Original Article

The Association Between Orthogeriatric Co-Management and Mortality Following Hip Fracture

An Observational Study of 58 000 Patients From 828 Hospitals

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Summary

Background: To meet the special needs of older patients with fragility fractures, models for collaborative orthogeriatric care have been developed. The objective of our study was to analyze the association of orthogeriatric co-management with mortality following hip fracture in older patients in Germany.

Methods: This observational study was based on health insurance claims data from 58 001 patients (79.4% women) aged ≥ 80 years admitted to the hospital with hip fracture between January 2014 and March 2016. They were treated in 828 German hospitals with or without orthogeriatric co-management. The outcome measure was cumulative mortality with adjustment of the regression analyses.

Results: The crude 30-day mortality was 10.3% for patients from hospitals with orthogeriatric co-management and 13.4% for patients from hospitals without orthogeriatric co-management. The adjusted 30-day mortality was 22% lower for patients in hospitals with orthogeriatric co-management (rate ratio 0.78; 95% CI [0.74; 0.82]; adjusted absolute difference -2.48% ; 95% CI $[-2.98; -1.98]$). The difference in 30-day mortality remained nearly unchanged over the first 6 months. The risk reduction with orthogeriatric co-management was consistently observed in both women and men, across age groups, and in patients with and without care needs. The mean length of the index stay was 19.8 days in hospitals with orthogeriatric co-management and 14.4 days in hospitals without orthogeriatric co-management.

Conclusion: A multidisciplinary orthogeriatric approach is associated with lower mortality and a longer index stay in hospital after hip fracture.

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Fragility fractures occur mainly in very old people and cause a high disease burden (1, 2). The fracture type with the most serious consequences in this age group is hip fracture (3,4). Although the prognosis has improved over recent decades, mortality following hip fracture is still high (5,6): the excess mortality during the first year after fracture (compared with control populations) ranges from 8.4% to 36% (7). Hip fracture patients are often frail with several comorbidities. Therefore, the fracture often represents only one of a number of medical problems. These problems are often beyond the scope and expertise of orthopedic surgeons. To deal better with the special needs of these patients, models for

collaborative care of patients with fragility fractures have been developed in which orthopedic surgeons and geriatricians work together (8–10).

A number of clinical trials have investigated the effects of different forms of multidisciplinary co-management on outcomes (e.g., physical function, length of stay, discharge destination). A randomized controlled trial (RCT) from Norway, for example, demonstrated better physical function 4 months after hip fracture in the group that received comprehensive geriatric care (11).

The sample sizes of the existing individual RCTs are not sufficient to detect differences in mortality.

FIGURE 1

Flow chart of data management

AOK, *Allgemeine Ortskrankenkasse*; ICD10, International Classification of Diseases, 10th revision; N, total number of participants; n, number of participants in subgroup; OGCM, orthogeriatric co-management

Three systematic reviews of RCTs, however, reported that mortality was lower, albeit nonsignificantly so, in hip fracture patients who received orthogeriatric co-management (12–14). Moreover, several observational studies have compared newly established orthogeriatric units with historical cohorts (15–18). Most of these report a mortality advantage for hip fracture patients treated in the orthogeriatric units. The numbers of cases in these studies were low, however, and the results may have been biased by temporal trends and other factors such as case selection.

Recently, three observational studies from Australia, Denmark, and Italy with larger cohorts of hip fracture patients have been published. They all reported lower 30-day mortality rates amongst the patients with orthogeriatric co-management (19–21).

In Germany, more and more hospitals are providing orthogeriatric co-management for patients with fragility fractures. These hospitals can be identified from health insurance claims data. Since this is a relatively new development, there are still many hospitals that do not deliver this type of care. Therefore, two large cohorts of hip fracture patients are currently available who have been treated in hospitals either with or without orthogeriatric co-management. We took advantage of this time window to analyze the association of

orthogeriatric co-management with mortality in 58 000 patients with hip fracture, based on nationwide hospital insurance claim records from a large health insurance company.

Methods

Data source and study population

The basic data set consisted of 131 258 patients aged ≥ 65 years who were admitted to German hospitals with a hip fracture between 1 January 2014 and 31 March 2016 and insured by the *Allgemeine Ortskrankenkasse* (AOK). The AOK is Germany's largest health insurance company and covers nearly one-third of Germany's 82.5 million population. Patient-related data were provided by the Research Institute of the AOK (*Wissenschaftliches Institut der AOK*, WIdO).

Hip fractures were identified using the hospital admission diagnoses S72.0 and S72.1 (ICD-10). Our a priori evaluation strategy restricted analyses to patients aged ≥ 80 years, because they are by definition regarded as geriatric patients. However, the same analyses were also performed in hip fracture patients aged 65–79 years to find out whether the results were consistent in younger patients.

To avoid the potential influence of low sample sizes on treatment quality and improve comparability between

the two groups, we excluded patients treated in hospitals with fewer than 80 hip fracture cases per year.

The number of hip fractures per hospital per year was estimated on the basis of the number of patients with hip fracture in the data set and the market share of the AOK. A sensitivity analysis that also embraced patients from the excluded hospitals changed the results only marginally (data not shown). The data preparation procedure is presented in *Figure 1*.

Independent variable

Orthogeriatric co-management (see *Box*) can be identified in insurance health claims data by the German procedure code OPS8-550 (complex early geriatric rehabilitation). The OPS8-550 code was used to identify those hospitals in which orthogeriatric co-management was available.

It might at first sight seem simplest to conduct analyses based on whether or not the patient received complex early geriatric rehabilitation treatment and thus an OPS8-550 code. This would be incorrect, however, because for the code OPS8-550 to be assigned, the orthogeriatric treatment must extend over a period of at least 14 days. Classification on the basis of the individual OPS8-550 coding would introduce immortal time bias (survivorship bias) (22). Identifying which hospitals provided orthogeriatric co-management based on the coding of patients treated in the hospitals overcame this problem. Patients who changed treatment type, e.g., were transferred from a hospital with to a hospital without orthogeriatric co-management, were excluded (*Figure 1*).

Dependent variable

The dependent variable was cumulative mortality at 30, 60, 90, and 180 days after hospital admission due to a hip fracture.

Covariables

Age (in years) at the time of the fracture and sex were documented in the claims database. Information about care needs (yes/no) and nursing home status was available only on a quarterly basis. For adjustment and stratification of the analyses, we used information from the quarter before the fracture (Q-1).

Assessment of the need for care is compulsory under German law (Social Code XI). Allocation to one of the three levels of care (valid up to the end of 2016) can be used as a surrogate marker of functional impairment (23).

The number of hip fracture patients per hospital per year was used as a surrogate for the size and/or the expertise of the trauma surgery unit. Time to surgery has been shown to influence mortality (24). Therefore, time from hospital admission to surgery was determined and used as a covariable.

Because reimbursement for OPS8-550 procedures depends on good documentation at the treating hospital, the coding of comorbidities seemed to be particularly comprehensive in these patients. There was thus a

BOX

Complex early geriatric rehabilitation

The procedure code OPS8-550 identifies complex early geriatric rehabilitative treatment, lasting for at least 14 days, provided by a multidisciplinary team headed by a geriatrician and made up of physiotherapists, occupational therapists, specifically trained nurses, and social workers. Further disciplines can be added if necessary. Complex early geriatric rehabilitative treatment comprises standardized geriatric assessment, regular interdisciplinary team meetings, and development of a rehabilitation plan with setting of functional goals and a focus on geriatric syndromes. Early mobilization is a key component of the treatment. In patients with hip fracture, this treatment begins in the days directly after surgery. Complex early geriatric rehabilitative treatment can be delivered on an orthopedic or a geriatric ward. The two models usually employed in Germany are joint treatment by orthopedic surgeons and geriatricians in an orthogeriatric unit and provision of a geriatric liaison service in the orthopedics department with early transfer to a geriatric unit.

danger that using conventional comorbidity scores might bias the results. Instead, we employed a medication-based comorbidity score (25), based on medical prescriptions in the quarters before and at the time of the fracture.

To control for confounding, we included all covariables in the analysis models (see *eMethods* for a detailed description of the statistical methods)

Results

The analyses were based on 58 001 hip fracture patients aged ≥ 80 years from 828 hospitals in Germany (441 with and 387 without orthogeriatric co-management). Nearly 80% of the patients were women. More than 60% of the patients ($n=34\,551$) were treated in hospitals in which orthogeriatric co-management was available (*Table 1*).

The mean duration of the index hospital stay for patients treated in hospitals with orthogeriatric co-management was 19.8 (95% confidence interval [19.7; 19.9] days, compared with 14.4 [4.3; 14.5] days for those in hospitals without orthogeriatric co-management. This difference changed only marginally when patients who died in hospital were excluded.

When the index hospital length of stay and any periods of subsequent inpatient rehabilitation were summed, the mean total stay in hospital was 41.4 [41.2; 41.6] days for the hospitals with and 39.3 [39.1; 39.5] days for those without orthogeriatric co-management (*Table 1*).

TABLE 1

Characteristics of patients with hip fracture aged ≥ 80 years in hospitals with and without orthogeriatric co-management

	Patients treated in hospitals	
	with OGCM (N = 34 551)	without OGCM (N = 23 450)
Patients with OPS-8550; n (%)	15 218 (44.0)	0 (0.0%)
Women; n (%)	27 462 (79.5)	18 603 (79.3)
Age (years); mean (SD)	87.1 (4.6)	87.2 (4.6)
80–85; n (%)	14 084 (40.8)	9446 (40.3)
≥ 86 ; n (%)	20 467 (59.2)	14 004 (59.7)
Classified as needing care at study onset; n (%)	21 597 (62.5)	15 010 (64.0)
Resident of a nursing home at study onset; n (%)	8263 (23.9)	6804 (29.0)
Medication-based comorbidity score; mean (SD)	4.1 (1.9)	4.2 (1.9)
Days from hospital admission to surgery		
0; n (%)	11 057 (32.0)	8 221 (35.1)
1; n (%)	13 871 (40.1)	9 589 (40.9)
2; n (%)	3550 (10.3)	2203 (9.4)
≥ 3 ; n (%)	2338 (6.8)	1579 (6.7)
NA; n (%)	3735 (10.8)	1858 (7.9)
Length of IHS (days); mean (SD)	19.8 (11.2)	14.4 (8.4)
Subsequent inpatient rehabilitation; n (%)	9462 (27.4)	8851 (37.7)
Total number of inpatient days (IHS + rehabilitation); mean (SD)	41.4 (11.3)	39.3 (10.3)

IHS, index hospital stay; N, number of patients, total; n, number of patients, subgroup; NA, no surgery-relevant OPS code found at individual patient level; OGCM, orthogeriatric co-management; OPS-8550, complex early geriatric rehabilitation according to the German classification of operations and procedures (OPS); SD, standard deviation

Patients from hospitals with orthogeriatric co-management were less likely to die following hip fracture than patients from hospitals without orthogeriatric co-management. The difference in mortality was greatest immediately after admission and decreased during the next 6 weeks (*Figure 2a*). After 6 weeks, mortality by day was about the same in both groups.

The crude 30-day mortality was 10.3% in patients from hospitals with orthogeriatric co-management and 13.4% in patients from hospitals without orthogeriatric co-management. The adjusted 30-day mortality was 22% lower for patients in hospitals with orthogeriatric co-management (rate ratio 0.78 [0.74; 0.82]; adjusted absolute difference -2.48% [-2.98 ; -1.98] (*Table 2*). The observed absolute difference in 30-day mortality remained nearly unchanged over the remainder of the follow-up period (*Figure 2B*; *Table 2*).

The risk reduction for those treated in hospitals with orthogeriatric co-management was observed in both women and men, in different age groups (80–85 years; ≥ 86 years), and in patients with and without care needs (*eFigures 1a–c*). The risk reduction was very similar in these subgroups (*eTable 1a–c*). In residents of nursing homes, orthogeriatric co-

management was associated with only a small additional reduction in risk. In contrast, the association between orthogeriatric co-management and mortality was even stronger in community-living hip fracture patients (rate ratio for adjusted 30-day mortality risk: 0.71 [0.67; 0.76]) (*eFigure 1d*; *eTable 1d*).

Further analysis showed that patients aged 65 to 79 years were also at less risk if they were treated in hospitals with orthogeriatric co-management (rate ratio for adjusted 30-day mortality risk: 0.86 [0.76; 0.96]). However, both the relative and the absolute risk reduction were lower than in patients aged ≥ 80 years (*eTable 2a, b*; *eFigure 2*).

Discussion

Treatment of hip fracture patients in hospitals where orthogeriatric co-management was available was associated with considerably lower mortality. We also observed the lower mortality in subgroups: in both women and men, in different age groups, and in patients with and without care needs. In contrast, orthogeriatric co-management was of only marginal benefit for nursing home residents.

Our results confirm those of recently published observational studies using routine data from Australia,

Denmark, and Italy, in which the reduction in mortality was even somewhat stronger (19–21).

The lower mortality amongst patients treated in hospitals with orthogeriatric co-management probably resulted from a number of different factors:

- First, in hospitals without orthogeriatric co-management, resolution of acute medical problems on the ward may be delayed if the orthopedic surgeon is detained in the operating room.
- Second, medical problems in this group of patients are often of geriatric nature and are therefore better treated by experts in this field.
- Third, the availability of a multidisciplinary geriatric team with experience of evidence-based procedures, specific geriatric interventions, and the possibility of supporting early mobilization may well offer a considerable postoperative survival advantage.

The lower daily mortality rates in hospitals with orthogeriatric co-management were limited to the first 6 weeks after hospital admission (*Figure 2a*). This suggests that the observed difference in mortality was caused by something that happened during this specific time window. The obvious difference between the two groups is the presence or absence of interdisciplinary care in hospitals with or without orthogeriatric co-management. We found no excess mortality later than 6 weeks in the group from hospitals with orthogeriatric co-management that had survived that long. In other words, the survival advantage from the first 6 weeks persisted beyond that time. We estimate that the attributable fraction accounts for about 30 avoided deaths per 1000 hip fractures.

The length of the index hospital stay was clearly higher in hospitals with orthogeriatric co-management. The main reason is that patients from hospitals with orthogeriatric co-management had already received rehabilitative treatment during the index hospital stay. Even though patients from hospitals without orthogeriatric co-management were more likely to take part in subsequent inpatient rehabilitation, the combined mean duration of the index stay and the inpatient rehabilitation was still 2.1 days longer in the group of patients from hospitals with orthogeriatric co-management.

The strengths of the study are the large dataset covering about one-third of all incident hip fractures in Germany in the study period, the exact documentation of the time at risk, and information about care needs and nursing home status on an individual basis. These data are fundamental to the reimbursement of, for example, complex early geriatric rehabilitation and are checked closely. A further strength are the robust findings, which were observed in a similar way in nearly all subgroups and even in younger and not necessarily geriatric patients.

Several types of misclassifications of exposure have to be considered and are a limitation of our study. First, only 44% of the patients in hospitals with orthogeriatric co-management were recorded as

FIGURE 2

Mortality per 10 000 person-days

a

Cumulative mortality (%)

b

Association of orthogeriatric co-management (OGCM) with mortality (a) and cumulative mortality (b) within 180 days after hospital admission in patients with hip fracture, adjusted for age, sex, care needs in the quarter before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and a medication-based comorbidity score

undergoing an OPS8-550 procedure and therefore definitely received interdisciplinary care. However, the code OPS8-550 can only be assigned if the treatment lasts at least 14 days. Some patients may have received orthogeriatric co-management but were discharged or died before 14 days had elapsed and were therefore not coded OPS8-550. Furthermore, patients from hospitals with orthogeriatric co-management benefited from the available structures and expertise even if they did not receive the code OPS8-550. However, it cannot be excluded that some patients from hospitals with orthogeriatric co-management did not receive interdisciplinary care.

TABLE 2

Association of orthogeriatric co-management with cumulative mortality at 30, 60, 90, and 180 days after hospital admission in patients with hip fracture aged ≥ 80 years

		Patients treated in hospitals					
		with OGCM (n = 34 551)		without OGCM (n = 23 450)		With OGCM vs. without OGCM	
Days after admission	Model	Deaths	Cumulative mortality (%)	Deaths	Cumulative mortality (%)	Difference (%) (95% CI)	Rate ratio (95% CI)
30	Crude	3567	10.32	3132	13.36	-3.03 [-3.61; -2.45]	0.77 [0.74; 0.81]
	Adjusted*					-2.48 [-2.98; -1.98]	0.78 [0.74; 0.82]
60	Crude	5402	15.63	4386	18.70	-3.07 [-3.76; -2.38]	0.84 [0.80; 0.87]
	Adjusted*					-2.37 [-2.98; -1.76]	0.85 [0.82; 0.89]
90	Crude	6569	19.01	5209	22.21	-3.20 [-3.96; -2.44]	0.86 [0.82; 0.89]
	Adjusted					-2.44 [-3.12; -1.75]	0.87 [0.84; 0.91]
180	Crude	8751	25.33	6678	28.48	-3.15 [-4.01; -2.28]	0.89 [0.86; 0.92]
	Adjusted*					-2.27 [-3.06; -1.48]	0.91 [0.88; 0.94]

CI, Confidence interval; n, number of patients, subgroup; OGCM, orthogeriatric co-management

* For age, sex, care needs in the quarterly period before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and medication-based co-morbidity score

Second, orthogeriatric co-management is still a new form of care in the German health system and several hospitals only began providing this type of care during our observation period. To exclude the influence of temporal trends, we categorized these hospitals as providing orthogeriatric co-management during the whole observation period. In both cases, we chose rather conservative forms of data analysis.

Third, selection bias from the exclusion of patients who changed treatment type cannot be completely excluded. Furthermore, it was not clear to us why the proportion of patients from nursing homes was higher in hospitals without orthogeriatric co-management. This imbalance, however, did not drive the results; on the contrary, the association between orthogeriatric co-management and mortality was more pronounced if residents from nursing homes were excluded.

To take account of potential confounders, we stratified analyses and adjusted for known risk factors such as age, sex, nursing home status, and time from hospital admission to surgery. As in all observational studies, however, residual confounders, e.g., socioeconomic status, cannot be excluded.

Our results were derived from the German health care system. Orthogeriatric co-management may differ between countries and between health care systems. This affects the external validity of our results. Nevertheless, our data support recent findings from various health care systems which show a clear and impressive advantage of orthogeriatric co-management over traditional systems of care.

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Ethical approval

Because this study comprised analysis of anonymized routine data, it was not considered necessary to request approval from the ethics committee of the University of Ulm.

Conflict of interest statement

Prof. Rapp has received consultancy payments and lecture fees from Amgen.

Prof. Becker has received consultancy payments from Lilly and lecture fees from Amgen, Pfizer, and Nutricia. He has received study support (third-party funding) for Mobilise-D, a project of the European Innovative Medicine Initiative (IMI) that is partly supported by pharmaceutical and technology companies.

Prof. Liener has received consultancy payments from Lilly and lecture fees from Amgen.

Prof. Hartwig has received consultancy payments and lecture fees from Amgen and Lilly, as well as reimbursement of congress registration fees and travel costs from Amgen.

The remaining authors declare that no conflict of interest exists.

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Key messages

- A multidisciplinary orthogeriatric approach is associated with lower mortality in patients with hip fracture.
- The adjusted 30-day mortality was 22% lower for patients in hospitals with orthogeriatric co-management.
- The average total stay in hospital was 41.4 days for orthogeriatric co-management and 39.3 days in the comparative arm
- The attributable fraction accounts for about 30 avoided deaths per 1000 hip fractures.
- The observed difference in mortality was highest immediately after hospital admission and decreased over the first 6 weeks.

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► Supplementary material

For eReferences please refer to:
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eMethods, eTables, eFigures:
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Supplementary material to:

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eMETHODS

Statistical analysis

The patients' characteristics at the beginning of the study were described using means and standard deviations or absolute numbers and percentages. In *Figure 2* and *eFigure 2*, adjusted mortality rates per 10 000 person-days are shown with splines based on Poisson regression models for each group including a time–group interaction term.

This form of calculation allowed the rates to change nonlinearly over time while assuming proportionality between the groups. For determination of the cumulative mortality (in %) the daily mortality rates were accumulated while paying attention to right censoring.

Crude mortality rates were calculated for the periods 30, 60, 90, and 180 days. Rate differences and rate ratios between patients from hospitals with and without orthogeriatric co-management were modeled using Poisson regression and shown with 95% confidence intervals.

All models were adjusted for age, sex, care needs in the quarter before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and a medication-based comorbidity score. Moreover, stratified analyses were performed to investigate differences between men and women, different age groups, patients with/without care needs, and patients living in the community versus nursing home residents.

The intra-class correlation coefficient (ICC) was tested in an intercept-only Poisson model featuring an additional hierarchy level for the hospitals. The ICC was less than 1%, so we dispensed with multi-level models. All calculations were performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA), and R, version 3.4.2 (R Foundation for Statistical Computing, Vienna, Austria).

eFIGURE 1

Association of orthogeriatric co-management (OGCM) with cumulative mortality at 30, 60, 90, and 180 days after hospital admission in patients with hip fracture, stratified by sex (a), age (b), care needs (c), and nursing home status (d)
 Adjusted for age, sex, care needs (yes/no) in the quarter before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and a medication-based comorbidity score

eTABLE 1

Association of orthogeriatric co-management with cumulative mortality at 30, 60, 90 and 180 days after hospital admission in patients with hip fracture aged ≥ 80 years

			Patients treated in hospitals					
			with OGCM (N = 34 551)		without OGCM (N = 23 450)		With OGCM vs. without OGCM	
Stratum	Days after admission	Model	Deaths n/N	Cumulative mortality (%)	Deaths n/N	Cumulative mortality (%)	Difference (%) (95% CI)	Rate ratio (95% CI)
a) Stratified by sex								
Men	30	Crude	1138/7089	16.05	1024/4847	21.13	-5.07 [-6.67; -3.48]	0.76 [0.70; 0.82]
		Adjusted*		14.43		18.91	-4.47 [-5.95; -2.99]	0.76 [0.70; 0.83]
	60	Crude	1640/7089	23.13	1381/4847	28.49	-5.36 [-7.23; -3.48]	0.81 [0.75; 0.87]
		Adjusted*		21.44		26.14	-4.70 [-6.48; -2.92]	0.82 [0.76; 0.88]
	90	Crude	1945/7089	27.44	1578/4847	32.56	-5.12 [-7.14; -3.10]	0.84 [0.79; 0.90]
		Adjusted*		25.70		30.08	-4.37 [-6.31; -2.44]	0.85 [0.80; 0.91]
	180	Crude	2467/7089	34.80	1939/4847	40.00	-5.20 [-7.45; -2.95]	0.87 [0.82; 0.92]
		Adjusted*		32.99		37.28	-4.29 [-6.47; -2.12]	0.88 [0.83; 0.94]
Women	30	Crude	2429/27 462	8.84	2108/18 603	11.33	-2.49 [-3.08; -1.89]	0.78 [0.74; 0.83]
		Adjusted*		7.50		9.58	-2.08 [-2.60; -1.56]	0.78 [0.74; 0.83]
	60	Crude	3762/27 462	13.70	3005/18 603	16.15	-2.45 [-3.18; -1.73]	0.85 [0.81; 0.89]
		Adjusted*		11.98		13.84	-1.87 [-2.51; -1.22]	0.87 [0.82; 0.91]
	90	Crude	4624/27 462	16.84	3631/18 603	19.52	-2.68 [-3.48; -1.88]	0.86 [0.83; 0.90]
		Adjusted*		14.92		16.94	-2.02 [-2.74; -1.30]	0.88 [0.84; 0.92]
	180	Crude	6284/27 462	22.88	4739/18 603	25.47	-2.59 [-3.51; -1.67]	0.90 [0.86; 0.93]
		Adjusted*		20.62		22.44	-1.82 [-2.66; -0.98]	0.92 [0.88; 0.95]
b) Stratified by age (years)								
80–85	30	Crude	1036/14 084	7.36	896/9446	9.49	-2.13 [-2.90; -1.36]	0.78 [0.71; 0.84]
		Adjusted*		5.97		7.84	-1.87 [-2.52; -1.22]	0.76 [0.69; 0.83]
	60	Crude	1608/14 084	11.42	1280/9446	13.55	-2.13 [-3.06; -1.20]	0.84 [0.78; 0.90]
		Adjusted*		9.61		11.41	-1.80 [-2.61; -0.99]	0.84 [0.78; 0.91]
	90	Crude	1961/14 084	13.92	1515/9446	16.04	-2.11 [-3.13; -1.10]	0.87 [0.81; 0.93]
		Adjusted*		11.88		13.67	-1.79 [-2.68; -0.89]	0.87 [0.81; 0.93]
	180	Crude	2698/14 084	19.16	1965/9446	20.80	-1.65 [-2.82; -0.48]	0.92 [0.87; 0.97]
		Adjusted*		16.67		18.04	-1.37 [-2.41; -0.32]	0.92 [0.87; 0.98]
≥ 86	30	Crude	2531/20 467	12.37	2236/14 004	15.97	-3.60 [-4.42; -2.78]	0.77 [0.73; 0.82]
		Adjusted*		10.87		13.90	-3.02 [-3.76; -2.28]	0.78 [0.74; 0.83]
	60	Crude	3794/20 467	18.54	3106/14 004	22.18	-3.64 [-4.62; -2.66]	0.84 [0.80; 0.88]
		Adjusted*		16.89		19.76	-2.87 [-3.78; -1.97]	0.85 [0.81; 0.90]
	90	Crude	4608/20 467	22.51	3694/14 004	26.38	-3.86 [-4.93; -2.79]	0.85 [0.82; 0.89]
		Adjusted*		20.88		23.88	-2.99 [-4.00; -1.99]	0.87 [0.84; 0.91]
	180	Crude	6053/20 467	29.57	4713/14 004	33.65	-4.08 [-5.30; -2.86]	0.88 [0.85; 0.91]
		Adjusted*		27.90		30.92	-3.02 [-4.19; -1.86]	0.90 [0.87; 0.94]

c) Stratified by care needs								
No care needs	30	Crude	756/12 954	5.84	629/8440	7.45	-1.62 [-2.33; -0.90]	0.78 [0.70; 0.87]
		Adjusted*		4.92		6.58	-1.66 [-2.30; -1.01]	0.75 [0.67; 0.83]
	60	Crude	1121/12 954	8.65	876/8440	10.38	-1.73 [-2.58; -0.87]	0.83 [0.76; 0.91]
		Adjusted*		7.55		9.32	-1.77 [-2.55; -0.98]	0.81 [0.74; 0.88]
	90	Crude	1377/12 954	10.63	1039/8440	12.31	-1.68 [-2.62; -0.74]	0.86 [0.79; 0.93]
		Adjusted*		9.37		11.21	-1.84 [-2.71; -0.97]	0.84 [0.77; 0.91]
Care needs	180	Crude	1866/12 954	14.40	1346/8440	15.95	-1.54 [-2.62; -0.47]	0.90 [0.84; 0.97]
		Adjusted*		13.08		14.90	-1.82 [-2.84; -0.80]	0.88 [0.81; 0.94]
	30	Crude	2811/21 597	13.02	2503/15 010	16.68	-3.66 [-4.47; -2.85]	0.78 [0.74; 0.82]
		Adjusted*		11.71		14.98	-3.27 [-4.03; -2.52]	0.78 [0.74; 0.82]
	60	Crude	4281/21 597	19.82	3510/15 010	23.38	-3.56 [-4.54; -2.59]	0.85 [0.81; 0.89]
		Adjusted*		18.60		21.65	-3.05 [-3.98; -2.11]	0.86 [0.82; 0.90]
d) Stratified by nursing home status	90	Crude	5192/21 597	24.04	4170/15 010	27.78	-3.74 [-4.81; -2.67]	0.87 [0.83; 0.90]
		Adjusted*		22.95		26.07	-3.12 [-4.16; -2.08]	0.88 [0.84; 0.92]
	180	Crude	6885/21 597	31.88	5332/15 010	35.52	-3.64 [-4.86; -2.43]	0.90 [0.87; 0.93]
		Adjusted*		30.92		33.78	-2.86 [-4.06; -1.66]	0.92 [0.88; 0.95]
Living in the community	30	Crude	2348/26 288	8.93	2026/16 646	12.17	-3.24 [-3.88; -2.60]	0.73 [0.69; 0.78]
		Adjusted*		7.28		10.19	-2.91 [-3.46; -2.36]	0.71 [0.67; 0.76]
	60	Crude	3557/26 288	13.53	2760/16 646	16.58	-3.05 [-3.81; -2.29]	0.82 [0.78; 0.86]
		Adjusted*		11.49		14.24	-2.75 [-3.43; -2.08]	0.81 [0.77; 0.85]
	90	Crude	4341/26 288	16.51	3273/16 646	19.66	-3.15 [-3.98; -2.32]	0.84 [0.80; 0.88]
		Adjusted*		14.26		17.17	-2.91 [-3.66; -2.16]	0.83 [0.79; 0.87]
Living in a nursing home	180	Crude	5789/26 288	22.02	4202/16 646	25.24	-3.22 [-4.17; -2.27]	0.87 [0.84; 0.91]
		Adjusted*		19.45		22.49	-3.04 [-3.91; -2.17]	0.86 [0.83; 0.90]
	30	Crude	1219/8263	14.75	1106/6804	16.26	-1.50 [-2.77; -0.24]	0.91 [0.83; 0.98]
		Adjusted*		13.39		14.74	-1.36 [-2.54; -0.18]	0.91 [0.83; 0.98]
	60	Crude	1845/8263	22.33	1626/6804	23.90	-1.57 [-3.11; -0.02]	0.93 [0.87; 1.00]
		Adjusted*		21.09		22.49	-1.40 [-2.90; 0.09]	0.94 [0.87; 1.00]
	90	Crude	2228/8263	26.96	1936/6804	28.45	-1.49 [-3.18; 0.20]	0.95 [0.89; 1.01]
		Adjusted*		25.86		27.04	-1.18 [-2.83; 0.48]	0.96 [0.90; 1.02]
	180	Crude	2962/8263	35.85	2476/6804	36.39	-0.54 [-2.47; 1.39]	0.99 [0.93; 1.04]
		Adjusted*		34.91		35.05	-0.14 [-2.06; 1.78]	1.00 [0.94; 1.05]

CI, Confidence interval; N, number of patients, total; n, number of patients, subgroup; OGCM, orthogeriatric co-management

*For age, sex, care needs in the quarter before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and a medication-based comorbidity score

eTABLE 2a

Characteristics of patients with hip fracture aged 65–79 years in hospitals with and without orthogeriatric co-management

	Patients treated in hospitals	
	with OGCM (N = 13 774)	without OGCM (N = 9857)
Patients with OPS-8550; n (%)	4711 (34.2%)	0 (0.0%)
Women; n (%)	8674 (63.0%)	6344 (64.4%)
Age (years); mean (SD)	74.4 (3.9)	74.2 (4.0)
Care needs; n (%)	5376 (39.0%)	3547 (36.0%)
Nursing home resident; n (%)	1764 (12.8%)	1436 (14.6%)
Medication-based comorbidity score; mean (SD)	4.2 (2.1)	4.1 (2.1)
Days from hospital admission to surgery		
0; n (%)	3923 (28.5%)	2993 (30.4%)
1; n (%)	5605 (40.7%)	4111 (41.7%)
2; n (%)	1467 (10.7%)	1037 (10.5%)
≥3; n (%)	1105 (8.0%)	878 (8.9%)
ND; n (%)	1674 (12.2%)	838 (8.5%)
IHS (days); mean (SD)	19.3 (12.5)	15.2 (10.5)
Subsequent inpatient rehabilitation; n (%)	5427 (39.4%)	5106 (51.8%)

IHS, In-hospital stay; N, number of patients, total; n, number of patients, subgroup; ND, no surgery-relevant OPS code found in individual patient level data; OGCM, orthogeriatric co-management; OPS-8550: code for geriatric complex early rehabilitation in the German classification of procedures and operations (OPS); SD, standard deviation

eTABLE 2b

Association of orthogeriatric co-management with cumulative mortality at 30, 60, 90, and 180 days after hospital admission in patients with hip fracture aged 65–79 years

		Patients treated in hospitals					
		with OGCM (n = 13 774)		without OGCM (n = 9857)		With OGCM vs. without OGCM	
Days after admission	Model	Deaths	Cumulative mortality (%)	Deaths	Cumulative mortality (%)	Difference (%) (95% CI)	Rate ratio (95% CI)
30	Crude	704	5.11	544	5.52	–0.41 [–1.01; 0.19]	0.93 [0.82; 1.03]
	Adjusted*					–0.63 [–1.13; –0.14]	0.86 [0.76; 0.96]
60	Crude	1045	7.59	795	8.07	–0.48 [–1.20; 0.25]	0.94 [0.85; 1.03]
	Adjusted*					–0.75 [–1.37; –0.13]	0.89 [0.81; 0.98]
90	Crude	1321	9.59	964	9.78	–0.19 [–0.99; 0.62]	0.98 [0.90; 1.06]
	Adjusted*					–0.61 [–1.30; 0.09]	0.93 [0.85; 1.01]
180	Crude	1852	13.45	1323	13.42	0.02 [–0.92; 0.97]	1.00 [0.93; 1.07]
	Adjusted*					–0.56 [–1.39; 0.26]	0.95 [0.88; 1.02]

CI, Confidence interval; OGCM, orthogeriatric co-management

*For age, sex, care needs in the quarterly period before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and medication-based co-morbidity score

eFIGURE 2

Mortality per 10 000 person-days

a

Cumulative mortality (%)

b

Association of orthogeriatric co-management (OGCM) with mortality (a) and cumulative mortality (b) within 180 days after hospital admission in patients with hip fracture aged 65–79 years

Adjusted for age, sex, care needs (yes/no) in the quarter before the fracture (Q-1), nursing home status in Q-1, number of hip fracture patients per hospital per year, days from hospital admission to surgery, and a medication-based comorbidity score