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Predictors of critical illness among young males with chest pain, abdominal pain, or headaches in the Republic of Korea Army

Byeong Geun Song[1,*], Jung Han Woo[2,*], Hyeon Kyung Yoon[3,*], Byeongwook Cho[1], Hyun Jae Lee[1], Moonki Jung[1,†], Yoonhyuk Jang[4,†]

[1]*Department of Internal Medicine, Armed Forces Seoul District Hospital, Seoul, Korea*
[2]*Department of Radiology, Armed Forces Seoul District Hospital, Seoul, Korea*
[3]*Hospital Headquarters, Armed Forces Seoul District Hospital, Seoul, Korea*
[4]*Department of Neurology, Armed Forces Seoul District Hospital, Seoul, Korea*

Purpose

Chest pain, abdominal pain, and headache are common symptoms associated with critical illness. Here, we aimed to evaluate predictors associated with critical illness in young males of the Republic of Korea Army.

Methods

We retrospectively reviewed previously healthy young males with chest pain, abdominal pain, or headaches who visited Armed Forces Seoul District Hospital between January 2019 and December 2020. Critical illness was defined as a condition that required hospitalization, a procedure or surgery, or referral to a tertiary hospital. The symptoms and signs of critical illness were evaluated.

Results

Of the 762 enrolled patients, a critical illness was diagnosed in 45 patients (5.9%). Among chest pain signs, palpitation (odds ratio [OR], 22.8; 95% confidence interval [CI], 5.08–102.4; p < 0.001), exertional dyspnea (OR, 16.3; 95% CI, 3.38–78.8; p = 0.001), duration (> 5 minutes) (OR, 7.54; 95% CI, 1.93–29.49; p = 0.004), and squeezing type (OR, 5.28; 95% CI, 1.11–25.11; p = 0.037) were significantly associated with critical illness. Among abdominal pain signs, right-lower-quadrant tenderness (OR, 11.87; 95% CI, 4.671–31.87; p < 0.001) was an alarming sign. For headaches, criticality was low (1.5%), and half of patients with critical illness were diagnosed incidentally regardless of headache.

Conclusion

We identified symptoms and signs significantly associated with critical illness in young male patients. This study might serve as a reference for deciding when to transfer soldiers in the field to a rear hospital, thereby contributing to the welfare and combat power of soldiers.

Keywords: Emergencies, Chest pain, Abdominal pain, Headache

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Correspondence: Moonki Jung
Department of Internal Medicine, Armed Forces Seoul District Hospital, 13 Samcheong-ro 10-gil, Jongno-gu, Seoul 03050, Korea
E-mail: yessul88@naver.com
ORCID: http://orcid.org/0000-0002-9935-7725

Yoonhyuk Jang
Department of Neurology, Armed Forces Seoul District Hospital, 13 Samcheong-ro 10-gil, Jongno-gu, Seoul 03050, Korea
E-mail: yoonhyuk@snu.ac.kr
ORCID: https://orcid.org/0000-0002-3346-3357

*These authors contributed equally to this study as co-first authors.
†These authors contributed equally to this study as co-corresponding authors.

Introduction

Chest pain, abdominal pain, and headache are common symptoms of mild illness but are also some of the initial symptoms of critical illness. Chest pain is often associated with cardiovascular diseases such as acute myocardial infarction and arrhythmia [1-3], while abdominal pain is frequently related to acute appendicitis and acute cholangitis [4,5]. In addition, in patients with severe headaches, it is necessary to differentiate cerebral hemorrhage, brain tumor, or infectious origins from primary headaches [6]. In the case of such a critical illness, the severity of the disease is high, and delayed diagnosis can have a devastating effect on the patient's prognosis [7]. The incidence rate of critical not high in healthy young males who have passed the military enlistment exam, but cases of critical illnesses are steadily reported every year [1-3,8-11].

Since all healthy male citizens of the Republic of Korea must be enlisted for at least 18 months, the welfare of soldiers and access to medical care should be guaranteed. Meanwhile, from a commander's point of view, transfer to a rear hospital without any specific criteria could weaken combat power and be a command burden. In particular, most field forces in South Korea are exposed to risk of traffic accident during patient transportation due to rural location. Therefore, the role of field military doctors is paramount to differentiate critical illness from mild diseases, but they often only rely on history taking and physical examination due to lack of basic diagnostic tools such as electrocardiogram or chest X-ray. Although there have been many previous studies on risk factors associated with a critical illness [12-18], no studies have been conducted on a population of males in their early twenties in the army.

Therefore, we aimed to evaluate the incidence of critical illness among patients who had chest pain, abdominal pain, or headache, which are common symptoms observed in the army. Furthermore, we analyzed risk factors associated with critical illness in each symptom and showed representative cases, so that the results can be helpful to primary care field doctors who are responsible for the triage and diagnosis of these patients.

Methods

Patients and definition of critical illness

This study was a retrospective, case-control, single-center trial to evaluate the predictors associated with critical illness in young male soldiers who complained of chest pain, abdominal pain, or headache. All subjects were patients who visited the Armed Forces Seoul District Hospital from January 2019 to December 2020 and previously passed medical screening examinations during military enlistment. Armed Forces Seoul District Hospital is a secondary military hospital based in Seoul, South Korea. Non-commissioned officers, officers, and civilians were excluded.

Critical illness was defined as a condition requiring inpatient treatment at a secondary hospital or treatment at a tertiary hospital such as a procedure or surgery. All medical records of the soldiers were reviewed by five medical specialists in each field, and all of the images were repeatedly reviewed by one radiologist. Additional outpatient follow-up was performed for patients whose examinations were incomplete or negative at the time of admission.

This study was approved by the Institutional Review Board of Armed Force Medical Command of the Republic of Korea Army (No. AFMC-202104-HR-021-01) with the waiver of informed consent. This study was carried out in accordance with relevant guidelines and regulations, including the Helsinki Declaration.

Statistics

Clinical data are summarized as a percentage or mean ± standard deviation. In the analysis of clinical data, we utilized the chi-square or Fisher exact tests for categorical variables and Student t-test for continuous variables. Multivariable logistic regression analysis was performed with parameters showing a p-value of < 0.10 on univariable analysis. All analyses were performed using IBM SPSS version 23.0 (IBM Corp, Armonk, NY, USA). A p-value of < 0.05 was considered statistically significant.

Results

Demographics and characteristics of enrolled patients

A total of 762 patients were analyzed in our study (Table 1). The mean age was 20.9 ± 1.6 years, and all patients were male. In terms of military rank, 58 (7.6%) were private, 295 (38.7%) were private first class, 306 (40.2%) were corporal, and 103 (13.5%) were sergeant. Abdominal pain was the most common chief complaint (n = 294, 38.6%), followed by headache (n = 263, 34.5%) and chest pain (n = 205, 26.9%). Forty-five patients (5.9%) were diagnosed with critical illness, and critical illness was most frequently detected in patients with chest pain (17 of 205, 8.3%), followed by abdominal pain

Table 1 Baseline characteristics and results of patients with chest pain, abdominal pain, and headache

Variable	Total	Critical illness	Noncritical illness	p-value
Chest pain	205	17	188	
Age (yr)	20.9 ± 1.6	20.3 ± 0.9	21.0 ± 1.6	0.120
Rank				0.070
Private	17 (8.3)	2 (11.8)	15 (8.0)	
Private first class	67 (32.7)	5 (29.4)	62 (33.0)	
Corporal	90 (43.9)	4 (23.5)	86 (45.7)	
Sergeant	31 (15.1)	6 (35.3)	25 (13.3)	
Onset (day)	135.6 ± 475.4	85.5 ± 197.5	140.2 ± 493.0	0.651
Associated symptom				
Palpitation	19 (9.3)	8 (47.1)	11 (5.9)	< 0.001
Dyspnea on exertion	16 (7.8)	7 (41.2)	9 (4.8)	< 0.001
Duration (min)	217.5 ± 508.1	431.8 ± 670.9	198.2 ± 488.5	0.178
> 5 min	49 (23.9)	11 (64.7)	38 (20.2)	< 0.001
Character				
Squeezing type	28 (13.7)	5 (29.4)	23 (12.2)	0.048
Stabbing type	17 (8.3)	0 (0.0)	17 (9.0)	0.37
Pleuritic type	52 (25.4)	5 (29.4)	47 (25.0)	0.689
Chest wall tenderness	29 (14.1)	0 (0.0)	29 (15.4)	0.139
Abdominal pain	294	24	270	
Age (yr)	21.0 ± 1.7	21.3 ± 1.6	21.0 ± 1.7	0.323
Rank				0.267
Private	20 (6.8)	2 (8.3)	18 (6.7)	
Private first class	111 (37.8)	10 (41.7)	101 (37.4)	
Corporal	121 (41.2)	6 (25.0)	115 (42.6)	
Sergeant	42 (14.3)	6 (25.0)	36 (13.3)	
Onset (day)	15.3 ± 63.5	1.8 ± 4.3	16.6 ± 66.3	0.298
Associated symptom	239			
Nausea/vomiting	103 (35.0)	8 (34.8)	95 (36.5)	0.867
Diarrhea	136 (46.3)	7 (30.4)	129 (49.6)	0.078
Physical examination	264			
Epigastric tenderness	77 (26.2)	6 (26.1)	71 (26.9)	0.933
RUQ tenderness	21 (7.1)	5 (21.7)	16 (6.1)	0.019
RLQ tenderness	60 (20.4)	16 (69.6)	44 (16.9)	< 0.001
LUQ tenderness	30 (10.2)	3 (13.0)	27 (10.3)	0.721
LLQ tenderness	37 (12.6)	2 (8.7)	35 (13.4)	0.750
Periumbilical tenderness	35 (11.9)	3 (13.6)	32 (13.1)	> 0.999
Rebound tenderness	4 (1.4)	1 (4.3)	3 (1.1)	0.284
Headache	263	4	259	
Age (yr)	21.0 ± 1.6	21.5 ± 2.4	21.0 ± 1.5	0.489
Rank				0.305
Private	21 (8.0)	1 (25.0)	20 (7.7)	
Private first class	117 (44.5)	2 (50.0)	115 (44.4)	
Corporal	95 (36.1)	0 (0.0)	95 (36.7)	
Sergeant	30 (11.4)	1 (25.0)	29 (11.2)	
Onset (day)	36.4 ± 148.5	NA	36.4 ± 148.5	NA
Associated symptom				
Syncope	7 (2.7)	0 (0.0)	7 (2.7)	> 0.999
Dizziness	47 (17.9)	1 (25.0)	46 (17.8)	0.549
Nausea/vomiting	78 (29.7)	0 (0.0)	78 (30.2)	0.321
Trauma history	32 (12.2)	1 (25.0)	31 (12.0)	0.408
Previous headache history	75 (28.5)	1 (25.0)	74 (28.7)	> 0.999
Abnormal neurologic sign	3 (1.2)	1 (25.0)	2 (0.8)	0.046

Values are presented as number only, mean ± standard deviation, or number (%).

RUQ, right upper quadrant; RLQ, right lower quadrant; LUQ, left upper quadrant; LLQ, left lower quadrant; NA, not available.

(24 of 294, 8.2%) and headache (4 of 263, 1.5%). Among the critical illness patients, 14 were hospitalized (31.1%; 6 with chest pain, 6 with abdominal pain, and 2 with headache), 13 had a surgery or procedure (28.9%; 1 with chest pain and 12 with abdominal pain), and 18 were transferred to a civilian tertiary hospital (40.0%; 10 with chest pain, 6 with abdominal pain, and 2 with headache).

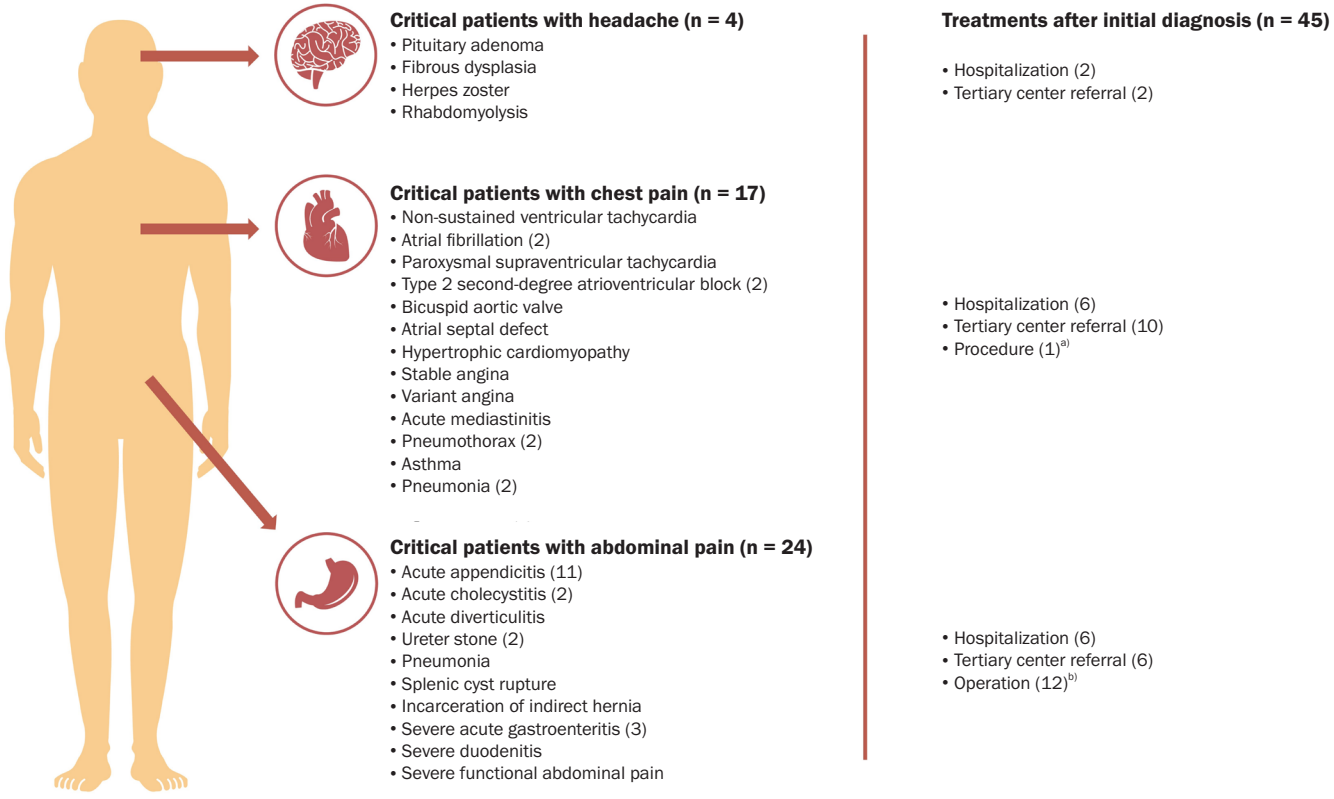
Analysis of patients with critical illness for each chief complaint

Chest pain

We investigated the risk factors for critical illness with each chief complaint (Table 1). Of the 205 patients who had chest pain, the mean age was 20.9 ± 1.6 years, and the rank was private for 17 patients (8.3%), private first class for 67 patients (32.7%), corporal for 90 patients (43.9%), and sergeant for 31 patients (15.1%). The onset of the chest pain was 135.6 ± 475.4 days ago, and the duration was 217.5 ± 508.1 minutes. Seventeen patients (8.3%) were diagnosed with critical illness, and their mean age was 20.3 ± 0.9 years. The following critical illnesses were diagnosed: arrhythmia (n = 6: non-sustained ventricular tachycardia, 1; atrial fibrillation, 2; paroxysmal supraventricular tachycardia [PSVT], 1; and type 2 second-degree atrioventricular block, 2), stable angina (n = 1), variant angina (n = 1), acute mediastinitis (n = 1), hypertrophic cardiomyopathy (n = 1), bicuspid aortic valve (n = 1), atrial septal defect (n = 1), pneumothorax (n = 2), asthma (n = 1), and pneumonia (n = 2) (Figure 1). For multivariable analysis, the following factors were significantly associated with the critical illness: palpitation (odds ratio [OR], 22.81; 95% confidence interval [CI], 5.08–102.40; p < 0.001), dyspnea on exertion (OR, 16.33; 95% CI, 3.38–78.84; p = 0.001), duration of chest pain greater than 5 minutes (OR, 7.54; 95% CI, 1.93–29.49; p = 0.004), and chest pain type of squeezing (OR, 5.28; 95% CI, 1.11–25.11; p = 0.037) (Figure 2).

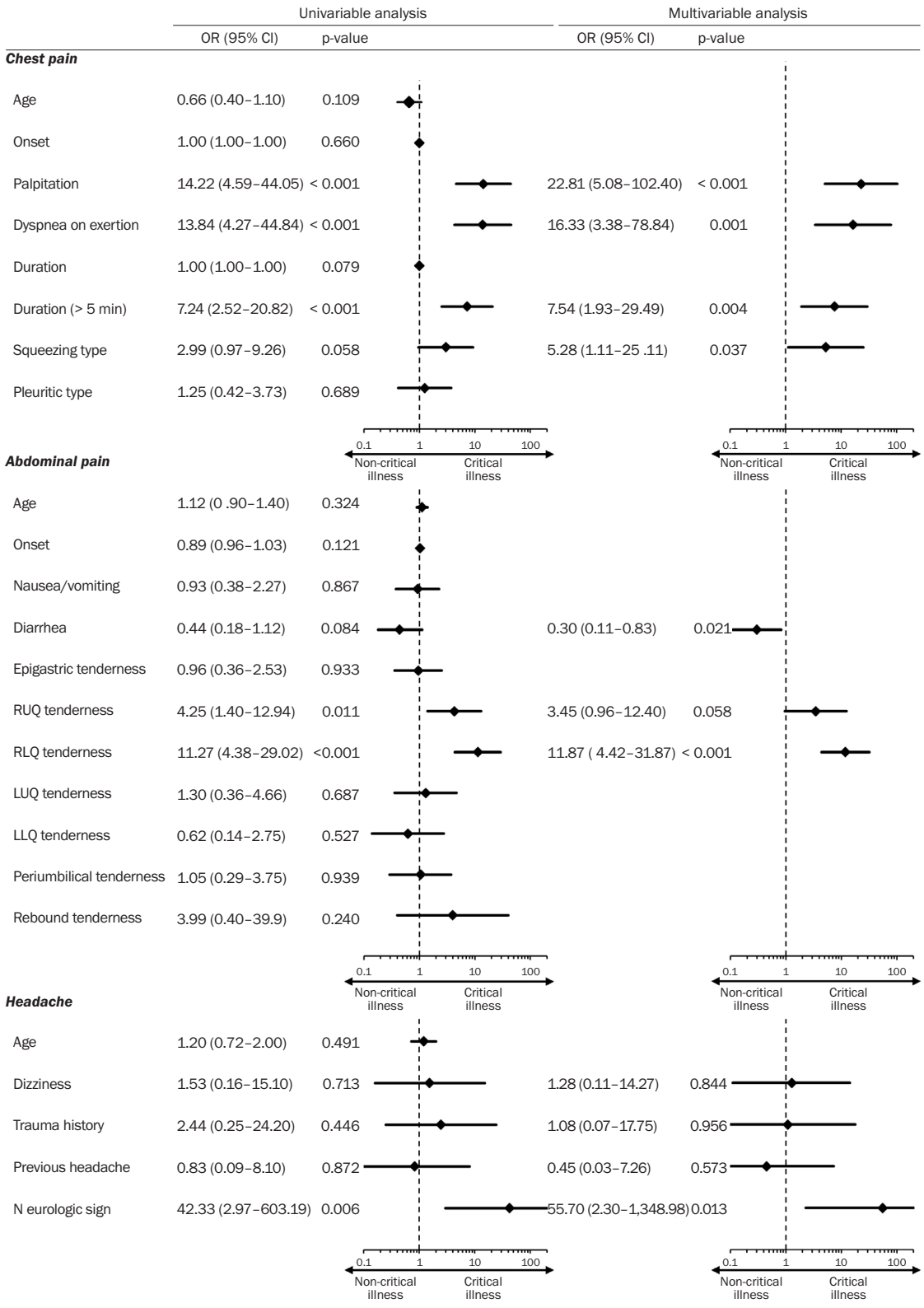
In diagnosing critical illness in patients with chest pain, chest

Figure 1 Graphic illustration of critical illness in each chief complaint and type of treatment after confirmed diagnosis



The numbers indicate the number of patients who were diagnosed with the disease.
a)Radiofrequency catheter ablation for paroxysmal supraventricular tachycardia was performed at a civilian tertiary center. b)All patients were referred for surgery, and acute appendicitis was confirmed after laparoscopic appendectomy in all cases.

Figure 2 Forest plot of univariate and multivariate analyses for risk factors associated with critical illness



OR, odds ratio; CI, confidence interval.

X-ray (2 of 17 [11.8%] vs 2 of 188 [1.1%], p = 0.035), electrocardiogram (8 of 17 [47.1%] vs 19 of 188 [10.1%], p < 0.001), echocardiogram (3 of 17 [17.6%] vs 5 of 188 [2.7%], p = 0.021), 24-hr Holter (7 of 17 [41.2%] vs 8 of 188 [4.3%], p < 0.001), chest computed tomography (CT) (4 of 17 [23.5%] vs 9 of 188 [4.8%], p = 0.015), and coronary CT (3 of 17 [17.6%] vs 1 of 188 [0.5%], p = 0.002) were meaningfully useful (Table 2). Moreover, the serum level of alanine aminotransferase also showed a significantly lower value in patients with critical illness associated with chest pain (17 ± 4 IU/L vs 24 ± 16 IU/L, p < 0.001).

Abdominal pain

A total of 294 patients were included in the analysis of abdominal pain (Table 1). The mean age of the patients was 21.0 ± 1.7 years, and the number of patients with each rank was 20 (6.8%) for private, 111 (37.8%) for private first class, 121 (41.2%) for corporal, and 42 (14.3%) for sergeant. Mean duration from the onset of abdominal pain was 15.3 ± 63.5 days. Twenty-four patients (8.2%) were diagnosed with a critical illness due to abdominal pain. Their mean age was 21.3 ± 1.6 years, and the critical illness diagnoses were as follows: acute appendicitis (n = 11), acute cholecystitis (n = 2), acute diverticulitis (n = 1), ureter stone (n = 2), pneumonia (n = 1), splenic cyst rupture (n = 1), incarceration of indirect hernia (1), severe acute gastroenteritis (n = 3), severe duodenitis (n = 1), and severe functional abdominal pain (n = 1) (Figure 1). For multivariable analysis, diarrhea, tenderness at the right upper quadrant, and tenderness at the right lower quadrant (RLQ) were included. Among them, tenderness at the RLQ (OR, 11.87; 95% CI, 4.42–31.87; p < 0.001) was significantly associated with critical illness. On the other hand, the symptom of diarrhea seemed to be associated with mild disease (OR, 0.30; 95% CI, 0.11–0.83; p = 0.021) (Figure 2).

Abdominal and pelvic CT (14 of 17 [82.4%] vs 15 of 270 [5.6%], p < 0.001) was significantly useful for diagnosing critical illness related to abdominal pain (Table 2). Among laboratory results, total bilirubin (1.4 ± 1.2 mg/dL vs 0.8 ± 0.4 mg/dL, p = 0.040) was significantly associated with critical illness.

Headache

Two hundred sixty-three patients visited our neurology clinic due to headaches (Table 1). Mean age was 21.0 ± 1.6 years, and the ranks were private for 21 patients (8.0%), private first class for 117 patients (44.5%), corporal for 95 patients (36.1%), and sergeant for 30 patients (11.4%). Mean duration from the onset of headache was 36.4 ± 148.5 days. Among the headache patients, four (1.5%) were diagnosed with critical illness. The critical illness diagnoses were pituitary adenoma, fibrous dysplasia, herpes zoster, and rhabdomyolysis (Figure 1). Abnormal neurologic signs were found in the patient with herpes zoster (1 of 4 [25.0%] vs 2 of 259 [0.8%], p = 0.046) and were associated with critical illness in multivariable analysis (p = 0.013, OR 55.70, 95% CI 2.30-1348.98) (Figure 2).

Both brain CT (2 of 4 [50.0%] vs 3 of 259 [1.2%], p = 0.002) and brain magnetic resonance imaging (MRI) (2 of 4 [50.0%] vs 9 of 259 [3.5%], p = 0.009) were sufficient to detect critical illness in patients with headache.

Representative cases of critical illnesses

Cardiac arrhythmia with chest pain

A 21-year-old male sergeant presented to our clinic for evaluation of intermittent tightening chest pain over the past 2 months. The chest pain was associated with mild shortness of breath and sudden onset of palpitations. These episodes occurred irregularly, several times a month, and lasted 1 to 5 minutes. A 12-lead electrocardiogram showed sinus bradycardia, and echocardiography revealed no abnormal findings. However, on Holter monitoring, the episodes of narrow QRS tachycardia were detected during physical activity (Figure 3A). Tachycardia of 190 beats per minute was induced by premature atrial complex and lasted up to 8 minutes. Therefore, the patient was diagnosed with PSVT and was transferred to a civilian tertiary hospital for electrophysiological study and ablation of PSVT. Since the procedure, the patient has had no recurrent episodes.

Acute appendicitis with abdominal pain

A 20-year-old male private first class was transferred to our emergency room with a 6-hour history of severe abdominal pain. His symptoms suddenly occurred as a vague pain around the umbilicus. As the pain worsened, it became sharp and migrated to the RLQ, accompanied by nausea and vomiting. On physical examination, tenderness at McBurney's point was positive with focal abdominal guarding. The white blood cell count was 10,340/mm^3 with 71.5% neutrophils. Abdominal and pelvic CT was performed, and acute appendicitis was diagnosed with findings of dilated appendix (1.5 cm) with wall enhancement and appendicolith (Figure 3B). The patient underwent a laparoscopic appendectomy for acute suppurative appendicitis. After successful treatment, he was discharged without any complications.

Discussion

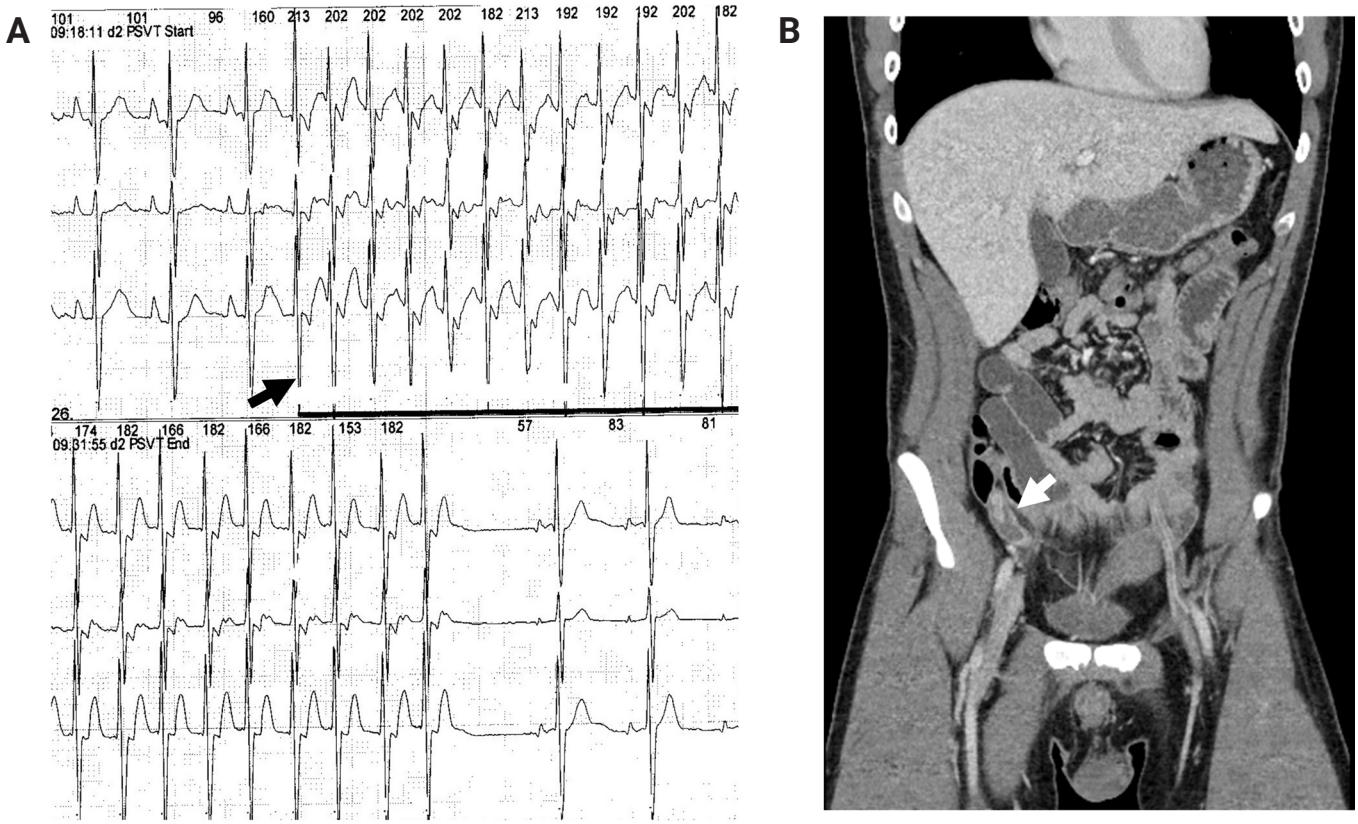
In our analysis of patients who had chest pain, abdominal

Table 2 Diagnostic evaluation of critical illness in patients with chest pain, abdominal pain, and headache

Variable	Total	Critical illness	Noncritical illness	p-value
Chest pain	205	17	188	
Abnormal imaging study				
Chest X-ray	4 (2.0)	2 (11.8)	2 (1.1)	0.035
Electrocardiogram	27 (13.2)	8 (47.1)	19 (10.1)	< 0.001
Echocardiogram	8 (3.9)	3 (17.6)	5 (2.7)	0.021
24-hr Holter	15 (7.3)	7 (41.2)	8 (4.3)	< 0.001
Chest CT	13 (6.3)	4 (23.5)	9 (4.8)	0.015
Coronary CT	4 (2.0)	3 (17.6)	1 (0.5)	0.002
Laboratory study				
WBC (/μL)	7,305 ± 1,601	6,591 ± 1,539	7,379 ± 1595	0.080
Hb (g/dL)	15.2 ± 0.9	15.2 ± 0.9	15.2 ± 0.9	0.817
Platelet (× 103/μL)	254 ± 53	230.5 ± 47.2	256.7 ± 53.4	0.079
CRP (mg/dL)	0.5 ± 1.7	1.37 ± 3.5	0.3 ± 0.7	0.355
AST (IU/L)	26 ± 21	21 ± 5	17 ± 4	0.365
ALT (IU/L)	23 ± 16	17 ± 4	24 ± 16	< 0.001
ALP (IU/L)	52 ± 84	88 ± 46	83 ± 23	0.578
Total bilirubin (mg/dL)	0.8 ± 0.3	0.8 ± 0.3	0.8 ± 0.3	0.699
Troponin-I (ng/mL)	0	0	0	> 0.999
Abdominal pain	294	24	270	
Abnormal imaging study				
Chest X-ray	0 (0)	0 (0)	0 (0)	> 0.999
Abdominal and pelvic CT	29 (9.9)	14 (58.3)	15 (5.6)	< 0.001
Laboratory study				
WBC (/μL)	8,259 ± 2,873	11,104 ± 3,571	7,856 ± 2,526	0.001
Hb (g/dL)	15.1 ± 1.0	15.5 ± 0.8	15.1 ± 1.0	0.115
Platelet (× 10^3/μL)	253 ± 59	250 ± 57	253 ± 60	0.826
CRP (mg/dL)	1.6 ± 3.5	2.7 ± 5.8	1.4 ± 2.9	0.349
AST (IU/L)	25 ± 12	21 ± 8	25 ± 12	0.168
ALT (IU/L)	24 ± 19	19 ± 6	24 ± 20	0.212
ALP (IU/L)	80 ± 21	77 ± 18	81 ± 22	0.507
Total bilirubin (mg/dL)	0.9 ± 0.6	1.4 ± 1.2	0.8 ± 0.4	0.040
Amylase (IU/L)	51 ± 15	54 ± 20	50 ± 13	0.452
Headache	263	4	259	
Abnormal imaging study				
Brain CT	5 (1.9)	2 (50.0)	3 (1.2)	0.002
Brain MRI	11 (4.2)	2 (50.0)	9 (3.5)	0.009
Laboratory study				
WBC (/μL)	7,423 ± 1,882	6,380 ± 1,580	7,453 ± 1,888	0.333
Hb (g/dL)	15.2 ± 0.8	15.5 ± 1.4	15.2 ± 0.8	0.514
Platelet (× 10^3/μL)	260 ± 53	217 ± 27	261 ± 53	0.159
CRP (mg/dL)	0.99 ± 3.65	1.0 ± 1.6	1.0 ± 3.8	0.987
AST (IU/L)	26 ± 16	27 ± 20	26 ± 23	0.900
ALT (IU/L)	26 ± 22	29 ± 26	21 ± 23	0.835
ALP (IU/L)	78 ± 18	85 ± 21	77 ± 18	0.470
Total bilirubin (mg/dL)	0.8 ± 0.4	0.5 ± 0.2	0.8 ± 0.4	0.199

Values are presented as number only, mean ± standard deviation, or number (%).
CT, computed tomography; WBC, white blood cell; Hb, hemoglobin; CRP, C-reactive protein; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; MRI, magnetic resonance imaging.

Figure 3 Two representative cases of critical illnesses with chest pain and abdominal pain



(A) Electrocardiogram tracing of paroxysmal supraventricular tachycardia from 24-hour Holter monitoring. Electrocardiogram revealed a heart rate above 180 beats/min with narrow QRS complexes and absence of P waves after a single atrial premature beat (black arrow). **(B)** Abdominal and pelvic computed tomography of acute appendicitis shows dilated appendix lumen (white arrow) filled with fluid and appendicolith and thickened and enhanced walls following the administration of intravenous contrast medium.

pain, or headache, a critical illness was diagnosed in 45 patients (5.9%). Chest pain was associated with the highest diagnostic rate of critical illness (17 of 205, 8.3%), while abdominal pain due to acute appendicitis was the most common critical disease entity (11 of 45, 24.4%). For chest pain, the presence of palpitations, dyspnea on exertion, duration exceeding 5 minutes, and squeezing-type pain were significantly associated with critical illness. For patients with abdominal pain, right-side tenderness was an alarming sign of critical disease. While the criticality was low for headaches (4 of 263, 1.5%), and half of patients with critical illness were incidentally diagnosed regardless of headache, neurologic examination was significantly associated with critical disease.

Our study is unique in that it was conducted with a population composed of previously healthy young males serving in the military. South Korea reflects a unique situation in which all healthy male citizens must serve in the military, so all enrolled patients were soldiers who had passed a previous medical examination during military enlistment. Therefore, the diseases detected in our patients are likely to have occurred sporadically in any population of healthy Korean males in their early twenties. However, the results should be interpreted cautiously, because this group of patients was obliged to join the military regardless of their own will and were placed in a restrained environment where they had to follow certain schedules and command structures. These stressful conditions might have affected patient psychiatric status and triggered somatization, leading to exaggerated symptoms [19-22]. Nevertheless, the results can serve as valuable data for critical illness in healthy young Korean males.

The risk factors analyzed for critical illness will be helpful for field military doctors and commanders to care for their sol-

diers. At a battalion's primary care site, field military doctors must depend on medical history and physical examination without any advanced diagnostic tools to distinguish critical from mild illness, and it is often challenging to transfer patients to a secondary care site due to the characteristics of the military. Chest pain, abdominal pain, and headache are well established as signs of critical illness [1,23,24], and our results are especially practical for military medicine in that the risk factors were gathered from soldiers in an actual clinical situation.

For critical illnesses associated with chest pain, arrhythmia was the most common and severe disease. Patients accompanied by palpitation and exertional dyspnea were associated with arrhythmias such as atrial fibrillation, ventricular tachycardia, and PSVT, and this result is consistent with a previous study with 24-hour electrocardiographic monitoring [25]. Supporting our result, a prospective study also revealed that palpitation was associated with arrhythmia in 40% of the patients diagnosed. Moreover, a German cohort study reported that palpitation and dyspnea accompanied by chest pain were associated with severe heart disease requiring treatment [26,27]. An increase in exercise volume through more intense training in the military than in daily life can cause other related symptoms in addition to chest pain. It is important to accurately select patients at risk of critical illness for transfer to a tertiary hospital based on the symptom complaints in environments where there is no special examination, such as in a field situation. Therefore, if a soldier has chest pain with palpitation, a field military doctor and a commander should consider transfer to a secondary care unit in which an electrocardiogram is available.

Right-side tenderness with abdominal pain was an alarming sign of critical illness. The right-side abdomen is anatomically more vulnerable to surgical diseases such as acute appendicitis and acute cholecystitis [28,29]. Indeed, acute appendicitis was the most common critical illness as a single disease entity in our analysis. Acute appendicitis can have a poor prognosis if diagnosis is delayed until perforation [30]. In the early stage, acute appendicitis is difficult to differentiate from acute gastroenteritis. According to our analysis, the presence of diarrhea could be a protective factor implying mild disease with a self-limiting course.

Patients complaining of headaches were mostly diagnosed with primary headaches. There were no cases of vascular or infectious origins that could be fatal, and tumorous conditions including pituitary adenoma and fibrous dysplasia were incidentally diagnosed. Our study showed a higher prevalence of abnormalities on brain imaging compared to a previous study with young healthy volunteers (13.6% vs 9.4%) but had a far lower diagnostic rate of critical illness (2.4% vs 5.2%) [31]. In particular, brain CT alone was sufficient to diagnose critical illness. This information could be meaningful to field clinicians in that it provides the prevalence of incidental findings if brain imaging is performed on patients who have headache. Considering that the prevalence of critical incidental findings is very low in patients with headaches [32], at a battalion's primary care site, neurologic examination should be carefully performed on patients, and nonsteroid anti-inflammatory agents could be tried first prior to transfer.

Our study has several limitations. The enrolled patients were all soldiers under stressful conditions, so psychiatric status might have affected the occurrence and severity of symptoms. Moreover, since Armed Forces Seoul District Hospital is mainly for soldiers guarding the capital, there were few febrile diseases. Considering that most of the armed forces in South Korea are near forests and mountains, febrile diseases should be ruled out when patients have such symptoms. Furthermore, due to the urban transportation system, transfer was relatively quick and accessible compared to transfer for field armies. Taken together, our results should not be generalized to field forces, and the judgment of field military doctors is paramount when deciding whether to transport patients to higher-level hospitals.

In conclusion, we showed the prevalence and risk factors associated with critical illness in male patients in their early twenties who were previously healthy. This study could provide a practical reference for field military doctors and commanders when deciding whether to transfer patients to a secondary hospital. We expect that further research on this topic would greatly contribute to the welfare and combat power of soldiers.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Jung M, Jang Y; Formal analysis: Song BG, Jung M; Visualization: Woo JH; Investigation: Song BG, Woo JH, Cho B, Lee HJ, Jung M, Jang Y; Resources: Song BG, Woo JH, Yoon HK, Jung M, Jang Y; Supervision: Jung M, Jang Y;

Writing– original draft: Song BG, Woo JH, Jung M, Jang Y; Writing–review and editing: all authors.

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