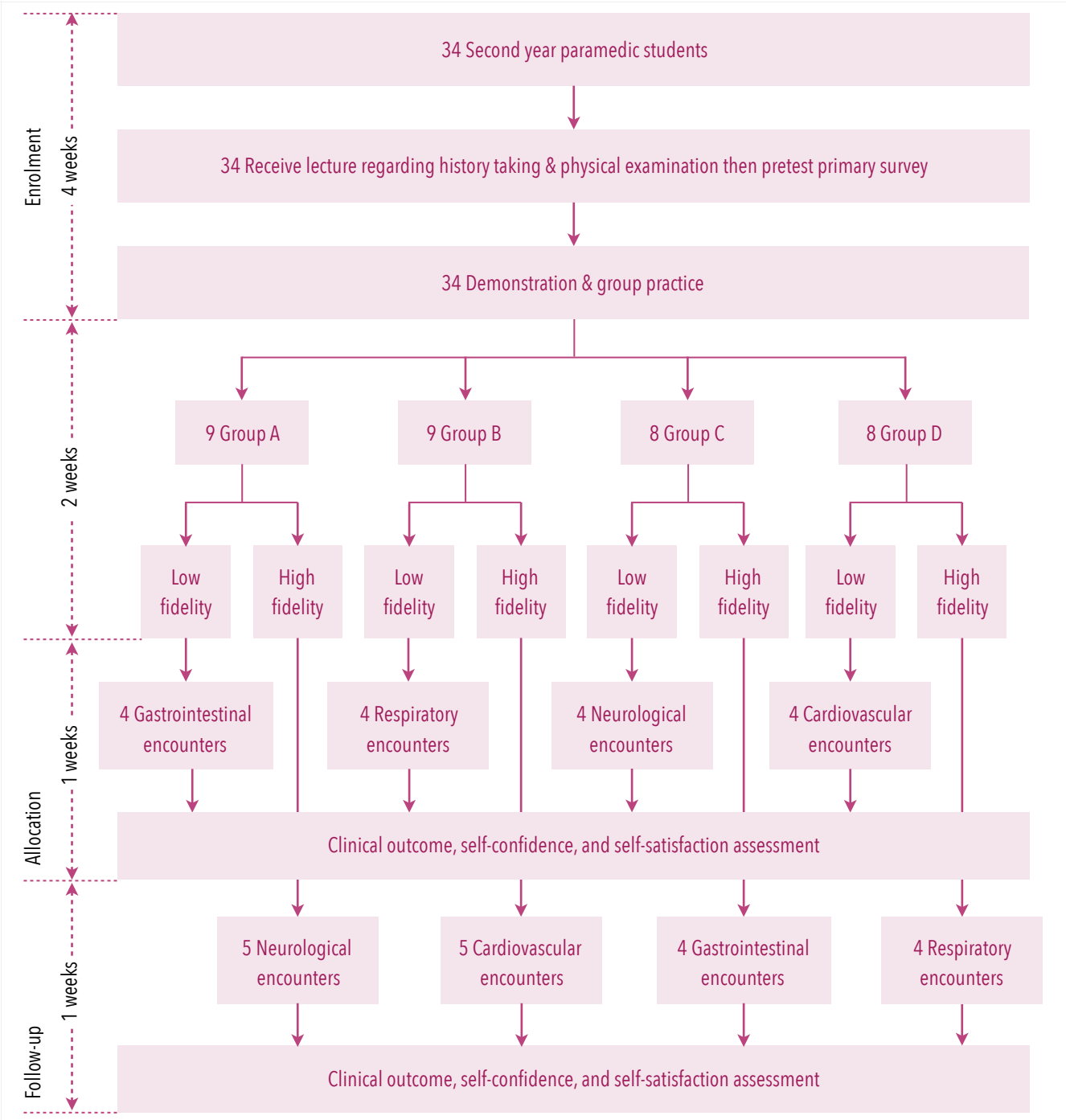

Figure 1. Study flow

Table 1. Primary survey score

Primary survey group score	Low fidelity (4 groups)	High fidelity (4 groups)	P-value
Total pretest score			0.69
Median	27.3	27.5	
IQR	27.3-27.4	27.2-27.6	
Range	27.3-27.4	27.0-27.7	
Posttest score			
Airway			0.88
Median	7.5	8.0	
IQR	6.5-8.5	4.0-10.0	
Range	6.0-10.0	2.0-10.0	
Breathing			>0.99
Median	8.0	7.5	
IQR	6.5-9.5	6.5-9.0	
Range	6.0-8.0	7.0-10.0	
Circulation			>0.99
Median	13.5	13.5	
IQR	13.0-14.5	10.0-17.5	
Range	13.0-15.0	10.0-18.0	
Disability			0.14
Median	6.5	9.5	
IQR	4.5-8.5	8.5-10.0	
Range	4.0-10.0	8.0-10.0	

Table 1. Continue

Primary survey group score	Low fidelity (4 groups)	High fidelity (4 groups)	P-value
Exposure			0.32
Median	2.50	3.0	
IQR	2.0-3.0	3.0-3.5	
Range	2.0-3.0	3.0-4.0	
Total			0.01
Median	38.0	39.0	
IQR	33.5-41.5	34.5-45.0	
Range	32.0-42.0	31.0-50.0	

were subjected to pretests using 40 multiple-choice questions. Then the instructor demonstrated how to do a primary survey in an emergency patient and allowed the students to do a return demonstration and a group practice for another week. The members of each subgroup were practiced by assigning the role to be the first-order as a paramedic or head of the group, the second-order as an advanced emergency medical technician (EMT), the third-order as a basic EMT and the fourth-order as an emergency medical rescuer. If there were the fifth-orders in some groups, they were assigned as a driver. A week later, the low fidelity group was practiced as a posttest with random clinical encounters of emergency conditions consisting of the cardiovascular problem, respiratory problem, gastrointestinal problem, and neurovascular problem (Figure 1). The students in the high fidelity group were allowed to observe their peers. In the last week, the high fidelity groups practiced as a post-tested with random clinical encounters for the same various emergency conditions with a different diagnosis. The students in the low fidelity groups were also allowed to observe.

For each clinical encounter, it comprised, first, 10-minute-long pre-briefing by the same instructor that gave the students details of fidelity simulation and instructions and let them familiarize with the tools such as emergency medical kit and the manikin; second, a 20-minute-long practice session with the instructor giving simulated scenarios and evaluating the students' clinical skills, third, a 20-minute-long session for debriefing by the instructor team.

SIMULATIONS

Each group of the students was given a 30-minute-long session. In the low fidelity group, the instructor indicated the clinical symptoms such as

pale, dyspnea, restless, tachycardia, cyanosis to recognize any illness. Meanwhile, the training of the high fidelity group was conducted in the high-fidelity simulation, the manikin with life-like body mechanisms such as functioning pupils, a respiratory rate, a blood pressure, a pulse rate, and EKG monitor that could be assessed. The same instructor provided simulated scenarios of emergency which had been presented using a computer-based. In both groups, a deterioration in the condition of the patient changed according to how well the students gave medical care in an emergency. The high-fidelity simulation was also being recorded on video from the beginning to the end of the session for reviewing during the debriefing.

DEBRIEFING

The debriefing was done in every group after finishing the clinical encounter session, the same instructor encouraged students to reflect their performance by exploring the process of simulation, the outcome achieved, and the application of the scenario to clinical practice with non judgemental feedback by welcoming all comments and correcting the misunderstanding. However, video-assisted instructor-facilitated debriefing using the recorded video was done only in the high fidelity group.

OUTCOME MEASURES

The three measures in the present study included outcome-based clinical skills, self-confidence, and student satisfaction. The clinical skills were assessed by a practical scenario simulated assessment using the non-trauma primary survey.[8] The scores were given regarding group (group score) using a 26-question with a three-point global rating scale, the high score showed the appropriate assessment and decision making consisting of lists for assessment and management of airway, breathing, circulation, disability, and exposure (ABCDE). After being provided with call-out information by the instructor, participants entered a room carrying a standardized medical kit to find a manikin awaiting diagnosis, stabilization, and to be made ready for transport. Score 0 meant undo or wrong which requires development; score 1 meant incomplete or required supervision' and score 2 meant complete or competent. The total score then could be ranged from 0 to 52.

To measure participants' level of confidence and satisfaction level, we adopted the checklist of the students' self-confidence and satisfaction using the National League for Nursing.[9,10] To measure the students' confidence, we used 8-item questions with a four-point Likert scale while the students' satisfaction was measured using 5-item questions with the same four-point Likert scale; very satisfied, satisfied, unsatisfied, and very unsatisfied. The instrument has a high reliability with a Cronbach's alpha of 0.90 for the presence of features and 0.96 for its importance.[11] Its content validity was scored by the expert opinions of the three instructors yielding 0.86, 1, and 1. The students' confidence and satisfaction was determined to be structurally valid.[12]

STATISTICAL ANALYSIS

The present study was using the Mann-Whitney U test for non-normally distributed continuous data and the chi-square test for categorical data. The clinical assessment scores, the level of confidence and the participants' satisfaction from the low and high-fidelity simulation were analysed.

Table 2. Self-confidence rating scale

	Low fidelity (N=16)				High fidelity (N=18)				P Value
I am confident that	Strongly disagree	Disagree	Agree	Strongly agree	Strongly disagree	Disagree	Agree	Strongly agree	
	no. (%)								
I am mastering the content of the simulation activity that my instructors presented to me.	0	9 (56)	7 (44)	0	0	3 (17)	12 (66)	3 (17)	0.03
This simulation covered critical content necessary for the mastery of paramedic curriculum.	0	7 (44)	9 (56)	0	0	3 (17)	12 (66)	3 (17)	0.09
I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a scene	0	8 (50)	7 (44)	1 (6)	1 (5)	1 (5)	12 (67)	4 (23)	0.02
My instructors used helpful resources to teach the simulation.	0	7 (44)	6 (38)	3 (18)	0	1 (5)	11 (61)	6 (34)	0.03
It is my responsibility as the student to learn what I need to know from this simulation activity.	0	0	13 (82)	3 (18)	0	0	12 (67)	6 (33)	0.34
I know how to get help when I do not understand the concepts covered in the simulation.	0	6 (38)	8 (50)	2 (12)	0	4 (22)	8 (44)	6 (33)	0.32
I know how to use simulation activities to learn critical aspects of these skills.	0	3 (19)	9 (56)	4 (25)	0	0	9 (50)	9 (50)	0.09
It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time.	0	4 (25)	10 (62)	2 (13)	0	1 (5)	8 (44)	9 (50)	0.04

RESULTS

Thirty-four second-year paramedic students participated in the present study. Most of them were female. The pretest scores between the two groups were similar (P=0.69). For the posttest score, there were also no significant differences between the two groups concerning all process of the primary survey; airway (P=0.88), breathing (P>0.99), circulation (P>0.99), disability (P=0.14), exposure (P=0.32). The total posttest score of the high fidelity group, however, was significantly higher than that of the low fidelity group (P=0.01) (Table. 1).

From Table 2, we found that the high fidelity group tended to have higher confidence compared with that of the low fidelity group in relation to class mastery (P<0.05); knowledge to perform necessary task (P<0.05); helpful resources (P<0.05) and get what need to learn from simulation activity (P<0.05).

For Table 3, we also found that the high fidelity group tended to have higher satisfaction compared with that of the low fidelity group in relation to effective teaching method (P<0.005); variety of learning materials and activities (P<0.005); motivated and helpful materials to learn (P<0.005) and suitable to their way of learning (P<0.005).

DISCUSSION

SUMMARY

The thirty-four second year students who received the lecture and then pretest before the primary survey practice using the low fidelity compared to the high fidelity simulation did not show a significant difference in pretest score and also the clinical assessment score in each process of primary survey. However, in the high fidelity group, they felt more confidence in group relation to class mastery, knowledge to perform necessary tasks, helpful resources, and have got what they need to learn from simulation activity. In the self-satisfaction outcome, there were found that the students were more satisfied in groups of high fidelity in relation to effective teaching methods, variety of learning materials and activities, motivated materials to learn and suitable to their way of learning.

COMPARISON WITH OTHER STUDIES

The result indicated that the clinical assessment outcome of the group practice with the higher fidelity was not significantly different to the low fidelity group practice when focus each step from A to E in the primary survey. It was the result same as many studies [14-16] which indicated that no difference in knowledge at course conclusion or no difference in skill performance. It may be due to the fact that the fidelity plays an important role in the choice of an appropriate simulation for a specific task, while the clinical assessment outcomes depend on the type of task and learner's level. The comparisons made between high and low fidelity simulations mainly investigated the educational impact. The psychometric advantages and disadvantages were evidently not elaborated.[17]

The high fidelity group practice tended to have higher confidence than the low fidelity group. The use of high-fidelity allows learners to engage physically with the simulated patient, assess physical findings, make clinical decisions, and can

Table 3. Student-satisfaction rating scale

Item of satisfaction	Low fidelity (N=16)				High fidelity (N=18)				P Value
	Very unsatisfied	Unsatisfied	Satisfied	Very satisfied	Very unsatisfied	Unsatisfied	Satisfied	Very satisfied	
	no. (%)								
The teaching methods used in this simulation were helpful and effective.	0	2 (12)	10 (62)	4 (26)	0	0	3 (17)	15 (83)	0.002
The simulation provided me with a variety of learning materials and activities to promote my learning of the medical surgical curriculum.	0	4 (24)	6 (38)	6 (38)	0	0	1 (5)	17 (95)	0.002
I enjoyed how my instructor taught the simulation.	0	2 (12)	5 (31)	9 (57)	0	0	2 (11)	16 (89)	0.08
The teaching materials used in this simulation were motivating and helped me to learn.	0	3 (18)	10 (62)	3 (20)	0	0	4 (22)	14 (78)	0.002
It is my responsibility as the student to learn what I need to know from this simulation activity.	0	0	13 (82)	3 (18)	0	0	12 (67)	6 (33)	0.34
I know how to get help when I do not understand the concepts covered in the simulation.	0	6 (38)	8 (50)	2 (12)	0	4 (22)	8 (44)	6 (33)	0.32
I know how to use simulation activities to learn critical aspects of these skills.	0	3 (19)	9 (56)	4 (25)	0	0	9 (50)	9 (50)	0.09
It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time.	0	4 (25)	10 (62)	2 (13)	0	1 (5)	8 (44)	9 (50)	0.04

increase realism of interactions with other healthcare professionals in team-based that closely clinical practice[18], therefore the confidence in domain; mastering content, developing skill, helpful resources were higher compare to the low fidelity using basic manikin and then response the abnormality of signs and symptoms by instructor only.

Higher fidelity group practice tended to have more satisfaction than low fidelity group practice, this finding deviates from a study conducted by Zulkosky[19] who were found that the different degree of complexity in the methods of high fidelity may have influenced the students' perceptions and the students seemed to prefer learning strategies that they were accustomed to.[20]

STRENGTH AND LIMITATION

In the present study, we used the self- confidence and self-satisfaction with high reliability; the Cronbach's alpha of 0.90 for the presence of features and 0.96 for its importance. However it was a subjective rating scale and may have a different rate from another examiner therefore the overall self-confidence and overall self-satisfaction should be asked to finalize the total score.

Each item of self-confidence not meaning confidence in skill, because of the fidelity simulations is regarding the environment and context of learning and application. Therefore, the self- confidences in clinical assessment skills were not clearly described.

The high fidelity practice after the observation of Low fidelity group practice may affect better clinical outcome and self-confidence. In the present study may bias the findings because the training was carried out on the low fidelity prior with allocation of students to observe then the next week was practice with the high fidelity group, therefore it may bias more confidence when practice after complete observation in the low fidelity group.

All participants were second-year paramedic students but have good experience on multiple tasks and complication tasks to improve decision making. As an essential part of professional development and education, the students were trained under safe conditions in order to practice in complex situations, as manifested by clinical practice.[21] Meanwhile, the mean score of satisfactions in high fidelity were significantly higher compared to low fidelity due to the video-assisted instructor-facilitated debriefing in high fidelity simulation is more reassurance of intentions and essential to create a safe emotional environment that is conducive to learning.

CONCLUSION AND IMPLICATION

The findings support the fact that from the clinical assessment outcome, simulation methods using low to high fidelity could be used in paramedic education at second year- level. However, the level of fidelity should be appropriate to the type of task and training stage. A novice can achieve similar or higher skills transfer with a simple simulator, than with a complex training aid such as a simulated environment. In the future study, the balancing fidelity and breadth of sampling as this will affect reliability, validity, educational impact, feasibility, and acceptability of the assessment method. Concerning the impact of high fidelity manikins, we need to define the best means of structuring debriefing to facilitate meaningful learning that will impact students' performance.

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"I shall either find a way or make one"

-Hannibal Barca

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