

The Danish Multidisciplinary Hip Fracture Registry 13-Year Results from a Population-Based Cohort of Hip Fracture Patients

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Aim of the Registry: The aim of the Danish Multidisciplinary Hip Fracture Registry (DMHFR) is to collect data on processes of treatment, nursing care and rehabilitation as well as outcomes for patients with hip fracture in Denmark, and thereby monitor and improve the quality.

Study Population: Hip fracture patients at age 65 or older that have undergone surgery with arthroplasty or internal fixation since 2004.

Main Variables: DMHFR collects quality indicators and descriptive variables. Quality indicators include eight process performance measures within treatment, nursing care and rehabilitation, reflecting recommendations from the national clinical guideline for hip fracture patients, and three outcome measures including survival within 30-days, unplanned acute readmission within 30 days and reoperation within 2 years. Descriptive variables include a number of patient- and surgery-related characteristics. All data are collected prospectively.

Results: By the end of 2018, the DMHFR included 86,438 hip fracture patients. Since 2006, all hospital departments in Denmark, treating patients with hip fracture, have reported improvement in quality of care and improvement in survival, and reoperation over time as well as high completeness of variables registration.

Conclusion: The DMHFR is a well-established nationwide clinical registry, which plays a key role for monitoring and improving hip fracture care in Denmark. The registry can further be linked to a range of other nationwide registries in order to answer a number of relevant clinical research questions.

Keywords: hip fracture, quality indicators, registry, mortality, reoperation, readmission

Introduction

The number of patients hospitalized due to hip fracture has been reported to be 620,000 in the European Union in 2010 and 210,000 per year between 2008 and 2011 in the United States.^{1,2} It is the dominant cause of trauma-related mortality in people above 65 years, and among the survivors, 50% never reached their previous functional level.³⁻⁶ Moreover, hip fracture is related to considerable healthcare costs.⁷⁻⁹ Previous research has indicated variation in outcome after hip fracture and only a slight improvement in survival over time.¹⁰⁻¹² Western healthcare systems have therefore developed clinical guidelines for hip fracture care and countries including Sweden, Norway, Finland, Denmark and the United Kingdom have initiated continuous monitoring of the quality of care after hip fracture.^{13,14}

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The Danish Multidisciplinary Hip Fracture Registry (DMHFR) was initiated in 2003 as part of a national quality improvement project called the Danish National Indicator Project.¹⁵ The aim of the DMHFR is to monitor and support implementation of evidence-based clinical guidelines for hip fracture care and ultimately improve the quality and outcome of hip fracture patients. The registry has a multidisciplinary steering committee appointed by the Danish regions, the Danish Orthopedic Society, the Danish Geriatric Society, the Danish Nurses Organization and the Danish Society for Physiotherapists.¹⁶ The steering committee chose quality of care indicators, including process performance measures and outcome, as well as descriptive prognostic variables, which reflect current evidence-based approaches within multidisciplinary hip fracture care and their feasibility in clinical practice. The DMHFR is part of the umbrella organization Danish Clinical Registries, and the results are publically available in an annual report in aggregated form.¹⁶

Aim

The present paper aims to describe the organization and content of the DMHFR, to present results regarding demographics and quality indicators during the period 2006–2018 and to illustrate the potential of the DMHFR for clinical epidemiological research.

Materials and Methods

Setting

Denmark is a country with 5.7 million inhabitants with free access to medical care and a longstanding tradition for health-care registries.¹⁷ All patients with hip fracture are admitted to the nearest public hospital treating acute patients. All inhabitants have a unique civil registration number, which is used in all healthcare contacts and allows unambiguous linkage between the healthcare registries.¹⁸

Data Collection Procedures

Reporting to the DMHFR is mandatory by law for all hospitals from 2006.¹⁹ During the period from 2006 to 2018 all hospitals treating hip fracture patients were reporting to the registry. Data are prospectively collected on an individual-level by healthcare professionals involved in treatment of hip fracture patients from the time of hospital admission to discharge, covering different aspects of the clinical pathway. Detailed data definitions are developed prior to data collection. Fulfillment of the process

performance measures are registered by the staff members prospectively as part of the clinical routine and are reported monthly to the registry. From 2004 to March 2010 the registry was a web-based standalone database, as data were collected using an independent web-based interface. From March 2010 and forward, the registry uses routine collected data retrieved directly from the Danish National Patient Registry to avoid double registration by clinicians.²⁰

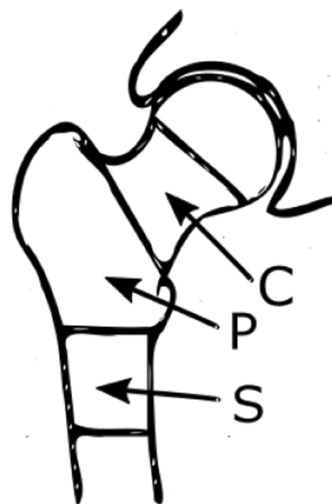
Study Population

The DMHFR includes patients' age ≥ 65 admitted acutely with a femoral neck, pertrochanteric (intertrochanterica femoris or trochanterica femoris) or subtrochanteric fracture (Figure 1) and treated surgically with osteosynthesis or total/hemi arthroplasty.

Main Variables

Quality Indicators

A documentary report, which reflects current evidence within multidisciplinary hip fracture care, is developed. On the basis of this evidence-based approach as well as feasibility in clinical practice, quality of care indicators are developed. The quality indicators in the DMHFR include process performance measures and outcome measures. Eight process performance measures are currently available and include timing of preoperative optimization, surgery



- C: Femoral neck fracture
- P: Pertrochanteric fracture
- S: Subtrochanteric fracture

Figure 1 Types of collum femoris fractures included in the multidisciplinary hip fracture registry.

delay (24 and 36 hours), mobilization within 24 hours, assessment of nutrition status, basic mobility score pre- and postoperative, rehabilitation program, osteoporosis- and fall prophylaxis. The process performance measures reflect key recommendations for healthcare processes, which are expected to be associated with patient outcome. The staff members classify the patient as eligible or non-eligible for the process performance measures according to detailed data definitions. Subsequently, the staff members register fulfillment or non-fulfillment of the measure. Missing registration of fulfillment would be coded as a non-fulfillment of the process performance measure.

Currently, three outcome measures are available: Survival within 30 days, readmission within 30 days after discharge and reoperation within two years. Due to the individual-level record linkage to other public registries and the civil registry number in Denmark, complete follow-up for every patient is possible for the outcome measures. Information on survival is obtained from the Civil Registration System, which has daily updated electronic records of all changes in vital status for the entire Danish population since 1968.¹⁸ Readmission is defined as an acute first time readmission to any hospital 24 hours after discharge from hip fracture with a length of stay of minimum 24 hours. Reoperation is defined in four different ways depending on fracture type and surgery type. Information on readmission and reoperation is obtained from the Danish National Patient Registry, which is a nationwide administrative registry that covers all admissions and discharges from Danish somatic hospitals since 1977. Since 1994, up to 20 diagnoses for every discharge are coded according to the Danish version of the International Classification of Diseases tenth edition.²⁰

The core of the quality of care indicators has been quite consistent in the first ten years. However, demands for fulfillment of some process performance measures have increased over time and data definitions were adjusted. For instance, a timestamp for mobilization within 24 hours was implemented in 2015. Before 2015, the clinicians reported whether the patient was mobilized within 24 hours with the answer yes or no. After 2015, clinicians have reported the exact time for first mobilization. Likewise, in 2013, fulfillment of the measure basic mobility assessment presupposes that the CAS score value also was reported. Moreover, new quality indicators have been added by the steering committee regularly. Detailed specifications for the individual indicator calculation are publicly available through the Danish Clinical Registry's

website.¹⁶ A description of the measures used in the registry is presented in [Table 1](#).

Local and regional audits on quality indicators are carried out every third month. Further, the steering committee performs an annually structured audit process and publishes an annual report followed by comments and recommendations from the audits on how to improve quality of care.

Descriptive Variables

The DMHFR has information on a number of patient- and surgery-related variables, which, based on the current evidence, appear to be well-established prognostic factors. Patient-related variables included admission age, sex, Body Mass Index (BMI) and residence. In the period from 2005 to 2010 information on alcohol intake and smoking were collected. The surgery-related variables included type of fracture, fracture displacement, and type of surgery ([Table 2](#)). In the period from 2005 to 2010, information on the American Society of Anesthesiologists' (ASA) classification score was collected. From 2010 and onward, the ASA score was replaced with the Charlson Comorbidity Index (CCI). The CCI is a method of categorizing comorbidities of patients based on ICD diagnosis codes from the Danish National Patient Registry.²¹ Surgical delay was included in the DMHFR as a prognostic factor in the period 2006 to 2014 and as a process performance measure since 2015.

Results

Patient Characteristics

During the period 2006–2018, the DMHFR included 87,803 hip fracture patients. The number of patients varied slightly during the study period, but the average was 6,800 patients ([Table 2](#)). The majority of hip fracture patients are women with a median age of 84 years, living alone. The most frequent fracture type is a femoral neck fracture and the most frequent surgery type is internal fixation. The proportion of hip fracture patients with comorbidity has increased over time ([Table 2](#)).

Quality Indicators

Process Performance Measures

For the process performance measures, improvement over the years has been observed for most of the measures even though the demands for fulfillment of the process performance measures have increased over the period ([Figure 2](#)). An exception is the process performance measures implemented in 2015, including preoperative optimization and

Table 1 The Quality Indicators in the Multidisciplinary Hip Fracture Registry Through the Years

	Indicator Area	Indicator	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Process Performance Measures	Pain assessment	Daily systematic pain assessment using a visual analog scale or a numeric rating scale at rest and during mobilization	+	+	+	+	+	+	+	+	+				
	Mobilization within 24 hours	Being mobilized within 24 hours postoperatively, defined as assisting the patient from bed rest to walking or rest in a chair					+	+	+	+	+	+ ^a	+	+	+
	Assessment of nutrition risk	Assessment of patients BMI and nutritional risk within two days after admission.	+	+	+							+	+	+	+
	Osteoporotic medication	Evaluation of need of anti-osteoporotic medications, which includes continued anti-osteoporosis medication, no indication for treatment due to cancer or psychiatric condition or referring to DEXA scan					+	+	+	+	+	+	+	+	+
	Fall prevention	Initiation of treatment to prevent future fall accidents, including a fall risk assessment to account for co-existing medical conditions, medication, functional disability, symptoms from the central nervous system, musculoskeletal system and cardiopulmonary status					+	+	+	+	+	+	+	+	+
	Prevention of osteoporotic fractures	Initiation of treatment includes ordination of any anti-osteoporotic medications or calcium and d-vitamin or hip protectors	+	+	+	+									
	Post discharge rehabilitation program	Post discharge rehabilitation program including assessment of activities of daily living (ADL) with a validated test before the fracture and again before discharge		+	+	+	+	+	+	+	+	+	+	+	+
	Assessment of functional level prior to admission	Basic mobility assessment using a validated test such as Cumulated Ambulation Score (CAS), Barthel 20, Functional Recovery score or New Mobility score. From 2013, only CAS is measured at admission.	+	+	+	+	+ ^a	+	+	+ ^a	+	+	+	+	+
	Assessment of functional level at discharge	Basic mobility assessment using a validated test such as Cumulated Ambulation Score (CAS), Barthel 20, Functional Recovery score or New Mobility score. From 2013, only CAS is measured prior to discharge	+	+	+	+	+	+	+	+	+	+	+	+	+
	Surgical delay	Patient had surgery within 24 hours after admission to hospital (from 2016, admission time was changed to arrival time)												+	+

Note: ^aChange in data definitions.

Table 2 Patient Characteristics of the Hip Fracture Population from 2006 to 2018

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of Admissions	6456	6566	7423	7155	5143	7158	6801	6904	6611	6789	6679	6502	6374
Age, median year (Q1-Q3)	83	83	84	84	83 (77-89)	83(77-89)	84(78-89)	84(77-89)	84(77-89)	83(77-89)	84(77-89)	83(77-89)	83(76-89)
Gender:													
Men	1686	1784	1998	1939	1413	2038	1970	1988	1867	2021	2060	2035	2045
Women	4770	4782	5425	5216	3730	5120	4831	4916	4744	4768	4619	4467	4329
Residence (2005-2009):													
Living together with another adult	1673	1686	1969	1914									
Living alone in one's own home	3244	3344	3946	3802									
Other including living in a nursing home or other institution	1060	1216	1256	1158									
Missing	479	320	252	281									
Residence (2010-)													
Own home					2871	4791	4540	4717	4457	4599	4609	4400	4501
Own home affiliated with an institution					378	424	385	405	360	378	391	257	217
Institution					871	1311	1227	1357	1182	1080	1147	1112	1136
Missing					1023	632	649	425	612	732	532	733	520
ASA: (2006-2009)													
0	602	543	570	546									
1	2977	3189	3538	3582									
2	2091	2207	2575	2383									
4	338	357	336	311									
5	10	12	12	9									
Missing	438	258	392	324									
CCI (2010-):													
None 0 point					2023	2800		2544	2399	2512	2420	2394	2307
Mild 1 point					1201	1723		1718	1591	1510	1554	1497	1441
Moderate 2 points					903	1266		1192	1154	1229	1199	1182	1151
Severe ≥ 3 points					1016	1369		1450	1467	1538	1506	1429	1475

BMI (2010→): < 19: Underweight 20–25: Normal 26–29: Overweight >30: Obese Missing					586 1770 871 323 1593	961 2919 1540 412 1326	958 2850 1383 375 1235	1030 2916 1455 429 1074	943 2811 1410 399 1048	881 2757 1484 402 1055	1426 2644 1476 478 655	795 2428 1394 461 1424	829 2327 1334 430 1454
Fracture Displacement Displaced Undisplaced Unspecified	4707 932 817	5375 1149 42	6184 1209 30	5880 1243 32	3142 549 1452	5314 835 1009	4985 787 1029	5202 828 874	4845 744 1022	5081 680 1028	4811 657 1211	4266 542 1694	3792 464 2118
Type of Fracture Medial femoral neck Petrochanteric Subtrochanteric Missing	3253 2628 410 165	3334 2721 484 27	3786 3075 551 11	3597 2966 577 15	2662 2093 388	3671 2949 538	3619 2704 478	3815 2593 496	3630 2714 526	3781 2526 482	3691 2502 486	3498 2495 509	3371 2527 476
Type of Surgery Osteosynthesis Hemi/total arthroplasty Missing	4597 1572 287	4734 1611 221	5309 1945 169	5018 1964 173	3538 1605	4877 2281	4435 2366	4464 2440	4336 2275	4365 2424	4325 2354	4176 2326	4082 2292
Alcohol Intake (2006–2009) ≤ 14/21 per week for women/men >14/21 units per week for women/men Missing	4405 188 1863	4801 230 1535	5759 272 1392	5307 230 1618									
Smoking Habits (2006–2009) Current Former Never Missing	1366 1001 2180 1909	1412 1151 2431 1572	1657 1422 2837 1507	1532 1401 2516 1706									
Time to Surgery (hours) ^a <24 hours 24–48 hours > 48 hours Missing	3293 2197 759 207	3405 2104 781 276	3855 2502 858 208	3901 2286 714 254	2858 1584 693 8	3899 2361 893 5	4299 1876 626	4392 1890 617 5	4377 1827 402 5				

(Continued)

Table 2 (Continued).

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Region													
North Denmark		925	872	852	606	913	844	765	783	769	800	804	702
Central Denmark		1607	1675	1628	1097	1513	1455	1509	1421	1454	1449	1419	1428
Southern Denmark		1844	1818	1757	1196	1714	1566	1566	1607	1556	1559	1566	1670
Capital region		1343	1780	1791	1434	1949	1898	1917	1777	1871	1770	1618	1495
Zealand region		1079	1142	1127	810	1069	1038	1147	1023	1139	1101	1095	1079

Note: ^aFrom 2015 and onward time to surgery is collected as a process performance measure.
Abbreviations: BMI, Body Mass Index; ASA, American Society of Anesthesiologists' classification score; CCI, Charlson Comorbidity Index.

surgery within 24 and 36 hours respectively, where the fulfillment has not improved over the three years. A decrease in fulfillment of some of the process performance measures such as mobilization within 24 hours in 2015 and basic mobility assessment in 2013 may be related to change in data definitions (Figure 2).

Outcome Measures 30-Day Mortality, Readmission and Reoperation

The overall 30-day survival varied from 90% to 88% during 2006–2018. The proportion of patients that were re-operated within two years has decreased over the study period, from 27% to 13% among patients with a displaced medial femoral neck fracture, and from 15% to 9% among patients with un-displaced medial fracture (Figure 3). Reoperations among patients treated with an arthroplasty were highest in the period from 2008 to 2011 with around 13%, and have decreased to 9% subsequently. Almost 1820% of patients were readmitted within 30 days during 2015 to 2018.

Examples of Research

The DMHFR data are accessible for research after application to the Danish Clinical Registries.¹⁶ Published papers are based on the DMHFR data linked to other Danish health registries, including the Danish National Patient Registry, the Civil Registration System, the Danish Transfusion Database, the Danish Prescription Database, the Laboratory Information System, and the Integrated Database for Labour Market Research. The studies have focused on variation in the outcome measures among patient types and hospitals.^{22–24} An association between fulfillment of the process performance measures and better survival and lower readmission rate has been found^{25–28} as well as an association between orthogeriatric specialization or patient volume and outcome.^{29–31} In addition, associations between transfusion practice and outcome,^{32,33} association between surgery delay and post-operative complications,^{34,35} associations between some commonly used medication preoperatively, including antidepressants, anticoagulants and anti-inflammatory drugs and post-operative complications^{36–40} have been observed. Moreover, studies have found that about 15% of hip fracture patients develop an acute kidney injury within 5 days of surgery^{41,42} and about 15% of patients sustain post-operative infections within 30 days of surgery,^{43,44}

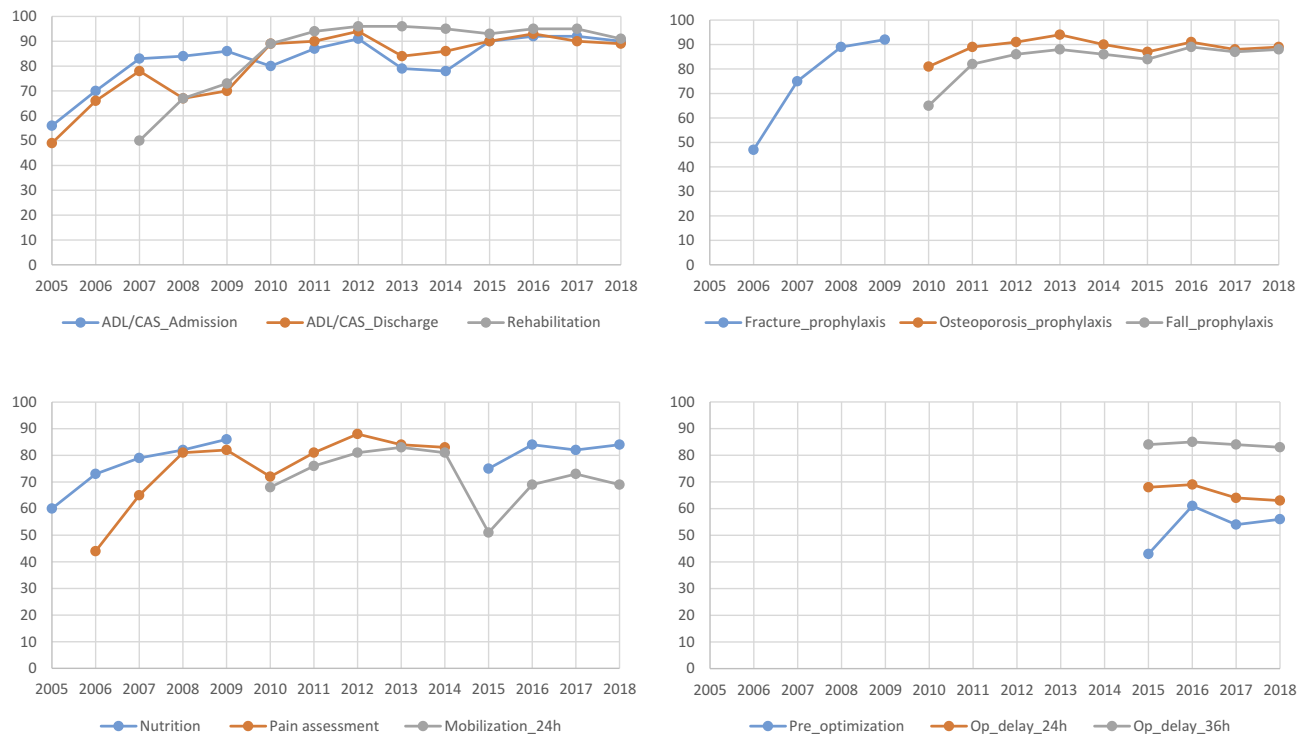


Figure 2 Proportion of patients in percent that have fulfilled the individual process performance measures over time.

complications which are strongly associated with 30 days mortality. Besides, hip fracture patients were at increased excess risk of venous thromboembolism, myocardial infarction and stroke up to one year following fracture.^{45,46}

Discussion

The DMHFR is a nationwide registry established in 2003 with the aim of monitoring and improving hip fracture treatment and care in Denmark. The hip fracture population in Denmark is characterized by a median age of 84

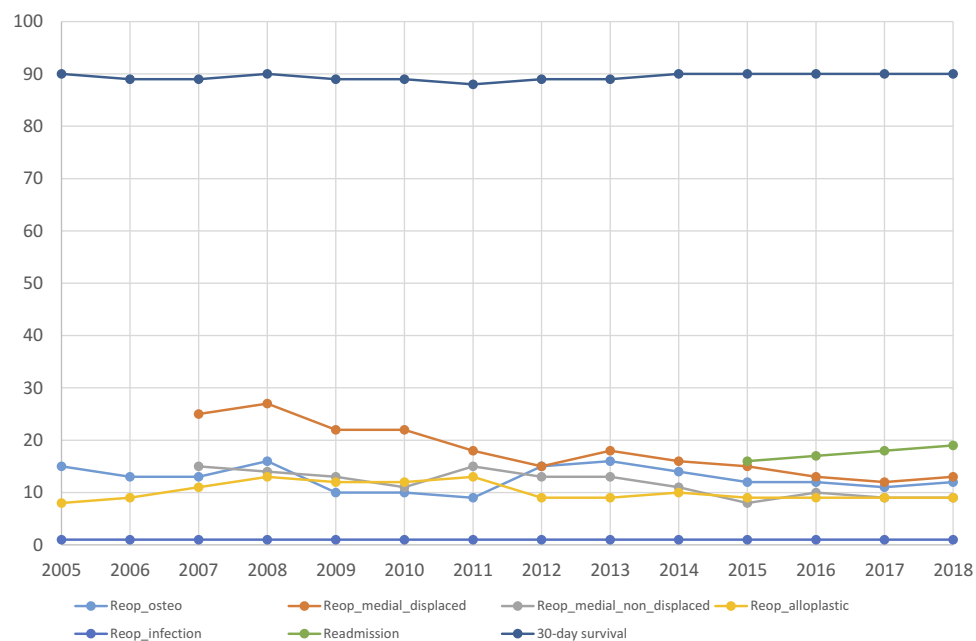


Figure 3 Proportion of patients with 30-day survival and readmission and reoperation within two years over time.

years and a high completeness of reporting. The quality of treatment and care reflected by receiving guideline recommended recommendations has increased over the years. The 30-day survival has improved from 88% to 90% in the period. The proportion of reoperations has decreased especially among patients with medial femoral neck fracture. In contrast, the risk for acute readmission has increased from 16% to 20% in the last three years.

Comparison with Other Hip Fracture Registries

Continuous monitoring of the quality of healthcare has been implemented in many European countries¹⁴ including Finland (PERformance, Effectiveness and Cost of Treatment episodes),⁴⁷ Sweden (Rikshöft),⁴⁸ the United Kingdom (UK) (the National Hip Fracture Database),^{13,49} Scotland (the Scottish Hip Fracture Audit),⁵⁰ Italy (Regional Outcome Evaluation Program in the Lazio region⁵¹ and Gruppo Italiano di Ortogeriatría),⁵² Norway (The Norwegian Hip Fracture Registry),⁵³ Spain (National Hip Fracture Registry),⁵⁴ Ireland (Irish Hip Fracture database),⁵⁵ Netherlands (Dutch National Hip Fracture Audit),⁵⁶ Germany (Alterstrauma register),⁵⁷ and Denmark (DMHFR). However, the majority of these registries^{47,50,51,53–55} mainly monitor outcome performance measures, eg, mortality and readmissions at the hospital level, and lack continuous monitoring of process performance measures. Exceptions are the DMHFR, Rikshöft⁴⁸ and the National Hip Fracture Database in the UK,^{13,49} which contain valuable information on process performance measures according to clinical guideline recommendations. The measures monitored in the National Hip Fracture Database in the UK are comparable to the process performance measures as they monitor mobilization on the first postoperative day, bone-protection medication and geriatric assessment. The fulfillment of the process performance measures is generally higher in the UK compared to Denmark, eg, 69% were mobilized on the first operative day in Denmark whereas 79% were mobilized in the UK. Likewise is the survival lower in Denmark compared to the UK and Sweden, as they report an overall 30-day mortality rate below 8% compared to 10% in Denmark.^{58,59} The lower mortality may be explained by different inclusion criteria in the hip fracture registries, eg, different inclusion ages, which may impact the risk of mortality. For instance, the Scottish Hip Fracture Audit, the Swedish Rikshöft registry and the Finish PERFECT registry include hip fracture patients from 50 years, whereas the Danish Multidisciplinary hip fracture registry includes patients from 65 years.

Perspective

The efforts are on-going to improve the fulfillment of the process performance measures and thereby improve the hip fracture patients' survival. The completeness of registered variables for each patient is high, however an in-depth validation of the data in the DMHFR with focus on completeness and positive predictive value of the registered data needs to be done. The length of hospital stay has decreased, which includes earlier discharge to care in the community settings or at home with support from home care or mobile rehabilitation units. The hip fracture registries therefore need data from the community setting including primary healthcare services to improve our knowledge on the full clinical pathway of hip fracture patients and its impact on the patient outcome.

Administrative Issues and Funding

The clinicians reporting to the registry have no economic incentives, but there is an increasing interest from politicians, hospital boards of directors and patient organizations regarding fulfillment of the quality indicators. DMHFR is funded by the Danish Regions and receives epidemiological, statistical and administrative support from the Danish Clinical Registries (RKKP), which has a budget of 9.9 million USD to operate 80 databases in Denmark. DMHFR receives 16,000 USD yearly for holding audits, multidisciplinary seminars and revising data definitions. The DMHFR is approved as a national clinical quality database by the National Board of Health and the Data Protection Agency. Permission to access the data from the DMHFR has been granted by the Data Protection Agency and the steering Committee following an application to the Data Protection Agency and RKKP.

Conclusion

The DMHFR plays an important key role in monitoring and improving hip fracture care in Denmark due to prospectively collected high-validity data. Furthermore, the DMHFR has been linked to a wide range of other national registries in order to answer a number of relevant clinical questions regarding the treatment and outcome of hip fracture patients. Thus, the DMHFR is a valuable tool for both quality improvement and epidemiological research.

Ethics

The study was approved by the Danish Data Protection Agency (journal number 2012-41-1274) and carried out in accordance with the principle of the Declaration of Helsinki.

The requirement for consent was waived as registry-based studies do not require formal ethical approval according to the Danish law. Patient data was kept confidential.

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Disclosure

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