

Original Article

The role of echocardiography in diagnostic evaluation of patients with syncope-a retrospective analysis

Ali Raza Ghani¹, Waqas Ullah¹, Hafez Mohammad Ammar Abdullah², Yasar Sattar³, Usman Sarwar¹, Irfan Ahsan¹, Wajahat Humayun⁴

¹Internal Medicine, Abington-Jefferson Health, Abington, PA, USA; ²Internal Medicine University of South Dakota, Sioux Falls, USA; ³Icahn School of Medicine at Mount Sinai-Elmhurst Hospital, Queens, NY, USA; ⁴Thomas Jefferson University Hospital, Philadelphia, USA

Received June 11, 2019; Accepted September 8, 2019; Epub October 15, 2019; Published October 30, 2019

Abstract: Background: Syncope is a symptom complex comprising of a brief loss of consciousness leading to a transient decrease in cerebral blood flow that resolves completely. 2D-transthoracic echocardiography (TTE) is a useful tool to detect underlying structural heart disease, which can lead to syncope, e.g., aortic stenosis, atrial masses. This study aimed to find the subgroups of patients with syncope who would benefit the most from a TEE. Methods: We did a retrospective chart review of all patients aged 18 years or older, admitted to our hospital with a primary diagnosis of syncope between January 2015 and January 2017 to determine the frequency and findings of echo in all these patients. The baseline characteristics, demographics were taken into account for the inclusion of these patients into the study. Results: A total of 369 patients were initially studied, but only 139 patients were included in the final analysis based on inclusion criteria. Among the high-risk patients (i.e., abnormal Physical exam and/or abnormal EKG, population), 43.75% had significant echocardiographic finding. While among low-risk patients (i.e., normal EKG and exam), 10% (9/91) had a significant finding. Patients with abnormal EKG or examination findings were 7.08 times (95% CI = 2.89-17.3) more likely to have an abnormal echocardiogram (P < 0.001). Conclusion: Our study suggests that the diagnostic yield of 2D-TTE in the absence of abnormal physical exam and/or abnormal EKG is very limited and may add an extra burden on the finances and resources of both the patient and the hospital.

Keywords: Syncope, electrocardiogram, transthoracic echocardiography, diagnosis

Introduction

A syncope is an event of transient loss of consciousness. It is a symptom explained by a brief loss of consciousness with an inability to maintain postural tone because of a transitory decrease in cerebral blood flow [1]. Syncope is usually self-resolving event without requiring further management. The differential diagnosis of syncope includes seizure, hypoglycemia, coma, shock, and other states of change in mental status or altered consciousness. It is a prevalent clinical condition with a vast number of different causes. It is one of the most common reasons of emergency room visits and hospital admissions and may lead to extensive workup [2]. It is estimated that it is the cause of 3% of all ED and 1-6% of all hospital visits and around 40% of those cases need to be admitted [3, 4]. Beyond this, there is also a recurrence rate of almost 35% [4]. The prevalence of syncope is about 42%, considering a lifetime

of 70 years and has an annual incidence of 6% [5]. As per the prior studies, its frequency varies from 15% (below 18 years of age) to 39% among medical students, reaching 23% among the elderly [6-8]. In the general population, the frequency of syncope is about 18.1-39.7 per 1000 patients, with a similar incidence between genders, and high prevalence between 10 and 30 years of age, mainly because of vasovagal syncope [5]. The first reported incidence of syncope was 6.2 per 1000 person-years. However, there is a significant increase in the incidence of syncope after 70 years of age, with 5.7 episodes/1000 individuals per year between 60 and 69 years old and with 11.1 episodes/1000 individuals per year between 70- and 79-years' age. After 80 years, the annual incidence may reach 19.5 per 1000 individuals [9].

We performed a retrospective analysis to look into the characteristics of patients presenting with syncope and investigated diagnostic yield

Echocardiography in syncope evaluation

Table 1. Represents general population demographics

Demographics of patients	Percentage (%)
Total patient population (n)	139 (100%)
Age > 65 years	80%
Age < 65 years	20%
Males	42%
Females	58%

of echocardiography in syncope cases. The purpose of this study was: 1) to examine the frequency with which echocardiography was used in the evaluation of patients admitted to our hospital because of syncope who have a normal clinical examination and normal electrocardiogram and 2) to determine any additional benefit in diagnosis contributed by the echocardiogram, over and above that provided by the initial history, physical examination, and electrocardiography.

Material and methods

This study is a retrospective observational analysis performed at Abington Jefferson Hospital, a teaching hospital in Abington, PA. Data collected over the 12 months from January 1, 2015, to January 31, 2017. Data collection was focused on determining the rate of performing echo, and the frequency of findings in patients over 18 years of age with syncope. Syncope cases were identified based on presenting illness at the time of presentation. The data collected from medical records include history/physical examination, demographic variables, EKG, and echocardiographic findings. An EKG and Echocardiogram were performed by trained technicians and read by a senior cardiologist. Analysis was performed using the SPSS. Categorical data was analysed using the Pearson chi square with an alpha criteria of p value of 0.05 as a significant value.

We set strict inclusion criteria, and eventually included only 139 of the 369 patients. The baseline characteristics, demographics were taken into account for these patients. All the 139 patients included met the following selection criteria.

Inclusion criteria

(1) All patients admitted to an observation unit and are over the age of 18 years admitted with

the primary diagnosis of syncope that had an abnormal EKG and echocardiogram during the index admission. (2) Abnormal EKG findings include abnormal axis, ischemic changes, conduction blocks including first degree, second degree, third-degree blocks, bi-fascicular blocks, abnormal QTc (short or prolonged QTc), and left bundle branch block. (3) Abnormal echocardiogram findings include ejection fraction less than 45%, valvular abnormalities, ventricular hypertrophy, outflow tract obstruction, pericardial effusion, and pulmonary hypertension. (4) Patients with standard cardiac biomarkers including troponin-I or t and CK-MB if checked as part of their evaluation.

Exclusion criteria

(1) Those patients with a misdiagnosis of syncope (e.g., seizure, myocardial infarction). (2) Patients who were transferred to another acute care hospital. (3) Patients who left against medical advice on index admission. (4) Patients with syncope diagnosis who did not get an echocardiogram. (5) Patients who had positive cardiac biomarkers, including troponin-I or t and CK-MB.

Results

Out of 139 patients admitted to an observation unit with a primary diagnosis of syncope, 80% of the patients were over 65 years of age. Amongst the included patients, 42% were male, and 58% were females. The included population also had at least one comorbid condition accounting for syncope. These comorbid conditions with percentage of prevalence in this population provides hypertension (63%), followed by diabetes mellitus (16%), CKD (11%), prior myocardial infarction and previous syncope (10%), CVA (8.6%), anemia (5%) and peripheral vascular disease present in only (4%) of patients. The demographic variables and prevalence of comorbid conditions are shown in **Tables 1 and 2**.

The normal and abnormal physical exam, EKG and echo findings in our patient population are depicted in **Table 3**.

The majority of patients (87%) had a normal physical examination, and 13% had an abnormal physical examination. Patients with abnormal examination had abnormal findings on TTE

Table 2. Represents percentages of populations with secondary medical conditions/risk factors

Risk factors	Percentage of the population
Hypertension	63%
Diabetes Mellitus	16%
Prior Myocardial infarction	10%
Prior percutaneous intervention	7.9%
Chronic Kidney Disease	11.5%
Prior cerebrovascular accident	8.6%
Peripheral vascular disease	4.3%
Anemia	5.0%
Prior syncope	10%

in only 36% (7/19) cases while less than 1% patients of the normal physical examination group had positive findings on echocardiography. The prevalence of positive TTE findings in the abnormal physical exam group was significantly higher than the normal physical exam group, and the difference was statistically significant ($P = 0.001$). These results are shown in **Table 4**.

The majority of our patients had a normal EKG (78.5%). Approximately one-fifth (21.5%) of the patients had an abnormal EKG, but only 23% of those had positive echocardiographic findings. The difference in positive TTE findings in the normal and abnormal EKG groups was statistically significant ($P < 0.05$). This is depicted in **Table 5**.

The relationship of abnormal echocardiography with following variables; abnormal physical examination, abnormal EKG, orthostatic vitals are given in **Table 6**.

The prevalence of positive TTE finding in patients with an abnormal physical exam or an abnormal EKG is described above. This becomes more significant when we consider patients with abnormal physical exam and EKG findings together. Among the high-risk patients (i.e., abnormal Physical exam and/or an abnormal EKG patient population), 43.75% (21/48) had a significant echocardiographic finding. While among low-risk patients (i.e., normal EKG and physical exam), 10% (9/91) had a significant finding. Patients with abnormal EKG or examination findings were 7.08 times (95% CI = 2.89-17.3) more likely to have an abnormal echocardiogram ($P < 0.001$).

Discussion

Most of the causes of syncope can be classified into four categories. These are reflex syncope, also called neural syncope, orthostatic syncope, cardiac arrhythmia, and cardiopulmonary disease leading to syncope. Some other common conditions that can be confused with and need to be differentiated from syncope include seizure disorders, sleep disturbances, accidental falls, and some psychotic conditions like conversion disorder. Cardiac syncope (from vascular disease, cardiomyopathy, arrhythmias, or valvular dysfunction) is associated with increased mortality, whereas noncardiac syncope is not. Syncope may result in significant morbidity and disability due to falls or accidents that occur as a result [10]. Besides the social impact of syncope with worsening quality of life, there is also the economic impact, with higher costs attributed to hospitalization with an estimated \$2.4 billion annual cost [11].

All of the causes of syncope need to be evaluated. The evaluation usually begins with a detailed history and physical exam. Many of the causes of syncope like orthostatic hypotension can be diagnosed reasonably well based on the history and physical exam. However, many cases require further evaluation and workup. Most patients do undergo some form of cardiac assessment too. Most patients undergo an EKG to detect any arrhythmia, though it does not always show a paroxysmal arrhythmia, and such patient may need to have a further evaluation like a Holter monitor placed if the index of suspicion is high. On the other hand, an EKG does not help much with the diagnosis of syncope from structural heart disease or cardiopulmonary disease. Most patients who are suspected of having a cardiac origin of syncope also undergo transthoracic echocardiography (TTE) [12].

TTE can be useful in the evaluation of patients who present with syncope. It is especially helpful in identify any underlying cause and also stratify the severity of any underlying cardiac lesions, like severe aortic stenosis, hypertrophic cardiomyopathy, and left ventricular dysfunction [13-15]. It has been reported as the most useful imaging study for evaluating the severity of underlying cardiac disease and for the risk stratification of patients who had unexplained syncopal events especially those with a

Echocardiography in syncope evaluation

Table 3. Depicts normal and abnormal percentage of the physical exam, orthostatic blood pressure, EKG and echocardiography findings in our patient population

Parameters	Percentage of the population (total n = 139)	
	Normal/Present	Abnormal/Absent
EKG	78.5%	21.5%
Physical Exam	87%	13%
Left ventricular systolic dysfunction (LVEF < 50%)	95%	5%
Valvular Heart disease	12.7%	87.3%
Abnormal Orthostatic Blood Pressure	12.3%	87.7%

Table 4. This table depicts the prevalence of positive TTE findings in both the normal and abnormal physical exam findings groups (P = 0.001)

Analyte	Echocardiography positive n = 8	Echocardiography negative n = 131	Total patients n = 139
Normal physical exam (87%)	1/120 (0.8%)	119/120 (99.1%)	n = 120 (87%)
Abnormal physical exam (13%)	7/19 (36%)	12/19 (64%)	n = 19 (13%)

Table 5. This table depicts the prevalence of positive TTE findings in both the normal and abnormal EKG groups (P < 0.046)

Analyte	Echocardiography positive	Echocardiography negative	Total patients n = 139
Normal EKG	2/109 (2%)	107/109 (98%)	n = 109 (78.5%)
Abnormal EKG	7/30 (23%)	23/30 (77%)	n = 30 (21.5%)

prior known positive cardiac history or an abnormal electrocardiogram (EKG) [16]. However, the exact role of echocardiography in the evaluation of syncope is still not clear, especially in patients with no cardiac history and no positive findings in the history, physical examination, and initial evaluation [17, 18]. In patients with a cardiac history or an abnormal EKG, it is usually recommended to be part of the evaluation of syncope [19, 20]. Since there is significant utilization of financial and human resources for echocardiography, there have been studies performed previously, and attempts have been made to streamline the approach to performing TTE in patients presenting with syncope [21, 22].

2D-TTE is widely used as a screening tool to rule out structural or valvular heart disease in patients presenting with syncope. The significance cannot be undermined in high-risk patients who have underlying cardiomyopathy and present with unexplained syncope along with an abnormal physical exam and/or abnormal EKG. Echocardiography in patients with a normal physical exam and normal EKG is not very

helpful and only adds to the additional cost to the patient and increase the length of stay. The average cost of echocardiogram in the US is between \$1000-\$3000 [23]. In clinical practice, inappropriately performed TTE can increase

the healthcare cost and delays the timely interpretation of relevant studies.

There have been questions regarding the role of transthoracic echo in evaluating patients with syncope, primarily as to who warrants it. ACC/AHA/HRS guidelines recommend patients who have a positive history of cardiac disease, positive findings in the history and physical exam and an abnormal EKG should undergo a transthoracic echo. It is especially helpful in diagnosing the presence of valvular conditions like Aortic stenosis, Hypertrophic cardiomyopathy and severe left ventricular dysfunction that can at times present with syncope [23, 24].

There have been previous studies to elucidate the role of transthoracic echo in syncope. In one retrospective review by Recchia et al., 48% of patients who had suspected cardiac disease based on history, physical exam, or EKG had an abnormal echocardiography [21].

In another prospective analysis of 650 patients by Sarasin et al., 24 of the 88 patients found to have an abnormal EKG were found to have systolic dysfunction on echocardiography. Half of

Echocardiography in syncope evaluation

Table 6. This table illustrates the relationship of positive echocardiographic findings with physical examination, EKG, orthostatic vitals, and prior history of PCI

Difference of positive echocardiography findings between population subgroups	Statistical significance
Murmur positive vs no murmur on physical examination	P = 0.000
Abnormal EKG vs normal EKG	P = 0.046
Orthostatic hypotension vs normal Orthostatic vitals	P = 1.000
Prior PCI vs no prior PCI	P = 0.059

these patients were found to have manifest arrhythmias too [12]. Our study is consistent with these prior studies, showing that an echo is more useful and has a higher yield in high-risk patients.

Limitations

Our study is a small retrospective study and is not as significant as a large prospective study would be. Secondly, we do not have to follow up with these patients after hospital discharge. Thirdly, reporting physical examination can be variable among physicians.

Conclusion

Echocardiography is frequently used in patients who are admitted with a diagnosis of syncope. Our study suggests that the use of echocardiography in patients with normal physical examination and normal electrocardiogram is very minimal. The utility of echocardiography in an appropriate subset of patients is high and this data provide an objective basis to prospectively define the optimal role of echocardiography in the evaluation of patients with syncope.

Acknowledgements

We thank Dr. Boigon for providing research opportunities in hospital.

Informed consent was waived via IRB.

Disclosure of conflict of interest

None.

Address correspondence to: Waqas Ullah, Internal Medicine, Abington-Jefferson Health, 1200 Old York Road, Abington, PA 19001, USA. Tel: 267-377-5410; 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, Belli 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.

Echocardiography in syncope evaluation

- [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] Crane SD. Risk stratification of patients with syncope in an accident and emergency department. *Emerg Med J* 2002; 19: 23-7.
- [15] 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: 1044-9.
- [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, 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] 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; American College of Chest Physicians, Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, Picard MH, Polk DM, Ragosta M, Parker Ward R 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, Society for Cardiovascular Magnetic Resonance American College of Chest Physicians. *J Am Soc Echocardiogr* 2011; 24: 229-267.
- [24] 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.