Economic and Clinical Outcomes of Hospital Care in Patients with Cardiac Amyloidosis

Tiffany P. Quock, PhD, MS[1], Jessie T. Yan, PhD[2], Ryan Tieu, MS[2], Anita D'Souza, MD, MS[3], Michael S. Broder, MD, MSHS[2]

[1] Prothena Biosciences Inc, South San Francisco, CA, USA; [2] Partnership for Health Analytic Research, LLC, Beverly Hills, CA, USA; [3] Medical College of Wisconsin, Milwaukee, WI, USA

BACKGROUND

- Cardiac amyloidosis is a rare, progressive, and fatal form of cardiomyopathy mostly found in patients with light chain (AL) and transthyretin (ATTR) amyloidosis.[1]
- Patients with cardiac amyloidosis tend to have extremely poor prognosis and require frequent hospital care.
- Improved detection and new treatments over the past several years have improved outcomes, but survival remains poor.[2]
- A recent study in US commercial claims found that inpatient hospitalizations accounted for >1/3 of healthcare costs for AL amyloidosis patients.[3]

PURPOSE

To understand patient characteristics, healthcare costs, and clinical outcomes in hospitalized patients with cardiac amyloidosis.

METHODS

Study Design and Data Source

- Retrospective, cross-sectional analysis of 2014-2016 data from Premier Perspective® Database
  - Contains complete de-identified clinical coding, hospital cost, and patient billing data from >600 hospitals throughout the US
  - Covers 20% of US hospital discharges, including all billed items (medications, laboratory, diagnostic and therapeutic services, and primary and secondary diagnoses for each patient's hospitalization)

Patient Population and Timeframe

- Hospitalized patients ≥18 years old with cardiac amyloidosis were identified if they had:
  - ≥1 inpatient claim consistent with amyloidosis [International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes: 277.30 or 277.39; International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) codes: E85.4x, E85.8x, or E85.9x] in any diagnosis field AND
  - Either cardiac involvement (defined as having an ICD-9/10 code for ≥1 of heart failure, syncope, postural/orthostatic hypertension, tricuspid/mitral regurgitation murmur, sudden cardiac death, dyspnea, edema, or ascites) or cardiac involvement plus renal disease (renal failure, nephropathy, nephrotic syndrome, dialysis, or renal transplantation) AND
  - In patients with multiple qualifying hospitalizations, the first hospitalization was included. Patients with a diagnosis for other types of amyloidosis or chronic inflammatory diseases were excluded.

Study Measures

- Patient demographic and clinical characteristics
  - Age, gender, race, payment source (Medicare, Medicaid, commercial, or other); comorbidities [Charlson Comorbidity Index, multiple myeloma, monoclonal gammopathy of undetermined significance (MGUS)]
- Hospital characteristics
  - Admission type (urgent/emergent, elective), geographic region, bed size (>500, ≤500), urban location (yes/no), teaching hospital (yes/no)
- Health outcomes
  - cost (2016 $ (USD)), utilization (length of stay (LOS) in days, intensive care unit (ICU), readmissions), in-hospital mortality

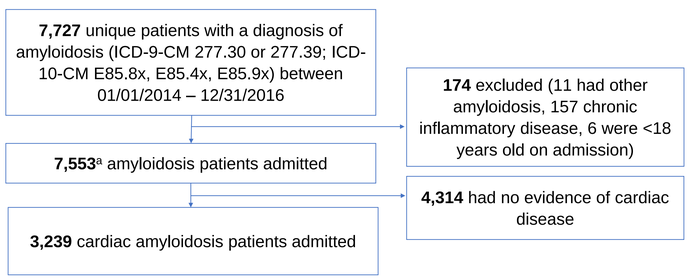
Statistical Analysis

- Descriptive statistics (means, standard deviations, and relative frequencies for continuous data, and percentages for categorical data) reported
- No statistical confidence testing was done to compare the groups studied.
- Data transformations and analyses performed using SAS© version 9.4

RESULTS

- Patient demographic and clinical characteristics
  - 3,239 patients were hospitalized with cardiac amyloidosis (**Figure 1**).
    - 1,795 (55.4%) had cardiac involvement plus renal disease, 1,444 (44.6%) had cardiac involvement only; proportions were roughly equal over all 3 study years (**Table 1**).
  - Mean (SD) age was 72.6 (11.8) years; 40.7% were female, 63.6% White (**Table 1**).
  - 77.5% were covered by Medicare (**Table 1**).
  - Patients without evidence of renal disease had fewer comorbid conditions, both as measured by Charlson index (3.0 vs. 4.7) and by the proportion with a code for multiple myeloma (11.7% vs. 16.9%) and MGUS (2.4% vs. 5.1%). (**Table 1**)
- Hospital characteristics
  - 90.9% were admitted through the emergency department (ED) and 25.2% were later admitted to the ICU (**Table 2, Figure 2**).
    - 27.9% of patients had cardiac involvement plus renal disease, 21.8% of patients with cardiac involvement only (**Figure 2**).
  - All US regions were represented; 51.3% of admissions were to teaching hospitals, and 93.3% were in urban settings (**Table 2**).
- Health outcomes
  - Mean (SD) ICU LOS was 5.1 (7.2) overall, 6.0 (8.2) for cardiac involvement plus renal disease, and 3.7 (4.9) days for cardiac only (**Figure 3**).
  - Mean (SD) hospitalization costs were $20,584 ($30,030) overall, $24,238 ($35,834) for patients with cardiac involvement plus renal disease, and $16,041 ($19,746) for cardiac only (**Figure 4**).
  - Mean (SD) overall LOS of 8.3 (11.1) for all, 9.7 (12.8) for cardiac involvement plus renal disease, and 6.7 (8.1) days for cardiac only (**Figure 3**).
  - The in-hospital mortality rate was 9.0% overall, 12.5% for patients with cardiac involvement plus renal disease, and 4.5% for patients with cardiac only (**Figure 2**).

Figure 1. Patient identification flowchart



[a] Only the first qualified hospitalization for each patient was included in the study.

Figure 2. ICU utilization and discharge status

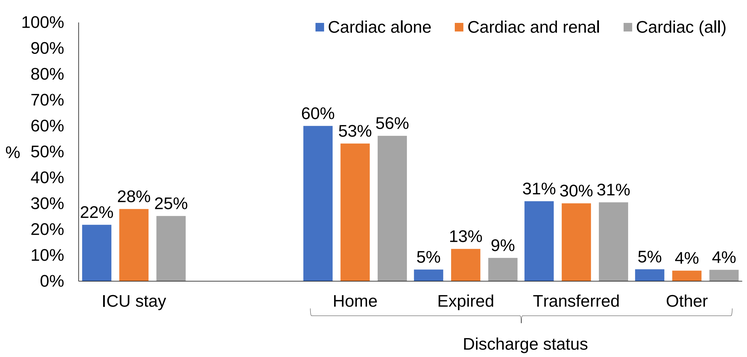


Table 1. Demographics of hospitalized cardiac amyloidosis patients

	Cardiac alone	Cardiac and renal	Cardiac (all)
N, %	1,444 (44.6)	1,795 (55.4)	3,239 (100)
Age, mean (SD)	74.3 (11.2)	71.3 (12.1)	72.6 (11.8)
Age group, n (%)			
18-34	2 (0.1)	12 (0.7)	14 (0.4)
35-54	80 (5.5)	159 (8.9)	239 (7.4)
55-64	183 (12.7)	289 (16.1)	472 (14.6)
65 or older	1,179 (81.6)	1,335 (74.4)	2,514 (77.6)
Sex, n (%)			
Female	632 (43.8)	687 (38.3)	1,319 (40.7)
Race, n (%)			
White	1,012 (70.1)	1,049 (58.4)	2,061 (63.6)
African American	256 (17.7)	488 (27.2)	744 (23.0)
Other	152 (10.5)	237 (13.2)	389 (12.0)
Unknown	24 (1.7)	21 (1.2)	45 (1.4)
Primary payer type, n (%)			
Medicare[a]	1,133 (78.5)	1,377 (76.7)	2,510 (77.5)
Medicaid[a]	61 (4.2)	115 (6.4)	176 (5.4)
Commercial	53 (3.7)	39 (2.2)	92 (2.8)
Self-pay	16 (1.1)	19 (1.1)	35 (1.1)
Managed care	151 (10.5)	199 (11.1)	350 (10.8)
Other	30 (2.1)	46 (2.6)	76 (2.3)
Charlson Comorbidity Index, mean (SD) [median]	3.0 (1.9) [3.0]	4.7 (2.1) [4.0]	4.0 (2.2) [4.0]
Other Comorbidities, n (%)			
Multiple myeloma	169 (11.7)	303 (16.9)	472 (14.6)
MGUS[a]	34 (2.4)	92 (5.1)	126 (3.9)
Manifestations, n (%)			
Carpal tunnel syndrome	3 (0.2)	6 (0.3)	9 (0.3)
Hepatomegaly	8 (0.6)	18 (1.0)	26 (0.8)
Purpura	100 (6.9)	308 (17.2)	408 (12.6)
Claudication	80 (5.5)	112 (6.2)	192 (5.9)
Stroke	256 (17.7)	112 (6.2)	368 (11.4)
Peripheral neuropathy	40 (2.8)	52 (2.9)	92 (2.8)

[a] Including traditional and managed care capitated and non-capitated plans.

Table 2. Hospital and admission characteristics

	Cardiac alone	Cardiac and renal	Cardiac (all)
N	1,444	1,795	3,239
Admission type, n (%)			
Urgent/emergent	1,311 (90.8)	1,632 (90.9)	2,943 (90.9)
Hospital region, n (%)			
Northeast	374 (25.9)	425 (23.7)	799 (24.7)
Midwest	289 (20.0)	377 (21.0)	666 (20.6)
West	235 (16.3)	323 (18.0)	558 (17.2)
South	546 (37.8)	670 (37.3)	1,216 (37.5)
Hospital type, n (%)			
Teaching	740 (51.2)	920 (51.3)	1,660 (51.3)
Hospital bed size, n (%)			
0-199	196 (13.6)	198 (11.0)	394 (12.2)
200-499	659 (45.6)	864 (48.1)	1,523 (47.0)
500+	589 (40.8)	733 (40.8)	1,322 (40.8)
Hospital location, n (%)			
Urban	1,325 (91.8)	1,698 (94.6)	3,023 (93.3)

Figure 4. Total costs

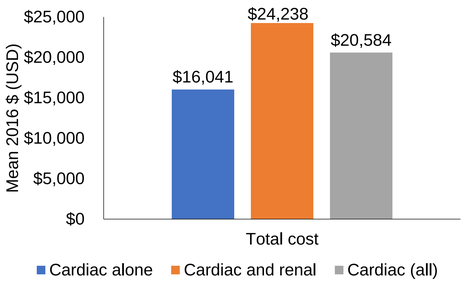
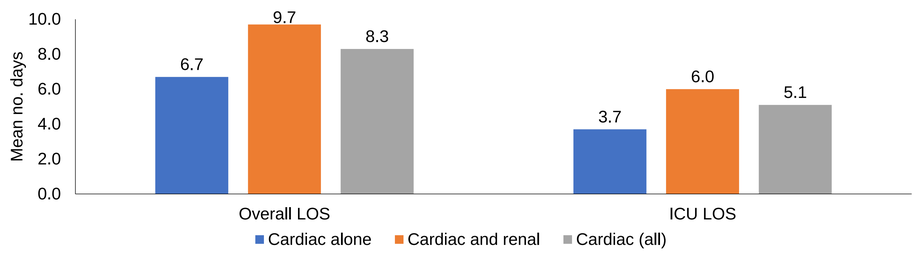


Figure 3. Mean length of stay



CONCLUSION

- Disease burden and hospital costs of cardiac amyloidosis are high.
- Average hospitalization costs for patients with both cardiac involvement and renal disease were >$24,000 (USD) / patient and many were admitted to ICU.
- New therapies aimed at improving organ response have the potential to reduce disease burden and yield substantial cost savings.
- ***Limitations***
  - Cardiac disease and amyloidosis were identified using coded data, not clinical records, possibly leading to errors because codes are primarily applied to support billing, not research.
  - Privacy restrictions that permit the use of coded data explicitly prevented us from seeking additional data on patients, so pathology, laboratory, or other clinical notes could not be used.

REFERENCES

1. Banypersad SM, et al. *J Am Heart Assoc*. 2012 Apr 23;1(2):e000364–e000364.
2. Kyle RA, et al. *Semin Hematol*. 1995 Jan;32(1):45–59.
3. Quock TP, et al. *J Comp Eff Res*. 2018. Available from: https://www.futuremedicine.com/doi/10.2217/cer-2017-0100

Declaration of interest: TPQ is an employee of Prothena Biosciences Inc, which funded this research. AD is an employee of the Medical College of Wisconsin and was paid by Prothena Biosciences Inc to consult as a subject matter expert. JY, RT, and MSB are employees of the Partnership for Health Analytic Research, LLC, which received funding from Prothena Biosciences Inc to conduct this research.

Presented at the 2018 European Society of Cardiology Congress, August 25-29, 2018, Munich