

# Standardized Approaches to Syncope Evaluation for Reducing Hospital Admissions and Costs in Overcrowded Emergency Departments

Tae Gun Shin,<sup>1</sup> June Soo Kim,<sup>2</sup> Hyoung Gon Song,<sup>3</sup> Ik Joon Jo,<sup>1</sup> Min Seob Sim,<sup>1</sup> and Seung-Jung Park<sup>2</sup>

<sup>1</sup>Department of Emergency Medicine, <sup>2</sup>Division of Cardiology, Department of Medicine, Cardiac and Vascular Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul;

<sup>3</sup>Executive Board Member of Public Relations, Korean Medical Association, Seoul, Korea.

Received: July 3, 2012

Revised: October 26, 2012

Accepted: October 29, 2012

Co-corresponding authors: Dr. June Soo Kim, Division of Cardiology, Department of Medicine, Cardiac and Vascular Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-ro, Gangnam-gu, Seoul 135-710, Korea.

Tel: 82-2-3410-3414, Fax: 82-2-3410-3417

E-mail: juneskim@skku.edu and

Dr. Hyoung Gon Song,

Executive Board Member of Public Relations, Korean Medical Association,

302-75 Ichon 1-dong, Yongsan-gu,

Seoul 140-721, Korea.

Tel: 82-2-794-2424, Fax: 82-2-792-1296

E-mail: cprkings@gmail.com

The authors have no financial conflicts of interest.

**Purpose:** The evaluation of syncope is often disorganized and ineffective. The objective of this study was to examine whether implementation of a standardized emergency department (ED) protocol improves the quality of syncope evaluation.

**Materials and Methods:** This study was a prospective, non-randomized study conducted at a 1900-bed, tertiary teaching hospital in South Korea. We compared two specific periods, including a 12-month observation period (control group, January-December 2009) and a 10-month intervention period after the implementation of standardized approaches, comprising risk stratification, hospital order sets and establishment of a syncope observational unit (intervention group, March-December 2010). Primary end points were hospital admission rates and medical costs related to syncope evaluation. **Results:** A total of 244 patients were enrolled in this study (116 patients in the control group and 128 patients in the intervention group). The admission rate decreased by 8.3% in the intervention group (adjusted odds ratio 0.31, 95% confidence interval 0.13-0.70,  $p=0.005$ ). There was a cost reduction of about 30% during the intervention period [369000 Korean won (KRW), interquartile range (IQR) 240000-602000 KRW], compared with the control period (542000 KRW, IQR 316000-1185000 KRW). The length of stay in the ED was also reduced in the intervention group (median: 4.6 hours vs. 3.4 hours). **Conclusion:** Standardized approaches to syncope evaluation reduced hospital admissions, medical costs and length of stay in the overcrowded emergency department of a tertiary teaching hospital in South Korea.

**Key Words:** Syncope, diagnosis, education, costs and cost analysis

## © Copyright:

Yonsei University College of Medicine 2013

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## INTRODUCTION

Syncope is a common clinical problem in the emergency department (ED), accounting for 3-5% of all ED visits and 1-6% of all hospital admissions.<sup>1-5</sup> Moreover, it has a substantial financial impact on health care and imposes a significant socio-economic burden.<sup>6,7</sup> The total annual costs for syncope-related hospital admissions

are estimated to be \$2.4 billion in the United States.<sup>8</sup>

The evaluation of syncope is often not standardized and ineffective.<sup>9,10</sup> Despite the recent publication of guidelines regarding appropriate and structured evaluation of syncope,<sup>2,11,12</sup> these guidelines have not been widely disseminated and are sometimes difficult to apply in clinical practice.<sup>9,13</sup> Even hospital-based education may be insufficient to ensure optimal evaluation. As a result, inappropriate diagnostic tests and unnecessary hospitalizations are frequent in the processes of diagnosing and managing syncope.<sup>14</sup>

Recently, several studies reported that the implementation of standardized care pathways significantly improved diagnostic yields and reduced the rate of hospital admissions as well as overall medical costs related to syncope evaluation.<sup>13,15-19</sup> However, to our knowledge, few have reported on improvements in the quality of syncope evaluation as a result of the implementation of standardized approaches in hospitals of different settings with limited medical resources in Asia.<sup>19</sup>

The aim of this study was to examine the effectiveness of a simple, standardized ED protocol comprising an educational program, risk stratification, hospital order sets, and establishment of a syncope observational unit at a tertiary-care hospital in South Korea.

## MATERIALS AND METHODS

### Study design and setting

This study was a prospective, nonrandomized study conducted at Samsung Medical Center, a 1900-bed, tertiary-care teaching hospital, with an annual ED census of 67000 visits, in Seoul, South Korea. We compared two specific periods: a 12-month observation period before the implementation of a standardized ED protocol (control group, January-December 2009) and a 10-month intervention period after protocol implementation (intervention group, March-December 2010). The study was approved by the hospital's institutional review board. Informed consent was obtained from all study participants or their legal designates.

### Selection of participants

Consecutive patients aged 18 years or older presenting to the ED with syncope were recruited to participate in the study. Syncope was defined as a sudden, transient loss of consciousness with spontaneous recovery due to transient global cerebral hypoperfusion.<sup>2,18</sup> Exclusion criteria were lack of

consent, previous enrollment in other studies, and non-syncope episodes such as lightheadedness, vertigo, hypoglycemia, seizure or stroke.

### Syncope evaluation in the observation period

Patients who visited the ED with syncope were evaluated without standardized guidelines or educational programs on proper syncope evaluation. There were no ED protocols for syncope or syncope observational unit. Clinical decisions were made largely by the ED resident or attending physician for each case.

### Syncope evaluation in the intervention period

Between January and February 2010, we conducted an educational program for physicians-in-training and ED faculty, including a 1-hour lecture. The educational program covered an initial evaluation for syncope, risk stratification, a standardized ED protocol, important electrocardiogram (ECG) findings and several clinical cases. The educational program and the ED protocol were largely based on the 2009 European Society of Cardiology (ESC) guidelines.<sup>2</sup> Risk stratification was conducted by initial history taking and evaluation in the ED. We defined "high risk" according to the ESC guidelines, summarized as follows: 1) severe structural heart disease or coronary heart disease, (1) heart failure, (2) low left ventricular ejection fraction, or (3) previous myocardial infarction; 2) clinical or ECG features suggesting arrhythmic syncope, (1) syncope during exertion or supine, (2) palpitations at the time of syncope, (3) family history of sudden cardiac death, (4) non-sustained ventricular tachycardia, (5) bifascicular-block or intraventricular conduction abnormalities with QRS duration  $\geq 120$  ms, (6) inadequate sinus bradycardia ( $< 50$  bpm) or sinoatrial block in the absence of negative chronotropic medications or physical training, (7) pre-excited QRS complex, (8) prolonged or short QT interval, (9) Brugada pattern, (10) ECG findings suggestive of arrhythmogenic right ventricular cardiomyopathy; or 3) important comorbidities (severe anemia, electrolyte disturbance). "Low risk" was defined as follows: 1) age  $< 50$  years, 2) no previous history of cardiovascular disease, 3) symptoms consistent with reflex-mediated or vasovagal syncope, 4) normal cardiovascular examination, and 5) normal ECG findings.<sup>18</sup> If patients were neither low nor high risk, they were categorized as "intermediate risk".

When patients visited the ED due to syncope, the ED physician obtained their clinical history and performed a

physical examination. After the ECG was performed, the ED physician stratified subjects into specific risk groups. Hospital order sets were provided according to risk. All order sets included regular vital sign checking, postural blood pressure evaluation, and order for initial evaluation at the ED. The order set for the low-risk group included a complete blood count and serum electrolytes (with or without blood chemistries depending on the physician's decision). For the intermediate and high-risk groups, blood chemistries were routinely assessed (glucose, blood urea nitrogen, creatinine, liver function tests). Continuous ECG monitoring, cardiac enzymes, and cardiologic consultation were added for the high-risk group. The sets were modified or tests were added depending on the patient's history, condition, or if further tests were deemed necessary by the physician.

Low-risk patients were discharged without further investigation in the ED and referred to the outpatient department (OPD) for additional evaluation, if needed. Outpatient follow-up was available for both the control and the intervention groups. We also recommended early follow-up and investigation for intermediate-risk patients who were stable and did not have any significant findings in the ED. All patients of high risk and patients of intermediate risk with significant findings in the ED were placed in a syncope observational unit in the ED, which consisted of two beds with continuous monitoring equipment for prompt and intensive monitoring of patients of high or intermediate risk. Unfortunately, the observational unit shared beds with a previously existing observational unit for coronary syndrome patients because of a severe overcrowding problem in the ED. However, during the observation period, no monitoring section was allowed to be used exclusively, and the ED bed-management protocol for patients with syncope, including decisions about which patients to monitor, was dependent on the physicians in charge without formal risk stratification. Additional tests including echocardiography, head-up tilt test, Holter monitoring, treadmill test, brain imaging, electroencephalography and carotid Doppler were performed at the ED or the OPD, according to the clinical decision of the emergency physicians or cardiologists based on the current ESC guidelines.<sup>2</sup> Coronary angiography, electrophysiological study and implantable loop recorder evaluations were performed after hospitalization, if appropriate. The on-duty cardiologist made decisions regarding whether or not to admit individual patients.

There were no differences in medico-sociological conditions or hospital policies between the two periods, except

the protocol for evaluation of syncope.

### End points and data collection

We evaluated two primary end points: hospital admission rates and medical costs. When patients were hospitalized after follow-up visits at the OPD, these hospitalizations were also included. Costs were calculated during diagnostic evaluation according to hospital accounting reports. Indirect costs such as loss of earnings or costs paid by patients at other hospitals were not evaluated. Costs are expressed in Korean won (KRW), the currency of South Korea (approximately 1000 won=1 United States dollar).

The secondary end points were ED length of stay (LOS), hospital LOS, rate of certain diagnosis, all-cause mortality and recurrent syncope during six-month follow-up. Certain diagnosis was recognized when the initial evaluation lead to a diagnosis based on symptoms, signs, ECG findings or when a suspected diagnosis was confirmed by direct testing.<sup>18</sup>

We prospectively collected data on each patient's demographic factors, comorbidities, family history, previous syncope episodes, presenting symptoms, risk stratification, syncope-related trauma, as well as diagnostic tests and procedures. The ED occupancy rate was also calculated in terms of enrolled patient visits.<sup>20</sup> Diagnoses were established based on previously described criteria:<sup>2,21</sup> neurally mediated, orthostatic hypotension, cardiac arrhythmia, structural cardiac, cerebrovascular, and unknown causes of syncope. Bony fractures, cerebral concussions and lacerations caused by syncopal episodes were defined as significant trauma. At the 6-month follow-up, recurrences of syncope and survival data were obtained through telephone interviews by a trained nurse coordinator.

### Power estimates and statistics

We expected to recruit 100 patients for each period according to previous data. If we assumed that a 20% difference in the hospital admission rate (30% vs. 10%) would be considered significant, the statistical power would be 92.5% (alpha error, 0.05). For a 15% difference in the admission rate, the estimated statistical power was 74.4 percent.

Continuous variables were expressed as the mean±standard deviation or the median (interquartile range, IQR). These variables were compared using Student's t-test or Wilcoxon's rank-sum test, while categorical variables were compared by chi-square test or Fisher's exact test. A multiple logistic regression analysis was used to estimate the adjusted odds ratio for hospitalization. A multiple linear re-

gression analysis was also performed to predict independent factors associated with total medical costs. In those multivariate models, we adjusted variables including age, gender, risk strata and syncope-related trauma. Stata version 12.0 (Stata Corp LP, College Station, TX, USA) was used to perform the statistical analyses, and two-tailed *p*-values <0.05 were considered to be significant.

## RESULTS

### Characteristics of the study subjects

A total of 281 eligible patients were identified. Among them, 37 patients who did not consent to participate were excluded (15 patients in the control group, 22 patients in the inter-

vention group). Finally, 244 patients were enrolled in this study (116 patients in the control group and 128 patients in the intervention group).

There were no significant differences in baseline characteristics between the two groups with the exception of age. The mean age of the intervention group was older than that of the control group (52.3±17.2 vs. 46.4±18.4, *p*=0.01). High-risk patients were slightly more frequent in the intervention group, but this difference was not statistically significant (18.7% vs. 10.3%, *p*=0.16). Neurally mediated syncope was the most common diagnosis in both groups (65.5% vs. 62.9%, *p*=0.35). The ED occupancy rates were very high for both periods (Table 1).

Fifty-five patients (47.4%) in the control group and 75 patients (58.5%) in the intervention group visited the OPD

**Table 1. Baseline Clinical Characteristics of the Control and Intervention Groups**

	All (n=244)	Control group (n=116)	Intervention group (n=128)	<i>p</i> value
Age (yrs)	49.5±18.2	46.4±18.4	52.3±17.2	0.010
Age >65 yrs	55 (22.5)	26 (22.4)	29 (22.6)	0.96
Male gender	122 (50.0)	58 (50.0)	64 (50.0)	1.00
Comorbidities				
Hypertension	64 (26.2)	28 (24.1)	36 (28.1)	0.49
Diabetes	24 (9.8)	11 (9.4)	13 (10.1)	0.86
Structural heart disease	15 (6.1)	8 (6.9)	7 (5.4)	0.64
Coronary disease	13 (5.3)	6 (5.1)	7 (5.4)	0.91
Arrhythmia*	15 (6.1)	9 (7.7)	6 (4.6)	0.31
Cerebrovascular disease	15 (6.1)	6 (5.1)	9 (7.0)	0.54
Chronic lung disease	3 (1.2)	0 (0)	3 (2.3)	0.24
Malignancy	7 (2.8)	4 (3.4)	3 (2.3)	0.60
Previous syncope	123 (50.4)	57 (49.1)	66 (51.5)	0.70
Prodromal symptom	187 (76.6)	93 (80.2)	94 (73.4)	0.21
Significant trauma	80 (32.8)	41 (35.3)	39 (30.5)	0.42
Risk stratification				0.16
High	36 (14.7)	12 (10.3)	24 (18.7)	
Low	83 (34.0)	43 (37.0)	40 (31.2)	
Intermediate	125 (51.2)	61 (52.5)	64 (50.0)	
Final diagnosis				0.35
Neurally mediated	157 (64.3)	73 (62.9)	84 (65.5)	
Orthostatic hypotension	24 (9.8)	9 (7.7)	15 (11.7)	
Cardiopulmonary	13 (5.3)	8 (6.2)	5 (4.3)	
Arrhythmia <sup>†</sup>	9 (3.6)	4 (3.4)	5 (3.9)	
Cerebrovascular	2 (0.8)	2 (1.7)	0 (0)	
Others	2 (0.8)	2 (1.7)	0 (0)	
Unexplained	37 (15.1)	21 (18.1)	16 (12.5)	
ED occupancy rate (%)	157 (134-186)	154 (135-185)	160 (133-188)	0.85

ED, emergency department.

Data are shown as mean±SD, median (interquartile range) or n (%).

\*In the control group, 6 patients had atrial fibrillation, 1 had second-degree atrioventricular block and 2 patients had sinus bradycardia. In the intervention group, 4 patients had atrial fibrillation and 2 patients had sinus bradycardia.

<sup>†</sup>In the control group, 1 patient had atrial fibrillation, 2 patients had high-degree atrioventricular block, and 1 patient had tachy-bradycardia syndrome. In the intervention group, 3 patients had atrial fibrillation, 1 patient had high-degree atrioventricular block and 1 patient had sick-sinus syndrome.

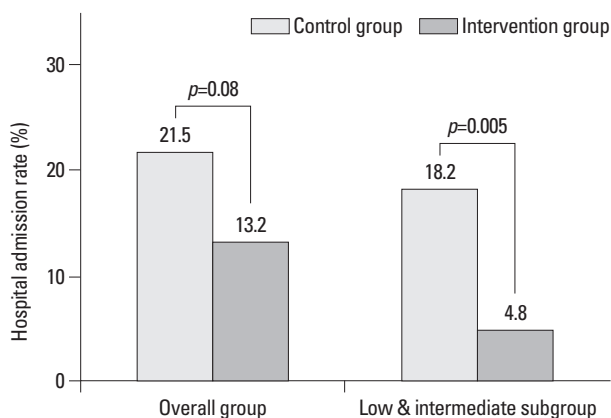
**Table 2.** Frequencies of Diagnostic Tests in Syncope Evaluation

	Control group (n=116)	Intervention group (n=128)	<i>p</i> value
Postural BP check	102 (87.9)	125 (97.6)	0.003
Electrocardiogram	116 (100)	128 (100)	1.00
Laboratory tests*	116 (100)	128 (100)	1.00
Cardiac enzymes	65 (56.0)	55 (42.9)	0.041
Echocardiography	54 (46.5)	54 (42.1)	0.49
Head-up tilt test	45 (38.7)	52 (40.6)	0.77
Carotid sinus massage	0 (0)	3 (2.3)	0.24
Holter recording	22 (18.9)	37 (28.9)	0.07
Electrophysiological study	3 (2.59)	2 (1.5)	0.67
Coronary angiography	6 (5.1)	6 (4.6)	0.54
Treadmill test	16 (13.7)	26 (20.3)	0.23
Brain CT scan	71 (61.2)	76 (59.3)	0.77
Brain MRI scan	13 (11.2)	8 (6.2)	0.16
Electroencephalography	10 (8.6)	3 (2.3)	0.029
Carotid Doppler	1 (0.9)	3 (2.3)	0.62
Implantable loop recorder	0 (0)	2 (1.5)	0.27

BP, blood pressure; CT, computed tomography; MRI, magnetic resonance imaging.

Data are shown as n (%).

\*Additional analysis showed that there was a significant reduction in the use of less informative tests for syncope evaluation, such as basic blood chemistry, d-dimer, C-reactive protein, creatine kinase, etc.



**Fig. 1.** Comparisons of hospital admission rates between the control and intervention groups.

after visiting the ED. The total numbers of OPD visits during the evaluation of syncope were 147 and 127, respectively. In the intervention group, the syncope unit treated a total of 37 patients (28.9%).

#### Diagnostic tests for the evaluation of syncope

Postural blood pressure measurement was more frequently performed in the intervention group than the control group (97.6% vs. 87.9%,  $p=0.003$ ). However, the use of cardiac enzymes and electroencephalography were lower in the intervention group than the control group, respectively (42.9% vs. 56.0%,  $p=0.041$ ; 2.3% vs. 8.6%,  $p=0.029$ ). The frequen-

cies of other diagnostic tests were not significantly different between the two groups (Table 2).

#### Primary endpoint-hospital admission rate

The admission rate decreased by 8.3% in the intervention group [unadjusted odds ratio (OR) 0.55, 95% confidence interval (CI) 0.28-1.09,  $p=0.08$ ]. In particular, the admission rate was reduced by 13.4% for low or intermediate-risk patients (unadjusted OR 0.22, 95% CI 0.08-0.63,  $p=0.005$ ) (Fig. 1). In the multivariate logistic regression test, membership in the intervention group was associated with a reduction in hospitalization after adjustment for potential confounding factors (OR 0.31, 95% CI 0.13-0.70,  $p=0.005$ ) (Table 3).

#### Primary endpoint-medical cost

There was a substantial cost reduction of about 30% in the intervention period (369000 KRW, IQR 240000-602000 KRW), compared with the control period (542000 KRW, IQR 316000-1185000 KRW). This difference was especially prominent when we compared the costs paid by low- or intermediate-risk patients, the costs at the ED, the costs paid by patients revisiting the OPD and the costs for diagnostic tests (Table 4). In the multivariate linear regression analysis of medical costs, membership in the intervention group was associated with decreased costs (coefficient



**Table 3. Univariate and Multivariate Analysis for Hospital Admissions**

Variable	Univariate		Multivariate	
	Odds ratio (95% CI)	<i>p</i> value	Odds ratio (95% CI)	<i>p</i> value
Age, per 10 yrs	1.29 (1.06-1.56)	0.009	1.02 (0.99-1.04)	0.13
Male gender	1.79 (0.90-3.54)	0.09	1.48 (0.69-3.19)	0.30
Risk (reference: low risk group)				
Intermediate risk	2.15 (0.81-5.69)	0.12	1.18 (0.34-4.07)	0.78
High risk	12.8 (4.46-36.92)	<0.001	10.5 (2.99-36.9)	<0.001
Significant trauma	0.75 (0.36-1.56)	0.45	0.73 (0.32-1.65)	0.46
Intervention group	0.55 (0.28-1.09)	0.08	0.31 (0.13-0.70)	0.005

CI, confidence interval.

**Table 4. Medical Costs during Syncope Evaluation**

	Control group (n=116)	Intervention group (n=128)	<i>p</i> value
Medical costs during syncope evaluation (1000 KRW)			
Cost per patient (all)	542 (316-1185)	369 (240-602)	<0.001
Cost per patient (patients who were followed at the outpatient department)	530 (361-819)	382 (259-548)	0.002
Cost per patient (hospitalized)	2464 (1377-7703)	2285 (1630-7469)	0.90
Cost per patient (low risk)	381 (288-616)	237 (126-386)	<0.001
Cost per patient (intermediate risk)	604 (329-1208)	380 (266-668)	0.003
Cost per patient (high risk)	1277 (723-2518)	637 (440-3374)	0.38
Cost per patient at the emergency department	429 (275-895)	313 (210-490)	<0.001
Cost for diagnostic tests	354 (213-553)	302 (106-517)	0.019

KRW, Korean won.

Data are shown as median (interquartile range) or n (%). The exchange rate used is roughly 1000 KRW for 1 United States dollar.

**Table 5. Univariate and Multivariate Linear Regression Analysis of Total Cost Per Patient**

Variable	Univariate		Multivariate	
	Coefficient (95% CI)	<i>p</i> value	Coefficient (95% CI)	<i>p</i> value
Age, per 10 yrs	363 (182 to 543)	<0.001	348 (161 to 580)	0.003
Male gender	268 (-401 to 939)	0.43	-112 (-758 to 533)	0.73
Risk (reference: low risk group)				
Intermediate risk	709 (10 to 1409)	0.047	-115 (-1029 to 798)	0.80
High risk	2791 (1805 to 3777)	<0.001	2202 (1098 to 3306)	<0.001
Significant trauma	303 (-406 to 1012)	0.40	365 (-296 to 1027)	0.27
Intervention group	-456 (-112 to 212)	0.18	-712 (-1341 to -83)	0.027

CI, confidence interval.

Unit: 1000 Korean won.

-712000 KRW, 95% CI -1341000 to -83000 KRW, *p*=0.027) (Table 5).

### Secondary endpoints

The ED LOS was significantly reduced in the intervention group, although the hospital LOS was not different between the two groups (median: 4.6 hours vs. 3.4 hours). There was an increasing trend in the rate of certain diagnosis in the intervention group, but it was not statistically significant.

During the six-month follow-up, three deaths were reported (1 patient in the control group and 2 patients in the intervention group). These were not unexpected events, as

they were deaths due to malignancies. Recurrent syncopal events were reported for 3 patients (one in the control group and two in the intervention group). Because very few adverse events were reported, we were unable to compare the two groups regarding this measure, although we did evaluate the outcomes of all patients through OPD visits or telephone interviews (Table 6).

## DISCUSSION

Although syncope is a commonly presenting symptom, the

**Table 6. Secondary Outcomes**

	Control group (n=116)	Intervention group (n=128)	p value
Length of stay			
ED length of stay (hrs)	4.6 (3.3-8.5)	3.4 (2.3-5.8)	<0.001
Hospital length of stay, admitted patients (days)	4 (2-8)	6 (3.5-7.3)	0.55
Certain diagnosis	70 (60.3)	88 (68.7)	0.17
All-cause mortality	2 (1.7)	1 (0.8)	0.50
Recurrent syncope	1 (0.8)	2 (1.7)	0.50

KRW, Korean won; ED, emergency department.

Data are shown as median (interquartile range) or n (%). The exchange rate used is roughly 1000 KRW for 1 United States dollar.

evaluation of syncope in the ED is often challenging and time-consuming, and may incur unnecessary health care costs and delays in the diagnostic process.<sup>6,7,22</sup> In our study, admission rates, medical costs and ED LOS were significantly reduced after the implementation of systematic approaches for syncope evaluation. We observed outcome improvements, particularly in low or intermediate-risk patients. These results have important clinical implications, as inappropriate admission, medical costs, and ED length of stay in the low and intermediate-risk patients were significantly reduced. Our results provide evidence for the importance of standardized evaluation and care for syncope in the ED.

Education alone may be insufficient to modify physician behavior, as local hospital education programs often do not lead to notable changes in the evaluation of syncope.<sup>9,23</sup> We hypothesized that a simple, organized approach would help to overcome this barrier. The educational program and protocol used in this study focused on initial risk stratification and evaluation in the ED. We also recommended that ED physicians use a hospital order set according to patient risk.

The effectiveness of a standardized order set in the evaluation of syncope has not yet been demonstrated. Such use may ensure that necessary procedures are performed and may allow for new practice changes.<sup>24</sup> Regarding diagnostic tests, we hypothesized that a standardized order set would have the positive effect of reducing the use of less specific tests for diagnosis and encourage the measurement of postural blood pressure during initial investigations. Our standardized order sets, however, were limited in the initial evaluation in the ED and should be optimized according to current evidence. Further study of a well-organized hospital order set and an extended decision-making system for additional testing are needed.

Although several methods for risk stratification have demonstrated prognostic value, there is no clear evidence that any method directly improves diagnostic accuracy or reduces costs; moreover, risk stratification methods may, in

fact, increase costs.<sup>2,15,18,25-27</sup> However, risk stratification may be useful if clinical evaluation is appropriately performed, depending on risk. Shen, et al.<sup>18</sup> showed that focused evaluation of intermediate-risk patients, based on a specific syncope unit, significantly improved diagnostic yield and reduced hospital admission.

The creation of formal syncope units may increase diagnostic yield and prevent unnecessary admissions and testing.<sup>15,17,18,28</sup> In our study, we were unable to fully evaluate the effectiveness of a dedicated syncope unit, because our unit was not exclusively used for syncope patients, and most tests and specialist assessments could be performed in other areas of the ED if clinically indicated.

One change that was made as a result of our study was the modification of the ED bed management policy. There was no established protocol for bed assignment of syncope patients during the control period, despite ED overcrowding. We hypothesized that the implementation of such a protocol would enable more rapid and safe monitoring and evaluation of high-risk or intermediate-risk patients. However, we anticipate that such protocols might have the negative effects of increasing ED LOS and costs in overcrowded EDs. Further investigations concerning the overall effects of dedicated syncope units in the ED are needed.

Unfortunately, there was no significant reduction in major adverse events. This is one of our study's main limitations. We, however, focused on the efficacy of care provision in acute settings. In addition, to the best of our knowledge, most previous studies showed similar outcomes: that there were significant improvements in admission rates, medical costs and diagnostic yields without long-term data or with no significant differences in long-term outcomes.<sup>13,17,18,22</sup>

There are several other limitations to this study. First, this study was a nonrandomized, single center study. Also, we compared the two patient groups on a historical basis, and our sample size was too small for sufficient statistical power to assess all end points. Additionally, we could not evalu-

ate whether or not our standardization procedure had any effect on morbidity and mortality. Therefore, our findings should be cautiously interpreted if considering similar implementation in other institutions. Second, we did not modify the diagnostic process outside the ED because our protocol was focused on ED evaluation. Hence, use of additional diagnostic tests was not strictly controlled. Further studies must be conducted after the adoption of a hospital-wide standardized protocol at our institution. Third, the approaches we used in our study might not be optimal and did not completely reflect the current guidelines, as we modified the guidelines to suit our hospital. For instance, basic blood tests and chest radiographs were conducted solely to prevent malpractice lawsuits, even when not clinically indicated. Fourth, we are unable to exclude the possibility that our findings resulted from a Hawthorne effect during the study period. Finally, we observed a difference in age between the two groups that might represent random variation or be associated with selection bias. However, we may have drawn the same conclusions after adjusting for potential confounders including age.

In conclusion, the implementation of standardized approaches to evaluate syncope reduced hospital admissions, medical costs and LOS in the overcrowded ED of a tertiary-care teaching hospital in South Korea.

## ACKNOWLEDGEMENTS

We would like to thank research nurses, Su Jin Bae and Hee Jung Park, in the clinical trial center of the Samsung Medical Center ED, as well as paramedics in the ED, including Hyun Yong Wi, for their assistance in data collection. We appreciate the provision of hospital accounting data by Jongsoo Seo, Manager, Department of Patient Affairs.

This study was supported by the Samsung Medical Center Clinical Research Development Program grant #CRS-109-35-2.

## REFERENCES

- Morichetti A, Astorino G. [Epidemiological and clinical findings in 697 syncope events]. *Minerva Med* 1998;89:211-20.
- Task Force for the Diagnosis and Management of Syncope; European Society of Cardiology (ESC); European Heart Rhythm Association (EHRA); Heart Failure Association (HFA); Heart Rhythm Society (HRS), Moya A, et al. Guidelines for the diagnosis and management of syncope (version 2009). *Eur Heart J* 2009;30:2631-71.
- Kenny RA, O'Shea D, Walker HF. Impact of a dedicated syncope and falls facility for older adults on emergency beds. *Age Ageing* 2002;31:272-5.
- Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ, et al. Incidence and prognosis of syncope. *N Engl J Med* 2002;347:878-85.
- Blanc JJ, L'Her C, Touiza A, Garo B, L'Her E, Mansourati J. Prospective evaluation and outcome of patients admitted for syncope over a 1 year period. *Eur Heart J* 2002;23:815-20.
- Chen LY, Benditt DG, Shen WK. Management of syncope in adults: an update. *Mayo Clin Proc* 2008;83:1280-93.
- Malasana G, Brignole M, Daccarett M, Sherwood R, Hamdan MH. The prevalence and cost of the faint and fall problem in the state of Utah. *Pacing Clin Electrophysiol* 2011;34:278-83.
- Sun BC, Emond JA, Camargo CA Jr. Direct medical costs of syncope-related hospitalizations in the United States. *Am J Cardiol* 2005;95:668-71.
- Sclafani JJ, My J, Zacher LL, Eckart RE. Intensive education on evidence-based evaluation of syncope increases sudden death risk stratification but fails to reduce use of neuroimaging. *Arch Intern Med* 2010;170:1150-4.
- Ammirati F, Colivicchi F, Santini M. Diagnosing syncope in clinical practice. Implementation of a simplified diagnostic algorithm in a multicentre prospective trial-the OESIL 2 study (Osservatorio Epidemiologico della Sincope nel Lazio). *Eur Heart J* 2000;21:935-40.
- Strickberger SA, Benson DW, Biaggioni I, Callans DJ, Cohen MI, Ellenbogen KA, et al. AHA/ACCF Scientific Statement on the evaluation of syncope: from the American Heart Association Councils on Clinical Cardiology, Cardiovascular Nursing, Cardiovascular Disease in the Young, and Stroke, and the Quality of Care and Outcomes Research Interdisciplinary Working Group; and the American College of Cardiology Foundation: in collaboration with the Heart Rhythm Society: endorsed by the American Autonomic Society. *Circulation* 2006;113:316-27.
- Huff JS, Decker WW, Quinn JV, Perron AD, Napoli AM, Peeters S, et al. Clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with syncope. *Ann Emerg Med* 2007;49:431-44.
- Brignole M, Ungar A, Bartoletti A, Ponassi I, Lagi A, Mussi C, et al. Standardized-care pathway vs. usual management of syncope patients presenting as emergencies at general hospitals. *Europace* 2006;8:644-50.
- Brignole M, Malasana G, Sherwood RP, Daccarett M, Jetter TL, Hamdan MH. Evaluation of patients with "faint" in an American teaching hospital: a dire need for a standardized approach. *Pacing Clin Electrophysiol* 2011;34:284-90.
- Sheldon RS, Morillo CA, Krahn AD, O'Neill B, Thiruganasambandamoorthy V, Parkash R, et al. Standardized approaches to the investigation of syncope: Canadian Cardiovascular Society position paper. *Can J Cardiol* 2011;27:246-53.
- Elesber AA, Decker WW, Smars PA, Hodge DO, Shen WK; American College of Emergency Physicians. Impact of the application of the American College of Emergency Physicians recommendations for the admission of patients with syncope on a retrospectively studied population presenting to the emergency department. *Am Heart J* 2005;149:826-31.
- Ammirati F, Colaceci R, Cesario A, Strano S, Della Scala A, Col-



- angelo I, et al. Management of syncope: clinical and economic impact of a Syncope Unit. *Europace* 2008;10:471-6.
18. Shen WK, Decker WW, Smars PA, Goyal DG, Walker AE, Hodge DO, et al. Syncope Evaluation in the Emergency Department Study (SEEDS): a multidisciplinary approach to syncope management. *Circulation* 2004;110:3636-45.
  19. Li YW, Chen L, Du JB, Yang YY, Jin HF. Cost-effectiveness of diagnostic approaches to vasovagal syncope. *Chin Med J (Engl)* 2010;123:2635-9.
  20. McCarthy ML, Aronsky D, Jones ID, Miner JR, Band RA, Baren JM, et al. The emergency department occupancy rate: a simple measure of emergency department crowding? *Ann Emerg Med* 2008;51:15-24, 24.e1-2.
  21. Brignole M, Alboni P, Benditt DG, Bergfeldt L, Blanc JJ, Thomsen PE, et al. Guidelines on management (diagnosis and treatment) of syncope-update 2004. Executive Summary. *Eur Heart J* 2004;25:2054-72.
  22. Fedorowski A, Burri P, Juul-Möller S, Melander O. A dedicated investigation unit improves management of syncopal attacks (Syncope Study of Unselected Population in Malmo--SYSTEMA I). *Europace* 2010;12:1322-8.
  23. Blanc JJ, L'her C, Gosselin G, Cornily JC, Fatemi M. Prospective evaluation of an educational programme for physicians involved in the management of syncope. *Europace* 2005;7:400-6.
  24. Thiel SW, Asghar MF, Micek ST, Reichley RM, Doherty JA, Kollef MH. Hospital-wide impact of a standardized order set for the management of bacteremic severe sepsis. *Crit Care Med* 2009;37:819-24.
  25. Gabayan GZ, Derose SF, Asch SM, Chiu VY, Glenn SC, Mangione CM, et al. Predictors of short-term (seven-day) cardiac outcomes after emergency department visit for syncope. *Am J Cardiol* 2010;105:82-6.
  26. Serrano LA, Hess EP, Bellolio MF, Murad MH, Montori VM, Erwin PJ, et al. Accuracy and quality of clinical decision rules for syncope in the emergency department: a systematic review and meta-analysis. *Ann Emerg Med* 2010;56:362-73.e1.
  27. Reed MJ, Newby DE, Coull AJ, Prescott RJ, Jacques KG, Gray AJ. The ROSE (risk stratification of syncope in the emergency department) study. *J Am Coll Cardiol* 2010;55:713-21.
  28. Brignole M, Ungar A, Casagrande I, Gulizia M, Lunati M, Ammirati F, et al. Prospective multicentre systematic guideline-based management of patients referred to the Syncope Units of general hospitals. *Europace* 2010;12:109-18.