

MEDICAL COSTS ASSOCIATED WITH 30-DAY READMISSIONS AMONG PATIENTS WITH HEART FAILURE AND PERSISTENT HYONATREMIA

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Abstract

OBJECTIVES: To estimate the medical costs among hospitalized heart failure patients discharged with or without corrected sodium. Hyponatremia (HN), defined as a serum sodium level <135 mmol/L, commonly occurs among patients hospitalized with heart failure (HF). Donzé et al. (*Am J Med.* 2016;129(8)) established an association between persistent HN (sodium level <135 at both admission and discharge) and increased risk of all-cause 30-day readmissions. Since readmission rate is an important quality measure, healthcare professionals may benefit from understanding the costs associated with discharging patients with uncorrected sodium.

METHODS: An interactive Microsoft® Excel-based economic model was developed to monetize (2016 \$US) the risk of 30-day readmissions. Per the multivariable logistic regression analyses in Donzé et al., patients who were admitted and subsequently discharged with sodium <135 mmol/L are 1.28 times (95% CI 1.11-1.48) more likely to be readmitted compared to patients discharged with corrected sodium. To translate the risk of readmission into a practical metric such as costs, the current economic model calculated the average cost for patients discharged with corrected sodium as: [(Number of patients discharged with corrected sodium X Hospitalization cost) + (Number of patients readmitted X Hospitalization cost)] / Number of patients discharged with corrected sodium. Similarly, average cost for patients discharged with uncorrected sodium was calculated. The numerical difference was the economic burden associated with discharging patients with uncorrected sodium. The model used readmission rate inputs from Donzé et al. and hospitalization costs from the Healthcare Costs and Utilization Cost Project and Premier Inpatient data, with an interactive functionality allowing users to specify costs for their own hospitals.

RESULTS: Discharging HF patients with uncorrected sodium increased costs from \$488-\$507 per discharge compared to patients with sodium >135 mmol/L.

CONCLUSIONS: Due to outcomes improvement over the continuum of care, results support the financial value of upfront monitoring and correction of low sodium before discharge.

Model Inputs

Table 1. 30-day hospital readmission rates by sodium level at discharge as reported by Donze et al.¹

	Patients with Corrected Sodium	Patients with Uncorrected Sodium
Readmission Rates (Unadjusted readmission rates from Donze et al. ¹)	23.4%	27.5%
Adjusted Odds Ratio (95% CI): Odds of readmission for patients discharged with uncorrected sodium versus corrected sodium (reference group)	1.28 (1.11-1.48)	
Readmission Rates (Calculated readmission rates using Adjusted Odds Ratio from above)	22.9%	27.5%

Table 2. Cost per hospitalization event

	2014 US \$	2016 US \$ ⁵
Premier hospital database derived cost of hospitalization for patients with HF ^a	\$11,318	\$12,366
2014 HCUP Database derived estimate of cost of hospitalization among patients with HF ⁴	\$10,885	\$11,893

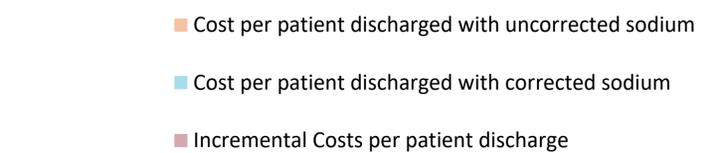
2014 US Dollars inflated to 2016 using the medical component of the Consumer Price Index (CPI)⁵ - i.e. by multiplying 2014 US \$ by factor of 1.0926 to estimate 2016 US \$

^aDefined as patients with ICD-9 codes 428.xx

HF- Heart Failure, HCUP- Healthcare Cost and Utilization Project

Model Results

Figure 1: Incremental cost of discharging a patient with uncorrected versus corrected sodium after accounting for higher readmission costs for patients discharged on uncorrected sodium



¹Age, gender, race, number of admissions within the last 6 months before the index admission, unplanned index admission versus elective, length of stay, atrial flutter or atrial fibrillation, ischemic heart disease, cancer, chronic obstructive pulmonary disease, diabetes, and chronic kidney disease. The severity of congestive heart failure was assessed using the last available laboratory value of the brain natriuretic peptide (BNP) or the last measurement of the ejection fraction before discharge.

- On average, discharging patients with uncorrected sodium cost \$488-\$569 more per discharge compared to discharging patients with corrected sodium.
- As expected, sensitivity analyses indicated that model results were most sensitive to cost of hospitalization and 30-day readmission rates among patients discharged with and without sodium correction.

Limitations and Conclusions

- Generalizability of results will be influenced by hospital-specific protocols on discharge planning, quality of care, management of HN etc.
- However, based on the potential for outcomes improvement in the form of reduced 30-day readmissions, results support the value of upfront monitoring and correction of low sodium before discharge among patients with heart failure and hyponatremia.

References

- Donzé JD, Beeler PE, Bates DW. Impact of Hyponatremia Correction on the Risk for 30-Day Readmission and Death in Patients with Congestive Heart Failure. *Am J Med.* 2016;129(8):836-842. doi:10.1016/j.amjmed.2016.02.036.
- Gheorghide M, Abraham WT, Albert NM, et al. Relationship between admission serum sodium concentration and clinical outcomes in patients hospitalized for heart failure: an analysis from the OPTIMIZE-HF registry. *Eur Heart J.* 2007;28(8):980-988. doi:10.1093/eurheartj/ehs542.
- Hernandez MB, Schwartz RS, Asher CR, et al. Predictors of 30-Day Readmission in Patients Hospitalized With Decompensated Heart Failure: Predicting Freedom from heart failure readmission. *Clin Cardiol.* 2013;36(9):542-547. doi:10.1002/clc.22180.
- Agency for Healthcare Research and Quality. HCUPnet. <https://hcupnet.ahrq.gov>. Published November 1, 2016. Accessed April 12, 2017. <https://hcupnet.ahrq.gov/#query/ej/EQVRBU0VUX1NPVVJDRS16WjYEU190SVMiXSwiWUVBUIMiOIsiWVjFmJAXNCJdLCJBTkFmWVNUJU19UWVBFjpbIkFUX1EiXSwiUUVVJQ0tUQUJMRV9UWVBFjpbIFUVF9PQSiJdCJdQVFR09SSVpBVEiPT9UWVBFjpbIKNUX0FMTCJdfQ==>.
- US. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers: Medical Care [CPIMEDSL], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/CPIMEDSL>, December 13, 2016.

Introduction

- Hyponatremia (HN) is an electrolyte abnormality that occurs either in isolation or as a complication of other medical illnesses (example: heart failure, liver failure, renal failure, pneumonia etc).¹
- HN is characterized by low serum sodium levels and is categorized as:
 - Mild (serum sodium 130 to <135 mmol/L)
 - Moderate (serum sodium 125 to < 130 mmol/L) and
 - Severe (serum sodium <125 mmol/L)
- HN is prevalent in 20-25% of patients hospitalized with heart failure (HF).²
- Evidence exists on the association of HN with increased morbidity and mortality in patients hospitalized for HF;² however clinical trial data are lacking on the independent association between sodium correction and improved patient outcomes.
- In terms of real-world data on resource utilization, Hernandez et al.³ demonstrated an association between low sodium and readmissions.
- Donzé et al.¹ established an association between persistent HN (sodium level <135 at both admission and discharge) correction and reduced risk of all-cause 30-day readmissions.
- Since readmission rate is an important quality measure, healthcare professionals may benefit from understanding the costs associated with discharging patients with uncorrected sodium .

Objective

- To compare medical costs among hospitalized HF patients discharged with or without corrected sodium.

Methods

- An economic model was developed to estimate the costs associated with readmissions for HF patients discharged with and without sodium correction. The goal of the analyses was to monetize the difference in readmission rates based on status of sodium correction at discharge as reported by Donzé et al.¹
- Model inputs were based on:
 - Healthcare Cost and Utilization Project (HCUP) database, sponsored by the Agency for Healthcare Research and Quality.⁴
 - A real-world data analysis of the Premier Healthcare Database representing 591 hospitals in the US from 1/1/2014 through 12/12/2014 in which 62,122 patients with HF (ICD-9: 428.xx) were admitted to the hospital.
- Per the multivariable logistic regression analyses in Donzé et al.,¹ patients who were admitted and subsequently discharged with sodium <135 mmol/L are 1.28 times (95% CI 1.11-1.48) more likely to be readmitted compared to patients discharged with corrected sodium.
- To translate the risk of readmission into a practical metric such as costs, the current economic model calculated the average cost for patients discharged with **corrected** sodium as:

$$A = \frac{(\text{Number of patients discharged with corrected sodium} \times \text{Hospitalization cost}) + (\text{Number of patients readmitted} \times \text{Hospitalization cost})}{(\text{Number of patients discharged with corrected sodium})}$$

- Similarly, average cost for patients discharged with **uncorrected** sodium was calculated as:

$$B = \frac{(\text{Number of patients discharged with uncorrected sodium} \times \text{Hospitalization cost}) + (\text{Number of patients readmitted} \times \text{Hospitalization cost})}{(\text{Number of patients discharged with uncorrected sodium})}$$

- The numerical difference (B minus A) is the economic burden associated with discharging patients with uncorrected sodium; this calculation can be simplified in the following equation:

$$\text{Incremental cost of discharging a patient with uncorrected versus corrected sodium} = \text{Readmission rates (among patients discharged with uncorrected sodium)} * \text{Hospitalization cost} - \text{Readmission rates (among patients discharged with corrected sodium)} * \text{Hospitalization cost}$$

Disclosures:

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