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Methodological challenges in hip fracture registration – The Harstad Injury Registry

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The aim of the study was to evaluate a hospital-based injury recording system on hip fracture registration in elderly persons aged + 65 years from 1994 through 2008, and to examine the agreement between the number of validated fractures and the number of fractures reported to the Norwegian Patient Registry using three different sources: (1) Medical records, (2) Patient administrative system and (3) The hospital's hip fracture record to the Norwegian Patient Registry from 2002 through 2008. The injury recording system included 582 hip fracture events and 535 (92%) were confirmed through the medical records. Reasons for non-verification were different coding failures. Searching the patient administrative system using ICD codes identified 16 hip fractures not included in the fracture registry between 2002 through 2008. The total number was the same as the number of hip fractures reported to the Norwegian Patient Registry using ICD codes alone for identification. The conclusion is that on well-defined diagnosis like hip fractures, local fracture registries may obtain a high degree of reliability if different sources are available for quality control. Well-functioning patient administrative systems may be used to study numbers of hip fractures.

Keywords: injury registry; fracture registration; hip fracture; validation

Introduction

Fractures constitute a major health problem with substantial morbidity, mortality and, as the ageing population increases, an increasing burden on the health care system (Cummings & Melton, 2002; Johnell & Kanis, 2004, 2006; Melton, 2003). Hip and forearm fractures range among the most common osteoporotic fractures. Usually occurring late in life, hip fractures are the most severe, causing long-standing pain, functional impairment, disability and premature death (Bentler et al., 2009; Johnell & Kanis, 2005), as well as tremendous costs both directly and indirectly attributable to the fracture itself (Kilgore et al., 2009).

Fracture incidence varies between countries (Johnell & Kanis, 2006; Kanis et al., 2002) and Norway has, together with the other Scandinavian countries, the highest reported incidence of osteoporotic fractures in the world (Bacon et al., 1996; Dennison & Cooper, 2000; Falch, Ilebekk, & Slungaard, 1985; Kanis et al., 2002; Lofthus et al., 2001; Meyer, Falch, O'Neill, Tverdal, & Varlow, 1995). Based on data from the capitol Oslo, it has been estimated that in Norway, with

a population of only 4.7 million, there are annually 9000 hip fractures, but the exact number is not known (Lofthus et al., 2001). Information concerning fracture incidence is of fundamental importance for the planning of health care expenditures, for research on shifting trends and geographical differences, and for development of preventive strategies. Reliable fracture registries on national, regional or district levels may provide valuable information for health care planners, researchers as well as clinicians. But, although the hip fracture diagnosis is clearly defined, the few existing methodological studies report that registries may either over- or underestimate the correct number of fractures (Fox et al., 1998; Joakimsen et al., 2001; Langlois, Maggi, & Crepaldi, 2000; Lofman, Berglund, Larsson, & Toss, 2002; Lofthus et al., 2005; McColl, Roderick, & Cooper, 1998).

From 1985 to 2003, the Norwegian Institute of Public Health commissioned four Norwegian hospitals, representing 10% of the population, to run a national injury registry (Ytterstad, 1996). The injury registry in the city of Harstad in Northern Norway, continued after 2003, and has been functioning for more than 23 years. During the years of the national injury registry,

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The Harstad Injury Registry rates closely resembled the national rates (Ytterstad & Wasmuth, 1995). Hip fractures are of the most serious injuries that are recorded in the registry. If the reliability of this registration is high, it provides a valuable tool for assessment of hip fracture incidence as well as injury mechanisms on a local and national level, and represents an example on how to organise local fracture registries.

On a national level, the Norwegian Patient Registry has been functioning since 1997 and all inpatient and outpatient hospital care in Norway are reported to this registry (Bakken, Nyland, Halsteinli, Kvam, & Skjeldstad, 2004). Data on patient's age, sex and residence, hospital and department, diagnosis and surgical procedures, dates of admission and discharge are included in the registry, but, until recently, the unique Norwegian personal identification number of each patient was not (Bakken et al., 2004). The Norwegian Patient Registry provides a historic database where also hip fractures are registered, but the registry is not yet validated for research purposes. A Norwegian study indicated that in 1997, the Norwegian Patient Registry overestimated the numbers of hip fractures by 19%, probably including re-admissions for the same hip fracture events as separate events (Lofthus et al., 2005). Utilising different registry data, the aim of the present study is:

- To validate the recorded hip fractures in the Harstad Injury Registry in terms of completeness and correctness in men and women aged 65 years and above.
- To examine the agreement between the number of validated fractures and the numbers reported to the Norwegian Patient Registry and to determine if recent data from the Norwegian Patient Registry, retrieved by different selection criteria, can be used for estimation of hip fracture incidence in Norway.

Materials and method

The municipality of Harstad, located 250 km north of the Arctic Circle, comprises, with its 23,200 inhabitants, 0.5% of the Norwegian population. All injured persons, including hip fracture patients, entering the Harstad Hospital's emergency room are recorded in the Harstad Injury Registry. The hospital has an X-ray department and access to orthopaedic surgery. The nearest hospital is 120 km away and all patients with hip fractures are treated locally. From 1985 through 1994 the registration of hip fractures was used for evaluation of a local injury prevention programme (Ytterstad, 1996; Ytterstad, 1999; Ytterstad &

Wasmuth, 1995). The present study encompasses the years from 1994 to 2008, after termination of the prevention study.

Registration of hip fractures

On admission to Harstad Hospital, the patient or someone accompanying him/her and the admitting doctor complete an injury form. The information collected for each injured person is name, date of birth, sex, place of residence, activity during injury, time, place, type and body part of injury as well as injury mechanism and admission to the hospital. An open-ended question describes in free text the event leading to the injury. The admitting doctor registers the patient's diagnosis, usually based on the present clinical symptoms. The forms are collected and examined by a specially trained nurse who also controls if all incidents are registered by comparing with the admission list. She then enters the data into a common database for the Harstad Injury Registry, from where data on hip fractures were retrieved by a search combining body part and diagnosis.

Medical records

During August and September 2009, a specially trained and authorised technician (the first author) retrieved and examined the medical records on every hip fracture in the Harstad Injury Registry. In the medical records, X-ray descriptions, operation and discharge reports were compared, and the verified date of hip fracture, fracture site (femoral neck, per-trochanteric or sub-trochanteric regions) and side was recorded. Patients with a sequel from previous fracture (e.g. caput necrosis, infection, failure of fixation materials), contusion of the hip without verified fracture, femur shaft or pelvic fractures and pathological fractures due to cancer metastasis were recorded as non-fracture and excluded from the registry. Repeated entries connected to the same event were registered as one event, and patients living outside the municipality were excluded from the analyses. For patients admitted to the hospital after 1 May 2001, electronic medical records were available. For those who died before 1 May 2001, the patient's paper journals had to be examined.

Patient administrative system

To determine the number of hip fractures that were treated at the hospital without being included in the Harstad Injury Registry, all patients with hip fractures admitted and treated at the hospital between 2002 through 2008 were identified searching the digitalised medical record system. The search included: (A) The

relevant ICD-codes for femoral neck, per-trochanteric or sub-trochanteric fractures, respectively (ICD-10: S72.0–S72.2). (B) The relevant procedure codes from the NOMESCO Classification of Surgical Procedures (NCSP) connected to surgical treatment of hip fracture (NFB01-02, NFB11-12, NFJ00-02, NFJ10-12, NFJ40-42, NFJ50-52, NFJ60-62, NFJ70-72, NFJ80-82, NFJ90-92). Using the personal identification number, this procedure provided the opportunity to compare the numbers of hip fractures registered in the patient administrative system with those recorded in the Harstad Injury Registry. The additional hip fractures identified in the patient administrative system were validated in the same way as described above, by examination of X-ray description, operation and discharge reports. The dataset using these verified sources for the period between 2002 through 2008 is the best available dataset on hip fractures in Harstad, and represents the ‘gold standard’. Only fractures occurring outside the municipality and not treated locally would be missing.

The hospital's report to the Norwegian Patient Registry

Representing the Northern Norwegian Health Authorities, our department has access to all data that the hospitals in the region are reporting to the Norwegian Patient Registry (patient's age, sex and residence, hospital and department, diagnosis and surgical procedures, dates of admission and discharge) The data concerning hip fracture in patients living in, admitted to and treated at the hospital in Harstad between 2002 through 2008 were retrieved using four different selection criteria: (A) Any diagnosis of hip fractures with ICD codes of S72.0–S72.2. (B) Any plausible procedure code from the NOMESCO Classification of Surgical Procedures (NCSP) connected to surgical treatment of hip fracture. (C) A combination of ICD and NCSP procedure codes. (D) A combination of ICD or NCSP procedure codes. The number of identified hip fractures was compared with number according to the ‘gold standard’ that was established above. Finally, we compared the numbers of hip fractures that was identified for Northern Norway using these four criteria. The stepwise procedures from the local registry data to the Norwegian Patient Registry data are displayed in Figure 1.

Ethics

The establishment of the Harstad Injury Registry was approved by the Norwegian Data Inspectorate. For validation of the registry's hip fractures, the first author was granted access to patient's medical records.

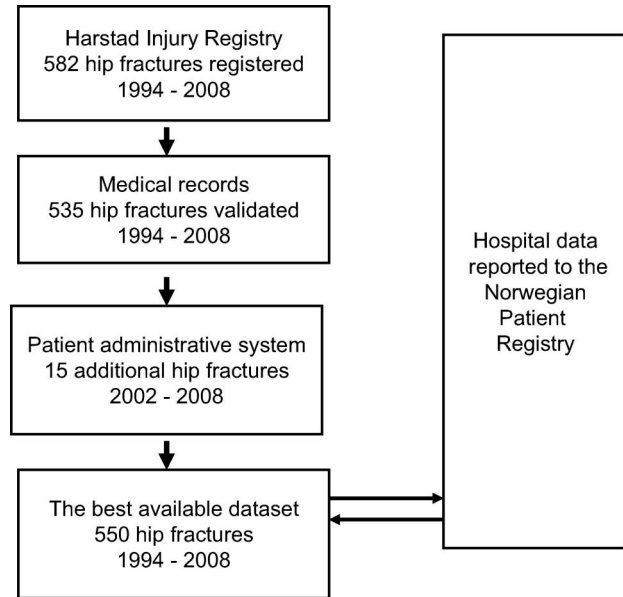


Figure 1. Overview of the stepwise validation procedure from the Harstad Injury Registry to the Norwegian Patient Registry.

This project is thus a publication of the results from an internal quality assessment procedure.

Data presentation and statistical analyses

The identified annual average numbers of hip fractures between 1994 through 2008 using the different sources are presented with 95% confidence intervals. Gender differences in site-specific ICD coding, was evaluated using chi square testing. The agreement of ICD coding between the registry and the validated data was evaluated by the kappa statistics.

For an estimation of the total numbers of hip fractures in the elderly from 2002 through 2008 in Norway, the reported data to the Norwegian Patient Registry for all hospitals included in the Northern Norway Regional Health Authority were identified. As Northern Norway comprises 10.3% of the total Norwegian population above 64 years, the incidence rate in Northern Norway was applied to calculate the total annual numbers of hip fractures in the elderly population in Norway.

Results

The hip fracture registration versus medical records

In the period between 1994 through 2008, altogether 582 hip fractures were recorded in the Harstad Injury Registry, indicating an annual average of 39 (95% CI 34, 44) new hip fracture cases in the elderly population

in Harstad, aged 65 years and above (Table 1). Through review of X-ray descriptions, operation and discharge reports, 535 hip fractures were confirmed, indicating an annual average of 36 (95% CI 32, 40) new hip fractures (Table 1) and an overestimation of 8% (95% CI 6, 10) by the Harstad Injury Registry. Non-confirmation included coding failure due to post-operative complications (11), contusion without fracture (10), femur shaft fracture (11), pathological fractures (6), pelvic fracture (4) and repeated registries (5).

Among the confirmed fractures, 139 (26%) occurred in men and 396 (74%) in women. According to the X-ray descriptions, 332 (62%), 179 (33.5%) and 24 (4.5%) of the hip fractures occurred at the femoral neck, per-trochanteric or sub-trochanteric regions, respectively, with no site differences between the genders ($p = 0.84$). The injury registry recorded the specific fracture site in 324 of the 535 persons. In those, 271 (84%), 39 (12%) and 14 (4%) was registered as femoral neck, per-trochanteric or sub-trochanteric fractures, respectively. The trends of most fractures occurring at the femoral neck and fewest at the sub-trochanteric region were similar, but the registry coding was significantly different from the validated coding ($p < 0.001$). There was full agreement in 229 of 324 cases only, providing a kappa of 0.37 (95% CI: 0.28, 0.46), which is regarded as 'fair' (Altman, 1999).

The hip fracture registration versus the patient administrative system

In the period between 2002 through 2008 there were altogether 310 recorded hip fractures in the Harstad

Injury Registry and 278 (90%) were confirmed through the medical records (Table 1). Searching the patient administrative system using the relevant ICD – codes (ICD-10: S72.0 – S72.2), identified only additional 15 hip fractures during these years (Table 1). Searching the patient administrative system using the relevant NCSP procedure codes did not identify any additional fractures. Instead, 27 (9%) of the confirmed hip fractures were missing a relevant procedure code. Reasons for missing procedures were operation performed at another hospital before being admitted to Harstad Hospital (7) or admitted, but not operated on (5), or using codes that were not included in our search in the patient administrative system (13). These codes were respectively NFB40 (3), NFC12 (4), NFB 12 (2), NFK 19 (1) and NXE10 (3). With two patients, the procedures NFJ52 and NFJ70 were performed according to the operation report, but not used in the discharge report or in the patient administrative system.

Reported data to the Norwegian Patient Registry

The total number of reported hip fractures to the Norwegian Patient Registry from 2002 through 2008 was the same as the number identified in the best available dataset when ICD codes were used for identification (Table 2). The number of hip fractures was underestimated by 5% when NCSP procedure codes alone were used for identification. Using both relevant ICD and procedure codes led to an underestimation of 13%, and allowing either ICD codes or procedure codes led to an overestimation of 7.5%.

Using ICD codes, NCSP procedure codes or a combination of ICD and NCSP procedure codes for

Table 1. Overview of the identified numbers of hip fractures in persons aged 65 + years in the municipality of Harstad from 1994 through 2008, from 3 different data sources.

Year	Hip fractures in the Harstad Injury Registry	Hip fractures verified through medical records ^a	Additional hip fractures identified through PAS ^b	Hip fractures in the best available dataset
1994	27	25 (93%)		25
1995	30	28 (93%)		28
1996	39	37 (95%)		37
1997	28	27 (96%)		27
1998	43	41 (95%)		41
1999	34	32 (94%)		32
2000	33	31 (94%)		31
2001	38	36 (95%)		36
2002	31	30 (97%)	1	31
2003	32	28 (90%)	2	30
2004	47	42 (90%)	4	46
2005	56	47 (84%)	4	51
2006	44	40 (91%)	0	40
2007	54	49 (91%)	3	52
2008	46	42 (91%)	1	43
Total	582	535 (92%)	15	550

Notes: ^aConfirmation by medical records (x-ray descriptions, operation or discharge reports).

^bPatient administrative system (PAS), searching any diagnosis of hip fractures with ICD codes of S72.0–S72.2.

Table 2. Overview of the numbers of persons aged 65 + years with hip fractures in the municipality of Harstad reported to the Norwegian Patient Registry database, in comparison with the most complete dataset ('the gold standard').

	2002	2003	2004	2005	2006	2007	2008	Total
The most complete dataset	31	30	46	51	40	52	43	293
ICD codes, S72.0–S72.2 ^a	30 (-1)	30	47 (+1)	44 (-7)	43 (+3)	53 (+1)	47 (+4)	294
Procedure codes ^b	31	29 (-1)	47 (+1)	44 (-7)	42 (+2)	43 (-9)	43	279 (-14)
ICD and procedure codes	28 (-3)	26 (-4)	42 (-4)	37 (-14)	41 (+1)	41 (-11)	42 (-1)	257 (-36)
ICD or procedure codes	33 (+2)	33 (+3)	52 (+6)	51	44 (+4)	55 (+3)	48 (+5)	316 (+23)

Notes: ^aIdentification based only on ICD codes, S72.0 – S72.2.

^bIdentification based on procedure codes from the NOMESCO Classification of Surgical Procedures (NCSP): NFB01, NFB02, NFB11, NFB12, NFJ00, NFJ02, NFJ10, NFJ11, NFJ12, NFJ40, NFJ41, NFJ42, NFJ50, NFJ51, NFJ52, NFJ60, NFJ61, NFJ62, NFJ70, NFJ71, NFJ72, NFJ80, NFJ81, NFJ82, NFJ90, NFJ91, NFJ92.

identification of the numbers of hip fractures reported to the Norwegian Patient Registry, gave mean annual incidence rates of 12, 11 and 10 per 1000 inhabitants, respectively, in Northern Norway in the period between 2002 through 2008. If hip fracture rates are similar throughout Norway, these figures correspond to an annual number of 7891, 7810 or 7079 hip fractures in the elderly 65 + years age group in Norway.

Discussion

The main finding of this study is that a hip fracture registry based on a hospital-based injury recording system identifies the large proportion of hip fractures, but overestimates the actual number of fractures, in this case by approximately 8%, mainly due to coding failures. The combination of the verified hip fractures in the registry and the additional verified fractures from the patient administrative system constitute the best possible fracture record. When relevant ICD codes alone were used for identification, the total numbers of registered hip fractures reported to the Norwegian Patient Registry was the same as the number according to the best available dataset.

The strength of this study lies in the possibility of identification (confirmation or not) of every fracture event in the registry with reliable medical records comprising both X-ray reports, operation theatre reports and discharge reports over a period of 15 years. In addition, with electronic medical records, all patients diagnosed with hip fractures at the hospital could be retrieved through the patient administrative system between 2002 through 2008. This enabled the assessment of the numbers of hip fractures that bypassed the fracture registration. The numbers were few; only 15 of totally 293 cases (5%).

With regard to establishing the gold standard for hip fractures in the respective municipality during 2002–2008, it is a minor limitation that, although several sources were available for the evaluation, fractures occurring and treated outside the

municipality, albeit few, could not be identified. These fractures mainly occur during holidays abroad. They are rare and may even be included in the fracture registry. In fact, one of the confirmed fractures in the registry occurred abroad. Since the patient was transferred and admitted to the local hospital for observation, the patient was included in the hip fracture registry. The event-based Norwegian patient Registry identifies patients admitted into any Norwegian hospital according to where people live (municipality). The fractures occurring in residents living outside of the municipality, but within Norway, can therefore be tracked down. Fractures occurring and treated outside Norway will not be included in any sources used in this study.

Our findings are in correspondence with other studies on validation of hip fracture registries (Brophy, John, Evans, & Lyons, 2006; Joakimsen et al., 2001; Lofthus et al., 2005). Although hip fracture is a defined diagnosis, it is still rendered with several challenges regarding registration. The hip fracture registration in the emergency room aims at the identification (age and sex) of the patient and to seek information about variables related to prevention of the fracture. This information is obtained as close to the event as possible in order to minimise recall bias. In the emergency room, the coding is done by the medical doctor admitting the patient. The coding is usually done on the basis of clinical symptoms, sometimes before X-ray verification is available. This coding is checked by a trained nurse for missing registrations and coding errors. This check notwithstanding, the registry is not complete and without errors. The main reasons for overestimation are that postoperative complications which are mainly due to failure of fixation materials, contusion without fracture and upper femoral shaft fractures are wrongly coded as hip fractures. Over a period of 15 years, the recorded numbers of hip fractures in the injury registry show stability by an annual overestimation by one or two fractures each year (Table 1). However, in 2005 and

2006, the numbers are overestimated by five and four fractures, respectively. Without validation, such numbers may falsely be interpreted as an increased incidence. An overestimation of 8% may also lead to false conclusions about where hip fractures occur and the mechanisms leading to fracture. Based on the results from this study, we recommend that verification by X-ray examination should be included in the procedure to improve performance of the registration of hip fractures in the Harstad Injury Registry.

The reported data to the Norwegian Patient Registry are based on routine event-based patient administrative systems. Internationally, such data are increasingly being used due to their potential to provide population-based epidemiological data, including hip fractures (Abrahamson & Vestergaard, 2010; Brauer, Coca-Perraillon, Cutler, & Rosen, 2009; Gehlbach, Avrunin, & Puleo, 2007; Kannus et al., 2006; Leslie et al., 2009, 2010; Ryg, Rejnmark, Overgaard, Brixen, & Vestergaard, 2009; Vestergaard, Rejnmark, & Mosekilde, 2007). Using event-based data, without the unique personal identification number or a specific personal hospital identification number, has disadvantages, as events registered as hip fractures cannot be confirmed through X-ray descriptions and operation reports (Brophy et al., 2006). How events are selected can have a significant impact on the estimated incidence and trends derived from hospital data (Brophy et al., 2006). Leslie et al. found that approximately 11% of the hip fracture cases had a second hospital admission with the same diagnosis during the same calendar year (Leslie et al., 2009). A substantial number of these are likely attributable to a second fracture (Leslie et al., 2009) since the risk of a subsequent fracture after a hip fracture may range up to 10% (Ryg et al., 2009), however, re-admissions can lead to some double entries using patient administrative data.

With its tendency for overestimation in 1997, Lofthus et al. question the use of Norwegian Patient Registry data as source in epidemiologic studies on hip fracture incidence in Norway (Lofthus et al., 2005). The results from the present study using ICD codes for identification of hip fractures indicate a change in performance of the Norwegian Patient Registry database. Since the introduction of a finance reimbursement system in Norway in 1997, all Norwegian hospitals have focused on the coding practice. This may explain the reduction of the overestimation reported by Lofthus et al. (2005), or that regional differences in coding practices exist. A major part of the funding from the state to the hospitals is connected to the performed and reported procedures. It was therefore surprising to see that identification of hip fracture patients by procedure code led to an underestimation compared to the best available dataset. The underestimation was partly explained by the

occurrence of hip fracture without any procedures performed and by the fact that our search did not include the relevant codes, so that in the patient administrative system only two persons were in reality missing the relevant procedure code. Without the personal identification number, we cannot confirm with certainty if the persons from the Norwegian Patient Registry are overlapping with those identified through the patient administrative system. However, these are minor discrepancies, suggesting that coding failure is not a major problem for the local hospital in the respective municipality.

Using a patient administrative system to identify hip fracture cases, Brophy et al. (2006) suggest the usage of ICD codes S72.0–S72.2, elective or emergency, primary or secondary diagnosis, plus all individuals with any operation code connected to hip fracture procedures. Furthermore, Brophy et al. suggest that patients with a procedure connected to hip fracture, but without a hip fracture diagnosis should be included, as they may have a multiple-fracture diagnosis (Brophy et al., 2006). In our study, searching the patient administrative system by procedure code did not identify any additional hip fracture patients. Using either ICD or procedure codes for identification led to an overestimation of 7.5%. Based on our results we recommend the usage of ICD codes only.

It is a matter of debate whether or not to include pathologic fractures in epidemiologic studies of osteoporotic fractures (Curtis et al., 2009). In a study by Curtis et al., it was reported that although the number of coded pathological hip fractures are few, more than 50% of these may be without evidence of cancer diagnosis (Curtis et al., 2009). Our strict quality assessment of the 582 registered events identified only 1% pathological fractures. This number lends support to Curtis et al., in that pathological fractures should not be excluded in epidemiologic analyses for estimation of total numbers of hip fractures (Curtis et al., 2009).

The agreement between the site specific coding was only 'fair' between the hip fractures in the registry as compared to the X-ray descriptions. Although there are studies indicating that the different fracture sites differ in severity of outcome (Fisher, O'Brien, & Davis, 2009), the achievement of high precision in site specific coding depends on access to the X-ray description and/or operation report. Moreover, the emphasis of this registry has been the identification of hip fractures and the collection of information regarding variables relevant for fall prevention. In other words, for preventive purposes it may be more important to register where falls occur than where specifically on the neck/trochanter the fracture is located.

In summary, even a well-organised registry may tend to overestimate the actual numbers of hip

fractures as the numbers of missed cases (in our study 15 cases during seven years) is lower than the number of cases misclassified as hip fractures (in our study 32 cases during the same seven years). Validation through medical records eliminates the false positive fractures, and additional search in patient administrative system may lead to the identification of fractures not initially included (false negatives). Even when dealing with well-defined diagnosis as hip fractures, the achievement of valid and reliable disease registries represents a challenge. The usage of different sources for validations improves register quality and should be included in quality assessment procedures. Despite the lack of personal identification, an estimate of the total number of hip fractures can be obtained through well-functioning official patient registries. Our study suggests that such data can well be retrieved on the basis of the relevant ICD-codes alone.

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