

Registration completeness in the Norwegian Arthroplasty Register

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Introduction A high degree of registration completeness is necessary in order to obtain unbiased and accurate register-based study results. We investigated the completeness of registration in the national Norwegian Arthroplasty Register (NAR).

Material and methods Registration completeness for the years 1999–2002 was calculated as a percentage, with the number of joint replacements reported to the NAR as numerator and those reported to the Norwegian Patient Register (NPR) as denominator. While the NAR received information directly from the orthopedic surgeons on a voluntary basis, the NPR, which is mandatory, received information from the electronic administrative patient records of the hospitals.

Results Registration completeness in the NAR was 97% (97% for primary operations; 101% for revisions). Completeness was 98% (97%; 106%) for hip replacements, and for knee replacements it was 99% (99%; 97%). Hip and knee replacements represented 95% of all operations. However, completeness was poorer for less common joint replacements and poorest for ankle implants (82%; 40%) and wrist implants (52%; 14%). In the NAR, completeness of registration of revisions involving only removal of one or more prosthetic parts was lower than for exchange revisions for all types of joint replacement. For hip implants, 76% of the removal revisions (80% of Girdlestone procedures) were reported, and for knee implants the figure was 62%. According to NPR statistics, removal procedures accounted for 9% of all revisions of hip and knee replacements.

Interpretation In the NAR, registration completeness of hip and knee replacements was high both for

primary operations and exchange revisions. For some of the less common joint replacements, completeness was low and may—if not improved—compromise prosthesis survival studies. The lower registration completeness of removal revisions also needs to be improved. ■

The Norwegian Arthroplasty Register (NAR) is a nationwide register that receives information on primary and revision joint replacements performed in Norway. Collection of data on total hip replacements started in September 1987 (Havelin et al. 1993). In January 1994, the registration was extended to include information on all types of joint replacement performed in Norway (Furnes et al. 1996). In accordance with the main objective of the NAR, the reported data has been used extensively to assess the survival of joint replacements (Engesæter et al. 1992, 1996, 2003, Havelin et al. 1993, 1994, 1995 a, b, c, 1999 a, b, 2000, 2002, 2004, Espehaug et al. 1995, 1997 a, b, 1998, 1999, 2002, Havelin 1995, Furnes et al. 1996 a, b, 1997, 2001 a, b, 2002, 2003, 2005 a, b, Skeide et al. 1996, Espehaug 1998, Lie et al. 2000, 2002, 2004 a, b, Flugsrud et al. 2002, 2003, Furnes 2002, Lie 2002, Byström et al. 2003, Småbrekke et al. 2004). National reports with mainly descriptive statistics are also published annually (<http://www.haukeland.no/nrl>), and each hospital is given individual information regarding its annual activity and the quality of the surgery performed locally. To obtain

unbiased and accurate reports and study results, it is necessary to have complete registration of both primary operations and revisions.

During the years 1987–1993, registration completeness of hip replacements was over 95% in Norway (Havelin 1995). However, one hospital reported a completeness of 93% from 1987 to 1996 (Frøen and Lund-Larsen 1998), while a recent study based on data from another hospital reported a completeness of 99.5% during the years 1999–2002 (Arthursson et al. 2005). National arthroplasty registers have also been established in other Nordic countries. In Sweden, the registration completeness was over 95% for hip arthroplasties from 1986 through 1995 (Söderman et al. 2000) and about 85% for knee arthroplasties from 1985 through 1992 (Knutson et al. 1994). From 1995 to 2000, 94% of hip prosthesis operations were reported to the Danish Arthroplasty Register (Pedersen et al. 2004). In Finland, registration completeness was less than 90% in 1995, but completeness has since increased to about 95% (Puolakka et al. 2001). In contrast to the Scandinavian countries, registration of joint replacements has been mandatory in Finland since 1997.

Our study investigated whether the initial high registration completeness of hip replacements had been upheld in the NAR, and whether a comparably high completeness had been achieved for the registration of other types of joint replacements. We investigated primary and revision procedures separately.

Material and methods

We compared the number of primary and revision joint replacements reported to the NAR by orthopedic surgeons with the number reported to the NPR from hospital administrations during the years 1999–2002. An exchange revision was defined as a reoperation in which at least one prosthesis component had been exchanged. A removal revision was defined as a reoperation in which at least one prosthesis component had been removed without insertion of a new prosthesis. In hip arthroplasty, a Girdlestone procedure means that all parts of a prosthesis are removed.

The Norwegian Arthroplasty Register

The NAR includes information on patient identification, hospital, reason for and type of operation, brand of prosthesis and of cement, antibiotic prophylaxis and operation technique (Havelin et al. 1993). The information is given on a voluntary basis where the orthopedic surgeon fills in a standard form, usually immediately after the operation. The same form is used both for primary operations and revisions, but with separate forms for hip replacements and for replacement of joints other than the hip. Collection of information for total hip replacements started on September 15, 1987 (Engesaeter et al. 1992, Havelin et al. 1993), while registration of other joint replacements began January 1, 1994 (Furnes et al. 1996). The different procedures are specified on the form; thus, the surgeon does not give specific procedure codes as defined by the NOMESCO Classification of Surgical Procedures (2004).

During the study period 1999–2002, 38,410 joint replacement operations were reported to the NAR. Operations performed abroad were also reported to the NAR but not to the Norwegian Patient Register (NPR), so these were excluded from the analyses ($n = 173$). If several prosthesis operations were reportedly performed the same day on the same person (for example in several finger joints), these were counted as one operation. This is because multiple operations are reported separately to the NAR but as one procedure to the NPR. This left 37,673 operations for analysis. The operations were reported to the NAR from 62 hospitals, of which 3 were private hospitals. Only 852 operations (2.3%) were performed in private hospitals. 2 more hospitals reported to the NPR, but these accounted only for 4 operations. Thus, 64 hospitals in total reported to the NPR, 4 of which were private hospitals.

The Norwegian Patient Register

The Ministry of Health and Social Services founded the Norwegian Patient Register (NPR) (<http://www.npr.no>) in 1997. The NPR collects and verifies data on hospitalizations in all public somatic hospitals and psychiatric institutions in Norway, as well as from some private hospitals. It is obligatory to give information to the NPR, and data is provided by hospital administrations based on the electronic

administrative patient records. Data, however, is not identifiable as pertaining to particular individuals and cannot be individually matched to information in other databases. Information on patient age, sex, place of residence, hospital and department, diagnosis, surgical procedure(s), and dates of admission, discharge and procedures are included in the registry. An anonymous patient number specific for each year and hospital is also recorded and allows identification of a patient within 1 calendar year at the same hospital.

In this study, we retrieved data on operations reported to the NPR for the years 1999–2002. Information is reported to the NPR using a coding system that is a Norwegian version of the NOMESCO Classification of Surgical Procedures (Statens helsetilsyn og Kompetansesenter for IT i Helsevesenet AS 1998). Specific codes are defined for insertion of primary and secondary implants and for removal of prosthetic components, with different codes for each type of joint replacement. In addition to codes for specific procedures, there are codes for unspecified implant procedures called “other implantation of primary prosthesis”, “other implantation of secondary prosthesis” and “removal of other implant”. As an example, for hip prostheses these codes are NFB99 for primary insertion, NFC99 for secondary insertion, and NFU99 for removal. Following the guidelines, the “99” codes are only to be used for procedures not otherwise accounted for by the coding system. Although the procedures studied in the present paper all are defined by specific codes, it is possible that the “99” code may have been used if the proper code was forgotten. Registration completeness for primary and revision prosthesis insertions was therefore calculated both with and without “99” codes included in the NPR statistics. This was not relevant for removal revisions, as “99” codes had most likely been applied for removal of implant material other than prosthetic parts, such as osteosynthesis material as screws and plates following fracture treatments.

Statistics

Completeness of registration in the NAR was calculated as a percentage with the number of operations reported to the NAR as numerator and the number reported to the NPR as denominator.

Results

Data on 37,673 joint replacements, 32,859 primary operations and 4,814 revisions were reported to the NAR during the study period 1999–2002. Of these, 27,150 (72%) were hip replacements, 8,639 (23%) were knee replacements, and 1,884 (5%) were replacements of other joints. Overall, registration completeness in the NAR was 97% (97% for primary operations and 101% for revisions).

Primary operations

Table 1 shows that compliance of primary operations was high both for hip (97%) and knee (99%) replacements, with only small changes observed during the study period (Table 2). These types of joint replacement represented 95% of all primary operations. High compliance was also observed for joint replacements of the hand (117%). However, response was poorer for less common procedures (Table 1). The lowest completeness of registration was found for ankle (82%) and wrist (52%) replacements.

Exchange revisions

As for primary operations, completeness of registration of exchange revisions was high both for hip (109%) and knee (103%) replacements (Table 1). High completeness of registration was also observed for joint replacements of the hand (122%). Again, however, response was poorer for the less common procedures (Table 1), with the lowest registration completeness for ankle (70%) and wrist (2.8%) replacements.

Removal revisions

Registration completeness of revisions involving only removal of prosthetic parts was lower than for exchange revisions (Table 1). For hip replacements, 76% of revisions were reported (80% of Girdlestone procedures), and for knee replacements the corresponding figure was 62%. According to NPR statistics, removal procedures accounted for 9.2% of all revisions of hip and knee replacements. The lowest completeness was observed for joint replacements of the ankle (10%) and hand (8.7%). 50 hospitals had reported this type of revision to the NPR. Among these, the registration completeness of removal revisions was less than 75% for 32

Table 1. Comparison of the number of joint replacements reported to the Norwegian Arthroplasty Register (NAR) and to the Norwegian Patient Register (NPR), 1999–2002

Joint	NAR			NPR			% of NPR ^a					% of NPR ^a (incl. "99" codes)	
	Prim ^b	R-e ^b	R-r ^b	Prim ^b	R-e ^b	R-r ^b	All	Prim ^b	R-all ^b	R-e ^b	R-r ^b	Prim ^b	R-e ^b
Hip	23,376	3,552	222	24,224	3,269	292	98	97	106	109	76	96	102
Knee	7,905	669	65	7,962	649	105	99	99	97	103	62	99	96
Ankle	108	14	2	131	20	20	73	82	40	70	10	86 ^d	85 ^d
Toe	258	47	13	280	50	32	88	92	73	94	41		
Shoulder	595	56	10	669	74	33	85	89	62	76	30	87	66
Elbow	158	48	11	181	54	20	85	87	80	89	55	85	81
Wrist	64	1	6	123	35	15	41	52	14	2.8	40	85 ^e	76 ^e
Hand ^c	395	96	2	338	79	23	112	117	96	122	8.7		
All	32,859	4,483	331	33,908	4,230	540	97	97	101	106	61	96	99

^a Registration completeness calculated as a percentage with the number of joint replacements reported to the NAR as numerator and the number reported to the NPR as denominator.

^b Prim – primary operations; R-all – all revisions R-e – revisions with exchange of at least one component; R-r – revisions with removal of at least one component (without insertion of a new prosthesis).

^c Includes replacement of joints in the finger and the carpometacarpal (CMC I) joint.

^d Separate statistics could not be established for ankle and toe joint replacements due to common codes for unspecified implant operations ("99" codes).

^e Separate statistics could not be established for wrist and hand (finger and CMC I) replacements due to common codes for unspecified implant operations ("99" codes).

Table 2. Comparison of the number of joint replacements reported to the Norwegian Arthroplasty Register (NAR) and the Norwegian Patient Register (NPR) by year of operation, 1999–2002

Joint Year	NAR		NPR		% of NPR ^a		
	P ^b	R ^b	P ^b	R ^b	All	P ^b	R ^b
Hip							
1999	5,464	941	5,560	928	99	98	101
2000	5,691	974	5,891	858	99	97	114
2001	6,108	916	6,378	893	97	96	103
2002	6,113	943	6,395	882	97	96	107
Knee							
1999	1,592	153	1,582	154	101	101	99
2000	1,872	169	1,887	174	99	99	97
2001	2,190	194	2,212	211	98	99	92
2002	2,251	218	2,281	215	99	99	101

^a Registration completeness calculated as a percentage with the number of joint replacements reported to the NAR as numerator and those reported to the NPR as denominator.

^b P – primary operations; R – revisions.

hospitals and less than 50% for 17 hospitals.

Unspecified procedures

Table 3 shows that unspecified procedure codes ("99" codes) were reported to the NPR more frequently for exchange revisions (6.4%) than for pri-

mary operations (0.6%). The completeness of registration of exchange hip revisions decreased from 109% to 102% when "99" codes were included in NPR data, and the corresponding figures for knee replacements were 103% and 96%, respectively (Table 1).

Discussion

We found that the high degree of registration completeness found during the first years of registration of total hip replacements (Havelin 1995, Frøen and Lund-Larsen 1998) has been upheld. During the years 1999–2002, 97% or more of primary and revision hip and knee replacements were reported to the register. These types of joint replacements represented 95% of all operations. Registration completeness was inadequate for some of the less common prostheses, however, and for removal revisions.

Primary operations

Completeness of registration was 97% and 99% for primary hip and knee replacements, respectively. The figure for primary hip replacements compared well with reports from the Swedish National Total

Table 3. Number of joint replacements reported to the Norwegian Patient Register (NPR) with unspecified operation codes ("99" codes), 1999–2002

Joint	Primary		Exchange revision	
	NPR	Code 99 (%)	NPR	Code 99 (%)
Hip	24,280	56 (0.2)	3,484	215 (6.1)
Knee	8,024	62 (0.7)	696	47 (6.7)
Ankle and toe ^a	426	15 (3.5)	72	2 (2.7)
Shoulder	683	14 (2.0)	85	11 (13)
Elbow	185	4 (2.1)	59	5 (8.4)
Wrist and hand ^b	539	78 (14)	128	14 (11)
All	34,137	229 (0.6)	4,524	294 (6.4)

^a Separate statistics could not be established for ankle and toe joint replacements due to a common "99" code.

^b Separate statistics could not be established for wrist and hand (finger and CMC I) replacements due to a common "99" code.

Hip Arthroplasty Register where more operations were reported to the register than to the National Hospital Discharge Register (Söderman et al. 2000), and also with the Danish Arthroplasty Register with a reported registration completeness of 94% (Pedersen et al. 2004).

Registration completeness in the NAR was also high for primary implants in joints of the hand (117%), but poorer for the less common joint implants, and lowest for ankle and wrist implants. One reason for the apparent under-reporting of wrist implants may be that some wrist implants were wrongly reported to the NPR as hand implants. As a consequence of the NOMESCO coding system used by the hospitals in reports to the NPR, separate statistics could not be established for replacements of finger and carpometacarpal (CMC I) joints.

Revisions

Completeness of registration was also high—above 97%—for revisions of hip and knee replacements. This finding contradicts reports from the Danish Arthroplasty Register where registration completeness of hip replacements was lower for revisions (81%) than for primary operations (94%) (Pedersen et al. 2004). In Sweden, registration completeness was 94% for revision hip replacements (Söderman et al. 2000) and 80% for knee replacements (Robertsson et al. 1999). However, for other implants the registration completeness of revisions in the NAR was lower, and lowest for ankle and wrist implants.

Registration completeness regarding revisions involving only removal of prosthetic parts was lower than for exchange revisions. Although the proportion of removal revisions was low, it is probable that figures on proportion of revisions based on data in the NAR are too low. This may especially affect revisions due to infection (Espehaug et al. 1997, Engesæter et al. 2003), as the majority of removal revisions are performed as a result of deep infection. For hip replacements, 20% of the Girdlestone procedures were not reported to the register. Since completeness of removal revisions was less than 75% at 32 of 50 hospitals, it is likely that confusion prevails among

Norwegian orthopedic surgeons as to whether removal revisions should be reported or not. Thus, it is unlikely that risk factors such as brand of prosthesis or use of antibiotic prophylaxis are associated with unreported prosthetic removals. Our previously published relative risk estimates should therefore be unaffected.

It should also be noted that an exchange revision was reported to the NPR with two codes, one for removal of the failed prosthesis and one for insertion of a new prosthesis. In this study, all numbers for exchange revisions were based on insertion codes only. If the insertion code is left out in reports to the NPR, this would lead to a falsely high value of registration completeness for exchange revisions in the NAR. This is unlikely, however, since reimbursement of money to hospitals was based on the number of implant insertions reported to the NPR.

The NPR as a measure of registration completeness

Previous studies have evaluated the registration completeness of operative procedures in the NPR with conflicting results. A validation of the number of deliveries in obstetrics units in Norway in 1999–2002, extracted from the NPR against information from Statistics Norway, showed only small discrepancies (Backe et al. 2003). Comparisons of the number of patients operated on due to ectopic pregnancy as identified by medical records (Bakken and Skjeldestad 2003a) and the NPR (Bakken and Skjeldestad 2003b) also gave similar results. The

same was reported in a study investigating cholecystectomy incidence and laparoscopy rates in Norway from 1990 through 2002 (Mjåland et al. 1998, Bakken et al. 2004). The number of breast cancer patients reported to the NPR was, however, 7% less than that reported to the National Cancer Registry (Lundgren et al. 2001). The discrepancy was explained by differences in registration practice. In a study investigating discharges at 3 hospitals in Norway with hip fracture as diagnosis, 98% of the patients were surgically treated according to medical records whereas only 59% were identified as such according to NPR data (Lofthus et al. 2005). In a recent study comparing data from one Norwegian hospital, based on medical records and operation logbooks, with data from the NPR, 0.4% of primary hip replacement operations and 16% of revisions were not reported to the NPR (Arthursen et al. 2005). These studies demonstrate the uncertainties of the data in the NPR, and the numbers presented in our study should be interpreted accordingly.

Since data in the NPR precludes patient identification, individual matching is not possible. This means that a thorough investigation into the validity of NPR data is not feasible. The fact that patients are not individually recognized can inflate NPR data, as duplicate patient information may have gone unnoticed in NPR data, but not in the NAR. The coding system used by hospitals in reports to the NPR may also be unclear for some procedures, and the use of “99” codes should be investigated.

Measures to improve and uphold registration completeness

We ascribe the high long-term registration completeness demonstrated in this paper to the high degree of motivation of the Norwegian orthopedic surgeons. One reason for this may be the simple one-page standard form, which takes only about 1 min to fill in. Another may be the information given back to the surgeons. In addition to national reports, annual reports are given at hospital level with information on productivity and the quality of the local surgery compared to the rest of the country. Reports are also sent to each hospital with information on discrepancies in numbers reported to the register and the NPR. As a further incentive,

a wide range of scientific publications have already been published based on data in the register.

Author contributions

BE performed the analyses and drafted the paper. All authors contributed to the study design, interpretation of results, revision of the paper and approved the final version.

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