

Accuracy of angina pectoris and acute coronary syndrome in the Danish National Patient Register

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ABSTRACT

INTRODUCTION: The Danish National Patient Register is widely used for research and administrative purposes. However, its usability is highly dependent of the validity of the registered data. We therefore aimed to determine the positive predictive value (PPV) of angina pectoris and acute coronary syndrome (ACS) in the Danish National Patient Register.

METHODS: We selected a random sample of 500 patients registered with angina pectoris and a random sample of 500 patients registered with ACS among all hospitalisations at any department in Northern Denmark between 1 January 2007 and 31 December 2007. We reviewed the medical records of the sample patients and recorded whether the angina pectoris and the ACS diagnoses were valid based on the European Society of Cardiology criteria.

RESULTS: The PPV of definite and probable angina pectoris was 45.9% (95% confidence interval (CI): 41.3-50.6%), whereas the PPV of verified ACS was 86.6% (95% CI: 83.3-89.5%). Stratification by hospital department revealed significantly higher PPVs for diagnoses received in a cardiology unit for both angina pectoris (61.7%; 95% CI: 53.4-69.6%) and ACS (95.5%; 95% CI: 91.3-98.0%). Stratification by gender showed a significantly higher PPV among men registered with angina pectoris (51.2%; 95% CI: 45.3-57.1%).

CONCLUSIONS: The angina pectoris and ACS data contained in the DNPR should be used with caution in register studies if validation is not possible. Restricting analyses of ACS data to patients discharged from cardiology wards may be a useful option in register-based studies.

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Coronary heart disease (CHD) remains a leading cause of death and morbidly worldwide [1]. The aging of the population increases the prevalence of CHD, which may challenge the economy of healthcare systems. Health surveillance and improvements in preventive strategies are essential in reducing the risk for and consequences of CHD [2]. Population-based epidemiological studies based on administrative data have been widely used for identifying CHD risk factors, disease surveillance and outcome research. Administrative data are cost-efficient data sources, but their usability is highly dependent on the validity of the registered data. Errors and incorrect

registrations of diagnostic codes may lead to underestimation of the associations studied due to the dilution of the case group by non-cases in aetiological studies. Furthermore, failure to adequately estimate true incidence rates of CHD may cause misinterpretation of the burden of disease and subsequently miscalculation of the health resources allocated to address them. Thus, consecutive assessments of the validity of discharge diagnoses are important to ensure optimal health resource allocation and to safeguard the quality of future research [3].

Previous studies of CHD diagnoses recorded in hospital discharge registers and other disease registers have primarily focused on acute myocardial infarction (MI), whereas little emphasis has been placed on the validity of stable angina pectoris. Furthermore, most previous validation studies on CHD were performed before the introduction of the tenth revision of the International Classification of Diseases (ICD)-10.

The objective of this study was to examine the accuracy in terms of the positive predictive value (PPV) of angina pectoris and ACS discharge diagnoses recorded in the Danish National Patient Register (DNPR).

METHODS

Study population

This study was conducted in the North Denmark Region using patients registered in the DNPR. The population of this region counts approximately 580,000 people, corresponding to approx. 10% of the Danish population. This study was approved by the Danish Data Protection Agency (R. no. 2013-41-1650).

Identification of possible cases of angina pectoris and acute coronary syndrome

The DNPR was established in 1977, and nearly all discharge diagnoses from both public and private somatic hospitals have been recorded in the database since. As from 1995, data from outpatient clinic and emergency room patients have been included as well [4]. The DNPR includes information on hospital, department, time of admission and discharge, and a primary diagnosis as well as any secondary diagnoses classified according to the ICD-8 until the end of 1993, and according to the ICD-10 henceforth [4]. The ICD code is determined by the discharging physician.

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TABLE 1

Classification of angina pectoris and acute coronary syndrome.^{a,b}

	Description
AP	
Definite AP	Included the 3 characteristics: Substernal chest discomfort of characteristic quality and duration Provoked by exertion or emotional stress Relieved by rest and/or GTN
Probable AP	Included 2 of the above-mentioned characteristics
Non-cardiac chest pain	Included ≤ 1 of the above-mentioned characteristics
ACS	
Verified ACS	Detection of rise and/or fall in cardiac biomarkers and evidence of myocardial ischaemia with ≥ 1 of: Symptoms of ischaemia ECG indicative of new ischaemia Development of pathological Q waves in the ECG Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality Or, normal cardiac biomarkers and symptoms of ischaemia and ECG changes indicative of new ischaemia Or, if fatal, typical ECG indicative of ischaemia and symptoms of ischaemia and/or evidence of fresh thrombus by coronary angiography and/or autopsy
Possible ACS	Symptoms of ischaemia and ECG indicative of new ischaemia, but missing information on cardiac biomarkers
Non-ACS	Included 0 of the above-mentioned combinations

ACS = acute coronary syndrome; AP = angina pectoris; ECG = electrocardiogram; GTN = glyceryl trinitrate.

a) Symptoms of ischaemia included chest pain and/or discomfort in chest, upper extremity, jaw, or epigastric region with exertion or at rest.

b) ECG indicative of ischaemia included new ST-T changes or new left bundle branch block.

TABLE 2

Frequency of discharges with angina pectoris (AP) and acute coronary syndrome (ACS) by ward and outpatient clinic type. The values are n (%).	AP	ACS
Cardiology ward	137 (30.1)	177 (35.8)
Cardiology outpatient clinic	12 (2.6)	1 (0.2)
Medical ward	205 (45.0)	290 (58.7)
Medical outpatient clinic	52 (11.4)	3 (0.6)
Surgical ward	40 (8.8)	19 (3.8)
Emergency room	7 (1.5)	3 (0.6)
Obstetrics and gynaecology ward	2 (0.4)	1 (0.2)
Total	455 (100.0)	494 (100.0)

We identified potential cases of angina pectoris (ICD-10: I20.9 and I25.1) and ACS, including unstable angina pectoris (ICD-10: I20.0) and myocardial infarction (ICD-10: I21 and I22), who were hospitalised between 1 January 2007 and 31 December 2007 at any department in any hospital in the North Denmark Region using the DNPR. Only the first registered discharge diagnosis of either angina pectoris or ACS within this year was considered. We randomly selected 400 patients registered with a primary angina pectoris diagnosis and 400 pa-

tients registered with a primary diagnosis of ACS. Furthermore, we selected 100 patients registered with a secondary diagnosis of angina pectoris and 100 patients registered with a secondary diagnosis of ACS.

Medical record review

We retrieved medical records corresponding to the discharge diagnosis and exact discharge date contained in the DNPR. However, minor mismatches were accepted in the registered date of admission or discharge in the register and the medical records.

The medical records were reviewed by one of three reviewers (SMH, KSA, or CSB). We defined angina pectoris and myocardial infarction based on the European Society of Cardiology guidelines in force at the time of registration of the diagnoses in the DNPR [5, 6] (Table 1). Unstable angina pectoris was defined as symptoms of ischaemia and electrocardiogram (ECG) indicative of ischaemia with concomitant normal cardiac biomarkers [7] (Table 1).

Statistical analyses

Patients registered with a discharge diagnosis of angina pectoris were categorised into definite, probable or non-cardiac chest pain. Patients registered with ACS were categorised into verified ACS, possible ACS and non-ACS. Patients were categorised as possible ACS if information on cardiac biomarkers was missing, but typical symptoms and ECG were indicative of ischaemia. Patients for whom information was insufficient to categorise them were excluded (e.g. patients with no available medical records).

PPVs of angina pectoris and ACS diagnoses registered in the DNPR were calculated as proportions with the numerator containing the number of patients with a verified diagnosis after review of medical records and the denominator containing the total number of patients registered with the specific diagnosis in the DNPR after exclusions. We stratified the analyses by gender, type of diagnosis (primary or secondary) and type of department. Furthermore, we investigated the PPVs of unstable angina pectoris and MI separately.

Data were analysed using Stata Statistical Software (version 12, StataCorp LP, College Station, US).

Trial registration: not relevant.

RESULTS

Angina pectoris

Table 1 shows how patients registered with angina pectoris were classified. Patients for whom information was insufficient to categorise them as either definite, probable or non-cardiac chest pain were excluded from the analyses (n = 45; 9.0%).



TABLE 3

	Definite angina pectoris		Definite and probable angina pectoris		Non-cardiac chest pain, n	Total, n
	n	PPV (95% CI)	n	PPV (95% CI)		
<i>Gender</i>						
Men	22	7.7 (4.9-11.4)	147	51.2 (45.3-57.1)	140	287
Women	5	3.0 (1.0-6.8)	62	36.9 (29.6-44.7)	106	168
<i>Diagnosis</i>						
Primary	15	4.2 (2.3-6.8)	161	44.7 (39.5-50.0)	199	360
Secondary	12	12.6 (6.7-21.0)	48	50.5 (40.1-60.9)	47	95
<i>Unit</i>						
Cardiology	10	6.7 (3.3-12.0)	92	61.7 (53.4-69.6)	57	149
Internal medicine	13	5.1 (2.7-8.5)	93	36.2 (30.3-42.4)	164	257
Other ^a	4	8.2 (2.3-19.6)	24	49.0 (34.3-63.7)	25	49
All	27	5.9 (3.9-8.5)	209	45.9 (41.3-50.6)	246	455

CI = confidence interval; PPV = positive predictive value.

a) Included discharges from surgical ward, emergency room, and obstetrics and gynaecology ward.

Number of verified cases and positive predictive values of discharge angina pectoris diagnoses in the Danish National Patient Register.

The median age was 69.0 (95% central range: 43.4-90.0) years, and 63.1% were males. The frequency of discharge diagnoses of angina pectoris from particular wards and outpatient clinics are shown in **Table 2**. The majority of patients registered with angina pectoris were discharged from either a department of cardiology (30.1%), from other internal medicine wards (45.0%) or from medical outpatient clinics (11.4%).

The classification of angina pectoris discharge diagnoses is presented in **Table 3**. The PPV for definite and probable angina pectoris combined was 45.9% (95% confidence interval (CI): 41.3-50.6%). Stratification by gender showed a PPV for definite and probable angina pectoris combined of 51.2% (95% CI: 45.3-57.1%) in men and 36.9% (95% CI: 29.6-44.7%) in women. When stratifying by type of diagnosis, we found a PPV of 44.7% (95% CI: 39.5-50.0%) and 50.5% (95% CI: 40.1-60.9%) for primary and secondary diagnoses, respectively. When we stratified the data by type of discharge department, the PPV for patients discharged from a department of cardiology was significantly higher (61.7%; 95% CI: 53.4-69.6%) than that of patients discharged from other internal medicine units (36.2%; 95% CI: 30.3-42.4%).

Acute coronary syndrome

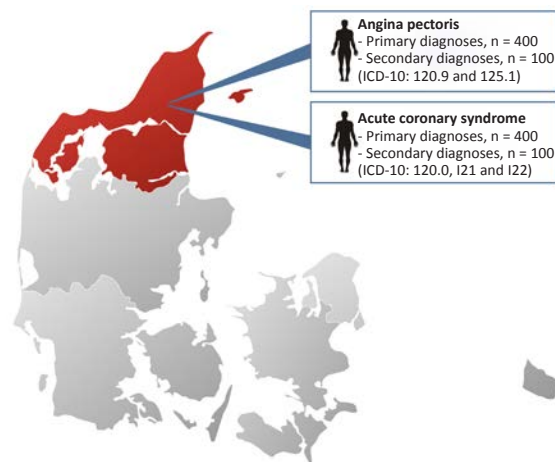
Patients for whom information was insufficient to categorise them as either verified ACS, possible ACS or non-ACS were excluded from the analyses (n = 6; 1.2%).

The median age was 71.0 (95% central range: 41.4-91.0) years, and 64.0% were males. Table 1 shows how patients registered with ACS were classified, and Table 2 shows the frequency of discharge diagnoses of ACS by type of ward. The majority of patients registered with ACS were discharged from either a department of cardiology (35.8%) or another internal medicine ward

(58.7%). The accuracy of ACS diagnoses is shown in **Table 4**. The PPV for verified ACS was 86.6% (95% CI: 83.3-89.5%). Stratification by gender showed no appreciable differences between men and women. When stratifying by type of diagnosis, we found a PPV of 90.2% (95% CI: 86.8-92.9%) and 71.9% (95% CI: 61.8-80.6%) for primary and secondary diagnoses, respectively.

When we stratified the data by type of department, the PPV for patients registered with a discharge diagnosis of ACS at a cardiology unit was significantly higher (95.5%; 95% CI: 91.3-98.0%) than the value recorded for patients diagnosed in other internal medicine units (83.3%; 95% CI: 78.5-87.4%) and other departments (60.9%; 95% CI: 38.5-80.3%).

Restricting the analyses to participants registered with unstable angina pectoris yielded a PPV of 22.9%



ICD-10 = International Classification of Diseases, Version 10. Source: Illustrations were sourced from Bigstock.

Patients registered with a discharge diagnosis of acute coronary syndrome (n = 500) or angina pectoris (n = 500) who had been hospitalised at any hospital in the North Denmark Region were randomly drawn from the Danish National Patient Register.

TABLE 4

Positive predictive values of discharge acute coronary syndrome diagnoses in the Danish National Patient Register.

	Verified ACS		Verified and possible ACS		Non-verified ACS, n	Total, n
	n	PPV (95% CI)	n	PPV 95% CI		
<i>Gender</i>						
Men	277	87.6 (83.5-91.1)	281	88.9 (84.9-92.2)	35	316
Women	151	84.8 (78.7-89.8)	153	86.0 (80.0-90.7)	25	178
<i>Diagnosis</i>						
Primary	359	90.2 (86.8-92.9)	364	91.5 (88.3-94.0)	34	398
Secondary	69	71.9 (61.8-80.6)	70	72.9 (62.9-81.5)	26	96
<i>Unit</i>						
Cardiology	170	95.5 (91.3-98.0)	171	96.1 (92.1-98.4)	7	178
Internal medicine	244	83.3 (78.5-87.4)	248	84.6 (80.0-88.6)	45	293
Other ^a	14	60.9 (38.5-80.3)	15	65.2 (42.7-83.6)	8	23
All	428	86.6 (83.3-89.5)	434	87.8 (84.6-90.6)	60	494

ACS = acute coronary syndrome; CI = confidence interval; PPV = positive predictive value.

a) Included discharges from surgical ward, emergency room and obstetrics and gynaecology ward.

(95% CI: 13.1-35.5). Restricting the analyses to participants registered with MI yielded a PPV of 90.3% (95% CI: 87.1-92.9%).

DISCUSSION

We evaluated the accuracy of discharge diagnoses of angina pectoris and ACS registered in the DNPR using review of medical records as reference. For definite and probable angina pectoris, the PPV was 45.9%. The PPV for definite and probable angina was higher in men than in women, and for diagnoses established at cardiology units than diagnoses established at other internal medicine units. For ACS, the PPV was 86.6%. The PPV of ACS was higher for diagnoses established at cardiology units than at other internal medicine units.

The strengths of our study included the access to medical records and detailed clinical data on a random sample of patients including both genders admitted to hospitals in the North Denmark Region. Moreover, we examined the validity using the most recent ICD codes (ICD-10).

However, this study also has some limitations that warrant consideration. The present study was a retrospective review of medical records, and the classification of patients depended heavily on the quality of the registered data. Although this is the conventional approach in most validation studies, inadequate or missing data in the medical records could have led to misclassification of true cases of angina pectoris and ACS into non-cardiac chest pain and non-verified ACS, respectively. Furthermore, changes in definitions, clinical practice and guidelines may have influenced the validity of diagnoses in the period after this study was conducted.

We used a conservative definition of unstable angina pectoris that is recommended for epidemiology and

clinical research studies and which included both new cardiac symptoms and positive ECG findings with normal cardiac biomarkers [7]. However, unstable angina pectoris is considered a clinical diagnosis in routine clinical practice, which does not require positive ECG findings indicative of ischaemia. Our approach may have led to misclassification and an underestimation of the number of verified ACS cases. In our study, most medical records were evaluated by a single reviewer, and inter-observer analyses were not performed. This is a possible limitation although the review was based on strictly defined criteria, especially with regard to patients with angina pectoris as this diagnosis is solely based on symptoms, whereas the majority of ACS patients were examined with sensitive cardiac biomarkers, which most likely has limited the impact of any subjective interpretation of symptoms and ECG findings. However, the use of cardiac biomarkers does not minimise the risk of errors associated with collecting the information from medical records. Previous validation studies on CHD diagnoses stored in hospital discharge registries have primarily focused on MI, and PPVs of MI have been reported with a variation ranging 60-100% [8-16].

A systemic review on the validity of MI in administrative databases revealed that the PPV of MI generally increased over time [3]. This may be explained by a higher specificity of MI diagnoses due to the use of more sensitive cardiac troponin levels [17].

Few studies have examined the validity of angina pectoris and ACS contained in hospital discharge registries. Pajunen et al [18] investigated the validity of CHD events in the Finnish National Hospital Discharge Register by comparing with the FINMONICA/FINAMI Register. They found a PPV of unstable angina pectoris and MI of 83% when the two sources were considered together.

Joensen et al [9] examined the validity of incident ACS discharge diagnoses recorded in the DNPR among participants enrolled into the Danish Diet, Cancer and Health Cohort. They reported an overall PPV of 65.5% (95% CI: 63.1-67.9%) for ACS. Stratification by hospital department further increased the PPV for ACS to 80.1% (95% CI: 77.7-82.3%) for patients registered with an ACS diagnosis in a ward. In contrast to Joensen et al [9], we did not observe a significant difference in the PPV of ACS between men and women. Surprisingly, we observed a somewhat higher PPV for patients registered with a secondary diagnosis of angina pectoris than for patients registered with a primary diagnosis. However, the confidence intervals did overlap, and the significance of this finding thus remains unclear. Heckbert et al [19], reported similar PPVs for angina among women enrolled into the Women's Health Initiative in the United States. We observed a significantly lower PPV of angina pectoris in women than in men. Whether this difference reflects a higher complexity in the diagnostics of angina pectoris remains unclear. However, previous studies have suggested that angina pectoris may be more diagnostically challenging in women than in men, which is possibly explained by a higher prevalence of atypical symptoms of angina pectoris and by differences in the perception of pain as well as the language used to report symptoms [20].

Our data indicate that angina pectoris in particular, but maybe also ACS data, recorded in the DNPR should be used with caution in register studies, and that data validation is recommended. However, if validation of ACS data is not possible, restricting analyses to patients discharged from cardiology wards may be a useful option in population-based studies.

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