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SHORT REPORT

Positive predictive value of the International Classification of Diseases, 10th edition diagnosis codes for anemia caused by bleeding in the Danish National Registry of Patients

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Objective: Valid data on anemia caused by bleeding are needed for epidemiological research and monitoring health care. The Danish National Registry of Patients (DNRP) is a nationwide medical database with information on all Danish residents' hospital history. We aimed to assess the positive predictive value (PPV) of the diagnostic coding of anemia caused by bleeding in the DNRP.

Methods: In the DNRP, we identified all patients with International Classification of Disease, 10th edition codes for anemia caused by bleeding (acute: D50.0; chronic: D62.6) at three Danish hospitals from 2000 through 2009. For these patients we computed the PPV using hemoglobin level data, from Aarhus University laboratory database, as reference standard. Anemia was defined by a hemoglobin level less than 7.0 mmol/L for women and less than 8.0 mmol/L for men.

Results: We identified 3391 patients in the DNRP with a diagnosis of anemia caused by bleeding. The overall PPV was 95.4% (95% confidence interval [CI]: 94.6%–96.0%). The PPV was 97.6% (95% CI: 96.6%–98.3%) for men and 94.0% (95% CI: 92.9%–94.9%) for women, and the PPV increased with age at diagnosis. The PPV varied according to type of discharging departments, from 89.2% (95% CI: 83.4%–93.4%) in gynecology to 96.8% (95% CI: 94.9%–98.2%) in surgery, and was lower for outpatients compared with inpatients.

Conclusion: We found a high PPV of the coding for anemia caused by bleeding in the DNRP. The registry is a valid source of data on anemia caused by bleeding for various purposes including research and monitoring health care.

Keywords: anemia, Danish National Registry of Patients, International Classification of Diseases, predictive value, laboratory database, validation

Introduction

The World Health Organization estimates that anemia affects 1.6 billion people, or nearly one quarter of the world's population, at some time during their life.[1] Anemia is defined by a hemoglobin level below a threshold value that varies with age and sex[2] and it is usually diagnosed by a complete blood cell count. The three main causes of anemia are hemolysis, bleeding, and iron deficiency. However, iron deficiency anemia is more often due to excess iron loss from long-lasting bleeding than an insufficient iron supply.[3] Anemia caused by bleeding is most frequently associated with gastrointestinal conditions, but is also related to a variety of other conditions including gynecological conditions.[4,5] Depending on severity, anemia can cause severe morbidity and ultimately death if sufficient treatment is not provided.[6,7]

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Valid data is a prerequisite for quality monitoring and for research on prevention, treatment, and prognostic impact of this condition. The Danish National Registry of Patients (DNRP) might be a source of population-based nationwide data on the occurrence of anemia caused by bleeding, but the quality of the recording is unknown. We thus aimed to assess the positive predictive value (PPV) of the International Classification of Disease, 10th edition (ICD-10) codes of anemia caused by bleeding in the DNRP using data from the Aarhus University laboratory database (the LABKA database) as the reference standard.

Materials and methods

Study period and setting

This validation study was based on data obtained from January 1st 2000 to December 31st 2009 at three hospitals in Denmark: two university hospitals (Aarhus and Aalborg) and one regional hospital (Randers). We used the unique Civil Registration (CPR) number assigned to all Danish residents since 1968 to link the databases.[8]

Data sources

The DNRP includes data on all nonpsychiatric hospital admissions in Denmark since 1977 and outpatient clinic and emergency room visits since 1995. The registry contains updated information on each patient's medical history and includes data on date of admissions and discharges, surgical procedures performed, major treatments, and up to 20 diagnoses. Diagnoses in the DNRP are classified according to the ICD-10 since 1994.[9]

The LABKA database contains laboratory test results from inpatient stays, outpatient hospital visits, and general practitioners in the catchment area of the three hospitals included in this study.[10] The information is recorded in a uniform way according to the international Nomenclature, Properties and Units (NPU) coding system and by use of Danish analysis codes.[11]

Study population

We identified all patients with an inpatient or outpatient diagnosis of anemia caused by acute or chronic bleeding [ICD-10 codes: D62.9 (acute post-hemorrhagic anemia) and D50.0 (iron deficiency anemia secondary to blood loss (chronic))] in the DNRP. Date of diagnosis was defined as the date of hospital admission or outpatient visit associated with anemia caused by bleeding. Hospitalizations separated by a day or less were considered as one.

For each hospital contact associated with anemia caused by bleeding, all hemoglobin measurements in the laboratory database from 30 days before hospital contact to date of discharge were examined for lowest hemoglobin level (NPU codes 02319, 02321, and 21690; Danish analysis codes AAA00359, AAA93003, AAB00012, ASS00126, and ASS00996). A low hemoglobin level, diagnosed as early as 30 days before admission, may have been the reason for current hospital contact and for assigning the diagnosis code of anemia. Anemia was defined as hemoglobin levels below 7 mmol/L for women and 8 mmol/L for men.[2] History of anemia was defined as any diagnosis of anemia in the 5 years before the hospitalization in question. In addition, we classified anemia into three severity levels: severe (hemoglobin < 5 mmol/L), moderate (hemoglobin 5–5.9 mmol/L), and light (hemoglobin 6 mmol/L – 7.0/8.0 mmol/L).

Statistical analysis

The PPV of the ICD-10 codes of anemia caused by bleeding in the DNRP was computed as the proportion that also had anemia according to the laboratory database (our reference standard). The corresponding 95% confidence interval (CI) for the PPVs was estimated using Jeffrey's method.[12]

We stratified the analyses by sex, age at diagnosis, hospital, year of diagnosis (2000–2005 and 2006–2009), primary/secondary diagnosis, hospital department (internal medicine, surgical, gynecology, or several departments referring to patients admitted to both internal medicine and either surgical or gynecology departments during the same hospitalization), inpatient stay/outpatient hospital visit, and by acute or chronic anemia. Since a history of anemia may influence the present coding, we also stratified by history of anemia.

Results

We identified 3391 patients in the DNRP with a diagnosis of anemia caused by bleeding. The median age at diagnosis was 76.0 years and 61% (n = 2071) were females. We were able to confirm anemia in 3234 patients; 1614 had severe anemia (hemoglobin < 5 mmol/L), 1126 had moderate anemia (hemoglobin 5–5.9 mmol/L), and 494 had light anemia (hemoglobin 6 mmol/L – 7.0/8.0 mmol/L).

The overall PPV of the ICD-10 codes for anemia caused by bleeding was 95.4% (95% CI: 94.6%–96.0%) and was virtually similar for acute and chronic anemia caused by bleeding, with 95.5% (95% CI: 94.6%–96.3%) and 95.1% (95% CI: 93.7%–96.3%), respectively. The PPV was higher for men at 97.6% (95% CI: 96.6%–98.3%) than women at 94.0% (95% CI: 92.9%–94.9%), and for inpatients with 97.5% (95% CI:

Table 1 The positive predictive value of ICD-10 diagnosis codes of anemia caused by bleeding in the Danish National Registry of Patients using the laboratory database as reference standard using data from three Danish hospitals

	Confirmed anemia (Hemoglobin < 7.0/8.0 mmol/L)		Not confirmed (Hemoglobin ≥ 7.0/8.0 mmol/L)		(No laboratory record)		Total	PPV (95% CI)
	n	%	n	%	n	%	n	%
Overall	3234	95.4	115	3.4	42	1.2	3391	95.4 (94.6–96.0)
Sex								
Female	1946	94.0	98	4.7	27	1.3	2071	94.0 (92.9–94.9)
Male	1288	97.6	17	1.3	15	1.1	1320	97.6 (96.6–98.3)
Age at diagnosis								
18–20	15	93.8	1	6.3	0	0.0	16	93.8 (74.3–99.3)
21–39	207	91.6	15	6.6	4	1.8	226	91.6 (87.4–94.7)
40–59	545	93.2	28	4.8	12	2.1	585	93.2 (90.9–95.0)
60–79	1218	95.5	39	3.1	18	1.4	1275	95.5 (94.3–96.6)
80+	1249	96.9	32	2.5	8	0.6	1289	96.9 (95.8–97.7)
Year of diagnosis								
2000–2005	1611	96.4	46	2.8	14	0.8	1671	96.4 (95.4–97.2)
2006–2009	1623	94.4	69	4.0	28	1.6	1720	94.4 (93.2–95.4)
Type of anemia								
Acute	2223	95.5	82	3.5	23	1.0	2328	95.5 (94.6–96.3)
Chronic	998	95.1	33	3.1	18	1.7	1049	95.1 (93.7–96.3)
Both	13	92.9	0	0.0	1	7.1	14	92.9 (71.2–99.2)
Type of hospital contact								
Inpatient stay	2111	97.5	31	1.4	24	1.1	2166	97.5 (96.7–98.1)
Outpatient hospital visit	743	88.6	80	9.5	16	1.9	839	88.6 (86.3–90.6)
Combined	380	98.4	4	1.0	2	0.5	386	98.4 (96.8–99.3)
Primary or secondary diagnosis								
Primary	1782	95.5	50	2.7	33	1.8	1865	95.5 (94.5–96.4)
Secondary	1452	95.2	65	4.3	9	0.6	1526	95.2 (94.0–96.1)
Prior diagnosis of anemia								
Yes	615	94.6	20	3.1	15	2.3	650	94.6 (92.7–96.2)
No	2619	95.5	95	3.5	27	1.0	2741	95.5 (94.7–96.3)
Hospital type								
Regional hospital	595	95.8	12	1.9	14	2.3	621	95.8 (94.0–97.2)
University hospital	2639	95.3	103	3.7	28	1.0	2770	95.3 (94.4–96.0)
Department								
Internal medicine	2636	95.4	92	3.3	35	1.3	2763	95.4 (94.6–96.1)
Surgical	427	96.8	10	2.3	4	0.9	441	96.8 (94.9–98.2)
Gynecology	132	89.2	13	8.8	3	2.0	148	89.2 (83.4–93.4)
Several departments[a]	39	100.0	0	0.0	0	0.0	39	100.0 (93.8–100.0)

Note: [a]Several departments refer to patients admitted to both internal medicine and either surgical or gynecology departments during the same hospitalization.
Abbreviations: ICD-10, International Classification of Disease, 10th edition; PPV, positive predictive value; CI, confidence interval.

96.7%–98.1%) compared to outpatients with 88.6% (95% CI: 86.3%–90.6%). The PPV increased slightly with age at diagnosis and was highest in the time period 2000–2005 (Table 1). In addition, the PPVs were almost similar for primary and secondary diagnoses and for hospital type, but were slightly lower for those with a prior diagnosis of anemia compared to those with no prior diagnosis (Table 1).

Among departments, the PPVs ranged from 89.2% (95% CI: 83.4%–93.4%) in the gynecology department to 96.8% (95% CI: 94.9%–98.2%) in the surgical department.

Discussion

In this validation study, we found that the overall PPV for the ICD-10 codes for anemia caused by bleeding in the DNRP was high using the laboratory database as reference standard. The PPVs were all above 88% regardless of diagnostic subcodes, patient characteristics, time periods, and hospital and department characteristics.

Despite the overall high PPVs, we still observed some differences in PPV by certain patient characteristics. It is widely known that anemia is more prevalent among the elderly[13,14] which may be the reason for the particularly high PPV among patients over 60 years of age in our study.[15] However, for females and particularly those recorded with bleeding anemia at a gynecology department, we find it likely that the relatively low PPV might have been a result of the anemia codes being used for heavy menstruation periods even without the presence of actual anemia. In addition, the slightly lower PPV among patients with prior anemic admissions may reflect that physicians continue to consider and record these patients as anemic despite the fact that they are well treated and have normal blood tests as the result.

No previous studies have investigated the PPV of anemia caused by bleeding. However, several other studies have investigated the PPV for a number of other diseases recorded in the DNRP and have found similarly high values.[16–19]

The strengths of this study include the population-based lifelong follow-up of patients in Danish databases.[20] We compared two large databases, which enabled us to do a large-scale validation study. In addition, we validated the coding at two university hospitals and one regional hospital. The generalizability of our findings may be questioned, but since the definition and diagnosis of bleeding anemia are clear, we do not consider this a major issue. Furthermore, the PPVs did not vary between regional and university hospitals (Table 1). It is important to stress that the DNRP only covers hospital-treated patients, and not outpatients diagnosed at general practitioner clinics. Our validation approach also had further limitations. By using the laboratory database as reference standard, we were only able to confirm the presence of anemia (ie, low hemoglobin levels), and not the underlying cause (ie, bleeding). Furthermore, we were not able to estimate completeness/sensitivity of the coding of anemia caused by bleeding since the true prevalence of anemia was unknown. In addition, some hemoglobin measurements may not be transferred to the laboratory database, for instance those from arterial blood gas analyzers in intensive care units and those from hemoglobin detection kits at general practitioners. This would have caused us to underestimate the PPV.

Conclusion

In conclusion, our study demonstrated high PPVs of the ICD-10 codes for anemia caused by bleeding in the DNRP. Hence, this database is valuable for epidemiological research and for quality monitoring concerning anemia caused by bleeding.

Disclosure

The authors declare no conflicts of interest in this work. The Department of Clinical Epidemiology, Aarhus University Hospital, receives funding for other studies from companies in the form of research grants to (and administered by) Aarhus University. None of these studies have any relation to the present study.

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