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EVIDENCE-BASED RESEARCH

Correlation of paramedic administration of furosemide with emergency physician diagnosis of congestive heart failure

Thomas Dobson, ACP BA[1,2]
Jan L Jensen, ACP BSc[1,2]
Saleema Karim, BSc MHSA MBA[1]
Andrew H Travers, BSc MD MSc FRCPC[1, 2, 3]

[1]Emergency Health Services Nova Scotia, [2]Dalhousie University Division of Emergency Medical Services, [3]Dalhousie University Department of Emergency Medicine

Abstract

Objective
Recent literature has questioned the accuracy of paramedic diagnosis of congestive heart failure and appropriateness of administration of diuretics. This study determined the agreement between paramedic administration of furosemide and emergency physician diagnosis of congestive heart failure. Treatments administered in the pre-hospital and emergency departments and adverse events are also described.

Methods
This retrospective study included patients treated with furosemide by paramedics from November 1, 2006 to June 1, 2008. Paramedic reports were matched with Emergency Department (ED) charts. Emergency physician diagnosis, prehospital and ED treatments, adverse events and mortality were identified.

Results
Of 94 patients, emergency physician diagnosis was congestive heart failure (CHF) in 60 cases, indicating agreement of 63.8% of paramedic administration of furosemide for this diagnosis. Leading alternate diagnoses were: pneumonia (n = 14); acute coronary syndrome (n = 8); chronic obstructive pulmonary disease (n = 7). The rate of death was higher in patients not diagnosed with congestive heart failure (6/28 vs. 2/58, p=0.017). Eight non-fatal adverse events were identified, all were patients diagnosed with congestive heart failure by emergency physicians.

Conclusion
Paramedic administration of furosemide demonstrates moderate agreement with physician diagnosis of congestive heart failure. This adds to the evidence that diagnosing the cause of dyspnea in the prehospital setting is difficult, most often confused with pneumonia. Paramedics should be cautious when administering furosemide, as it may be related to increased mortality.

Keywords: *diagnosis; emergency medical technicians; furosemide; heart failure; prehospital emergency care.*

Introduction

Congestive heart failure is a clinical condition encountered in the emergency and prehospital settings. The condition affects more than 400,000 Canadians, with over 50,000 new cases occurring annually.[1] For example, in Montreal, Canada, a city with a current population of 3.6 million the rates of hospital admission increased over the 1990-1997 period, while the length of stay decreased, and rates of re-admission were found to have increased.[2,3] If these results are typical of most locations, CHF will continue to be a common clinical condition paramedics face when patients call for help and transport.

The diagnosis of CHF in the prehospital setting can pose challenges to paramedics. CHF may be commonly confused with chronic obstructive pulmonary disease (COPD), pneumonia and other respiratory conditions, each with different treatment strategies. Studies conducted on paramedic diagnostic accuracy for CHF have shown moderate accuracy (53-87% sensitivity),[4,5] although a misdiagnosis rate as high as 42% has been reported.[6] A small study indicated paramedics are best able to identify the most acute cases of CHF, which result in admission.[7]

Positive outcomes have been associated with advanced paramedic treatment of respiratory distress. The Ontario Prehospital Advanced Life Support study, a large before-and-after cohort study, determined that patients who received advanced interventions for respiratory distress (endotracheal intubation, furosemide, nebulized salbutamol and/or sublingual nitroglycerin) had a decreased mortality rate (12.4%) compared with those receiving only basic life support (14.3%).[8] Some studies have reported paramedic treatment of CHF decreased mortality rates, particularly in non-hypotensive, critical patients.[9] However, more recent evidence questions the efficacy of such interventions on patient outcome.[6,10] Specifically, prehospital administration of furosemide and morphine have come under scrutiny as having questionable benefit and potentially detrimental effects in some patients, especially in those patients treated for CHF and incorrectly diagnosed by paramedics.[11,12]

Adverse events are defined as events which result in unintended harm to the patient, related to the care and/or services provided to the patient rather than to the patient's underlying medical condition.[13] One study demonstrated increased mortality when a combination of medications was administered by paramedics to patients incorrectly diagnosed with CHF.[11] Mortality and fluid and electrolyte imbalances are adverse events correlated with paramedic administration of furosemide and morphine to dyspneic patients.[14]

There were three objectives of this study. The first was to determine agreement between paramedic administration of furosemide with EP diagnosis of CHF. The second was to examine differences in interventions administered by paramedics and in the ED by EP diagnosis of CHF. The third objective was to identify any adverse events that occurred during patient care.

Methods

Study Design

This retrospective chart review included all patients who received furosemide by paramedics over a 19-month period (November 1, 2006 to June 1, 2008). Patients were identified by the Emergency Health Services (EHS) electronic patient care report (ePCR) database. This study received approval from the Capital District Health Authority Research Ethics Board (# CDHA-RS/2009-113).

Setting

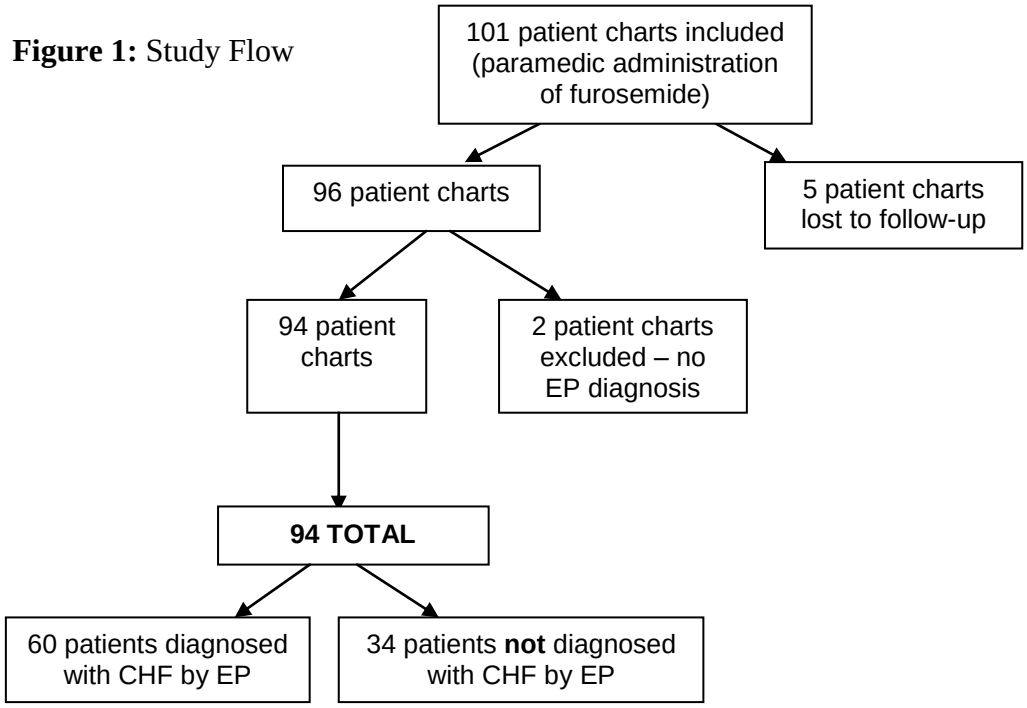
In Nova Scotia, all air and ground ambulance services are provided by a single service, and are regulated by EHS, a branch of the Department of Health. Protocols, equipment and paramedic registration are standardized across the province. The province, which has a total population of approximately one million, is divided into four administrative regions. The two regions with the highest call volume were included in this sample and contain the province's largest municipalities and the two tertiary care hospitals (Halifax Regional Municipality and Cape Breton Regional Municipality). The total population of these two regions is 482,188.[15,16] Within this catchment, patients are transported to seven hospitals. No destination bypass protocol exists for CHF or shortness of breath patients.

Approximately 1000 paramedics are employed in the EHS ground ambulance system, 273 of which are Advanced Care Paramedics (ACPs) or Critical Care Paramedics (CCPs). CCPs are trained to work on the air ambulance, with additional interventions. While working in the ground ambulance service, they follow the ACP scope of practice. Therefore, ACPs and CCPs were considered one provider type for this study. EHS ground ambulance paramedics attended 105,799 emergency calls in 2006-07. Shortness of breath (SOB) was the most common dispatch complaint in Nova Scotia during this time period, constituting 6.8% of these calls (n = 7194).[17] The EHS protocol for CHF/pulmonary edema dictates ACPs and CCPs treat patients with sublingual nitroglycerin, intravenous morphine and furosemide.[18] Only ACPs and CCPs are permitted to administer furosemide, and this drug only appears in the CHF/pulmonary edema protocol. Protocol selection is dependent on paramedic working diagnosis. ACPs and CCPs in this system generally work independently of online medical control.

Subjects

The database was queried for patients who received furosemide by paramedics within the specified time period in the two included regions. Each included EHS ePCR was matched with the corresponding emergency department (ED) chart. Patients were excluded if the ED chart was not located (lost to follow-up) or if a diagnosis by the emergency physician (EP) was not documented. See Figure 1 for study flow.

Figure 1: Study Flow



Methods of Measurement

The EHS ePCR database identified paramedic reports in which furosemide was administered. As furosemide only appears in the CHF/pulmonary edema protocol, paramedic differential diagnosis of this was assumed by furosemide administration. Data abstraction from the EHS ePCR and ED chart included the EP primary diagnosis, considered the gold standard. Other data points collected included: demographic information; EHS treatment administered; treatment administered in the ED; adverse events and patient disposition. Data were collected by two paramedics who used standard data collection forms. One author (TD) entered all data into a study database (Microsoft® Excel, Redmond WA).

Data Analysis

All data analysis was performed with SPSS® Version 5.0 (SPSS Inc., Chicago, IL). Mean values and standard deviations and frequencies were used to describe data distributions. All categorical variables were analyzed using the chi-square statistics and all means were compared using Students' t-tests. For all statistical tests, a p value of <0.05 was considered significant.

Results

A sample of 101 patients was identified from the EHS ePCR database in the study period. Five patients were excluded because their ED charts were not located (lost to follow up), and an additional two were excluded because no EP diagnosis was recorded on the ED chart. The final sample contained 94 patients. See Table 1.

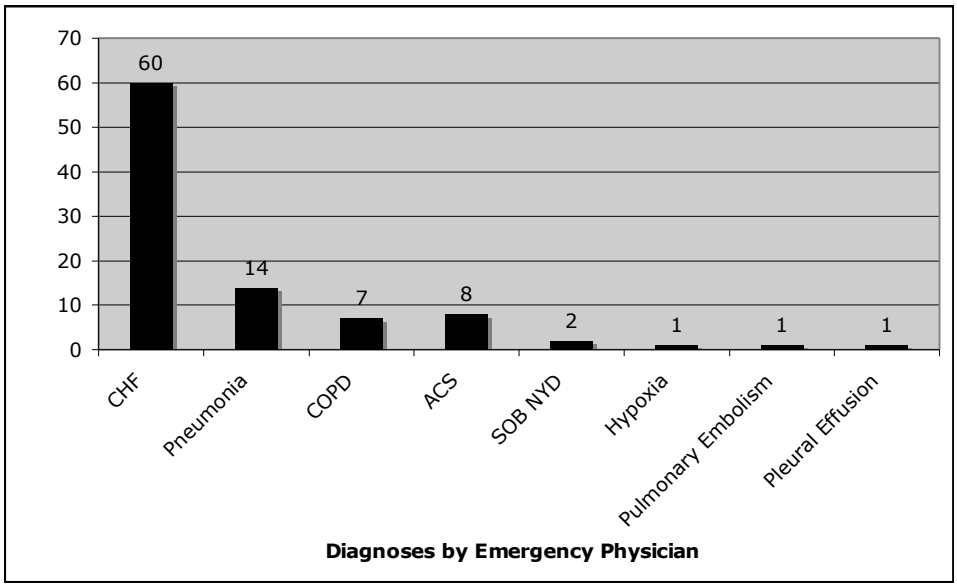
Table 1: Sample Characteristics

Characteristic	**TOTAL (n = 94)**	**EP diagnosis of CHF (n = 60)**	**Not EP diagnosis of CHF (n = 34)**	**P Value < 0.05**
Age Mean (SD)	76.7 (11.45)	76.1 (11.0)	77.7 (12.3)	p = 0.533
Gender Female n (%)	47 (50)	30 (50)	17 (50)	p = 1.000
EHS Transported n (%)	94 (100%)	60 (100%)	34 (100%)	p = 1.000
Length of Stay (days) Mean (SD) Range	8.76 (9.58) 0-51	9.62 (9.72) 0-51	7.24 (9.28) 0 – 43	p = 0.249
Mortality in ED (n) Death n (%)	8 (8.5%)	2 (3.4%)	6 (17.6%)	p = 0.017

EP = Emergency Physician; **CHF** = congestive heart failure; **EHS** = Emergency Health Services; **n** = number; **SD** = standard deviation; **ED** = Emergency Department

The EP diagnosis was CHF in 60/94 patients, indicating agreement with paramedic administration of furosemide of 63.8%. There were 34 patients not diagnosed with CHF by the EP. The majority of alternate diagnoses were pneumonia (14/34, 41.2%), acute coronary syndrome (8/34, 23.5%) or COPD (7/34, 20.6%). See Figure 2.

Figure 2: Diagnoses made by Emergency Physicians for all patients in sample (n=94)



CHF = congestive heart failure; **COPD =** chronic obstructive pulmonary disease; **ACS =** acute coronary syndrome (includes 1 myocardial infarction); **SOB NYD =** shortness of breath not yet diagnosed.

A difference was not found in the amounts of medications administered by paramedics between the patients diagnosed with CHF by the EP and the patients who had an alternate diagnosis. 87/94 patients received sublingual nitroglycerin by paramedics. A significantly higher number of patients received a diuretic in the ED who were diagnosed with CHF, compared to those with an alternate diagnosis. See Table 2.

Table 2: Treatment administered by EHS and by ED

Treatment per patient	**TOTAL**	**EP diagnosis of CHF**	**Not EP diagnosis of CHF**	**P Value < 0.05**
EHS O2 (L) mean (SD)	10.02 (4.27)	10.60 (4.10)	9.03 (4.43)	p = 0.086
EHS Nitro (mg) mean (SD)	1.34 (0.84)	1.46 (0.81)	1.13 (0.88)	p = 0.068
EHS Morphine (mg) mean (SD)	1.40 (1.55)	1.53 (1.60)	1.19 (1.45)	p = 0.317
EHS Furosemide (mg) mean (SD)	69.57 (28.40)	73.33 (27.97)	62.94 (28.34)	p = 0.088
	TOTAL	**EP diagnosis of CHF**	**Not EP diagnosis of CHF**	**P Value < 0.05**
Patients who received treatment	(n = 94)	(n = 60)	(n = 34)	
ED Nitro n (%)	43 (45.7%)	32 (53.3%)	23 (67.6%)	p = 0.050
ED Diuretic n (%)	53 (56.4%)	46 (76.7%)	7 (20.6%)	p < 0.001

CHF = congestive heart failure; **O2** = oxygen; **Nitro** = nitroglycerin; **ED** = emergency department

ED mortality was higher in patients with an alternate diagnosis than those diagnosed with CHF by the EP (2/60 vs. 6/34, p=0.017). As documented on ED charts, eight patients in this

sample suffered adverse events other than death. These adverse events were: hypotension (n =3), heart rate problem (n =3), electrolyte imbalance (n =1), and respiratory effort decline (n = 1). All of the patients who suffered adverse events were diagnosed with CHF by the EP. Adverse events were not associated with the amount of nitroglycerine, morphine or furosemide administered.

Discussion

Our study demonstrated similar results to previous studies on paramedic accuracy for diagnosing CHF. In this study, furosemide was administered correctly (i.e., patients had an EP diagnosis of CHF) to 60/94 patients. CHF was most often confused with pneumonia and COPD. EHS treatment did not vary between the group diagnosed by the EP with CHF and the group given alternate diagnoses. ED treatment did differ, not surprisingly, as diuretics were given less often to the non-CHF patients. An increased mortality was found in the patients who had an EP diagnosis other than CHF. Of the six patients with an alternate diagnosis who had an outcome of death, three were diagnosed with pneumonia. Eight adverse events other than death were identified in this sample. Interestingly, all these patients were correctly identified as having CHF, which contradicts previous research which has found adverse events were more likely in patients incorrectly treated for CHF by paramedics.[11,12] This indicates that furosemide should be administered with caution, even in cases where diagnosis of CHF is correct.

Limitations

This small retrospective study did not have a comparison group, therefore sensitivity, specificity and kappa calculations could not be performed.

It should be noted that seven patients without an ED diagnosis of CHF received ED furosemide and 43 patients received ED nitro with only eight of those having a primary diagnosis of ACS. This data put the accuracy of the primary ED final diagnosis as a reference standard into question, as it appears CHF may have been in the differential diagnosis for many patients not ultimately diagnosed with CHF. Secondary diagnoses were not sought out and included. Therefore, paramedic accuracy reported in this study may be falsely low, if CHF was part of the EP secondary diagnoses. It should also be noted that there were two patients with a diagnosis of "shortness of breath not yet diagnosed." It is possible that these patients did indeed have CHF, but were not diagnosed until a later time during hospital care. This needs to be considered when determining paramedic diagnostic accuracy.

As the paramedics in this study worked in the two largest call volume areas of Nova Scotia - attending to highly acute and dyspneic patients more frequently than their rural colleagues, generalizability of these findings to all EMS services may be limited.

Additionally, EHS ambulances are not equipped with thermometers. However, increased diagnostic accuracy for pneumonia may have been found if this equipment had been available to paramedics. This is an area worthy of future research.

Conclusion

Although this study demonstrates moderate paramedic accuracy, our results indicate that CHF can be difficult to diagnose in the prehospital setting. Misdiagnosis by paramedics can lead to poor patient outcomes, including increased mortality, especially in patients who have pneumonia. Paramedic continuing education and clinical protocols should reflect this.

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