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Původní sdělení | Original research article

Cardiology department hospitalization costs in patients with acute heart failure vary according to the etiology of the acute heart failure: Data from the AHEAD Core registry 2005–2009

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INFORMACE O ČLÁNKU

Historie článku:
Došel do redakce: 24. 6. 2012
Přepracován: 21. 10. 2012
Přijat: 22. 10. 2012
Dostupný online: 5. 11. 2012

Keywords:
AHEAD registry
Heart failure
In-hospital costs

ABSTRACT

Background: To assess the distribution of costs associated with Cardiology Unit hospitalization due to acute heart failure (AHF) and evaluate, from the perspective of the healthcare payer, the heterogeneity of resources use according to AHF etiology in patients from 2005 to 2009.
Methods: The type and etiology of AHF was determined upon hospital admission. The cost of in-patient care was based on the individual hospital account of each patient (1759 patients in total; 58.7% male; mean age 71 years).
Results: The median hospital stay was 7 days and the mean total cost of in-patient care was €3364. A Coronary Care Unit (CCU) stay was recorded in 67.4% patients (median 3 days). Significantly higher costs were found in de-novo AHF patients (mean €3678) with a greater need for CCU care, a longer stay in the CCU and a greater need for intervention (particularly that of percutaneous coronary intervention [PCI]), than in patients with acute decompensation of chronic heart failure (mean cost €2878; $p < 0.001$). Acute coronary syndrome was a major precipitating factor, with the highest costs (€4429) resulting from having received PCI (63.3% of patients) and CCU admission (91.7% of patients). Variations in length of stay according to AHF etiology were minor (median, 6–8 days). In-hospital mortality was 15.0%.
Conclusions: Hospitalization costs as they relate to AHF are high, particularly in new-onset AHF patients. The heterogeneity of resources use is largely a reflection of interventions undertaken, particularly if revascularization or anti-arrhythmic therapy is provided.

SOUHRN

Cíl: Stanovení nákladů na hospitalizaci pacientů s akutním srdečním selháním (ASS) hospitalizovaných v letech 2005–2009 na kardiologické klinice z pohledu plátce zdravotní péče a následné zhodnocení heterogenity výdajů dle etiologie ASS.
Metodologie: Typ ASS a jeho etiologie byla určena při přijetí pacienta na kliniku. Náklady na péči vycházejí z individuálního hospitalizačního účtu každého pacienta (celkem 1 759 pacientů; 58,7 % mužů; průměrný věk 71 let).

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DOI: 10.1016/j.crvasa.2012.10.004

Tento článek prosím citujte takto: B. Rihova, et al., Cardiology department hospitalization costs in patients with acute heart failure vary according to the etiology of the acute heart failure: Data from the AHEAD Core registry 2005–2009, Cor et Vasa 55 (2013) e7–e14, jak vyšel v online verzi *Cor et Vasa* na http://www.sciencedirect.com/science/article/pii/S0010865012001154

Výsledky: Medián délky hospitalizace pacientů pro ASS byl 7 dní při průměrných nákladech 3 364 € (92 515 Kč). U 67,4 % pacientů byl zaznamenán pobyt na koronární jednotce (KJ) po dobu 3 dnů (medián). Signifikantně vyšší náklady (průměrně 3 678 €; 101 139 Kč) byly spojeny s hospitalizací pacientů s nově vzniklým ASS (tzv. *de novo* ASS) než u pacientů s akutní dekompenzací chronického srdečního selhání (průměrné náklady 2 878 €; 79 154 Kč; $p < 0,001$). U pacientů s *de novo* ASS byla vyšší potřeba pobytu na JIP a/nebo KJ, delší pobyt na JIP/KJ a častěji byly provedeny intervenční zákroky (zejména perkutánní koronární intervence – PCI). Dle etiologie ASS byly nejčastěji se vyskytující příčinou hospitalizace akutní koronární syndromy, jež byly zároveň spojeny s nejvyššími průměrnými náklady na hospitalizaci (4 429 €; 121 797 Kč), vyplývajícími z provedených PCI u 63,3 % pacientů a pobytu na KJ u 91,7 % pacientů. Variabilita délky hospitalizace dle etiologie ASS byla minimální (medián 6–8 dní). K úmrtí za hospitalizace došlo u 15,0 % pacientů.
Závěry: Náklady na hospitalizaci pacientů s ASS jsou vysoké, zejména u podskupiny s *de novo* ASS. Heterogenita ve spotřebě zdrojů je dána provedenými nákladnými intervencemi v jednotlivých podskupinách, zejména perkutánní koronární intervencí a implantací antiarytmických zařízení.
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Klíčová slova:
Hospitalizační náklady
Registr AHEAD
Srdeční selhání

Background

According to the European Society of Cardiology, acute heart failure (AHF) is defined as the "rapid onset of symptoms and signs secondary to abnormal cardiac function" [1]. Cardiac dysfunction associated with AHF can be related to anything from systolic or diastolic dysfunction, to abnormalities in cardiac rhythm, or preload/afterload mismatch. AHF may present as acute de-novo (the new onset of AHF in patients without previously documented cardiac dysfunction) or as acute decompensation of previously diagnosed chronic heart failure (ADCHF). The AHF severity ranges from the sudden appearance of mild dyspnea to cardiogenic shock. The major therapeutic aim is to control symptoms and stabilize hemodynamics. Prognosis is improved by immediate elimination of the cause of the acute condition (ischemia is treated by surgical or interventional revascularization; valvular disease by surgery; arrhythmias by anti-arrhythmic drugs or defibrillation), or the application of pharmacotherapy to prevent disease progression and future acute decompensation.

AHF is associated with a poor prognosis. Although AHF is a life-threatening disease and a high burden on

Table 1 – Characteristics of the study population.

			All	Type of heart failure		p
				De-novo AHF	ADCHF	
Total		N %	1759 100%	1062 60.8%	690 39.2%	–
Sex (female)		N %	727 41.3%	458 42.8%	269 39.0%	0.113
Age	All (years)	mean (SD)	70.9 (12.2)	69.8 (12.5)	72.5 (11.5)	**< 0.001**
	≤ 60 years	N %	324 18.4%	236 22.1%	88 12.8%	**< 0.001**
	61–70 years	N %	401 22.8%	246 23.0%	155 22.5%	0.816
	71–80 years	N %	614 34.9%	353 33.0%	261 37.8%	**0.041**
	> 80 years	N %	420 23.9%	234 21.9%	186 27.0%	**0.016**
History	Hypertension	N %	1217 71.0%	694 67.5%	523 76.1%	**< 0.001**
	Diabetes mellitus	N %	711 41.3%	385 37.3%	326 47.4%	**< 0.001**
	Previous PCI/CABG	N %	198 13.5%	47 4.4%	151 21.9%	**< 0.001**
	Previous PM/ICD/CRT	N %	232 11.3%	69 6.7%	163 23.7%	**< 0.001**

ADCHF – acute decompensation of chronic heart failure; CABG – coronary artery bypass graft; CRT – cardiac resynchronization therapy with biventricular device; ICD – implantable cardioverter-defibrillator; PCI – percutaneous coronary intervention; PM – pacemaker.

healthcare systems, there is relatively limited data describing the epidemiology, treatment, prognosis and resource utilization in AHF patients in European countries. The EuroHeart Failure Survey (EHFS) evaluated 11,327 patients in 24 countries. The study population involved patients with AHF and CHF who were primarily hospitalized for other reasons (40% of admissions were due to heart failure), as well as those with only possible heart failure (17%) [2,3]. HF patient characteristics, presentation, treatment and outcome were assessed by the EuroHeart Failure Survey II (EHFS II). This involved 3580 patients from 30 countries and was in accordance with the European Society of Cardiology's published guidelines for the diagnosis and treatment of AHF [1,4]. Similar objectives were also established in the Finnish Acute Heart Failure Study (FINN-AKVA) [5], as well as in the Czech Republic's Acute Heart Failure Database (AHEAD) registry [6]. The latter database was established to monitor the diagnosis and treatment of AHF patients hospitalized in the Czech Republic. The project was initiated in 2005 at the Department of Internal Cardiology Medicine of University Hospital Brno (AHEAD Core; Brno, Czech Republic) as a part of a research project. The project continued in 2006 as a prospective database called 'AHEAD Main' and was operational in five large healthcare facilities with onsite Angiography Units (General Teaching Hospital in Prague, IKEM Prague, St. Anne's Teaching Hospital, University Hospital Brno and University Hospital Olomouc) [6]. Currently, 15 centers with > 8200 records have been compiled by the project (AHEAD Network).

The treatment of heart-failure patients consumes 1–2% of the healthcare budget in some countries (UK, The Netherlands, Sweden), two thirds of which are spent on hospitalizations [7]. However, little is known about the structure of in-hospital costs and variability in the financial burden among hospitalized AHF patients according to AHF etiology. Therefore, we examined the distribution of costs associated with AHF hospitalizations in a Cardiology Department.

Methods

AHEAD is a national, observational, prospective, multicenter registry based on the etiology, treatment and prognosis of patients hospitalized for AHF. The AHEAD Core includes only patients from University Hospital Brno. The health/economic sub-project initiated at University Hospital Brno only evaluates the cost of the first recorded hospitalization per AHF subject admitted during the study period, regardless of whether or not hospitalization was due to de-novo AHF or ADCHF.

Cost analysis was undertaken from the perspective of the healthcare payer; neither indirect (e.g. loss of earnings) nor intangible costs (e.g. pain and suffering) were measured. The costs were subtracted from the hospital account of each registered patient. The burden incurred during hospitalization consisted of the burden of a Standard Cardiology Unit (SCU) and the burden of a Coronary Care Unit (CCU). There are 2 CCUs with a total of 12 beds. Two doctors and four nurses take care of 6 patients at a time. Each CCU provides monitoring of ECG and blood pressure, non-invasive and invasive pulmonary ventilation, methods of continuous renal replacement therapy and hemodynamic support including an intra-aortic balloon pump (IABP). The total in-hospital cost included the flat rate of admission, hospital stay and the cost of investigations and interventions. Expenses for cardiac surgeries (coronary artery bypass grafting, valve replacement, etc.) were not included because the procedures were carried out in the Cardiac Surgery Unit which is external to University Hospital. After cardiac surgery, patients were discharged home without being sent back to the previous cardiology department. The overall cost for cardiac surgery was only determined for a portion of the patients (2005–2007) and was described in a previous article; some of these results are presented in the discussion. Medical therapy provided during a hospital stay was included in the daily in-patient rate (room rate); extra medications and extra sanitary materials used during medical procedures were calculated separately. The costs of daily care in the CCU were counted according to the Therapeutic Intervention Scoring System (TISS) score. All charges came from fixed-fee schedules in the index of medical procedures (physicians' services) and the code-lists of pharmaceuticals published by the Czech Ministry of Health.

Statistical analysis was carried out in cooperation with the Institute of Biostatistics and Analyses, Masaryk University (Brno, Czech Republic). Costs were presented as the mean, standard deviation, median, 5^{th} and 95^{th} percentiles. Statistical significance was tested using the Fisher exact test for two dichotomous categories and the ML χ^2 test for variables with more than two categories. The (non-parametric) Mann-Whitney U test was used for continuous data between two groups of patients and the Kruskal-Wallis test for comparison among several groups of patients or years. $P < 0.05$ was considered significant. All prices were calculated without value-added tax (VAT). The average exchange rate for 2005–2009 was €1 = 27.5 CZK [8], exchange rate USD/EUR was used from 2005 – USD 1.2441 = €1.

The study protocol complied with the Declaration of Helsinki and was approved by the local Ethics Committee of University Hospital Brno and by the Ethics Committee of Masaryk University in Brno. An informed written consent was obtained from all subjects before participation in the study.

Study population

A total of 1759 patients (58.7% male) hospitalized at University Hospital Brno with AHF between 2005 and 2009 were enrolled. Study Physicians grouped patients according to AHF etiology upon hospital admission (acute coronary syndrome [ACS], chronic ischemic heart disease [CIHD], valvular dysfunction, arrhythmia, hypertensive crisis and others).

Results

The baseline characteristics of patients upon hospital admission, and their distribution by AHF type, are shown in Table 1. Acute decompensation of chronic heart failure

Table 2 – Structure of in-hospital costs (€) according to type and etiology of AHF.

			CCU + SCU				PCI				CAG				Anti-arrhythmic				Total			
		N/%	Mean (SD)	Median	0.05	0.95	Mean (SD)	Median	0.05	0.95	Mean (SD)	Median	0.05	0.95	Mean (SD)	Median	0.05	0.95	Mean (SD)	Median	0.05	0.95
All patients		1759/100	1217 (1714)	729	208	4294	4086 (1729)	3621	2287	7878	479 (132)	466	298	712	14,309 (16,182)	4983	1595	40,543	3364 (5928)	1383	236	9502
Type of AHF	**De-novo AHF**	1069/60.8	1337 (1670)	815	243	4734	4037 (1680)	3589	2286	7812	469 (123)	454	298	676	11,530 (14,459)	4460	1601	40,995	3678 (4810)	2670	309	9598
	ADCHF	690/39.2	1031 (1767)	553	188	3136	4415 (2014)	3831	2188	9028	498 (146)	474	298	751	16,531 (17,247)	6570	1566	41,211	2878 (7307)	758	199	8770
	p		**< 0.001**				0.146				**0.027**				0.169				**< 0.001**			
Etiology	**ACS**	782/44.5	1458 (1701)	884	277	5181	4060 (1696)	3589	2287	7823	462 (118)	451	297	682	12,319 (16,749)	2068	544	44,938	4429 (4589)	3916	560	10,097
	CIHD	329/18.7	965 (2003)	525	199	3056	4856 (2162)	4251	2399	10,484	509 (170)	472	300	993	17,104 (16,169)	7043	1596	40,985	2827 (7502)	649	203	9274
	Valvular disorder	140/8.0	1050 (2016)	519	179	3417	4287 (2523)	3857	2289	9616	516 (148)	477	343	748	3060 (3105)	1939	672	6570	1489 (2430)	697	179	4839
	Arrhythmia	97/5.5	983 (1056)	641	180	3520	4134 (–)	4134	4134	4134	496 (187)	454	286	987	14,009 (14,834)	5489	1611	37,694	3991 (9276)	742	180	34,231
	Hypertensive crisis	91/5.2	844 (826)	626	198	2842	–	–	–	–	452 (151)	454	286	766	14,068 (16,922)	4491	4107	33,607	1371 (3994)	702	229	3990
	Other	320/18.2	1133 (1552)	627	188	3450	3591 (1684)	3405	1575	7796	475 (90)	474	319	619	14,309 (18,007)	4613	1507	58,258	2512 (6682)	877	207	8073
	p		**< 0.001**				0.303				**0.022**				0.435				**< 0.001**			

ACS – acute coronary syndrome; ADCHF – acute decompensation of chronic heart failure; CAG – coronary angiography; CCU – Coronary Care Unit stay; CIHD – chronic ischaemic heart disease; PCI – percutaneous coronary intervention; SCU – Standard Cardiology Unit stay.
Costs presented as Euro: mean (SD), median, 5th and 95th percentiles.

Table 3 – Length of stay, interventions and mortality.

			Total	In-hospital stay			Intervention			Mortality
				CCU need	CCU days[a]	Total LOS[b]	PCI	CAG	Anti-arrhythmic	
	All patients	N %	1759 100%	1186 67.4%	2.6 (3.7) 2.0 (0.0; 9.0)	8.1 (5.9) 7.0 (1.0; 19.0)	534 30.4%	1125 64.0%	99 5.6%	263 15.0%
Type of AHF	De-novo	N %	1069 60.8%	838 78.4%	2.9 (3.7) 2.0 (0.0; 9.0)	7.9 (5.8) 7.0 (1.0; 18.0)	466 43.6%	744 69.6%	44 4.1%	170 15.9%
	ADCHF	N %	690 39.2%	348 50.4%	2.0 (3.6) 1.0 (0.0; 8.0)	8.5 (6.1) 7.0 (1.0; 20.0)	68 9.9%	381 55.2%	55 8.0%	93 13.5%
	p			**< 0.001**	**< 0.001**	**0.026**	**< 0.001**	**< 0.001**	**0.001**	**0.171**
Etiology	ACS	N %	782 44.5%	717 91.7%	3.3 (3.5) 2.0 (0.0; 9.9)	7.3 (5.7) 6.0 (1.0; 18.0)	495 63.3%	687 87.9%	19 2.4%	144 18.4%
	CIHD	N %	329 18.7%	148 45.0%	1.8 (3.5) 0.0 (0.0; 8.0)	8.7 (5.3) 8.0 (1.0; 18.0)	21 6.4%	189 57.4%	28 8.5%	35 10.6%
	Valvular disorder	N %	140 8.0%	57 40.7%	2.3 (5.5) 0.0 (0.0;11.0)	10.0 (8.1) 8.0 (1.0; 26.0)	7 5.0%	67 47.9%	3 2.1%	16 11.4%
	Arrhythmia	N %	97 5.5%	38 39.2%	1.6 (3.0) 0.0 (0.0; 8.1)	9.3 (5.4) 8.0 (2.0; 22.2)	1 1.0%	20 20.6%	20 20.6%	4 4.1%
	Hypertensive crisis	N %	91 5.2%	57 62.6%	2.1 (3.1) 1.0 (0.0; 6.4)	7.7 (5.9) 6.0 (1.0; 18.5)	0 0	23 25.3%	3 3.3%	5 5.5%
	Other	N %	320 18.2%	169 52.8%	2.2 (3.2) 1.0 (0.0; 9.0)	8.5 (5.8) 7.0 (1.0; 19.1)	10 3.1%	139 43.4%	26 8.2%	58 18.2%
	p			**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**

ACS – acute coronary syndrome; ADCHF – acute decompensation of chronic heart failure; CAG – coronary angiography; CCU – Coronary Care Unit; CIHD – chronic ischaemic heart disease; LOS – length of stay; PCI – percutaneous coronary intervention.

[a] CCU days counted from all patients in category; presented as mean (SD); median (5^{th} and 95^{th} percentiles).

[b] LOS presented as mean (SD); median (5^{th} and 95^{th} percentiles).

was found in 39.2% of patients; others were diagnosed as de-novo AHF. Males suffered from CIHD and ACS more often than females (68% vs. 62%), whereas more females (69%) were admitted with hypertensive crisis as the cause of AHF.

The mean cost of hospitalization due to AHF was €3364 (CZK 92,515). The median length of stay (LOS) was 7 days. Two thirds of the study group were treated in the CCU and their median LOS in the CCU was 3 days. Significantly higher costs were found in patients with new-onset AHF (mean €3678; CZK 101,139) compared to ADCHF patients (€2878; CZK 79,154; $p < 0.001$). The difference was mainly caused by a greater need for CCU care, a longer stay in the CCU and a greater number of interventions (particularly PCI) in patients with new-onset AHF.

ACS was the major causal factor for hospitalization due to AHF (present in 44.5% of patients) and the total cost was three times higher than that of valvular dysfunction and hypertensive crisis, and one third higher than in patients with CIHD or other precipitating factors. More ACS patients needed treatment in the CCU compared to other clinical classes (twice as many as patients with CIHD, valvular dysfunction, arrhythmias), but the length of stay in the CCU was, on average, shorter (Table 2). Variations in total LOS for patients with different causes of AHF were small (median, 6–8 days) (Table 3).

Coronary angiography was carried out during the course of hospitalization or recently performed in 64.0% of patients. Results were mainly recorded in ACS patients (87.9%) and CIHD patients (57.4%). PCI revascularization was carried out in 30.4% of patients; 43.6% in de-novo AHF and 9.9% in ADCHF. As expected, most were performed in ACS patients (63.3% PCI rate). The burden of anti-arrhythmic treatment with pacemakers, implantable cardioverter-defibrillators or cardiac resynchronization therapy was recorded only in 5.6% of patients (8.0% in ADCHF and 4.1% in new-onset AHF). The pacemakers were implanted in 3.2% of patients, cardioverter-defibrillators (with or without CRT) in 1.6% of patients and cardiac resynchronization therapy in 0.8% of patients. Hence, their costs were not compared between subgroups.

The mean cost per day was €370.2 (CZK 10,179) in the CCU and €51.6 (CZK 1420) in the Standard Cardiology Unit. The mean cost per intervention (including the device) was €4086 (CZK 112,353) for PCI revascularization and €14,309 (CZK 393,486) when treatment involved arrhythmia treatment via pacemaker implantation, implantable cardioverter-defibrillator or cardiac resynchronization therapy with a biventricular device.

The structure of total in-hospital costs varied according to the type of AHF and etiology. Concerning results for all patients, the most expensive factors were revascularization procedures and cardiac catheterizations. These contributed to 40% of total in-patient costs. The stay in the CCU represented 28% of total in-patient costs and anti-arrhythmic interventions comprised 24%. In patients for whom valvular dysfunction or hypertensive crisis led to AHF hospitalization, the room rate equaled about two thirds of the total cost (mainly due related to the CCU stay) (Fig. 1).

Overall in-hospital mortality was 15.0%. No relationship between mortality rate of ADCHF and de-novo AHF was observed. However, a significant difference in mortality rate was observed among AHF etiologies (Table 3).

No statistically significant annual growth in a mean cost per a patient was observed between the years 2005–2008 (€3482; 3090; 3261 and 3674, respectively; $p = 0.119$). Because a limited number of hospitalization records were evaluated in 2009, this year was not included in trend analysis.

Discussion

The present study confirmed that AHF patients should not be regarded as a single, "uniform" population, but grouped according to AHF type or precipitating factors which led to hospitalization. There were significant differences during the course of hospitalizations and their outcomes. In our patients, de-novo AHF was more common than ADCHF, which is not in accordance with international data [2,4,5,9]. However, concordant to other studies [2,5,10], the most frequent precipitating factor was the presence of ACS. The main cause of a larger number of patients with de-novo AHF is probably the centralization of care for patients with ACS and other severe cardiac diseases in the Czech Republic. Patients with de-novo AHF often undergo examinations including coronary angiography in a specialized center, while patients with ADCHF are hospitalized in a regional hospital. The Department of Internal Cardiology Medicine, University Hospital Brno, is a specialized cardiology center; its catchment area includes 500,000 potential cardiac patients while the general internal medicine area covers just 20,000 people to be treated in this center. Patients with de-novo AHF were younger, and with fewer co-morbidities, than those with ADCHF. Despite the fact that new-onset AHF patients incurred higher costs than ADCHF patients; a better predictor of a longer in-hospital stay was ADCHF.

Among all patients, ACS patients incurred the highest costs; 92% of ACS patients required a CCU stay, but had a shorter LOS. We identified the primary drivers of increased costs in all patients hospitalized with AHF: undergoing PCI and a stay in the CCU. The proportion of costs (CCU, SCU, CAG, PCI, and anti-arrhythmic interventions) varied between subgroups and confirmed that in-patient care for AHF patients was heterogeneous with respect to resources used. In patients with hypertensive crisis and arrhythmias as the precipitating causes of AHF, cost and outcome must be interpreted with caution, given the small number of patients evaluated.

Admission for AHF is a high-risk event, particularly for patients with ACS. Overall in-hospital mortality in the study population was 15%, which was higher than in comparable AHF studies. In previous studies, an increased risk of in-hospital mortality in AHF patients was related to myocardial infarction, cardiogenic shock, worsening of renal function, higher age, tachycardia, increased level of natriuretic peptides, hyponatremia, hypotension and left-ventricular systolic dysfunction [11–15].

Healthcare expenditures in the Czech Republic are still very low compared to Western countries. AHF hos-

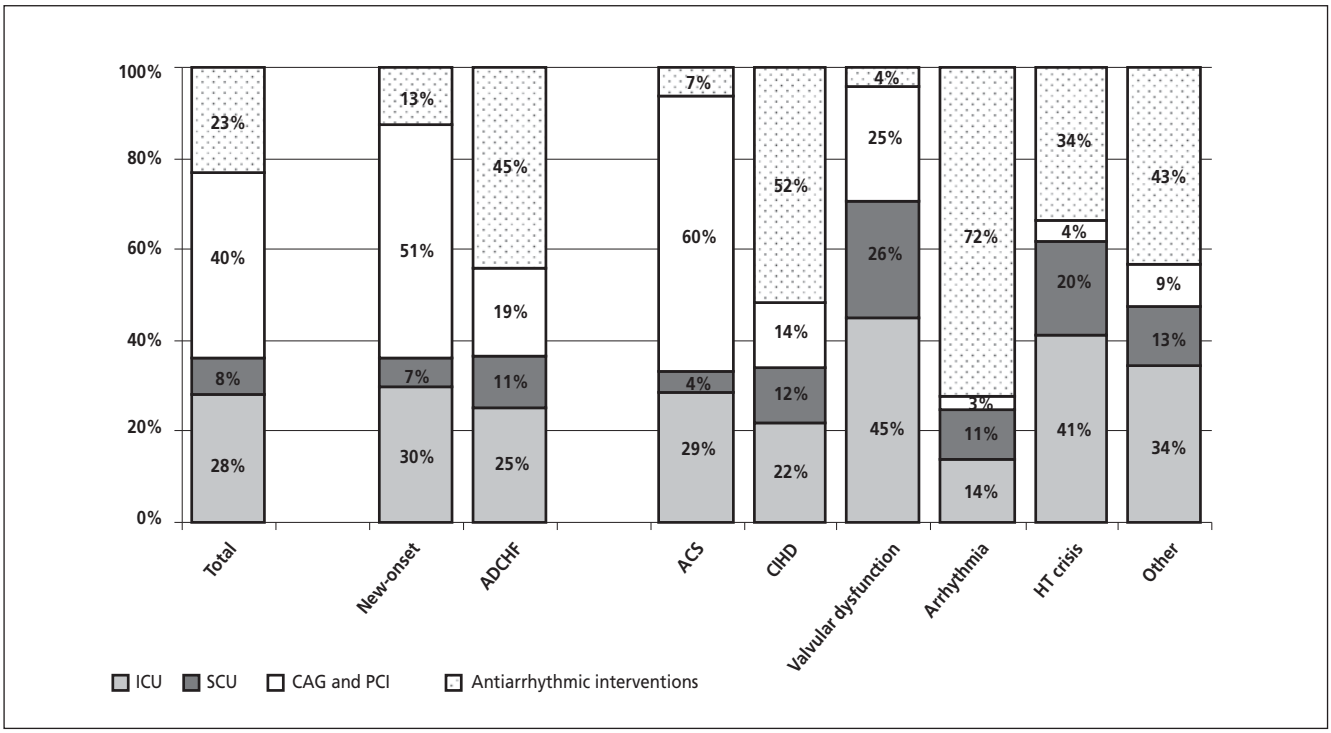

Fig. 1 – Proportion of costs according to type of AHF and etiology.

pitalization incurred a mean cost of €3364 with a mean LOS of 8.1 days. A comparison with previously published studies involving the utilization of resources in AHF hospitalizations would be misleading because most of the data are only based on the in-patient cost of treating subjects with heart failure, without AHF etiology differentiation. Furthermore, in many coding systems, AHF caused by ACS could be coded as a myocardial infarction and not AHF. Moreover, the strategies for evaluating these expenditures in published sources might have been different. The costs associated with acute hospitalization and subsequent rehabilitation among different classes of AHF were evaluated in the FINN-AKVA study population in Finland [5]. The cost of the index hospitalization was calculated based upon the number of days in the Intensive Cardiology Unit (ICU; €1576/day), CCU (€970/day) and the cost of a stay on a conventional ward (€340/day). The mean length of index hospitalization was 9.2 days. The mean cost per index hospitalization was €6743, based solely on room rates per day [16], which was double that of our analysis, which also included interventions and devices. The mean cost per hospitalization for heart failure in the USA in 2005 varied according to the inotropic therapy used. The mean length of stay for patients initiated on a single vasodilator or inotrope was 6.7 days and 9.6 days, respectively and the cost was $12,038 and $18,411, respectively (€9676 and €14,799). In patients receiving ≥ 2 vasoactive drugs during hospitalization, the total mean cost ranged from $14,790 to $46,479 (€11,888 and €37,360); patients receiving only intravenous inotropes, or in combination with other therapies, had consistently higher mortality and costs. We suppose that costs in this study, in comparison with our data, were slightly undervalued because the hospitalizations accompanied by a device procedure (e.g. implantable cardioverter-defibrillator on day 1 and percutaneous intervention within the first 2 days) were excluded [17,18]. In a retrospective cost analysis of patients hospitalized for acute decompensation of chronic heart failure while enrolled in the Randomized Evaluation of Intravenous Levosimendan Efficacy (REVIVE II) study, the average stay in a hospital network in the USA lasted 8.96 days with the average cost of $19,021 (€15,289) when standard therapy was provided [18,19].

Cardiac surgery was required in 5.7% of patients who were hospitalized in the Department of Cardiology due to AHF. Surgery carried out after an AHF episode might be immediate or delayed. All cardiac surgeries were undertaken at the specialized Department of Cardiac and Transplant Surgery, Brno, and not at University Hospital, Brno. In our previous article, we evaluated the cost of cardiac surgical procedures (including CABGs, as well as valve replacements) in a population of 63 patients with AHF [20]. The mean cost per a stay in a Cardiac Surgery Unit was CZK 310,781 (€11,301) and represented as much as 86% of the total in-hospital costs of these patients. If we added the mean cost per stay in the Cardiac Surgery Unit, to all 100 patients in the present study who had also undergone immediate CABG, the mean cost of hospitalization due to AHF would increase to €4007 (CZK 110,183; a 19% increase). Because the data about cardiac surgery costs were already published, we discussed the major results in this section.

Our results may be helpful in estimating future resource requirements. At the same time, the work shows doctors potential cost of AHF treatment.

Study limitations

The presented data are from one hospital with CathLab service. This could lead to a slightly higher contribution of patients with de-novo AHF, ACS and a higher percentage of patients with coronary angiography and PCI performed during hospitalization, possibly resulting in an overestimation of the average cost per hospitalization.

The number and cost of anti-arrhythmic interventions may have been partly underestimated because some patients, particularly those with ACS, were electively readmitted for device implantation. According to the guidelines of the European Society of Cardiology, prophylactic implantation of ICD to reduce the risk of sudden death in patients with left ventricle dysfunction is indicated no less than 40 days after myocardial infarction. In our work, we only evaluated the first hospitalization of each patient and, moreover, such a therapeutic approach might be considered as treating a stable patient with chronic heart failure. Finally, the long-term monitoring of all such costs was beyond our capabilities.

When comparing cost results to studies in other countries, without knowing the background of the centers in which the studies were completed, the assessment is only approximate. For example, different health services treat patients with the same diagnosis in different ways. There are several techniques to compare the costs among countries. We decided to use the annual mean exchange rates to make the data easier to understand. Certain economic methods which reflect differences in price levels among countries are available for currency conversion, i.e. based on purchasing-power parity. Moreover, when comparing our data to studies from the United States or Finland, we did not adjust costs for inflation from different years, even for time preference. However, we do not expect our original results to be utilized for foreign pharmaco-economic studies, because economic data cannot be easily transferred from one setting to another (e.g. availability of treatments, patterns of clinical practice, relative prices) [21–24].

Conclusions

Hospitalization costs related to AHF were high (particularly in new-onset AHF patients). The median hospital stay was 7 days and in-patient costs averaged €3364 (including all interventions) in all AHF patients. The heterogeneity of resource use was largely a reflection of interventions undertaken (particularly if revascularization or anti-arrhythmic therapy was provided). The room rate reflected only 36% of total costs in AHF patients (28% of the total cost was related to the CCU stay).

The most important finding was that hospitalization costs of patients admitted with AHF vary tremendously among different AHF etiologies. There were significant differences in CCU need, LOS, SCU costs, total CCU + SCU costs, total in-hospital costs (including interventions) and mortality rates. Among all patients, ACS patients incurred the greatest costs, because PCI was carried out in almost two thirds of these patients and a CCU stay was required for > 90% of them.

The major limitation of this work was that only direct costs of cardiology department hospitalizations for the acute phase of heart failure were evaluated, and no long-term monitoring of subsequent costs was carried out.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

The project was supported by European Regional Development Fund – Project of St. Anne's University Hospital – ICRC (no. CZ.1.05/1.1.00/02.0123) and by the project (Ministry of Health, Czech Republic) for conceptual development of research organization 65269705 (University Hospital Brno, Brno, Czech Republic). The work of Simona L. as Ph.D. student was financially supported by the Czech Science Foundation-GACR (Project no. 102/09/H083, Information Technology in Biomedical Engineering).

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