Am J Cardiovasc Dis 2019;9(6):127-133
www.AJCD.us /ISSN:2160-200X/AJCD0102869

Original Article

Role of echocardiography in diagnostic evaluation of patients admitted to observation unit

Muhammad Arslan Cheema[1], Hafez Mohammad Ammar Abdullah[3], Waqas Ullah[1], Yasar Sattar[4], Shujaul Haq[1], Khadija Cheema[1], Asrar Ahmad[1], Zain Ali[1], Asoka Balaratna[2]

[1]Internal Medicine, [2]Cardiology, Abington-Jefferson Health, 1200 Old York Road, Abington, PA 19001, USA; [3]Internal Medicine, University of South Dakota, Sioux Falls, SD 57107, USA; [4]Internal Medicine, Icahn School of Medicine at Mount Sinai-Elmhurst Hospital, 79-01 Broadway Elmhurst, Queen, NY 11373, USA

Received September 26, 2019; Accepted November 25, 2019; Epub December 15, 2019; Published December 30, 2019

Abstract: Background: Syncope is a transient loss of consciousness due to transient decrease in cerebral perfusion. Syncope accounts for a 3-6% of all emergency department visits. Etiology of syncope can be neural, cardiogenic, or vascular. Previous studies have evaluated the types and management of syncope. Echocardiography is a commonly used test in the evaluation of causes of syncope. Whether the benefit compared to financial burden of this diagnostic study is in all subsets of syncope cases remains unclear. Aim: To evaluate the impact of echocardiography in the diagnostic evaluation of syncope and to evaluate the subset of patients that would benefit more from this diagnostic imaging. Methods: We performed a retrospective chart review of patients > 18 years of age with a primary diagnosis of syncope in a period of January 1st 2015-January 31st 2017. Our inclusion criteria included patients > 18 years of age who were admitted to the observation floor with the primary complaint as syncope, had a normal or abnormal physical examination for syncope, had a normal or abnormal electrocardiogram during admission, had an echocardiography performed at admission. Our exclusion criteria included patients with seizures, hypoglycemia, myocardial infarction, patients who didn't get echocardiography, and patients who had a positive marker of cardiac injury. Results: A total of 369 patients were initially identified with a primary diagnosis of syncope, however only 120 of these patients fulfilled our inclusion and exclusion criteria. A total of n=25 of included patients had either an abnormal physical exam or abnormal echocardiography. Among this "high risk" group, 24% (n=6) of the patients had an abnormal finding on their transthoracic echocardiography. On the other hand, in the "low risk" group with a normal physical examination and electrocardiogram (EKG), 14 had a trans-thoracic echocardiography (TTE) positive for cause of syncope, that led to a change in medication, workup, or intervention in 6.7% (n=8) of the patients. Conclusion: The analysis of our study suggested that the diagnostic yield of transthoracic echocardiography in syncope is very limited in the absence of an abnormal physical exam or electrocardiogram, and it increase the health care cost burden with no additional benefits.

Keywords: Syncope, echocardiography, diagnostic evaluation, observation unit, treatment, outcome

Introduction

Syncope is a form of temporary loss of consciousness with no focal neurologic deficits. It is usually secondary to a transient decrease in the blood supply of the brain resulting in loss of the ability to maintain posture. Syncope is oftentimes self-resolving and doesn't require any intervention [1]. Syncope accounts for up to 3-6% of ED visits. Out of all syncope presentations to the emergency department, 40% of these patients get admitted. In admitted patients, a detailed workup is usually a practice of most of hospitals [2-4]. Furthermore, the recurrence rate of syncope admission cases accounts for up to 35% [4]. In addition, the lifetime probability of getting syncope is 42% in a lifespan of 70 years that results in an annual incidence rate of 6% [5]. The incidence of syncope increases exponentially with an increase in age. Syncope was reported to occur in 15% of the patients < 18 years of age, and around 23% in age > 18 years [6, 7]. A reported incidence of syncope in patients age > 60-69 is 5.7 episodes/1000 people per year and for patients > 70 years is 11.1/10000 people per year [7-9].

In patients > 80 years of age, the annual incidence of syncope reaches up-to 19.5 episodes/1000 people [9].

Syncope is broadly divided into neurogenic, vascular, and cardiogenic. A combination of a physical examination, orthostatic vitals, and an electrocardiogram play a key role in diagnosis of syncope and its subtypes. A complete history/physical examination holds a great significance in categorizing the type of syncope, and should include the presence of precipitating factors, presence of prodrome, association with a change in posture, trauma, associated symptoms including palpitation, dyspnea, chest pain, cyanosis, nausea, and vomiting [4]. Physical examinations should include orthostatic vitals over the 3-5 minute gap between sitting and standing, along with a cardiovascular and detailed neurological examination [4]. Physical examinations should also be focused to rule out secondary causes of loss of consciousness including seizures, metabolic abnormalities, stroke, and trauma. The electrocardiogram holds a great significance in ruling out cardiovascular causes of syncope [3, 4]. The role of echocardiography in diagnostic evaluation of all cases of syncope remains unclear, specifically in routine evaluation. Only studies justified its routine evaluation in cases of syncope by history, physical examination, and electrocardiogram.

Our analysis is focused to see the results of echocardiography in all cases of syncope, and correlate whether all cases should get a baseline echocardiography on admission. Our study also evaluated the frequency of ordering echocardiography in patients with syncope and normal physical exams and electrocardiograms in the observation unit.

Materials and methods

Ethical considerations

This study was designed with the combined knowledge and expertise of faculty of Abington-Jefferson Health. This study strictly follows the Helsinki Ethical guidelines for animals and humans. It also maintains the confidentiality of the participants.

Patient populations and definitions

We performed a retrospective observational cohort study to determine the frequency of ordering echocardiography in patients with syncope on the observation floor and who have a normal physical exam and electrocardiogram, and the frequency of positive findings in this population group. We included all the patients who were over 18 years of age that were admitted to our observation floor with the primary diagnosis of syncope from January 1st, 2015 to January 31st, 2017. Inclusion criteria also constitutes of patients who got electrocardiogram and echocardiography. Abnormal EKG findings include arrhythmia, Q waves, ischemic changes, 2nd/3rd degree AV block, paced rhythm, QTc > 500 ms, left bundle branch block, bi-fascicular block, Abnormal Axis, and Brugada pattern. Abnormal echocardiography includes right/left ventricular hypertrophy, right/left ventricular dysplasia, valvular dysfunction including stenosis or regurgitation, and low left/right ventricular ejection fraction. Included patients also constitutes of normal or abnormal physical exam. A physical exam that constitutes abnormal criteria includes jugular venous distention, systolic/diastolic murmurs, S3, S4, and loud S1. Exclusion criteria included patients whose symptoms could be explained by other medical conditions like seizures, hypoglycemia, and MI, patient who were transferred to acute care, patients who left against medical advice, patients who did not get an echocardiogram, and patients who had positive cardiac biomarkers. Our study population after applying the inclusion and exclusion criteria was 120 patients. The demographic and clinical characteristics of these patients were taken into account.

Study population

Among the patient population in hospital location, age, and gender variables were studied. Among this population, the following comorbidities were studied: hypertension, diabetes mellitus, prior myocardial infarction, prior percutaneous intervention, chronic kidney disease, prior cardiovascular accident, peripheral vascular disease, anemia, and prior syncope.

Statistical analyses

Descriptive analysis was utilized to describe the population with syncope and echocardiography. A mean + SD was reported for continuous variables. A percentage and absolute numbers were used for categorical variables. In order to test for difference in the proportion of the variables, Fischers exact test was used.

Table 1. This table depicts the demographic variables of a study sample

Patient demographics	Percentage (%)
Total patient population	120 (100%)
Age > 65 years	54.2%
Age < 65 years	45.8%
Males	45.8%
Females	54.2%

Table 2. This table depicts the associated comorbidities in our patients

Risk factors	Number of patients (total n=120)	Percentage of the population
Hypertension	61	50.8%
Diabetes Mellitus	39	32.5%
Chronic Kidney Disease	23	19.2%
Prior Myocardial infarction	22	18.3%
Prior syncope	20	16.7%
Prior percutaneous intervention	20	16.7%
Prior cerebrovascular accident	4	3.3%
Peripheral vascular disease	0	0%
Anemia	0	0%

Table 3. This table depicts the physical exam findings and abnormal vitals in our patient population

Parameters	Percentage of the population (total n=120)	
	Normal	Abnormal
Physical Exam	84.2% (n=101)	15.8% (n=19)
Orthostatic vitals	98.3% (n=118)	1.7% (n=2)

Table 4. This table depicts the rhythm abnormalities in our patient population

EKG findings	Number of patients (total n=120)	Percentage of the population
Normal Sinus Rhythm	99	82.5%
Atrial fibrillation	8	6.7%
Atrial flutter	0	0%
LBBB	2	1.7%
RBBB	0	0%

Results

The analysis of our study involved patient population with an age greater or less than 65 years, and admitted to the observation unit for syncope evaluation. A total of 120 patients meet our inclusion criteria for syncope evaluation on observation floor. Among the sample of 120 patients, 54.2% were above 65 years of age, 45.8% were under 65 years of age. The gender difference of included sample showed that 45.8% were males, and 54.2% were females. A demographic variable of patient population is shown in **Table 1**.

The included study population also had secondary comorbid. A subgroup analysis of co-morbidities showed hypertension as a most prevalent among study sample with up-to 50.8% prevalence. The prevalence of other comorbidities includes diabetes (32.5%), chronic kidney disease (19.2%), prior myocardial infarction (18.3%), prior percutaneous intervention (16.7%), prior syncope (16.7%), prior cerebrovascular event (3.3%). Furthermore, our study sample didn't have any patients with anemia, or peripheral vascular disease. A co-morbidities analysis is shown in **Table 2**.

To subcategories the patients that need further testing, we subcategories the patients with abnormal physical exam, and abnormal orthostatic vitals. Our sample mostly had a normal physical exam in 84.2% of the patients and only 15.8% of patients had an abnormal exam including heart murmurs, with no carotid bruit. Further review, also showed that 98.3% of patients had normal orthostatic vitals. Only 2 patients in our sample had abnormal orthostatic vitals. The analysis of physical exam, and orthostatic vitals are shown in **Table 3**.

Analysis of electrocardiogram review in out patient population showed that 82.5% (n=99) of the patients had a normal baseline sinus rhythm with no arrythmias. Arrythmias prevalence review in our sample includes atrial fibrillation (6.7%, n=8), left bundle branch block (1.7%, n=2), with no right bundle branch block, or any other arrythmias. An analysis of EKG findings is shown in **Table 4**.

Analysis of echocardiographic review of our patient sample showed aortic stenosis as a most common echocardiographic finding in our sample with a prevalence of 18.3%, n=22. Other percentage of echocardiographic findings include mitral regurgitation (5.8%, n=7), left ventricular systolic dysfunction (5%, n=6),

Table 5. This table depicts the echo findings in our patient population

Echocardiographic findings	Number of patients (total n=120)	Percentage of the population
Aortic Stenosis	22	18.3%
Mitral Regurgitation	7	5.8%
Left ventricular systolic dysfunction (LVEF < 50%)	6	5%
Aortic Regurgitation	1	0.8%
Mitral Stenosis	0	0%

Table 6. Patient outcomes with a positive echocardiographic finding

Treatment/Procedure performed	Frequency	Out of total sample
Cath performed	98.4%	1.6%
Medication review, management workup, or further workup	93.44%	6.66%

Table 7. This table depicts the prevalence of positive TTE findings in both the normal and abnormal physical exam findings groups

Physical exam normal/abnormal	echocardiography positive	echocardiography negative	Total patients n=120
Normal	7/99 (7%)	93/99 (93%)	n=99 (84.2%)
Abnormal	3/21 (15%)	17/21 (85%)	n=21 (15.8%)

Table 8. This table depicts the subgroup analysis comparison in patients with a positive TTE

Difference between positive TTE findings in various groups	Significance level
Murmur Positive vs no Murmur (Physical exam findings??)	P=0.01
Abnormal EKG vs Normal EKG	P=0.046
Orthostatic Vitals vs no Orthostatic vitals	P=1.000
Prior PCI vs no Prior PCI	P=0.059

aortic regurgitation (0.8%, n=1), and no mitral stenosis, or other valvular or cardiac pathologies. The echocardiographic findings analysis is shown in **Table 5**.

For management of our patient sample, 2 patients (1.6%) with new LBBB got cardiac catheterization performed for evaluation of ischemia. Other patients of syncope on observation floor were managed symptomatically by medication review, controlling inciting agent, or further workup in only 6.66% (n=8). The patient outcome of management/workup of positive echocardiographic and EKG findings are shown in **Table 6**.

In our study sample, head to head review of electrocardiogram and echocardiographic findings of a study sample depicted 15% (n=3) of the patients had a positive EKG and echocardiographic findings for syncope cause with a statistically significant results (P=0.001). Furthermore, 7% (n=7) of patients had an abnormal echocardiographic finding with a normal EKG. Analysis of echocardiographic and physical examination is shown in **Table 7**.

A subgroup difference was also evaluated in positive TTE sample. The patients with a positive TTE findings with a murmur vs no murmur (P=0.01), abnormal EKG vs normal EKG (P=0.046), and prior PCI vs no PCI (P=0.05). The results of positive TTE findings, and subgroup of orthostatic vitals abnormal vs normal orthostatic vitals were not statistically significant (P=1.00) likely 2/2 to low population sample. The analysis of subgroup difference of findings is shown in **Table 8**.

Discussions

Syncope is a condition where the blood supply to the brain is reduced for various reasons, and results in an inability to maintain postural tone for a while. It has many causes, though they can be broadly classified into 4 main categories. These are reflex syncope or neural syncope, orthostatic syncope, cardiac arrhythmia, and cardiopulmonary disease leading to syncope. Some other conditions that can present

similarly but need to be differentiated from syncope include seizure disorders, accidental falls, sleep disturbances, and conversion disorder. Most of the causes of syncope are relatively benign, besides the risks inherent to falls. Cardiac syncope which includes syncope from vascular disease, cardiomyopathy, arrhythmias, and valvular dysfunction, may be associated with increased mortality and need more attention. The other causes of syncope do not increase mortality on their own, but can result in significant morbidity and disability due to accidents and falls that may occur as a result [10]. Besides this, there is also the social impact including the worsening of the quality of life, and the economic impact due to hospitalizations. It is estimated that this cost may be up to 2.4 billion dollars annually [11].

All cases of syncope need to be further evaluated, to rule out any underlying sinister pathology and to help prevent recurrence. This evaluation usually starts with a detailed history focused but not limited to asking about the symptoms onset, any inciting factor(s), any symptoms just prior to the episodes, and also the past medical history. This is usually followed by checking orthostatic vitals and a detailed physical exam also focused on the cardiovascular and neurologic systems, and to identify any hidden trauma. Many of the cases of syncope like vasovagal and orthostatic hypotension can easily be identified based on history and a physical exam. Many other cases however require further evaluation and workup. This usually entails some form of cardiac workup, and usually starts with an electrocardiogram. Some of the arrhythmias can be detected by this, however, paroxysmal arrhythmias may not be picked up by a 12-lead EKG. Such patient may require further evaluation with a holter monitor or a loop recorder if the index of suspicion is high. An electrocardiogram on the other hand will not help much with the diagnosis of syncope secondary to structural heart disease or cardiopulmonary disease. These patients would need to undergo an evaluation by a transthoracic echocardiography (TTE).

Syncope patients who are suspected to have a cardiac origin of their syncope usually also undergo transthoracic echocardiography [12]. It can be helpful in both finding the underlying cause and also stratifying the severity of any underlying cardiac lesion, like hypertrophic cardiomyopathy, aortic stenosis, and left ventricular dysfunction [13-15]. It is one of the most useful imaging modalities for evaluating the severity of an underlying cardiac disease, and also the risk stratification of patients who have unexplained syncope. It is especially useful in patients who have an abnormal electrocardiogram or patients with a known positive cardiac history [16]. The exact role of echocardiography in the workup of syncope is still not clear, especially in syncope patients who do not have any known history of cardiac conditions and no indication of cardiac pathology in their history, physical examination, and initial workup of syncope [17, 18]. On the other hand, in patients with an abnormal electrocardiogram or cardiac history, a transthoracic echo is usually recommended as part of the evaluation of syncope [19, 20]. Due to the significant use of financial and manpower resources associated with echocardiography, studies have been previously conducted to elucidate the role of echocardiography in syncope patients. There have been attempts to better streamline the approach of doing echocardiography in patients presenting with syncope [21, 22].

Transthoracic echocardiography is used widely in clinical practice as a screening tool to rule out valvular or structural heart disease in patients who present with syncope. It is especially significant in patients who have underlying cardiomyopathy and present with unexplained syncope and also have abnormal findings on their physical exam or an abnormal electrocardiogram. Transthoracic echocardiography on the other hand in patients with a normal physical exam and normal electrocardiogram is not a very high yield, and it adds to the additional cost to the patient. Transthoracic echocardiography costs around 1000 dollars on average in the US. Inappropriately performed transthoracic echocardiogram may increase the cost of healthcare.

Though the role of transthoracic echo is well established in patients who have some underlying cardiac disease, however there have been questions regarding the utility of echocardiography in other patient groups. Current ACC/AHA guidelines recommend that all the patients who have a positive cardiac history, or have findings in the patient's history and physical, are recommended to undergo a transthoracic echocardiography [23, 24].

There have been studies done previously to better elucidate the role of transthoracic echocardiography in syncope. Recchia et al described a retrospective review in which they found that 48% of the patients who had a suspected cardiac origin of the syncope based on history, physical exam, or electrocardiogram had an abnormal transthoracic echo [21]. The abnormal echo was not necessarily the underlying reason for the syncope.

Sarasin et al in another prospective study of 650 patients, found that 24 out of 88 patients found to have an abnormal electrocardiogram were also found to have left ventricular systolic dysfunction on echocardiography. A clinically significant arrhythmia was also present in around half of the patients [12]. Our study also indicates that echocardiography is more useful and has a higher yield in high risk patients. As such, our study is consistent with previous studies described above.

Limitations

Our retrospective study is small and is not as significant as a large prospective study would be. Secondly, the physical exam findings and echocardiogram reads can be variables between different examiners. Also, the diagnosis of syncope can be subjective and was based on patient reported symptoms in our study. One other limitation was that we did not have any follow up with our patients after discharge.

Conclusion

In conclusion, TTE has a low diagnostic yield in patients with normal physical exams/electrocardiograms and a high diagnostic yield in patients with abnormal physical examinations/electrocardiograms respectively.

Acknowledgements

IRB (FWA0000-4123) was approved by Abington Jefferson Health. We would like to acknowledge for his continuation of efforts to enhance research among faculty members.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Waqas Ullah, Internal Medicine, Abington-Jefferson Health, 1200 Old York Road, Abington, PA 19001, USA. Tel: 126-737-7541; E-mail: waqasullah.dr@gmail.com

References

[1] Walsh K, Hoffmayer K and Hamdan MH. Syncope: diagnosis and management. Curr Probl Cardiol 2015; 40: 51-86.

[2] Kapoor WN. Syncope. N Engl J Med 2000; 343: 1856-1862.

[3] Colman N, Nahm K, Ganzeboom KS, Shen WK, Reitsma J, Linzer M, Wieling W and Kaufmann H. Epidemiology of reflex syncope. Clin Auton Res 2004; 14 Suppl 1: 9-17.

[4] da Silva RM. Syncope: epidemiology, etiology, and prognosis. Front Physiol 2014; 5: 471.

[5] 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, Sutton R, Ammirati F, Blanc JJ, Brignole M, Dahm JB, Deharo JC, Gajek J, Gjesdal K, Krahn A, Massin M, Pepi M, Pezawas T, Ruiz Granell R, Sarasin F, Ungar A, van Dijk JG, Walma EP and Wieling W. Guidelines for the diagnosis and management of syncope (version 2009). Eur Heart J 2009; 30: 2631-2671.

[6] Lewis DA and Dhala A. Syncope in the pediatric patient. The cardiologist's perspective. Pediatr Clin North Am 1999; 46: 205-219.

[7] Serletis A, Rose S, Sheldon AG and Sheldon RS. Vasovagal syncope in medical students and their first-degree relatives. Eur Heart J 2006; 27: 1965-1970.

[8] Lipsitz LA, Wei JY and Rowe JW. Syncope in an elderly, institutionalised population: prevalence, incidence, and associated risk. Q J Med 1985; 55: 45-54.

[9] Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ and Levy D. Incidence and prognosis of syncope. N Engl J Med 2002; 347: 878-885.

[10] Ungar A, Mussi C, Nicosia F, Ceccofiglio A, Bellelli G, Bo M, Riccio D, Landi F, Martone AM, Langellotto A, Ghidoni G, Noro G and Abete P. The "syncope and dementia" study: a prospective, observational, multicenter study of elderly patients with dementia and episodes of "suspected" transient loss of consciousness. Aging Clin Exp Res 2015; 27: 877-882.

[11] Sun BC. Quality-of-life, health service use, and costs associated with syncope. Prog Cardiovasc Dis 2013; 55: 370-375.

[12] Sarasin FP, Louis-Simonet M, Carballo D, Slama S, Rajeswaran A, Metzger JT, Lovis C, Unger PF and Junod AF. Prospective evaluation of patients with syncope: a population-based study. Am J Med 2001; 111: 177-184.

[13] Middlekauff HR, Stevenson WG, Stevenson LW and Saxon LA. Syncope in advanced heart failure: high risk of sudden death regardless of origin of syncope. J Am Coll Cardiol 1993; 21: 110-116.
[14] Bachinsky WB, Linzer M, Weld L and Estes NA 3rd. Usefulness of clinical characteristics in predicting the outcome of electrophysiologic studies in unexplained syncope. Am J Cardiol 1992; 69: 1044-1049.
[15] Krol RB, Morady F, Flaker GC, DiCarlo LA Jr, Baerman JM, Hewett J and de Buitleir M. Electrophysiologic testing in patients with unexplained syncope: clinical and noninvasive predictors of outcome. J Am Coll Cardiol 1987; 10: 358-363.
[16] Sarasin FP, Junod AF, Carballo D, Slama S, Unger PF and Louis-Simonet M. Role of echocardiography in the evaluation of syncope: a prospective study. Heart 2002; 88: 363-367.
[17] Linzer M, Yang EH, Estes NA 3rd, Wang P, Vorperian VR and Kapoor WN. Diagnosing syncope. Part 1: value of history, physical examination, and electrocardiography. Clinical efficacy assessment project of the American college of physicians. Ann Intern Med 1997; 126: 989-996.
[18] Cheitlin MD, Alpert JS, Armstrong WF, Aurigemma GP, Beller GA, Bierman FZ, Davidson TW, Davis JL, Douglas PS and Gillam LD. ACC/AHA guidelines for the clinical application of echocardiography. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Clinical Application of Echocardiography). Developed in collaboration with the American Society of Echocardiography. Circulation 1997; 95: 1686-1744.
[19] Brignole M, Alboni P, Benditt DG, Bergfeldt L, Blanc JJ, Bloch Thomsen PE, van Dijk JG, Fitzpatrick A, Hohnloser S, Janousek J, Kapoor W, Kenny RA, Kulakowski P, Masotti G, Moya A, Raviele A, Sutton R, Theodorakis G, Ungar A and Wieling W; Task Force on Syncope, European Society of Cardiology. Guidelines on management (diagnosis and treatment) of syncope--update 2004. Europace 2004; 6: 467-537.
[20] Shen WK, Sheldon RS, Benditt DG, Cohen MI, Forman DE, Goldberger ZD, Grubb BP, Hamdan MH, Krahn AD, Link MS, Olshansky B, Raj SR, Sandhu RK, Sorajja D, Sun BC and Yancy CW. 2017 ACC/AHA/HRS guideline for the evaluation and management of patients with syncope: a report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines and the Heart Rhythm Society. Circulation 2017; 136: e60-e122.
[21] Recchia D and Barzilai B. Echocardiography in the evaluation of patients with syncope. J Gen Intern Med 1995; 10: 649-655.
[22] Panther R, Mahmood S and Gal R. Echocardiography in the diagnostic evaluation of syncope. J Am Soc Echocardiogr 1998; 11: 294-298.
[23] Chiu DT, Shapiro NI, Sun BC, Mottley JL and Grossman SA. Are echocardiography, telemetry, ambulatory electrocardiography monitoring, and cardiac enzymes in emergency department patients presenting with syncope useful tests? A preliminary investigation. J Emerg Med 2014; 47: 113-118.
[24] American College of Cardiology Foundation Appropriate Use Criteria Task Force; American Society of Echocardiography; American Heart Association; American Society of Nuclear Cardiology; Heart Failure Society of America; Heart Rhythm Society; Society for Cardiovascular Angiography and Interventions; Society of Critical Care Medicine; Society of Cardiovascular Computed Tomography; Society for Cardiovascular Magnetic Resonance, Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, Picard MH, Polk DM, Ragosta M, Ward RP and Weiner RB. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 appropriate use criteria for echocardiography. A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance Endorsed by the American College of Chest Physicians. J Am Coll Cardiol 2011; 57: 1126-1166.