COMPETENCY IN DIAGNOSIS AND MANAGEMENT OF DENGUE INFECTION AMONG GRADUATING MEDICAL STUDENTS IN THAILAND

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Abstract. Dengue infection is a major problem in Thailand. Physicians are required to manage patients with dengue infection effectively. We aimed to determine the ability of medical students in Thailand to manage these patients in order to inform their training programs. We used a modified essay questionnaire (MEQ) to assess the knowledge of graduating medical students about the recognition and management of the various stages of dengue infection. The MEQ consisted of a hypothetical case of a patient with dengue infection that developed dengue shock syndrome. Scores from the examination of 259 graduating medical students from 4 different medical schools were collected in this study. We calculated the percentage of students who correctly managed the case scenario and then compared the correct responses by medical school and student performance group. Eighty-two percent of participants correctly recognized dengue infection and 87% correctly recognized dengue hemorrhagic fever (DHF). Of these, 30% correctly chose intravenous fluid resuscitation. Forty-three percent correctly recognized impending shock and 17% gave appropriate resuscitation. About 50% of participants recognized the bleeding and the convalescent stages. Forty-five percent of participants chose appropriate management of the convalescent stage. The correct response rates did not differ significantly by medical school. Above-average students performed better than average and below-average students in nearly all the scenarios. Most study participants correctly diagnosed dengue infection. However, the percentages of participants who recognized the different stages of dengue infection and who correctly managed the intravenous fluid treatment of the dengue patient were inadequate. Greater emphasis needs to be placed in the curriculum of these students on those aspects in their respective training programs.

Keywords: MEQ, dengue infection teaching

INTRODUCTION

Dengue infection is an important health problem in Thailand. The Ministry of Public Health for Thailand reported 142,925 cases of dengue infection in 2015, with an incidence rate of 219/100,000 population and a death rate of 0.1% (MOPH, 2015). Early disease recognition

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and proper fluid management are important. Dengue hemorrhagic fever and dengue shock syndrome are associated with high levels of morbidity and mortality, including internal organ bleeding, multiple organ failure, pulmonary edema and death (Gubler, 1998).

Patients with dengue infection are managed mainly by primary care physicians in Thailand. The training of medical students in Thailand regarding disease awareness, pathophysiology and management is crucial. We developed a modified essay questionnaire (MEQ) as an instrument to assess the management of patients with dengue infection. A MEQ can be used to test a student's higher cognitive, thinking and reasoning skills (The Boards of Censors of the Royal College of General Practitioners, 1971; Irwin and Bamber, 1982; Stratford and Pierce-Fenn, 1985). Dengue infection consists of several stages with varying complications. A MEQ is a good tool to assess the competency of the students to recognize and manage each stage in the clinical course and identify deficiencies in patient management. These data can be used to inform medical student training programs in order to improve patient care.

MATERIALS AND METHODS

MEQ instrument

In most Thai medical schools, a MEQ is part of the comprehensive examination given prior to graduation. At our institution, the MEQ examination is usually held 4 months before graduation. There are 8 parts of the examination, one for each subspecialty of medicine. A thirty minute time limit is allowed for each part. In 2014, dengue infection was one of the 8 tested items. The MEQ consisted of a scenario about a 5-year-old boy presenting with fever, followed by a clinical course that included dengue shock syndrome: leakage stage with internal organ bleeding and a convalescent stage with pulmonary edema. Examinees were asked to recognize each stage of infection and indicate proper management. The details of the questions are shown in Table 1.

Data collection

The scores of the 259 students from four different medical schools were obtained from the Medical Education Affairs Department at the Faculty of Medicine, Ramathiobdi Hospital. The students all attended the same classes during their preclinical years (years 1-3) but had different clinical rotations at different hospitals during their clinical years (years 4-6).

Data analyses

The student responses to the MEQ were checked by one examiner. The percentages of correct responses was calculated. Students whose correct answers from all 8 items ranked in the upper third were classified as above-average, students who ranked in the middle third were classified as average and students who ranked in the lower third were classified as below-average. We compared correct responses by medical school and student group using the chi-square test with SPSS, version 16.0 (SPSS, Chicago, IL).

The MEQ instrument used belongs to the Faculty of Medicine, Ramathibodi Hospital. Use of the data for this study was approved by the ethics committee of the Faculty of Medicine, Ramathibodi Hospital.

RESULTS

There were 160, 49, 31 and 19 participants from medical schools 1 (M1), 2 (M2), 3 (M3), and 4 (M4), respectively. The

Medical Education Affairs Department allowed classification of above average, average and below average students to be performed among in M1 students only.

Performance of the students in each scenario

Disease recognition. The scenario was a 5-year-old boy who presented with a 4 day history of fever, poor appetite and vomiting. On physical examination, he had a body temperature of 38.5°C, a pulse rate of 100/min, and a blood pressure of 90/60 mmHg; he had hepatomegaly on examination. Of the 259 participants, 211 (81.5%) listed dengue infection as a part of the differential diagnosis. The percentages of students by medical school who listed dengue infection in the differential diagnosis were not significantly different (Fig 1). Of the 211 participants who listed dengue infection in the differential diagnosis, 111 (42.9%) chose a tourniquet test to confirm the diagnosis. When the result of tourniquet test was positive, 99.6% of students were able to make the provisional diagnosis of dengue infection. The complete blood count (CBC) results were listed as a hematocrit of 42%, a total white blood count of 3,000/µl with lymphocyte predominance and a platelet count of 80,000/µl; 225 students (86.9%) were able to classify the disease as dengue hemorrhagic fever (DHF); no differences were seen by medical school (Fig 2).

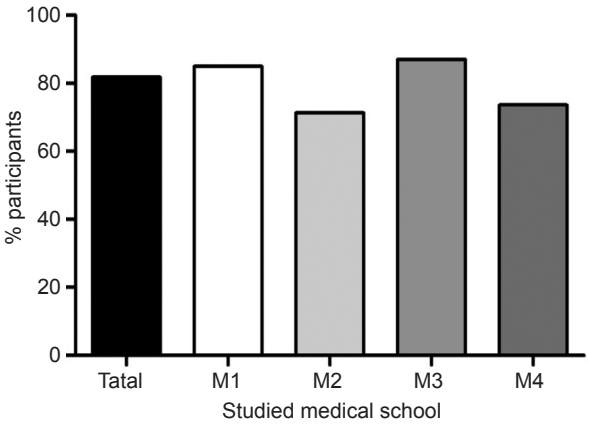

Fig 1–Percent of participants who included dengue infection in the differential diagnosis by school. M1, M2, M3, M4 designate the medical schools.

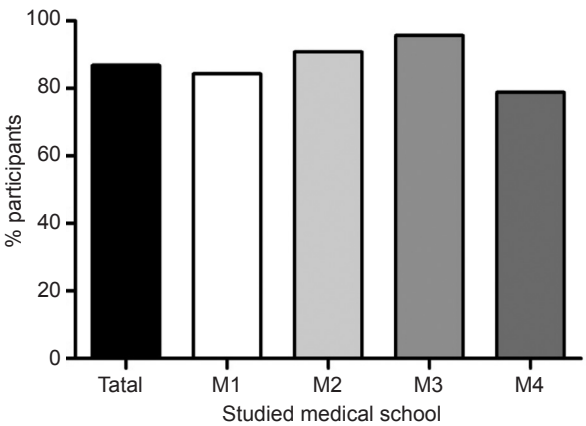

Fig 2–Percent of participants who correctly recognized dengue hemorrhagic fever. M1, M2, M3, M4 designate the medical schools.

Management of the patient during the leakage stage of dengue infection. Students were asked about the recommended intravenous fluid type and rate to manage the patient during the leakage stage if the vital signs were stable. The World Health Organization (WHO) recommends isotonic solution at a rate of 5-7 ml/kg/hr in this scenario (WHO, 2012). Various intravenous fluid forms and rates were chosen by the participants (Fig 3). Seventy point seven percent of participants chose isotonic fluid (5% dextrose in normal saline, normal saline, Ringer lactate or Ringer acetate and 10% dextrose in normal saline), 30.9% of participants chose the appropriate type and rate of intravenous fluid. There were no significant differences by

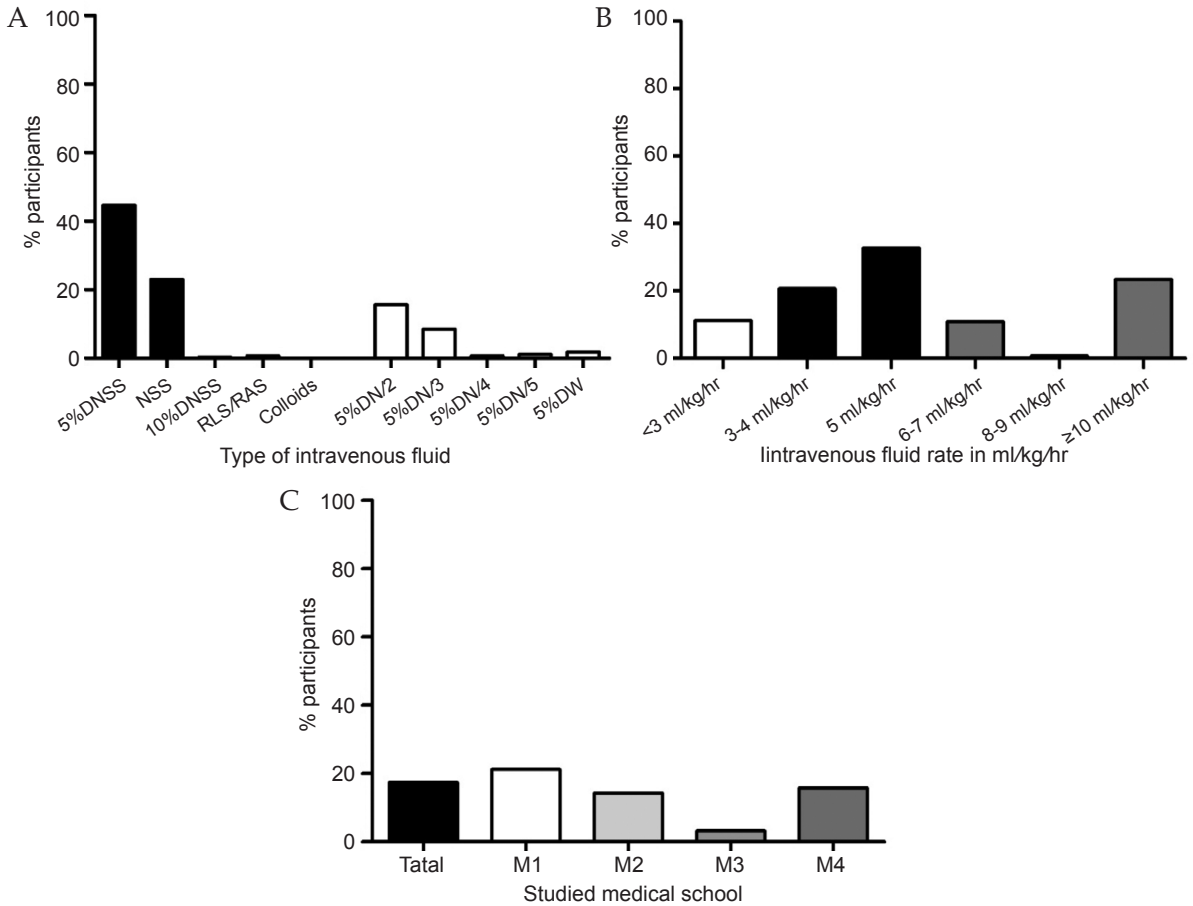

Fig 3–A. Percentage of participants choosing various types of intravenous fluid to manage the dengue patient in the leakage stage with stable vital signs. B. Percentage of participants choosing various rates of intravenous fluid to manage the dengue patient in the leakage stage with stable vital signs. C. Percentages of participants who correctly chose the type and rate of intravenous fluid to manage the patient with dengue infection during the leakage stage with stable vital signs by medical school. DNSS: dextrose in normal saline, NSS: normal saline, RLS: Ringer lactate. DW: dextrose water. M1, M2, M3, M4 designate the medical schools.

medical school. Twenty-five percent of participants prescribed more intravenous fluid than recommended (>8 ml/kg/hr). Of the students who correctly diagnosed DHF, 71.1% chose isotonic solution for resuscitation and 32% chose the correct type and rate of intravenous fluid. Ninety-five point eight percent, 92.7%, 89.6%, and 43.2% of students chose to monitor vital signs, urine output or urine specific gravity, serial hematocrits, and patient bleeding, respectively. There were no significant differences by medical school.

Recognition and management of shock. The WHO defines dengue shock syndrome as the clinical manifestation of dengue hemorrhagic fever with clinical evidence of circulatory failure (WHO, 1997) such as narrow pulse pressure or rapid pulse for age. In our test scenario, the patient

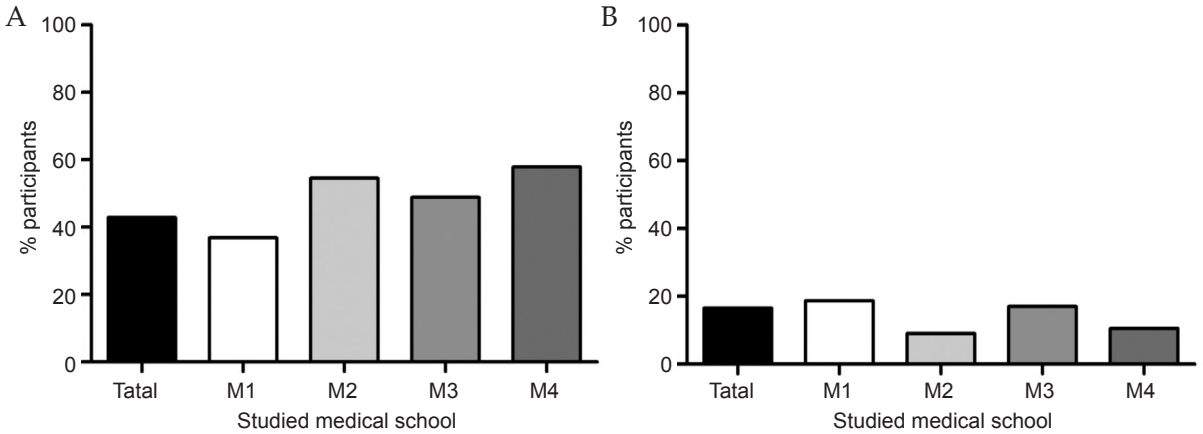

Fig 4–A. Percentage of participants who correctly recognized impending shock by medical school. B. Percentage of participants who correctly administered appropriate intravenous fluid to manage impending shock by medical school. M1, M2, M3, M4 designate the medical schools.

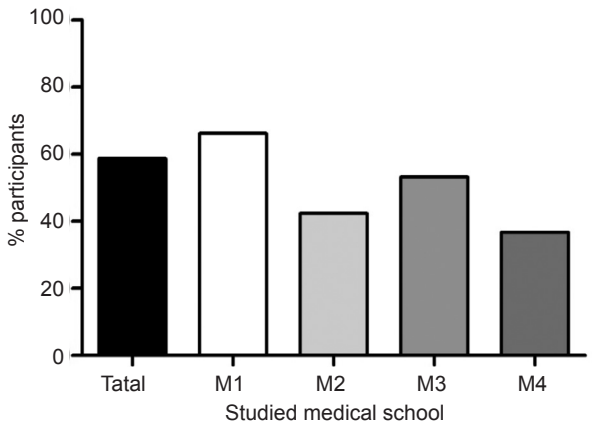

Fig 5–Percentage of participants who correctly recognized occult bleeding by medical school. M1, M2, M3, M4 designate the medical schools.

developed a narrow pulse pressure (blood pressure 90/70 mmHg), a rapid pulse (increasing from 100 to 120/min), and a hematocrit of 45% 6 hours after admission. About half the students recognized the situation as shock or impending shock. The expected response was to increase intravenous isotonic crystalloid fluid to 10 ml/Kg/hr. Only 16.6% of participants did this correctly at this stage. Of those who correctly recognized shock or impending shock, 24.3% responded correctly. There were no significant differences by medical school (Fig 4). Only two students chose to give oxygen therapy to the patient during the impending shock stage.

Recognition of internal organ bleeding. In the next scenario, the patient developed hypotension, poor capillary refill, and a drop in hematocrit (from 45% to 40%), a situation when the participants should suspect an occult bleed. Fifty-eight point seven percent of participants recognized an occult bleed. The percentages of students who answered correctly (36.8-66.2%) did differ significantly by school (Fig 5).

Recognition and management during convalescent stage. During convalescence, extravascular fluid shifts back into the intravascular space increase the potential for developing volume overload. In the scenario, the patient developed dyspnea,

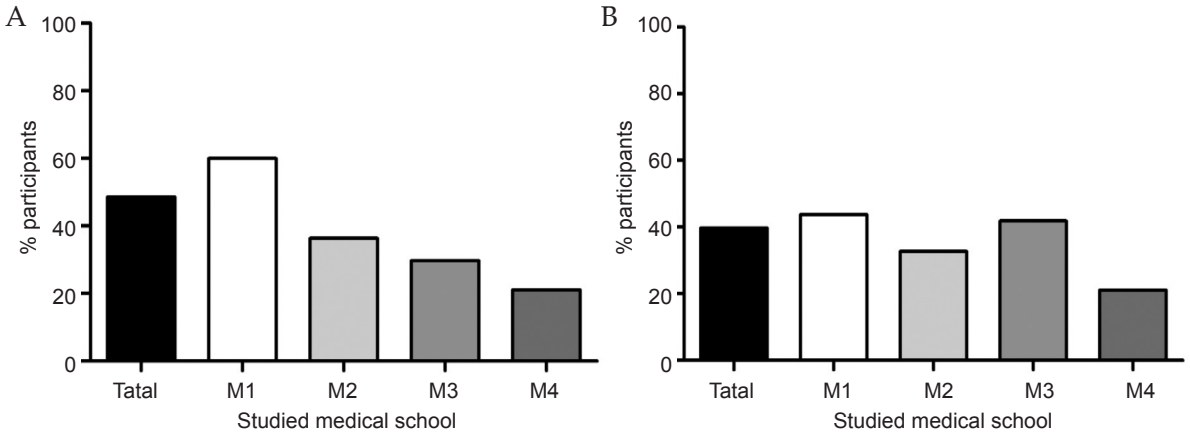

Fig 6–A. Percentage of participants who correctly recognized the convalescent stage by medical school. B. Percentage of participants who correctly reduced the intravenous fluid and administered diuretics. M1, M2, M3, M4 designate the medical schools.

decreased breath sounds in the right lung field, bilateral fine crepitations and slight hypertension with a wide pulse pressure (blood pressure 125/70 mmHg). About half the participants recognized the patient was in the convalescent stage. The percentages of participants who correctly recognized this stage (21.1-60%) varied significantly by school. Forty-two percent of participants incorrectly responded the patient was still in the leakage stage. Sixty point six percent of participants reduced the rate of intravenous fluid, 63.7% administered diuretics, and 40% did both. Interestingly, 13.9% of students switched from crystalloid to colloid fluid and 1.2% chose to do pleurocentesis. Of those who correctly recognized the convalescent stage, 65.8% reduced the intravenous fluid rate, 63.7% gave diuretics, and 44.7% did both. Of those who incorrectly stated this was the leakage stage, 49.5% reduced the intravenous fluid, 43.1% gave diuretics and 22% did both. The percentages who managed this stage correctly did not differ significantly by school (Fig 6).

Performance of each task by group ranking of students

Participants in the above-average group performed better than those in the average and below-average groups in most tasks (Table 2). Participants in the average group performed better than those in the below-average group. The most striking difference between the 3 groups of students was in resuscitation of the patient with impending shock, which was performed correctly by 40% of the participants in the above-average group, 7.4% in the average group and 9.6% in the below average group.

DISCUSSION

We used a MEQ to test graduating medical student ability to recognize and manage dengue infection. In our study, more than 80% of participants included dengue infection in the differential diagnosis of a child presenting with fever, poor appetite, and hepatomegaly. Nearly all our participants were able to correctly

Table 1
Items of MEQ used in the study.

Scenarios	Questions
Scenario 1 A 5-year-old boy presents with high grade fever for 4 days. He has had vomiting 4-5 times per day, has not had any respiratory tract symptoms, his appetite has decreased. He complains of abdominal pain today. Physical examination: T 38.5°C, PR 100/min, RR 20/min, BP 90/60 mmHg, BW 20 Kg Alert but crying, no pallor, no jaundice, moderate dehydration Heart: normal S1, S2, no murmur Lungs: equal breath sound, no adventitious sounds Abdomen: no distention, normoactive bowel sound, no ascites, liver 4 cm below right costal margin with tenderness, no splenomegaly No stiffness of neck, no neurological deficit.	Question 1: Please give the possible 4 diseases that this child may have. Question 2: Which additional information would you need from history and physical examination to support the diagnosis of each disease?
Scenario 2 Additional information: The patient did not have any recent traveling, no history of wading in dirty water, no joint pain, no wounds, two of his classmates had the same symptoms necessitating admission. HEENT: mildly injected conjunctivae Skin: no rash, pustules or petechiae Extremities: no joint swelling Tourniquet test: 20 points/inch^2 CBC: Hb 14 g/dl, Hct 42%, WBC 3,000/cumm (N 15, L 70, M 5, AypL 5, E 5%), platelets 80,000/cu mm UA: Sp gr 1.030, ketone 2+, pH 5.0, sugar neg, protein trace, WBC 0-1, RBC 0-1/HPF.	Question 3: Please give the final diagnosis. Question 4: Which type and rate of intravenous fluid would you like to administer? Question 5: What would you like to monitor upon admission?
Scenario 3 The patient got 5%D/NSS 100 ml/hr. Six hours after admission, his vital signs were T 37°C, PR 120/min, RR 25/min, BP 90/70 mmHg; full peripheral pulses; Hct 45%, intake/output 600/80 ml.	Question 6: What is the problem of the patient at present? Question 7: What is the most appropriate treatment?
Scenario 4 The patient got 5%D/NSS 200 ml/hr and oxygen cannula 3 LPM. Two hours later, the patient became more agitated, cool extremities. T 36.5°C, PR 160/min, RR 30/min, BP 75/60 mmHg; capillary refill 3 sec; Hct 40%.	Question 8: What is the cause that made the patient worse?
Scenario 5 The patient vomited fresh blood one time, and got packed red blood cells. The amount of intravenous fluid was adjusted regarding the patient's vital signs. He was improving. Twenty-four hours later, the patient became more dyspneic. T 37.5°C, PR 120/min, RR 30/min, BP 125/70 mmHg; decreased breath sound at right lung with fine crepitation bilaterally.	Question 9: In which stage of the disease is the patient at present? Question 10: What is the proper management in this stage?

Table 2
Percentages of participants by performance group responding correctly to each task.

Tasks	Participants responding correctly (%)			*p*-value
	Above-average (*n*=54)	Average (*n*=54)	Below-average (*n*=52)	
Dengue infection in differential diagnosis	96.3	83.3	75	0.008
Diagnosis of dengue hemorrhagic fever	92.6	77.8	82.7	0.097
Correct fluid resuscitation in leakage stage	35.2	18.5	9.6	0.005
Recognition of impending shock	40.7	37	32.7	0.691
Correct fluid resuscitation in impending shock	38.9	7.4	9.6	<0.001
Recognition of bleeding	85.2	64.8	48.1	<0.001
Recognition of convalescent stage	77.8	55.6	46.2	0.003
Correct management in convalescent stage	64.8	38.9	26.9	<0.001

diagnose provisional dengue infection with a positive tourniquet test. However, only half the participants who suspected dengue infection thought to use the tourniquet test as a screening tool. Therefore, tourniquet tests should be encouraged in clinical teaching in Thailand. Although many studies have shown that a complete blood count (CBC) can be used to differentiate dengue infection from other causes (Kalayanarooj *et al*, 1997; Wilder-Smith *et al*, 2004; Chadwick *et al*, 2006) and may be used in place of a tourniquet test, the latter still has fair diagnostic sensitivity (around 52-55%), especially in the later febrile stage (Halsey *et al*, 2013). In our study, 90% of participants were able to correctly recognize DHF despite the borderline hematocrit level provided in the scenario. Seventy percent of participants chose isotonic solution during the leakage stage, but only 30% chose both the correct form and rate for intravenous fluid. This means 70% of respondents used inappropriate intravenous fluid that is less effective in preventing hypovolemic shock or more likely to contribute volume overload in the recovery stage. Even among students correctly recognizing DHF, the percentage of participants choosing the correct intravenous fluid type and rate did not increase, meaning they were unaware of the correct intravenous fluid regimen for DHF patients. Seven participants did not correctly identify DHF but did choose the correct intravenous fluid type and rate. It is possible these participants were aware the patient was in the leakage but were not aware DHF should be diagnosed if leakage is present. This suggests most students understood the definition of DHF but they did not know the correct intravenous fluid therapy. Ninety percent of participants chose to monitor vital signs, urine output, and serial hematocrits. However, monitoring bleeding precautions should be emphasized.

Our finding showed participant ability to recognize impending shock and administer proper intravenous fluids at this stage was poor. A narrow pulse pressure and rapid pulse in dengue-infected patients during the critical stage may portend circulatory collapse. Only half the participants recognized these signs. Of those who did correctly identify these signs, only 20% correctly administered appropriate intravenous fluid. Fewer

than 10% of below-average students knew proper management of impending shock. Adequate fluid administration is essential during dengue shock to lower the mortality rate (Ranjit *et al*, 2005). However, overinfusion of intravenous fluid can cause respiratory distress (Rosenberger *et al*, 2016). Prolonged shock from dengue infection can lead to organ dysfunction, such as hepatic impairment (Kamath *et al*, 2006). These are the leading causes of death in dengue-infected patients (Tomashek *et al*, 2012). Only 45% of participants who recognized the convalescent stage knew they should decrease the intravenous fluid rate and administer diuretics when appropriate. This could mean that most participants did not understand the pathophysiology of volume overload in this stage so appropriate management was not implemented. Of the 109 participants who recognized the patient had plasma leakage, 77 (70.7%) reduced the intravenous fluid rate or gave diuretics or both, which is inappropriate management of this stage. This suggests the students do not understand the pathophysiology of the various stages of dengue infection suggesting better training of pathophysiology of dengue infection is needed at the study schools. In conclusion, our findings show five important aspects of dengue infection should be emphasized in teaching: 1) recognition that a narrow pulse pressure is a sign of impending shock, 2) how to order appropriate intravenous fluid resuscitation, 3) oxygen supplementation should be administered to shock or impending shock patients, 4) how to recognize occult bleeding and 5) how to recognized and manage the convalescent stage.

Our study findings show participants had good awareness of dengue infection. However, improvement is needed in the teaching of this subject, especially in understanding the pathophysiology of dengue infection, how to order appropriate intravenous fluid administration during the leakage, shock and the convalescent stage, recognition of occult bleeding and recognition and management of the convalescent stage. Below-average students need to receive adequate training in order to make sure they understand the disease correctly. Most results were similar among students from different medical schools, suggesting the problem is generalized.

A limitation of this study was that it was a retrospective study. The number of participants was about 10% of the Thai graduating medical students. This may not reflect the competency of all graduating students. Responses to examination items may not correlate with real practice performance (Choi and Sunwoo, 2009). This study revealed weaknesses in the participant's training regarding pathophysiology and the recognition of dengue infection. Our findings show which areas need to be improved and show the problem is pervasive, suggesting improvement should come from higher than institutional levels. After making these changes, further studies are needed to determine if goals are being met to improve the quality of care of dengue-infected patients.

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