



# Assessment of Competence in Emergency Medicine among Healthcare Professionals in Cameroon

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## INTRODUCTION

Infectious disease outbreaks such as malaria and human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) have resulted in growing demand for medical care in sub-Saharan Africa. In recent years, incidence of road traffic injuries and cardiovascular disease has also increased due to rapid urbanization, industrial development, and health behavior changes. However, emergency medical services (EMS) system is still underdeveloped, and mortality and disability from acute medical conditions and injuries are markedly higher compared to developed countries (1,2). The rising burden of acute medical conditions puts more emphasis on emergency medical care in prehospital as well as hospital settings (3).

In 2009, the African Federation for Emergency Medicine (AFEM) was established with joint efforts of South Africa, Ghana, and Ethiopia, to develop emergency care system in partnership with advanced countries. In addition, countries including Madagascar, Rwanda, Sudan, Uganda, and Zambia developed resi-

Development of a competence-based curriculum is important. This study aimed to develop competence assessment tools in emergency medicine and use it to assess competence of Cameroonian healthcare professionals. This was a cross-sectional, descriptive study. Through literature review, expert survey, and discrimination tests, we developed a self-survey questionnaire and a scenario-based competence assessment tool for assessing clinical knowledge and self-confidence to perform clinical practices or procedures. The self-survey consisted of 23 domains and 94 questionnaires on a 5-point Likert scale. Objective scenario-based competence assessment tool was used to validate the self-survey results for five life-threatening diseases presenting frequently in emergency rooms of Cameroon. Response rate of the self-survey was 82.6%. In this first half of competence assessment, knowledge of infectious disease had the highest score ( $4.6 \pm 0.4$ ) followed by obstetrics and gynecology ( $4.2 \pm 0.6$ ) and hematology and oncology ( $4.2 \pm 0.5$ ); in contrast, respondents rated the lowest score in the domains of disaster, abuse and assault, and psychiatric and behavior disorder (all of mean 2.8). In the scenario-based test, knowledge of multiple trauma had the highest score ( $4.3 \pm 1.2$ ) followed by anaphylaxis ( $3.4 \pm 1.4$ ), diabetic ketoacidosis ( $3.3 \pm 1.0$ ), ST-elevation myocardial infarction ( $2.5 \pm 1.4$ ), and septic shock ( $2.2 \pm 1.1$ ). Mean difference between the self-survey and scenario-based test was statistically insignificant (mean,  $-0.02$ ; 95% confidence interval,  $-0.41$  to  $0.36$ ), and agreement rate was 58.3%. Both evaluation tools showed a moderate correlation, and the study population had relatively low competence for specific aspects of emergency medicine and clinical procedures and skills.

**Keywords:** Professional Competence; Emergency Medicine; Developing Countries

dency training programs in emergency medicine (4). Through international partnerships, several African countries tried to strengthen emergency care system by training local directors in emergency medicine, developing training modules, establishing an emergency training center, and creating an academic training program for residents and nurses (4-7).

Development of emergency care system in Cameroon, however, is still in a nascent stage. Total health expenditure in Cameroon was a 5% of the gross domestic product during the past 10 years, and poor coordination between stakeholders impeded quality development of services in emergency departments (8). Recently, the Cameroonian government has taken an initiative to establish training schools for emergency medicine to address lack of health resources, revise education curricula, promote permanent employment of healthcare workers in the public sector, and increase funds from external sponsorships (9).

Well-trained emergency physicians serve as key human resources in emergency care system. Emergency physicians should have well-rounded competence in both the diagnosis and treat-

ment of emergency patients, be able to manage patients, effectively utilize emergency resources, cooperate with local community, and develop and collaborate with prehospital EMS system. In Cameroon, however, residency training program in emergency medicine has not yet been implemented, and development of a training curriculum to strengthen the competence of emergency physicians remains as an urgent task for providing reliable emergency care.

Competence is the ability of an individual to apply one's knowledge, understanding, skills, and judgment in performing effectively in the field of professional practice (10). Development of a competence-based curriculum has become central to the education and training of healthcare professionals (11,12). However, tools to evaluate competence of emergency personnel have not yet been developed. Therefore, this study aimed to develop a competence assessment tool in emergency medicine and to validate it by applying the tools to Cameroonian healthcare professionals.

## MATERIALS AND METHODS

### Study design and setting

This was a cross-sectional, descriptive study. The Korea International Cooperation Agency (KOICA), which is a government-run bilateral aid agency in Korea, has progressed a project with the Cameroon Ministry of Public Health to construct the Yaoundé National Emergency Center. Between October 27 and 31, 2014, a short-term educational program was provided to 58 healthcare professionals (13 specialists, 10 general physicians, and 35 nurses) in the Central Hospital of Yaoundé who are expected to work at the Yaoundé National Emergency Center after its opening in 2015. The educational program for doctors included Advanced Trauma Life Support (ATLS), emergency ultrasound, electrocardiogram course, etc.

In Cameroon, medical student educational program is a 7-year course including a 1-year research activity at a college; and continuous medical education programs are a 2-year general physician training and a 4-year residency programs. For emergency medicine, a 2-year special training program is offered but is not recognized as a certified residency program.

### Development of competence evaluation tools

We developed a self-survey questionnaire and a scenario-based assessment tool to evaluate competence in clinical knowledge and self-confidence to perform clinical practices or procedures.

The self-survey questionnaire was developed based on the European curriculum for emergency medicine, core curriculum of the International Federation for Emergency Medicine, learning objectives of the Korean Academy of Medical Sciences, and emergency resident training programs of Korean Society of Emergency Medicine (13,14). It is composed of a total of 113

questions: 17 domains with 82 questions about core clinical knowledge, 4 domains with 11 questions about specific aspects of emergency medicine, and 2 domains with 20 questions about clinical procedures and skills.

A two-step pretest was conducted to improve the validity of the competence assessment tool. The first step involved an expert consensus survey with 7 Korean emergency physicians who have previously contributed to the educational program for healthcare professionals in Yaoundé. Questions in which more than 4 emergency specialists reached consensus were selected as appropriate items for the survey, and those in which more than 4 emergency specialists found confusing were modified as appropriate. As a result of the expert consensus survey, a total of 94 questions were selected as potential candidates of the competence assessment tool; seventeen questions on core clinical knowledge and two questions on clinical procedures and skills were excluded. The second step assessed the discrimination power of each question between junior (1st or 2nd year) and senior (3rd or 4th year) emergency residents. Korean junior ( $n = 7$ ) and senior ( $n = 5$ ) emergency residents participated in the evaluation. All 94 questions in the 23 domains showed high discrimination power, and as a result, were selected for the competence assessment tool for emergency healthcare professionals in Yaoundé (Table 1). Full results of the two-step pretest are reported in Supplementary Table 1.

To test validity of the self-survey and to objectively assess competence in emergency medicine, we also developed a scenario-based competence assessment tool based on a simulation workbook and a relevant web site (15-17). Five life-threatening diagnoses frequently presenting in the emergency room of the Central Hospital of Yaoundé were selected as scenario topics: ST elevation myocardial infarction (STEMI); diabetes ketoacidosis (DKA); septic shock due to necrotizing fasciitis; multiple trauma by road traffic injury; and anaphylaxis. For these scenarios, 14 questions were chosen among the self-survey questions, and a total of 26 sub-questions (3 for STEMI, 6 for DKA, 11 for septic shock, 3 for multiple trauma, and 3 for anaphylaxis) and answers were also developed to assess the competence in diagnosis and treatment of the 5 diseases. Detailed information of the scenario-based competence assessment tool is reported in Supplementary Table 2.

### Study population and study protocols

Eligible population was Cameroonian doctors (13 specialists and 10 general physicians) who had taken the education program in 2014. Competence was assessed in two steps with healthcare professionals who agreed to participate in the study.

The first step of competence assessment was conducted in November 2014 using a 17-page self-survey on clinical knowledge and self-confidence to perform clinical practices or procedures. The survey took roughly 40 minutes to complete includ-

**Table 1.** Comparison of self-survey competency assessment results in Korean emergency residents and Cameroonian healthcare professionals

Topic-domain	Question No.	Korean emergency residents			Cameroonian healthcare professionals			P value
		Junior (n = 7)	Senior (n = 5)	AUC (95% CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	
<b>I. Core clinical knowledge</b>								
1. Cardiovascular	5	2.8 ± 0.2	4.2 ± 0.1	1.00 (1.00–1.00)	3.8 ± 0.6	3.4 ± 0.5	4.1 ± 0.5	0.007
2. Pulmonary	5	3.5 ± 0.2	4.2 ± 0.1	0.85 (0.61–1.00)	3.8 ± 0.5	3.6 ± 0.4	4.0 ± 0.5	0.114
3. Gastrointestinal	5	3.5 ± 0.3	4.2 ± 0.3	1.00 (1.00–1.00)	3.9 ± 0.6	3.9 ± 0.4	4.0 ± 0.7	0.753
4. Renal and genitourinary	6	2.8 ± 0.3	3.9 ± 0.2	1.00 (1.00–1.00)	3.7 ± 0.5	3.5 ± 0.5	3.9 ± 0.4	0.116
5. Obstetrics and gynecology	1	2.4 ± 0.3	3.9 ± 0.4	1.00 (1.00–1.00)	4.2 ± 0.6	4.4 ± 0.5	4.1 ± 0.6	0.275
6. Pediatrics	5	3.2 ± 0.2	3.9 ± 0.1	0.90 (0.69–1.00)	4.1 ± 0.4	4.1 ± 0.3	4.1 ± 0.5	0.692
7. Infectious disease	5	2.5 ± 0.4	3.5 ± 0.3	0.94 (0.78–1.00)	4.6 ± 0.4	4.6 ± 0.4	4.6 ± 0.4	0.629
8. Neurological disorder	6	3.1 ± 0.2	4.0 ± 0.1	0.92 (0.73–1.00)	4.0 ± 0.5	3.8 ± 0.5	4.2 ± 0.5	0.126
9. Toxicology	2	2.3 ± 0.3	3.6 ± 0.0	0.96 (0.84–1.00)	3.3 ± 0.6	3.2 ± 0.7	3.4 ± 0.5	0.512
10. Endocrine and metabolic	3	2.5 ± 0.4	3.8 ± 0.3	1.00 (1.00–1.00)	4.0 ± 0.5	3.9 ± 0.6	4.1 ± 0.5	0.384
11. Hematologic and oncologic	4	2.8 ± 0.5	3.8 ± 0.3	0.98 (0.90–1.00)	4.2 ± 0.5	4.0 ± 0.4	4.4 ± 0.5	0.103
12. Eyes, ears, nose, throat, oral, and neck	8	3.1 ± 0.2	3.8 ± 0.1	0.79 (0.50–1.00)	3.2 ± 0.6	3.3 ± 0.5	3.1 ± 0.6	0.429
13. Dermatologic	1	3.4 ± 0.4	4.6 ± 0.4	0.92 (0.74–1.00)	4.1 ± 0.6	4.1 ± 0.5	4.2 ± 0.7	0.626
14. Trauma	4	2.8 ± 0.3	3.9 ± 0.5	0.92 (0.74–1.00)	3.7 ± 0.5	3.5 ± 0.4	3.8 ± 0.5	0.195
15. Musculoskeletal	2	2.9 ± 0.4	4.1 ± 0.3	0.98 (0.90–1.00)	3.8 ± 0.6	3.4 ± 0.6	4.1 ± 0.5	0.032
16. Psychiatric and behavior	1	2.6 ± 1.0	3.6 ± 0.5	0.88 (0.65–1.00)	2.8 ± 1.0	3.0 ± 1.0	2.7 ± 0.9	0.511
17. Resuscitation	2	3.0 ± 0.3	4.3 ± 0.3	0.94 (0.78–1.00)	3.3 ± 0.7	2.9 ± 0.6	3.7 ± 0.5	0.017
<b>II. Specific aspects of emergency medicine</b>								
18. Disaster	1	1.9 ± 0.9	3.0 ± 1.4	0.77 (0.43–1.00)	2.8 ± 1.1	2.6 ± 1.0	3.1 ± 1.1	0.277
19. Abuse and assault	1	2.6 ± 1.0	3.5 ± 0.6	0.75 (0.44–1.00)	2.8 ± 1.0	2.4 ± 0.9	3.2 ± 1.0	0.106
20. Environmental injuries	4	2.4 ± 0.3	3.6 ± 0.4	0.83 (0.57–1.00)	3.1 ± 0.6	2.8 ± 0.4	3.4 ± 0.6	0.045
21. Prehospital care	5	1.6 ± 0.3	3.1 ± 0.2	0.79 (0.45–1.00)	3.2 ± 0.6	3.0 ± 0.4	3.3 ± 0.6	0.204
<b>III. Clinical procedures and skills</b>								
22. CPR skills	9	2.1 ± 0.3	4.3 ± 0.3	1.00 (1.00–1.00)	3.0 ± 0.7	2.6 ± 0.4	3.4 ± 0.7	0.007
23. Procedure	9	2.4 ± 0.4	3.5 ± 0.1	0.92 (0.73–1.00)	3.5 ± 0.5	3.3 ± 0.5	3.8 ± 0.4	0.028
<b>Total</b>	<b>94</b>	<b>2.7 ± 0.4</b>	<b>3.8 ± 0.3</b>	<b>1.00 (1.00–1.00)</b>	<b>3.6 ± 0.4</b>	<b>3.5 ± 0.3</b>	<b>3.8 ± 0.3</b>	<b>0.038</b>

Values are presented as mean ± SD.

SD = standard deviation, AUC = area under the curve, CI = confidence interval, GP = general physician, CPR = cardiopulmonary resuscitation.

ing an introduction to purpose and methods of the survey. Each question was answered in a 5-point Likert scale. All results were coded using Microsoft Excel (ver. 14.0, Microsoft®, Los Angeles, CA, USA) by an appointed data entry clerk.

The second scenario-based assessment was conducted with 6 doctors (3 general physicians and 3 specialists) who had previously participated in the self-survey on December 10 and 11, 2014, in the form of an individual interview with two Korean emergency physicians. One emergency physician explained a scenario, and the physicians evaluated the answers in which a Cameroonian respondent provided about his or her medical knowledge on patient assessment, interpretation, diagnosis, and treatment. For increased objectivity, both emergency physicians independently assessed the respondent's answers on a 5-point Likert scale.

### Main outcomes

Main outcome was competence in emergency medicine, captured by self-survey and scenario-based competence assessment on a 5-point Likert scale: 1) don't know at all; 2) don't know; 3) average; 4) know; and 5) know well. Secondary outcomes were

agreement rate and difference of scores between the two methods of self-survey and scenario-based competence assessment.

### Statistical analysis

Descriptive statistics of the self-survey and scenario-based competence assessment results on a 5-point Likert scale were expressed with means and standard deviations (SDs). Differences of assessment results between groups were compared using the Student's t-test.

The power of discrimination for the self-survey between junior and senior residents was measured as the area under the generated receiver operating characteristic (ROC) area under curve (AUC); and AUC greater than 0.7 was said to have high discrimination power. For the scenario-based competence assessment, inter-rater reliability between the two Korean emergency physicians was analyzed using the weighted kappa.

For every doctor participating in both competence assessment methods, we compared the score difference of all 14 questions between the first self-survey and the second scenario-based competence assessment. The difference between the two assessment results was analyzed using paired t-test, agreement

rate, and weighted kappa. When the difference between the result of the first self-survey and the second scenario-based assessment was within one point, it was said that the two results had an agreement. Level of statistical significance was defined as  $P < 0.05$ .

### Ethics statement

The study received and approved by the Institutional Review Board of the Seoul National University Hospital (IRB No. E-1506-048-679). Written informed consent was obtained from all study participants.

## RESULTS

### The first competence assessment: self-survey

Among a total of 23 doctors, 10 specialists and 9 general physicians participated in the first competence assessment (82.6%). Mean (SD) age of the 19 participants was 33.1 (5.6). And 6 (31.6%) were male. Main areas of practice for the 10 specialists included anesthesia ( $n = 3$ ), internal medicine ( $n = 3$ ), general surgery ( $n = 2$ ), gynecology and emergency medicine ( $n = 1$ ), and laboratory medicine ( $n = 1$ ).

In the self-survey competence assessment, the Cameroonian healthcare professionals scored the highest in the domain of infectious disease (mean  $\pm$  SD,  $4.6 \pm 0.4$ ), followed by obstetrics and gynecology ( $4.2 \pm 0.6$ ) and hematology and oncology ( $4.2 \pm 0.5$ ); in contrast, they scored the lowest grade in the domains of disaster, abuse and assault, and psychiatric and behavior disorder

(each with a mean of 2.8). Domains of cardiovascular, musculoskeletal, procedure, resuscitation, cardiopulmonary resuscitation (CPR) skills, and environmental injuries had significantly higher scores in specialists compared to general physicians (all  $P < 0.05$ ). The average scores in general physicians were higher than specialists only in the 3 domains of obstetrics and gynecology; eyes, ear, nose, throat, oral, and neck; and psychiatric and behavior; however, the score differences were not statistically significant (Table 1).

### The second competence assessment: scenario-based

For the 14 questions of the scenario-based competence assessment which were answered by the 6 study participants, the inter-rater reliability between the two interviewers had a weighted kappa 0.88 and 95% confidence interval (CI) 0.82–0.95 (Table 2). Highest scores of the scenario-based assessment were observed in the knowledge of multiple trauma (mean  $\pm$  SD,  $4.3 \pm 1.2$ ), followed by anaphylaxis ( $3.4 \pm 1.4$ ), DKA ( $3.3 \pm 1.0$ ), and STEMI ( $2.5 \pm 1.4$ ). Knowledge of septic shock scored the lowest in the scenario-based assessment (mean  $\pm$  SD,  $2.2 \pm 1.1$ ) (Table 3).

### Comparison between first and second competence assessment

Mean difference between the self-survey and scenario-based assessment was statistically insignificant (mean,  $-0.02$ ; 95% CI,  $-0.41$  to  $0.36$ ). In terms of individual participants, the mean difference (95% CI) between the scenario-based assessment and the self-survey ranged from  $-1.21$  ( $-2.15$  to  $-0.28$ ) to  $0.64$  ( $-0.25$

**Table 2.** Inter-rater reliability between two interviewers (Korean emergency physicians)

Interviewer	Interviewer 2					Total	
	1	2	3	4	5		
Interviewer 1	1	12	2	0	1	0	15
	2	1	12	3	0	0	16
	3	0	2	13	2	0	17
	4	0	0	2	18	0	20
	5	0	0	0	0	16	16
Total	13	16	18	21	16	84*	

Agreement rate, 84.5%; weighted kappa, 0.88; 95% CI, 0.82 to 0.95.

\*A total score of 84 was derived from 14 questions answered by 6 Cameroonian doctors.

The gray color cells are the number of items that match the score of two reviewers.

**Table 4.** Difference between scenario-based test and self-survey test

Subjects	Position	Mean difference*	95% CI
Doctor 1	GP	-0.50	-1.80 to 0.80
Doctor 2	S	0.00	-0.82 to 0.82
Doctor 3	S	0.36	-0.54 to 1.25
Doctor 4	S	0.57	-0.43 to 1.58
Doctor 5	GP	0.64	-0.25 to 1.54
Doctor 6	GP	-1.21	-2.15 to -0.28
Total		-0.02	-0.41 to 0.36

GP = general physician, S = specialist, CI = confidence interval.

\*Mean difference was calculated as the average of scenario-based scores subtracted by the average of self-survey score of 14 questions.

**Table 3.** Scenario-based competency assessment between GPs and specialists in Cameroon

Clinical scenario	Question No.	Detailed item No.	Total (n = 6)	GP (n = 3)	Specialist (n = 3)	P value
1. Septic shock	3	11	$2.2 \pm 1.1$	$1.9 \pm 0.8$	$2.6 \pm 1.2$	0.186
2. Diabetes ketoacidosis	3	6	$3.3 \pm 1.0$	$2.8 \pm 1.0$	$3.8 \pm 0.7$	0.018
3. STEMI	3	3	$2.5 \pm 1.4$	$2.0 \pm 1.3$	$3.0 \pm 1.4$	0.136
4. Multiple trauma	2	3	$4.3 \pm 1.2$	$4.2 \pm 1.6$	$4.5 \pm 0.8$	0.656
5. Anaphylaxis	3	3	$3.4 \pm 1.4$	$3.6 \pm 1.5$	$3.3 \pm 1.3$	0.740
Total	14	26	$3.1 \pm 1.4$	$2.8 \pm 1.5$	$3.4 \pm 1.3$	0.062

Values are presented as number or mean  $\pm$  SD.

STEMI = ST-elevation myocardial infarction, SD = standard deviation, GP = general physician.

**Table 5.** Comparison of scores between self-survey and scenario-based competency assessments

Self-survey score	Scenario-based score					Total
	1	2	3	4	5	
1	4	2	0	2	1	9
2	0	5	3	3	4	15
3	6	2	6	9	5	28
4	3	4	6	5	5	23
5	2	3	2	1	1	9
Total	15	16	17	20	16	84*

Agreement rate, 58.3%; under-estimation rate, 17.9%; over-estimation rate, 23.8%.

\*A total score of 84 was derived from 14 questions answered by 6 Cameroonian doctors.

Gray color cells are the number of items with similar survey-based and scenario-based scores.

to 1.54) (Table 4). Results of the 14 questions in the self-survey and the scenario-based assessment showed 58.3% agreement rate, 17.9% under-estimation rate, and 23.8% over-estimation rate (Table 5).

## DISCUSSION

This study involved development of a self-survey and a scenario-based competence assessment tool for emergency medicine using literature review, expert consensus, and a discrimination test with pilot survey. We administered the self-survey to Cameroonian healthcare professionals and later conducted an objective, scenario-based competence assessment to test validity of the self-survey. Mean difference between the self-survey and scenario-based assessment was negligible, and scores between two assessments showed moderate agreement rate (58%). Competence-based education has become an important key of curriculum for healthcare professionals, which highlights the needs for reliable, valid, and feasible competence assessment tools in mid- and long-term education courses (18-20). The areas of practice which showed poor competence in this study should comprise the main contents of emergency medicine curriculum for the Cameroonian healthcare professionals.

The self-survey competence assessment is one of the most formative and summative forms of evaluation. Repetitive self-surveys can benefit both learners and educators through continuous monitoring of self-competence and education impacts, respectively. In this study, the Cameroonian participants showed high competence in the domains of infectious disease, obstetrics and gynecology, hematology and oncology. Specialists who had completed advanced education and training showed high competence in the domains of clinical procedure, CPR skills, and resuscitation. However, all Cameroonian participants had relatively low competence in specific aspects of emergency medicine including disasters and prehospital care. There are specific aspects of emergency medicine as well as clinical skills and procedures which function as key competence of an emergency

physician (14); therefore, those domains which showed poor competence should be of particular interest for the development of emergency medicine curriculum for the Cameroonian healthcare professionals. Furthermore, periodic monitoring of physicians' competence can also be utilized to evaluate the effects of curriculum in the future.

The self-survey has its advantage of convenience and cost-effectiveness, but its results may be subjective. When the self-survey is combined with objective assessment methods, we may expect to obtain more valid and practical results (14,21). In this study, we developed scenario-based assessment tools for the 5 life-threatening diseases which frequently present in the emergency rooms of Cameroon. When comparing results of the subjective self-survey and the objective scenario-based competence assessment, the scores were comparable with mean difference of  $-0.02$  ( $-0.41$  to  $0.36$ ) and had a moderate agreement rate of 58.3%. However, one of the study participants overrated his or her own competence with self-survey than did in the scenario-based assessment, and the calculated overestimation rate (23.8%) was higher than the underestimation rate (17.9%). In previous literature, the correlations between self-survey and externally observed measurement of competence had been controversial. Some studies reported that self-assessment for selected fields or categories was a reliable predictor of clinical performance (15,22-24). In another meta-analysis, however, only 35% of studies showed positive correlation between self-assessments and external assessments (21,25). In our study, self-surveys had a moderate correlation with the externally observed measurement. Methodologic quality of a self-survey, knowledge level and training experience of a respondent, and quality and skills of an evaluator are important factors to consider for an accurate evaluation of competence using self-survey.

Self-survey assessment in medical knowledge should accurately measure competence as well as actual performance as reflected by an external assessment (18). There are many external, objective competence assessment methods that compensate for the weaknesses of a self-survey, such as oral examinations, procedure tests, simulation examinations, objective structured clinical examination (OSCE), standard patient examinations, and clinical record reviews (14,18). In this study, we developed self-survey and scenario-based oral examination which were designed to assess competence of clinical performance in an environment which resembles an actual situation. Furthermore, we applied both assessment tools to the Cameroonian healthcare providers, and results of the two showed a moderate correlation. Using the two competence assessment tools, we expect to develop curriculums for emergency medicine that focuses on specific aspects of emergency medicine and clinical skills and procedures in which the Cameroonian healthcare professionals had poor competence on.

There are several limitations in this study. First, only 14 se-

lected questions among the 94 self-survey questions were used in the scenario-based test. Although the selected topics were based on their high frequency of incidence in Cameroon, not all questions in the self-survey were evaluated with the objective scenario-based assessment, resulting in limited validity of the self-survey. Second, since Korea and Cameroon have different medical environment, there is a possibility that some questions were not considered as important and were excluded during the process of expert consensus and discrimination test in Korea. Supplementary assessment such as clinical behavior observation might be helpful to improve the validity of competence evaluation tool. Third, there was a one month gap between the administration of self-survey and scenario-based assessment. Therefore, we could not measure if there had been any individual efforts to improve competence in the interim.

In conclusion, we developed and administered self-survey and objective scenario-based competence assessment tools to evaluate the competence in emergency medicine among Cameroonian healthcare professionals. Results of the two evaluation tools showed a moderate correlation, and study participants showed relatively low competence in specific aspects of emergency medicine and clinical procedures and skills. Results of this assessment can be used to develop curriculums for emergency medicine which is tailored to the needs of Cameroonian healthcare professionals. The assessment tools can be used as valuable resources for assessing competence and developing need-based curriculum for emergency medicine in developing countries including those in Africa.

## DISCLOSURE

The authors have no potential conflicts of interest to disclose. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

## AUTHOR CONTRIBUTION

Conceptualization: Kim SC, Ro YS, Shin SD, Wi DH, Jeong J, Park JO. Data curation: Kim SC, Ro YS, Sun KM, Bae K. Formal analysis: Kim SC, Ro YS. Funding acquisition: Shin SD, Jeong J. Investigation: Kim SC, Sun KM, Bae K. Resources: Sun KM, Bae K. Supervision: Ro YS, Shin SD, Wi DH, Jeong J. Writing - original draft: Kim SC, Ro YS. Writing - review & editing: Shin SD, Jeong J.

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**Supplementary Table 1.** Self-survey competency assessment tool and its results in Korean emergency residents and Cameroonian doctors

Topics and questions	Korean emergency residents			Cameroonian doctors			
	Junior (n = 7)	Senior (n = 5)	AUC (95%CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	P value
<b>I. Core clinical knowledge</b>							
<b>1. Cardiovascular</b>							
1 Can differentiate the following illnesses of chest pain: acute coronary syndromes, stable angina, aortic dissection/aneurysm rupture, and pulmonary embolism	3.3	4.3	0.88 (0.65–1.00)	3.9 ± 0.7	3.6 ± 0.5	4.2 ± 0.6	0.028
2 Know the treatment of cardiogenic shock	2.1	4.3	1.00 (1.00–1.00)	3.8 ± 1.0	3.4 ± 1.0	4.2 ± 0.9	0.106
3 Can interpret ECG	3.0	4.0	0.92 (0.72–1.00)	3.1 ± 1.0	2.6 ± 0.7	3.5 ± 1.0	0.052
4 Can make a diagnosis of traumatic cardiac tamponade	2.7	4.3	0.85 (0.61–1.00)	3.5 ± 0.8	2.9 ± 0.8	4.1 ± 0.3	0.001
5 Can identify hypertensive emergencies and know the relevant pharmacotherapy	2.7	4.3	0.88 (0.65–1.00)	4.5 ± 0.5	4.4 ± 0.5	4.6 ± 0.5	0.525
* Can differentiate the following inflammatory cardiac disease: endocarditis, myocarditis, and pericarditis							
<b>2. Pulmonary</b>							
6 Can differentiate the following illnesses of dyspnea: asthma, COPD, and congestive heart failure	3.4	4.0	0.75 (0.44–1.00)	4.5 ± 0.5	4.6 ± 0.5	4.5 ± 0.5	0.821
7 Know the cause and treatment of hemoptysis	3.1	4.0	0.77 (0.46–1.00)	3.9 ± 0.7	4.0 ± 0.9	3.8 ± 0.6	0.570
8 Know the diagnoses and treatment of traumatic pulmonary disorder: hemothorax, tension pneumothorax, and pneumothorax	3.0	4.0	0.77 (0.46–1.00)	3.9 ± 0.8	4.0 ± 0.5	3.9 ± 1.0	0.789
9 Know the diagnoses and treatment of spontaneous pneumothorax	4.3	4.5	0.58 (0.20–0.96)	3.7 ± 1.1	3.1 ± 0.9	4.2 ± 0.9	0.020
10 Can interpret ABGA	3.4	4.0	0.75 (0.44–1.00)	2.9 ± 1.1	2.3 ± 0.7	3.5 ± 1.1	0.014
* Know the diagnoses and treatment of infectious pulmonary disorder: bronchitis, bronchiolitis, pneumonia, tuberculosis, emphysema, lung abscess, pleurisy and pleural effusion, and pulmonary fibrosis							
<b>3. Gastrointestinal</b>							
11 Can differentiate the following illnesses of acute abdomen: appendicitis, cholecystitis, cholangitis, diverticulitis, exacerbations and complications of inflammatory bowel diseases, gastritis, gastroenteritis, gastroesophageal reflux disease, hepatitis, pancreatitis, peptic ulcer, peritonitis, intussusception, bowel perforation, and ischemic colitis	3.4	4.0	0.83 (0.57–1.00)	4.1 ± 0.7	4.1 ± 0.6	4.1 ± 0.7	0.972
12 Know the diagnoses and treatment of different illnesses of upper GI bleeding	3.7	4.3	0.75 (0.44–1.00)	4.1 ± 0.7	4.1 ± 0.6	4.1 ± 0.9	0.975
13 Know the diagnoses and treatment of different illnesses of lower GI bleeding	3.6	4.3	0.75 (0.44–1.00)	4.0 ± 0.6	3.9 ± 0.3	4.1 ± 0.7	0.442
14 Know how to treat foreign body in upper GI	3.3	4.3	0.88 (0.65–1.00)	3.5 ± 0.8	3.4 ± 0.7	3.6 ± 1.0	0.699
* Know the stage and treatment of hernia							
* Know the diagnoses and treatment of intestinal obstruction							
<b>4. Renal and genitourinary</b>							
15 Can diagnose and treat acid-base disturbance	2.6	4.0	0.92 (0.72–1.00)	3.2 ± 0.7	2.9 ± 0.8	3.5 ± 0.5	0.060
16 Can diagnose and treat electrolyte disorders	2.7	3.8	0.85 (0.61–1.00)	3.6 ± 0.5	3.3 ± 0.5	3.8 ± 0.4	0.018
17 Can differentiate the cause of infectious illnesses related to genitourinary tract and treat accordingly: acute pyelonephritis, prostatitis, sexually transmitted diseases, and urinary tract infections	3.0	4.0	0.83 (0.57–1.00)	4.7 ± 0.5	4.9 ± 0.3	4.5 ± 0.5	0.071
18 Can differentiate and treat urinary metabolic disorders: acute renal failure, nephrotic syndrome, and uremia	2.4	4.0	1.00 (1.00–1.00)	3.6 ± 0.7	3.3 ± 0.5	3.8 ± 0.8	0.147
19 Can diagnose and treat urolithiasis	3.7	4.5	0.75 (0.44–1.00)	3.9 ± 0.9	3.6 ± 0.9	4.2 ± 0.8	0.172
20 Know the indication of renal replacement treatment: hemodialysis, CAPD, and hemoperfusion	2.4	4.0	0.92 (0.72–1.00)	3.3 ± 0.8	3.0 ± 0.9	3.5 ± 0.7	0.184
* Can evaluate and treat dehydration							
* Can differentiate and treat testicular pain: epididymo-orchitis and testicular torsion							

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**Supplementary Table 1.** Continued

Topics and questions	Korean emergency residents			Cameroonian doctors			P value
	Junior (n = 7)	Senior (n = 5)	AUC (95%CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	
<b>5. Obstetrics and gynecology</b>							
21 Know the following illnesses of lower abdominal pain: pelvic inflammatory disease and ovarian torsion	2.6	4.0	0.92 (0.72–1.00)	4.3 ± 0.7	4.4 ± 0.5	4.1 ± 0.7	0.263
22 Know illnesses of vaginal bleeding	2.1	4.0	1.00 (1.00–1.00)	4.2 ± 0.5	4.3 ± 0.5	4.1 ± 0.6	0.357
* Know the definition of following gynecologic disorders: abruptio placentae, eclampsia, ectopic pregnancy, emergency delivery, HELLP syndrome during pregnancy, hyperemesis gravidarum, placenta praevia, post-partum hemorrhage, and uterine atony							
<b>6. Pediatrics</b>							
23 Can differentiate the causes of dehydration in pediatric patients and treat accordingly	3.3	4.3	0.81 (0.54–1.00)	4.4 ± 0.6	4.3 ± 0.5	4.4 ± 0.7	0.816
24 Can differentiate the causes of fever in pediatric patients	3.6	4.3	0.75 (0.44–1.00)	4.5 ± 0.5	4.6 ± 0.5	4.5 ± 0.5	0.821
25 Can differentiate the causes of dyspnea in pediatric patients	2.9	3.8	0.73 (0.39–1.00)	4.2 ± 0.6	4.1 ± 0.3	4.2 ± 0.8	0.750
26 Can differentiate the causes of acute abdomen in pediatric patients including intussusception	3.4	4.3	0.75 (0.44–1.00)	4.2 ± 0.5	4.2 ± 0.4	4.1 ± 0.6	0.610
27 Know SIDS	3.0	3.5	0.63 (0.27–0.98)	3.3 ± 0.7	3.1 ± 0.3	3.4 ± 0.9	0.313
* Can differentiate the causes of seizure and treat in pediatric patients							
<b>7. Infectious disease</b>							
28 Know the diagnosis and treatment of malaria	2.7	3.5	0.75 (0.43–1.00)	4.9 ± 0.2	5.0 ± 0.0	4.9 ± 0.3	0.343
29 Know the complications of AIDS	2.3	3.0	0.81 (0.51–1.00)	4.8 ± 0.4	4.8 ± 0.4	4.8 ± 0.4	0.912
30 Know the diagnosis and treatment of parasitosis	2.1	2.8	0.69 (0.32–1.00)	4.6 ± 0.6	4.9 ± 0.3	4.3 ± 0.7	0.029
31 Know the diagnoses and treatment of sepsis and septic shock	2.7	4.5	0.96 (0.84–1.00)	4.4 ± 0.6	4.3 ± 0.7	4.5 ± 0.5	0.565
32 Know the appropriate response and preventive strategy for accidental exposure of the following illnesses: HBV, HCV, AIDS, syphilis, rabies, and tetanus	2.9	3.5	0.67 (0.32–1.00)	4.3 ± 0.7	4.2 ± 1.0	4.3 ± 0.5	0.832
<b>8. Neurological disorder</b>							
33 Can diagnose patients admitted for mental change as a chief complaint	2.7	4.0	0.92 (0.72–1.00)	3.4 ± 0.8	3.0 ± 0.7	3.8 ± 0.8	0.033
34 Know the diagnosis and treatment of stroke	3.3	4.0	0.69 (0.33–1.00)	4.3 ± 0.8	4.1 ± 0.9	4.5 ± 0.7	0.316
35 Know the diagnosis of dizziness	2.9	4.0	0.83 (0.56–1.00)	3.6 ± 0.7	3.7 ± 0.5	3.5 ± 0.8	0.615
36 Know the treatment of convulsion	2.7	3.8	0.83 (0.56–1.00)	4.4 ± 0.6	4.4 ± 0.5	4.3 ± 0.7	0.613
37 Know the diagnosis and treatment of headache	3.4	4.0	0.75 (0.44–1.00)	4.4 ± 0.5	4.3 ± 0.5	4.4 ± 0.5	0.779
38 Can interpret CT image of traumatic head injuries: subarachnoid hemorrhage, subdural and extradural hematomata	3.4	4.5	0.81 (0.47–1.00)	4.1 ± 1.0	3.4 ± 0.9	4.6 ± 0.7	0.005
* Know the definition and treatment of following neurologic disorder: Guillain-Barré syndrome, meningitis, and peripheral facial palsy (Bell's palsy)							
<b>9. Toxicology</b>							
39 Know the general treatment of poisoned patients: antidote, urine alkalization, and dialysis	2.4	3.8	0.88 (0.65–1.00)	3.1 ± 0.7	3.0 ± 0.7	3.1 ± 0.7	0.767
40 Know the treatment of caustic injury	2.1	3.8	0.98 (0.90–1.00)	3.8 ± 0.7	3.3 ± 0.9	3.6 ± 0.5	0.420
* Know the treatment of specific drug intoxication: paracetamol, salicylates, amphetamine, anticholinergics, anticonvulsants, tricyclic antidepressants, antihypertensive, benzodiazepines, digitalis, monoamine oxidase inhibitors, neuroleptics, agricultural pesticides, and plants & mushrooms							
<b>10. Endocrine and metabolic</b>							
41 Know the diagnoses and treatment of DKA, HHS, and AKA	2.6	4.0	0.92 (0.72–1.00)	4.0 ± 0.7	3.9 ± 0.6	4.1 ± 0.7	0.506
42 Know the diagnoses and treatment of hypoglycemia	2.7	4.0	1.00 (1.00–1.00)	4.7 ± 0.5	4.7 ± 0.5	4.8 ± 0.4	0.537
43 Know adrenal crisis and insufficiency	2.1	3.5	0.96 (0.84–1.00)	3.2 ± 0.9	3.0 ± 1.1	3.3 ± 0.7	0.483
* Know the emergency disorder about thyroid: hyperthyroidism, hypothyroidism, myxedema coma, and thyroid storm							

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Supplementary Table 1. Continued

Topics and questions	Korean emergency residents			Cameroonian doctors			P value
	Junior (n = 7)	Senior (n = 5)	AUC (95%CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	
11. Hematologic and oncologic							
44 Know the cause and diagnosis of anemia	3.1	4.0	0.83 (0.57–1.00)	4.6 ± 0.5	4.6 ± 0.5	4.6 ± 0.5	0.855
45 Know transfusion reaction	3.0	4.0	0.83 (0.57–1.00)	4.4 ± 0.7	4.2 ± 0.7	4.6 ± 0.7	0.246
46 Know the following vascular disorders (ischemia and bleeding): acquired bleeding disorders (coagulation factor deficiency, disseminated intravascular coagulation), drug induced bleeding (anticoagulants, antiplatelet agents, fibrinolytic), idiopathic thrombocytopenic purpura, and thrombotic thrombocytopenic purpura	2.3	3.8	0.96 (0.84–1.00)	3.6 ± 0.7	3.2 ± 0.7	3.9 ± 0.6	0.028
* Know hematologic congenital disorder: hemophilia and VWD, hereditary hemolytic anemia, and sickle cell disease							
* Know inflammatory and infectious disorders about hematology: neutropenic fever and infections in immuno-compromised patients							
12. Eyes, ears, nose, throat, oral, and neck							
47 Know how to remove foreign bodies of mouth and nasal cavity	3.4	4.0	0.65 (0.28–1.00)	3.0 ± 0.9	2.9 ± 1.1	3.1 ± 0.7	0.616
48 Know the diagnoses and treatment of oral inflammatory illnesses: angioedema, epiglottitis, laryngitis, and paratonsillar abscess	2.9	4.3	0.94 (0.78–1.00)	3.5 ± 0.7	3.6 ± 0.5	3.4 ± 0.8	0.641
49 Know the diagnoses and treatment of the following injuries: foreign body in the eye, ocular injuries, canalicular laceration, corneal abrasion, and hyphema	3.0	3.5	0.71 (0.37–1.00)	2.7 ± 0.9	2.9 ± 0.9	2.5 ± 0.8	0.354
50 Know the diagnostic standard of acute glaucoma	2.4	3.0	0.67 (0.32–1.00)	2.9 ± 0.8	3.0 ± 0.7	2.8 ± 0.9	0.605
51 Know the treatment of chemical-induced eye injury	3.0	3.3	0.56 (0.20–0.93)	2.8 ± 0.8	2.9 ± 0.6	2.7 ± 0.9	0.616
52 Know the treatment of nasal hemorrhage	3.6	4.3	0.75 (0.44–1.00)	3.5 ± 0.7	3.6 ± 0.7	3.4 ± 0.7	0.641
53 Know the diagnosis of traumatic perforation of ear drum	3.1	3.8	0.58 (0.20–0.97)	3.3 ± 1.1	3.7 ± 1.0	3.0 ± 1.1	0.177
54 Can diagnose nasal bone fracture	3.6	4.8	0.92 (0.72–1.00)	3.6 ± 0.7	3.8 ± 0.4	3.6 ± 0.7	0.522
13. Dermatologic							
55 Know the diagnosis and treatment of herpes zoster	3.3	4.8	0.88 (0.65–1.00)	4.2 ± 0.7	4.2 ± 0.7	4.1 ± 0.7	0.711
56 Know the diagnosis and treatment of anaphylaxis	3.6	4.5	0.83 (0.56–1.00)	4.1 ± 0.8	3.9 ± 0.8	4.3 ± 0.8	0.281
* Know the diagnosis and treatment of herpes zoster							
* Know the character and can differentiate of following dermatologic disorders: erythema multiforme, toxic epidermal necrosis, exfoliative dermatitis, toxic shock syndrome, staphylococcal scalded skin syndrome, and meningococemia							
14. Trauma							
57 Can identify anatomical location of injury in a trauma patient	3.7	4.3	0.69 (0.34–1.00)	4.2 ± 0.5	4.1 ± 0.6	4.3 ± 0.5	0.458
58 Can triage patient with multiple injuries	2.9	3.3	0.58 (0.20–0.96)	4.2 ± 0.6	4.1 ± 0.3	4.2 ± 0.8	0.750
59 Know fluid therapy for traumatic hypovolemic shock	2.6	4.0	0.88 (0.65–1.00)	4.0 ± 0.7	3.9 ± 0.8	4.1 ± 0.7	0.553
60 Can identify presence of injury using FAST	2.1	4.3	0.96 (0.84–1.00)	2.3 ± 1.0	1.9 ± 0.9	2.6 ± 1.1	0.143
15. Musculoskeletal							
61 Can diagnose the following musculoskeletal illnesses: cellulitis, and necrotizing fasciitis	2.7	4.0	0.90 (0.66–1.00)	3.9 ± 0.7	3.7 ± 0.9	4.1 ± 0.6	0.210
62 Know the diagnoses and treatment of the following symptoms and illnesses: back pain, common fractures and dislocations, compartment syndromes, crush syndrome, osteoarthritis, rhabdomyolysis, and soft tissue trauma	3.0	4.3	0.94 (0.78–1.00)	3.6 ± 0.7	3.2 ± 0.7	4.0 ± 0.7	0.021
* Can differentiate types of musculoskeletal inflammatory disorders: arthritis, bursitis, complications of systemic rheumatic diseases, osteomyelitis, and rheumatic polymyalgia							

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Supplementary Table 1. Continued

Topics and questions	Korean emergency residents			Cameroonian doctors			
	Junior (n = 7)	Senior (n = 5)	AUC (95%CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	P value
16. Psychiatric and behavior							
63 Know the following psychiatric emergency illnesses: anorexia and bulimia complications, anxiety and panic attacks, conversion disorders, deliberate self-harm and suicide attempt, depressive illness, personality disorders, substance, drug and alcohol abuse	2.6	3.8	0.88 (0.65–1.00)	2.8 ± 1.0	3.0 ± 1.0	2.7 ± 0.9	0.511
* Know the following behavior disorders: affective disorders, confusion and consciousness disturbances, intelligence disturbances, memory disorders, perception disorders, psycho-motor disturbances, and thinking disturbances							
17. Resuscitation							
64 Know the treatment course of cardiac arrest in need of defibrillation	3.1	4.3	0.94 (0.78–1.00)	3.3 ± 0.9	2.8 ± 0.8	3.7 ± 0.7	0.016
65 Know illnesses of pulseless electric activity and asystole: Acidosis, hypoxia, hypothermia, hypo-/hyperkalemia, hypocalcaemia, hypo-/hyperglycemia, hypovolemia, tension pneumothorax, cardiac tamponade, myocardial infarction, pulmonary embolism, and poisoning	2.9	4.3	0.94 (0.78–1.00)	3.4 ± 0.7	3.1 ± 0.6	3.6 ± 0.7	0.123
II. Specific aspects of emergency medicine							
18. Disaster							
66 Know the following concepts of disaster: disaster preparedness, major incident planning/procedures/practice, disaster response, and mass gatherings	1.9	3.0	0.77 (0.43–1.00)	2.8 ± 1.1	2.6 ± 1.0	3.1 ± 1.1	0.279
19. Abuse and assault							
67 Know the following concepts of abuse and assault: abuse in the elderly and impaired, child abuse and neglect, intimate partner violence and abuse, sexual assault, patient safety in emergency medicine, and violence management and prevention in the ED	2.6	3.5	0.75 (0.44–1.00)	2.8 ± 1.0	2.4 ± 0.9	3.2 ± 1.0	0.106
20. Environmental injuries							
68 Know the diagnosis and treatment of illness cause by electricity and lightning	2.3	3.3	0.79 (0.47–1.00)	3.3 ± 0.7	3.0 ± 0.7	3.5 ± 0.5	0.096
69 Know the diagnosis and treatment of febrile illnesses and cold-related illnesses	2.3	3.5	0.92 (0.74–1.00)	3.5 ± 0.6	3.3 ± 0.7	3.6 ± 0.5	0.356
70 Know the treatment of water-related injuries: near-drowning, dysbarism and complications of diving, and marine fauna	2.6	3.5	0.79 (0.50–1.00)	2.6 ± 0.8	2.2 ± 0.4	3.0 ± 0.8	0.021
71 Know the diagnosis and treatment of CO poisoning	2.6	4.0	0.88 (0.65–1.00)	3.0 ± 1.0	2.7 ± 0.7	3.3 ± 1.2	0.175
21. Prehospital care							
72 Know about emergency medical service organizations (administration, structure, staffing, resources)	1.6	3.3	0.79 (0.45–1.00)	3.1 ± 0.6	3.1 ± 0.8	3.1 ± 0.3	0.964
73 Is informed of medical transport (including neonates, children, and air transport)	1.6	3.0	0.77 (0.43–1.00)	2.9 ± 0.9	2.7 ± 0.7	3.1 ± 1.1	0.328
74 Know about concepts and issues of safety at the scene	1.8	3.0	0.73 (0.38–1.00)	3.2 ± 0.9	3.0 ± 0.9	3.3 ± 0.9	0.483
75 Know about paramedic training and function	1.6	3.0	0.75 (0.42–1.00)	3.2 ± 0.6	3.1 ± 0.6	3.2 ± 0.6	0.758
76 Know concepts of collaboration with other emergency services (e.g. police and fire department)	1.4	3.0	0.79 (0.47–1.00)	3.5 ± 0.8	3.1 ± 0.8	3.8 ± 0.6	0.049

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Supplementary Table 1. Continued

Topics and questions	Korean emergency residents			Cameroonian doctors			P value
	Junior (n = 7)	Senior (n = 5)	AUC (95%CI)	Total (n = 19)	GP (n = 9)	Specialist (n = 10)	
III. Clinical procedure and skill							
22. CPR skills							
77 Know CPR procedure guidelines for adults and pediatrics	3.0	4.3	0.88 (0.65–1.00)	3.6 ± 0.9	3.2 ± 0.8	3.9 ± 0.9	0.103
78 Know advanced CPR skills (e.g. therapeutic hypothermia or open chest CPR)	2.9	4.3	0.94 (0.78–1.00)	2.7 ± 0.9	2.4 ± 0.5	2.9 ± 1.1	0.263
79 Know the following airway management techniques: insertion of oropharyngeal or nasopharyngeal airway, endotracheal intubation, alternative airway techniques in the emergency setting (e.g. laryngeal mask insertion or surgical airway)	2.6	4.5	1.00 (1.00–1.00)	2.9 ± 1.1	2.3 ± 0.9	3.5 ± 1.1	0.020
80 Know the following breathing and ventilation management techniques: oxygen therapy, pulse oximetry and capnography, bag-mask-valve ventilation, thoracentesis, chest tube insertion, connection to under-water drainage and assessment of functioning, non-invasive ventilation techniques, and invasive ventilation techniques	2.3	4.5	1.00 (1.00–1.00)	3.2 ± 0.9	2.8 ± 0.8	3.6 ± 0.7	0.032
81 Know the following circulatory support and cardiac skills and procedures: monitoring of ECG and the circulation, defibrillation and pacing (e.g. cardioversion, transcutaneous pacing), emergency pericardiocentesis, and vascular access (peripheral venous, arterial, and central venous catheterization, and intrascosseous access)	2.4	4.5	1.00 (1.00–1.00)	2.9 ± 0.8	2.4 ± 0.9	3.4 ± 0.5	0.010
82 Know about difficult airway management algorithm	1.9	3.8	0.96 (0.84–1.00)	2.8 ± 1.0	2.2 ± 0.7	3.4 ± 1.0	0.007
83 Know about the drugs used in ACLS	2.1	4.3	1.00 (1.00–1.00)	3.2 ± 1.0	3.0 ± 1.1	3.4 ± 0.8	0.388
84 Know the concepts and techniques of rapid sequence intubation	2.4	4.5	0.96 (0.84–1.00)	2.9 ± 1.1	2.3 ± 0.7	3.5 ± 1.2	0.020
85 Can perform insertion and replacement of tracheostomy tube	1.6	4.3	1.00 (1.00–1.00)	2.9 ± 1.0	2.4 ± 0.5	3.3 ± 1.3	0.071
23. Procedure							
86 Know the following gastrointestinal procedures: insertion of nasogastric tube, gastric lavage, peritoneal lavage, abdominal hernia reduction, and abdominal paracentesis	3.1	4.3	0.94 (0.78–1.00)	3.8 ± 0.8	3.4 ± 1.0	4.1 ± 0.3	0.094
87 Know the following genitourinary procedures: insertion of indwelling urethral catheter, suprapubic cystostomy, testicular torsion reduction, and evaluation of patency of urethral catheter	2.4	3.8	0.83 (0.52–1.00)	3.4 ± 0.8	3.1 ± 0.8	3.6 ± 0.8	0.209
88 Know the following musculoskeletal procedures: aseptic joint aspiration, fracture immobilization, reduction of joint dislocation, log roll and spine immobilization, splinting (plasters, braces, slings, tapes and other bandages), and management of compartment syndrome	2.3	3.5	0.83 (0.52–1.00)	3.3 ± 0.9	3.0 ± 0.7	3.5 ± 1.1	0.255
89 Know the following neurological procedures: evaluation of consciousness including the Glasgow Coma Scale, funduscopic exam, and lumbar puncture	2.9	3.8	0.71 (0.34–1.00)	4.3 ± 0.5	4.3 ± 0.5	4.3 ± 0.5	0.884
90 Know the following obstetric and gynecological procedures: emergency delivery, vaginal examination using speculum, and assessment of the sexual assault victim	1.7	2.0	0.58 (0.22–0.95)	3.8 ± 0.8	3.8 ± 0.7	3.9 ± 0.9	0.739
91 Know the following temperature control procedures: measuring and monitoring of body temperature, cooling techniques (evaporative cooling, ice water or slush immersion), internal cooling methods, warming techniques, monitoring heat stroke patients, and treatment and prevention of hyper- and hypothermia	1.6	3.5	1.00 (1.00–1.00)	3.3 ± 0.9	3.0 ± 0.7	3.5 ± 1.0	0.222
92 Know the following wound management procedures: abscess incision and drainage, aseptic techniques, treatment of lacerations and soft tissue injuries, and wound irrigation and wound closure	3.0	4.0	0.77 (0.46–1.00)	3.9 ± 0.9	3.4 ± 0.9	4.3 ± 0.8	0.043
93 Know decontamination procedure for patients and surroundings	2.3	3.3	0.73 (0.41–1.00)	3.3 ± 0.9	2.9 ± 0.8	3.6 ± 0.8	0.075
94 Know patient transfer procedures: telecommunication and telemedicine procedures, preparation of the EMS vehicle, and specific aspects of monitoring and treatment during transportation	2.3	3.5	0.73 (0.40–1.00)	2.9 ± 0.8	2.6 ± 0.7	3.3 ± 0.7	0.033
* Know the following ophthalmic procedures: removal of foreign body from the eye, slit lamp use, and lateral canthotomy							
* Know the following procedures: measurement of abdominal pressure, proctoscopy, fasciotomy, and escharotomy							

Values are presented as mean (for Korean emergency residents) and mean ± SD (for Cameroonian doctors).

AUC = area under curve, GP = general physician, ECG = electrocardiogram, COPD = chronic obstructive pulmonary disease, ABGA = arterial blood gas analysis, GI = gastrointestinal, CAPD = continuous ambulatory peritoneal dialysis, SIDS = sudden infant death syndrome, AIDS = acquired immune deficiency syndrome, HBV = hepatitis B virus, HCV = hepatitis C virus, CT = computed tomography, DKA = diabetes ketoacidosis, HHS = hyperglycemic hyperosmolar state, AKA = alcoholic ketoacidosis, VWD = Von Willebrand disease, FAST = focused abdominal sonography for trauma, ED = emergency department, CO = carbon monoxide, CPR = cardiopulmonary resuscitation, ACLS = advanced cardiac life support, EMS = emergency medical service.

\*Nineteen questions were removed after expert survey.

**Supplementary Table 2.** Scenario-based competency assessment tool of 26 sub-questions developed for 14 questions of the self-survey competency assessment

Scenario	Questions and items for the scenario-based competency assessment
1. Septic shock	<ol style="list-style-type: none"> <li>1 Know the diagnosis and treatment of sepsis and septic shock (self-survey #31)               <ol style="list-style-type: none"> <li>1) Check onset of fever (1 day ago)</li> <li>2) Check onset of groin pain (3 days ago)</li> <li>3) Check past medical history (diabetes mellitus, hypertension, etc.)</li> <li>4) Can interpret initial vital sign 100/50 mmHg – 106 bpm – 12/min – 99.5°F (37.5°C)</li> <li>5) Can recognize septic shock (vital sign after 5 min) 80/- mmHg – 120 bpm – 28/min – (SpO2 100%)</li> <li>6) Can order appropriate blood lab tests                   <ul style="list-style-type: none"> <li>- CBC, chemistries, coagulation panel, lactate, ABGA (or VBGA), serology, ABO Rh type-Ab screening, etc.</li> </ul> </li> <li>7) Can interpret blood lab test results                   <ul style="list-style-type: none"> <li>- Leukocytosis, hyponatremia, ARF or ARF on CRF or CRF, hyperglycemia, elevated lactate level, high anion gap metabolic acidosis</li> </ul> </li> <li>8) Know the targets and targeted goal therapy for septic shock patients                   <ul style="list-style-type: none"> <li>- CVP (8–12 mmHg), mean BP (65–90 mmHg), ScvO2 (<math>\geq 70\%</math>)</li> </ul> </li> <li>9) Can provide proper surgical consultation</li> </ol> </li> <li>2 Can diagnose the following musculoskeletal illnesses: cellulitis, necrotizing fasciitis (self-survey #61)               <ol style="list-style-type: none"> <li>1) Can diagnose the following musculoskeletal illness (with a picture) - necrotizing fasciitis</li> </ol> </li> <li>3 Can interpret ABGA (self-survey #10)               <ol style="list-style-type: none"> <li>1) Can interpret ABGA results with electrolytes ABGA 7.20 – 32 – 95 – 14                   <ul style="list-style-type: none"> <li>- High AG metabolic acidosis, metabolic alkalosis, respiratory acidosis</li> </ul> </li> </ol> </li> </ol>
2. Diabetes ketoacidosis	<ol style="list-style-type: none"> <li>4 Can evaluate fluid status (dehydration) (self-survey #4)               <ol style="list-style-type: none"> <li>1) Can evaluate fluid status (dehydration): nausea, vomiting, thirsty (polydipsia), polyuria, low BP, tachycardia, tachypnea, dry mucous membrane, clammy and cool skin, confusion status, dehydrated status</li> </ol> </li> <li>5 Know the diagnosis and treatment of DKA (self-survey #41)               <ol style="list-style-type: none"> <li>1) Recognition of DKA – high anion gap metabolic acidosis (<math>\text{pH} &lt; 7.3</math>), decreased <math>\text{TCO}_2</math> (<math>&lt; 10</math>), hyperglycemia (<math>&gt; 250</math>), ketonemia</li> <li>2) Initial treatment of DKA – normal saline 2 L/hr for 2hr</li> <li>3) Precautions for insulin administration – confirmation of urine output and K level</li> <li>4) Add 5% dextrose water if BST is approaching 250 mg/dL</li> </ol> </li> <li>6 Can treat electrolyte disorders (self-survey #16)               <ol style="list-style-type: none"> <li>1) Can explain the reason why a patient should have serum potassium level checked frequently</li> </ol> </li> </ol>
3. STEMI	<ol style="list-style-type: none"> <li>7 Can differentiate the following illnesses of chest pain: acute coronary syndromes, stable angina, aortic dissection/aneurysm rupture, pulmonary embolism (self-survey #1)               <ol style="list-style-type: none"> <li>1) Can make a differential diagnosis of chest pain including these diseases: acute coronary syndromes, aortic dissection pulmonary embolism</li> </ol> </li> <li>8 Can interpret ECG (self-survey #3)               <ol style="list-style-type: none"> <li>1) Can make an interpretation of ECG                   <ul style="list-style-type: none"> <li>- 1. Inferior STEMI; 2. Lead II, III, aVF ST segment elevation; 3. Lead I, aVL, V6 (reciprocal) ST segment depression</li> </ul> </li> </ol> </li> <li>9 Know the following circulatory support and cardiac skills and procedures: Monitoring of ECG and the circulation, Defibrillation and pacing (self-survey #81)               <ol style="list-style-type: none"> <li>1) Can perform defibrillation and pacing (e.g. cardioversion, transcutaneous pacing)                   <ul style="list-style-type: none"> <li>- 1. Prompt CPR; 2. Defibrillation; 3. Manufacturer recommending dose or biphasic 200J or monophasic 360J</li> </ul> </li> </ol> </li> </ol>
4. Multiple trauma	<ol style="list-style-type: none"> <li>10 Know fluid therapy for traumatic hypovolemic shock (self-survey #59)               <ol style="list-style-type: none"> <li>1) Choice of fluid for initial resuscitation</li> <li>2) Method of transfusion for hemorrhagic shock patients</li> </ol> </li> <li>11 Know the diagnoses and treatment of traumatic pulmonary disorders: hemothorax, tension pneumothorax, pneumomediastinum (self-survey #8)               <ol style="list-style-type: none"> <li>1) Can explain the diagnosis and the treatment of traumatic pulmonary disorder – hemothorax</li> </ol> </li> </ol>
5. Anaphylaxis	<ol style="list-style-type: none"> <li>12 Know the diagnoses and treatment of oral inflammatory illnesses: angioedema, epiglottitis, laryngitis, paratonsillar abscess (self-survey #48)               <ol style="list-style-type: none"> <li>1) Can explain the diagnosis and treatment of angioedema</li> </ol> </li> <li>13 Know the diagnosis and treatment of anaphylaxis (self-survey #56)               <ol style="list-style-type: none"> <li>1) Can explain the diagnosis and treatment of anaphylaxis</li> </ol> </li> <li>14 Know about difficult airway management algorithms (self-survey #82)               <ol style="list-style-type: none"> <li>1) Know about difficult airway management algorithms</li> </ol> </li> </ol>

CBC = complete blood count, ABGA = arterial blood gas analysis, VBGA = venous blood gas analysis, ARF = acute renal failure, CRF = chronic renal failure, CVP = central venous pressure, BP = blood pressure, ScvO2 = central venous oxygen saturation, AG = anion gap, DKA = diabetes ketoacidosis,  $\text{TCO}_2$  = total carbon dioxide, STEMI = ST elevation myocardial infarction, ECG = electrocardiogram, CPR = cardiopulmonary resuscitation.