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ORIGINAL RESEARCH

Descriptive Epidemiology and Outcomes of Patients with Short Stay Hospitalizations for the Treatment of Congestive Heart Failure in the US

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Background: Congestive heart failure (CHF) hospitalizations cost the US $35 billion annually. Two-thirds of these admissions, generally requiring </=3 days in the hospital, are solely for the purpose of diuresis, and may be avoidable.

Methods: Among patients discharged with CHF as the principal diagnosis (PD), we compared characteristics and outcomes between those with hospital length of stay (LOS) </=3 days (short, SLOS) and >3 days (long, LLOS) in a cross-sectional multicenter analysis within the 2018 National Inpatient Sample. We applied complex survey methods to calculate nationally representative results.

Results: Among 4,979,350 discharges with any CHF code, 1,177,910 (23.7%) had CHF-PD, of whom 511,555 (43.4%) had SLOS. Patients with SLOS were younger (>/=65 years: 68.3% vs 71.9%), less likely covered by Medicare (71.9% vs 75.4%), and had a lower comorbidity burden (Charlson: 3.9 [2.1] vs 4.5 [2.2] than patients with LLOS; they less frequently developed acute kidney injury (0.4% vs 2.9%) or a need for mechanical ventilation (0.7% vs 2.8%). A higher proportion with SLOS than with LLOS underwent no procedures (70.4% vs 48.4%). Mean LOS (2.2 [0.8] vs 7.7 [6.5]), direct hospital costs ($6150 [$4413]) vs $17,127 [$26,936]), and aggregate annual hospital costs $3,131,560,372 vs $11,359,002,072) were all lower with SLOS than LLOS. All comparisons reached alpha = 0.001.

Conclusion: Among patients admitted for CHF, nearly ½ have LOS </=3 days, and almost ¾ of them requires no inpatient procedures. A more aggressive outpatient heart failure management strategy may allow many patients to avoid hospitalizations and their potential complications and costs.

Keywords: congestive heart failure, epidemiology, outcomes, hospital, costs

Introduction

Hospitalizations are a major driver of healthcare costs in the US, constituting nearly 1/3 of total US healthcare expenditures.[1] In addition to the adverse economic consequences, hospitalization disrupts patients' lives and exposes them to risks of contracting hospital-acquired complications (HAC). In 2016, for example, there were nearly 50,000 cases of HACs responsible for over 3000 deaths and $2 billion in excess costs in the US.[2] For these reasons, many interventions focus on preventing hospitalization.

Congestive heart failure (CHF) represents a leading reason for hospitalization. Annually in the US there are over 4 million admissions that involve CHF, adding in aggregate $35 billion in direct costs, and accounting for 75–80% of the total annual direct costs associated with CHF care.[3–5] Further raising these costs is the potential for HACs in this disproportionately elderly population. For example, recent analyses suggest that one out of every 13 patients admitted with CHF develops hospital-acquired pneumonia, leading to a substantially elevated subsequent risk of death.[6]

According to some calculations, as many as 2/3 of all admissions for the treatment of CHF are potentially avoidable.[7] Some of the common features of such admissions include: 1) not requiring advanced care beyond intravenous (IV) diuresis, 2) lack of

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the need for an escalation of such therapy, and 3) short durations of hospital stay (LOS), generally under four days. Since worsening signs and symptoms of congestion due to fluid overload are the most common reasons for hospitalization among patients with CHF, one can postulate that at least some of these admissions could be avoided with optimizing diuresis strategies among persons likely not to require a prolonged hospital stay.[8,9] While it is understood that patients admitted for CHF exacerbations on average spend 5.4 days in the hospital, this value, representing the mean of those with both short and long stays, does not shed light on the potential to reduce hospital days and the attendant cost savings.[10] To understand the present-day volume and outcomes of such potentially avoidable hospitalizations in the US, we conducted an analysis in the National Inpatient Sample (NIS) comparing patients with shorter LOS (≤3 days) and longer LOS (>3 days) so as to describe similarities and differences between their characteristics and outcomes, as well as to quantify the annual aggregate hospital costs for those potentially avoidable hospitalizations.

Materials and Methods

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Statement

Because this study used publicly available fully de-identified data, it was exempt from ethics review under US 45 CFR 46.101(b)4.[11]

Study Design and Patient Population

We conducted a multicenter cross-sectional study of adult patients (age >/= 18 years) admitted to all US acute care hospitals in the year 2018 for treatment of CHF. Our case identification approach relied on a previously published administrative algorithm, as recommended by the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines and included the following ICD-10-CM codes: I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50.9.[12–14] To optimize the specificity of this algorithm we also included patients with DRG codes 291, 292, 293.

Because we sought to describe the population that could potentially avoid hospitalization due to worsening heart failure, we included only discharges with CHF as the principal diagnosis, indicating that it was the primary reason for admission. We excluded all transfers from another acute care institution, as data on their hospitalization at the referring hospital are not available in the NIS. We defined a hospital's CHF caseload as a proportion of all admissions at that hospital that fit the CHF criteria.

Data Source

The NIS, a database publicly available from the Agency for Healthcare Research and Quality, approximates a 20-percent stratified sample of discharges from US community hospitals, excluding rehabilitation and long-term acute care hospitals.[15] It is specifically designed to identify, track, and analyze national trends in health care utilization, access, direct hospital costs and charges, quality, and outcomes. NIS cost-to-charge ratios (CCRs) are calculated as the ratio of total costs to total charges based on the cost report for specific hospitals.[16] The CCRs are in turn applied to total charges, as reported on inpatient encounter records, to produce an estimate of direct service delivery costs. Covering approximately 97% of the US population, complex survey methods estimate over 35 million annual hospitalizations, and aid in developing national estimates for specific conditions listed in the database.[15]

The unit of analysis in this database is a discharge and not a patient. Thus, it is not feasible to distinguish rehospitalizations from index hospitalizations for any single patient. In the current manuscript, we use the terms "hospitalization", "admission", and "discharge" interchangeably.

Statistical Analyses

We compared demographic, clinical, and hospital characteristics of the individual discharges, as well as their hospital outcomes between the groups requiring shorter LOS (SLOS, defined as </= 3 days) and longer LOS (LLOS, defined as > 3 days). Between these groups, we further stratified comparisons of hospital mortality by age (under 65 vs 65+ years), gender, race, and day of hospitalization to characterize further subgroups likely to be considered high- vs low-risk for outpatient therapy.

We report continuous variables as means with standard deviations (SD) and as medians with interquartile ranges (IQR), and categorical variables as percentages based on complex survey methods that weight strata provided by NIS. For the rare occasion where a stratum contained a single hospitalization, the stratum was centered at the grand mean rather than the stratum mean. Because the intent of the study was to provide descriptive epidemiology of potentially avoidable hospitalizations in the US, we did not attempt to model the outcomes to adjust for confounding.

Results

Among 4,979,350 discharges with any CHF code, 1,177,910 (23.7%) had CHF-PD, of whom 511,555 (43.4%) had SLOS, with the rest having LLOS. Compared to LLOS, a lower proportion of SLOS were hospitalized in urban teaching institutions (62.7% vs 69.9%) and in hospitals located in the Northeast (16.1% vs 20.8%), and a higher proportion in small hospitals (24.9% vs 20.9%) and in the West (19.6% vs 15.4%) (Table 1). The proportion of hospitalizations for CHF associated with shorter vs longer LOSs did not vary as a function of hospital mean CHF caseload volume. While

Table 1 Baseline Characteristics

CHF Discharges	SLOS (</= 3 Days)		LLOS (>3 Days)		*P* value
	N= 511,555		N= 666,355		
	N/Mean/Median	%/SD/IQR	N/Mean/Median	%/SD/IQR	
Demographic and clinical					
Sex					
Male	273,430	53.45%	340,365	51.08%	<0.001
Female	238,095	46.55%	325,955	48.92%	
Age, years					
18 to 44	26,595	5.20%	26,155	3.93%	
45 to 54	46,895	9.17%	50,405	7.56%	
55 to 64	88,865	17.37%	110,695	16.61%	<0.001
65 to 84	237,405	46.41%	329,730	49.48%	
≥ 85	111,795	21.85%	149,370	22.42%	
Mean (SD)	71.0 (14.6)		72.1 (13.8)		<0.001
Median [IQR]	73 [61, 83]		74 [63, 83]		<0.001
Race					
White	318,605	62.28%	425,655	63.88%	
Black	109,555	21.42%	139,570	20.95%	
Hispanic	48,510	9.48%	57,015	8.56%	

(*Continued*)

Table 1 (Continued).

CHF Discharges	SLOS (</= 3 Days)		LLOS (>3 Days)		*P* value
	N= 511,555		N= 666,355		
	N/Mean/Median	%/SD/IQR	N/Mean/Median	%/SD/IQR	
Asian or Pacific Islander	11,875	2.32%	14,225	2.13%	<0.001
Native American	2520	0.49%	2950	0.44%	
Other/Unknown	20,490	4.01%	26,940	4.04%	
Primary Expected Payer					
Medicare	367,665	71.87%	502,630	75.43%	
Medicaid	57,725	11.28%	66,650	10.00%	
Private	58,090	11.36%	68,865	10.33%	
Self-pay	17,210	3.36%	16,200	2.43%	<0.001
No charge	1170	0.23%	1120	0.17%	
Other	9140	1.79%	10,325	1.55%	
Missing	555	0.11%	565	0.08%	
Total Number of Charlson comorbidities					
Mean (SD)	3.9 (2.1)		4.5 (2.2)		<0.001
Median [IQR]	4[2.5]		4[3.6]		<0.001
Charlson comorbidity scores					
1	57,765	11.29%	46,875	7.03%	
2	89,795	17.55%	89,755	13.47%	<0.001
3+	363,995	71.15%	529,705	79.49%	
Hospital					
Geographic Region					
Northeast	82,535	16.13%	138,790	20.83%	
Midwest	115,795	22.64%	151,770	22.78%	<0.001
South	213,110	41.66%	273,280	41.01%	
West	100,115	19.57%	102,515	15.38%	
Location/Teaching					
Rural	66,170	12.94%	59,565	8.94%	
Urban Nonteaching	124,520	24.34%	141,040	21.17%	<0.001
Urban Teaching	320,865	62.72%	465,750	69.90%	
Bed Size (%)					
Small	127,485	24.92%	139,190	20.89%	

(*Continued*)

Table 1 (Continued).

CHF Discharges	SLOS (</= 3 Days)		LLOS (>3 Days)		*P* value
	N= 511,555		N= 666,355		
	N/Mean/Median	%/SD/IQR	N/Mean/Median	%/SD/IQR	
Medium	159,070	31.10%	199,200	29.89%	<0.001
Large	225,000	43.98%	327,965	49.22%	
Hospital CHF caseload, all hospitals*					
Mean (SD)	2.0% (1.4%)		1.9% (1.2%)		<0.001
Median [IQR]	1.7% [1.1%, 2.5%]		1.8% [1.1%, 2.5%]		0.007

Notes: *Defined as CHF discharges as a proportion of all hospital discharges; excludes hospitals with fewer than 50 annual total discharges.
Abbreviations: CHF, congestive heart failure; SLOS, shorter length of stay; LLOS, longer length of stay; SD, standard deviation; IQR, interquartile range.

there were minimal differences between the groups by race, patients with SLOS were younger (>/=65 years: 68.3% vs 71.9%), less likely to be covered by Medicare (71.9% vs 75.4%), and had a lower co-morbidity burden (mean Charlson: 3.9 [2.1] vs 4.5 [2.2]) than patients with LLOS (Table 1). As for individual comorbidities, nearly all patients suffered from hypertension, and nearly all enumerated conditions were more prevalent in LLOS than SLOS (Figure 1). Notably, discharges in the LLOS group were far more likely to have such disorders as cardiac arrhythmias, fluid and electrolyte imbalances, complicated diabetes, and renal failure, to name a few.

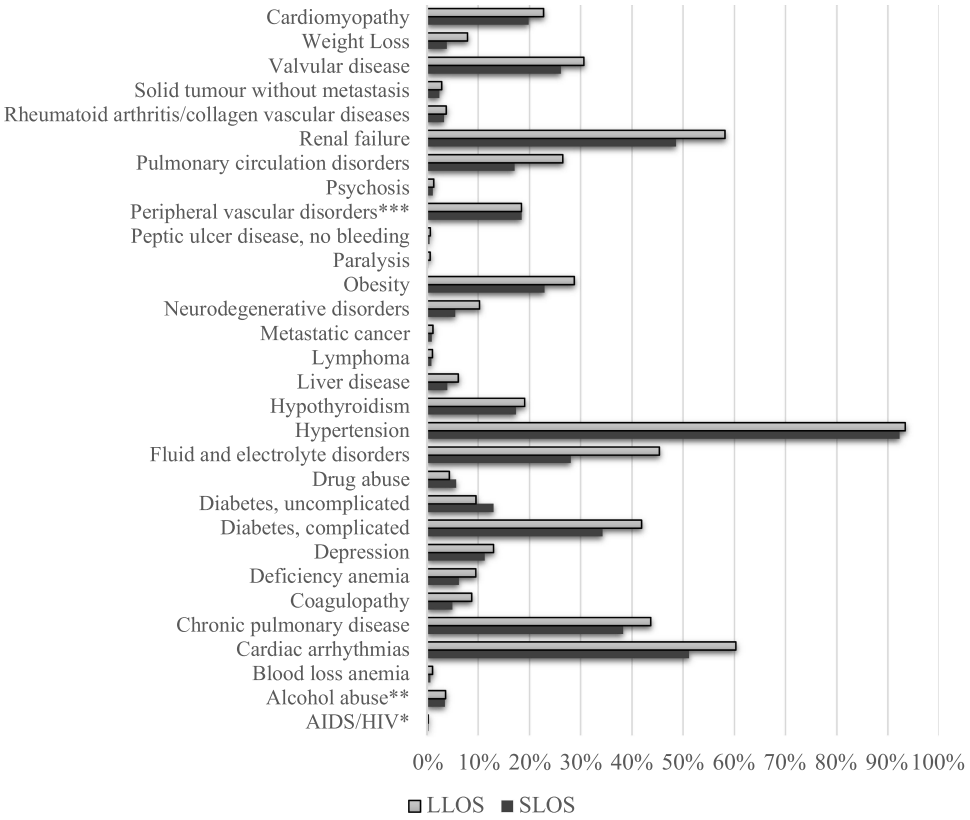

Figure 1 Individual comorbidities. *P* values for all comparisons are <0.001 with the exception of: *P=0.070, **P=0.063, ***P=0.714.
Abbreviations: SLOS, shorter length of stay; LLOS, longer length of stay.

The two groups were similar with regard to admission source (nearly 90% from the emergency department), and admission type (>95% non-elective; ie, urgent or emergent) (Table 2). Compared to those with LLOS, during hospitalization, patients with SLOS were less likely to develop acute kidney injury (20.3% vs 39.0%), need dialysis (0.4% vs 2.9%), or require mechanical ventilation (0.7% vs 2.8%). Patients with SLOS underwent fewer procedures overall (0.5 [1.1] vs 1.5 [2.6]), and a higher proportion had no procedures (70.4% vs 48.4%) than those with LLOS. Mean LOS was 2.2 (0.8) days in SLOS and 7.7 (6.5) in LLOS, and more in SLOS had a routine discharge home (61.8% vs 39.7%). Mean direct hospital costs in LLOS ($17,127 [$26,936]) were ~ 3-fold higher than those in SLOS ($6150 [$4413]). The aggregate annual costs mirrored individual costs, with $11,359,002,072 among discharges with LLOS and $3,131,560,372 with SLOS (Table 2).

In the comparisons stratified by age, gender, and race, mortality was consistently lower in SLOS than LLOS group. These differences were larger among those under 65 years than 65 years or older (Figure 2). Similar distinctions persisted across gender and certain racial groups. The highest percent mortality occurred among those whose LOS was shortest (10.6% on admission day), followed by late in the hospitalization, on day 10 and beyond (5.7%) (Figure 2).

Table 2 Hospitalization Characteristics and Outcomes

	SLOS (</= 3 Days)		LLOS (>3 Days)		*P* value
	N= 511,555		N= 666,355		
	N/Mean/Median	%/SD/IQR	N/Mean/Median	%/SD/IQR	
Admission Source					
ED	458005	89.53%	587,145	88.11%	<0.001
Non-ED	53550	10.47%	79,210	11.89%	
Admission Type					
Non-elective*	491,735	96.13%	639,230	95.93%	
Elective	19,490	3.81%	26,720	4.01%	<0.001
Missing	330	0.06%	405	0.06%	
Weekend admission	124,210	24.28%	150,685	22.61%	<0.001
Number of procedures					
Mean (SD)	0.5 (1.1)		1.5 (2.6)		<0.001
Median [IQR]	0 [0.1]		1 [0.2]		<0.001
No procedures	360,355	70.44%	322,745	48.43%	<0.001
AKI					
No AKI	406000	79.37%	387,455	58.15%	
AKI	103620	20.26%	259,725	38.98%	<0.001
AKI with Dialysis	1935	0.38%	19,175	2.88%	
Mechanical Ventilation					
<24 hours	2610	0.51%	4295	0.64%	
24–96 hours	985	0.19%	8645	1.30%	<0.001
>96 hours	0	0.00%	5765	0.87%	

(*Continued*)

Table 2 (Continued).

	SLOS (</= 3 Days)		LLOS (>3 Days)		*P* value
	N= 511,555		N= 666,355		
	N/Mean/Median	%/SD/IQR	N/Mean/Median	%/SD/IQR	
Discharge type					
Routine	315,960	61.76%	264,580	39.71%	
Short-term hospital	16,865	3.30%	14,835	2.23%	
SNF/LTACH	49440	9.66%	177,710	26.67%	
Home health care	104,030	20.34%	185,705	27.87%	<0.001
Against medical advice	14,515	2.84%	5445	0.82%	
Died in hospital	10,525	2.06%	17,925	2.69%	
Discharged alive, destination unknown	105	0.02%	20	0.00%	
Missing	115	0.02%	135	0.02%	
Length of stay (days)					
Mean (SD)	2.2 (0.8)		7.7 (6.5)		
Median [IQR]	2[2.3]		6[4.9]		
0–2 days	300,365	58.72%			
3–4 days	211,190	41.28%	168,000	32.84%	<0.001
5+ days			498,330	97.41%	
Total Charges					
Mean (SD)	25,871 (22,562)		74,249 (129,244)		<0.001
Median [IQR]	20,316 [13,258, 31,734]		46,632 [28,651, 80,100]		<0.001
Total Costs					
Mean (SD)	6150 (4413)		17,127 (26,936)		<0.001
Median [IQR]	5253 [3803, 7270]		11,520 [7947, 17,930]		<0.001
Aggregate annual hospital costs	$3,131,560,372		$11,359,002,072		NA

Note: "*Non-elective" classification includes urgent and emergent admissions.
Abbreviations: CHF, congestive heart failure; SLOS, shorter length of stay; LLOS, longer length of stay; ED, emergency department; AKI, acute kidney injury; SD, standard deviation; IQR, interquartile range; SNF, skilled nursing facility; LTACH, long-term acute care hospital.

Discussion

We have demonstrated that among patients admitted specifically for the management of CHF exacerbation, 43% require 3 days or fewer in the hospital, with one-half of these discharged after only 2 days. Furthermore, nearly ¾ of the SLOS group did not require any procedures during their hospitalization. The mean direct hospital costs in the SLOS group were $6150, or about 1/3 of the costs in LLOS, or $17,127. Because all of the admissions were specifically for the treatment of CHF, it is fair to assume that the entirety of these costs can be attributed to CHF. To put this into context, reimbursements for DRGs 291, 292, and 293 are $7764, $5286, and $3611, respectively, with the weighted mean payment of $6944.[17]

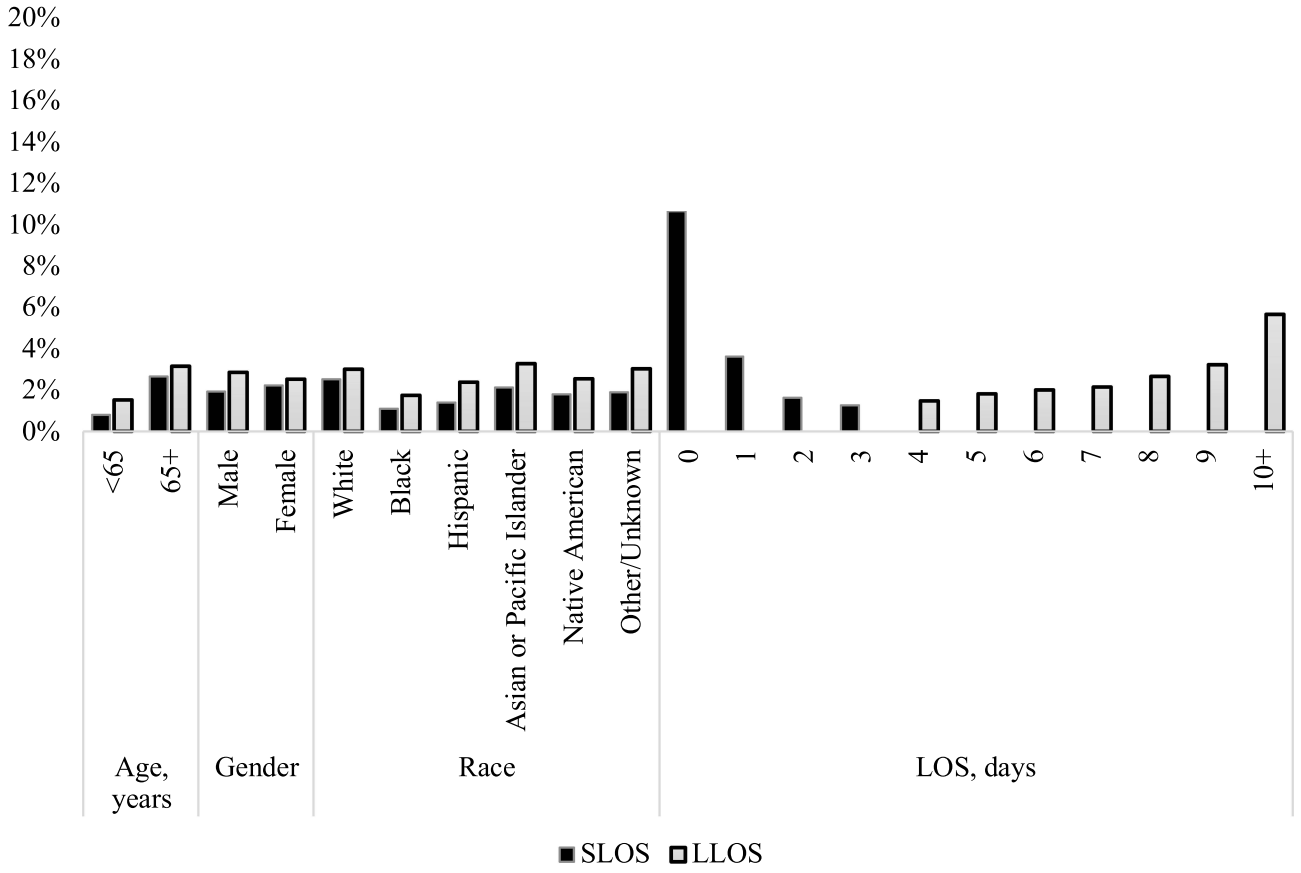

Figure 2 Stratified mortality*. *P values for all comparisons are <0.001.
Abbreviations: SLOS, shorter length of stay; LLOS, longer length of stay.

While costs with SLOS were lower than those in the LLOS group, they were not inconsequential, adding up in aggregate to over $3 billion in 2018. The characteristics of those with short admissions for CHF raise the issue of whether the admission was avoidable altogether, potentially avoiding the inconvenience and risks associated with hospitalization while also saving the healthcare system substantial resources.

Our findings have several important implications. First, if even one-half of this population could be successfully treated as outpatients, over $1.5 billion could be saved annually in both CHF-related and general healthcare costs for these patients. A recent systematic review of literature dealing with costs of heart failure in the US noted that hospitalization costs vary based on the presence of comorbidities and age.[18] It is, therefore, possible that at least some of the reduction in the cost of SLOS compared to LLOS is due to a somewhat younger and less chronically ill population comprising the former group. However, it is very likely that a much greater proportion of this difference is driven by the large gap in the hospital LOS between SLOS and LLOS groups. Regardless of the reasons, the fact remains that cost savings from avoiding these admissions could be significant. And given that over 2/3 of this population is on Medicare, these savings would be a substantial advance toward its solvency. Second, a hospitalization necessarily exposes a patient to the risk of contracting a HAC. For example, a recent analysis from Japan suggests that 8% of patients hospitalized for treatment of a CHF exacerbation develop HAP, one of the costliest and deadliest of HACs.[6] In this study, incident HAC raised the risk of hospital death to staggering degree from 1% in its absence to 12% in the presence of HAP. In addition, the rate of CHF worsening rose 4-fold from the baseline of 7% to 28%, along with a consequent LOS prolongation. Although we were unable to explore incident HACs or their impacts in the current analysis, it is quite likely that at least some of the patients in the SLOS group developed HACs, which incurred costs that were potentially avoidable if the in hospitalization had not transpired. Third, and along the same lines, it is possible and even likely that some of the patients in the LLOS were subjects who might otherwise have been discharged earlier were it not for the development of some

nosocomial complication. The precise impact of HACs on this population is a question that needs attention in future studies.

Our study builds on previous efforts to define groups of CHF patients who, despite being admitted for the management of their exacerbations, may, given minor treatment pathway alterations, be able to avoid hospitalization. Greene and coworkers analyzed a large and geographically diverse US multicenter electronic health record database between 2007 and 2018 with the view to further our understanding of inpatient CHF treatment intensity.[7] They discovered that in a cohort of over 22,000 adult patients with a reduced ejection fraction hospitalized for CHF exacerbations and with no evidence of a concurrent acute coronary syndrome, approximately 2/3 did not require escalation of their treatment beyond IV diuretic started at admission. Despite having the shortest time on diuretics, this group was nevertheless least likely to die or to require a readmission within 30 days of discharge relative to other groups where treatment had been escalated. Although our population is slightly different from that examined by Greene et al we did focus on patients admitted specifically for the treatment of CHF, and by contrasting groups based on their hospital LOS, attempted to identify a group that, similar to that in the Greene analysis, might be considered less complex and resource intensive than others. Although our estimate of 43% of this population falling into this category is lower than the prior number, it is still quite substantial. We add to the literature on this population by quantifying explicitly not only its annual volume in the US, but also the potential opportunity for cost savings if inpatient treatment could be avoided.

Our study, although large and highly generalizable, has a number of limitations. Because our case definition relied on administrative coding, there may be misclassification. However, we did employ a previously published algorithm that has been used routinely by many other investigators and recommended in the ACA/AHA guidelines.[12–14] Another important limitation is our inability to differentiate between initial and repeat hospitalizations. However, given the aim of the study, this did not preclude us from estimating the full burden of hospitalizations for the treatment of a CHF exacerbation. Because the study is purely descriptive, we did not attempt to draw any inferences or causalities, and thus confounding is not a concern. The structure of the current dataset did not allow us to explore drug treatments given to these patients, and this may have contributed to misclassifying other conditions that mimic CHF as actual CHF. However, since we focused specifically on patients with the principal diagnosis of CHF, it, and not another cause, is likely to have been the primary reason for admission.

Conclusions

In summary, we have quantified not only the current annual burden of inpatient admissions for CHF in the US, but also described in detail a group of patients whose hospitalizations may be averted by retooling some outpatient procedures and making them more conducive to effective outpatient diuresis. This group of patients is large and costly, and the savings from converting their treatment from inside the hospital to the outpatient setting would be substantial, even if even a fraction of this population could avoid admission. Future investigations need to provide more granular descriptions of this population to establish in detail how to identify these patients a priori. In addition, data on the incidence of various important HACs complicating these potentially avoidable admissions would contribute to a fuller picture of their healthcare resource utilization.

Abbreviations

CHF, congestive heart failure; PD, principal diagnosis; LOS, length of stay; SLOS, short LOS; HLOS, long LOS; HAC, hospital-acquired complications; IV, intravenous; NIS, National Inpatient Sample; ACC, American College of Cardiology; AHA, American Heart Association; CCR, cost-to-charge ratio; SD, standard deviation; IQR, interquartile range.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Statement

Because this study used publicly available fully de-identified data, it was exempt from ethics review under US 45 CFR 46.101(b)4.[11]

Acknowledgments

No person other than the listed authors participated in the study, its design, or its reporting.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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- BHN's employer, OptiStatim, LLC, has received support from EviMed Research Group, LLC, Goshen, MA, USA.
- KS has consulted for and reports personal fees from scPharmaceuticals, Burlington, MA, USA.
- JFM is an employee scPharmaceuticals, Burlington, MA, USA.
- MMG is an employee scPharmaceuticals, Burlington, MA, USA.
- AFS is a clinical consultant to EviMed Research Group, LLC, Goshen, MA, USA. He has been a clinical consultant to and has received research grant support from scPharmaceuticals. Also, he has received grant support and/or has served as a consultant to Spero, Melinta, Pfizer, Astellas, Shionogi, and Lungpacer.

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