ORIGINAL RESEARCH

Congenital Heart Disease (CHD) in Seniors: a Retrospective Study Defining a Brand New Cohort

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ABSTRACT

Background:

With improved surgical techniques and medical therapy, patients with congenital heart disease (CHD) are now expected to achieve normal life expectancies. As a result, a new cohort of senior patients with adult congenital heart disease (ACHD) is emerging which has not been well characterized.

Methods:

This study is a retrospective chart review of patients with moderate to complex CHD over the age of 60 years in Southern Alberta. We examined the number, length, and reasons for hospitalizations, and identified common adult comorbidities.

Results:

A total of 84 patients with CHD who were 60 years or older were identified. The average age was 67.9 ± 6.6 years, with the majority of patients having moderate CHD. The most common cardiac comorbidities were arrhythmia, hypertension, and heart failure, which were also the most common reasons for hospital admission. There were 1.85 admissions per 10 patient-years, with a median length of stay of 6.0 (3.8–10.5) days.

Conclusions:

With advanced age, the ACHD population is at risk of developing significant medical burden from acquired cardiac comorbidities, resulting in hospitalization. This analysis provides insight into disease characteristics of seniors with CHD. Further studies are needed to better understand this population and the association with geriatric syndromes.

Key words: congenital heart disease, seniors, hospitalization, cognitive impairment

INTRODUCTION

Congenital heart disease (CHD) is usually diagnosed during pediatric years, affecting over one per cent of newborns.(1) A Quebec study by Marelli *et al*.(1) estimated the prevalence of all CHD in children to be 11.9 per 1,000 in the year 2000. Before the development of contemporary surgical techniques, many children with CHD did not survive into adulthood, and those with complex forms did not survive past one year.(1,2) Due to advances in medical and surgical therapy, there has been a 60% decrease in mortality among children with CHD over the past two decades.(2) As a result, patients with CHD are now living into adulthood, with many predicted to have a normal life expectancy. This has resulted in a drastic demographic shift, with more adults than children now living with complex CHD.(2,3)

Given increased longevity, patients with CHD are now living long enough to acquire adult medical conditions and are at high risk for developing acquired cardiac diseases. A population-based case control study showed an increased prevalence of cardiac comorbidities such as atrial fibrillation, heart failure, hypertension, and stroke among adult patients with CHD compared with age- and sex- matched controls.(4) Subsequently, Islam *et al*.(5) showed a 4.0% per year increase in number of hospitalization for patients with CHD over the age of 18 from 2003 to 2012, with late cardiac events such as heart failure, ischemic heart disease, and atrial fibrillation to be the most common reasons for hospitalization. Patients with adult congenital heart disease (ACHD) have also been documented to have a longer mean length of stay in hospital (11.5 days) compared to adults in the general population (8.0 days).(6) Hence, hospital admissions in the ACHD population represent a significant burden on health-care resources.

Many prior studies examine adult patients with CHD over the age of 18, with little data specifically on patients over the age of 60 years. Thus, the later life of patients with ACHD

remains poorly studied. There is limited data on the types of acquired comorbidities and the burden of comorbid disease in senior patients with CHD. Additionally, there is limited data on specific geriatric syndromes among senior patients with CHD, particularly cognitive impairment and dementia. As a result, the aim of this study was to describe patients with moderate to complex CHD over the age of 60 years residing in Southern Alberta, and to determine acquired adult comorbidities and hospital resource utilization in this novel patient population.

METHODS

Study Design, Setting, Study Population

This study was a retrospective cohort chart review of patients 60 years or older with moderate to complex CHD (as defined by Bethesda criteria)[7] in the Southern Alberta Adult Congenital Heart Clinic (CAPS 2.0 database). Patients who were part of the clinic from 1994 to 2018 were identified. Years of follow-up were determined by the number of years between the first and last clinic visit.

Variables

The patients' paper clinic charts consist of information from clinical evaluations, emergency room visits, and patient hospitalizations. Data extracted included: age at time of data collection; age at time of diagnosis of CHD; sex; type of CHD; complexity of disease; number and type of comorbidities (cardiac and non-cardiac) accumulated at the time of data extraction; number of hospitalizations; reason for hospitalization; length of hospital stay; employment; and highest level of education. Complexity of disease was determined using the Bethesda Criteria (simple, moderate, complex), developed by the American College of Cardiology Task Force 1 of the 32nd Bethesda Conference.[7] For the purposes of this study, admissions for cardiac surgeries pertaining to the underlying CHD were excluded. Coronary artery disease was only diagnosed if proven by coronary angiogram or if there was a history of percutaneous coronary intervention or aorto-coronary bypass. A history of arrhythmia was recorded if there was any type of documented supraventricular or ventricular arrhythmia. Heart block was defined as documented atrioventricular block.

Statistical Methods

Descriptive statistics were performed to characterize the population. For categorical variables, proportions were calculated as percentages. For continuous variables, means, medians, standard deviation (SD), and interquartile ranges (IQR) were calculated based on the distribution of the data. Dichotomous end points were compared using chi-squared tests or Fisher's exact tests, where appropriate. Continuous variables of independent samples were compared using two sample *t*-tests. A 2-sided *p* value less than .05 was considered statistically significant. Number of patient-admissions were documented as admissions per 10 patient-years, calculated using the sum of all years of follow-up. Statistical analyses were conducted using SPSS Version 25.0 (IBM® SPSS® Statistics software licensed at the University of Calgary). This study was approved by the Health Research Ethics Board of the University of Calgary.

RESULTS

Baseline Characteristics of Study Population

Demographic and baseline characteristics of the study population are presented in Table 1. A total of 84 patients with CHD who were 60 years or older in Southern Alberta were identified. The average age of patients was 67.9 ± 6.6 years, and the average age at diagnosis was 25.8 ± 25.5 years. The majority (93%) of patients had Bethesda group 2 or moderate disease. The distribution of types of CHD lesions among this population is shown in Figure 1. The most common cardiac comorbidities are shown in Figure 2, with the leading cardiac comorbidity being hypertension (54%), followed by atrial fibrillation (36%), other tachyarrhythmias (32%), heart block (30%), and heart failure (30%). Assessment of non-cardiac comorbidities revealed a high proportion of vascular risk factors, which included dyslipidemia (39%), history of smoking (32%), and history of stroke (25%). Mood disorders were also

TABLE 1.
Patient characteristics

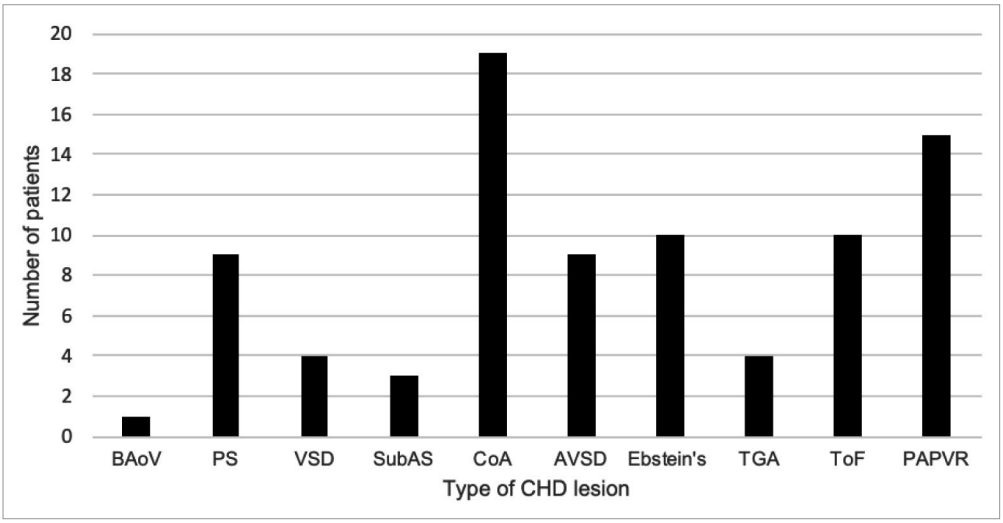
Patient Characteristics	*N = 84*
Sex, % (n)	
Male	52% (44)
Female	48% (40)
Age at Iinclusion (years) (mean ± SD)	67.9 ± 6.6
Age at Diagnosis (years) (mean ± SD)	25.8 ± 25.5
Bethesda Group, % (n)	
complex	7% (6)
moderate	93% (78)
Cardiac Comorbidities, % (n)	
Atrial Fibrillation	36% (31)
Tachyarrhythmia (other than Atrial Fibrillation)	32% (27)
Heart block	30% (25)
Heart Failure	30% (25)
Stroke	25% (21)
Coronary Artery Disease	18% (15)
Vascular Risk Factors, % (n)	
Hypertension	54% (45)
Dyslipidemia	39% (33)
Current or previous smoker	32% (27)
Obstructive Sleep Apnea	23% (19)
Type 2 Diabetes	13% (11)
Non-cardiac Comorbidities, % (n)	
Depression/Anxiety	25% (21)
Osteoarthritis	21% (18)
Chronic obstructive lung disease	19% (16)
Hypothyroidism	18% (15)
Malignancy	17% (14)
Gastric esophageal reflux	14% (12)
Gout	13% (11)

common, with one-fourth of the population having a medical diagnosis of depression or anxiety. Of the 76 patients who had data on employment history, 84% (n=64) were currently or previously employed. There was limited data on level of education and, therefore, this was not analyzed. No formal assessments of cognitive function were available.

Hospitalizations

Of 84 patients, 43 (51%) patients were admitted to hospital in adulthood, with a total of 83 admissions. Of these 83 admissions, 58% (n=48) were admitted for cardiac complications outside of planned admissions for cardiovascular surgery. The most common cardiac reasons for admission were arrhythmias (27%), heart failure (18%), and chest pain (13%) (Figure 3). Of the arrhythmia admissions, 18% were diagnosed with atrial fibrillation or an intra-atrial re-entrant tachycardia (IART). Of the admissions related to non-cardiac complications, the most common reasons for hospitalization were pneumonia, chronic obstructive pulmonary disease, and intra-abdominal pathology. There was an average of 1.98 ± 1.7 admissions documented per patient, translating to 1.85 admissions per 10 patient-years. The median length of stay in hospital was 6.0 days (3.8–10.5) days. Data for length of stay was obtained from 57 admissions.

Baseline characteristics of patients admitted to hospital and those not admitted to hospital are shown in Table 2. Older patients with CHD who are hospitalized have a significantly higher proportion of diagnosed SVT (28% vs. 7%, p = .02)



BAoV = bicuspid aortic valve, PS = pulmonary stenosis, VSD = ventricular septal defect, SubAS = subaortic stenosis, CoA = coarctation of the aorta, AVSD = atrioventricular septal defect, Ebstein's = Ebstein's anomaly of the tricuspid valve, TGA = transposition of the great arteries, ToF = tetralogy of Fallot, PAPVR = Partial anomalous pulmonary venous return.

FIGURE 1. Congenital heart disease lesions of older adults

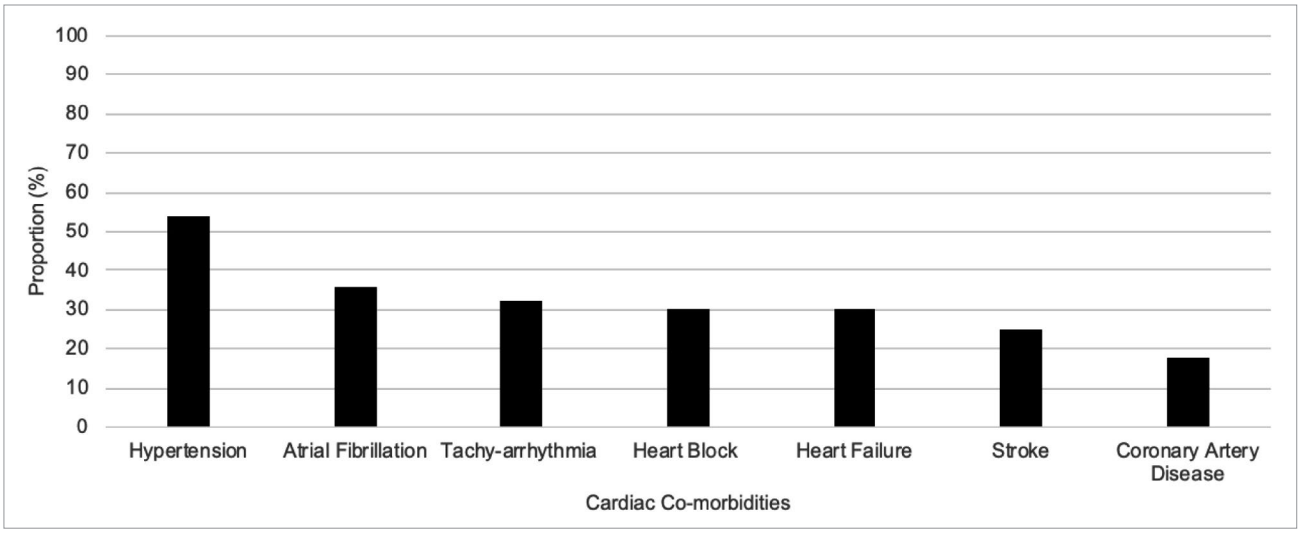


FIGURE 2. Distribution of common cardiac comorbidities diagnosed in older adults with CHD (n=84 patients).

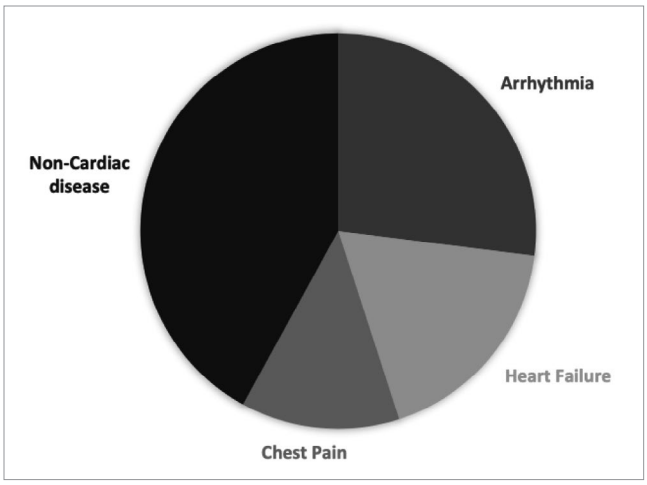


FIGURE 3. Reasons for presentation and admission to hospital among older adults with CHD (n=83 admissions)

and heart failure (40% vs. 20%, $p = .04$). The proportion of diagnosed CAD in the hospitalized group is almost double that of patients not admitted to hospital, but did not reach statistical significance (23% vs. 12%, $p = .19$). Of the non-cardiac comorbidities, the hospitalized group have a significantly higher proportion of diagnosed gastric esophageal reflux (23% vs. 5%, $p = .02$).

There were 40 emergency department visits documented for 24 patients with an average of 1.67 ± 1.2 emergency visits per patient. This translates to 1.59 emergency visits per 10 patient-years. Of these 40 visits, 73% (n=29) were for cardiac complications, including chest pain (25%), atrial fibrillation (15%), presyncope/syncope (12.5%), and palpitations (10%).

DISCUSSION

This study is the first retrospective chart review describing the novel senior CHD population. Previously published studies have relied on administrative data alone, typically focusing on a population of patients with ACHD under the age of 60. This study shows that elderly patients with CHD are high users of the health-care system, with 51% of senior patients with CHD from Southern Alberta being admitted to hospital at a rate of 1.85 admissions per 10 patient-years. Local admission data on the general population in Calgary, Alberta obtained from Alberta Health Services (AHS) shows an admission rate of 0.8 admissions per 10 patient-years during the fiscal year of 2015–2016.[8] This is a clinically significant lower admission rate compared to this older CHD population. However, we do recognize that these data are not specific to the general senior population over the age of 60 years.

Our study results are in correspondence to the high burden of cardiac comorbidities among senior patients with CHD and subsequent complications resulting in hospital admission. The majority of patients had a documented arrhythmia (68%), in particular atrial fibrillation and IART; arrhythmias were also the most common reason for hospital presentation, defined as emergency visits without admission and admissions to hospital.

Those patients who were hospitalized had a significantly higher proportion of diagnosed SVT, heart failure, and a trend towards more CAD. This patient population was also found to have a high burden of vascular risk factors, with over half of the patients being diagnosed with hypertension and one-quarter of patients having had a previous stroke. As a result, we can conclude that patients with CHD develop acquired cardiac comorbidities and vascular risk factors in adulthood, which become more prevalent with advanced age and result in cardiac events that often require in-patient management.

There is a theoretical increased risk of cognitive impairment in senior patients with CHD; however, it has not been well studied. We were unable to obtain data on cognitive function as very few hospitals had documented cognitive assessments in their charts; however, we were able to identify that a high proportion of senior patients with CHD are or have been employed. This is in contrast to findings by Ilardi *et al*.[9] who reported that patients with ACHD had an increased likelihood of being unemployed or on disability, which was associated with greater executive dysfunction. As a result, employment may be a protective factor in this senior CHD population. The lack of cognitive assessments performed is notable in itself. It suggests a missed opportunity for early identification of cognitive dysfunction, and an avenue for future study.

Our results are comparable to those documented by Afialo *et al*.[10] who characterized the geriatric CHD population in Quebec between 1983 and 2005 and reported 47% of their population to have hypertension, 27% to have dyslipidemia, and 21% to have atrial fibrillation, with 10% diagnosed with a stroke or TIA. Billett *et al*.[4] characterized all registered patients with CHD in 2005 from the UK, with a mean age of 28 years, and reported hypertension to be the most common comorbidity in 9.3% of cases, followed by atrial fibrillation in 4.3% of cases, with 2.6% of cases having had a stroke or TIA. The proportion of patients with these comorbidities is lower than seen in our population; however, this is likely secondary to the age difference, as only 11% of patients with CHD in their study were 60 years or older and age is a well-established cardiac risk factor. Furthermore, Islam *et al*.[5] and Verheugt *et al*.[11] demonstrated late cardiac events such as congestive heart failure, ischemic heart disease, and supraventricular arrhythmia to be the most common reasons for admission among all patients with CHD. From 1996 to 2000, a total of 214 hospitalizations per 1,000 patient-years was documented for all patients with CHD in Quebec.[6] Hence, prior research has concluded that patients with CHD are living long enough to acquire general medical conditions[11] and have higher health-care utilization and admission rates compared to the general population.[4,11]

This study contributes to the current literature as it the first to examine senior patients with CHD through a retrospective cohort study and describe disease characteristics specific to CHD, as well as acquired medical conditions that come with older age. We also describe corresponding complications that

TABLE 2.
Patient characteristics of senior patients with CHD who were hospitalized and those who were not hospitalized

Patient Characteristics	*Hospitalized N=43*	*Not Hospitalized N=41*	*p value*
Sex, % (n)			
Male	47% (20)	59% (24)	
Female	53% (23)	41% (17)	.27
Age at Inclusion (years) (mean ± SD)	67.7 ± 5.3	68.3 ± 7.8	.67
Age at Diagnosis (years) (mean ± SD)	26.7 ± 26.8	25.1 ± 24.4	.78
Years of Follow Up(mean ± SD)	10.4 ± 5.7	8.2 ± 6.2	.11
Bethesda Group, n (%)			
complex	9% (4)	5% (2)	
moderate	91 % (39)	95% (39)	.43
Cardiac Comorbidities, % (n)			
Atrial Fibrillation	42% (18)	32% (13)	.33
SVT	28% (12)	7% (3)	**.02**
Heart block	35% (15)	24% (10)	.29
Heart Failure	40% (17)	20% (8)	**.04**
Stroke	30% (13)	20% (8)	.26
Coronary Artery Disease	23% (10)	12% (5)	.19
Vascular Risk Factors, % (n)			
Hypertension	56% (24)	51% (21)	.67
Dyslipidemia	44% (19)	34% (14)	.35
Current or previous smoker	30% (13)	34% (14)	.70
Obstructive Sleep Apnea	21% (9)	17% (7)	.65
Type 2 Diabetes	12% (5)	12% (6)	.68
Non-cardiac Comorbidities, % (n)			
Depression/Anxiety	26% (11)	24% (10)	.90
Osteoarthritis	28% (12)	15% (6)	.14
Chronic obstructive lung disease	21% (9)	17% (7)	.19
Hypothyroidism	23% (10)	12% (5)	.19
Malignancy	14% (6)	20% (8)	.49
Gastric esophageal reflux	23% (10)	5% (2)	**.02**
Gout	14% (6)	12% (5)	1.0

bring these patients into hospital. The data from this study can aid in guiding future practice in the management of senior patients with CHD. Many specialists caring for older adults may have never seen a patient with CHD, and our study highlights the need for lifelong and collaborative care. Despite our study limitations, we can conclude that the increasing number of acquired vascular risk factors and cardiac comorbidities are relevant in defining outcomes in older adults, specifically SVT and heart failure.

Currently, there is limited data assessing adequacy of vascular risk factor management in these patients, but it is important to recognize that older patients with CHD are a high- risk population, and it is important to aggressively manage modifiable vascular risk factors to reduce cardiac events and subsequent hospitalizations. Furthermore, there was a high proportion with atrial fibrillation, likely secondary to underlying structural defects, which correlates with the high frequency (25%) of stroke in this population.[12] We can postulate that suboptimal vascular risk factor management, including inadequate use of antiplatelets, in this population would increase the risk of cardioembolic stroke and vascular dementia.[13,14,15,16] As a result, there is opportunity to intervene early to reduce the risk of cardiac events and complications such as heart failure, stroke, and cognitive impairment.[16,17] The disproportionate burden of disease suggests a need for increased resources and ACHD specialist care for this growing population of older adults. More broadly, a multidisciplinary care team approach is needed to evaluate and address the psychosocial struggles, including depression, which are associated with worsening cognitive function in older adults.[18]

The primary limitation of this study is its retrospective design and susceptibility to measurement bias from the use of chart reviews as a key data source. The data quality is limited by availability, completeness, and accuracy of patient charts. This led to incomplete data on length of stay for the patients who were hospitalized. However, at the time of data collection, there were no documented patient deaths. Furthermore, we are unable to comment on predictors of all-cause mortality. Afilalo *et a*l.[10] described dementia, chronic kidney disease, and gastrointestinal bleeding over ACHD-related conditions to

be the most powerful predictors of all-cause mortality among their geriatric ACHD population. These conditions, however, were relatively rare among our population. Tutarel *et al*.,[19] however, found a positive association between mortality and disease severity in patients 60 years and older with CHD. Furthermore, coronary artery disease (CAD) and systolic ventricular function have been reported to be independent predictors of mortality in senior patients with CHD. Our population had a small proportion of patients with CAD, so this is difficult to generalize as a predictor of mortality; however, we may be missing diagnoses of CAD as we only included patients with CAD documented by angiogram, and the majority of our patients had at least one cardiovascular risk factor.

There is little published research focused on the cognition of older adults with CHD, but we know this population is at risk for neurocognitive dysfunction and developmental delay from a young age, with a high prevalence of executive dysfunction, lower cognitive scores, and weaker attention.[20, 21] Our study was limited in assessing cognitive function as patients did not have documented cognitive assessments available in their charts; however, there is some data to show cognitive deficits increase with age in patients with CHD and will be an important assessment for further studies. A study in Demark showed the risk of all-cause dementia increased by 60% in individuals with CHD, and the risk of developing early onset dementia (<65 years of age) was more than double.[22] This in the context of the underlying pathophysiology and significant cardiac burden of adults with CHD, which provides a platform for neurocognitive decline.[23] Risk factors for cognitive impairment include atrial arrhythmias, subsequent stroke, and heart failure[24,25,26]—comorbidities that are common among seniors with CHD. As a result, we propose that next steps are to prospectively assess dementia and cognitive impairment in senior patients with CHD.

CONCLUSION

These initial results provide insight into the cardiac and non-cardiac disease characteristics of a novel cohort of senior survivors with CHD. These patients have many risk factors for frailty, and face biophysical challenges that put them at risk for medical and cognitive decline. As a result, an improved understanding of the challenges senior patients with CHD face will aid in development of targeted medical interventions and the provision of anticipatory and preventative care, with the goal to reduce the burden of modifiable risk factors and related complications.

CONFLICT OF INTEREST DISCLOSURES

The authors declare that no conflicts of interest exist.

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