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Original Article

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Utilization of Echocardiogram, Carotid Ultrasound, and Cranial Imaging in the Inpatient Investigation of Syncope: Its Impact on the Diagnosis and the Patient's Length of Hospitalization

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Abstract

Background: Although guidelines suggest that the best strategy for evaluating syncope is clinical history and physical examination, the inappropriate utilization of diagnostic imaging is common.

Methods: A single center retrospective analysis conducted in adult patients admitted for evaluation and management of syncope for a period of 12 months. Charts were reviewed to abstract demographic data, admitting and discharge diagnosis, diagnostic investigatory tests including imaging modalities (echocardiogram, carotid ultrasound, and cranial computed tomography (CT)) ordered, subspecialty consultation requested, treatment rendered and hospital length of stay (LOS).

Results: A total of 109 patients were admitted for syncope, mean age was 68.74 ± 21.04 years and 39.44% were men. Echocardiogram, carotid ultrasound, and cranial CT were ordered in 69.72%, 33.02%, and 76.14% respectively. The mean hospital LOS was 2.6 days. Patients with no imaging test, one imaging test, two imaging tests, and three imaging tests ordered have an average hospital LOS of 2.22 days, 2.44 days, 2.58 days, and 3.07 days respectively. The number of imaging test and its relation to the admitting (Chi-square (chi-sq) P = 0.4165, nominal logistic regression (LR) P = 0.939) and discharge (chi-sq P = 0.1507, nominal LR P = 0.782) diagnosis as well as the LOS in relation to the number of imaging test ordered (analysis of variance (ANOVA) P = 0.368, Kruskal Wallis (KW) P = 0.352) were not statistically significant although there was a trend of prolonged hospital LOS the more imaging diagnostic test had been ordered. Syncope was the admitting and discharge diagnosis in 89.9% and 91.74% respectively.

Conclusions: Choosing the appropriate diagnostic tests as dictated by the patient's clinical manifestation and utilizing less expensive test would be appropriate and cost-effective approach in appraising patients with syncope.

Keywords: Syncope; Imaging; Length of hospitalization

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Introduction

Syncope is a sudden temporary loss of consciousness and associated with inability to support postural tone with quick spontaneous recovery that is generally the result of cerebral hypoperfusion [1]. It is a common condition, which accounts 1% to 2% of emergency department visit [2]. The US Department of Human and Health Services' Healthcare Cost and Utilization Project reported a $ 3.7 billion annual aggregate charge for syncope with a mean cost of 6,647 per admission [3]. Thirty to forty percent of syncope patients are admitted for additional test which translated to an annual expenditure of $ 2.4 billion as documented in the USA Medicare Database [4]; and much of these costs are directly linked to the diagnostic testing implemented to detect the causes of syncope [5]. Endeavors to diminish nonessential and costly admission have included clinical decision tools regarding the decision to admit, but have not determined the benefit and yield of testing in syncope [6].

The objective of the study is to determine the utilization of echocardiogram, carotid ultrasound, and cranial computed tomography (CT) and its impact on the admitting and discharge diagnosis in patients admitted for syncope as well as to establish if the length of their hospital stay had been affected by these investigatory imaging tests.

Materials and Methods

A single center retrospective analysis was conducted in adult patients admitted for evaluation and management of syncope at Atlantic Health System's (AHS) Overlook Medical Center from January 2015 to December 2015. Charts were reviewed to abstract demographic data, admitting and discharge diagno-

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sis, diagnostic investigatory test ordered, subspecialty consultation requested, and treatment rendered. Imaging modalities ordered that included echocardiogram, carotid ultrasound, and cranial CT were also abstracted as well as the hospital LOS. This study was approved by the AHS Institutional Review Board and was conducted according to the institutional guidelines and standards.

Statistical analysis

Values are expressed as mean ± standard deviation (SD). Chi-square (chi-sq) and nominal logistic regression (nominal LR) were utilized to see the association of number of imaging test ordered in relation to the admitting and discharge diagnosis. Analysis of variance (ANOVA) and Kruskal Wallis (KW) were utilized to compare the mean and median data distribution respectively to determine the association of number of imaging test ordered in relation to hospital LOS. A statistically significant level was set at 0.05.

Results

A total of 109 patients were admitted for syncope from January 1, 2015 to December 31, 2015. The mean age was 68.74 ± 21.04 years, 60.55% were women while 39.44% were men. Whites comprised 66.05% of the admissions followed by Blacks (16.51%), Hispanics (11.92%), and Asians (3.66%). Hypertension (63.30%), hyperlipidemia (32.11%), and coronary artery disease (20.18%) were the leading comorbidities. Statin (33.94%), antiplatelet (33.94%), and beta blocker (33.02%) comprised the most common medications taken (Table 1). Orthostatic vital signs were done in 41.28% of patients (51.11% were positive). Telemetry and electrocardiogram (ECG) were ordered in 97.24% of patients in which normal sinus rhythm has been documented in 80.18% and 68.86% respectively. Also, electroencephalogram was ordered in 44.95% in which 95.91% have been negative. Nuclear stress test and tilt table test were ordered in 3.66% (100% negative) and 2.75% (33.33% positive) of patients respectively (Table 2). Echocardiogram, carotid ultrasound, and cranial CT were ordered in 69.72%, 33.02%, and 76.14% respectively. Cranial imaging revealed normal results in 67.46%, microvascular disease in 20.48%, and chronic basal ganglia infarct in 6.02% of patients. Carotid ultrasound showed normal results in 86.11% of patients. Echocardiogram documented a mean EF of 56.81±7.82%, diastolic dysfunction in 46.68%, concentric hypertrophy in 35.52%, and normal results in 18.42% of patients (Table 3). Intravenous fluid had been administered in 41 (37.61%) patients while no intravenous fluid had been ordered in 68 (62.38%) of patients. Cardiology (54.12%), epilepsy (31.19%), neurology (26.60%) and physiatry (5.50%) consults were requested for these patients. Discharge medications were the same from home medications in 74.31%, was revised in 22.01%, and no home medications were ordered in 3.66% of patients. The mean hospital length of stay (LOS) was 2.6 days. Patients with no imaging test, one imaging test, two imaging tests, and three imaging tests ordered have an average hospital LOS of 2.22 days, 2.44 days, 2.58 days, and 3.07 days respectively (Table 4 and Figure 1). The number of imaging test ordered in association to LOS (ANOVA P = 0.368, KW P = 0.352) as well as the number of imaging test ordered and its relation to the admitting (chi-sq P = 0.4165, nominal LR P = 0.939) and discharge (chi-sq P = 0.1507, nominal LR P = 0.782) diagnosis were not statistically significant although there was a trend of prolonged hospital LOS the more imaging diagnostic test had been ordered (Tables 5-7). Syncope was the admitting and discharge diagnosis in 89.9% and 91.74% respectively (Table 8). Eighty seven percent of the patients were discharged home.

Table 1. Baseline Characteristics, Comorbidities, and Home Medications of Patients Admitted for Syncope

	N = 109(%)
Age	68.74 ± 21.04 years
Male	43 (39.44%)
Female	66 (60.55%)
Race	
White	72 (66.05%)
Black	18 (16.51%)
Hispanic	13 (11.92%)
Asian	4 (3.66%)
Other	2 (1.83%)
Common Comorbidities	
Hypertension	69 (63.30%)
Hyperlipidemia	35 (32.11%)
Coronary artery disease	22 (20.18%)
Hypothyroidism	18 (16.82%)
Diabetes mellitus	17 (15.59%)
Atrial fibrillation	15 (16.51%)
Anemia	15 (13.76%)
Cerebrovascular accident	11 (10.09%)
Chronic kidney disease	11 (10.09%)
Dementia	11 (10.09%)
Common Medications	
Statin	37 (33.94%)
Antiplatelet	37 (33.94%)
Beta blocker	36 (33.02%)
Calcium channel blocker	32 (29.35%)
Multivitamins	23 (21.10%)
Angiotensin converting enzyme inhibitor	22 (20.18%)
Selective serotonin reuptake inhibitor	20 (18.34%)
Thyroid hormone	19 (17.43%)
Angiotensin receptor block	15 (13.76%)
Anticonvulsant	13 (11.92%)

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Table 2. Investigatory Studies Ordered and Performed for Patients Admitted for Syncope and Its Results

	N = 109(%)
Orthostatic vital signs	
Done	45 (41.28%)
Positive	23 (51.11%)
Not done	64 (58.71%)
Telemetry	
Ordered	106 (97.24%)
Normal sinus rhythm	85 (80.18%)
Sinus bradycardia	14 (13.20%)
Bundle branch block	14 (13.20%)
First degree atrioventricular block	10 (9.43%)
Atrial fibrillation/flutter	7 (6.60%)
Premature atrial contraction	3 (2.83%)
Paced rhythm	3 (2.83%)
Nonsustained ventricular tachycardia	3 (2.83%)
Supraventricular tachycardia	1 (0.94%)
Sinus arrhythmia	1 (0.94%)
Sinus tachycardia	1 (0.94%)
Not ordered	3 (2.83%)
Electrocardiogram	
Ordered	106 (97.24%)
Normal sinus rhythm	73 (68.86%)
Sinus bradycardia	13 (12.26%)
Right bundle branch block	13 (12.26%)
Nonspecific ST wave changes	10 (9.43%)
Left ventricular hypertrophy	10 (9.43%)
First degree atrioventricular block	8 (7.54%)
Premature atrial contraction	7 (6.60%)
Atrial fibrillation/flutter	7 (6.60%)
Sinus tachycardia	6 (5.66%)
Premature ventricular contraction	6 (5.66%)
Sinus arrhythmia	5 (4.71%)
Poor R wave progression	5 (4.71%)
Left bundle branch block	4 (3.77%)
Left anterior fascicular block	4 (3.77%)
Intraventricular conduction delay	4 (3.77%)
Lateral wall ischemia	3 (2.83%)
Left atrial enlargement	2 (1.88%)
Anterolateral wall ischemia	1 (0.94%)
Old inferior wall myocardial infarction	1 (0.94%)
Prolonged QT interval	1 (0.94%)
Not ordered	3 (2.83%)
Electroencephalogram	
Ordered	49 (44.95%)
Negative	47(95.91%)
Positive	2 (4.08%)
Primary generalized epilepsy	1 (50%)
Left temporal region epilepsy	1 (50%)
Nuclear stress test	
Ordered	4 (3.66%)
Positive	0 (0%)
Negative	4 (100%)
Tilt table test	
Ordered	3 (2.75%)
Positive	1 (33.33%)
Negative	2 (66.66%)
Intracardiac loop recorder placement	
Ordered	5(4.58%)
Pacemaker interrogation	
Ordered	2 (1.83%)
Electrophysiological studies	
Ordered	0 (0%)

Discussion

The recommended strategy for determining the etiology of syncope is clinical evaluation with history, physical examination, and orthostatic blood pressure (BP) measurement. When the initial cause remains unclear, further investigation is appropriate. Several algorithms have been developed by specialty organizations to determine the cause of syncope but no single protocol had established its cause which translates to unnecessary utilization of test including imaging modalities to evaluate syncope. The 2018 European Society of Cardiology (ESC) guidelines for the diagnosis and management of syncope recommended that the initial evaluation of the patient presenting with transient loss of consciousness should include careful history, physical examination (including orthostatic BP measurement), and ECG which can establish the etiology of syncope in most patients, thus, enabling no further evaluation needed and instead institute planned treatment when the diagnosis is nearly evident or highly possible [7]. Also, the 2017 American College of Cardiology/American Heart Association/Heart Rhythm Society (ACC/AHA/HRS) guideline for the evaluation and management of patients with syncope recommended detailed history, physical examination (including orthostatic BP measurement), and ECG in the initial evaluation of syncope [1].

Initial evaluation is able to define the cause of syncope in 23-50% of patients [8, 9]. In some circumstances, the initial evaluation does not unravel a definite diagnosis but rather sug-

Table 3. Imaging Studies Ordered and Performed for Patients Admitted for Syncope and Its Results

	N = 109(%)
Cranial computed tomography	
Ordered	83 (76.14%)
Normal	56 (67.46%)
Microvascular disease	17 (20.48%)
Chronic basal ganglia infarct	5 (6.02%)
Hematoma	2 (2.40%)
Meningioma	2 (2.40%)
Chronic ischemic changes	1 (1.20%)
Central cortical atrophy	1 (1.20%)
Parenchymal volume loss	1 (1.20%)
Calcification	1 (1.20%)
Nonspecific white matter changes	1 (1.20%)
Small intraparenchymal hemorrhage	1 (1.20%)
Basal ganglia neuroepithelial cyst	1 (1.20%)
Cavernous malformation	1 (1.20%)
Hemorrhagic contusion	1 (1.20%)
Acute Maxillary sinusitis	1 (1.20%)
Not ordered	26 (23.85%)
Carotid ultrasound	
Ordered	36 (33.02%)
Normal	31 (86.11%)
Proximal ICA bilateral stenosis (60-79%)	1 (2.77%)
Proximal ICA bilateral stenosis (40-59%)	1 (2.77%)
Right ICA stenosis (80-89%)	1 (2.77%)
Bilateral stenosis ICA (40-59%)	1 (2.77%)
Left ICA mild to moderate plaque	1 (2.77%)
Not ordered	73 (66.97%)
Echocardiogram	
Ordered	76 (69.72%)
Diastolic dysfunction	37 (46.68%)
Concentric hypertrophy	27 (35.52%)
Normal	14 (18.42%)
Mild mitral regurgitation	12 (15.78%)
Mild tricuspid regurgitation	9 (11.84%)
Mitral annulus calcification	8 (10.52%)
Moderate to severe mitral regurgitation	8 (10.52%)
Mild Aortic regurgitation	5 (6.57%)
Moderate aortic regurgitation	5 (6.57%)
Moderate aortic stenosis	5 (6.57%)
Moderate tricuspid regurgitation	5 (6.57%)
Mild aortic stenosis	4 (5.26%)
Mild pulmonary hypertension	4 (5.26%)
Mild left ventricular hypertrophy	4 (5.26%)
Mild bilateral atrial enlargement	4 (5.26%)
Moderate pulmonary hypertension	2 (2.63%)
Severe right atrial enlargement	2 (2.63%)
Mild to moderate global hypokinesis	2 (2.63%)
Bioprosthetic valve	2 (2.63%)
Severe tricuspid regurgitation	1 (1.31%)
Speckled pattern	1 (1.31%)
Severe pulmonary hypertension	1 (1.31%)
Mild pericardial effusion	1 (1.31%)
Mild mitral stenosis	1 (1.31%)
Severe aortic stenosis	1 (1.31%)
Mild asymmetric hypertrophy	1 (1.31%)
Basal septum hypokinesis	1 (1.31%)
Mild aortic root dilation	1 (1.31%)
Mild basal septal hypertrophy	1 (1.31%)
Primum atrial septal defect	1 (1.31%)
Paramembranous ventricular septal defect	1 (1.31%)
Endocardial cushion defect	1 (1.31%)
Not ordered	33 (30.27%)

ICA: internal carotid artery.

gests other etiologies which necessitate additional diagnostic testing that assess the risk of major cardiovascular events or sudden cardiac death. Investigatory modalities including cardiac enzymes tests, CT scans, echocardiography, carotid ultrasonography, and electroencephalography all affected diagnosis or management in less than 5% of cases and helped determine the etiology of syncope less than 2% of the time; however, postural BP recording, performed in only 38% of episodes, had the highest yield with respect to affecting diagnosis (18% - 26%) or management (25% - 30%) and determining etiology of the syncopal episode (15% - 21%) [10].

Cardiac imaging performed routinely is not beneficial in the appraisal of patients with syncope unless a cardiac cause is uncertain based on findings on initial evaluation that includes history, physical examination, or ECG [11, 12]. Echocardiography plays an essential function in risk stratification and serves to validate or contradict the uncertainties for the patients with suspected heart disease [13]; however, it establishes the etiology of syncope in very few patients when no further tests are required [14]. A syncope retrospective study documented that echocardiography proposed a cardiac syncope diagnosis in 48% of study patients [12]. On the other hand in a prospective syncope study, echocardiography suggested critical valvular disease or compromised left ventricular systolic function as the etiology of syncopal event in 22% of patients [6]. Albeit echocardiography may never be capable to determine the

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Table 4. Number of Imaging Test Ordered for Patients Admitted for Syncope and Its Impact on the Hospital Length of Stay

	N (%)	Length of stay in days
No imaging test ordered	9 (8.25%)	2.22
One imaging test ordered	27 (24.77%)	2.44
Two imaging tests ordered	46 (42.20%)	2.58
Three imaging tests ordered	27 (24.77%)	3.07

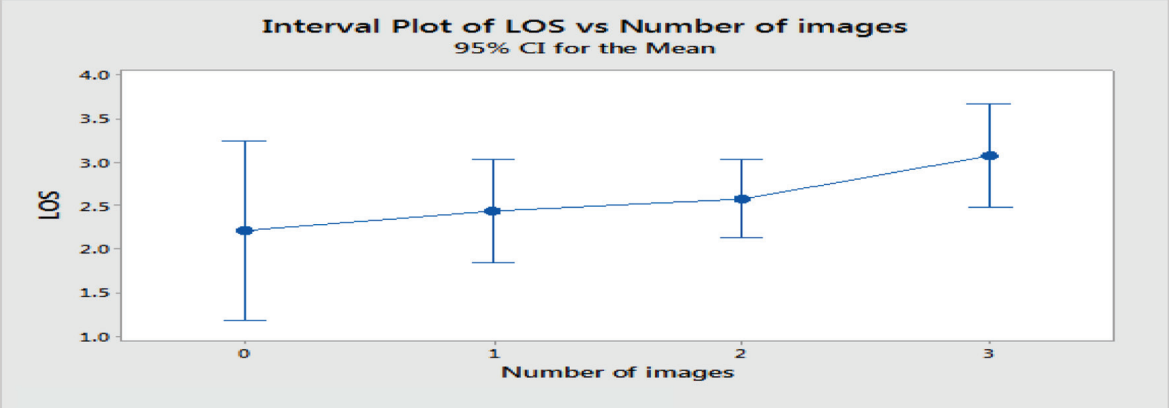

Figure 1. Interval plot of hospital length of stay (LOS) in correlation with number of imaging test ordered. LOS: length of stay. The pooled standard deviation was used to calculate the intervals.

proximate syncopal etiology, it contributes knowledge for a conceivable disease burden linked to outcome. Cranial MRI and CT are not advocated in the conventional evaluation of patients with syncope in the lack of focal neurological deficit or head trauma that aid additional investigation [15, 16]. A retrospective study that obtained cranial CT scan in patients with syncope provided diagnosis in 2% of patients [17] while a prospective study that utilized cranial CT scan in patients with syncope yielded abnormal results in 5% of patients [18]. Also, imaging of the carotid is not endorsed as well in the customary syncope evaluation in the dearth of focal neurological findings that substantiate more investigation since this approach determined a diagnosis only in 0.5% of patients [11, 15, 16, 19, 20].

In our study, cranial CT scan, echocardiography, carotid ultrasonography all affected the diagnosis in 2% of cases, have low diagnostic yield in determining the etiology of syncope, prolonged the hospital LOS, and were costly. A previous study documented an average of 4.7 days LOS for admitted syncope patients [21] while another one documented an average of 3 days which correlated with number of predictors such as age,

Table 5. Number of Imaging Test Ordered (Echocardiogram, Carotid Ultrasound, and Cranial Computed Tomography) and Its Association to Patient's Hospital Length of Stay

Hospital length of stay	0 test (N = 9)	1 test (N = 27)	2 tests (N = 46)	3 tests (N = 27)	P (ANOVA)	P (KW)
Mean ± SD	2.222 ± 1.481	2.444 ± 1.396	2.587 ± 1.627	3.074 ± 1.639	0.368	
Median(minimum - maximum)	1 (1 - 4)	2 (1 - 7)	2 (1 - 6)	3 (1 - 7)		0.352

Table 6. Number of Imaging Test Ordered (Echocardiogram, Carotid Ultrasound, and Cranial Computed Tomography) and Its Influence on Admitting Diagnosis

Number of imaging test ordered	Syncope	Vasovagal syncope	Syncope vs. seizure	Total
0	7 (8.092)	1 (0.330)	1 (0.578)	9
1	22 (24.275)	2 (0.991)	3 (1.734)	27
2	43 (41.358)	1 (1.688)	2 (2.954)	46
3	26 (24.275)	0 (0.991)	1 (1.734)	27
Total	98	4	7	109

Chi-square P value = 0.4165, nominal logistic regression P value = 0.939.

Table 7. Number of Imaging Test Ordered (Echocardiogram, Carotid Ultrasound, and Cranial Computed Tomography) and Its Influence on Discharge Diagnosis

Number of imaging test ordered	Syncope	Vasovagal syncope	Neurocardiogenic syncope	Syncope with seizure	Syncope vs. seizure	Total
0	8 (8.2569)	0 (0.3303)	0 (0.1651)	0 (0.1651)	1 (0.0826)	9
1	23 (24.770)	2 (0.9908)	1 (0.4954)	1 (0.4954)	0(0.2477)	27
2	43 (42.2018)	2 (1.6881)	0 (0.8440)	1 (0.8440)	0 (0.4220)	46
3	26 (24.7706)	0 (0.9908)	1 (0.4954)	0 (0.4954)	0 (0.2477)	27
Total	100	4	2	2	1	109

Chi-square P value = 0.1507; nominal logistic regression P value = 0.782.

sex, and comorbidities [22]. Our study determined the utilization of an incremental number of imaging modalities ordered (echocardiography, cranial CT scan, and carotid ultrasound) and its impact on the hospital LOS which showed a trend towards a prolonged course although it was not statistically considerable.

Limitations

This is a small retrospective study and thus the sample size may possibly be a confounding factor to achieve a statistically significant power. There is a demand for extensive clinical trials that determine the diagnostic yield and observance of a systematic application of standardized syncope guideline.

Conclusions

Choosing the appropriate diagnostic tests as dictated by the patient's clinical manifestation and utilizing less expensive modality would be the appropriate and cost-effective approach in appraising patients with syncope.

Conflict of Interest

The authors declare that they have no conflict of interest.

Table 8. Admitting and Discharge Diagnosis of Patients Admitted for Syncope

	N = 109 (%)
Admitting diagnosis	
Syncope	98 (89.90%)
Syncope with fall	7 (6.42%)
Syncope vs. Seizure	4 (3.66%)
Discharge diagnosis	
Syncope	100 (91.74%)
Vasovagal syncope	4 (3.66%)
Neurocardiogenic syncope	2 (1.83%)
Syncope with seizure	2 (1.83%)
Syncope vs. Seizure	1 (0.91%)

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