Background: In recent years, the number of acute hospital admissions has increased and this has imposed both organizational and financial strains on the health care system. Consequently, it is of crucial importance that we have valid data on admission types in the administrative databases in order to provide data for health care planning and research.

Objective: To examine the validity of registration of acute admissions among medical patients in the Danish National Patient Registry (DNPR) using medical record reviews as the reference standard.

Methods: We used the nationwide DNPR to identify a sample of 160 medical patients admitted to a hospital in the North Denmark Region during 2009. Data on admission type was obtained from the DNPR and confirmed by a medical record review. We computed positive predictive values, sensitivity, and specificity including 95% confidence intervals (CI) using the medical record review as the reference standard.

Results: Among the 160 medical inpatients identified in the DNPR, 128 were registered with an acute admission, and 32 were registered with a nonacute admission. Two medical records could not be located. Thus, the analyses included 158 medical patients. Among the 127 patients registered with acute admission, 124 were confirmed to be correctly classified. Correspondingly, 28 of the 31 patients with a registered nonacute admission were confirmed to be correctly classified. The overall positive predictive value of the acute admissions among medical patients was 97.6% (95% CI, 93.8%–99.3%). Sensitivity was 97.6% (95% CI, 93.8%–99.3%) and specificity was 90.3% (95% CI, 76.4%–97.2%).

Conclusion: The registration of acute admission among medical patients in the DNPR has high validity.

Keywords: medical patients, registries, epidemiology, positive predictive value, sensitivity, specificity

Introduction

According to Statistics Denmark, acute admissions constitute approximately 70% of all admissions to hospitals in Denmark. The total number of acute admissions has increased by 14% in a 5-year period from 2006 to 2010. A similar pattern is reported in many other parts of the world. The rise in the number of acute admissions imposes both a substantial organizational challenge to and a considerable financial strain on the health care system.

Stratification by admission type is used in studies of prognosis, in the surveillance of health care quality, and in the reimbursement of hospital costs between the hospitals and the state. Valid data on the admission type are therefore pertinent from both an administrative and a research perspective.
To our knowledge, only two national reports evaluating
the admission type registered in the Danish National Patient
Registry (DNPR) exist.\textsuperscript{5,6} One was based on a random sample
of 1094 hospital admissions in 1990.\textsuperscript{7} The evaluation covered
medical, surgical, gynecological, orthopedic, and pediatric
departments at a national level. The acute admissions were
correctly classified in 98.6\% of the cases. More recently,
a second report included a validation of the admission type
across surgical and gynecology departments.\textsuperscript{6} This report
estimated a 3\% misclassification in admission type. No
validation study has specifically examined the registration
of admission type in medical patients.

The aim of the present study is to examine the validity of
the registration of acute admissions among medical patients
in the DNPR using medical record review as the reference
standard.

Method

Study design and setting

We conducted this cross-sectional validation study in the
North Denmark Region, covering 580,000 inhabitants
(10\% of the total Danish population). The Danish population
has unrestricted and unfettered access to tax-supported
health care, guaranteeing equal access to treatment and
hospital admission. The six hospitals in the region report all
admissions to the DNPR.

Study population

We used the DNPR to identify a sample of 160 medical
patients admitted to hospital in the North Denmark Region
during 2009. Medical patients were defined as patients with
an admission to any of the medical departments in the study
area. In the DNPR, admission type is only registered for
inpatients. The admission type is assigned by a secretary
upon admission and is either acute or nonacute. Each year,
the National Board of Health provides a guideline for
correct registration. For the purpose of this study, oncology
departments were not included because both surgical and
nonsurgical cancer patients are referred to this department.
The identified medical patients were admitted to 15 different
medical departments, of which nine were highly specialized
departments.

The Danish National Patient Registry

The DNPR contains information on all hospital admissions
to nonpsychiatric hospitals since 1977 and all hospital
contacts to emergency rooms and outpatient clinics since
1995.\textsuperscript{7} Information on the admission type has been included
in the DNPR since 1987. Besides the admission type,
other information includes dates of referral, admission,
and discharge, data on the hospital and each department,
diagnostic codes, and surgical procedures. Diagnostic codes
include one principal diagnosis reflecting the main reason
for hospital admission and up to 19 secondary discharge
diagnoses coded according to the International Classification
of Diseases (ICD), 8th revision until 1993 (ICD-8), and the
10th revision (ICD-10) thereafter. Diagnoses are assigned by
the attending physician at the time of discharge. Each hospital
electronically transfers administrative and clinical data from
their patient administrative system to the DNPR. The DNPR
is managed by the National Board of Health, and reporting
to the DNPR is mandatory. Based on the Diagnosis Related
Group system, information from the DNPR is extracted and
used for the purpose of financial reimbursement between the
hospitals and the state.

Medical record review

The unique personal identification number assigned to all
Danish residents, as well as the hospital and department
codes registered for the sampled medical inpatients, were
used to retrieve the patients’ medical records for review.
Each medical record review was initiated with a verification
of the patient’s personal identification number and the date
of hospital admission. All medical records were reviewed
by the same physician (BVH). Through the review process,
we confirmed the admissions to be acute if the attending
physician used the word “acute” in the sentences concerning
the type and reason for admission, or if it was stated that the
admission was unscheduled. All scheduled admissions were
considered nonacute admissions. Data on lifestyle factors
are usually not available from administrative registries,
but may be available from medical records. We therefore
included data on smoking status, alcohol abuse (more than
14 or 21 standard drinks in 1 week for women and men,
respectively), and weight and height in order to calculate
body mass index (BMI) from the medical records to
demonstrate availability of these variables. The misclassified
acute and nonacute patients were described in terms of their
specific characteristics.

Statistical analysis

We described the sample in terms of gender, age, smoking
status, alcohol abuse, and BMI. Age was described with the
median age and the associated interquartile range (IQR).
The concordance between admission type in the DNPR and
in the medical records was ascertained with estimates of the
positive predictive value (PPV), sensitivity, and specificity with corresponding 95% confidence intervals (CI). We estimated 95% CIs using Jeffrey’s method for a binomial proportion. Data collected through the medical record review were used as the reference standard.

To estimate the PPV of the registration of acute admissions in the DNPR, we computed the proportion of patients registered in the DNPR with an acute admission which was confirmed by medical record review (ie, the numerator was the number of patients registered with an acute admission in both data sources, and the denominator was the number of patients registered with an acute admission in the DNPR). Sensitivity was estimated with the numerator being the number of patients registered with an acute admission in both data sources, and the denominator being the total number of patients confirmed by medical record review to have an acute admission. The specificity was estimated with the numerator being the number of patients registered with a nonacute admission in both data sources, and the denominator being the total number of patients confirmed by medical record review to have a nonacute admission. Furthermore, we estimated PPV, sensitivity, and specificity for each hospital. In a subsequent analysis, we restricted the analysis to the medical patients arriving through the emergency room to confirm whether the patients were registered with an acute admission when becoming an inpatient. Sensitivity analysis using a different approach was conducted; it included data from the DNPR on the date of referral and date of admission, as the dates are expected to be the same for acute admissions and different for nonacute admissions. Data were analyzed with the statistical software package STATA (version 11; Stata Corp, College Station, TX, USA). The study was approved by The Danish Data Protection Agency (record number 2006-53-1396).

### Results

#### Characteristics

Table 1 displays information on age, smoking, alcohol abuse, and BMI of the patients confirmed by the medical record review to be correctly registered with an acute or nonacute admission in the DNPR. The acute patients were slightly younger (median age of 62 years [IQR 49–80]), on average, than the nonacute patients (median age of 63 years [IQR 52–69]). Among the acute patients, 49.6% were males, in contrast to 67.7% of the nonacute patients. The medical records lacked data on smoking status for only 13.4% of the acute patients and for 47.2% of the nonacute patients. Data on weight and height in order to compute BMI was missing for 47.2% of the acute patients and for 35.4% of the nonacute patients. Data on alcohol abuse were missing for 23.6% of the acute patients and for 51.6% of the nonacute patients (Table 1).

#### Medical record review process

All 160 sampled inpatients had a registration of either acute or nonacute admission in the DNPR. In total, 128 (80.0%) were registered as acute and 32 (20.0%) were registered as nonacute admissions in the DNPR. In the review process, two medical records could not be located and these admissions were therefore not included in the analysis. A flowchart of the medical record review process is outlined in Figure 1.

### PPV, sensitivity, and specificity

The final study population, on which the estimates were computed, included 158 medical inpatients, of which 127 were registered in the DNPR with an acute admission and 31 with a nonacute admission. Of the 127 medical patients registered with an acute admission, we confirmed 124 to be an acute admission based on our review of the medical records. Among the three nonconfirmed acute admissions, two were registered as acute and one was registered as nonacute. The specificity was estimated with the numerator being the number of patients registered with a nonacute admission in both data sources, and the denominator being the total number of patients confirmed by medical record review to have a nonacute admission. The sensitivity was estimated with the numerator being the number of patients registered with an acute admission in both data sources, and the denominator being the total number of patients confirmed by medical record review to have an acute admission. The positive predictive value (PPV) was estimated with the numerator being the number of patients registered with an acute admission in both data sources, and the denominator being the total number of patients confirmed by medical record review to have an acute admission. Sensitivity analysis using a different approach was conducted; it included data from the DNPR on the date of referral and date of admission, as the dates are expected to be the same for acute admissions and different for nonacute admissions. Data were analyzed with the statistical software package STATA (version 11; Stata Corp, College Station, TX, USA). The study was approved by The Danish Data Protection Agency (record number 2006-53-1396).

### Table 1. Characteristics of 158 medical hospital admissions in the North Denmark Region in 2009

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Medical hospital admission</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acute (n = 127)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>64 (50.4)</td>
</tr>
<tr>
<td>Men</td>
<td>63 (49.6)</td>
</tr>
<tr>
<td>Age, years</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>62</td>
</tr>
<tr>
<td>IQR</td>
<td>49–80</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>46 (36.2)</td>
</tr>
<tr>
<td>Current</td>
<td>32 (25.2)</td>
</tr>
<tr>
<td>Former</td>
<td>32 (25.2)</td>
</tr>
<tr>
<td>Unknown</td>
<td>17 (13.4)</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>86 (67.7)</td>
</tr>
<tr>
<td>Current</td>
<td>9 (7.1)</td>
</tr>
<tr>
<td>Former</td>
<td>2 (1.6)</td>
</tr>
<tr>
<td>Unknown</td>
<td>30 (23.6)</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
</tr>
<tr>
<td>&lt;18.5</td>
<td>3 (2.4)</td>
</tr>
<tr>
<td>≥18.5 and &lt;25</td>
<td>25 (19.7)</td>
</tr>
<tr>
<td>≥25 and &lt;30</td>
<td>16 (12.6)</td>
</tr>
<tr>
<td>≥30</td>
<td>23 (18.1)</td>
</tr>
<tr>
<td>Unknown</td>
<td>60 (47.2)</td>
</tr>
</tbody>
</table>

**Note:** Information collected through the DNPR and medical record review.

**Abbreviations:** N, number; IQR, interquartile range; DNPR, Danish National Patient Registry.
Medical record review 31 90.3% (76.4%–97.2%) 97.6% (93.8%–99.3%) In total 3 Nonacute 124 28 158 3 97.6% (93.8%–99.3%) 31 127 Powered by TCPDF (www.tcpdf.org)

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Despite these limitations, our findings were confirmed by a sensitivity analysis showing that virtually all acute patients were admitted the same day as they were referred to hospital, and that all nonacute patients had a referral date prior to the admission date.

Our results are comparable to the previous results in terms of the correct classification of acute admissions in 97% and 98.6% of cases. The latest validation of administrative data dates back to 2004 and includes only data from surgical and gynecology departments. The first report from 1990 included data on medical patients, but the results are reported in an overall analysis and missing data on admission type are considered correctly classified, which may cause an overestimation of the data quality.

The results of the present study show that the admission type registered in the DNPR is valid. Our study has important perspectives for future studies of acute medical admissions based on the DNPR.

**Conclusion**

In conclusion, we found that the registration of acute admission among medical patients in the DNPR has a high validity.

**Acknowledgments**

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**Disclosure**

The authors report no conflicts of interest in this work.

**References**