European Journal of Ophthalmology / Vol. 17 no. 4, 2007 / pp. 557-564

Health care supply for cataract in Austrian public and private hospitals

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PURPOSE. *This study aims to explain spatial variability or cataract and cataract surgery in Austria. The effect of the availability of health care services on spatial variation is investigated.*
METHODS. *A retrospective study, using routine hospital data from all Austrian public and private hospitals. Calculation of age- and gender-standardized hospitalization ratios (SHR) for all 121 Austrian districts. Poisson regression for age-specific relative risks was performed.*
RESULTS. *The authors found high regional variability between districts and significant differences in the hospitalization rates of cataract disease and extraction between men and women. There was a significant correlation between standardized hospitalization ratios for districts and the availability of hospitals with departments of ophthalmology. There was a significant difference in length of stay for patients with cataract surgery between public and private hospitals.*
CONCLUSIONS. *Use of routine hospital data in geographic analysis allows large regional studies on health care supply for cataract surgery. Differences in the supply by hospitals between districts depend on the availability of hospitals with departments of ophthalmology. The overall demand for cataract surgery in Austria finds its proper supply in many Austrian regions, but needs further development. (Eur J Ophthalmol 2007; 17: 557-64)*

KEY WORDS. *Cataract surgery, Routine hospital data, Spatial variation*

Accepted: January 6, 2007

INTRODUCTION

Cataract, which refers to a clouding of the crystalline lens of the eye, is the leading cause of visual impairment worldwide (1) and cataract surgery is one of the most common interventions worldwide and also in Austria (2). Cataract is an age-related problem (3). The 5-year incidence of cataract surgery for people aged 50 years and older is about 5.7% in Australia (4) and 6.3% in the United States (4, 5) and seems to grow (6). For these reasons the health care supply for cataract should be as exhaustive as possible. The cataract surgery rate (CSR) for Austria is about 6569 per million inhabitants.

Indicators for health care demand and supply concerning cataract can be the hospitalization rates of patients with cataract diagnosis and with a cataract surgical procedure. The hospitalization rates of cataract and cataract surgery in Austria can be estimated using routine hospital data that document the number of all hospital admissions within Austria during recent years. Routine information like age, gender, postal code, citizenship, main and additional diagnoses, and surgical procedures are documented for every patient. All these data comprise the Minimum Basic Dataset (MBDS), which is routinely documented in Austrian hospitals for reimbursement.

The MBDS of public hospitals for 2001 and of public and private hospitals for 2002 was used for this study. Data from private hospitals for 2001 were not available.

Using these datasets, analysis on health care supply for cataract was carried out. The principal aims were to detect geographic variations in the hospitalization of patients with cataract as a diagnosis and as a surgical pro-

 1120-6721/557-08$15.00/0

cedure. In a second step, we tried to explain possible differences in demand for and supply of cataract treatment to evaluate the Austrian health care system.
Differences between public and private hospitals concerning length of stay (LOS) are investigated. Further, we compared these two types of hospitals regarding the percentage of interventions in hospitals with and without departments of ophthalmology.
In this context the question was addressed how a single hospital can have an impact on the number of cataract diagnoses and procedures in nearby areas. For this reason differences in hospitalization between hospitals were investigated. In our analyses we focused on the differences between public and private hospitals as well as on the variability within these two groups.
Differences in hospitalization can arise from convention, financial reasons, or misclassification in coding (7). They have to be assessed for providing a better interpretation of routine hospital data. The influence of a single hospital on the hospitalization rates of cataract disease and surgery in a district may depend on the capacity of the hospital and its distance to the district. This information also can be deduced from the MBDS.
Differences between public and private hospitals concerning LOS are investigated. Further, we compared these two types of hospitals regarding the percentage of interventions in hospitals with and without departments of ophthalmology.

METHODS

Data sources

The MBDS of the Austrian Diagnosis Related Groups (DRG) system of 2001 and 2002 were used for analyses. For every inpatient admitted to an Austrian hospital, these datasets contain demographic information, information about main and additional diagnoses according to the International Statistical Classification of Diseases and Related Health Problems (10th Revision; ICD-10), and information on surgical procedures. Data were made anonymous and every hospital admission was assigned to a unique code.
Data were available from public hospitals for both years and from private hospitals for 2002. Data are complete with regard to all inpatient admissions in Austria because these data are also used for reimbursement according to the Austrian DRG system. For this special analysis data of private hospitals are very important because many cataract procedures are done in these hospitals.
Population data on the district level were obtained from Statistic Austria (8). Data were split in 5-year bands, from 0–4 to 95+ years for men and women. These data referred to the census of 2001.

Study population and hospitals

The study population includes all Austria resident inpatients of public hospitals in 2001 and of public and private hospitals in 2002 who were diagnosed with cataract as main or additional diagnosis according to ICD-10 or underwent cataract surgery. Medical procedures are documented according to the Austrian catalogue of procedures as MEL (Medizinische Einzelleistung, i.e., single medical procedure).
The ICD-10 codes for the diagnoses under investigation are as follows: H25.-, H25.0, H25.1, H25.2, H25.8, H25.9, H26.-, H26.0, H26.1, H26.2, H26.3, H26.8, H26.9, H28.-, H28.0, H28.1, Q12.0.
Surgical procedures for cataract extraction were identified according to the Austrian catalogue of procedures. We used MEL number 1554 (cataract surgery with implantation of an intraocular lens) and MEL number 1555 (extracapsular cataract extraction using controlled irrigation/aspiration or phacoemulsification and implantation of an intraocular lens) for our analyses.
For comparisons with results from other studies calculations were done only on patients aged 50 years and older.
All public hospitals supplied the MBDS in 2001 (n=145) and in 2002 (n=144). The documentation of private hospitals (n=38) is available for 2002 as well. Twenty-nine of the public and four of the private hospitals have a special department of ophthalmology and optometry.

Statistical methods

Regional comparisons regarding hospitalization were done on the district level (all 121 Austrian districts); hospitals were compared with each other regarding cataract diagnoses and surgery.
Regional analyses were done first on the number of hospital admissions and additionally on the number of persons admitted to hospital. Date of birth, postal code, citizenship, and gender were used as pseudonym of a person. Hospital-dependent investigations were done on

the number of admissions.

Crude hospitalization rates (HRs) and standardized hospitalization ratios (SHRs) were calculated on district level according to indirect standardized mortality rates (9). Standardization was necessary because age and gender distribution highly varies between districts' populations. Standardization was done using the weights of the distribution of the Austrian population (8). Poisson regression was performed for the age-specific relative risks for genders. These investigations were done on the number of admitted persons.

Ninety-five percent confidence intervals (CI) were calculated for the means of length of stay using bootstrap methods and for hospital comparisons using survey estimation. Calculations were done using the statistical program StataSE7.0.

For comparison of LOS between public and private hospitals we calculated a log-rank test. We compared the LOS of all patients between public and private hospitals. In a second step we included only patients with a LOS <7 days. This restriction came from the fact that 6 days is the defined upper limit for a normal period for cataract surgery in the Austrian DRG system. Spearman's correlation coefficient was calculated with SPSS12.

Hospitals' availability was defined by the percentage of the cataract procedures done in the hospitals of that district. Regional patterns of the SHRs of cataract and of cataract surgery were visualized using RegioGraph 6.0. We used five percentiles, based upon a deviation of 25% and 10% from the all over Austrian HR.

RESULTS

Diagnoses: Hospital admissions/persons

Table I shows descriptive statistics of cataract diagnoses and cataract surgery for 2001 and 2002. In 2002 the number of admissions with cataract diagnoses was 58,857 in public hospitals (47,750 [81.13%] main diagnoses). We identified 47,797 persons with cataract diagnosis. The average age was 73.81(±10.81). A total of 30,293 (63.37%) were female. The age-specific HRs are shown in Table II. The standardized female/male ratio is 1.04 (1.02; 1.05). The relatively most affected age group was the 80- to 84-year-olds among both men and women. Considering the

TABLE I - BASELINE STATISTICS FOR CATARACT AND CATARACT SURGERY IN AUSTRIA IN 2001 AND 2002

Diagnoses	2001 public hospitals, admissions	2001 public hospitals, persons	2002 public hospitals, admissions	2002 public hospitals, persons	2002 private hospitals, admissions	2002 private hospitals, persons
No. cases	59,597	48,443	58,857	47,797	6480	5100
Main diagnosis	47,614		47,750		6118	
Men	21,840	17,802	21,552	17,506	2210	1778
Women	37,757	30,641	37,305	30,291	4270	3322
Mean age ± standard deviation, yr	73.9±10.9	73.88±10.89	73.77±10.86	73.81±10.81	75.01±9.4	74.9±9.62
Men: relatively most affected age group, yr	80-84		80-84			
Women: relatively most affected age group, yr	80-84		80-84			
Procedures						
No. cases	46,093	38,962	46,656	39,560	6104	4818
Double interventions	2804	2792	1218	1212	71	71
Two single interventions within one staying period	193	6972	2057	8773	80	1337
One staying – one procedure	43,096	29,107	43,391	29,457	5953	3397
Mean age ± standard deviation, yr	73.94±10.69	73.87±10.8	73.88±10.56	73.86±10.63	74.73±9.82	74.6±10.07
Women		29,476		29,931		4004
Men		16,617		16,725		2100

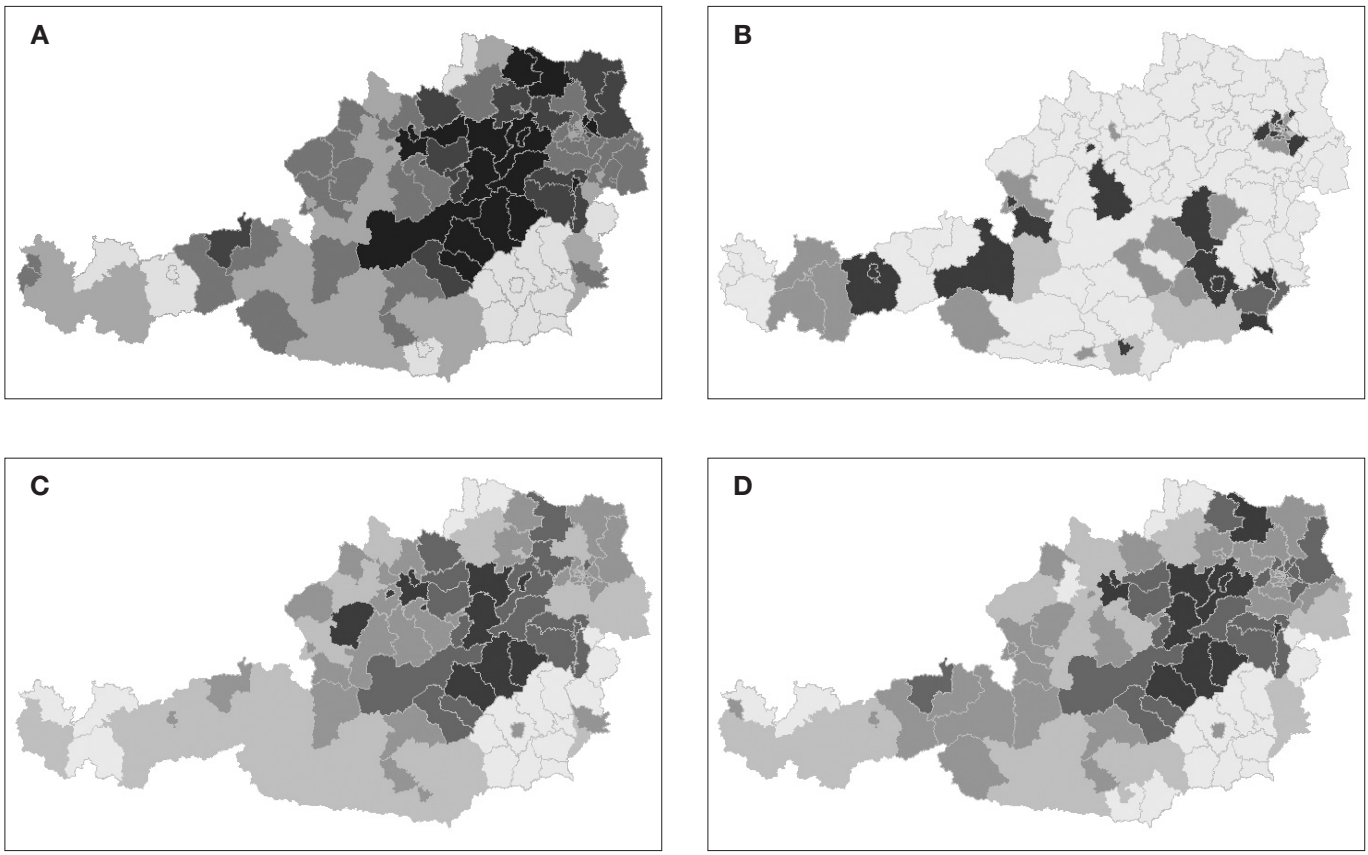

Fig. 1 - *Standardized hospitalization ratios for cataract diagnosis and cataract surgery:* **(A)** *cataract surgery in public hospitals in 2002;* **(B)** *cataract surgery in private hospitals in 2002;* **(C)** *cataract diagnosis in Austria in 2002;* **(D)** *cataract surgery in Austria in 2002.*

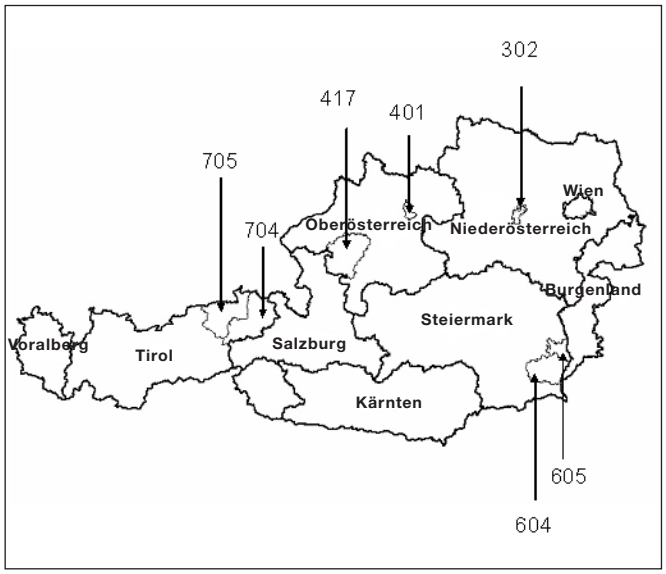

Fig. 2 - *The nine Austrian provinces and some selected districts.*

regional distribution of cataract in Austria, high variation between districts was found (Fig. 1C). While the SHR of cataract diagnoses in public hospitals was above average in Lower Austria (Niederösterreich) and in parts of Upper Austria (Oberösterreich), it was lower than the all over Austrian mean in the southern and western parts of Austria. There was a high supply from private hospitals in towns, in Tyrol (Tirol), Salzburg, and Styria (Steiermark).

Cataract surgery (hospital admissions/persons)

The surgical procedures MEL 1554 and MEL 1555 (Tab. I) were performed for 46,656 admissions in 40 Austrian public hospitals in 2002.

The HRs for cataract surgery are shown in Table II. Visualization of the geographic distribution of the SHRs showed high variations in the Austrian health care supply (Fig. 1, A

and B). The highest supply from public hospitals was found in Lower Austria and in the northern Austrian regions in both years. In Western Austria the highest supply was found in districts 704 and 705 (Fig. 2). The health care supply with cataract surgery from private hospitals was above average in all major towns. A high frequency of cataract interventions in private hospitals was found in Tyrol (Tirol), in parts of Salzburg, in Styria (Steiermark), and in Vienna (Wien). All together there was a high supply of cataract surgery in the middle of Eastern Austria in 2002. Parts of Styria (Steiermark) and the South-West of Austria had a low supply.

Hospitals

Statistics on hospitalization in Austrian hospitals are shown in Table III.

In 2002, cataract was diagnosed in 132 hospitals, 90.98% of the diagnoses made in hospitals with departments of ophthalmology. A total of 58.84% of all patients of these

TABLE II - ONE-YEAR HOSPITALIZATION RATE (HR) FOR CATARACT AND CATARACT SURGERY IN ALL AUSTRIAN HOSPITALS IN 2002

	Diagnoses				Surgery			
Age group, yr	**HR women**	**HR men**	**RR**	**95% Confidence interval**	**HR women**	**HR men**	**RR**	**95% Confidence interval**
0–50	0.02	0.03	0.80	0.72; 0.89	0.02	0.03	0.82	0.73; 0.91
50–55	0.21	0.25	0.84	0.75; 0.94	0.17	0.21	0.8	0.71; 0.91
55–60	0.41	0.53	0.76	0.70; 0.83	0.34	0.45	0.75	0.7; 0.82
60–65	0.83	0.88	0.94	0.89; 1.01	0.68	0.72	0.95	0.88; 1.02
65–70	1.66	1.46	1.13	1.07; 1.20	1.36	1.17	1.17	1.1; 1.24
70–75	3.00	2.63	1.14	1.09; 1.19	2.55	2.17	1.17	1.12; 1.23
75–80	4.78	4.35	1.10	1.06; 1.14	4.12	3.66	1.12	1.08; 1.17
80–85	6.87	6.30	1.09	1.04; 1.14	5.87	5.46	1.08	1.03; 1.13
85–90	4.57	4.89	0.94	0.88; 1.00	3.79	4.01	0.95	0.88; 1.02
90–95	3.69	4.30	0.86	0.76; 0.97	2.83	3.28	0.86	0.75; 0.99
95+	2.05	3.27	0.80	0.44; 0.90	1.46	2.31	0.63	0.41; 0.96
Overall HR	0.81	0.49			0.68	0.41		
Age-adjusted proportion women/men			1.04	1.02; 1.05			1.05	1.03; 1.08

TABLE III - CATARACT AND CATARACT SURGERY IN AUSTRIAN HOSPITALS

	2001 Public	**2002 Public**	**2002 Private**
No. hospitals	145	144	38
No. departments of ophthalmology	29	29	4
% of all diagnoses made in such departments	91.23	90.98	30.87
% of all procedures done in such departments	95.44	94.45	31.47
Average no. interventions in departments of ophthalmology	1483.5	1480.1	476.5
No. hospitals with at least one diagnosis	136	132	24
No. hospitals with at least one procedure	41	40	18
% Patients with cataract of all patients in department of ophthalmology	59.77	58.84	71.97
% Patients with cataract procedures of all patients in department of ophthalmology	52.4	52.11	70.57
% Cataract procedures of all procedures in department of ophthalmology	46.89	46.33	72.09

departments had a cataract diagnosis and 52.11% underwent cataract surgery. A total of 46.33% of all medical procedures in these departments were documented as cataract surgery. Cataract surgery was performed in 40 public hospitals in 2002 (94.45% in hospitals with departments of ophthalmology).

In 2001 in public hospitals, 6.5% (0.33; 12.67) of the patients had a cataract intervention in both eyes during one stay, and 93.5% (87.33; 99.67) of the patients had one intervention. A total of 0.7% (0; 1.54) of the patients left the hospital at the same day, 6.54% (1.13; 11.96) left it after 1 night, and 92.76% (87.16; 98.36) stayed in the hospital for at least 2 nights. The rates for cataract intervention in both eyes and for one single intervention were 7.01% (0.75; 13.29) and 92.98% (86.71; 99.25) in public hospitals in 2002. In private hospitals, these rates were 2.47% (0; 5.91) and 97.53% (94.09; 100). In the same year, 1.12% (0; 2.56) of the patients left the hospital on the day of the intervention, 7.41% (1.41; 13.41) left after 1 night, and 91.47% (85.11; 97.83) stayed there for at least 2 nights. The same rates for private hospitals were 4.7 (0; 1.36), 36.31 (6.42; 66.21), and 58.98 (30.01; 87.96).

In public hospitals the average LOS for patients with cataract surgery was 4.42 (4.4; 4.45) in 2001 and 4.21 (4.18; 4.23) in 2002; it was 2.97 (2.91; 3.02) in private hospitals in 2002. The average LOS for the 2997 patients with two interventions within one inpatient period in public hospitals in 2001 was 6.45 (6.30; 6.58) days; 6.22 (6.08; 6.38) days for the 3275 patients with two interventions within one staying period in public hospitals in 2002; and 5.51 (4.98; 6.04) days for the 151 patients with two interventions within one staying period in private hospitals in 2002. Comparing LOS between public and private hospitals by log-rank test yielded a significant difference ($p<0.001$). Including only patients with a LOS < 7 days also yielded a significant difference ($p<0.001$).

Correlations

The correlation coefficient r between the SHRs of cataract disease and surgery in the districts was 0.804 ($p<0.001$) in public hospitals in 2001, 0.844 ($p<0.001$) in public hospitals in 2002, 0.997 ($p<0.001$) in private hospitals in 2002, and 0.837 ($p<0.001$) in all Austrian hospitals in 2002. The correlation coefficient between the diagnoses in public hospitals over the 2 years was about 0.886 ($p<0.001$) and between the cataract surgeries 0.886 ($p<0.001$). The comparison of public and private hospitals showed a slightly negative correlation for cataract ($r=–0.264$, $p<0.001$) and cataract surgery ($r=–0.234$, $p<0.001$). We found a positive correlation (0.233; $p<0.001$) between the SHRs of cataract surgery of 2002 and the availability of hospitals in districts. The correlation for private hospitals alone was 0.417 ($p<0.001$); for public hospitals alone there was no significant correlation between the SHRs of cataract surgery in 2002 and the availability of hospitals. There was a significant correlation (0.423; $p<0.001$) between the availability of public and of private hospitals as well.

DISCUSSION

Since documentation of hospital data became obligatory in the recent years, the use of routine data in health care supply research has become popular (10). Thus, very large and complete datasets are available for regional statistical comparisons. The MBDS data reflect the real amount of hospital admissions in Austria. HRs can be interpreted as incidence rates and SHRs as relative risks. Further, not only regional analyses of diseases can be done, but hospital-based comparisons as well. Since age and sex are documented in the MBDS for every patient, we can standardize the HRs for these factors. Other socioeconomic data were not available on the patients' level. This lack of information is one of the main disadvantages of the use of routine data for epidemiologic investigations (11). Risk factors for cataract (12, 13) like current smoking and large drusen were not available and factors like educational standard, diabetes disease, and sunlight exposure were only available aggregated on the district level. This means some loss of information in the context of explaining regional imbalance. Further, no information on former patients' conditions and diseases were available (14, 15), so we could not define inclusion or exclusion criteria. Also, we did not have general criteria for the diagnosis of cataract disease. Data could be biased, since different practicing eye doctors may use a different labeling of the disease. For this reason it was important to assess the influence of hospitals with departments of ophthalmology. Since we have an exact knowledge of the hospitalization numbers of Austrian hospitals, we had the possibility to explain the impact of the availability of hospitals on the SHR of a district. For these reasons we focused in our analyses on the influence of the hospitals with departments of ophthalmology on cataract and cataract surgery and decided not to eval-

uate socioeconomic factors.

SHRs of cataract and cataract surgery led to the statement that there is a lack of supply in some parts of Austria. We found a correlation between the SHRs of the districts and the availability of the hospitals with departments of ophthalmology within these districts. Since no better availability function is available, the impact of the nearest care units on a districts' SHR may be higher than we found in this analysis. In a further step, distance functions, considering the difficult geographic situation in alpine regions, have to be modeled.

Another factor may be the regional distribution of general practitioners and ophthalmologists and their interaction with the hospitals. Getting these data completely on the district level is not possible.

We used five categories for the graphical presentation of the regional variability of SHRs that are similar to quintiles on the one hand and visualize relevant differences in health care demand and supply on the other.

SHRs for private hospitals showed a high supply in large cities, in Tyrol (Tirol), parts of Salzburg, and parts of Styria (Steiermark). The maps showed that private hospitals took part in the supply of cataract surgery and the correlation coefficient between demand and supply was very high. This means that the demand of cataract surgery found its proper supply. The correlation coefficient for public hospitals indicates a slight imbalance between demand and supply.

The negative correlation between the SHRs of cataract surgery of public and private hospitals led to two possible hypotheses. We can suppose that districts with a low, maybe not exhaustive health care supply for cataract surgery from public hospitals got their supply from private hospitals. On the contrary, the availability of supply from private hospitals may cause a lower usage of public hospitals.

We found a high percentage of cataract diagnoses and surgical procedures in private hospitals without departments of ophthalmology. This may be explained by the fact that many practicing eye doctors did surgical procedures in private hospitals as well.

Significant differences in LOS between public and private hospitals were found. A total of 5.4% of the patients from public hospitals with cataract surgery had a LOS above the upper limit of 6 days of our DRG system. Public hospitals often did additional procedures during one staying period. Analyses of patients with LOS <7 days only still showed a significant difference between public and private hospitals. Private hospitals had a significantly shorter LOS. This may reflect differences in the management of the two hospital types. This phenomenon can be found in other studies (16). We found a higher number of double interventions or two single interventions within one staying period in public hospitals. The difference between public and private hospitals was not significant. CIs were very large. This fact results from the high variability in clinical practice between hospitals.

The use of the MBDS for epidemiologic analyses caused the problem that no unique personal identifier was available. A person at the hospital more than once could not be identified as the same one. For identification at the person level we used date of birth, gender, postal code, and citizenship as reference key. This still caused an error, but this strategy was necessary since many persons are admitted to the hospital for cataract diagnosis or surgery several times.

Comparison between genders showed a significant difference. There were significant differences between genders in the prevalence of cataract in white patients (1, 17) and in hospitalization (3, 4). This could be a trend among women to consult hospitals or practitioners more often.

Comparisons of our results with the results of the Beaver Dam Eye Study (BDES) and the Blue Mountain Eye Study (BMES) (4) showed significantly higher incidence rates for cataract surgery in people aged 50 years and older in Austria. We found a HR of 1.619 (1.603; 1.634). The incidence rate in the BMES is 1.14 and 1.26 in the BDES. Those results come from large follow-up studies and reflect the real distribution and incidence of cataract in those countries. The use of routine hospital data led to an underestimation of the rates, since no personal ID was assigned to Austrian inpatients and data of outpatient care were not available. Thus, we can say that the overall health care supply for cataract in Austria was higher than in comparable countries.

There were no data available from persons who had a diagnosis or an intervention abroad. This fact could cause some bias, especially in boarder regions.

Medical diagnosis and therapy is freely available for most people in Austria (>99%). The elderly population will increase in the future, and an even higher number of patients requiring cataract surgery will result. There is increasing demand of patients to have good visual acuity that enables them to stay mobile (drive cars) and to manage reading tasks (newspaper, Internet). The results of this study demonstrate that many regions in Austria are able to

meet the demand for cataract surgery today and in the future. However, in other areas measures should be taken to be able to provide this needed health care service.

Proprietary interest: None.

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