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Research Brief

Inpatient characteristics, complications, and outcomes of patients with cardiac sarcoidosis: A study from the National Inpatient Sample

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ABSTRACT

Although seen in ~5% of sarcoidosis patients, cardiac sarcoidosis (CS) accounts for nearly 25% of disease-related deaths. This study aimed to describe characteristics and outcomes among CS patients. Patients diagnosed with CS in 2016–2017 in the US National Inpatient Sample Database were evaluated to study patient characteristics, reasons ascribed to admission, in-hospital outcomes, and complications. A total of 2420 patients (median age 56 years) were included in the analysis. Most admissions occurred due to ventricular tachycardia (12.8%), followed by myocarditis (9.9%) with a mean length of stay of 7 ± 7 days. The overall incidence of in-hospital mortality was 2.5%.

1. Introduction

Sarcoidosis is a systemic disease characterized by the formation of non-caseating granulomas. In the US, African-Americans are disproportionately affected by Sarcoidosis with a threefold greater age-adjusted annual incidence (35.5 per 100,000 vs 10.9 per 100,000) than Caucasians.[1] Although lungs are predominantly involved in more than 90% of sarcoidosis patients, roughly 5% of these are seen to develop cardiac infiltration i.e., cardiac sarcoidosis (CS).[2] The phenotypic presentation of CS can be due to cardiac contractile dysfunction — that affects ventricular filling, eventually leading to heart failure — and conduction abnormalities owing to basal interventricular septum involvement predisposing to high-degree AV or bundle branch block. Sarcoid granulomas in ventricular myocardium can become foci for abnormal automaticity often leading to ventricular arrhythmias.[3–5] Despite an increased risk for sudden cardiac death,[6] transplant-free survival at 5 years is reported to range from 70 to 90%.[7,8] CS patients often need recurrent hospitalizations and medical care but the resource utilization and characteristics of these patients are not well understood. Thus, we sought to evaluate patient demographics, admission characteristics, inpatient complications, utilization of device-related therapies, and clinical outcomes in patients with CS.

2. Methods

National Inpatient Sample (NIS) is the largest, publicly available, anonymized, all-payer inpatient care database in the United States, produced by the Healthcare Cost and Utilization Project (HCUP) and sponsored by the Agency for Healthcare Research and Quality (AHRQ). The NIS is designed to produce U.S. regional and national estimates of inpatient utilization, access, charges, quality, and outcomes. It contains data for more than 7 million (unweighted) hospital stays within a calendar year, which when weighted estimates more than 35 million hospitalizations nationally.[9] Using the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code D86.85, we identified patients with CS. Patients' demographics, comorbidities, hospital characteristics, and inpatient variables were derived from the NIS, AHRQ comorbidity measure, and ICD-10 diagnosis procedure codes. The statistical analyses were performed in SPSS 26.0 (IBM Corp., Armonk, NY) and STATA 13 (StataCorp LP., TX).

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3. Results

Between January 01st 2016 and December 31st 2017, there were 2420 hospitalizations with a clinical diagnosis of CS. The demographic characteristics and underlying comorbidities of patients are outlined in Table 1. Ventricular tachycardia (12.8%), followed by myocarditis (9.9%), and acute on chronic systolic heart failure (7.2%) were the leading cardiovascular etiologies for admission. Other cardiovascular causes such as complete heart block, supraventricular tachycardia, and ventricular fibrillation (VF) accounted for a very small proportion of admission — 2.5%, 2.1%, and 1.7%, respectively.

The mean length of stay in hospital was 7 ± 7 days and the incident all-cause mortality was seen in 2.5% of our study population. Around 71.4% of patients were discharged home, while 15.8% were discharged with home-health services. The course of hospital stay was complicated by acute heart failure in 34.1% of patients, whereas infra-nodal block and complete heart block were seen in 11% and 8.7% of patients, respectively (Table 2). Among patients with cardiogenic shock (n = 125), intra-aortic balloon pump (IABP) was placed in 28%, percutaneous left-ventricular assist device (LVAD) in 8%, extra-corporeal life support (ECLS) in 4%, and 16% of patients underwent orthotropic heart transplantation. For bridging to transplant, IABP was utilized in 7.1% while LVAD was implanted in 35.7% of the total patient population. Lastly, 10.5% received implantable converter and defibrillator (ICD) insertion and 1.4% were implanted a pacemaker.

Table 1
Patient- and Hospital- Level baseline characteristics for 2420 hospitalizations.

Variable	N (%)
Demographics	
• Age, years, median (IQR)	56 (48–64)
• Male	1485 (61.4)
Race/Ethnicity	
• White	1095 (47.6)
• Black	1025 (44.6)
• Hispanic	105 (4.6)
• Asian	40 (1.7)
Median household income	
• 0–25th percentile	730 (30.7)
• 26th-50th percentile	405 (17.1)
• 51st-75th percentile	600 (25.3)
• 76th-100th percentile	640 (26.9)
Location/Teaching Status of hospital	
• Rural	30 (1.2)
• Urban, Non-teaching	160 (6.6)
• Urban, Teaching	2230 (92.1)
Primary expected payer	
• Medicare	930 (38.4)
• Medicaid	310 (12.8)
• Private insurance	1055 (43.6)
• Self-pay	50 (2.1)
• No charge	(0.2)
• Other	70 (2.9)
Control/Ownership of hospital	
• Government, non-federal	350 (14.5)
• Private (non-profit)	1945 (80.4)
• Presence of pacemaker	140 (5.8)
• Presence of ICD	1195 (49)
• Presence of LVAD	60 (2.5)
Comorbidities	
• Congestive Heart Failure	1915 (79.1)
• Cardiac Arrhythmias	1670 (69.0)
• Hypertension	1625 (67.1)
• Diabetes (complicated & uncomplicated)	885 (37)
• Renal Failure	780 (32.2)
• Chronic Pulmonary Disease	660 (27.3)
• Obesity	585 (24.2)
• Pulmonary Circulation Disorders	520 (21.5)
• Peripheral Vascular Disorders	520 (21.5)
Elixhauser Score (Mean ± SD)	16 ± 9
Non-Elective admission	2140 (88.8)

ICD = Implantable cardioverter defibrillator, LVAD = Left ventricular assist device.

Table 2
Outcomes for the 2420 index admissions among CS patients.

Variable	N (%)
Discharge location	
• Home Discharge	1728 (71.4)
• Short Term Care	75 (3.1)
• Home Health	382 (15.8)
Device-related therapies	
• Intra-Aortic Balloon Pump	41 (1.7)
• Percutaneous LVAD	10 (0.4)
• ECLS	10 (0.4)
• Orthotopic heart transplant	70 (2.9)
• AICD implantation	254 (10.5)
• Pacemaker implantation	34 (1.4)
Cardiogenic shock subpopulation (N=125)	
• Intra-Aortic Balloon Pump	35 (28.0)
• Percutaneous LVAD	10 (8.0)
• ECLS	5 (4.0)
• Orthotopic Heart Transplant	20 (16.0)
MCS as bridge to heart transplant (N=70)	
• Intra-Aortic Balloon Pump	5 (7.1)
• LVAD	25 (35.7)
Complications	
• Acute Heart Failure	825 (34.1)
• Complete Heart Block	210 (8.7)
• Second Degree AV Block	50 (2.1)
• Bi-fascicular Block	95 (3.9)
• Tri-fascicular Block	(0.4)
• Sick Sinus Syndrome	30 (1.2)
• Other Infranodal Blocks	265 (11.0)
• Ventricular Tachycardia or Fibrillation	95 (3.9)
• Cardiogenic Shock	125 (5.2)
All-cause mortality	60 (2.5)
Length of stay (Mean ± SD), days	7 ± 7

AICD = Automatic Implantable Cardioverter Defibrillator; ECLS = Extracorporeal Life Support; LVAD = Left Ventricular Assist Device.

4. Discussion

The key findings of the current study can be summarized as follows: 1) The most common reasons for admission were ventricular tachycardia followed by myocarditis and heart failure exacerbation; 2) Most common complications of CS included acute heart failure, infra-nodal block and complete heart block; 3) Overall in-hospital mortality due to any cause in CS patients is low; 4) IABP was the most frequently used mechanical circulatory support (MCS) device in cardiogenic shock patients.

Our findings are consistent with prior studies reporting that CS patients are at increased risk for conduction abnormalities such as ventricular arrhythmias and heart blocks.[10,11] In fact, approximately 25% of unexplained AV blocks in adults <55 years are attributed to CS.[12] Cardiac sarcoid can infiltrate any segment of the right or left ventricular myocardium leading to scar formation (secondary to inflammatory damage from granuloma), which is believed to be a dominant substrate for VT due to a large number of re-entrant circuits.[13] Besides conduction abnormalities, heart failure is another principal manifestation of CS.[2] The pathophysiology of congestive heart failure in CS appears to be multifactorial — occurring as a result of widespread granulomatous infiltration of myocardium, rhythm disturbances, cor pulmonale from pulmonary hypertension, and/or ventricular aneurysm.[14]

It is well known that cardiac involvement in sarcoidosis patients correlates with increased risk of sudden cardiac death,[2] with both fatal and aborted sudden cardiac deaths constituting upto 14% of the presenting manifestations of CS.[6] However, contrary to this, the

all-cause mortality among CS patients during index hospitalization was low (2.5%) in our study, which can be ascribed to a better understanding and patient-specific advancements in the recent clinical practices.

We saw that a considerable proportion of CS patients in our cohort developed cardiogenic shock. Our findings also illustrated that both MCS and heart transplantation can be effectively pursued in CS patients with cardiogenic shock. These findings are further backed-up by another study conducted by Ahmed et al who found that survival outcomes among CS patients following LVAD implantation were similar ($p = 0.86$) to those with non-ischemic cardiomyopathy.[15]

Our study has several limitations. First, this study is based on an administrative dataset (including only inpatient information) derived from billing data that can introduce coding errors. Second, we couldn't discern the diagnostic modality(s) used for confirming a diagnosis of sarcoidosis owing to chronic nature of the disease, with most of the work-up completed in outpatient setting. Third, since the numbers in dataset represent actual hospitalizations, some rates may be over or underestimated, as the same patient could have been recounted. Fourth, the database also lacks individual patient level information, and on long-term follow-up, acute care and rehabilitation, and medications used for treatment. Despite these limitations, our study provides key insights into inpatient complications, therapies utilized, and type of MCS used to bridge to heart transplantation.

5. Conclusions

VT is the major reason for admission in CS patients. Heart failure and rhythm disturbance are among commonly observed complications with a low in-hospital mortality. Among CS patients requiring heart transplant, LVAD is the commonly utilized MCS device for bridging.

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The authors have self-purchased the publicly available administrative database from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality of the United States of America.

Statement of ethics

The paper is exempt from ethical committee approval because the research is conducted from a publicly available national administrative database which contains de-identified data from the United States' hospitals.

Credit author statement

Siva S. Taduru: Conceptualization; Data curation; Investigation; Methodology; Project Administration; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing. Amandeep Goyal: Conceptualization; Data curation; Investigation; Methodology; Data curation, Writing-review and editing. Tarun Dalia: Writing - review & editing. Ioannis Mastoris: Data curation, Writing - review & editing. Aniket S. Rali: Roles/Writing - original draft; Writing - review & editing. Prakash Acharya: Methodology, Writing - review & editing. Robert Weidling: Data curation, Writing - review & editing. Nicholas Haglund: Conceptualization, Investigation; Methodology, Project Administration; Supervision, Validation, Visualization, Roles/Writing - original draft, Writing - review & editing. Andrew Sauer: Conceptualization, Data curation, Investigation, Methodology, Project Administration, Supervision, Validation, Visualization, Roles/Writing - original draft; Writing - review & editing. Zubair Shah: Conceptualization, Data curation, Investigation, Methodology, Project Administration, Supervision, Validation, Visualization, Roles/Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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References

1. Hutchinson J. Statement on sarcoidosis. Joint statement of the American thoracic society (ATS), the European respiratory society (ERS) and the world association of sarcoidosis and other granulomatous disorders (WASOG) adopted by the ATS board of directors and by the ERS executive committee. *Am J Respir Crit Care Med*. 1999;160:736–755. February 1999.
2. Birnie DH, Nery PB, Ha AC, Beanlands RS. Cardiac sarcoidosis. *J Am Coll Cardiol*. 2016;68:411–421.
3. Nery PB, Beanlands RS, Nair GM, et al. Atrioventricular block as the initial manifestation of cardiac sarcoidosis in middle-aged adults. *J Cardiovasc Electrophysiol*. 2014;25:875–881.
4. Desai R, Kakumani K, Fong HK, et al. The burden of cardiac arrhythmias in sarcoidosis: a population-based inpatient analysis. *Ann Transl Med*. 2018;6:330.
5. Tandon V, Gabriel A, Khurana A, Tandon A, Balakumaran K. Cardiac sarcoidosis: a national analysis OF arrhythmias, conduction blocks, and ICD'S. *Chest*. 2019;156.
6. Ekstrom K, Lehtonen J, Nordenswan HK, et al. Sudden death in cardiac sarcoidosis: an analysis of nationwide clinical and cause-of-death registries. *Eur Heart J*. 2019;40:3121–3128.
7. Kandolin R, Lehtonen J, Airaksinen J, et al. Cardiac sarcoidosis: epidemiology, characteristics, and outcome over 25 years in a nationwide study. *Circulation*. 2015;131:624–632.
8. Okura Y, Dec GW, Hare JM, et al. A clinical and histopathologic comparison of cardiac sarcoidosis and idiopathic giant cell myocarditis. *J Am Coll Cardiol*. 2003;41:322–329.
9. Databases H. *Healthcare Cost and Utilization Project (HCUP)*. Rockville, MD: Agency for Healthcare Research and Quality; 2021.
10. Okada DR, Smith J, Derakhshan A, et al. Ventricular arrhythmias in cardiac sarcoidosis. *Circulation*. 2018;138:1253–1264.
11. Ipek E, Demirelli S, Ermis E, Inci S. Sarcoidosis and the heart: a review of the literature. *Intractable Rare Dis Res*. 2015;4:170–180.
12. Nordenswan HK, Lehtonen J, Ekstrom K, et al. Outcome of cardiac sarcoidosis presenting with high-grade Atrioventricular block. *Circ Arrhythm Electrophysiol*. 2018;11, e006145.
13. Kumar S, Barbhaiya C, Nagashima K, et al. Ventricular tachycardia in cardiac sarcoidosis: characterization of ventricular substrate and outcomes of catheter ablation. *Circ Arrhythm Electrophysiol*. 2015;8:87–93.
14. Doughan AR, Williams BR. Cardiac sarcoidosis. *Heart*. 2006;92:282–288.
15. Ahmed S, Mohammed SF, Majure D, et al. Characteristics and outcomes of LVAD recipients with cardiac sarcoidosis. *J Heart Lung Transplant*. 2017;36.