CODING OF HEART FAILURE DIAGNOSES IN SASKATCHEWAN: A VALIDATION STUDY OF HOSPITAL DISCHARGE ABSTRACTS

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ABSTRACT

Background
Validity of Heart Failure (HF) diagnoses from administrative records has not been extensively evaluated, especially with respect to small / unselected hospitals.

Objectives
To determine the positive predictive value of a primary / most responsible diagnosis of HF among a general population of subjects discharged from Saskatchewan hospitals.

Methods
Using administrative health records from the Province of Saskatchewan, Canada, we identified subjects experiencing their first HF hospitalization between 1994 and 2003. From this cohort, we randomly selected 500 subjects for individual validation using Framingham and Carlson criteria.

Results
The 466 charts available for analysis, 74% (345/466) and 63.9% (298/466) of subjects met criteria for a clinical diagnosis of HF based on Framingham or Carlson criteria, respectively; 57.5% (268/466) met both criterion. Provincial hospitals (located in the largest urban centres) were associated with the highest proportion of confirmed HF diagnoses (87.8% by Framingham criteria) compared to progressively smaller hospitals (regional 77.9%; district 64.2%; and community 60.0%). Accuracy also differed when stratified by physician category. Cardiologists and internists were associated with the highest rates of confirmed diagnoses [97.5% (39 / 40) and 85.0% (34 / 40)] compared to general practitioners [73.1% (95 / 130)] and other physicians [69.1% (177 / 256)], by Framingham criteria.

Conclusions
Hospital discharge abstracts indicating HF are frequently inaccurate. These findings have important implications for the epidemiologic study of HF as well as the clinical management of patients.

Key Words: *Diagnosis, heart failure, validation, epidemiology*

Heart failure (HF) is a chronic condition associated with frequent hospitalizations and a shortened lifespan.[1] It has been the focus of intensive, prospective, clinical research over the past decade, resulting in a major shift in the pharmacologic management of these patients.[2,3] In addition, observational studies have been widely used to document obvious trends in factors such as the ever-changing utilization of drugs,[4-6] the death rate,[7-9] as well as the increase in the overall prevalence of this condition during the past decade.[10]

Hospital discharge diagnoses are frequently used to identify HF subjects in these observational studies[4-6] because validation studies from North America,[11-14] as well as Europe/Scandinavia[15-19]

have indicated positive predictive values between 80% and 94%. However, most of these studies restricted their analyses to one specific institution or a specific selection of institutions,[13-19] despite the fact that, many observational studies enrol subjects without regard to the source hospitals.[5,7,8,20,21] Considering the well known difficulties in diagnosing HF,[22-24] it is highly likely that the positive predictive value is lower among smaller community hospitals, which is rarely investigated in validation studies.

We undertook a HF validation study in the Province of Saskatchewan, Canada, using standardized diagnostic criteria that were applied to all available hospital charts. The primary objective was to determine the accuracy of HF discharge coding in Saskatchewan hospitals and secondarily, to explore factors associated with better coding.

Data Source

The government of Saskatchewan maintains administrative records for all beneficiaries of the province's health benefit plans. Over 99% of the population is covered for health benefits, excluding only members of the military, the Royal Canadian Mounted Police, and federal inmates. Each beneficiary can be identified through a unique identifier that allows linkage of the various databases, such as, the insurance registry, prescription drug file, physician services file, hospital services file, and vital statistics file. These data sources have been used for several epidemiologic analyses, including studies involving heart failure diagnoses.[4,11]

Hospital separations (discharges, inpatient deaths, transfers) in Saskatchewan are processed by the Canadian Institute for Health Information (CIHI) and are coded with the International Classification of Disease, 9th revision (ICD-9) prior to April 1, 2001 and with the 10th revision (ICD-10CA - Canadian Enhancement) starting April 1, 2001 for most hospitals. Five hospitals converted to ICD-10-CA April 1, 2002 leaving a one-year period of time when ICD-9 and ICD-10CA codes were being used simultaneously in the province. Up to 16 discharge diagnoses are recorded using the ICD-9 system and up to 25 are recorded using ICD-10CA. In addition to diagnostic information, in-hospital procedures are coded with the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures (CCP)[25] prior to 2001 and with the Canadian Classification of Health Interventions (CCI) since 2001. Patient identification and date of birth are also recorded for every hospitalization.

Saskatchewan hospitals can be categorized by the size of the population they serve as well as the complexity of service delivered (community, district, regional, and provincial). Community hospitals provide 24-hour emergency service, general medicine, basic lab and x-ray services, and observation, assessment, convalescent and palliative care service to a population less than 3,500. District hospitals provide 24-hour emergency services, general medicine for adults and children, low complexity surgeries, and low-risk obstetric deliveries to populations between, 3,500 and 15,000. Regional hospitals provide the same minimum range of services found in district hospitals as well as reliable basic specialty services (including internal medicine, general surgery, obstetrics and gynecology) and also offer intensive care services to populations between 15,000 and 40,000. Provincial hospitals are located in the two largest cities in the province and provide many specialized services that include diagnostic tests (e.g., MRI scans), a wide range of surgeries, and specialized medical services (e.g., cancer treatment, heart surgery, or intensive care for infants) to the whole province.

METHODS

We retrospectively identified a cohort of subjects who underwent their first hospitalization for heart failure (primary or most responsible diagnosis only) between January 1st, 1994 and December 31, 2003. For the purposes of this study, a first hospitalization was defined as no previous record of HF hospitalization (primary or most responsible) within 5 years prior to the index event. All subjects were required to have at least five years of continuous coverage prior to the index event and be eligible for provincial prescription drug benefits. We also excluded subjects with diagnoses or drug use related to HIV/AIDS, solid organ transplant or terminal illness during the 5 years prior, which left a large population of subjects that would be eligible for most longitudinal studies in HF research.

From this overall HF population, we randomly selected 500 subjects for individual validation of their HF diagnosis. The size of the random sample was limited by the funds available for this study. Trained abstractors reviewed the relevant hospital charts from each individual's index HF admission and recorded clinical information on a purpose-designed data collection form.

Data Analysis

For each patient, we determined if the hospital chart documentation satisfied either Carlson (Boston)[26] or Framingham[27] criteria for a clinical diagnosis of HF (Table 1). Next, we calculated the positive predictive value for the entire sample and analyzed the results within subgroups based on year, type of hospital (provincial, regional, district, community), ICD-9 and ICD-10CA coding, and type of attending physician at the index HF hospitalization. The proportion of subjects meeting criteria for a clinical diagnosis of HF within subgroups were adjusted and compared using logistic regression analysis. The following variables were included within each of these models: age, sex, type of hospital and year of HF hospitalization discharge. Other variables were included only if they exhibited a significant ($P<0.1$) effect on the outcome in univariate analysis: Chronic Disease Score,[28] diabetes, number of hospitalizations in the prior year, and lung disease (as evidenced by use of medication for either asthma or COPD in the prior year).

RESULTS

From the 500 randomly selected subjects, 10 charts were not available and 24 had been destroyed, leaving 466 subjects available for analysis. Baseline characteristics of these 466 subjects closely matched those of the overall HF population. Mean age was 78.9 (SD 10.8) years and half of the population was male. Less than 50% of all subjects had received beta-blockers or angiotensin converting enzyme inhibitors prior to admission. In terms of distribution by hospital type, 38% of randomly selected subjects were admitted to a provincial hospital, 19% to a regional hospital, 15% to district, and 28% were admitted to a community or Northern hospital. Although 2.6% of the original cohort was hospitalized out of province, they were ineligible for chart review for logistical reasons (Table 2).

TABLE 1 Diagnostic Criteria for Heart Failure

FRAMINGHAM CRITERIA*
Major Criteria
Paroxysmal nocturnal dyspnea
Neck-vein distention
Rales
Cardiomegaly
Acute pulmonary edema
S3 gallop
Increased central venous pressure
Hepatojugular reflux
Minor Criteria
Bilateral ankle edema
Nocturnal cough
Dyspnea on ordinary exertion
Hepatomegaly
Pleural effusion
Heart rate ≥ 120bpm
Major or Minor Criteria
Weight loss ≥4.5kg in 5 days in response to treatment

CARLSON CRITERIA ^
History
Dyspnea at rest
Orthopnea
Paroxysmal nocturnal dyspnea
Dyspnea on walking on level
Dyspnea on climbing6ty5
Physical Examination
Tachycardia
Elevated jugular venous pressure
Lung crackles
Wheezing
S3
Chest Radiography
Alveolar pulmonary edema
Interstitial pulmonary edema
CT ratio > 0.50
Bilateral pleural effusions
Upper-zone flow redistribution

*diagnosis requires 2 major criteria OR 1 major and 2 minor criteria;
^Involves a point system dependent upon severity or importance of symptom.
Scored with a 4-point maximum for each of the subcategories. Diagnosis requires a total score ≥ 5 points

TABLE 2 Subject Characteristics

Characteristic (%)	Abstraction Group (n=466)	All other HF discharges (n=13,989)
Mean age (SD)	78.9 (10.8)	78.4 (10.7)
Male	233 (50)	7245 (51.8)
Mean CDS (SD)	7.2 (3.3)	6.9 (3.3)
Mean days at index hospitalization (SD)	9.6 (22.2)	9.6 (28.6)
Prior BB use	82 (17.6)	2958 (21.1)
Prior ACEI use	184 (39.5)	5612 (40.1)
Type of hospital		
Provincial	178 (38.2)	4930 (35.2)
Regional	88 (18.9)	2574 (18.4)
District	69 (14.8)	2062 (14.7)
Community and Northern	131 (28.1)	4059 (29)
Out of Province	-	364 (2.6)
Attending physician at index hospital		
GP	130 (27.9)	3587 (25.6)
Internist	40 (8.6)	1274 (9.1)
Cardiologist	40 (8.6)	769 (5.5)
Missing value or "other physician specialty"*	256 (54.9)	8358 (59.7)
ICD coding		
ICD9	357 (76.6)	10834 (77.4)
ICD10CA	109 (23.4)	3155 (22.6)

* Note: Physician specialty was not provided in 55.6% (8,039 / 14,455) of all electronic discharge records whereas "other physician specialty" made up only 4.0% (576 / 14,455) of all records.

Overall, 74% (345/466) and 63.9% (298/466) of subjects met criteria for a clinical diagnosis of HF based on Framingham or Carlson criteria, respectively, while 57.5% (268/466) met both criteria simultaneously. Results appeared consistent across on sex and age groups (data not shown). More recent diagnostic criteria proposed by the European Society of Cardiology (ESC)[29] were not applied because objective testing such as echocardiography, which is necessary for an ESC diagnosis, was only documented in 18.9% (88/466) of the study sample. Regardless, using the traditional criteria (Framingham and Carlson), clear differences in the rates of confirmed diagnoses were observed when the sample was divided into type of hospital (provincial, regional, district, or community). Provincial hospitals (located in the largest urban centres) were associated with the highest proportion of confirmed HF diagnoses (Table 3). Notably, adjusting the proportions for stated covariates made little difference from the crude proportions.

TABLE 3 Positive Predictive Value of a discharge diagnosis of heart failure

	Framingham Criteria		Carlson Criteria	
	Crude Proportion	Adjusted Proportion (SD)	Crude Proportion	Adjusted Proportion (SD)
Overall	74.0% (345/466)	--	63.9% (298/466)	--
Type of hospital				
Provincial	87.6% (156/178)	87.8% (82.0 – 91.9)	77% (137/178)	76.8% (69.8 – 82.5)
Regional	76.1% (67/88)	77.9% (68.0 – 85.3)	59.1% (52/88)	60.0% (49.0 – 69.8)
District	65.2% (45/69)	64.2% (51.9 – 74.9)	53.6% (37/69)	54.0% (41.8 – 65.7)
Community	58.8% (77/131)	60.0% (51.0 – 68.2)	55% (72/131)	56.2% (47.2 – 64.7)
Physician type				
Cardiologist	39 / 40 (97.5%)	96.7% (79.8 – 99.6)	33 / 40 (82.5%)	79.3% (61.1 – 90.2)
Internist	34 / 40 (85.0%)	82.7% (65.2 – 92.4)	34 / 40 (85.0%)	81.1% (63.0 – 91.5)
General Practitioner	95 / 130 (73.1%)	70.3% (58.9 – 79.6)	81 / 130 (62.3%)	57.4% (45.9 – 68.2)
Other	177 / 25 (69.1%)	72.4% (63.9 – 79.5)	150 / 256 (58.6%)	63.4% (54.6 – 71.3%)

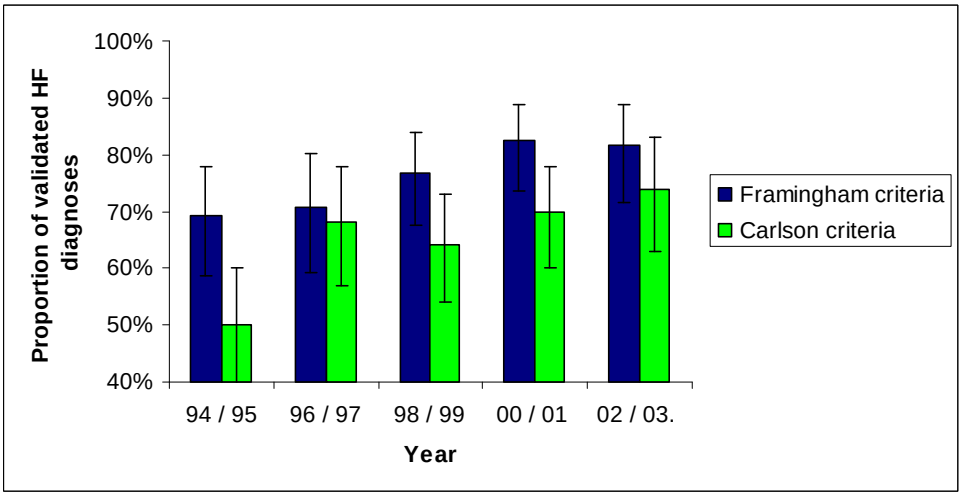
* Note: Physician specialty was not provided in 55.6% (8,039 / 14,455) of all electronic discharge records whereas "other physician specialty" made up only 4.0% (576 / 14,455) of all records.

Physician specialty also differed significantly between hospital types. Cardiologists were listed as the most responsible physician for 22.5% (40/178) of all discharges from provincial hospitals (urban hospitals), but, they were not listed for any patients discharged from other hospitals (regional, district, community). In contrast, general practitioners attended only 4.5% (8/178) of study patients in provincial hospitals compared to higher proportions in regional (27.3%; 24/88), district (55.1%; 38/69), and community hospitals (45.8%; 60/131). However, these data were limited by the fact that many discharge records did not indicate a physician specialty. Out of the entire cohort of 14,455 discharge records available electronically, 55.6% (8,039) did not provide any information about the type of attending physician.

Records where a cardiologist or an internist was listed as the most responsible physician were frequently accurate, with Framingham and Carlson criteria satisfied in 97.5% (39/40) and 82.5% (33/40) of all discharges where a cardiologist was listed as the most responsible physician and in 85.0% (34/40) and 85.0% (34/40) of those discharges where an internist was listed as the attending physician (i.e., same for both criteria). However, adjusting for physician specialty in the logistic regression analysis did not influence the differences in diagnostic accuracy observed between hospital types shown in Table 3 (data not shown). Of the charts listing a general practitioner as the most responsible physician, Framingham and Carlson criteria were satisfied 73.1% (95/130) and 62.3% (81/130) of the time, respectively. In all other records (i.e., where the physician specialty was missing or another physician specialty was indicated) the proportion of confirmed HF cases reached 69.1% (177/256) according to Framingham criteria and 58.6% (150/256) according to Carlson.

Compared to ICD-9 coded discharges, a higher proportion of ICD-10CA diagnoses met HF criteria based on both Framingham (82.6% vs. 71.4%, adjusted proportions: 84.5% vs. 73.8%; p=0.023) and Carlson (76.1% vs. 60.2%, adjusted proportions: 76.2% vs. 61.4%; p=0.006) criteria. However, this observed difference may not have been directly related to the coding subtype (ICD-9 to ICD-10CA) because a gradual increase in the rate of confirmed HF diagnoses was observed throughout the entire observation period, which did not appear to fluctuate in 2001 when the vast majority of Saskatchewan hospitals converted their coding practice to ICD-10CA (Figure 1). In addition, when the comparison of ICD-9 and ICD-10CA were restricted to discharges occurring after 2001, the differences were eliminated with respect to Framingham criteria (81.5% vs. 82.6%, adjusted proportion: 82.6% vs. 86.7%; p=0.61) but persisted when Carlson criteria were used (55.6% vs. 76.1%, adjusted proportion: 53.8% vs. 80.0%; p=0.016).

FIG. 1 Adjusted proportions of validated heart failure (HF) diagnoses using Carlson[17] or Framingham[18] criteria



The most commonly documented diagnostic symptoms were rales (65%), cardiomegaly (56.9%), and pulmonary edema (36.3%). Frequency of all symptoms remained relatively consistent over the years except for pulmonary edema, which was documented in 26% of hospital charts in 1994 compared to 53% in 2003. The increased frequency of pulmonary edema might explain the increasing PPV because 98% of subjects exhibiting pulmonary edema satisfied Framingham criteria while at least 95% of all subjects exhibiting alveolar or interstitial pulmonary edema satisfied Carlson criteria for a clinical diagnosis of HF.

DISCUSSION

We conducted in-depth chart reviews on 500 randomly selected subjects across the province of Saskatchewan, Canada, who received a primary or most responsible diagnosis of HF between 1994 and 2003. Contrary to previous findings, we found that these "real world" diagnoses of HF were frequently not supported by the criteria of two well validated tools. Overall, only 74% and 64% of subjects met Framingham and Carlson criteria, respectively. However, in the stratified analysis, clear differences were observed among subgroups of this study sample. The diagnostic accuracy appeared higher in provincial (urban) hospitals (adjusted rate 87.8% by Framingham criteria) compared to smaller district hospitals (64.2%) and community hospitals (60.0%). Physician specialty also appeared to play a role as cases where cardiologists or internists were listed as the most responsible physician were associated with high rates of confirmed diagnoses (97.5% and 85.0%, respectively by Framingham criteria) compared to cases where a general practitioner (73.1%) was listed as well as all other cases (69% - i.e., when no physician speciality was provided or another physician type was specified). Finally, we observed increasing trends in the rate of documented pulmonary edema and in confirmed HF diagnoses throughout the observation period and we could detect no obvious influence of a system-wide change to ICD-10 CA diagnostic coding in the year 2001.

Compared to previously published validation studies, the rate of confirmed HF diagnoses was relatively low in our study.[11-14,17] The most important distinction between our study compared to others is the fact that we did not restrict our sample to high volume hospitals, and thereby, demonstrated significant differences in the coding accuracy among various types of hospitals across our province. For example, in a validation study of the Swedish hospital discharge register, HF diagnoses were confirmed in 82% of cases, however, 90% of all subjects examined were from a single University hospital.[16] Similarly, a Canadian study reported a high positive predictive value for HF discharge diagnoses (PPV - 89% to 94%) of the ICD-9th revision; but, the validation sample was restricted to subjects discharged from hospitals with a minimum of 100 HF discharges per year.[13]

Other differences should also be noted. In other studies, diagnostic criteria were either not clearly defined[11,14] or based on simplified criteria.[12] In the United States, a positive predictive value of over 80% was reported from the Corpus Christi Heart Project;[12] however, the criteria to evaluate the existence of HF were limited to either a chart notation of acute congestive HF or pulmonary edema. It is not clear how the results of these studies may have been influenced if standardized diagnostic criteria had been used. Regardless, our findings suggest HF diagnoses from hospital discharge abstracts may be frequently inaccurate, even when restricting to the primary or most responsible diagnostic position. Consequently, we believe the results of previous observational studies reporting trends in drug utilization, adherence, and outcomes should be re-evaluated based on our findings that diagnostic accuracy during these times may have also been on the rise.

We also believe our findings likely represent a general problem of inaccurately diagnosed HF patients in observational research as well as clinical practice. If our assumption is true, several implications must be considered. First, from an epidemiologic perspective, the widely recognized increasing prevalence of HF may have been overestimated because it is generally estimated from all available hospital discharge data from geographic regions rather than specific hospitals.[10,20,21] Also, observational studies reporting underutilization of target medications such as beta-blockers and ACE inhibitors[6] may be inaccurate. Although our data might suggest that

under-utilization rates could be exaggerated in the literature, we did not capture false-negative or mis-diagnoses, which would need to be taken into account to sort out the true accuracy of utilization in this population. However, from a clinical perspective, inaccurate HF diagnoses appear to be an important clinical problem.[22-24] One of the key points of the recently published CCS Consensus Guidelines on CHF was that "Management of heart failure begins with an accurate diagnosis…".[3] In order for evidence-based treatments to be optimally used, the right patients must be identified.

We were unable to identify the driving factors behind the contrasting diagnostic accuracy between the various types of hospitals in Saskatchewan. It is possible that the lack of specialist care in smaller hospitals contributes to the lower PPV we observed. Indeed, high rates of confirmed HF diagnoses were associated with cases that listed cardiologists or internists as attending physicians. However, these two physician categories were only listed in a small number of cases (n=80) and the differences between hospital types persisted despite controlling for physician type. Also, the physician specialty field was not entered in over 50% of our electronic discharge abstracts because it is not mandatory for hospitals to populate this field before submitting the discharge abstract. Also, cases of missing data were grouped into the 'other physician' category by Saskatchewan Ministry of Health personnel, making it impossible to provide validity estimates for 'other physicians' vs. 'missing specialty' records. However, we believe this field might still serve to improve the diagnostic accuracy of discharge abstracts. Indeed, cardiologist or internist care has been previously associated with greater accuracy of discharge HF diagnoses.[16] It is possible that the availability of specialist care allowed more diagnostic consultations in provincial hospitals; however, we could not evaluate this factor because we did not capture information on in-patient consultations. Similarly, larger hospitals likely have greater access to diagnostic technology such as echocardiography, which could have been used to confirm suspected cases of HF. Of note, Saskatchewan hospitals did not use B-type natiuretic peptide at the time of the review, which may help clarify the diagnosis in cases which are unclear.

The diagnostic accuracy of HF codes increased consistently throughout our observation period (Figure 1). This observation is interesting because many published reports have highlighted trends in the epidemiology of HF,[10,20,30] as well as the utilization of medications.[4-6] To our knowledge, none of these reports (including our own[4]) have evaluated the extent to which changes in the diagnostic accuracy of these patients has contributed to any of the trends in drug utilization or epidemiology. Indeed, in our randomly selected study sample, documentation of pulmonary edema increased from 26% in 1994 to 53% in 2003. In contrast to our findings, Ingelsson et al reported that HF accuracy decreased over time.[16] However, the time period examined in this paper was very long (1976 to 2001), 90% of subjects were discharged from a single hospital, and less than 110 subjects were evaluated in each of the periods from 1976-1991, 1992-1996, and 1997-2001. As a result, it is difficult to compare these results with the data reported herein.

Although our study of the validity of discharge HF diagnoses in Saskatchewan has strengths (random sample from entire province and in-depth chart review using standardized diagnostic criteria), some limitations must be noted. First, we only accessed patients with a primary or most responsible diagnosis of HF. Therefore, we cannot generalize our findings to those with a HF diagnosis reported as comorbidity or minor significance (although it seems likely that inaccurate coding for heart failure would be worse in this situation). Also, this sample was restricted to subjects with a diagnosis of HF; therefore, it was impossible to ascertain the actual sensitivity or specificity of these diagnoses. Second, because we hired several abstractors, there may have been inconsistencies in the way data were collected from each chart, despite the fact that all went through the same training and standardization activities. Indeed, eligible charts were located in various hospitals across Saskatchewan; consequently, the layout of individual charts and documentation protocols would have been extremely variable in many cases. Furthermore, each chart was reviewed by only one individual. Therefore, inter-rater and

intra-rater reliability are unknown. Third, because our abstraction procedure was limited to reviewing the hospital chart, our assumption was that if a symptom or sign was not documented, it was not present. Clearly, incomplete documentation could have contributed to the low rate of confirmed HF cases we found. Abstractors periodically suspected that charts may have been "thinned" to facilitate storage in medical record departments. Alternatively, a diagnosis might have been reported in the absence of documented diagnostic criteria if echocardiography was performed; however, objective testing was only documented in 18.9% of our study sample. Finally, over the course of the study, heart failure with preserved systolic function (sometimes called "diastolic heart failure") has been increasingly recognized.[31] Because clinical signs and symptoms for the two types of HF are similar, both could satisfy Framingham and Carlson criteria. However, echocardiographic findings are markedly different and physicians may have been loathe to diagnose heart failure in subjects with a normal ejection fraction or heart size on chest roentgenography. As such, it is possible that we missed some persons with heart failure and preserved systolic function. More importantly, smaller hospitals without echocardiography might be more likely to make the diagnosis clinically.

In summary, we found that hospital discharge abstracts frequently report inaccurate diagnoses of HF when the sample is not restricted to specialist care or larger hospitals. These findings have important implications for the epidemiologic study of this condition as well as the clinical care of patients. Further study is needed to clarify the accuracy of coding of this condition and further characterize whether the clinical profile of HF patients has changed over time.

Disclaimer

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