The validity of the diagnosis of heart failure (I50.0-I50.9) in the Danish National Patient Register

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ABSTRACT
INTRODUCTION: National discharge registers are important and cost-effective data sources for administrative and research purposes, but their value depends much on the validity of the registered data. The objective of this study was to assess the validity of heart failure (HF) diagnoses (ICD10: I50.0-I50.9) in the Danish National Patient Register (DNPR).
METHODS: We reviewed medical records from a random sample of 500 patients with either a primary or a secondary discharge diagnosis of HF registered in the DNPR from any department in Northern Denmark in 2007. We noted symptoms, objective signs, diagnostic imaging and biomarkers and used the European Society of Cardiology definition of HF to categorise patients into definite, probable or non-verified HF.
RESULTS: We classified 305 patients as having definite HF and 113 patients as having probable HF. The remaining cases were classified as non-verified HF. Thus, the positive predictive value (PPV) for definite and probable HF was 83.6% (95% confidence interval (CI): 80.1-86.7%).
THE PPV INCREASED TO 88.0% (95% CI: 84.4-91.0%) when we restricted analyses to primary diagnoses and to 95.2% (95% CI: 89.2-98.4%) when we restricted analyses to HF diagnoses established at cardiology units.
CONCLUSIONS: The HF diagnoses (I50.0-I50.9) in the DNPR should be used with caution if validation is not possible. However, restricting analyses to patients registered with a primary diagnosis of HF or patients discharged from cardiology units may be a useful alternative in population-based studies.
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based on strictly defined criteria and performed by thorough and systematic review of discharge summaries and medical records corresponding to the discharge diagnosis and the discharge date contained in the DNPR. Minor mismatches were accepted in the registered date of admission or discharge in the register and medical records. Results of blood tests, chest X-ray and echocardiography descriptions were collected accordingly. If echocardiography descriptions were missing in the medical records, we investigated an echocardiography database for further information (EchoPAC PC, GE Medical Systems).

Cases with uncertainty were discussed within the group and with a specialist in cardiology (AMJ), and diagnoses were made according to consensus.

We defined HF based on the European Society of Cardiology (ESC) Guidelines that were valid at the time of registration of the diagnoses in the DNPR, and we registered whether the patients had typical symptoms, signs and objective evidence of structural or functional cardiac dysfunction at rest [14].

Patients were categorised into definite, probable or non-verified HF (Table 1).

**FIGURE 1**

Patients registered with a discharge diagnosis of heart failure in Northern Denmark were randomly drawn from the Danish National Patient Register.

<table>
<thead>
<tr>
<th>Heart failure Primary diagnoses (n = 400)</th>
<th>Secondary diagnoses (n = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ICD-10: I50.0-I50.9)</td>
<td>(ICD-10: I50.0-I50.9)</td>
</tr>
</tbody>
</table>

DNPR = Danish National Patient Register; ICD-10 = International Classification of Diseases, Version 10.
Source: Bigstock.

**Statistical analysis**

We calculated PPV with corresponding 95% Clopper-Pearson binomial confidence intervals (CI). The PPV were calculated as the proportions of validated cases divided by the total number of patients registered with a HF diagnosis.

We stratified the data based on gender, type of diagnosis (primary versus secondary), type of department and whether or not echocardiography had been performed.

All data analyses were conducted using STATA (version 11, StataCorp LP, College Station, USA).

**Trial registration:** not relevant.

**RESULTS**

Out of 500 patients included in the study, 53% were males and the median age was 77 years (interquartile range: 68-84). A total of 105 (21%) patients were discharged from cardiology units, and 370 (74%) patients were discharged from other internal medicine units. The frequency of discharge diagnoses of HF from particular wards and outpatient clinics is presented in Table 2.

In all, 305 patients (61.0%) fulfilled the criteria of definite HF and another 113 (22.6%) patients were classified as probable HF cases. The remaining 82 (16.4%) cases were classified as non-verified HF; of these, 80 patients had at least one sign and/or one symptom typical for HF but no objective evidence of cardiac dysfunction, and another two patients had some objective evidence of cardiac dysfunction other than echocardiography, but no registered signs and/or symptoms of HF. Thus, the PPV for definite and probable HF was 83.6% (95% CI: 80.1-86.7%) (Table 3).

A total of 380 patients (76%) underwent echocardiography, and 305 of them (80.3%) had an abnormality on their echocardiograms. Fifty patients (13.2%) were classified as having probable HF with preserved LVEF, as they had a written report stating preserved LVEF, but the measurements of diastolic function were not stated in echocardiography descriptions. Thus, the PPV for the HF diagnosis among patients who underwent echocardiography was 93.4% (95% CI: 90.4-95.7%) (Table 3).

When stratifying the data based on type of diagnosis, we found PPV of 88.0% (95% CI: 84.4-91.0%) for a primary diagnosis and 66.0% (95% CI: 55.8-75.2%) for a secondary diagnosis (Table 3).

When stratifying for type of department, we found PPV of 95.2% (95% CI: 89.2-98.4%) for a primary diagnosis and 82.9% (95% CI: 78.7-86.6%) and 46.2% (95% CI: 26.6-66.6%) for cardiology, internal medicine and other departments, respectively. In gender-specific analyses, we found PPV for HF of 85.4% (95% CI: 80.6-89.4%) among men and of 81.5% (95% CI: 76.0-86.3%) among women (Table 3).
**DISCUSSION**

We evaluated the validity of discharge diagnoses of HF (I50.0-I50.9) in the DNPR using review of medical records as reference. The overall PPV for definite and probable HF was 83.6%. The PPVs were slightly higher for primary diagnoses (88.0%) and significantly higher for diagnoses established at cardiology units (95.2%).

Previous validation studies from Denmark [9-11], Sweden [12], Great Britain [13] and Portugal [2] have reported PPV of HF diagnoses in the range 76-100%.

Mard & Nielsen [11] investigated the validity of HF diagnoses obtained from a cardiac care unit of a university hospital in Copenhagen and found a PPV of 84%. Ingelsson et al [12] examined the PPV of HF among 317 Swedish men and found a PPV of definite HF of 82%. The authors observed a marked increase in the PPV of HF to 95% when only primary diagnoses of HF were considered and to 91% when patients were discharged from a cardiology unit.

Similar findings were reported by Kümler et al [10], who assessed the accuracy of HF diagnoses in the DNPR in the late nineties. The authors evaluated a large number of patients who were consecutively admitted to all departments within one hospital in Copenhagen and found a PPV of HF diagnoses of 81%. Of note, the researchers reported a sensitivity of HF diagnoses of 29%, which indicated a large underestimation of the true number of cases.

Substantial underestimation of the burden of HF has also been reported by Khand et al [13], who evaluated the accuracy of HF diagnoses in patients discharged with either a diagnosis of HF or atrial fibrillation. The authors concluded that the examined discharge codes were relatively valid with PPV ranging from 77% to 87%, but may substantially underestimate admissions related to HF in the United Kingdom. Our study design does not allow us to assess such important measures of validity as sensitivity, specificity or negative predictive values.

A Danish study by Thygesen et al [15] examined the PPV of 50 discharge diagnoses of HF registered in the DNPR from the Northern Denmark Region within a ten-year study period (1998-2007) and found a PPV of 100%. However, the authors used descriptions in the discharge summaries as a reference, and review of medical records for discharge codes was only performed if information in the discharge summary was not available; thus, the study did not consider whether the patients fulfilled the diagnostic criteria of HF.

Sundbøl et al [9] investigated PPV of 100 randomly chosen first-time discharge diagnoses of HF and several other cardiovascular diagnoses registered in the DNPR between 2010 and 2012 from the Central Denmark Region, using review of medical records as reference. They found a PPV of HF diagnoses of 76%, whereas markedly higher PPV were seen for several other cardiovascular diseases. However, the authors have not presented the diagnostic criteria used to confirm the diagnoses and have not specified how patients with missing information at the time of the diagnosis were evaluated.

The findings by Sundbøl et al [9] together with other previous studies reporting lower PPV of HF diagnoses compared with other cardiovascular diseases, such as acute myocardial infarction [7, 16] or stroke [8], may reflect the complex nature and definition of HF, which includes several non-specific signs and symptoms that may be challenging to identify in clinical practice. Therefore, ESC experts have recommended echocardiographic assessment of cardiac function in every patient with a clinical suspicion of HF [1, 14]. Some further diffi-
TABLE 3

Positive predictive values of heart failure diagnoses in the Danish National Patient Register.

<table>
<thead>
<tr>
<th>Discharge diagnoses</th>
<th>Verified heart failure*</th>
<th>Non-verified heart failure</th>
<th>Total, n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>PPV (95% CI)</td>
<td>heart failure, n</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>228</td>
<td>85.4 (80.6-89.4)</td>
<td>39</td>
</tr>
<tr>
<td>Women</td>
<td>190</td>
<td>81.5 (76.0-86.3)</td>
<td>43</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>352</td>
<td>88.0 (84.4-91.0)</td>
<td>48</td>
</tr>
<tr>
<td>Secondary</td>
<td>66</td>
<td>66.0 (55.8-75.2)</td>
<td>34</td>
</tr>
<tr>
<td>Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiology</td>
<td>100</td>
<td>95.2 (89.2-98.4)</td>
<td>5</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>306</td>
<td>82.9 (78.7-86.6)</td>
<td>63</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>46.2 (26.6-66.6)</td>
<td>14</td>
</tr>
<tr>
<td>All discharge diagnoses</td>
<td>418</td>
<td>83.6 (80.1-86.7)</td>
<td>82</td>
</tr>
</tbody>
</table>

CI = confidence interval; PPV = positive predictive value.

a) Definite and probable heart failure.

b) Included discharges from surgical wards, orthopaedic surgery wards, emergency departments, an oncology ward, an obstetrics and gynaecology ward and a psychiatric ward.

culties arise in symptomatic patients with preserved LVEF. Grading of diastolic dysfunction is demanding, especially in patients with coexisting atrial fibrillation or mitral valve stenosis.

In the present study, echocardiography was performed in 76% of all patients. Consequently, in the remaining cases, the diagnosis was based on the clinical presentation and other imaging modalities or blood tests. Previous studies have reported echocardiographic assessment of cardiac function in 49-86.7% of cases [2, 12, 13].

Strengths and limitations

The present study has some strengths and limitations that warrant consideration. We investigated the validity of discharge diagnoses in routine clinical practice, which reflects authentic diagnostic difficulties. The observed study population included patients of both genders admitted to several hospitals in the North Denmark Region. Furthermore, we examined the accuracy of the diagnoses using the most recent ICD codes (ICD-10).

As in most validation studies, we used review of medical records as reference. Consequently, classification of cases depended highly on the quality of the data registered in the medical records, which varied significantly. Inadequate or missing data may have led to misclassification of true cases into non-verified HF and an underestimation of the observed PPV. Moreover, most medical records were evaluated by a single reviewer. However, data collection was based on strictly defined criteria, which may have limited errors due to any subjective judgements about symptoms, signs and other diagnostic findings. Another limitation was insufficiently documented echocardiographic examinations. We noticed that echocardiography focused primarily on systolic dysfunction and heart valve abnormalities, and measurements of diastolic function were not routinely reported. Moreover, the definition of HF, guidelines and thus medical practice may have influenced the validity of HF diagnoses after this study was conducted.

In accordance with several previous studies [10, 17], we limited potential cases of HF to patients registered with ICD-10 codes ranging from I50.0-I50.9. Thus, we did not include patients registered with hypertensive heart disease with HF (I11.0), hypertensive heart and renal disease with HF (I13.0), hypertensive heart and renal disease with both HF and renal disease (I13.2) or cardiomyopathies (I42.0 and I42.6-9). However, we believe that the discharge codes I50.0-I50.9 cover the vast majority of all ICD-10 codes describing HF [18].

Furthermore, we included both patients with incident and recurrent HF. As previous studies [9] have shown that PPV may vary within these two groups, all validations in the current study were based on the same strictly defined diagnostic criteria of HF according to relevant guidelines [14], which may have limited potential errors. Also, we only considered patients admitted to hospitals in one region of Denmark. However, we do not expect appreciable differences in coding errors or significant differences in the validity of registered diagnoses across the Danish regions.

CONCLUSIONS

In conclusion, the HF diagnoses (I50.0- I50.9) in the DNPR should be used with caution if validation is not possible. However, the observed overall PPV of 83% is moderately high and may be acceptable for some studies. Restricting analyses to patients registered with a primary diagnosis of HF or patients discharged from cardiology units may be a useful alternative in population-based studies if higher PPV of HF are needed.

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CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk

LITERATURE


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