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ORIGINAL ARTICLE

Regional differences in healthcare costs at the end of life: an observational study using Swiss insurance claims data

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Abstract

Objectives We evaluated healthcare cost differences at the end of life (EOL) between language regions in Switzerland, accounting for a comprehensive set of variables, including treatment intensity.

Methods We evaluated 9716 elderly who died in 2014 and were insured at Helsana Group, with data on final cause of death provided by the Swiss Federal Statistical Office. EOL healthcare costs and utilization, ≥ 1 ICU admission and 10 life-sustaining interventions (cardiac catheterization, cardiac assistance device implantation, pulmonary artery wedge monitoring, cardiopulmonary resuscitation, gastrostomy, blood transfusion, dialysis, mechanical ventilation, intravenous antibiotics, cancer chemotherapies) reimbursed by compulsory insurance were examined.

Results Taking into consideration numerous variables, relative cost differences decreased from 1.27 (95% CI 1.19–1.34) to 1.06 (CI 1.02–1.11) between the French- and German-speaking regions, and from 1.12 (CI 1.03–1.22) to 1.08 (CI 1.02–1.14) between the Italian- and German-speaking regions, but standardized costs still differed. Contrary to individual factors, density of home-care nurses, treatment intensity, and length of inpatient stay explain a substantial part of these differences.

Conclusions Both supply factors and health-service provision at the EOL vary between Swiss language regions and explain a substantial proportion of cost differences.

Keywords End-of-life care · Health care costs · Cause of death · Regional variation · Claims data · Intensity of treatment

Introduction

As the population ages and number of patients with at least one chronic disease grows, end-of-life (EOL) care is becoming increasingly important. Population aging is associated with increased demand for intensive care among elderly patients (Flaatten et al. 2017). Yet, previous research has shown that treatments and costs at the EOL vary widely between regions, internationally (Hanchate et al. 2009; Sprung et al. 2003) and in Switzerland, where

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considerable variations exist between language regions (Bähler et al. 2016; Busato and Künzi 2008; Matter-Walstra et al. 2016; Panczak et al. 2017). Differences in healthcare utilization and costs between language regions are highly complex, potentially arising from cultural variations in the healthcare system (supply, density of healthcare providers, tariffs for ambulatory, and stationary services) and individuals (i.e., lifestyle, family support, expectations, and attitudes of patients and healthcare providers toward health and healthcare). These variations may lead to different healthcare services use, like length of hospital stay or intensity of treatments.

Switzerland poses the unique opportunity to examine cultural aspects in healthcare utilization in people living in relative proximity. Better understanding of possible regional differences in healthcare utilization and costs incurred by decedents may help to identify and potentially reduce factors related to unwarranted differences in medical supply. Findings also may help interpreting international differences. Indeed, differences in cause-specific mortality risks appear to mirror differences between Germany and France in several respects (Faeh et al. 2009). We therefore aimed to examine variations in healthcare costs and utilization by language region, thereby accounting for various individual, sociodemographic, and system-related factors.

Methods

Study design and study population

This is a claims data-based observational study of an elderly Swiss population insured by the Helsana Group, which ensured about one-fifth ($\sim$ 18%) of all Swiss decedents in 2014, $\geq$ 65 years old at the time of death. Data on the main cause of death from death certificates were provided by the Swiss Federal Statistical Office. Merging was performed on the premises of the Swiss Federal Statistical Office using predefined key variables.

Overall, 10,166 elderly decedents were eligible. Of these, 67 (0.7%) were excluded for missing data (e.g., used to live abroad or dropped out in the last 6 months of life (L6MOL)). Another 383 (3.8%) were excluded due to an unknown cause of death or because they were lost merging the two datasets, leaving 9716 decedents for analysis.

Measures

The main outcome of the study was individual healthcare costs for the three language regions. Total healthcare costs comprised inpatient costs (acute hospitals, psychiatric hospitals, inpatient rehabilitation centers, nursing homes, transitional-care services, emergency-transport services) and outpatient costs (office-based primary-care physician and specialist visits, hospital outpatient visits, paramedical visits, home-care nursing services, laboratory tests, medical devices, medications) covered by mandatory health insurance. The canton-specific subsidy rate, which equals $\sim$ 55% of stationary services (acute hospitals, psychiatric hospitals, an inpatient rehabilitation centers), was also considered. Tariffs, therefore costs, for the same healthcare service differ between cantons and institutions in the ambulatory and stationary setting in Switzerland. These different tariffs are not due to variations in healthcare utilization and must be equalized, with tariffs per canton standardized to a national value (e.g., in the outpatient sector, the tariff for general practitioner and specialists (TARMED) varies in its cantonal reference cost value (Taxpunktwert) from 0.80 to 0.97 Swiss Francs (CHF)). A mean reference cost value was calculated as CHF 0.8815. All such costs were then recalculated as if the mean reference cost value was used instead of actual values. The same calculation scheme was applied to the reference cost value of physiotherapists using the tariff Physioswiss, outpatient care of hospitals again with the tariff TARMED, inpatient care of acute hospitals with the base rate and subsidy rate from the cantons. We did not consider the following costs, not covered by mandatory health insurance: out-of-pocket payments, depending on the chosen deductible level, and an additional private premium, limited to a maximum 20% of nursing services costs in nursing homes. According to recent intern analysis, out-of-pocket payments for mandatory health insurance comprise $\sim$ 1.5% of total costs. All costs are quoted in Swiss Francs (1 CHF = 1.037 US$, and 1 CHF = 0.83 Euro; both effective December 2014).

Based on previous research on end-of-life care, several individual, regional, and system-related variables were included (Bähler et al. 2016, 2018). The following individual patient characteristics were considered in analysis: age group (65–74, 75–84, 85+ years), sex, cause of death, place of death (hospital, nursing home, or home/others, determined by the last claim received), health-insurance plan (being in a managed-care model, having a higher deductible, or having supplementary hospital insurance) and family size (living in a single household). Claims contain the date and duration of the specific treatment, which allowed us to compare it with date of death. If several claims covered the date of death, the hospital was considered place of death. Language region (German, French, Italian) and type of residence (urban vs. rural) were included as regional factors. Thereby, the Rhaeto-Romanic region (hosting $<$ 1% of inhabitants) was assigned to the German region. Purchasing power (per residence zip code) was included as a sociodemographic indicator. Standardized data on purchasing power were based on the statistical report of the international polling institute GFK and were divided into quintiles. The following system-related factors

were included in analysis: cantonal density of hospital beds and nursing-home beds, and density of home-care nurses and ambulatory care physicians at the cantonal level. Information on system-related factors was derived from hospital statistics (KS), statistics on social medical institutions (SOMED), and statistics on home-care services (SPITEX), all administered by the Swiss Federal Statistical Office. Physician density information was provided by the Swiss Medical Association (FMH).

To clarify cost variations between the language regions at the EOL, we further examined healthcare services use. At least one ICU admission and the following 10 intensive life-sustaining interventions, defined by Hanchate et al., were used as intensive treatment measures: cardiac catheterization, cardiac assistance device implantation, pulmonary artery wedge monitoring, cardiopulmonary resuscitation/cardiac conversion, gastrostomy (for artificial nutrition), blood transfusion, dialysis, use of mechanical ventilators, intravenous antibiotics, and cancer chemotherapies in the L6MOL (Hanchate et al. 2009). These indicators of intensive EOL care originate from administrative data like claims data and have since been used by others (Hanchate et al. 2009; Kwok et al. 2011; Yarnell et al. 2017). Additional healthcare utilization measures included length of hospital and length of nursing-home stay in the L6MOL.

Statistical analysis

Descriptive statistics were calculated. A generalized linear model with gamma distribution was used to model healthcare costs. Log transformation was applied to account for the nonlinear relationship between predictors and costs by adding a constant to the response variable: log(Y + a), where $a = 100$. Exponentials of coefficients [Exp (β)] are presented. The following parameters were successively added: language region (model a), sex, age group, and single household (model b), type of residence and purchasing power (model c), health-insurance plan (model d), cause of death (model e), place of death (model f), cantonal density of hospital beds, nursing-home beds, home-care nurses, and physicians (model g), intensive treatments and ICU admission (model h), and length of hospital and nursing-home stays (model i). All analyses were conducted using R version 3.6.1.

Results

Median (IQR) age of the decedents was 83(12) years in men and 87(11) years in women ($p < 0.001$). Patients in the French- and Italian-speaking regions were slightly older, more often died of respiratory or nervous system disease, and were more and less likely to die in hospital and nursing home, respectively, than patients in the German-speaking region. No sex-related differences were found. Deceased from the German-speaking region more often chose supplementary hospital insurance and managed-care models. In that same region, densities of nursing-home beds and home-care nurses were highest, while density of hospital beds was highest in the Italian-speaking region (Table 1).

Almost one-third (32.3%) of all patients had at least one intensive procedure at the EOL (Table 2). Blood transfusion and ICU admission were the most, and pulmonary artery monitoring and cardiac assistance device implantation least common. The proportion of decedents with at least one intensive procedure at the EOL did not differ between language regions, though dialysis and mechanical ventilation were slightly more common in the Italian-speaking region. Versus the French-speaking region, patients in the Italian- and German-speaking regions more often had at least one ICU admission in the L6MOL.

Decedents from the French- (1.27, 95% CI 1.19–1.34) and Italian-speaking (1.12, 1.03–1.22) regions generated significantly higher crude total standardized costs, whereby inpatient and outpatient costs were highest in the French-speaking region (Table 3). Cost differences in the ambulatory setting arose from significantly higher average costs for medications in the French-speaking region (CHF = 2580 in the French- versus CHF = 2290 and CHF = 2120 in the German- and Italian-speaking regions, respectively), while costs by specialists were comparable. Similarly, higher mean costs in the Italian-speaking region were found for primary-care physicians (CHF = 900, 790 and 830 in the Italian- German- and French-speaking regions, respectively) and for home-care nursing (CHF = 1400, 1040 and 1190). Regarding inpatient costs in patients with at least one admission, mean costs by acute hospitals were highest in the French-speaking region (CHF = 39,900 in the French- versus 33,750 and 32,710 in the Italian and German-speaking regions), and costs by nursing homes were highest in the Italian-speaking region (CHF = 6280 in the Italian versus 4690 and 5320 in the German- and French-speaking region). However, the distribution of nursing-home costs was particularly skewed, which is why the higher costs in the Italian region mainly resulted from a low proportion of patients generating very high costs.

In the L6MOL, patients in the French- and Italian-speaking regions spent significantly more days in an acute hospital and fewer in a nursing home (Table 4). Unsurprisingly, those patients were more likely to die in hospital and less likely to die in the nursing home versus patients in the German-speaking region (Table 1). Differences were more pronounced between the French- and German-speaking regions than between the Italian- and German-

Table 1 Characteristics of the study population by language region (n = 9716), Switzerland, 2014

Characteristics n (%)	Total 9716	German 7414 (76.3)	French 1532 (15.8)	Italian 770 (7.9)	P[a]
Female sex	5387 (55.4)	4075 (55.0)	870 (56.8)	442 (57.4)	0.222
Age group					0.014
65–74	1443 (14.9)	1122 (15.1)	209 (13.6)	112 (14.5)	
75–84	3033 (31.2)	2363 (31.9)	458 (29.9)	212 (27.5)	
85+	5240 (53.9)	3929 (53.0)	865 (56.5)	446 (57.9)	
Single household	7258 (74.7)	5504 (74.2)	1214 (79.2)	540 (70.1)	< 0.001
Type of residence (urban)	3162 (32.5)	2356 (31.8)	523 (34.1)	283 (36.8)	0.007
Purchasing power					< 0.001
5 (high)	1965 (20.2)	1215 (16.4)	390 (25.5)	360 (46.8)	
4	1936 (19.9)	1549 (20.9)	198 (12.9)	189 (24.5)	
3	1930 (19.9)	1567 (21.1)	268 (17.5)	95 (12.3)	
2	1948 (20.0)	1573 (21.2)	285 (18.6)	90 (11.7)	
1 (low)	1937 (19.9)	1510 (20.4)	391 (25.5)	36 (4.7)	
Higher deductible	454 (4.7)	375 (5.1)	50 (3.3)	29 (3.8)	0.005
Managed-care model	2884 (29.7)	2429 (32.8)	266 (17.4)	189 (24.5)	< 0.001
Supplementary hospital insurance	1948 (20.0)	1624 (21.9)	179 (11.7)	145 (18.8)	< 0.001
Cause of death					< 0.001
Diseases of the circulatory system	2962 (30.5)	2291 (30.9)	448 (29.2)	223 (29.0)	
Neoplasms	2308 (23.8)	1761 (23.8)	364 (23.8)	183 (23.8)	
Diseases of the respiratory system	622 (6.4)	441 (5.9)	123 (8.0)	58 (7.5)	
Mental, behavioral, neurodevelopmental disorders	868 (8.9)	696 (9.4)	122 (8.0)	50 (6.5)	
Diseases of the nervous system	565 (5.8)	384 (5.2)	121 (7.9)	60 (7.8)	
Diseases of the digestive system	376 (3.9)	273 (3.7)	65 (4.2)	38 (4.9)	
Stroke	660 (6.8)	509 (6.9)	99 (6.5)	52 (6.8)	
Other	1355 (13.9)	1059 (14.3)	190 (12.4)	106 (13.8)	
Place of death (%)					
Home	1837 (18.9)	1466 (19.8)	235 (15.3)	136 (17.7)	< 0.001
Hospital	3672 (37.8)	2626 (35.4)	716 (46.7)	330 (42.9)	
Nursing home	4207 (43.3)	3322 (44.8)	581 (37.9)	304 (39.5)	
Cantonal supply of care (mean; median density)					
Hospital beds	4.6 (4.5)	4.5 (4.4)	4.5 (4.8)	5.4 (5.4)	< 0.001
Nursing-home beds	66.2 (72.7)	69.8 (72.7)	54.5 (52.1)	54.6 (54.3)	< 0.001
Home-care nurses	2 (1.9)	2.1 (1.9)	1.5 (1.4)	1.8 (1.7)	< 0.001
Ambulatory care physicians	215.7 (217.2)	209.5 (217.2)	246.8 (243.6)	213.1 (214)	< 0.001

[a] p values, assigning the differences between the language regions, were calculated using Kruskal–Wallis test for continuous, and using Chi-squared test for dichotomous and categorical variables

speaking regions, though once a patient was admitted to a nursing home, he/she most likely died there (Table 4). Just 19.8% of patients in the German-speaking regions died at home, and only 15.3% and 17.7% of patients died at home in the French- and Italian-speaking regions, respectively (Table 1).

In the multivariate gamma regression model, only female sex, being in a managed-care model and cantonal density of hospital beds and nursing-home beds, had no impact on costs (Table 5). Higher age, living in a single household and having a higher deductible were associated with lower total costs, while living in an urban area and having supplementary hospital insurance were associated with higher healthcare costs. Including at least one intensive life-sustaining intervention or at least one ICU admission was associated with 52% and 61% higher healthcare costs at the EOL, respectively. Every day in a hospital increased costs by 1.8%.

Table 2 Use of intensive procedures at the end of life by language region (n = 9716), Switzerland, 2014

Intensive procedure n (%)	Total 9716	German 7414 (76.3)	French 1532 (15.8)	Italian 770 (7.9)	P[a]
≥ 1 Intensive procedure	3142 (32.3)	2400 (32.4)	470 (30.7)	272 (35.3)	0.079
Cardiac catheterization	128 (1.3)	107 (1.4)	14 (0.9)	7 (0.9)	0.149
Cardiac assistance device	42 (0.4)	34 (0.5)	6 (0.4)	2 (0.3)	na
Pulmonary artery monitoring	4 (0)	0 (0)	2 (0.1)	2 (0.3)	na
Resuscitation/cardiac conversion	229 (2.4)	175 (2.4)	32 (2.1)	22 (2.9)	0.518
Gastrostomy	72 (0.7)	57 (0.8)	8 (0.5)	7 (0.9)	0.504
Blood transfusion	1298 (13.4)	986 (13.3)	202 (13.2)	110 (14.3)	0.728
Dialysis	158 (1.6)	114 (1.5)	18 (1.2)	26 (3.4)	< 0.001
Mechanical ventilation	299 (3.1)	225 (3.0)	37 (2.4)	37 (4.8)	0.007
I.v. antibiotics	374 (3.8)	302 (4.1)	50 (3.3)	22 (2.9)	0.107
Chemotherapy	1127 (11.6)	845 (11.4)	186 (12.1)	96 (12.5)	0.522
ICU admission	1286 (13.2)	1012 (13.6)	165 (10.8)	109 (14.2)	0.008

na, not applicable

[a]p values, assigning the differences between the language regions, were calculated using Chi-squared test

Table 3 Crude standardized healthcare costs of basic mandatory health insurance at the end of life by language region (n = 9716), Switzerland, 2014

n (%)	Total 9716	German 7414 (76.3)	French 1532 (15.8)	Italian 770 (7.9)	P[a]
Healthcare costs median (IQR; mean)					
Total	21,480 (25,950, 32,510)	20,130 (24,460, 30,910)	26,580 (34,460, 39,160)	23,450 (24,540, 34,640)	< 0.001
Inpatient	15,900 (19,810, 24,790)	15,110 (18,590, 23,570)	19,550 (27,940, 30,290)	17,510 (17,220, 25,610)	< 0.001
Outpatient	4500 (6670; 7730)	4370 (6470; 7470)	5380 (7430; 8850)	4170 (7040; 8020)	< 0.001

[a]p values, assigning the differences between the language regions, were calculated using Kruskal–Wallis test

Table 4 Healthcare utilization at the end of life by language region (n = 9716), Switzerland, 2014

n (%)	Total 9716	German 7414 (76.3)	French 1532 (15.8)	Italian 770 (7.9)	P[a]
Healthcare utilization Median (IQR)					
Hospital admission (%)	6098 (62.8)	4608 (62.2)	1008 (65.8)	482 (62.6)	0.027
Days in hospital	6 (22)	6 (20)	9 (37)	6 (25)	< 0.001
Days in hospital[b]	17 (25)	16 (22)	26 (47)	18.5 (28)	< 0.001
Nursing home admission (%)	5092 (52.4)	4029 (54.3)	676 (44.1)	387 (50.3)	< 0.001
Days in nursing home	10 (178)	15 (178)	0 (176)	2.5 (181)	< 0.001
Days in nursing home[b]	177 (91.2)	175 (99)	181 (67.5)	181 (35.5)	< 0.001

[a]p values, assigning the differences between the language regions, were calculated using Kruskal–Wallis test for continuous, and using Chi-squared test for dichotomous and categorical variables

[b]In patients with at least one admission

Taking into consideration all the above-mentioned factors, standardized costs still differed between the French-and Italian- versus German-speaking region, though cost differences were attenuated (Fig. 1). Concerning the French- and German-speaking regions, relative cost differences decreased significantly from 1.27 (CI 1.19–1.34) to 1.06 (CI 1.02–1.11). Relative cost differences between the Italian- and German-speaking regions ranged from 1.12 (CI 1.03–1.22) in model a to 1.08 (CI 1.02–1.14) in model g. However, the study sample in the Italian region was smaller, so results must be interpreted cautiously.

Table 5 Multivariate gamma regression model (i) on relative healthcare cost differences at the end of life (n = 9716), Switzerland, 2014

	Exp(β)	95% CI	p
French region	1.060	(1.015, 1.108)	0.009
Italian region	1.079	(1.019, 1.143)	0.009
Female sex	1.002	(0.975, 1.029)	0.891
Age group 75–84	0.913	(0.877, 0.950)	< 0.001
Age group 85+	0.853	(0.818, 0.888)	< 0.001
Single household	0.914	(0.886, 0.943)	< 0.001
Type of residence (urban)	1.032	(1.003, 1.062)	0.030
Purchasing power: 4	0.975	(0.937, 1.015)	0.218
Purchasing power: 3	1.032	(0.990, 1.076)	0.132
Purchasing power: 2	1.013	(0.972, 1.056)	0.534
Purchasing power: 1 (low)	1.039	(0.993, 1.087)	0.095
Higher deductible	0.922	(0.869, 0.979)	0.007
Managed-care model	0.979	(0.952, 1.006)	0.129
Supplementary hospital insurance	1.056	(1.023, 1.090)	< 0.001
Cause of death			
Neoplasms	1.226	(1.181, 1.273)	< 0.001
Diseases of the respiratory system	1.077	(1.021, 1.138)	0.007
Mental, behavioral, neurodevelop. disorders	1.097	(1.045, 1.151)	< 0.001
Diseases of the nervous system	1.187	(1.122, 1.257)	< 0.001
Diseases of the digestive system	1.103	(1.031, 1.181)	0.005
Stroke	1.090	(1.034, 1.149)	0.001
Other	1.075	(1.032, 1.119)	< 0.001
Place of death: Hospital	1.440	(1.387, 1.495)	< 0.001
Place of death: Nursing home	1.344	(1.283, 1.408)	< 0.001
Density of nursing home beds	1.000	(0.998, 1.001)	0.508
Density of hospital beds	0.998	(0.983, 1.014)	0.810
Density of home-care nurses	0.976	(0.953, 1.000)	0.045
Density of ambulatory care physicians	1.000	(1.000, 1.001)	0.037
At least 1 intensive procedure	1.522	(1.472, 1.573)	< 0.001
At least 1 ICU admission	1.612	(1.547, 1.680)	< 0.001
Number of days in hospital	1.018	(1.017, 1.018)	< 0.001
Number of days in nursing home	1.001	(1.001, 1.001)	< 0.001

Overall, individual, sociodemographic and clinical patient characteristics, like cause of death, only played a tangential role explaining relative cost differences between language regions. Conversely, system-related factors, like density of health-service providers, and medical care variations, like intensity of treatment, and length of hospital and nursing-home stay explained a substantial proportion of the detected cost variations in Switzerland.

Discussion

This study reveals that system-related factors, like the density of home-care nurses, as well as intensity of treatments, and length of inpatient stays explain a substantial part of cost differences between language regions in Switzerland. Contrary to previous studies, we also accounted for tariffs systematically varying across Switzerland. Unlike differences in the distribution of population factors, like sociodemographic or clinical characteristics, supply factors and health-service provision can principally be modified. Therefore, our results might contribute to reducing unwarranted variations in cost and healthcare at the EOL in Switzerland. However, neither system- nor supply-related factors can be disentangled from cultural impacts by means of our data, and a more sophisticated evaluation of culturally and demand-driven healthcare supply is therefore needed.

In the L6MOL, crude median total healthcare costs of our study population ranged from CHF 30,910–39,160 between the three language regions. Total costs decreased with increasing age and were lower in decedents who used

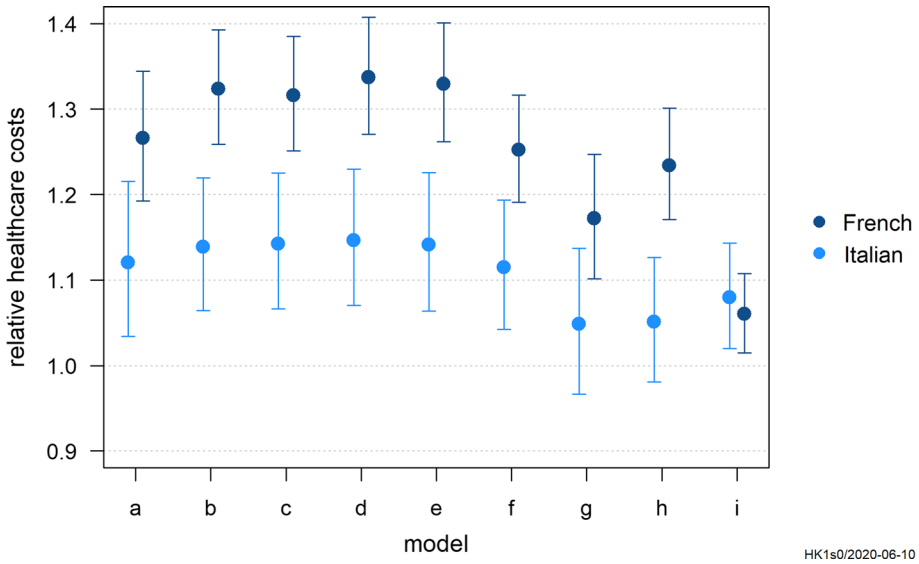

Fig. 1 Estimates of the relative cost differences between language regions at the end of life (n = 9716). Models: (a) language region, (b) sex, age group, and single household, (c) type of residence and purchasing power, (d) health-insurance plan, (e) cause of death, (f) place of death, (g) cantonal density of hospital beds, nursing-home beds, home-care nurses, and physicians, (h) intensive treatments and intensive care unit (ICU) admission, and (i) the length of hospital and nursing-home stays (Switzerland, 2014)

to live alone, while sex had no impact on costs. Others have found lower healthcare expenditures for the oldest old, versus younger decedents, at the EOL after adjusting for several influencing factors, mainly due to lower-intensity medical care with increasing age (Gielen et al. 2010; Hanchate et al. 2009; Polder et al. 2006). Conversely, Canadian decedents ($\sim$ 1.1% of the study population) used more than one-fifth of the total healthcare costs in the L6MOL (Menec et al. 2004); these high costs in the oldest old arose from high use of nursing homes. In another study, living alone increased the risk of longer nursing-home stays (Hedinger et al. 2015). Unexpectedly, living alone was associated with lower healthcare costs in our study. According to sub-analysis, living in a single household was significantly associated with fewer chronic conditions, which might indicate that they were healthier and, therefore, generated lower healthcare costs.

Concerning further individual variables, impacts on cost differences were small. Costs at the EOL were lowest for circulatory system diseases and highest for neoplasms and neurological diseases. Similarly, in the Netherlands, healthcare costs in the last year of life were highest for cancer causes of death and lowest for myocardial infarction (Polder et al. 2006). Differences across French- and German-speaking Switzerland also exist in cause-specific mortality rates, which could only partially be explained by differences in risk-factor prevalence and health-related lifestyle behavior (Faeh et al. 2009; Faeh and Bopp 2010). These in turn seem to be related to variations in health literacy between language regions (Wang and Schmid 2007). However, cause of death did not reduce relative cost differences between our three study regions. Unlike in previous studies, the number of chronic conditions (identified by means of the Anatomical Therapeutic Chemical classification system using Pharmacy-based Cost Group models (Huber et al. 2013)) could not be considered as an additional explanatory factor in the present study. A comparably higher proportion of nursing homes in the Italian-speaking region used medication lump sums in 2014, the reason why no detailed information on the type of prescribed medications was available, thereby masking the comorbidity status of the patient. This would have led to the exclusion of an over-proportionally higher number of nursing home residents in that region. However, cause of death did not explain cost differences between language regions, which might apply to chronic conditions as well. The higher costs in patients dying in hospitals and nursing homes, versus at home, are widely known (Morrison et al. 2008; Reich et al. 2013). Besides, remarkable regional variations in places of death exist (Gruneir et al. 2007; Hedinger et al. 2014). Nevertheless, these variations explain little of the cost differences between regions.

Conversely, system-related factors reduced relative cost differences between the three regions. Living in regions with a higher density of home-care nurses at the EOL was associated with lower costs, while all other measures related to cantonal supply of care had no or hardly any influence, analogous to our previous findings (Bähler et al. 2016). Similarly, care-related factors, especially ICU admission and length of inpatient stay, seem to partially account for the higher costs in the French- and Italian-speaking regions. ICU admission was more frequent in the Italian-speaking region, where the number of hospital beds/1000 inhabitants was highest. Dialysis and mechanical ventilation also were slightly more common in the Italian-speaking region, though given the small samples with a specific intensive procedure, results must be interpreted cautiously. Comparable results were found for several

procedures, like resuscitation/cardiac conversion (2.8% vs 2.4%), cardiac assistance device implantation (0.5% vs 0.4%), and dialysis (1.3% vs 1.6%) in a previous US study (Hanchate et al. 2009). While some procedures were more often used in the USA (cardiac catheterization in 3.4% vs 1.3% in our study, pulmonary artery monitoring in 1.3% vs 0%, gastrostomy in 4.5% versus 0.7%, and ventilation in 12.1% versus 3.1%), the following were found more frequently in our cohort: blood transfusion (10.9% in the USA versus 13.4%), intravenous antibiotics (1.0% vs 3.8%), and chemotherapy (7.9% vs 11.6%) (Hanchate et al. 2009). The large difference in ventilation might be attributed to the way we defined mechanical ventilation use. Ventilation was seen in 7.6% of all decedents if kind of ventilation was not considered. Furthermore, oral chemotherapy was not included in the study by Hanchate and colleagues, which may explain some of the observed differences. In a recent Canadian study, decedents were more frequently admitted to the ICU (19.5%), and more often had dialysis (3.5%) or mechanical ventilation (14.0%) in the L6MOL; however, their observed sample was not restricted to elderly decedents (Yarnell et al. 2017). The adjusted proportion of patients receiving resuscitation at the EOL ranged from 7.6 to 8.2 in a recent retrospective study (Jena et al. 2018). Corresponding proportions were 1.5–2.0 for gastrostomy, 30.5–33.1 for mechanical ventilation, and 6.3–6.4 for dialysis. Regional variations of intensive procedures of hospitalized patients generally partially explained cost differences between the German- and Italian-speaking regions, and—to a lesser extent—those between the German-and French-speaking regions. Regarding length of inpatient stays, hospitalizations were more frequent in the French- and Italian-speaking regions, averaging 16–26 days. In Belgium, mean length of stay ranged between 14 days (in non-cancer persons age 90+) and 29 days (in cancer-patients age 70–79) in the L6MOL (Gielen et al. 2010). Regarding nursing-home admissions, differences between regions were less significant. The average number of days ranged from 135 to 147. Unfortunately, three different instruments for cost calculations per nursing-home stay, covered by the mandatory health insurance, exist in Switzerland. We were unable to adjust for potential cost differences, because the classification of level of care per nursing-home resident differed between instruments. This might be one reason why differences in the length of nursing-home stays between the German- and Italian-speaking regions explained little. Overall, most cost variations between the French- and German-speaking regions were explained by the length of inpatient stays and supply of health-service provision, while cantonal system-related factors and treatment intensity seemed to account—to a lesser extent—for the higher costs in the Italian- versus German-speaking region.

Strengths and limitations

The study examined a large cohort of Swiss decedents with comprehensive, highly reliable information on healthcare utilization and costs at the EOL in the context of mandatory health insurance, including cause of death. One limitation is that our retrospectively collected data include a known date and cause of death, but neither is foreseeable. However, the vast majority of Swiss residents die of chronic illnesses with a predictable course of disease. Two studies about healthcare utilization and costs revealed very similar results comparing their prospectively and retrospectively collected data (Pyenson et al. 2004; Setoguchi et al. 2008). A second limitation is we only included intensity measures identifiable on the basis of mandatory health insurance. Consequently, other aspects, like psychological burden of patients and their relatives, or severity/stage of underlying disease could not be included. Additionally, the given period of time (6 months) is rather long for the interpretation of end-of-life care. Nonetheless, among others, ICU admission has been found to be relatively robust and stable as a EOL treatment-intensity measure (Barnato et al. 2009). A third limitation is the lack of information on hospice use, although this measure did not contribute to differences in healthcare costs in the study by Hanchate et al. (2009), and the proportion of people in Swiss hospices is negligibly small. Fourth, German native speakers who live in the Italian-speaking region and who potentially use its healthcare services may have biased our results. Last, our study cannot judge the appropriateness of the single-care measures provided to patients. Nevertheless, analyses are based on a broad range of detailed data on healthcare utilization and costs, and the intensity measures have been assessed previously (Hanchate et al. 2009; Kwok et al. 2011; Yarnell et al. 2017).

Implications

Transparency concerning variations in management and costs of medical care at the EOL across Switzerland is urgently warranted. It is recognized that overtreatment is present in high-income countries, particularly regarding EOL care (Borasio and Jox 2016; Brownlee et al. 2017). For instance, recently published studies have not found survival benefits of systematic ICU admission in elderly patients (Boumendil et al. 2012; Guidet et al. 2017). Cultural differences between language regions exist that become apparent in healthcare utilization (Busato and Künzi 2008). Analyzing culturally diverse cohorts (regarding language and health behavior) within the same country (hence, same national legislations) offers a unique opportunity to clarify the relationship between regional

aspects and healthcare utilization and costs at the EOL. Only after detecting variations in healthcare utilization and costs can the underlying reasons and potential interventions to eliminate unwarranted disparities be examined. Underpinning cultural and institutional aspects has an important impact on healthcare provision (Torbica et al. 2018). While some institutional conditions are based on national legislations in Switzerland (e.g., universal access to healthcare), substantial power is given to cantons, making allowances for differences at the cultural level. Most Swiss cantons saw deficits in the availability of specialized ambulatory palliative care, and only one-third of cantons was satisfied with its hospital palliative care supply (de Pietro et al. 2015). In our sample, a higher cantonal density of home-care nursing was associated with lower costs at the EOL. Yet the shortage of skilled manpower in home-care nursing is an important issue in Switzerland. The goal is not a higher level of harmonization of healthcare provision across the country, but to identify which approach best suits regional circumstances. However, neither system- nor supply-related factors can be disentangled from cultural impacts by means of our data, and a more sophisticated evaluation of culturally and demand-driven healthcare supply is therefore needed. Quantifying regional variations may guide policymakers with the implementation of culturally and linguistically adapted strategies for EOL care; e.g., in Spain, subsidization of long-term care was associated with reduced hospital admissions and length of hospital stay (Costa-Font et al. 2018).

Advance care planning might prevent elderly patients from numerous burdensome or avoidable hospitalizations, as suggested recently (Muench et al. 2019). Timely conversations about EOL care will ensure that patients make informed decisions about further hospitalizations or treatments, whether curative or palliative, according to their preferences (Borasio and Jox 2016; Chini et al. 2010). In a randomized controlled trial, advance care planning was associated with improved patient satisfaction and reduced stress, anxiety, and depression in surviving relatives (Detering et al. 2010). More consultations by primary-care physicians before the L6MOL were related to lower healthcare costs and less hospital use thereafter (Kronman et al. 2008). To reduce inappropriate emergency department visits, telephone triage systems and the co-location of primary-care physician practices and emergency departments were shown to be promising in a recent review (van den Heede and van de Voorde 2016) and former Swiss study (Eichler et al. 2014). Physicians should be enforced in their role as possible gatekeepers or guides for intensive procedures. Interestingly, physicians receive significantly less intensive care at the EOL than the general population (Weissman et al. 2016). Data suggest a potential for improved medical EOL decisions in Switzerland (Schmid et al. 2016). However, our study could not take into account treatment decisions. Further research is needed to explore the roles of patients' and health professionals' preferences across Switzerland.

Conclusions

Analyzing a broad range of reliable, detailed data on healthcare utilization and costs in patients at the EOL, including main cause of death, is a great opportunity to gain insights into the real-life setting of such patients' treatment. We found that density of home-care nurses, intensity of treatments, and length of inpatient stay explain a substantial part of cost differences between language regions in Switzerland. Contrary to previous studies, ours accounted for tariffs systematically varying across Switzerland and adjusted for this. Unlike differences in the distribution of population factors, like sociodemographic or clinical characteristics, supply factors and health-service provision can principally be modified by healthcare policy. Therefore, our results might contribute to reducing unwarranted variation in Swiss costs and healthcare at the EOL. However, neither system- nor supply-related factors can be disentangled from cultural impacts by means of our data, and a more sophisticated evaluation of culturally and demand-driven healthcare supply is therefore needed. And the time period of 6 months prior to death that we regarded as end-of-life care is rather long. Hence, intensive treatments may still have been considered curative and warranted. Patient preferences and expectations, and health professional attitudes driving these differences warrant further exploration.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval According to the national ethical and legal regulation (article 22 of the Swiss data protection law), ethical approval was not needed, as this study is retrospective and based on anonymized routine administrative healthcare claims data. Furthermore, a formal request was sent to the Ethics committee Kantonale Ethikkommission Zürich in the Canton of Zurich. According to this committee, no further ethics approval was needed as the study falls outside the scope

of the Swiss Federal Act on Research involving Human Beings (Human Research Act).

Informed consent Informed consent was not needed as this retrospective study used routinely collected data.

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