ISSN: 2634 - 6796

Journal of Cardiology Research Reviews & Reports

SCIENTIFIC Research and Community

Research Article

Open Access

Unplanned Thirty-Day Readmission after Surgical Myectomy for Hypertrophic Obstructive Cardiomyopathy: Using the Nationwide Readmission Database

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ABSTRACT

Hypertrophic Obstructive Cardiomyopathy (HOCM) often masquerades as coronary artery disease. Symptoms which persisted after a 30-day readmission following surgical myectomy included; angina-like chest pain owing to myocardial ischemia, shortness of breath/dyspnea, atrial fibrillation and diastolic dysfunction. HOCM is the most common inherited cardiac disorder. Our study honed-in on the predictability of readmission's surging healthcare resources; for example, the cost and length of stay utilization after surgical myectomy. Recent theories about the cause of hypertrophy in HOCM patients have been linked to inefficient utilization of ATP. The purpose of this study is to access the incidence, predictors, as well as the causes for readmission in HOCM patients who undergo surgical myectomy. We wanted to investigate the incidence so as to better predict the causes for symptoms after a thirty-day readmission rate following surgical myectomy. Readmission nationwide rates from January 2010 to September 2015's database was investigated to find out about the 30-day unplanned readmission after surgical myectomy. International Classification of Disease; ninth Revision, and Clinical Modification were used. Patients who were readmitted consisted of those with similar ages as well as sex as well as burdened with higher comorbidities.

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Received: May 18, 2022; **Accepted:** May 27, 2022; **Published:** May 31, 2022

Keywords: Hypertrophic Obstructive Cardiomyopathy (HOCM), Surgical Myectomy, 30 - Day Symptoms after Readmission, Incidence, Predictors.

Introduction

Hypertrophic obstructive cardiomyopathy is an autosomal dominant inherited disorder with prevalence of 1:200 (or 0.5%) when genetically diagnosed in family members or prevalence of 1 in 500 (that is; 0.2%) when accounting for the general population [1, 2]. Sarcomeric mutations of eighteen genes that code for myofilaments has been found as a cause with many hundreds of HOCM causing mutations being dispersed over many loci of the 18 genes [3, 4].

The cost of readmission plus those who are readmitted lead to worsened outcomes [5]. Copious conditions connected to interventional cardiovascular diseases have been reported for predictors, causes and incidence for 30-days readmissions [6-8]. Data was gathered from the largest readmission database in the United States.

A reversed septal curvature causing a crescent-shaped LV cavity predicts gene-positive patients [9]. Myocardial ischemia can be caused by narrowing of the intramural penetrating coronary arteries, arteriolar intimal as well as media increase in the number of cells. This narrowing's makes surgical myectomy the leading management option [9]. Most symptoms that occur happen at the commonest location of obstruction which is the Left Ventricular Outflow Tract. LVOT occurs due to systolic anterior motion (SAM). We predict changes the affect anterior motion especially during systole will be one of few causes of readmissions after 30 days when patients undergo surgical myectomy. HOCM is a diastolic issue meaning less blood volume is pumped through to the aortic valve. This thickness allows the left ventricle to generate

enough pressure to overcome that of the aortic pressure but tends to do it too quickly because the chamber size cannot expand enough to pump the required blood volume forward. This can create stress in the systemic circulation and therefore physiologic mechanisms to increase blood volume and decrease systemic pressures occurs which can further worsen LVOT, create fluid overload and lead to atrial fibrillation especially of the mitral valve and mitral-septal contact. Surgical options like left ventricular myectomy have outcomes that are good provided patients remain compliant with treatment because it decreases the first symptom which is sudden cardiac death and helps to reduce readmissions [10,11].

Symptoms that can occur after 30-day readmissions following surgical myectomy include chest pain or pressure occurring during exercise or physical activity or at rest, shortness of breath mainly with exertion and fatigue. Atrial fibrillation that occurs can lead to syncope and also arrhythmias are also likely especially after myocardial infarction or following myectomy due to possible ischemia. HOCM is a lifelong condition and symptoms can still persist even after myectomy (has low-surgical mortality incidence of 1% when performed) [12]. Systolic anterior motion (SAM) is caused by an anatomic overlap between the inflow and outflow regions of the left ventricle. Narrowing of the LVOT and the anterior position of the coaptation point places the protruding leaflet into the edge of the flow stream and hence causing obstruction [13]. When intervention is contemplated, the site of obstruction must be ascertained in every patient. The main aim of this research study was to 'bring to light' predictors, incidences and causes of readmission after 30-days following surgical myectomy. Also, additional resource utilization in terms of healthcare costs and the length of stay was also studied.

Materials and Methods

Healthcare Cost and Utilization project (HCUP), releases National Readmission Data (NRD). The NRD data are sampled from twenty-two (22) different as well as individual states inpatient databases. This can be approximated to about 50% of all hospitalizations nationwide. NRD encompasses all discharges that occurred from all hospitals which are each only known by their de-identification number in the states they participated in. Each entry shows a unique verified patient linkage number which is employed to track such patients across several hospitals [14].

Data sampled from January 2010 to September 2015 were included and analyzed. Our team included all adult patients from the ages of ≥ 18 years and above from the NRD. Those patients who underwent ASA were of particular interest for surgical myectomy and were included. Selection occurred through the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Adult patients with concomitant HOCM diagnosis were of particular research interest and were included through the selection of ICD-9 code 425.1. We counted the first readmission for patients with two or more readmissions within 30-days as well as those patients with only non-elective readmissions that happened within the span of 30 days after being discharged were eligible for surgical myectomy and were included.

Exclusions criteria; index admissions that occurred from December 1st to 31st 2009 (at 11:59pm) were excluded. Patients had to be in January 2010. Those who did not meet the 30-readmission period even if they spent twenty-nine and half days were excluded. Patients below age 18 years were excluded. Those with no comorbidities were excluded. Those patients with discharge information that were missing and those who passed away during the index admission were excluded.

Comorbid disorders associated with chronicity were also of particular interest and were identified, summarized, and categorized on the basis of the Charlson–Deyo Comorbidity index (CCI). The CCI is a summarized score which is calculated in accordance with the presence of comorbid conditions. The CCI entails a list of 29 comorbid conditions with each condition being weight assigned from 1 to 6. Such a design was retrieved from the relative risk estimates for proportional hazard regression models using clinical data [15]. Such variables gotten were used to generate a comorbidity score for which each patient was grouped into three categories (that is; 1 to 3, 4 to 6 or ≥7 comorbidities) [16].

Univariate and multi-variate analytic factors considered for patients encompassed payer information. They entailed; Medicaid, Medicare, private insurances, no charge, other, self-pay). Also included Patient in NRD as a continuous variable and categorized for analysis was; age. When it came to code generation, ICD-9-CM diagnostic codes were pooled from comorbidities like prior cerebrovascular disease, prior myocardial infarction, dyslipidemia, atrial fibrillation, prior coronary artery bypass graft, prior percutaneous coronary intervention and major complications like acute renal failure (ARF), acute myocardial infarction, acute stroke, pacemaker placement and bleeding needing transfusions.

Costs of hospitals were generated through the merging of hospital charges with the cost-to-charge ratio files given with the data set. Costs were adjusted for inflation through the use of US Bureau of Labor Statistics Consumer Price Index, setting 2019 as the year of reference [17]. Time-to-readmission variables and primary admission dates as well as length of stay were sort after to compute the readmission number of days. Descriptive analyses were done for readmission through; readmitted vs. non-readmitted hospital status. Mean and standard deviation (SD) were reported for variables that were continuous, and categorical variables were reported in percentages. Unpaired t-test was sort after to compare continuous variables with normal distribution as well as Rao-Scott chi-square when the variables were categorical for example high vs low. When it comes to the choice of covariates, multivariate analyses were addressed on the descriptive nature of the analysis. Cost analysis was done through linear regression. Extraction of virtually all data as well as performance analysis was achieved through SPSS 26). Based on all imputed information, reports were provided in the form of effect sizes, 95% confidence intervals (CI), and finally the p-values.

Results

The 30-day unplanned readmission rate was 6.4%. We identified (537) patients after surgical myectomy was performed. The average age was 56 years. Readmissions proceeded to include hospitalization costs of about $10.654 U.S. dollars with a hospital stay of about 6.5 days. Unplanned readmission predictors of liver disease in a 30-day period were (adjusted odds ratio

[OR] 5.47, 95% confidence interval [CI] 1.22-5.59), renal failure (OR 2.30, 95%CI 1.52-3.50), prior myocardial infarction (OR 1.97, 95%CI 1.35-22.4), P=.016 Hypertension (OR 3.71, 95% CI 1.06-12.8), P=.036 COPD (OR 2.06, 95%CI 1.02-3.84), P=.042 Atrial fibrillation (OR 2.11, 95% CI 1.28-3.26), P=.001). Pertinent reasons for readmissions included atrial fibrillation (10.7%), acute on chronic systolic heart failure (15.2%), paroxysmal ventricular tachycardia (6.4%), atrioventricular block (5.9%), and HOCM (7.2%).

Approximately 5,462 admissions of surgical myectomy patients occurred in the United States between the study periods. Out of those, about 537 (6.4%) were met with unplanned readmissions within the span of about 30-days of which those readmitted in 30-days had similar ages. Female sex comparisons with patients of female sex that were not readmitted showed those readmitted had higher percentages of renal failure, prior pacemaker use, deficiency anemia, prior myocardial infarction, atrial fibrillation, on maintenance dialysis, and on Medicaid insurance.

Table1: Baseline characteristics of SM and ASA in initial hospitalization

	Septal Myectomy (SM) (n=5462)	Septal Alcohol Ablation (ASA) (n=18555)	P- value
Age (average, y/o)	62.5	65.8	0.03
Gender (female, %)	44.0	38.6	0.5
Hospital size (admission to large hospital, %)	70.6	70.2	.08
Requiring ICU level care (%)	10.6	4.17	< .005
Hospital stays complicated by shock (%)	1.66	0.4	< .005
Discharge requiring rehab (%)	3.7	0.6	< .005
Length of stay (days)	12.15	5.42	< .005
Total hospital cost ($)	225,793	123,350	< .005
In-patient Mortality Rate (%)	3.26	0.86	OR 12.76 P< 0.005

Discussion

Table 1; has the results of our study conducted which was based on investigating the incidence so as to better predict reasons behind symptoms occurring after a thirty-day readmission rate following surgical myectomy. To better predict, we needed to compare our research with similar age group of patients as well as gender to better ascertain these predictors. Female percentage was around 44%, while 'discharge requiring rehab' was 3.7% when compared to only 0.6% for ASA. However, our study focuses on length of stay which is more than twice that of ASA patients on average. The cost of surgical myectomy is much greater than that of Alcohol Septal Ablation (ASA). It would make sense that ASA would be preferred by most physicians which could be true. ASA was 18555 in total sample size when compared to 5302 sample size for surgical myectomy. The higher sample size in statistics is very crucial as more procedures doesn't always mean patients perform better when symptoms are due to obstruction. Surgical myectomy cures the symptoms of HOCM while also relieving the obstruction. HOCM is usually managed with beta blockers. However, patients tend to complain of outflow obstruction which leads to less blood supply leaving the heart and hence decreased cardiac output which further leads to severe weakness, shortness of breath. With surgical myectomy, there is significant improvement in patient's lifestyle. The procedure also takes four to six hours to perform which is ideal for medication non-compliant patients and patients are kept for seven to ten days post operation for observation. Most patients typically noticed a big improvement in their breathing and lifestyle patterns.

Most physicians prefer surgical myectomy since ASA has higher rates of pacemaker implantations and reintervention. In addition, surgical myectomy symptoms almost completely disappear when the symptoms are as a result of obstruction. 30-day unplanned readmission resulted in 6.4% after surgical myectomy for HOCM patients. Comorbidities centered around liver diseases, prior pacemaker use, current or history of atrial fibrillation, chronic renal failure, prior myocardial infarction just to name a few were adversely affected in terms of costs following surgical myectomy. Cardiovascular diseases were linked to most common pitfalls that resulted from unplanned 30-day readmissions. The substantial length of stay; that is, beyond 30 days, increased hospitalization costs of readmissions. The Readmissions Reduced Hospital Program was enacted through the Affordable Care Act with the primary purpose of curtailing readmissions rate in three high volume cases or conditions which include; pneumonia, acute myocardial infarction and congestive heart failure [18].

Though therapy with surgical myectomy improves LVOT significantly per some studies for HOCM patients, culprits for both atherosclerosis and arteriosclerosis like hypercholesterolemia must be detected and managed since HOCM and coronary disease have adverse synergistic effect on prognosis. It is also possible that patients were started on beta blocker or to a lesser degree, verapamil which causes chronotropic incompetence in HOCM patients who might also be treated with surgical myectomy [19]. These could be causes for readmissions after 30 days. Beta blockers delay early trigger of Systolic anterior motion (SAM) which can reassert chordal tension by papillary muscle shortening to provide countertraction to prevent SAM. In some cases, verapamil can lead to vasodilation, pulmonary edema and death. Patients can also have fluid overload with edema or rales and could benefit from diuretics. It is possible to also suspect Amyloid as a cause especially if the ECG QRS voltage is low. It depends on initial management before resorting to surgical myectomy.

Readmissions rate for acute myocardial infarctions, pneumonias and congestive heart failures in 2013-2014 amounted to about 14.7%, 15.5%, and 23.5% respectively [20]. After program implementation, readmissions rate curtailed significantly in those targeted diseases as well as in non-targeted conditions [21]. After percutaneous coronary intervention, the 30-day unplanned readmissions rate was 5.7% which was relatively similar to readmission rate after surgical myectomy. Unplanned readmissions rate for surgical myectomy is very relatively low since surgical myectomy is only offered in limited facilities with special expertise. This creates bias in selection. Appropriately selecting particular patients who are symptomatic after 30-day readmission helps clarify discharge with instructions as to follow-up. Physiologic stimuli like Valsalva, standing and exercise can be used to provoke gradient and be correlated to symptoms of obstruction and help to focus therapy when surgical myectomy patients continue to present with symptoms after 30-days of readmission.

Candidates for surgical myectomy have persistent disabling symptoms and gradients of > 50mm Hg at rest or following physiologic provocation. It reduces both gradient and symptoms when performed. Interventions are not always successful. Some causes for symptomatic 30-day readmission after myectomy could be if the resection focused on just the subaortic septum,

targeted to widen the outflow tract and curtail Venturi forces [22]. Such symptoms lead to SAM and obstruction. That is, a limited myectomy misses the impact of the mid-ventricular septal bulge that redirects LV flow so that it comes from a relatively posterolateral direction [23]. This sort of resection can lead to persistent SAM and either outflow obstruction or mitral regurgitation. Symptoms are almost non-existent when myectomy resection is extended far enough down toward the apex so as to permit flow to tract anteriorly.

Interventions that were reported in the past thirty years have helped to curtail readmissions though readmissions cases still continue to exist. Such interventions entailed telephone follow-ups, home visits, tele-monitoring, follow-up scheduling as well as discharge planning. These interventions helped to curtail the risk of early readmissions by 15% as well as serving a more effective approach when interventions with several components became participants [24]. Reasons for the most frequent readmissions include chest pain or pressure occurring during exercise or physical activity or at rest, heart failure, shortness of breath mainly with exertion and fatigue, atrial fibrillation sometimes leading to syncope and arrhythmias likely from acute myocardial infarction. It is pertinent to know that past researches have shown that by reducing heart failure readmissions and medication adherence, interventions with surgical myectomy would achieve highly futile outcomes [25].

Diseases specific to interventions have to be strongly considered when it comes to common readmission causes. Left ventricular wall thickness or hypertrophy eventually leads to left ventricular outflow obstruction (LVOT), diastolic dysfunction and myocardial ischemia [26]. Disopyramide is given to patients who are refractory to beta blockers and hence requires intervention with surgical septal myectomy. Myectomy is the treatment of choice for patients who fail medical therapy and continue to be symptomatic [27]. Another cause can be through acute decompensation in acute onset atrial fibrillation. Loss of atrial kick and rapid heart rate provokes heart failure symptoms following surgical myectomy after 30 days of readmission. Pulmonary congestion, cardiogenic shock, are also possible acutely and the complete relief plus reversal of symptoms LVOT indicates that symptoms were caused by dynamic obstruction due to Systolic anterior motion (SAM) of the mitral valve and mitral-septal contact.

Recommendations

Lifestyle changes like avoiding competitive sports can decrease symptoms. Regular follow-ups with the cardiologist is also crucial. Medical therapy is also required to minimize symptoms of readmissions like chest pain, dyspnea and new onset of atrial fibrillation which can lead to syncope. A step that could be taken to curtail patient readmissions for atrial fibrillation could entail maintenance of sinus rhythm particularly in heart failure patients [28].

Conclusion

Myectomy is the treatment of choice for patients who fail medical therapy and continue to be symptomatic. Surgical myectomy reduces both gradient and symptoms of HOCM. Interventions to curtail symptoms of 30-day readmission after surgical myectomy are not always successful. Resection focused on just the subaortic septum will widen the outflow tract and curtail Venturi forces. Complete relief including reversal of symptoms of LVOT indicates that symptoms caused by dynamic obstruction are due to SAM of the mitral valve and mitral-septal contact.

Limitations to Study

Some limitations for our study include; 1) using ICD-9 codes to find out diagnosis. Procedures were not validated and as such were prone to errors and miscoding, 2) since our study was observational, employing such administrative database sets the platform for biases as well as residual confounding variables, 3) thirdly, readmissions which lead to atrial fibrillation fell short of classifying as to whether readmissions were based solely on new-onset atrial fibrillation or possibly a worsening of chronic atrial fibrillation.

Code Availability: Non-applicable

Author Contributions

Data collection process:

1. From HCUP specifically on NRD.
   (Dr. Tomo Ando, Dr. Aubin Sandio)
2. Data collection of outpatient/inpatient, conducting research, writing the manuscript
   (Dr. Smart Asare, Dr. Aubin Sandio, Dr. Christina Reji, Dr. Donald Tynes)
3. Interpreting results; figures, results, discussions, recommendations, limitations to study and Reviewing (Dr. Mohan Palla, Dr. Smart Asare, Dr. Eric Ayers, Dr. Patrice Delafontaine and Dr. Pascal Kingah)
4. Data Availability; HCUP via NRD; patients visit; inpatient/ outpatient; non-applicable.

Declarations

Consent to Participate: Non-applicable

Consent for Publication: Non-applicable

Conflict of Interest: The authors declare no competing interests

Acknowledgments: None

Disclosures: All authors have no disclosures

Funding: There was no extramural funding for this research

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