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Characteristics and healthcare utilization patterns of high-cost beneficiaries in the Netherlands

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Abstract

Objective: To determine medical needs, demographic characteristics and healthcare utilization patterns of the top-1% and top-2%-5% high-cost beneficiaries in the Netherlands.

Design: Observational 1-year study. We broke down high-cost beneficiaries by demographics, beneficiary's most cost incurring condition, and expensive treatment use (e.g. dialysis, expensive drugs, intensive care unit).

Setting: Dutch curative health system, a comprehensive health system with universal coverage.

Participants: 4.5 million enrollees of one health insurer.

Measures: annual total costs through hospital, intensive care unit use, expensive drugs, other pharmaceuticals, mental care, and others; demographics; most cost incurring and secondary conditions; inpatient stay; number of morbidities; costs per ICD10-chapter.

Results: The top-1% and top-2-5% beneficiaries accounted for 23% and 26% of total expenditures respectively. Among top-1% beneficiaries, hospital care represented 76% of spending, of which respectively 9.0% and 9.1% were spent on expensive drugs and ICU care. We found that 54% of top-1% beneficiaries were aged 65 or younger, and that average costs sharply decreased with higher age within the top-1% group. Expensive treatments contributed to high costs in one third of top-1% beneficiaries, and in less than 10% of top-2-5% beneficiaries. The average number of conditions was 5.5 and 4.0 for top-1% and top-2-5% beneficiaries respectively. 53% of top-1% beneficiaries were treated for circulatory disorders, but for only 22% of top-1% beneficiaries this was their most cost incurring condition.

Conclusions: Expensive treatments, most cost incurring condition, and age proved to be informative variables for studying this heterogeneous population. Expensive treatments play a substantial role in high-costs beneficiaries. High-cost programs need to be aimed at beneficiaries in all ages; a mere

focus on elderly would leave many high-cost beneficiaries unaddressed. Tailored interventions are needed to meet the needs of high-cost beneficiaries, and to avoid waste of scarce resources.

Strengths and limitations of this study

- This study presents an in-depth analysis in the medical needs, demographics and utilization of high-cost beneficiaries in the Netherlands.
- We characterized high-cost beneficiaries and spending patterns using several variables, including expensive treatment use (e.g. dialysis, expensive drugs, ICU), most cost incurring condition, and age.
- Analyses were limited to one large insurer, but representative for the Netherlands.

Introduction

It is known that health care costs are concentrated among small numbers of 'high-cost' beneficiaries. These high-cost beneficiaries make up the sickest and most complex populations. Although they receive substantial care from multiple sources, they have critical health care needs unmet, and many receive unnecessary and ineffective care[1-4]. This suggests that this is a logical group to seek for both quality improvement and cost-containment.

For effective quality improvement and cost reduction it is necessary to acquire an in-depth understanding of the characteristics, health care use and the factors driving costs of these groups of high-cost beneficiaries[5, 6]. Current literature points to a high prevalence of multiple (chronic) conditions to explain high-cost beneficiaries' excessive care use[7, 8]. This multimorbidity among high-cost beneficiaries has led to difficulties in understanding them: how to characterize patients that suffer from several diseases? Lehnert et al[9] found that the number of chronic comorbidities were nearly exponentially related to costs: the higher the number of chronic comorbidities, the higher the costs of an additional comorbidity. In this study, we hypothesized that in high-cost beneficiaries the most cost incurring condition accounts for a disproportionate share of costs, and that secondary conditions account for the remainder of costs.

A major limitation in current literature is that little is known about patterns in care use and characteristics among different age groups[10]. In addition, until today no studies have reported the role of expensive treatments (e.g. expensive drugs, transplant surgery, intensive care units, dialysis) as drivers of high costs. Further insight in such healthcare utilization patterns is needed to develop interventions and inform policy aimed at the high-need, high-cost populations.

The primary aim of this study was to determine medical needs, demographic characteristics and healthcare utilization patterns of high-cost beneficiaries in the Netherlands. We first determined characteristics and spending and quantified the share of high-cost beneficiaries that use expensive treatments. Furthermore, we used a beneficiary's most cost incurring condition to examine

characteristics and utilization patterns. In addition, we compared utilization and conditions across age groups. All analyses were performed for top-1% and top-2-5% beneficiaries separately. This distinction is often used in literature[11-14] and may improve understanding of high-cost beneficiaries.

Methods

Design

We conducted an observational study using claims data from 2013 in the Netherlands. In the Netherlands, the Health Insurance Act legally requires health insurers to provide a comprehensive nationally set benefits package. Nearly universal coverage for curative care is achieved through mandatory purchase of statutory health insurance from private insurers[15, 16]. Analyses were done in-house with Zilveren Kruis, a health insurer covering 4.5 million beneficiaries. The Dutch curative health system provides a wide range of services, including care provided by general practitioners, hospitals, and specialists; dental care through age 18; prescription drugs; physiotherapy through age 18; most mental care; medical aids and devices; maternity care; transportation and others. We also included private voluntary supplementary insurance which typically covers dental care, some allied healthcare and complementary medicine.

Data

Several beneficiary characteristics were obtained from the insurer's databases, including gender, socio-economic status based on income estimates per postal code, date of birth and date of death (until February 20th, 2015). Date of death was categorized to four quarters in 2013 and post-2013.

Total costs per beneficiary were calculated by summing all claims with a starting date in 2013. We defined the top-1% and the top-2%-5% of total costs as two groups of high-cost beneficiaries. The remaining 95% were categorized as low-cost beneficiaries. All claims were categorized in nine cost groups (health sectors) using a link table provided by the Dutch Healthcare Institute. These sectors included: hospital care (including care used abroad), mental health care, primary care, maternal care, allied health care, outpatient pharmaceutical prescriptions, medical devices, dental care (most dental care is reimbursed through complementary insurance benefits), and voluntary complementary insurance benefits.

Treatment cost per diagnosis

We categorized and analyzed hospital and mental care costs, according to the ICD10 classification of diseases. Treatment costs were categorized to the level of ICD10-chapters (e.g. chapter IX: diseases of the circulatory system) and ICD10-subchapters (e.g. subchapter I60-I69 cerebrovascular diseases).

The great majority of hospital care in the Netherlands is reimbursed through payment products similar to Diagnosis Related Group (DRGs; that cover both in- and outpatient hospital care) and so-called add-ons for expensive drugs and treatment at the intensive care unit (ICU). To compute treatment costs per diagnosis, the DRGs were categorized using a link table provided by the Dutch Health Care Authority. This link table (version 22 December 2014) was developed to categorize hospital claims to specific health care needs, following the ICD10 international classification of diseases[17]. For the purpose of our study, we made a few minor corrections to the link table. As we found the ICD-subchapter I30-I52 (*other circulatory diseases)* highly prevalent but not informative, we decided to disaggregate this subchapter. Add-ons were not used for establishing treatment cost per diagnosis.

In 2013, the Dutch mental care sector consisted of 'primary' mental care, such as provided through GPs, psychologists and psychotherapists, and 'secondary' or specialized mental care provided in mental care institutions. Only claims from secondary mental health care were used for characterization as these specify information about diagnoses and treatment. These claims were categorized to ICD10-(sub)chapter and summed with the hospital claims for ICD-10 chapter V: mental and behavioral disorders. Additionally, the number of inpatients days in mental care per beneficiary was included (but not used for establishing treatment cost).

Prevalence of conditions and multimorbidity count

Prevalence of conditions was established using the same process as described above. In addition, we used parameters from the Dutch risk-equalization scheme: pharmaceutical cost groups that indicate chronic use of drugs for different conditions. These pharmaceutical cost groups were categorized to ICD10-(sub-)chapters and integrated with the former to establish prevalence of conditions.

Multimorbidity was operationalized in three ways. First, multimorbidity was calculated by counting the number of prevalent ICD10-chapters per beneficiary. Second, we counted the number of prevalent ICD10-subchapters per beneficiary. Third, the number of pharmaceutical cost groups was counted, reflecting the number of chronic multimorbidities.

Use of specific expensive services

We developed dummy variables for specific types of care. Beneficiaries were regarded 'expensive care users' if they use a minimum of €10,000 expenses of 'add-ons'. Add-ons are separate payments that have been developed for the reimbursement of expensive drugs and intensive care unit admission. We used €10,000 as threshold because in 2013 expensive drugs qualified for add-on reimbursement when average yearly costs per beneficiary exceeded this value. *Intensive care unit (ICU) treatment* as reimbursed through add-ons included ICU treatment days, ICU consultations, ICU surcharges for specific services, ICU neonatal and pediatric care, and ICU transport services such as inter-clinical transportation services and Mobile Intensive Care Unit (MICU). *Expensive drugs* reimbursed through add-ons included growth hormones, antineoplastic agents, TNF-alfa inhibitors, orphan drugs, haemostatics and other expensive drugs [18].

A separate variable 'transplant' was developed, for beneficiaries who received a transplant or transplant related care (both pre- and post). One DRG-description naming 'transplant' was sufficient to qualify as transplant-beneficiary. Similarly, a variable 'dialysis' was created for all beneficiaries on dialysis for renal failure (both abdominal and hemodialysis). Third, all beneficiaries incurring a DRG with an average price >€30,000 were identified and included as separate variable. This price was chosen as top-1% beneficiaries incurred €30,000 or more. Fourth, two dummy variables for mental health use were computed, the first on mental care use (>€0 mental care costs) and the second on inpatient stays (>0 days). Fifth, the total number of inpatient hospital days per beneficiary was estimated using national averages of hospital days per DRG[19]. Finally, we determined the number of hospitals, university medical centers, and hospital specialisms per beneficiary.

Analyses

We explored the composition of expenditures across health sectors for both top-1% and top-2-5% beneficiaries. Demographics, medical characteristics and (expensive) health care use were analyzed using descriptive statistics.

Most cost incurring and secondary conditions

For each high-cost beneficiary we identified the most cost incurring ICD10-(sub)chapter. For both top-1% and top-2-5% beneficiaries, we first determined the prevalence of each ICD10-subchapter. Second, we calculated the frequency of each ICD10-subchapter as most cost incurring condition. Per ICD10-subchapter, we divided the percentage as most cost incurring condition by the overall prevalence. This metric was used to distinguish between ICD10-subchapters that were mainly found as most cost incurring conditions compared to ICD10-subchapters that were mainly found as secondary conditions. Fourth, for each beneficiary we divided the treatment cost for the most cost incurring condition by total costs. This figure was averaged per ICD10-subchapter. Fifth, for both high-cost groups we summed treatment cost per ICD10-subchapter, and divided this with the sum of total costs.

Health care use according to most cost incurring ICD10-chapter and across age groups

To identify patterns in (expensive) health care use, we developed cross-tables with costs per ICD10-chapter, (expensive) health care use indicators and demographic characteristics as descriptive variables. Beneficiaries were selected by the most cost incurring ICD10-chapter, to prevent that beneficiaries with multimorbidity would be counted several times.

Finally, we compared utilization patterns and conditions across age groups. We examined total costs, spending per sector and we identified the five most cost incurring ICD10-chapters per age group.

All analyses were performed using SAS 9.4, Enterprise Guide 6.1.

Results

Average total costs for top-1%, top-2-5% and bottom-95% beneficiaries were €56,424, €15,780 and €1,345 respectively, representing 22.8%, 25.5% and 51.7% of spending (table 1). For top-1% beneficiaries, hospital care represented 76% of costs, of which respectively 9.0% and 9.1% were spent on expensive drugs and ICU care. 12.7% and 6.6% were spent on mental health care and pharmaceuticals. For top-2-5% beneficiaries, hospital care represented 59.7% of spending, of which 6.0% and 2.1% were spent on expensive drugs and ICU care. 9.8% and 11.2% were spent on mental health care and pharmacy.

Demographics and (expensive) healthcare use

Table 1 presents demographic and medical characteristics of the study population as well as (expensive) healthcare use. Among top-1% beneficiaries, males were overrepresented, and females were overrepresented among top-2-5% beneficiaries. Top-1% and top-2-5% beneficiaries were much older than low-cost beneficiaries. Furthermore, high-cost beneficiaries were more likely to die: 9.9% and 6.1% of top-1% and top-2-5% beneficiaries died. However, 63.7% of enrollees dying in 2013 or later did not incur high costs in 2013. The average number of morbidities based on ICD10-chapters was 4.2, 3.3 and 0.7 for top-1%, top-2-5% and bottom-95% beneficiaries respectively.

Table 1 further illustrates that top-1% and top-2-5% beneficiaries scored higher than low-cost users in each utilization indicator, and top-1% beneficiaries scored higher than top-2-5% beneficiaries. Both top-1% and top-2-5% beneficiaries used on average one type of drugs (pharmaceutical cost groups) continuously. One quarter of top-1% and six percent of top-2-5% beneficiaries incurred more than €10,000 on expensive drugs and ICU. Furthermore, six percent of top-1% beneficiaries were dialyzed and four percent received transplant care. Top-1% and top-2-5% beneficiaries were treated in on average 1.9 and 1.6 hospitals, and used on average 22 and 7 inpatient days respectively. Finally, 13% and 3.3% of top-1% and top-2-5% beneficiaries were admitted to mental care institutions.

Most cost incurring and secondary conditions

Appendix 1 presents five parameters for both high-cost populations. Among those in the top-1%, a high prevalence of several cardiovascular diseases, COPD, diabetes mellitus, and depression were found. We use table 2 to illustrate the other parameters for top-1% beneficiaries. Renal insufficiency, certain cancers, and several cardiovascular diseases were frequently found as most cost incurring conditions among top-1% beneficiaries. Furthermore, several cancers were primarily found as most cost incurring condition (e.g. 74.3% of beneficiaries with leukemia). In contrast, less than 30% of beneficiaries with ischemic heart diseases or heart failure, this condition was their most cost incurring condition. In addition, the most cost incurring condition accounted for on average 40%-50% of total costs (data not shown). Treatment costs for renal insufficiency (including dialysis) accounted for seven percent of total costs among top-1% beneficiaries.

Utilization according to most cost incurring ICD10-chapter

Table 3 and appendix 2 show cross-tables for spending, demographics and indicators for (expensive) healthcare use. In these analyses, beneficiaries were selected by most cost incurring ICD10-chapter, to avoid multimorbid beneficiaries being analyzed on multiple rows. Among top-1% beneficiaries, three ICD10-chapters were frequently found as most cost incurring ICD10-chapter. Beneficiaries with mental or behavioral disorders were relatively young, had a low number of morbidities and low mortality. Beneficiaries with neoplasms were the largest subgroup with high mortality. Beneficiaries with diseases of circulatory system were oldest (on average 69 years old) and predominantly men. Expensive drugs were heavily concentrated among beneficiaries with neoplasms. ICU costs were distributed more proportionally; a quarter was incurred by beneficiaries with circulatory diseases.

Among high-cost beneficiaries, the same three most cost incurring ICD10-chapters predominated, albeit they represented a smaller share of the group. Several other ICD10-chapters played a significant role, including diseases of the digestive system; injury, poisoning and certain other consequences of external causes (femur fracture most prominently); and diseases of the

musculoskeletal system and connective tissue. Beneficiaries with neoplasms; diseases of the respiratory system; and symptoms, signs and abnormal clinical and laboratory findings were most likely to die. Expensive drugs were primarily used by beneficiaries with diseases of the musculoskeletal system (rheumatoid arthritis), neoplasms and diseases of the digestive system.

Health care use across age groups

Figure 1 and appendix 4 provide an overview of cost segments per age category among top-1% and top-2-5% beneficiaries. Apart from infants, treatment at ICU represented maximally ten percent of costs per age group. Moreover, treatment at ICU represented a major cost driver primarily among top-1% beneficiaries. The proportion of costs spent on expensive drugs was highest (13.4% of total costs) among top-1% beneficiaries between 21 and 30 years old. Mental health care accounted for large shares of costs among children and young and middle aged adults. The percentage paid on outpatient and non-expensive pharmaceuticals was more pronounced among top-2-5% beneficiaries than among top-1% beneficiaries.

Table 4 and appendix 3 present the five most important ICD10-chapters in total costs per age group for top-1% and top-2-5% beneficiaries. Above we showed high costs were associated with higher age. However, table 4 shows that *within* the top-1% beneficiaries average costs decreased with higher age: average costs ranged from >€80,000 for infants to €47,000 for top-1% beneficiaries over 80. In addition, 54% of top-1% and 57% of top-2-5% beneficiaries were younger than 66.

For each age group, different conditions accounted for most costs. Among top-1% beneficiaries, cardiovascular diseases and diseases of the genitourinary system gained importance with higher age, whereas mental and behavioral disorders predominated among younger and middle-aged beneficiaries. Among top-2-5% beneficiaries, a similar pattern of diseases across age groups was observed. However, pregnancy-related conditions among middle-aged and musculoskeletal conditions in several age groups played a more significant role than among top-1% beneficiaries.

Discussion

In this study, we determined medical needs, demographics and utilization patterns of high-cost beneficiaries in the Netherlands. Expensive treatments, most cost incurring condition, and age proved to be informative variables for studying this heterogeneous population. We found that expensive care use contributed to high costs in one third of top-1% beneficiaries and in less than ten percent of top-2-5% beneficiaries. High-cost beneficiaries were overwhelmingly treated for diseases of circulatory system, neoplasms, and mental disorders. However, neoplasms and mental disorders were mainly found as most cost incurring condition, whereas circulatory disorders were mainly found as secondary condition. Finally, more than 50% of high-cost beneficiaries were under age 66, and average costs decreased sharply with higher age within the top-1% population. Such insights are needed to develop tailored interventions and inform policy aimed at the high-need, high-cost populations.

Strengths and limitations

This was the first study assessing utilization patterns of high-cost beneficiaries in a European universal and comprehensive health system, and we used innovative variables to examine characteristics and utilization. We used data from one health insurer with a market share of approximately 27%, and the data are representative for the Dutch population. Despite the limited number of variables, our data allowed detailed identification of health care use and categorization of costs towards conditions. We chose to use expensive treatments, most cost incurring condition and age as variables for further analyses as such analyses were lacking in the literature and we regarded these most informative for policy and practice. One limitation is that our analysis was restricted to one year only. Consequently, we could not discern persistent high-cost users from episodic high-cost users (those with a high-cost event[5]).

Reflections on our findings

Our findings generally align with prior research on high-cost beneficiaries. Similar to US studies[12, 20], we identified three main subgroups of high-cost beneficiaries with cardiovascular diseases, mental disorders, and neoplasms, besides several smaller subgroups. In addition, we confirm that high-cost beneficiaries are treated for several conditions and use care from multiple providers[10]. Like prior studies[12, 20] we reported a high prevalence of diabetes, but with limited direct cost impact. This may be explained by the fact that Dutch diabetic care is primarily situated in primary care. Moreover, complications of diabetes were aggregated to the particular condition (e.g. retinopathy) using our link table. Furthermore, in line with Aldridge et al[5], we found that dying increases the risk for high costs (data not shown), but that less than ten percent of high-cost beneficiaries were in their last year of life. However, we found 64% of those dying did not incur high costs, compared to 80% who did in the US[5]. This may be explained by many Dutch dying in long term care, but may also result from the GP oriented organization of palliative care in the Netherlands, which is known for its low costs[21, 22].

Our study is unique in estimating the relative contribution of expensive treatments in high-cost beneficiaries. The findings indicate that high unit costs for selected services play a substantial role in high-costs beneficiaries. We identified *expensive treatment users* among *expensive patients.* Furthermore, our analyses show expensive treatment users may use lots of care besides such expensive treatments, suggesting that better alignment of expensive treatments with other care may be worthwhile. In line Joynt et al, we suggest that expensive procedures (including less expensive orthopedic surgery, pacemaker-implantation etc) and catastrophic events may be a more significant cost driver in high-cost beneficiaries than avoidable hospitalizations, and that a complementary approach (see below) in high-need high-cost programs is needed[20].

To our knowledge, we are the first that have distinguished the most cost incurring versus secondary conditions in high-cost beneficiaries. For example, diseases of circulatory system were mainly found

as a secondary condition, but also frequently as most cost incurring condition. Vice versa, mental disorders and neoplasms were predominantly the most cost incurring condition. Our findings contribute to the rapidly evolving field of multimorbidity and patterns of healthcare use. We suggest that conditions that were frequently and primarily found as most cost incurring condition should be priorities for policies that seek to contain costs and improve quality of care. However, the observational nature of our study does not allow for causal inference; i.e. the high number of morbidities in cancer patients may either indicate the many complications from cancer treatment, or point to prior chronic disease in patients with cancer.

Many high-cost beneficiaries were younger than 66 years old; and the average costs decreased sharply with increasing age within the top-1% beneficiaries. These patterns were associated with typical needs per age group. Both findings have rarely been reported in literature[10] and underline the need for total-population studies in comprehensive health systems. Furthermore, high-need, high-cost programs need to be aimed at beneficiaries of all ages; a mere focus on elderly would leave many high-cost beneficiaries unaddressed.

Policy and research implications

Our findings suggest a need for approaches that address patients' care needs across multiple conditions and to integrate care use across multiple providers. Several interventions have been taken to increase quality and reduce the costs of high-cost beneficiaries' care[2-4, 23]. So far, such high-need high-cost programs – which primarily aim to reduce avoidable admissions - have shown mixed results[23-25]. A major finding is that successful programs were tailored to the local needs of populations. In other words, the effectiveness and efficiency increase when interventions are targeted to the people that most likely benefit[26]. In addition, multifaceted programs are likely more successful than programs relying on one intervention[25]. Important policy questions remain concerning the breadth of health care delivery innovations (i.e. care coordination programs, bundled payments; what should a bundle encompass?)[27]. We suggest high-need, high-cost programs may

aim to align the usual care for most cost incurring conditions with the care for associated or common secondary conditions in specific care pathways. Based on our findings we recommend a complementary approach geared towards expensive procedures and drugs as well as the extensive additional care besides expensive treatments. This suggests bundled payments may be worthwhile, as well as multidisciplinary assessment of patients' care needs for expensive treatments. In addition, prices for expensive drugs or procedures could be lowered, for example through reference pricing or competitive bidding[28, 29]. For clinicians, treating patient with multiple and complex care needs requires teamwork, individualized care plans, and a focus on quality of life, careful consideration of patient preferences and (non-medical) treatment goals, and weighing the risks and benefits of potentially conflicting treatments[30].

Our research provides a precise and comprehensive picture of high-cost beneficiaries, but further research is necessary to specify characteristics and utilization of high-cost beneficiaries at a local level. Patient segmentation analysis has been suggested as a method for identifying homogenous target population groups from diverse populations, which allows for tailored policies[31]. Our analyses may inform segmentation analyses. Furthermore, we suggest research into longitudinal patterns of multimorbidity to identify relevant subgroups who benefit from intervention. More research is needed to identify beneficiaries at risk of incurring high costs[25].

In conclusion, our findings show that high-cost beneficiaries are treated for several conditions and use care from multiple providers. Expensive treatments, most cost incurring condition, and age proved to be informative variables for studying this heterogeneous population. Tailored interventions are needed to meet the needs of high-cost beneficiaries, and to avoid waste of scarce resources.

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Contributors: JW drafted the first manuscript and conducted the data analyses. JW, PvdW and MT conceptualized the study and interpreted the data. WJ provided assistance in data preparation, statistical analyses and was involved in interpretation of the findings. GW and PJ made a substantial contribution to the development of the research question and interpretation and presentation of the findings. All authors provided feedback to, and approved the final manuscript.

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Tables

Table 1. General characteristics and indicators for health care use for three distinct cost groups.

General characteristics		Top-1%	Top-2%-5%	Bottom-95%
Number of beneficiaries		45,207	180,826	4,294,611
Average total costs (SD)		€56,424 (€40,830)	€15,780 (€5,208)	€1,345 (€1,773)
Share of total costs		22.8%	25.5%	51.7%
Private spending (SD)		€330 (€172)	€335 (€165)	€159 (€181)
Gender	Male:	52.3%	44.8%	49.6%
	Female:	47.7%	55.2%	50.4%
Mean age (SD)		58.5 (21.6)	58.0 (21.8)	39.2 (23.3)
Median age		64	62	39
Percentage dying in or after study period	Q1:	0.7%	0.9%	0.2%
	Q2:	1.8%	1.6%	0.2%
	Q3:	3.2%	1.7%	0.1%
	Q4:	4.2%	1.9%	0.1%
	>Q4†:	12.5%	5.9%	0.7%
Socioeconomic status	>15 inhabitants‡:	4.5%	3.1%	1.0%
	Lowest incomes:	31.1%	31.5%	31.4%
	Average income:	37.5%	38.5%	37.7%
	High income:	26.8%	26.7%	28.6%
Medical characteristics		Top-1%	Top-2%-5%	Bottom-95%
Average number of comorbidities – ICD-chapter (SD)		4.2 (2.1)	3.3 (1.8)	0.7 (1.1)
Average number of comorbidities – ICD-subchapter (SD)		5.5 (3.1)	4.0 (2.3)	0.8 (1.2)
Average number of chronic comorbidities – calculated by pharmaceutical cost groups (SD)		1.1 (1.2)	1.0 (1.1)	0.2 (0.6)
(Expensive) healthcare use		Top-1%	Top-2%-5%	Bottom-95%
Percentage using expensive care > €10,000		24.6%	5.8%	0.0%
Percentage transplant beneficiaries		3.7%	0.8%	0.03%
Percentage receiving dialysis		6.1%	0.1%	0.0%
Percentage receiving DRG > €30,000		4.5%	0.03%	0%
Percentage with >0 inpatient mental health care stays		13.0%	3.3%	0.04%
Percentage with mental health care costs >€0		23.5%	20.6%	6.4%
Average number of inpatient mental hospital days‡‡		54.7 (74.3)	4.0 (11.7)	0.05 (0.8)
Percent visiting a specialized mental care center		22.5%	19.2%	4.8%
Average number of hospital specialists involved (SD)		4.2 (2.3)	3.0 (1.8)	0.6 (1.0)
Average number of hospitals visited (SD)		1.9 (1.0)	1.6 (0.9)	0.5 (0.7)
Average number of inpatient hospital days (SD)		22.3 (26.0)	7.2 (8.4)	0.4 (1.5)
Percentage using care at a university hospital		39.7%	25.8%	4.5%
Average number of ambulance transportations (SD)		1.4 (4.3)	0.5 (1.0)	0.02 (0.17)
Average number of emergency department visits[3] (SD)		0.7 (1.4)	0.4 (0.7)	0.07 (0.27)

† Dates of death were recorded until the 20th of February 2015.

‡ Most of whom are institutionalized.

‡‡ For those with mental health care costs >€0.

Table 2. Ten conditions with highest total costs among top-1% beneficiaries.

	Prevalence[a]	% as most cost incurring condition[b]	% most cost incurring / prevalence[c]	% of costs by most cost incurring condition[d]	% of total costs[E]
N17-N19 Renal failure	12.2%	6.4%	52.4%	66.0%	6.8%
C81-C96 Leukemia	5.6%	4.1%	74.3%	41.4%	3.0%
C15-C26 Malignant neoplasms of digestive organs	7.5%	5.4%	71.2%	47.9%	2.4%
I60-I69 Cerebrovascular diseases	7.9%	4.2%	53.1%	52.7%	2.1%
I70-I79 Diseases of arteries, arterioles and capillaries	9.6%	4.1%	42.7%	47.3%	2.0%
C30-C39 Lung cancer	5.9%	3.5%	59.1%	52.5%	1.7%
I51-I52 Complications/ill-defined descriptions, other heart disorders	9.6%	3.2%	33.1%	50.3%	1.6%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	11.8%	2.9%	24.3%	58.5%	1.6%
I20-I25 Ischemic heart diseases	12.7%	3.7%	29.0%	41.9%	1.6%
I50 Heart failure	9.3%	2.6%	28.4%	57.1%	1.5%

A Prevalence of each ICD10-subchapter among top-1% beneficiaries. E.g. 12.2% of top-1% beneficiaries were treated for renal failure.
B Percentage of top-1% with this ICD10-subchapter as most cost incurring condition. E.g. 6.4% of top-1% beneficiaries had renal failure as most cost incurring condition.
C Percentage most cost incurring condition relative to prevalence: second column divided by fifth column. E.g. for 52.4% of top-1% beneficiaries who were treated for renal failure, this was also their most cost incurring condition.
D Percentage of costs accounted for by the most cost incurring condition. E.g. among top-1% beneficiaries with renal failure as most cost incurring condition, this disease accounted for on average 66% of total costs per beneficiary.
E Sum of total treatment costs per ICD10-subchapter. E.g. treatment of renal failure accounted for 6.8% of total expenditures of top-1% beneficiaries.

Table 3. Cross table describing patterns of health care use and demographics of top-1% beneficiaries.

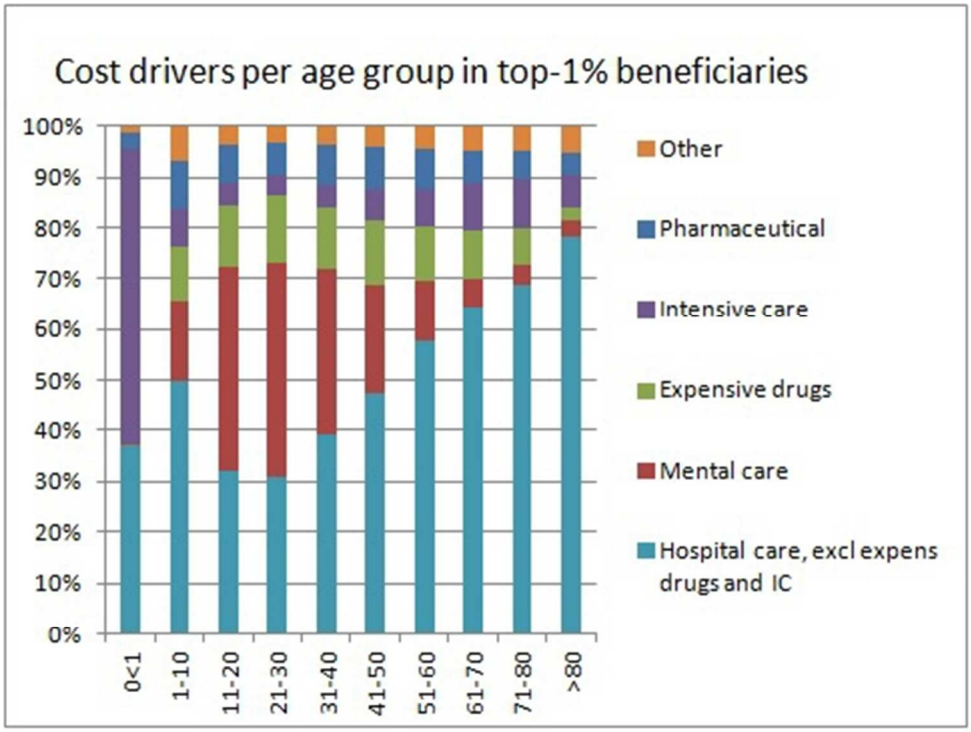
ICD10-chapter	Prevalence[a]	% most cost incurring ICD10-chapter	Average age	Percentage dying	Percentage men	Average number of comor (ICD-chapter)	Average cost (*€1000)	Expensive drugs (*€1000)	Intensive care (*€1000)	Neoplasm (*€1000)	Mental and behavioural disorders (*€1000)	Diseases circulatory system (*€1000)	Diseases genitourinary system (*€1000)
Certain infectious and parasitic diseases	10.2%	1.0%	60.3	16.8%	60.4%	5.5	54	2,515	3,407	407	247	382	400
Neoplasms	36.8%	23.2%	62.0	16.4%	49.5%	3.9	56	111,927	27,734	295,902	2,062	7,629	4,991
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	4.4%	1.0%	42.1	3.7%	65.9%	3.3	103	33,535	531	143	62	213	91
Endocrine, nutritional and metabolic diseases	21.5%	1.3%	39.2	6.1%	49.2%	4.0	67	8,452	3,025	191	228	432	224
Mental and behavioural disorders	32.2%	14.7%	41.1	1.2%	51.8%	2.7	55	4,487	4,292	841	135,431	1,746	787
Diseases of the nervous system	29.3%	2.6%	54.7	8.4%	52.2%	4.6	56	9,303	6,185	845	682	1,064	442
Diseases of the eye and adnexa	18.2%	0.2%	62.4	1.1%	43.6%	4.0	47	974	112	45	15	13	9
Diseases of the ear and mastoid process	5.4%	0.3%	44.5	1.6%	48.8%	3.4	60	200	232	25	14	59	23
Diseases of the circulatory system	52.8%	22.3%	68.7	9.5%	60.9%	4.6	49	7,564	63,668	5,992	2,519	269,394	4,709
Diseases of the respiratory system	24.1%	4.4%	62.8	16.7%	48.9%	4.8	53	5,258	20,204	1,865	801	2,628	801
Diseases of the digestive system	20.0%	4.0%	55.2	12.0%	51.2%	4.7	55	10,359	19,343	1,717	873	1,523	1,013
Diseases of the skin and subcutaneous tissue	10.0%	0.5%	59.5	7.2%	48.3%	4.8	51	1,371	1,009	103	60	234	82
Diseases of the musculoskeletal system and connective tissue	19.4%	4.1%	66.0	4.1%	34.8%	4.8	47	10,750	3,104	1,090	862	2,359	699
Diseases of the genitourinary system	24.4%	7.2%	63.4	10.5%	58.0%	5.2	82	5,000	12,307	2,546	691	8,921	171,360
Pregnancy, childbirth and the puerperium	0.5%	0.2%	31.0	0.0%	0.0%	3.8	44	159	182	8	60	28	18
Certain conditions originating in the perinatal period	0.1%	0.0%	0.2	0.0%	60.0%	6.0	239	1	874	1	4	13	0
Congenital malformations, deformations and chromosomal abnormalities	3.1%	0.7%	8.2	6.3%	54.3%	3.6	73	1,262	9,230	9	69	285	51
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	49.2%	2.1%	55.4	14.1%	50.8%	4.6	60	9,824	9,086	482	460	1,034	387
Injury, poisoning and certain other consequences of external causes	22.3%	6.8%	71.5	9.7%	39.5%	4.7	50	2,986	15,169	1,813	1,789	5,668	1,055
Factors influencing health status and contact with health services	31.7%	3.6%	30.5	2.1%	55.3%	3.9	67	3,417	30,951	1,388	447	3,234	636

[A] Prevalence of ICD10-chapters among the total population. All other columns apply for beneficiaries with the selected most cost incurring ICD10-chapter per row.

Table 4. Top-1% beneficiaries according to age group, and total expenditure per ICD10-chapter[†].

Age group	<1	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	>80
Number	938	1125	1793	1892	2506	4670	6856	9811	9815	5801
Average per capita costs	€ 81,458	€ 69,576	€ 68,220	€ 62,428	€ 59,161	€ 59,546	€ 55,569	€ 55,253	€ 52,123	€ 47,166
	Factors influencing health status and contact with health services 13.5%	Neoplasms 15.5%	Mental and behavioral disorders 21.2%	Mental and behavioral disorders 18.8%	Mental and behavioral disorders 14.1%	Neoplasms 12.9%	Neoplasms 16.0%	Neoplasms 17.2%	Diseases of the circulatory system 20.1%	Diseases of the circulatory system 21.1%
	Congenital malformations, deformations and chromosomal abnormalities 5.2%	Mental and behavioral disorders 11.0%	Neoplasms 9.1%	Neoplasms 5.8%	Neoplasms 8.9%	Mental and behavioral disorders 9.1%	Diseases of the circulatory system 9.9%	Diseases of the circulatory system 14.7%	Neoplasms 11.9%	Injury, poisoning and certain other consequences of external causes 15.0%
	Diseases of the digestive system 2.5%	Factors influencing health status and contact with health services 4.6%	Factors influencing health status and contact with health services 2.1%	Diseases of the genitourinary system 4.0%	Diseases of the genitourinary system 6.1%	Diseases of the genitourinary system 7.3%	Diseases of the genitourinary system 8.1%	Diseases of the genitourinary system 7.8%	Diseases of the genitourinary system 5.5%	Diseases of the genitourinary system 9.8%
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 1.8%	Congenital malformations, deformations and chromosomal abnormalities 2.9%	Injury, poisoning and certain other consequences of external causes 1.6%	Injury, poisoning and certain other consequences of external causes 2.2%	Diseases of the circulatory system 3.5%	Diseases of the circulatory system 5.9%	Mental and behavioral disorders 5.2%	Injury, poisoning and certain other consequences of external causes 2.5%	Injury, poisoning and certain other consequences of external causes 5.1%	Neoplasms 6.1%
	Neoplasms 1.6%	Diseases of the nervous system 2.4%	Diseases of the genitourinary system 1.5%	Factors influencing health status and contact with health services 2.2%	Factors influencing health status and contact with health services 2.6%	Factors influencing health status and contact with health services 2.6%	Factors influencing health status and contact with health services 2.6%	Diseases of the respiratory system 2.5%	Diseases of the musculoskeletal system and connective tissue 2.9%	Diseases of the musculoskeletal system and connective tissue 4.9%

[†] Total costs per ICD-chapter were summed per age group. In the table, the five ICD10-chapters with highest costs per age group are presented. I.e. among beneficiaries 1-10 years old, 15.5% of total costs were accounted for by neoplasm care.



Cost drivers per age group in top-1% beneficiaries

128x96mm (96 x 96 DPI)

Appendix 1a. Five parameters for top-1% beneficiaries.

ICD10-subchapter (condition)	Prevalence	% as most cost incurring condition	% most cost incurring / prevalence	% of costs by most cost incurring condition	% of total costs
A00-A09 Intestinal infectious diseases	0,9%	0,1%	8,9%	19,4%	0,1%
A15-A19 Tuberculosis	0,2%	0,0%	23,4%	36,6%	0,0%
A20-A28 Certain zoonotic bacterial diseases	0,0%				0,0%
A30-A49 Other bacterial diseases	2,9%	0,7%	22,7%	23,8%	0,3%
A50-A64 Infections with a predominantly sexual mode of transmission	0,1%				0,0%
A65-A69 Other spirochaetal diseases	0,0%				0,0%
B00-B09 Viral infections characterized by skin and mucous membrane lesions	0,4%				0,0%
B15-B19 Viral hepatitis	0,3%	0,1%	18,5%	10,4%	0,0%
B20-B24 Human immunodeficiency virus [HIV] disease	5,0%	0,2%	4,7%	16,8%	0,1%
B25-B34 Other viral diseases	0,3%	0,0%	8,6%	12,2%	0,0%
B50-B64 Protozoal diseases	0,0%				
B85-B89 Pediculosis, acariasis and other infestations	0,0%				0,0%
B99-B99 Other infectious diseases	0,9%	0,1%	12,5%	22,5%	0,1%
C00-C14 Malignant neoplasms of lip, oral cavity and pharynx	1,2%	0,5%	42,4%	40,8%	0,2%
C15-C26 Malignant neoplasms of digestive organs	7,5%	5,4%	71,2%	47,9%	2,4%
C30-C39 Malignant neoplasms of respiratory and intrathoracic organs	5,9%	3,5%	59,1%	52,5%	1,7%
C40-C41 Malignant neoplasms of bone and articular cartilage	0,4%	0,1%	28,1%	56,0%	0,2%
C43-C44 Melanoma and other malignant neoplasms of skin	3,0%	0,3%	9,9%	16,2%	0,1%
C45-C49 Malignant neoplasms of mesothelial and soft tissue	0,7%	0,3%	44,1%	36,8%	0,2%
C50-C50 Malignant neoplasm of breast	5,0%	3,7%	75,4%	42,8%	1,4%
C51-C58 Malignant neoplasms of female genital organs	1,3%	0,8%	62,0%	50,0%	0,4%
C60-C63 Malignant neoplasms of male genital organs	2,2%	0,8%	37,9%	34,8%	0,3%
C64-C68 Malignant neoplasms of urinary tract	3,5%	1,3%	36,9%	44,6%	0,6%
C69-C72 Malignant neoplasms of eye, brain and other parts of central nervous system	1,1%	0,2%	14,7%	41,1%	0,2%
C73-C75 Malignant neoplasms of thyroid and other endocrine glands	0,2%	0,1%	31,8%	50,1%	0,1%
C76-C80 Malignant neoplasms of ill-defined, secondary and unspecified sites	4,2%	1,1%	25,6%	40,4%	0,6%
C81-C96 Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue	5,6%	4,1%	74,3%	41,4%	3,0%

D00-D09 In situ neoplasms	1,5%	0,0%	0,4%	2,6%	0,0%
D10-D36 Benign neoplasms	4,5%	0,2%	3,4%	20,8%	0,1%
D37-D48 Neoplasms of uncertain or unknown behaviour	3,2%	1,1%	32,5%	41,6%	0,7%
D50-D53 Nutritional anaemias	1,4%	0,1%	5,5%	22,7%	0,1%
D55-D59 Haemolytic anaemias	0,3%	0,1%	31,8%	25,2%	0,0%
D60-D64 Aplastic and other anaemias	0,5%	0,1%	12,7%	35,1%	0,1%
D65-D69 Coagulation defects, purpura and other haemorrhagic conditions	1,2%	0,5%	39,4%	6,1%	0,1%
D70-D77 Other diseases of blood and blood-forming organs	0,4%	0,0%	12,9%	28,5%	0,0%
D80-D89 Certain disorders involving the immune mechanism	0,7%	0,3%	41,4%	15,1%	0,1%
E00-E07 Disorders of thyroid gland	4,2%	0,0%	0,7%	16,0%	0,0%
E10-E14 Diabetes mellitus	13,8%	0,3%	2,1%	24,2%	0,2%
E20-E35 Disorders of other endocrine glands	1,1%	0,2%	19,5%	6,6%	0,0%
E40-E46 Malnutrition	1,5%	0,1%	7,6%	11,6%	0,0%
E50-E64 Other nutritional deficiencies	0,0%	0,0%	14,4%	12,3%	0,0%
E65-E68 Obesity and other hyperalimentation	0,4%	0,1%	24,4%	23,8%	0,0%
E70-E90 Metabolic disorders	2,6%	0,7%	25,9%	18,1%	0,2%
F00-F09 Organic, including symptomatic, mental disorders	6,5%	0,6%	9,7%	20,9%	0,2%
F10-F19 Mental and behavioural disorders due to psychoactive substance use	5,0%	2,7%	54,0%	34,0%	0,9%
F20-F29 Schizophrenia, schizotypal and delusional disorders	5,7%	3,5%	60,7%	32,9%	1,1%
F30-F39 Mood [affective] disorders	12,7%	3,0%	23,5%	35,4%	1,1%
F40-F48 Neurotic, stress-related and somatoform disorders	2,8%	1,1%	39,0%	43,2%	0,5%
F50-F59 Behavioural syndromes associated with physiological disturbances and physical factors	0,6%	0,3%	52,3%	51,9%	0,2%
F60-F69 Disorders of adult personality and behaviour	2,4%	1,4%	58,5%	42,1%	0,6%
F70-F79 Mental retardation	0,1%	0,0%	12,6%	8,4%	0,0%
F80-F89 Disorders of psychological development	1,3%	0,9%	68,7%	46,3%	0,4%
F90-F98 Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1,6%	0,7%	41,8%	58,0%	0,3%
F99-F99 Unspecified mental disorder	13,1%	0,6%	4,8%	32,7%	0,5%
G00-G09 Inflammatory diseases of the central nervous system	0,8%	0,2%	27,5%	30,7%	0,1%
G10-G14 Systemic atrophies primarily affecting the central nervous system	0,2%	0,0%	17,7%	16,1%	0,0%
G20-G26 Extrapyramidal and movement disorders	9,2%	0,2%	2,3%	12,0%	0,0%

G35-G37 Demyelinating diseases of the central nervous system	0,5%	0,2%	37,4%	14,0%	0,0%
G40-G47 Episodic and paroxysmal disorders	8,4%	0,7%	8,5%	33,8%	0,4%
G50-G59 Nerve, nerve root and plexus disorders	2,0%	0,0%	2,2%	22,0%	0,0%
G60-G64 Polyneuropathies and other disorders of the peripheral nervous system	1,5%	0,3%	19,4%	15,6%	0,1%
G70-G73 Diseases of myoneural junction and muscle	0,7%	0,2%	24,8%	32,2%	0,1%
G80-G83 Cerebral palsy and other paralytic syndromes	0,0%	0,0%	21,6%	3,9%	0,0%
G90-G99 Other disorders of the nervous system	3,2%	0,4%	12,2%	34,7%	0,2%
H00-H06 Disorders of eyelid, lacrimal system and orbit	1,1%	0,0%	1,2%	3,1%	0,0%
H10-H13 Disorders of conjunctiva	1,1%				0,0%
H15-H22 Disorders of sclera, cornea, iris and ciliary body	0,7%	0,0%	1,5%	6,5%	0,0%
H25-H28 Disorders of lens	4,1%	0,1%	2,7%	4,4%	0,1%
H30-H36 Disorders of choroid and retina	5,7%	0,1%	1,2%	24,5%	0,1%
H40-H42 Glaucoma	3,3%	0,0%	0,3%	1,4%	0,0%
H43-H45 Disorders of vitreous body and globe	0,6%	0,0%	0,4%	0,1%	0,0%
H46-H48 Disorders of optic nerve and visual pathways	0,9%	0,0%	0,2%	0,2%	0,0%
H49-H52 Disorders of ocular muscles, binocular movement, accommodation and refraction	0,9%	0,0%	1,3%	9,3%	0,0%
H53-H54 Visual disturbances and blindness	0,4%	0,0%	0,6%	0,6%	0,0%
H55-H59 Other disorders of eye and adnexa	2,2%	0,0%	0,4%	0,6%	0,0%
H60-H62 Diseases of external ear	1,5%	0,0%	1,5%	33,9%	0,0%
H65-H75 Diseases of middle ear and mastoid	1,4%	0,0%	3,5%	9,0%	0,0%
H80-H83 Diseases of inner ear	0,7%	0,0%	1,6%	7,6%	0,0%
H90-H95 Other disorders of ear	2,3%	0,2%	9,8%	81,4%	0,2%
I00-I02 Acute rheumatic fever	0,0%				0,0%
I05-I09 Chronic rheumatic heart diseases	0,4%	0,4%	95,0%	50,8%	0,2%
I10-I15 Hypertensive diseases	6,4%	0,0%	0,5%	15,0%	0,0%
I20-I25 Ischaemic heart diseases	12,7%	3,7%	29,0%	41,9%	1,6%
I26-I28 Pulmonary heart disease and diseases of pulmonary circulation	1,5%	0,3%	18,1%	13,7%	0,1%
I30-I33 Pericarditis/endocarditis	1,3%	0,2%	18,1%	42,4%	0,2%
I34-I39 Valve disorders	6,1%	0,7%	11,0%	62,5%	0,5%
I40-I41 Myocarditis	0,1%	0,0%	20,1%	19,3%	0,0%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	11,8%	2,9%	24,3%	58,5%	1,6%
I50 Heart failure	9,3%	2,6%	28,4%	57,1%	1,5%
I51-I52 Complications/ill-defined descriptions, other heart disorders	9,6%	3,2%	33,1%	50,3%	1,6%

I60-I69 Cerebrovascular diseases	7,9%	4,2%	53,1%	52,7%	2,1%
I70-I79 Diseases of arteries, arterioles and capillaries	9,6%	4,1%	42,7%	47,3%	2,0%
I80-I89 Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	5,9%	0,1%	1,2%	15,4%	0,2%
I95-I99 Other and unspecified disorders of the circulatory system	5,7%	0,1%	1,2%	30,6%	0,1%
J00-J06 Acute upper respiratory infections	0,6%	0,0%	5,1%	18,2%	0,0%
J09-J18 Influenza and pneumonia	6,4%	1,2%	19,0%	20,4%	0,5%
J20-J22 Other acute lower respiratory infections	0,8%	0,1%	15,6%	20,0%	0,1%
J30-J39 Other diseases of upper respiratory tract	1,8%	0,1%	3,6%	13,1%	0,0%
J40-J47 Chronic lower respiratory diseases	14,1%	1,8%	13,1%	26,2%	0,6%
J60-J70 Lung diseases due to external agents	0,0%				
J80-J84 Other respiratory diseases principally affecting the interstitium	0,8%	0,2%	19,1%	24,5%	0,1%
J85-J86 Suppurative and necrotic conditions of lower respiratory tract	0,2%	0,0%	17,7%	25,1%	0,0%
J90-J94 Other diseases of pleura	2,2%	0,2%	8,4%	33,6%	0,1%
J95-J99 Other diseases of the respiratory system	2,9%	0,5%	15,8%	42,2%	0,3%
K00-K14 Diseases of oral cavity, salivary glands and jaws	0,4%	0,0%	1,8%	6,4%	0,0%
K20-K31 Diseases of oesophagus, stomach and duodenum	3,9%	0,3%	6,6%	18,7%	0,2%
K35-K38 Diseases of appendix	0,2%	0,0%	23,3%	21,9%	0,0%
K40-K46 Hernia	1,6%	0,1%	8,6%	17,1%	0,1%
K50-K52 Noninfective enteritis and colitis	2,4%	0,8%	32,4%	23,6%	0,2%
K55-K64 Other diseases of intestines	5,0%	0,9%	18,4%	31,3%	0,4%
K65-K67 Diseases of peritoneum	1,0%	0,3%	31,7%	27,1%	0,1%
K70-K77 Diseases of liver	1,7%	0,4%	24,8%	43,1%	0,3%
K80-K87 Disorders of gallbladder, biliary tract and pancreas	2,2%	0,5%	24,0%	34,8%	0,3%
K90-K93 Other diseases of the digestive system	7,0%	0,7%	9,8%	26,5%	0,4%
L00-L08 Infections of the skin and subcutaneous tissue	3,4%	0,3%	9,3%	25,1%	0,2%
L10-L14 Bullous disorders	0,7%	0,0%	1,7%	15,0%	0,0%
L20-L30 Dermatitis and eczema	2,4%	0,0%	0,7%	20,7%	0,0%
L40-L45 Papulosquamous disorders	0,7%	0,1%	10,2%	10,2%	0,0%
L50-L54 Urticaria and erythema	0,1%	0,0%	4,7%	1,2%	0,0%
L60-L75 Disorders of skin appendages	0,6%	0,0%	1,1%	12,0%	0,0%
L80-L99 Other disorders of the skin and subcutaneous tissue	3,2%	0,1%	4,6%	27,8%	0,1%
M00-M03 Infectious arthropathies	0,1%	0,0%	23,2%	31,7%	0,0%
M05-M14 Inflammatory polyarthropathies	5,0%	0,4%	8,0%	22,6%	0,1%
M15-M19 Arthrosis	4,5%	1,7%	37,4%	51,4%	0,8%

M20-M25 Other joint disorders	2,3%	0,3%	12,2%	34,4%	0,1%
M30-M36 Systemic connective tissue disorders	1,5%	0,3%	18,0%	26,9%	0,1%
M40-M43 Deforming dorsopathies	0,4%	0,1%	34,1%	55,1%	0,1%
M45-M49 Spondylopathies	1,7%	0,3%	17,8%	28,9%	0,1%
M50-M54 Other dorsopathies	3,9%	0,5%	12,2%	39,2%	0,2%
M60-M63 Disorders of muscles	0,1%	0,0%	1,6%	2,3%	0,0%
M65-M68 Disorders of synovium and tendon	0,3%	0,0%	2,0%	12,3%	0,0%
M70-M79 Other soft tissue disorders	1,9%	0,1%	3,3%	12,7%	0,0%
M80-M85 Disorders of bone density and structure	1,4%	0,0%	1,3%	20,8%	0,0%
M86-M90 Other osteopathies	1,0%	0,1%	12,2%	33,1%	0,1%
M91-M94 Chondropathies	0,0%	0,0%	12,6%	82,9%	0,0%
M95-M99 Other disorders of the musculoskeletal system and connective tissue	0,1%	0,0%	5,5%	56,1%	0,0%
N00-N08 Glomerular diseases	0,3%	0,0%	14,2%	31,0%	0,0%
N10-N16 Renal tubulo-interstitial diseases	1,1%	0,1%	11,6%	30,1%	0,1%
N17-N19 Renal failure	12,2%	6,4%	52,4%	66,0%	6,8%
N20-N23 Urolithiasis	0,8%	0,1%	14,4%	28,3%	0,1%
N25-N29 Other disorders of kidney and ureter	1,8%	0,1%	4,1%	21,0%	0,1%
N30-N39 Other diseases of urinary system	6,5%	0,4%	5,7%	21,9%	0,2%
N40-N51 Diseases of male genital organs	3,4%	0,1%	1,9%	15,9%	0,1%
N60-N64 Disorders of breast	0,6%	0,0%	1,1%	7,7%	0,0%
N70-N77 Inflammatory diseases of female pelvic organs	0,4%	0,0%	3,0%	3,9%	0,0%
N80-N98 Noninflammatory disorders of female genital tract	2,4%	0,1%	3,0%	12,0%	0,0%
O00-O08 Pregnancy with abortive outcome	0,1%	0,0%	5,2%	1,1%	0,0%
O20-O29 Other maternal disorders predominantly related to pregnancy	0,0%				0,0%
O60-O75 Complications of labour and delivery	0,0%				0,0%
O80-O84 Delivery	0,4%	0,0%	7,6%	27,0%	0,0%
O94-O99 Other obstetric conditions, not elsewhere classified	0,4%	0,2%	43,9%	59,1%	0,1%
P20-P29 Respiratory and cardiovascular disorders specific to the perinatal period	0,0%	0,0%	23,9%	9,2%	0,0%
P50-P61 Haemorrhagic and haematological disorders of fetus and newborn	0,0%	0,0%	25,1%	26,9%	0,0%
Q00-Q07 Congenital malformations of the nervous system	0,2%	0,0%	17,7%	16,8%	0,0%
Q10-Q18 Congenital malformations of eye, ear, face and neck	1,0%	0,0%	0,7%	1,2%	0,0%

Q20-Q28 Congenital malformations of the circulatory system	1,2%	0,5%	42,4%	39,8%	0,2%
Q30-Q34 Congenital malformations of the respiratory system	0,0%	0,0%	23,9%	27,9%	0,0%
Q35-Q37 Cleft lip and cleft palate	0,0%	0,0%	18,3%	24,6%	0,0%
Q38-Q45 Other congenital malformations of the digestive system	0,1%	0,0%	5,2%	53,9%	0,0%
Q50-Q56 Congenital malformations of genital organs	0,1%	0,0%	7,2%	6,6%	0,0%
Q60-Q64 Congenital malformations of the urinary system	0,1%	0,0%	6,6%	14,6%	0,0%
Q65-Q79 Congenital malformations and deformations of the musculoskeletal system	0,4%	0,0%	10,8%	34,6%	0,0%
Q80-Q89 Other congenital malformations	0,2%	0,0%	10,9%	13,4%	0,0%
Q90-Q99 Chromosomal abnormalities, not elsewhere classified	0,2%	0,0%	10,9%	9,1%	0,0%
R01 Cardiac murmurs and other cardiac sounds	0,0%	0,0%	15,1%	8,0%	0,0%
R04 Haemorrhage from respiratory passages	1,2%	0,0%	2,3%	19,3%	0,0%
R05 Cough	0,3%	0,0%	4,2%	11,1%	0,0%
R06 Abnormalities of breathing	3,8%	0,6%	16,4%	32,7%	0,3%
R07 Pain in throat and chest	0,5%	0,0%	1,8%	21,9%	0,0%
R09 Other symptoms and signs involving the circulatory and respiratory systems	0,0%	0,0%	5,0%	9,8%	0,0%
R10 Abdominal and pelvic pain	2,3%	0,1%	2,4%	21,5%	0,1%
R11 Nausea and vomiting	0,0%	0,0%	9,1%	30,3%	0,0%
R13 Dysphagia	1,3%	0,0%	0,9%	2,8%	0,0%
R15 Faecal incontinence	0,1%	0,0%	43,1%	43,1%	0,0%
R22.1 Localized swelling, mass and lump, neck	0,2%	0,0%	2,1%	11,6%	0,0%
R26 Abnormalities of gait and mobility	0,1%	0,0%	2,3%	40,9%	0,0%
R29 Other symptoms and signs involving the nervous and musculoskeletal systems	1,2%	0,0%	2,9%	14,3%	0,0%
R31 Unspecified haematuria	0,1%	0,0%	7,7%	5,7%	0,0%
R32 Unspecified urinary incontinence	0,0%	0,0%	7,7%	5,3%	0,0%
R35 Polyuria	0,0%	0,0%	50,3%	73,5%	0,0%
R39 Other symptoms and signs involving the urinary system	0,2%				0,0%
R40 Somnolence, stupor and coma	0,0%				0,0%
R42 Dizziness and giddiness	0,1%	0,0%	3,1%	44,1%	0,0%
R43 Disturbances of smell and taste	0,0%				0,0%
R47 Speech disturbances, not elsewhere classified	0,0%				0,0%
R49 Voice disturbances	1,2%	0,0%	0,9%	3,2%	0,0%
R50 Fever of other and unknown origin	1,1%	0,0%	3,6%	27,4%	0,1%

R51 Headache	0,0%	0,0%	5,3%	0,5%	0,0%
R52 Pain, not elsewhere classified	2,6%	0,1%	4,9%	45,9%	0,1%
R53 Malaise and fatigue	1,2%	0,1%	4,5%	16,2%	0,0%
R54 Senility	3,1%	0,7%	24,5%	31,8%	0,3%
R55 Syncope and collapse	1,5%	0,0%	3,2%	14,3%	0,0%
R56 Convulsions, not elsewhere classified	0,6%	0,1%	11,5%	40,4%	0,0%
R59 Enlarged lymph nodes	0,5%	0,0%	2,3%	52,9%	0,0%
R60 Oedema, not elsewhere classified	0,2%	0,0%	4,5%	10,2%	0,0%
R62 Lack of expected normal physiological development	0,1%	0,0%	23,2%	68,9%	0,0%
R63 Symptoms and signs concerning food and fluid intake	0,9%	0,1%	10,0%	28,0%	0,1%
R68 Other general symptoms and signs	12,8%	0,1%	0,5%	21,4%	0,1%
R69 Unknown and unspecified causes of morbidity	32,5%	0,3%	0,8%	13,7%	0,3%
R70-R79 Abnormal findings on examination of blood, without diagnosis	2,3%	0,1%	3,4%	22,1%	0,1%
R87 Abnormal findings in specimens from female genital organs	0,3%	0,0%	2,5%	5,2%	0,0%
R95-R99 Ill-defined and unknown causes of mortality	0,0%				0,0%
S00-S09 Injuries to the head	3,2%	0,4%	11,4%	29,4%	0,2%
S10-S19 Injuries to the neck	0,4%	0,0%	8,1%	21,9%	0,0%
S20-S29 Injuries to the thorax	0,6%	0,2%	27,9%	31,5%	0,1%
S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis	0,8%	0,3%	41,6%	36,7%	0,1%
S40-S49 Injuries to the shoulder and upper arm	1,1%	0,1%	12,2%	19,3%	0,1%
S50-S59 Injuries to the elbow and forearm	0,3%	0,0%	7,3%	16,6%	0,0%
S60-S69 Injuries to the wrist and hand	1,2%	0,0%	4,0%	13,4%	0,0%
S70-S79 Injuries to the hip and thigh	4,3%	2,8%	64,2%	55,2%	1,4%
S80-S89 Injuries to the knee and lower leg	0,7%	0,2%	27,7%	17,3%	0,0%
S90-S99 Injuries to the ankle and foot	1,0%	0,2%	16,5%	16,6%	0,0%
T00-T07 Injuries involving multiple body regions	2,0%	0,5%	25,6%	39,1%	0,3%
T08-T14 Injuries to unspecified part of trunk, limb or body region	7,5%	0,3%	4,0%	26,1%	0,2%
T15-T19 Effects of foreign body entering through natural orifice	0,2%	0,0%	1,0%	0,3%	0,0%
T20-T32 Burns and corrosions	0,3%	0,1%	41,7%	61,2%	0,1%
T33-T35 Frostbite	0,0%				0,0%
T36-T50 Poisoning by drugs, medicaments and biological substances	1,5%	0,0%	1,3%	13,8%	0,0%
T51-T65 Toxic effects of substances chiefly nonmedicinal as to source	0,1%				0,0%
T66-T78 Other and unspecified effects of external causes	0,7%	0,1%	7,9%	9,4%	0,0%
T79-T79 Certain early complications of trauma	0,0%				0,0%
T80-T88 Complications of surgical and medical care, not elsewhere	2,0%	0,6%	32,1%	47,5%	0,4%

classified					
T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes	0,9%	0,1%	12,0%	24,6%	0,0%
Z00-Z13 Persons encountering health services for examination and investigation	5,5%	0,2%	4,2%	30,2%	0,2%
Z20-Z29 Persons with potential health hazards related to communicable diseases	0,0%				0,0%
Z30-Z39 Persons encountering health services in circumstances related to reproduction	3,9%	1,2%	29,5%	26,6%	0,4%
Z40-Z54 Persons encountering health services for specific procedures and health care	16,3%	2,0%	12,0%	42,4%	1,4%
Z80-Z99 Persons with potential health hazards related to family and personal history and certain conditions influencing health status	13,9%	0,3%	2,4%	56,2%	0,5%

Appendix 1b. Five parameters for top-2-5% beneficiaries.

ICD10-subchapter (condition)	Prevalence	% as most cost incurring condition	% most cost incurring / prevalence	% of costs by most cost incurring condition	% of total costs
A00-A09 Intestinal infectious diseases	0,5%	0,2%	32,6%	32,5%	0,1%
A15-A19 Tuberculosis	0,1%	0,0%	22,5%	32,3%	0,0%
A20-A28 Certain zoonotic bacterial diseases	0,0%				
A30-A49 Other bacterial diseases	1,0%	0,6%	61,2%	39,8%	0,3%
A50-A64 Infections with a predominantly sexual mode of transmission	0,2%	0,0%	8,9%	9,2%	0,0%
A65-A69 Other spirochaetal diseases	0,0%	0,0%	14,8%	23,3%	0,0%
B00-B09 Viral infections characterized by skin and mucous membrane lesions	0,4%	0,0%	2,4%	4,8%	0,0%
B15-B19 Viral hepatitis	0,3%	0,1%	22,3%	13,8%	0,0%
B20-B24 Human immunodeficiency virus [HIV] disease	3,5%	2,2%	61,4%	13,3%	0,3%
B25-B34 Other viral diseases	0,1%	0,0%	29,4%	38,2%	0,0%
B50-B64 Protozoal diseases	0,0%	0,0%	50,6%	16,2%	0,0%
B85-B89 Pediculosis, acariasis and other infestations	0,0%	0,0%	23,8%	40,0%	0,0%
B99-B99 Other infectious diseases	0,3%	0,1%	42,5%	43,8%	0,1%
C00-C14 Malignant neoplasms of lip, oral cavity and pharynx	0,5%	0,2%	47,5%	45,8%	0,1%
C15-C26 Malignant neoplasms of digestive organs	3,8%	2,5%	67,2%	56,7%	1,8%
C30-C39 Malignant neoplasms of respiratory and intrathoracic organs	2,7%	1,6%	59,1%	52,1%	1,1%
C40-C41 Malignant neoplasms of bone and articular cartilage	0,1%	0,0%	28,6%	56,8%	0,0%
C43-C44 Melanoma and other malignant neoplasms of skin	3,0%	0,4%	12,2%	25,5%	0,2%
C45-C49 Malignant neoplasms of mesothelial and soft tissue	0,3%	0,2%	54,7%	47,6%	0,1%
C50-C50 Malignant neoplasm of breast	3,8%	2,5%	65,6%	60,1%	1,8%
C51-C58 Malignant neoplasms of female genital organs	0,9%	0,6%	64,3%	59,1%	0,4%
C60-C63 Malignant neoplasms of male genital organs	2,2%	0,7%	32,3%	53,2%	0,5%
C64-C68 Malignant neoplasms of urinary tract	2,8%	1,5%	53,6%	57,0%	1,0%
C69-C72 Malignant neoplasms of eye, brain and other parts of central nervous system	0,3%	0,1%	30,6%	50,3%	0,1%
C73-C75 Malignant neoplasms of thyroid and other endocrine glands	0,2%	0,1%	49,4%	57,0%	0,1%
C76-C80 Malignant neoplasms of ill-defined, secondary and unspecified sites	1,5%	0,5%	34,4%	46,6%	0,4%
C81-C96 Malignant neoplasms, stated or presumed to be primary, of	1,6%	0,8%	53,3%	40,1%	0,4%

lymphoid, haematopoietic and related tissue					
D00-D09 In situ neoplasms	1,8%	0,1%	4,1%	10,8%	0,1%
D10-D36 Benign neoplasms	4,6%	0,5%	11,8%	34,2%	0,4%
D37-D48 Neoplasms of uncertain or unknown behaviour	1,6%	0,6%	38,4%	50,3%	0,4%
D50-D53 Nutritional anaemias	1,0%	0,2%	18,1%	33,2%	0,1%
D55-D59 Haemolytic anaemias	0,2%	0,1%	35,0%	37,6%	0,0%
D60-D64 Aplastic and other anaemias	0,3%	0,1%	21,0%	33,6%	0,0%
D65-D69 Coagulation defects, purpura and other haemorrhagic conditions	0,4%	0,1%	22,5%	32,3%	0,0%
D70-D77 Other diseases of blood and blood-forming organs	0,2%	0,0%	20,5%	34,0%	0,0%
D80-D89 Certain disorders involving the immune mechanism	0,3%	0,1%	36,0%	24,3%	0,0%
E00-E07 Disorders of thyroid gland	4,8%	0,1%	2,4%	34,3%	0,1%
E10-E14 Diabetes mellitus	12,2%	1,1%	9,3%	33,5%	0,5%
E20-E35 Disorders of other endocrine glands	1,1%	0,3%	31,5%	11,7%	0,1%
E40-E46 Malnutrition	0,3%	0,1%	16,8%	21,4%	0,0%
E50-E64 Other nutritional deficiencies	0,0%	0,0%	16,9%	40,7%	0,0%
E65-E68 Obesity and other hyperalimentation	1,4%	1,0%	70,5%	72,4%	0,6%
E70-E90 Metabolic disorders	2,3%	0,4%	16,1%	33,2%	0,2%
F00-F09 Organic, including symptomatic, mental disorders	3,0%	0,5%	17,3%	38,6%	0,3%
F10-F19 Mental and behavioural disorders due to psychoactive substance use	3,3%	1,8%	55,4%	51,5%	1,1%
F20-F29 Schizophrenia, schizotypal and delusional disorders	3,7%	2,1%	55,2%	59,0%	1,3%
F30-F39 Mood [affective] disorders	12,5%	2,7%	22,0%	49,8%	1,5%
F40-F48 Neurotic, stress-related and somatoform disorders	2,9%	1,6%	57,7%	53,9%	1,0%
F50-F59 Behavioural syndromes associated with physiological disturbances and physical factors	0,5%	0,3%	54,6%	65,7%	0,2%
F60-F69 Disorders of adult personality and behaviour	2,3%	1,6%	71,8%	57,7%	1,0%
F70-F79 Mental retardation	0,1%	0,0%	14,8%	11,6%	0,0%
F80-F89 Disorders of psychological development	1,0%	0,7%	70,8%	67,0%	0,5%
F90-F98 Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1,6%	0,8%	47,7%	74,0%	0,6%
F99-F99 Unspecified mental disorder	7,9%	1,0%	12,8%	43,6%	0,8%
G00-G09 Inflammatory diseases of the central nervous system	0,3%	0,1%	42,7%	50,3%	0,1%
G10-G14 Systemic atrophies primarily affecting the central nervous system	0,1%	0,0%	22,6%	21,3%	0,0%

G20-G26 Extrapyramidal and movement disorders	8,4%	0,2%	2,3%	27,7%	0,1%
G35-G37 Demyelinating diseases of the central nervous system	1,1%	0,6%	58,9%	10,7%	0,1%
G40-G47 Episodic and paroxysmal disorders	7,6%	1,3%	16,5%	33,7%	0,8%
G50-G59 Nerve, nerve root and plexus disorders	2,0%	0,2%	8,9%	23,4%	0,1%
G60-G64 Polyneuropathies and other disorders of the peripheral nervous system	0,8%	0,1%	10,3%	31,6%	0,1%
G70-G73 Diseases of myoneural junction and muscle	0,3%	0,1%	19,4%	30,3%	0,0%
G80-G83 Cerebral palsy and other paralytic syndromes	0,0%	0,0%	18,4%	7,5%	0,0%
G90-G99 Other disorders of the nervous system	1,6%	0,3%	16,2%	41,5%	0,2%
H00-H06 Disorders of eyelid, lacrimal system and orbit	1,4%	0,1%	4,2%	14,5%	0,0%
H10-H13 Disorders of conjunctiva	1,2%	0,0%	1,1%	6,2%	0,0%
H15-H22 Disorders of sclera, cornea, iris and ciliary body	0,9%	0,1%	8,8%	18,1%	0,0%
H25-H28 Disorders of lens	4,6%	0,5%	11,0%	16,6%	0,3%
H30-H36 Disorders of choroid and retina	6,3%	0,8%	12,3%	39,9%	0,4%
H40-H42 Glaucoma	3,8%	0,0%	1,3%	5,2%	0,0%
H43-H45 Disorders of vitreous body and globe	0,7%	0,0%	3,8%	19,2%	0,0%
H46-H48 Disorders of optic nerve and visual pathways	0,6%	0,0%	2,0%	10,4%	0,0%
H49-H52 Disorders of ocular muscles, binocular movement, accommodation and refraction	0,9%	0,0%	1,5%	11,1%	0,0%
H53-H54 Visual disturbances and blindness	0,4%	0,0%	1,2%	1,0%	0,0%
H55-H59 Other disorders of eye and adnexa	1,8%	0,0%	0,9%	1,2%	0,0%
H60-H62 Diseases of external ear	1,4%	0,1%	6,2%	37,9%	0,1%
H65-H75 Diseases of middle ear and mastoid	1,3%	0,2%	13,6%	43,5%	0,1%
H80-H83 Diseases of inner ear	0,7%	0,1%	7,1%	25,8%	0,0%
H90-H95 Other disorders of ear	1,9%	0,1%	3,5%	34,5%	0,1%
I00-I02 Acute rheumatic fever	0,0%	0,0%	28,9%	61,4%	0,0%
I05-I09 Chronic rheumatic heart diseases	0,0%	0,0%	72,3%	82,8%	0,0%
I10-I15 Hypertensive diseases	6,6%	0,1%	1,9%	23,2%	0,1%
I20-I25 Ischaemic heart diseases	11,0%	5,4%	49,1%	51,9%	3,3%
I26-I28 Pulmonary heart disease and diseases of pulmonary circulation	0,8%	0,3%	33,4%	34,0%	0,1%
I30-I33 Pericarditis/endocarditis	0,4%	0,1%	30,2%	50,9%	0,1%
I34-I39 Valve disorders	2,6%	0,2%	7,9%	35,8%	0,2%
I40-I41 Myocarditis	0,0%	0,0%	57,9%	36,0%	0,0%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	8,9%	3,1%	35,0%	59,1%	2,2%

I50 Heart failure	4,6%	1,7%	36,7%	43,7%	1,0%
I51-I52 Complications/ill-defined descriptions, other heart disorders	3,3%	0,2%	7,2%	60,0%	0,3%
I60-I69 Cerebrovascular diseases	3,6%	2,2%	60,2%	55,4%	1,5%
I70-I79 Diseases of arteries, arterioles and capillaries	5,1%	2,0%	39,6%	59,0%	1,5%
I80-I89 Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	3,3%	0,3%	9,6%	26,9%	0,2%
I95-I99 Other and unspecified disorders of the circulatory system	3,7%	0,1%	3,7%	20,9%	0,2%
J00-J06 Acute upper respiratory infections	0,5%	0,0%	10,1%	21,0%	0,0%
J09-J18 Influenza and pneumonia	3,1%	1,6%	53,0%	38,4%	0,8%
J20-J22 Other acute lower respiratory infections	0,5%	0,2%	32,2%	32,4%	0,1%
J30-J39 Other diseases of upper respiratory tract	1,8%	0,2%	12,6%	32,6%	0,1%
J40-J47 Chronic lower respiratory diseases	13,6%	1,8%	13,6%	35,4%	0,9%
J60-J70 Lung diseases due to external agents	0,0%				
J80-J84 Other respiratory diseases principally affecting the interstitium	0,5%	0,2%	31,8%	40,1%	0,1%
J85-J86 Suppurative and necrotic conditions of lower respiratory tract	0,1%	0,0%	24,5%	47,7%	0,0%
J90-J94 Other diseases of pleura	0,9%	0,3%	36,7%	51,2%	0,2%
J95-J99 Other diseases of the respiratory system	1,3%	0,2%	17,1%	38,4%	0,2%
K00-K14 Diseases of oral cavity, salivary glands and jaws	0,2%	0,0%	2,7%	21,6%	0,0%
K20-K31 Diseases of oesophagus, stomach and duodenum	2,9%	0,5%	16,4%	32,0%	0,3%
K35-K38 Diseases of appendix	0,3%	0,2%	54,8%	47,3%	0,1%
K40-K46 Hernia	1,3%	0,4%	32,5%	39,5%	0,2%
K50-K52 Noninfective enteritis and colitis	2,6%	1,3%	50,0%	21,5%	0,4%
K55-K64 Other diseases of intestines	4,0%	1,1%	27,6%	42,5%	0,7%
K65-K67 Diseases of peritoneum	0,3%	0,2%	59,0%	49,0%	0,1%
K70-K77 Diseases of liver	1,0%	0,4%	35,7%	42,1%	0,2%
K80-K87 Disorders of gallbladder, biliary tract and pancreas	2,3%	1,4%	62,2%	53,2%	0,8%
K90-K93 Other diseases of the digestive system	3,5%	0,8%	22,0%	42,6%	0,5%
L00-L08 Infections of the skin and subcutaneous tissue	2,1%	0,5%	24,1%	38,1%	0,3%
L10-L14 Bullous disorders	0,5%	0,0%	4,6%	22,2%	0,0%
L20-L30 Dermatitis and eczema	2,0%	0,1%	3,9%	24,2%	0,1%
L40-L45 Papulosquamous disorders	1,1%	0,3%	28,4%	7,8%	0,0%
L50-L54 Urticaria and erythema	0,1%	0,0%	3,2%	32,7%	0,0%
L60-L75 Disorders of skin appendages	0,7%	0,0%	3,0%	9,3%	0,0%

L80-L99 Other disorders of the skin and subcutaneous tissue	2,4%	0,2%	8,4%	22,5%	0,1%
M00-M03 Infectious arthropathies	0,1%	0,0%	38,5%	44,5%	0,0%
M05-M14 Inflammatory polyarthropathies	6,6%	2,0%	31,1%	11,7%	0,4%
M15-M19 Arthrosis	9,3%	6,7%	72,4%	71,5%	4,5%
M20-M25 Other joint disorders	3,6%	0,7%	20,6%	41,2%	0,4%
M30-M36 Systemic connective tissue disorders	1,3%	0,3%	19,9%	34,0%	0,1%
M40-M43 Deforming dorsopathies	0,3%	0,1%	31,2%	68,8%	0,1%
M45-M49 Spondylopathies	2,4%	0,9%	37,5%	36,5%	0,4%
M50-M54 Other dorsopathies	5,5%	1,7%	30,3%	45,3%	1,0%
M60-M63 Disorders of muscles	0,2%	0,0%	6,0%	9,5%	0,0%
M65-M68 Disorders of synovium and tendon	0,5%	0,0%	6,5%	16,2%	0,0%
M70-M79 Other soft tissue disorders	2,6%	0,4%	14,5%	34,3%	0,2%
M80-M85 Disorders of bone density and structure	1,4%	0,1%	6,2%	18,9%	0,1%
M86-M90 Other osteopathies	1,0%	0,2%	19,4%	45,3%	0,1%
M91-M94 Chondropathies	0,1%	0,0%	27,4%	57,0%	0,0%
M95-M99 Other disorders of the musculoskeletal system and connective tissue	0,2%	0,0%	22,7%	45,3%	0,0%
N00-N08 Glomerular diseases	0,2%	0,1%	31,9%	45,5%	0,0%
N10-N16 Renal tubulo-interstitial diseases	0,7%	0,3%	38,2%	47,5%	0,2%
N17-N19 Renal failure	3,8%	1,1%	28,8%	36,4%	0,6%
N20-N23 Urolithiasis	1,0%	0,5%	45,7%	51,8%	0,3%
N25-N29 Other disorders of kidney and ureter	0,8%	0,1%	14,4%	39,5%	0,1%
N30-N39 Other diseases of urinary system	4,9%	1,0%	20,1%	28,5%	0,5%
N40-N51 Diseases of male genital organs	2,9%	0,5%	16,1%	38,0%	0,3%
N60-N64 Disorders of breast	0,9%	0,0%	4,8%	17,0%	0,0%
N70-N77 Inflammatory diseases of female pelvic organs	0,6%	0,0%	6,7%	27,8%	0,0%
N80-N98 Noninflammatory disorders of female genital tract	3,9%	1,0%	25,2%	42,8%	0,5%
O00-O08 Pregnancy with abortive outcome	0,5%	0,1%	21,0%	35,7%	0,1%
O20-O29 Other maternal disorders predominantly related to pregnancy	0,3%	0,0%	0,2%	15,5%	0,0%
O60-O75 Complications of labour and delivery	0,2%	0,0%	23,1%	28,4%	0,0%
O80-O84 Delivery	3,3%	1,6%	48,0%	35,2%	0,7%
O94-O99 Other obstetric conditions, not elsewhere classified	3,2%	1,3%	40,8%	45,9%	0,7%
P20-P29 Respiratory and cardiovascular disorders specific to the perinatal period	0,0%	0,0%	22,5%	24,5%	0,0%

P50-P61 Haemorrhagic and haematological disorders of fetus and newborn	0,0%	0,0%	35,4%	33,5%	0,0%
Q00-Q07 Congenital malformations of the nervous system	0,1%	0,0%	23,6%	24,0%	0,0%
Q10-Q18 Congenital malformations of eye, ear, face and neck	0,6%	0,0%	4,5%	21,5%	0,0%
Q20-Q28 Congenital malformations of the circulatory system	0,4%	0,2%	44,2%	46,4%	0,1%
Q30-Q34 Congenital malformations of the respiratory system	0,0%	0,0%	16,5%	50,5%	0,0%
Q35-Q37 Cleft lip and cleft palate	0,0%	0,0%	58,5%	41,8%	0,0%
Q38-Q45 Other congenital malformations of the digestive system	0,0%	0,0%	38,0%	54,5%	0,0%
Q50-Q56 Congenital malformations of genital organs	0,1%	0,0%	31,8%	50,0%	0,0%
Q60-Q64 Congenital malformations of the urinary system	0,1%	0,0%	25,4%	50,8%	0,0%
Q65-Q79 Congenital malformations and deformations of the musculoskeletal system	0,3%	0,1%	39,6%	56,5%	0,1%
Q80-Q89 Other congenital malformations	0,1%	0,0%	15,5%	15,2%	0,0%
Q90-Q99 Chromosomal abnormalities, not elsewhere classified	0,1%	0,0%	24,3%	9,4%	0,0%
R01 Cardiac murmurs and other cardiac sounds	0,0%	0,0%	23,0%	27,1%	0,0%
R04 Haemorrhage from respiratory passages	0,7%	0,1%	9,9%	27,6%	0,0%
R05 Cough	0,2%	0,0%	9,2%	16,1%	0,0%
R06 Abnormalities of breathing	1,8%	0,3%	17,2%	45,1%	0,2%
R07 Pain in throat and chest	0,3%	0,0%	6,7%	26,6%	0,0%
R09 Other symptoms and signs involving the circulatory and respiratory systems	0,0%	0,0%	41,6%	34,8%	0,0%
R10 Abdominal and pelvic pain	1,7%	0,2%	9,6%	30,7%	0,1%
R11 Nausea and vomiting	0,0%				0,0%
R13 Dysphagia	0,8%	0,0%	4,1%	17,7%	0,0%
R15 Faecal incontinence	0,1%	0,1%	45,9%	61,1%	0,0%
R22.1 Localized swelling, mass and lump, neck	0,1%	0,0%	7,8%	16,0%	0,0%
R26 Abnormalities of gait and mobility	0,1%	0,0%	13,7%	24,2%	0,0%
R29 Other symptoms and signs involving the nervous and musculoskeletal systems	1,1%	0,1%	6,1%	35,1%	0,1%
R31 Unspecified haematuria	0,0%	0,0%	8,3%	21,1%	0,0%
R32 Unspecified urinary incontinence	0,0%	0,0%	5,6%	2,3%	0,0%
R35 Polyuria	0,0%	0,0%	28,9%	19,2%	0,0%
R39 Other symptoms and signs involving the urinary system	0,2%	0,0%	9,4%	26,9%	0,0%
R40 Somnolence, stupor and coma	0,0%	0,0%	25,3%	25,4%	0,0%
R42 Dizziness and giddiness	0,1%	0,0%	9,8%	34,2%	0,0%

R43 Disturbances of smell and taste	0,0%	0,0%	4,0%	70,7%	0,0%
R47 Speech disturbances, not elsewhere classified	0,0%	0,0%	2,5%	11,9%	0,0%
R49 Voice disturbances	0,8%	0,0%	4,8%	20,0%	0,0%
R50 Fever of other and unknown origin	0,4%	0,1%	24,3%	38,8%	0,1%
R51 Headache	0,0%	0,0%	5,8%	36,0%	0,0%
R52 Pain, not elsewhere classified	1,2%	0,1%	10,4%	31,1%	0,1%
R53 Malaise and fatigue	0,8%	0,1%	14,8%	35,6%	0,1%
R54 Senility	2,1%	1,0%	45,4%	49,8%	0,6%
R55 Syncope and collapse	0,7%	0,1%	14,3%	31,2%	0,1%
R56 Convulsions, not elsewhere classified	0,5%	0,1%	22,5%	44,5%	0,1%
R59 Enlarged lymph nodes	0,2%	0,0%	8,3%	27,2%	0,0%
R60 Oedema, not elsewhere classified	0,1%	0,0%	14,8%	28,4%	0,0%
R62 Lack of expected normal physiological development	0,0%	0,0%	30,3%	33,6%	0,0%
R63 Symptoms and signs concerning food and fluid intake	0,5%	0,1%	21,3%	33,5%	0,1%
R68 Other general symptoms and signs	5,3%	0,1%	2,3%	33,9%	0,1%
R69 Unknown and unspecified causes of morbidity	13,6%	0,3%	1,9%	34,5%	0,3%
R70-R79 Abnormal findings on examination of blood, without diagnosis	1,1%	0,2%	14,3%	33,3%	0,1%
R87 Abnormal findings in specimens from female genital organs	0,6%	0,0%	6,5%	18,1%	0,0%
R95-R99 Ill-defined and unknown causes of mortality	0,0%				0,0%
S00-S09 Injuries to the head	2,0%	0,3%	13,9%	37,0%	0,2%
S10-S19 Injuries to the neck	0,1%	0,0%	21,4%	48,5%	0,0%
S20-S29 Injuries to the thorax	0,4%	0,2%	41,0%	49,7%	0,1%
S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis	0,4%	0,2%	51,1%	40,1%	0,1%
S40-S49 Injuries to the shoulder and upper arm	1,0%	0,3%	35,3%	41,5%	0,2%
S50-S59 Injuries to the elbow and forearm	0,3%	0,1%	36,9%	41,5%	0,1%
S60-S69 Injuries to the wrist and hand	1,3%	0,2%	18,6%	31,5%	0,1%
S70-S79 Injuries to the hip and thigh	2,5%	2,2%	85,2%	62,4%	1,5%
S80-S89 Injuries to the knee and lower leg	0,7%	0,3%	46,6%	46,8%	0,2%
S90-S99 Injuries to the ankle and foot	1,1%	0,4%	34,8%	47,3%	0,2%
T00-T07 Injuries involving multiple body regions	0,9%	0,2%	22,4%	38,0%	0,1%
T08-T14 Injuries to unspecified part of trunk, limb or body region	5,1%	0,4%	8,3%	34,1%	0,3%
T15-T19 Effects of foreign body entering through natural orifice	0,1%	0,0%	8,5%	27,6%	0,0%
T20-T32 Burns and corrosions	0,1%	0,0%	28,3%	59,6%	0,0%
T33-T35 Frostbite	0,0%	0,0%	50,6%	2,7%	0,0%

T36-T50 Poisoning by drugs, medicaments and biological substances	0,6%	0,0%	7,4%	22,1%	0,0%
T51-T65 Toxic effects of substances chiefly nonmedicinal as to source	0,0%	0,0%	5,8%	18,4%	0,0%
T66-T78 Other and unspecified effects of external causes	0,4%	0,1%	17,7%	25,6%	0,0%
T79-T79 Certain early complications of trauma	0,0%	0,0%	33,8%	48,6%	0,0%
T80-T88 Complications of surgical and medical care, not elsewhere classified	1,2%	0,7%	54,8%	66,7%	0,5%
T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes	0,8%	0,2%	20,1%	43,1%	0,1%
Z00-Z13 Persons encountering health services for examination and investigation	3,8%	0,3%	8,6%	28,7%	0,2%
Z20-Z29 Persons with potential health hazards related to communicable diseases	0,0%	0,0%	4,1%	1,5%	0,0%
Z30-Z39 Persons encountering health services in circumstances related to reproduction	4,1%	0,7%	17,3%	46,4%	0,5%
Z40-Z54 Persons encountering health services for specific procedures and health care	10,6%	2,7%	25,7%	49,2%	1,8%
Z80-Z99 Persons with potential health hazards related to family and personal history and certain conditions influencing health status	9,6%	0,3%	3,0%	22,1%	0,5%

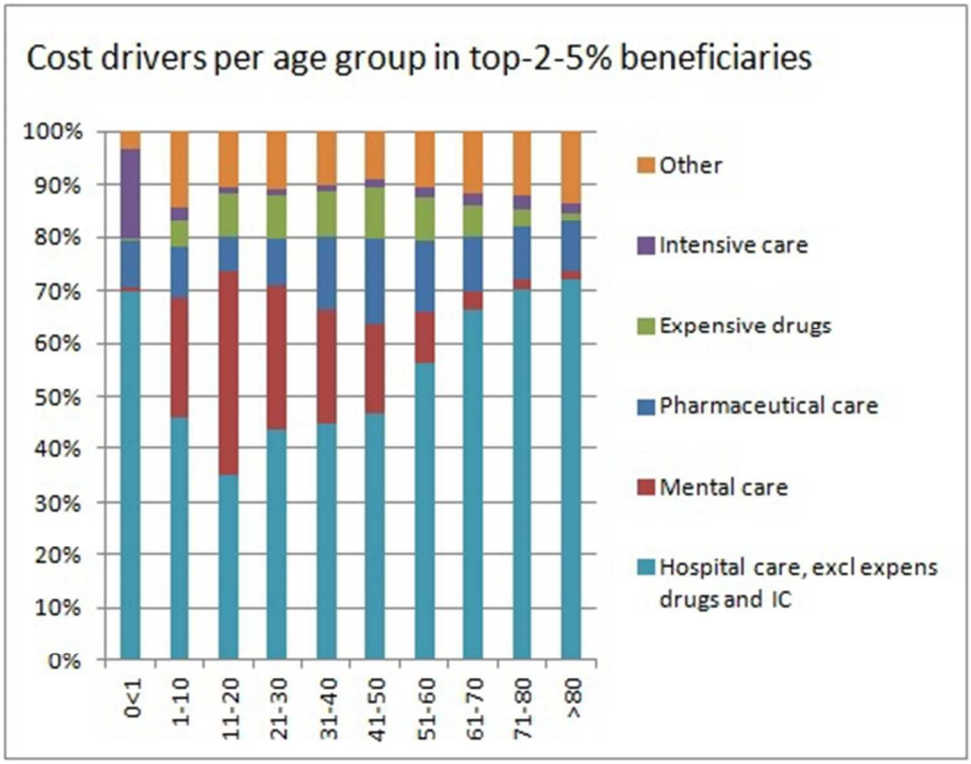
Appendix 2. Cross table describing patterns of health care use and demographics of top-2-5% beneficiaries.

ICD10-chapter	Prevalence	% most cost incurring ICD10-chapter	Average age	Percentage dying	Percentage men	Average number of comor (ICD-chapter)	Average cost (*€1000)	Expensive drugs (*€1000)	Intensive care (*€1000)	Neoplasm (*€1000)	Mental and behavioural disorders (*€1000)	Diseases circulatory system (*€1000)	Diseases musculoskeletal system (*€1000)
Certain infectious and parasitic diseases	6.3%	3.2%	53.6	5.0%	70.8%	3.4	15	794	1,597	656	723	955	432
Neoplasms	27.4%	13.0%	65.9	14.8%	46.8%	3.2	17	28,980	6,602	224,741	2,120	6,267	2,829
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	2.4%	0.6%	57.3	5.7%	46.6%	4.1	16	2,138	242	244	124	351	157
Endocrine, nutritional and metabolic diseases	20.2%	2.9%	42.3	2.0%	38.0%	3.4	15	6,748	1,122	518	1,051	955	662
Mental and behavioural disorders	26.6%	13.1%	41.1	1.0%	48.4%	2.6	16	4,216	2,067	1,597	217,204	3,339	3,022
Diseases of the nervous system	23.4%	2.8%	52.9	4.5%	44.7%	3.7	16	5,475	1,737	617	1,071	1,575	949
Diseases of the eye and adnexa	19.2%	1.5%	71.9	1.5%	42.4%	3.7	14	4,875	194	494	201	790	487
Diseases of the ear and mastoid process	4.9%	0.4%	48.4	1.1%	50.5%	3.4	14	654	70	72	176	116	88
Diseases of the circulatory system	40.3%	16.0%	69.3	8.1%	56.4%	3.7	17	5,085	17,064	5,430	3,416	267,652	4,555
Diseases of the respiratory system	19.2%	4.7%	66.6	13.0%	48.3%	3.9	16	4,054	6,835	2,491	1,582	4,232	1,431
Diseases of the digestive system	15.7%	6.1%	57.0	5.3%	44.4%	3.7	16	28,002	5,754	2,491	1,971	3,481	1,937
Diseases of the skin and subcutaneous tissue	8.2%	1.1%	58.7	3.5%	50.9%	3.5	15	8,449	217	271	250	566	336
Diseases of the musculoskeletal system and connective tissue	27.4%	13.4%	62.8	0.6%	35.1%	3.1	15	55,769	1,011	2,948	2,428	5,520	187,982
Diseases of the genitourinary system	17.0%	4.5%	59.3	4.8%	43.9%	3.8	15	3,545	1,993	2,235	1,259	2,411	1,445
Pregnancy, childbirth and the puerperium	4.0%	3.2%	31.0	0.0%	0.0%	2.7	13	884	564	178	1,661	413	348
Certain conditions originating in the perinatal period	0.0%	0.0%	0.0	0.0%	37.5%	2.6	18	0	26	0	0	0	0
Congenital malformations, deformations and chromosomal abnormalities	1.8%	0.5%	14.5	0.5%	54.7%	3.0	16	945	743	63	127	145	80
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	28.2%	3.0%	66.4	15.1%	40.9%	4.0	16	2,223	2,390	1,266	1,354	2,338	1,066
Injury, poisoning and certain other consequences of external causes	15.9%	6.1%	67.8	9.2%	36.4%	3.5	16	1,957	4,388	1,497	2,283	3,554	3,483
Factors influencing health status and contact with health services	24.2%	3.9%	37.9	0.9%	40.8%	3.3	15	3,409	5,022	1,495	1,549	2,180	1,749

Appendix 3. Top-2-5% beneficiaries according to age group[†].

Age group	<1	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	>80
Number	1902	4311	6451	10612	14757	20971	26916	34047	33895	26964
Average per capita costs	€ 15,668	€ 15,704	€ 68,220	€ 14,900	€ 14,926	€ 15,648	€ 15,811	€ 15,971	€ 16,087	€ 16,038
Most important ICD-subchapters in terms of costs and share of total costs among the age group.	Factors influencing health status and contact with health services 33.8%	Mental and behavioral disorders 22.3%	Mental and behavioral disorders 35.5%	Mental and behavioral disorders 22.2%	Mental and behavioral disorders 17.6%	Mental and behavioral disorders 14.0%	Diseases of the circulatory system 10.2%	Neoplasms 13.8%	Diseases of the circulatory system 15.6%	Diseases of the circulatory system 17.0%
	Congenital malformations, deformations and chromosomal abnormalities 7.6%	Factors influencing health status and contact with health services 8.5%	Factors influencing health status and contact with health services 3.9%	Pregnancy, childbirth and the puerperium 12.9%	Pregnancy, childbirth and the puerperium 12.9%	Neoplasms 6.6%	Neoplasms 10.2%	Diseases of the circulatory system 13.7%	Neoplasms 12.2%	Injury, poisoning and certain other consequences of external causes 10.9%
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 5.2%	Endocrine, nutritional and metabolic diseases 3.7%	Endocrine, nutritional and metabolic diseases 3.8%	Diseases of the digestive system 3.7%	Factors influencing health status and contact with health services 4.2%	Diseases of the circulatory system 6.1%	Diseases of the musculoskeletal system and connective tissue 8.2%	Diseases of the musculoskeletal system and connective tissue 11.0%	Diseases of the musculoskeletal system and connective tissue 10.8%	Neoplasms 7.2%
	Diseases of the digestive system 3.3%	Congenital malformations, deformations and chromosomal abnormalities 3.6%	Injury, poisoning and certain other consequences of external causes 3.1%	Factors influencing health status and contact with health services 3.5%	Diseases of the musculoskeletal system and connective tissue 3.3%	Diseases of the musculoskeletal system and connective tissue 5.6%	Mental and behavioral disorders 8.0%	Diseases of the digestive system 3.4%	Injury, poisoning and certain other consequences of external causes 4.8%	Diseases of the musculoskeletal system and connective tissue 6.1%
	Diseases of the respiratory system 2.7%	Diseases of the nervous system 2.7%	Diseases of the musculoskeletal system and connective tissue 2.9%	Diseases of the musculoskeletal system and connective tissue 2.3%	Diseases of the genitourinary system 3.2%	Factors influencing health status and contact with health services 2.6%	Diseases of the digestive system 3.5%	Injury, poisoning and certain other consequences of external causes 3.4%	Diseases of the respiratory system 3.7%	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 5.1%

[†] Total costs per ICD-chapter were summed per age group. In the table, the five ICD10-chapters with highest costs per age group are presented. I.e. among beneficiaries 1-10 years old, 22.3% of total costs were accounted for treatments for mental and behavioral disorders.



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Abstract

Objective: To determine medical needs, demographic characteristics and healthcare utilization patterns of the top-1% and top-2-5% high-cost beneficiaries in the Netherlands.

Design: Cross-sectional study using 1-year claim data. We broke down high-cost beneficiaries by demographics, the most cost-incurring condition per beneficiary, and expensive treatment use.

Setting: Dutch curative health system, a health system with universal coverage.

Participants: 4.5 million beneficiaries of one health insurer.

Measures: annual total costs through hospital, intensive care unit use, expensive drugs, other pharmaceuticals, mental care, and others; demographics; most cost-incurring and secondary conditions; inpatient stay; number of morbidities; costs per ICD10-chapter; and expensive treatment use (including dialysis, transplant surgery, expensive drugs, intensive care unit and DRGs >€30,000).

Results: The top-1% and top-2-5% beneficiaries accounted for 23% and 26% of total expenditures respectively. Among top-1% beneficiaries, hospital care represented 76% of spending, of which respectively 9.0% and 9.1% were spent on expensive drugs and ICU care. We found that 54% of top-1% beneficiaries were aged 65 or younger, and that average costs sharply decreased with higher age within the top-1% group. Expensive treatments contributed to high costs in one third of top-1% beneficiaries, and in less than 10% of top-2-5% beneficiaries. The average number of conditions was 5.5 and 4.0 for top-1% and top-2-5% beneficiaries respectively. 53% of top-1% beneficiaries were treated for circulatory disorders, but for only 22% of top-1% beneficiaries this was their most cost-incurring condition.

Conclusions: Expensive treatments, most cost-incurring condition, and age proved to be informative variables for studying this heterogeneous population. Expensive treatments play a substantial role in high-costs beneficiaries. Interventions need to be aimed at beneficiaries of all ages; a sole focus on

elderly would leave many high-cost beneficiaries unaddressed. Tailored interventions are needed to meet the needs of high-cost beneficiaries, and to avoid waste of scarce resources.

Strengths and limitations of this study

- This study presents an in-depth analysis of the medical needs, demographics and healthcare utilization of high-cost beneficiaries in the Netherlands.
- We characterized high-cost beneficiaries and spending patterns using several variables, including expensive treatment use (e.g. dialysis, expensive drugs, ICU), most cost-incurring condition, and age.
- Analyses were limited to one large insurer, but its beneficiaries are representative for the Netherlands.

Introduction

It is known that health care costs are concentrated among small numbers of 'high-cost' beneficiaries. These high-cost beneficiaries are the sickest and most complex populations. Although they receive substantial care from multiple sources, critical health care needs are often unmet, and many receive unnecessary and ineffective care[1-4]. Therefore, high-cost beneficiaries are a useful group on which to focus efforts of quality improvement and cost containment.

For effective quality improvement and cost reduction it is necessary to acquire an in-depth understanding of the characteristics, health care use and other factors that drive the costs of these groups of high-cost beneficiaries[5, 6]. Current literature suggests that a high prevalence of multiple (chronic) conditions may explain high-cost beneficiaries' excessive care use[7, 8]. This presence of multimorbidity among high-cost beneficiaries makes them difficult to understand: how to characterize patients that suffer from several diseases? Lehnert et al[9] found that the number of chronic comorbidities were nearly exponentially related to costs: the higher the number of chronic comorbidities, the higher the costs of an additional comorbidity. Based on this study, we hypothesized that in high-cost beneficiaries the most cost-incurring condition accounts for a disproportionate share of costs, and that secondary conditions account for the remainder of costs.

A major limitation of current literature is that little is known about patterns in care use and characteristics among different age groups[10]. In addition, until today no studies have reported the role of expensive treatments (e.g. expensive drugs, transplant surgery, intensive care units, dialysis) as drivers of high costs. Further insight in healthcare utilization patterns is needed to develop interventions and inform policy aimed at high-need, high-cost populations.

The primary aim of this study was to determine medical needs, demographic characteristics and healthcare utilization patterns of high-cost beneficiaries in the Netherlands. We first determined characteristics and spending and quantified the share of high-cost beneficiaries that use expensive treatments. We then used a beneficiary's most cost-incurring medical condition to examine

characteristics and utilization patterns. In addition, we compared utilization and conditions across age groups. All analyses were performed for top-1% and top-2-5% beneficiaries separately. This distinction is often used in literature[11-14] and may improve understanding of high-cost beneficiaries.

Methods

Design and context

We conducted an cross-sectional study using claims data from 2013 in the Netherlands. In the Netherlands, the Health Insurance Act legally requires health insurers to provide a nationally set benefits package. Nearly universal coverage for curative care is achieved through mandatory purchase of statutory private health insurance [15, 16]. Analyses were done in-house with Zilveren Kruis, a health insurer covering 4.5 million beneficiaries who were primarily living in the central, eastern and western parts of the Netherlands. The basic principle of the Dutch curative health system is that insurers compete for beneficiaries, and that they act as prudent buyers of services for their beneficiaries. Health insurers operate nationwide, are obliged to accept all applicants for basic health plans and are not permitted to risk-rate premiums for these basic plans. Every insured person, aged 18 years or older, is required to pay an annual deductible (350 euro in 2013), from which some services, such as general practice visits, are excluded. In addition to the basic health plan, more than 80% of the population buys voluntary insurance. Premiums for voluntary insurance are not regulated, and insurers are allowed to screen applicants. The system provides a wide range of services, including care provided by general practitioners, hospitals, and specialists; dental care through age 18; prescription drugs; physiotherapy through age 18; most mental care; medical aids and devices; maternity care; transportation and others. In our study we also included private voluntary supplementary insurance which typically covers dental care, some allied healthcare (including

physiotherapy, occupational therapy, dietary advice, speech therapy) and alternative medicine (typically homoeopathy, acupuncture, natural medicine, magnetizing and osteopathy).

Data

All insured in 2013 were included in this study. Several beneficiary characteristics were obtained from the insurer's databases, including gender, socio-economic status based on income estimates per postal code, date of birth and date of death (until February 20th, 2015). Date of death was categorized to four quarters in 2013 and any date post-2013. More information about (a predecessor of) this database is provided in Smeets et al[17].

Total costs per beneficiary were calculated by summing all claims with a starting date in 2013. We defined the beneficiaries with the top-1% and the top-2-5% of total costs as two groups of high-cost beneficiaries. The remaining 95% were categorized as low-cost beneficiaries. All claims were categorized in nine cost groups (health sectors) using a link table provided by the Dutch Healthcare Institute. These sectors included: hospital care (including care used abroad), mental health care, primary care, maternal care, allied health care, outpatient pharmaceutical prescriptions, medical devices, dental care (most dental care is reimbursed through complementary insurance benefits), and voluntary complementary insurance benefits.

Below, we describe how we operationalized the variables that we included in our analysis, including the treatment costs per diagnosis, the prevalence of conditions and multimorbidity count, and the use of specific (expensive) services.

Treatment cost per diagnosis

We categorized and analyzed hospital and mental care costs, according to the ICD10 international classification of diseases[18]. Treatment costs were categorized to the level of ICD10-chapters (e.g. chapter IX: diseases of the circulatory system) and ICD10-subchapters (e.g. subchapter I60-I69 cerebrovascular diseases).

The great majority of hospital care in the Netherlands is reimbursed through payment products similar to Diagnosis Related Group (DRGs, which cover both in- and outpatient hospital care) and so-called add-ons for expensive drugs and treatment at the intensive care unit (ICU). To compute treatment costs per diagnosis, the DRGs were categorized using a link table provided by the Dutch Health Care Authority. This link table (version 22 December 2014) was developed to categorize hospital claims to specific health care needs, following the ICD10 classification [18]. For the purpose of our study, we made a few minor corrections to the link table. As we found the ICD-subchapter I30-I52 (*other circulatory diseases)* highly prevalent but not informative, we decided to disaggregate this subchapter. Add-ons were not used for establishing treatment cost per diagnosis, but are dealt with separately (see "use of specific expensive services").

In 2013, the Dutch mental care sector consisted of 'primary' mental care, such as care provided at general practices, by psychologists and psychotherapists, and at 'secondary' or specialized mental care provided in mental care institutions. Only claims from secondary mental health care were used for characterization as these specify information about diagnoses and treatment. These claims were categorized to the ICD10-(sub)chapter and added to the hospital claims for ICD-10 chapter V: mental and behavioral disorders. Additionally, the number of inpatients days in mental care per beneficiary was calculated (but not used for establishing treatment cost).

Prevalence of conditions and multimorbidity count

Prevalence of conditions was established using the same categorization as described above. In addition, we used parameters from the Dutch risk-adjustment scheme: pharmaceutical cost groups that indicate chronic use of drugs for different conditions. These pharmaceutical cost groups were categorized to ICD10-(sub-)chapters and integrated with the former to establish prevalence of conditions. A detailed description of the Dutch risk-adjustment scheme is provided in van Veen et al[19]. Multimorbidity was operationalized in three ways. First, multimorbidity was calculated by counting the number of prevalent ICD10-chapters per beneficiary. Second, we counted the number

of prevalent ICD10-subchapters per beneficiary. Third, the number of pharmaceutical cost groups was counted, reflecting the number of chronic multimorbidities.

Use of specific (expensive) services

We developed dummy variables for specific types of care. Beneficiaries were regarded 'expensive care users' if their claims included a minimum of €10,000 for 'add-ons' for ICU treatment or expensive drugs. We used €10,000 as threshold because in 2013 expensive drugs only qualified for add-on reimbursement when average yearly costs per beneficiary exceeded this value. *ICU treatment* as reimbursed through add-ons included ICU treatment days, ICU consultations, ICU surcharges for specific services, ICU neonatal and pediatric care, and ICU transport services such as inter-clinical transportation services and Mobile Intensive Care Unit (MICU). *Expensive drugs* reimbursed through add-ons included growth hormones, antineoplastic agents, TNF-alfa inhibitors, orphan drugs, haemostatics and other expensive drugs [20]. The list of drugs and indications that qualify for add-on reimbursement can be found at www.farmatec.nl.

A separate dummy variable 'transplant' was developed, for beneficiaries who received a transplant or transplant-related care (both pre- and post transplant). One DRG-description that included the word 'transplant' was sufficient for a person to qualify as transplant-beneficiary. Similarly, the variable 'dialysis' was created for all beneficiaries receiving dialysis for renal failure (both peritoneal and hemodialysis). In addition, all DRGs with an average price >€30,000 were identified and together included as separate binary variable. This price was chosen as all top-1% beneficiaries incurred €30,000 or more. Furthermore, two dummy variables for mental health use were computed, the first on mental care use (>€0 mental care costs) and the second on inpatient stays (>0 days).The total number of inpatient hospital days per beneficiary was estimated using national averages of hospital days per DRG[21]. Finally, we used claim data to derive the number of different hospitals, university medical centers, and hospital specialisms that beneficiaries were treated at, as well as the number of

ambulance transportations, and emergency department visits. For full details concerning the variable computation, please contact the corresponding author.

Analyses

We explored the composition of expenditures across health sectors for both top-1% and top-2-5% beneficiaries. Demographics, medical characteristics and (expensive) health care use were analyzed using descriptive statistics.

Most cost-incurring and secondary conditions

For each high-cost beneficiary we identified the most cost-incurring ICD10-(sub)chapter. For both top-1% and top-2-5% beneficiaries, we first determined the prevalence of each ICD10-subchapter. Second, for both high-cost groups we summed treatment cost per ICD10-subchapter, and divided this with the sum of total costs. Third, for each ICD10-subchpater we calculated how frequently it was the most cost-incurring condition for the beneficiaries in these groups. Fourth, we divided the percentage of beneficiaries with a ICD10-subchapter as the most cost-incurring condition by the overall prevalence of the ICD10-subchapter. This metric was used to distinguish between ICD10-subchapters that were mainly found as most cost-incurring conditions compared to ICD10-subchapters that were mainly found as secondary conditions. Fifth, for each beneficiary we divided the treatment cost for the most cost-incurring condition by total costs. This figure was averaged for each ICD10-subchapter and determines the contribution of these conditions to total costs within the subpopulation.

Health care use according to most cost-incurring ICD10-chapter and across age groups

To identify patterns in (expensive) health care use, we developed cross-tables with costs per ICD10-chapter, (expensive) health care use indicators and demographic characteristics as descriptive variables. Beneficiaries were selected by the most cost-incurring ICD10-chapter, to prevent that beneficiaries with multimorbidity would be counted several times.

Finally, we compared utilization patterns and conditions across age groups. We examined total costs, spending per sector and we identified the five most cost-incurring ICD10-chapters per age group.

All analyses were performed using SAS 9.4, Enterprise Guide 6.1.

Results

General breakdown of costs

Average total costs for top-1%, top-2-5% and bottom-95% beneficiaries were €56,424, €15,780 and €1,345 respectively, representing 22.8%, 25.5% and 51.7% of total spending (table 1). For top-1% beneficiaries, hospital care represented 76% of costs, of which respectively 9.0% and 9.1% were for expensive drugs and ICU care. 12.7% and 6.6% of costs were for mental health care and outpatient pharmaceuticals. For top-2-5% beneficiaries, hospital care represented 59.7% of spending, of which 6.0% and 2.1% were spent on expensive drugs and ICU care. 9.8% and 11.2% were spent on mental health care and outpatient pharmaceuticals.

Demographics and (expensive) healthcare use

Table 1 presents demographic and medical characteristics of the study population as well as (expensive) healthcare use. Males were overrepresented among top-1% beneficiaries, and females were overrepresented among top-2-5% beneficiaries. Top-1% and top-2-5% beneficiaries were much older than low-cost beneficiaries. Furthermore, high-cost beneficiaries were more likely to die: 9.9% and 6.1% of top-1% and top-2-5% beneficiaries died. However, 63.7% of beneficiaries in our study who died in 2013 or later did not incur high costs in 2013. The average number of morbidities based on ICD10-subchapters for top-1%, top-2-5% and bottom-95% beneficiaries was 5.5, 4.0 and 0.8 respectively.

Table 1 also shows that top-1% and top-2-5% beneficiaries scored higher than low-cost users for each specific service, and top-1% beneficiaries scored higher than top-2-5% beneficiaries. Both top-1% and

top-2-5% beneficiaries used on average one type of drugs (pharmaceutical cost groups) continuously. 24.8% of top-1% and 5.8% of top-2-5% beneficiaries incurred more than €10,000 on expensive drugs and ICU. Furthermore, 6.1% of top-1% beneficiaries underwent dialysis and 3.7% received transplant care. Top-1% and top-2-5% beneficiaries were treated in on average 1.9 and 1.6 hospitals, and used on average 22 and 7 inpatient days respectively. Finally, 13% and 3.3% of top-1% and top-2-5% beneficiaries were admitted to mental care institutions, respectively.

Utilization according to ICD10-subchapters, and most cost-incurring and secondary conditions

Appendix 1 presents five parameters for both high-cost populations. Among those in the top-1%, a high prevalence of several cardiovascular diseases, COPD, diabetes mellitus, and depression were found. In addition, the total treatment costs for renal insufficiency (including dialysis) were much higher than for any other ICD10-subchapter, and accounted for 6.8% of total costs among top-1% beneficiaries. We use table 2, with a selection of ten ICD10-subchapters in top-1% beneficiaries, to illustrate the other parameters for top-1% beneficiaries. Renal insufficiency, certain cancers, and several cardiovascular diseases were frequently found as the most cost-incurring condition among top-1% beneficiaries. Furthermore, for beneficiaries that were treated for cancer, the cancer itself was in most cases the most cost-incurring condition (e.g. 74.3% of beneficiaries with leukemia). In contrast, circulatory disorders were mainly found as secondary condition: for example, in less than 30% of patients with ischemic heart disease or heart failure this was their most cost-incurring condition. Finally, we determined the contribution of ICD10-subchapters towards total costs per beneficiary. The most cost-incurring condition accounted for 40-70% of total costs per beneficiary, depending on the ICD10-subchapter.

Utilization according to most cost-incurring ICD10-chapter

Table 3 and appendix 2 show cross-tables for spending, demographics and indicators for (expensive) healthcare use. In these analyses, beneficiaries were selected by most cost-incurring ICD10-chapter, to avoid multimorbid beneficiaries being analyzed on multiple rows. Among top-1% beneficiaries,

three ICD10-chapters were frequently found as most cost-incurring ICD10-chapter: mental or behavioral disorders, neoplasms and diseases of the circulatory system. These groups had quite different characteristics and utilization. Beneficiaries with mental or behavioral disorders were relatively young, had a low number of morbidities and low mortality. Beneficiaries with neoplasms were the largest subgroup with high mortality. Beneficiaries with diseases of circulatory system were oldest (on average 69 years old) and predominantly men. Expensive drugs were heavily concentrated among beneficiaries with neoplasms. ICU costs were distributed more proportionally; a quarter was incurred by beneficiaries with circulatory diseases.

Among top-2-5% beneficiaries, the same three most cost-incurring ICD10-chapters predominated, albeit they represented a smaller share of the group. Several other ICD10-chapters had relatively high costs, including diseases of the digestive system; injury, poisoning and certain other consequences of external causes (femur fracture most prominently); and diseases of the musculoskeletal system and connective tissue. Beneficiaries with neoplasms; diseases of the respiratory system; and symptoms, signs and abnormal clinical and laboratory findings most frequently died. Expensive drugs were primarily used by beneficiaries with diseases of the musculoskeletal system (rheumatoid arthritis), neoplasms and diseases of the digestive system.

Health care use across age groups

Figure 1 and appendix 3 provide an overview of cost segments per age category among top-1% and top-2-5% beneficiaries. With the exception of infants, treatment at the ICU represented a maximum of 10% of costs per age group. Moreover, treatment at the ICU represented a major cost driver primarily among top-1% beneficiaries. The proportion of costs spent on expensive drugs was highest (13.4% of total costs) among top-1% beneficiaries between 21 and 30 years old. Mental care accounted for a large share of costs among children and young and middle aged adults. The percentage of cost incurred by outpatient and non-expensive pharmaceuticals was more pronounced among top-2-5% beneficiaries than among top-1% beneficiaries.

Table 4 and appendix 4 present the five ICD10-chapters with highest total costs per age group for top-1% and top-2-5% beneficiaries. As mentioned before, we found that high-cost beneficiaries are generally older than low-cost beneficiaries. However, table 4 shows that *within* the top-1% beneficiaries average costs decreased with higher age: average costs ranged from €47,000 on average for top-1% beneficiaries over 80 of age to >€80,000 on average for infants . In addition, 54% of top-1% and 57% of top-2-5% beneficiaries were 65 years of age or younger.

For each age group, there were different ICD10-chapters with highest costs. Among top-1% beneficiaries, cardiovascular diseases and diseases of the genitourinary system gained importance with higher age, whereas mental and behavioral disorders predominated among younger and middle-aged beneficiaries. Among top-2-5% beneficiaries, a similar pattern of diseases across age groups was observed. However, pregnancy-related conditions played a more significant role among beneficiaries between 20 and 40 years of age, and musculoskeletal conditions played a more significant role in several age groups than they did among top-1% beneficiaries.

Discussion

In this study, we determined medical needs, demographics and utilization patterns of high-cost beneficiaries in the Netherlands. Expensive treatments, most cost-incurring condition, and age proved to be informative variables for studying this heterogeneous population. We found that expensive care use (expensive drugs, ICU treatment, dialysis, transplant care, DRG > €30,000) contributed to high costs in one third of top-1% beneficiaries and in less than 10% of top-2-5% beneficiaries. High-cost beneficiaries were overwhelmingly treated for diseases of circulatory system, neoplasms, and mental disorders. However, neoplasms and mental disorders were mainly found as most cost-incurring condition for a beneficiary, whereas circulatory disorders were mainly found as secondary condition. More than 50% of high-cost beneficiaries were 65 years of age or younger, and average costs decreased sharply with higher age within the top-1% population. Such insights are

needed to develop tailored interventions and inform policy aimed at the high-need, high-cost populations.

Strengths and limitations

This was the first study assessing utilization patterns of high-cost beneficiaries in a European universal health system, and we used innovative variables to examine characteristics and utilization. We used data from one health insurer with a market share of approximately 27%, with data representative for the Dutch population. Despite the limited number of variables, our data allowed detailed identification of health care use and categorization of costs towards conditions. We chose to use expensive treatments, most cost-incurring condition and age as variables for further analyses as such analyses were lacking in the literature and we regarded these most informative for policy and practice. One limitation is that our analysis was restricted to one year only. Consequently, we could not discern persistent high-cost users from episodic high-cost users (those with single a high-cost event[5]).

Reflections on our findings

Our findings generally align with prior research on high-cost beneficiaries. Similar to US studies[12, 22], we identified three main subgroups of high-cost beneficiaries with cardiovascular diseases, mental disorders, and neoplasms, as well as several smaller subgroups. In addition, our findings confirm that high-cost beneficiaries are usually treated for several conditions and use care from multiple providers[10]. Like prior studies[12, 22] we reported a high prevalence of diabetes, but this condition had a limited direct cost impact. This may be explained by the fact that Dutch diabetic care is primarily situated in primary care. Moreover, complications of diabetes were aggregated to the particular condition (e.g. retinopathy) using our link table. Furthermore, in line with Aldridge et al[5], we found that dying increases the risk for high costs (data not shown), but that less than ten percent

of high-cost beneficiaries were in their last year of life. However, we also found that 64% of those dying did not incur high costs, compared to 80% of decedents in the US who did incur high costs[5]. This may be explained by decedents that could have used long term care services which were not included in our analyses. However, this may also result from the GP oriented organization of palliative care in the Netherlands, which is known for its low costs[23, 24].

Our study is unique in estimating the relative contribution of expensive treatments in high-cost beneficiaries. The findings indicate that high unit costs for selected services play a substantial role in high-costs beneficiaries. We identified *expensive treatment users* among *expensive patients.* Furthermore, our analyses show expensive treatment users may use a lot of care besides such expensive treatments, suggesting that better alignment of expensive treatments with other care may be worthwhile. In line with Joynt et al, we suggest that expensive procedures (including orthopedic surgery, pacemaker-implantation etc) and catastrophic events may be a more significant cost driver in high-cost beneficiaries than avoidable hospitalizations, and that a complementary approach (see below) in high-need high-cost programs is needed[22].

To our knowledge, we are the first that have distinguished the most cost-incurring versus secondary conditions in high-cost beneficiaries. For example, diseases of circulatory system were mainly found as a secondary condition, though they also frequently occurred as most cost-incurring condition. In addition, mental disorders and neoplasms were predominantly the most cost-incurring condition. Our findings contribute to the rapidly evolving field of multimorbidity and patterns of healthcare use. We suggest that conditions that were frequently and primarily found as most cost-incurring condition should be priorities for policies that seek to contain costs and improve quality of care. However, the observational nature of our study does not allow for causal inference; i.e. the high number of morbidities in cancer patients may either indicate the many complications from cancer treatment, or point to prior chronic disease in patients with cancer.

Many high-cost beneficiaries were 65 years of age or younger; and the average costs decreased sharply with increasing age within the top-1% beneficiaries. In addition, we found typical care needs and utilization per age group. Both findings have rarely been reported in literature[10] and underline the need for studies in the general population with comprehensive data. Furthermore, high-need, high-cost programs need to be aimed at beneficiaries of all ages; a mere focus on elderly would leave many high-cost beneficiaries unaddressed.

Policy and research implications

Our findings suggest a need for approaches that address patients' care needs across multiple conditions and to integrate care use across multiple providers. Important policy questions remain concerning the breadth of health care delivery innovations (i.e. care coordination programs, bundled payments; what should a bundle encompass?)[25]. We suggest that high-need, high-cost programs may aim to align the usual care for most cost-incurring conditions with the care for associated or common secondary conditions in specific care pathways. Furthermore, based on our findings we recommend a complementary approach geared towards expensive procedures and drugs as well as the extensive additional care besides expensive treatments. This suggests bundled payments may be worthwhile, as well as multidisciplinary assessment of patients' care needs for expensive treatments. In addition, prices for expensive drugs or procedures could be lowered, for example through reference pricing or competitive bidding[26, 27].

Our research provides a precise picture of high-cost beneficiaries, but further research is necessary to specify characteristics and utilization of high-cost beneficiaries at a local level. Patient segmentation analysis has been suggested as a method for identifying homogenous target population groups from diverse populations, which allows for tailored policies[28]. Our analyses may inform such segmentation analyses. Furthermore, we suggest research into longitudinal patterns of multimorbidity to identify relevant subgroups that benefit from intervention. More research is needed to identify beneficiaries at risk of incurring high costs[29].

In conclusion, our findings show that high-cost beneficiaries are usually treated for several conditions and use care from multiple providers. Expensive treatments, the most cost-incurring condition, and age proved to be informative variables for studying this heterogeneous population. Tailored interventions are needed to meet the needs of high-cost beneficiaries, and to avoid waste of scarce resources.

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Contributors: JW drafted the first manuscript and conducted the data analyses. JW, PvdW and MT conceptualized the study and interpreted the data. WJ provided assistance in data preparation, statistical analyses and was involved in interpretation of the findings. GW and PJ made a substantial contribution to the development of the research question and interpretation and presentation of the findings. All authors provided feedback to, and approved the final manuscript.

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Tables

Table 1. General characteristics and indicators for health care use for three distinct cost groups.

General characteristics		Top-1%	Top-2-5%	Bottom-95%
Number of beneficiaries		45,207	180,826	4,294,611
Average total costs (SD)		€56,424 (€40,830)	€15,780 (€5,208)	€1,345 (€1,773)
Share of total costs		22.8%	25.5%	51.7%
Private spending† (SD)		€330 (€172)	€335 (€165)	€159 (€181)
Gender	Male:	52.3%	44.8%	49.6%
	Female:	47.7%	55.2%	50.4%
Mean age (SD)		58.5 (21.6)	58.0 (21.8)	39.2 (23.3)
Median age		64	62	39
Percentage dying in or after study period	Q1:	0.7%	0.9%	0.2%
	Q2:	1.8%	1.6%	0.2%
	Q3:	3.2%	1.7%	0.1%
	Q4:	4.2%	1.9%	0.1%
	>Q4‡:	12.5%	5.9%	0.7%
Socioeconomic status	>15 inhabitants††:	4.5%	3.1%	1.0%
	Lowest incomes:	31.1%	31.5%	31.4%
	Average income:	37.5%	38.5%	37.7%
	High income:	26.8%	26.7%	28.6%
Medical characteristics		Top-1%	Top-2%-5%	Bottom-95%
Average number of comorbidities – ICD-chapter (SD)		4.2 (2.1)	3.3 (1.8)	0.7 (1.1)
Average number of comorbidities – ICD-subchapter (SD)		5.5 (3.1)	4.0 (2.3)	0.8 (1.2)
Average number of chronic comorbidities – calculated by pharmaceutical cost groups (SD)		1.1 (1.2)	1.0 (1.1)	0.2 (0.6)
(Expensive) healthcare use		Top-1%	Top-2%-5%	Bottom-95%
Percentage using expensive care > €10,000		24.6%	5.8%	0.0%
Percentage transplant beneficiaries		3.7%	0.8%	0.03%
Percentage receiving dialysis		6.1%	0.1%	0.0%
Percentage receiving DRG > €30,000		4.5%	0.03%	0%
Percentage with >0 inpatient mental health care stays		13.0%	3.3%	0.04%
Percentage with mental health care costs >€0		23.5%	20.6%	6.4%
Average number of inpatient mental hospital days‡‡		54.7 (74.3)	4.0 (11.7)	0.05 (0.8)
Percent visiting a specialized mental care center		22.5%	19.2%	4.8%
Average number of hospital specialists involved (SD)		4.2 (2.3)	3.0 (1.8)	0.6 (1.0)
Average number of hospitals visited (SD)		1.9 (1.0)	1.6 (0.9)	0.5 (0.7)
Average number of inpatient hospital days (SD)		22.3 (26.0)	7.2 (8.4)	0.4 (1.5)
Percentage using care at a university hospital		39.7%	25.8%	4.5%
Average number of ambulance transportations (SD)		1.4 (4.3)	0.5 (1.0)	0.02 (0.17)
Average number of emergency department visits (SD)		0.7 (1.4)	0.4 (0.7)	0.07 (0.27)

† Consisting of the compulsory deductible of €350.

‡ Dates of death were recorded until the 20th of February 2015.

†† Most of whom are institutionalized.

‡‡ For those with mental health care costs >€0.

Table 2. Ten conditions with highest total costs among top-1% beneficiaries.

	Prevalence[a]	% of total costs[b]	% as most cost-incurring condition[c]	% most cost-incurring / prevalence[d]	% of costs by most cost-incurring condition[e]
N17-N19 Renal failure	12.2%	6.8%	6.4%	52.4%	66.0%
C81-C96 Leukemia	5.6%	3.0%	4.1%	74.3%	41.4%
C15-C26 Malignant neoplasms of digestive organs	7.5%	2.4%	5.4%	71.2%	47.9%
I60-I69 Cerebrovascular diseases	7.9%	2.1%	4.2%	53.1%	52.7%
I70-I79 Diseases of arteries, arterioles and capillaries	9.6%	2.0%	4.1%	42.7%	47.3%
C30-C39 Lung cancer	5.9%	1.7%	3.5%	59.1%	52.5%
I51-I52 Complications/ill-defined descriptions, other heart disorders	9.6%	1.6%	3.2%	33.1%	50.3%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	11.8%	1.6%	2.9%	24.3%	58.5%
I20-I25 Ischemic heart diseases	12.7%	1.6%	3.7%	29.0%	41.9%
I50 Heart failure	9.3%	1.5%	2.6%	28.4%	57.1%

A Prevalence of each ICD10-subchapter among top-1% beneficiaries. E.g. 12.2% of top-1% beneficiaries were treated for renal failure.
B Sum of total treatment costs per ICD10-subchapter. E.g. treatment of renal failure accounted for 6.8% of total expenditures of top-1% beneficiaries.
C Percentage of top-1% with this ICD10-subchapter as most cost-incurring condition. E.g. 6.4% of top-1% beneficiaries had renal failure as most cost-incurring condition.
D Percentage most cost-incurring condition relative to prevalence: fourth column divided by second column. E.g. for 52.4% of top-1% beneficiaries who were treated for renal failure, this was also their most cost-incurring condition.
E Percentage of costs accounted for by the most cost-incurring condition. E.g. among top-1% beneficiaries with renal failure as most cost-incurring condition, this disease accounted for on average 66% of total costs per beneficiary.

Table 3. Cross table describing patterns of health care use and demographics of top-1% beneficiaries.

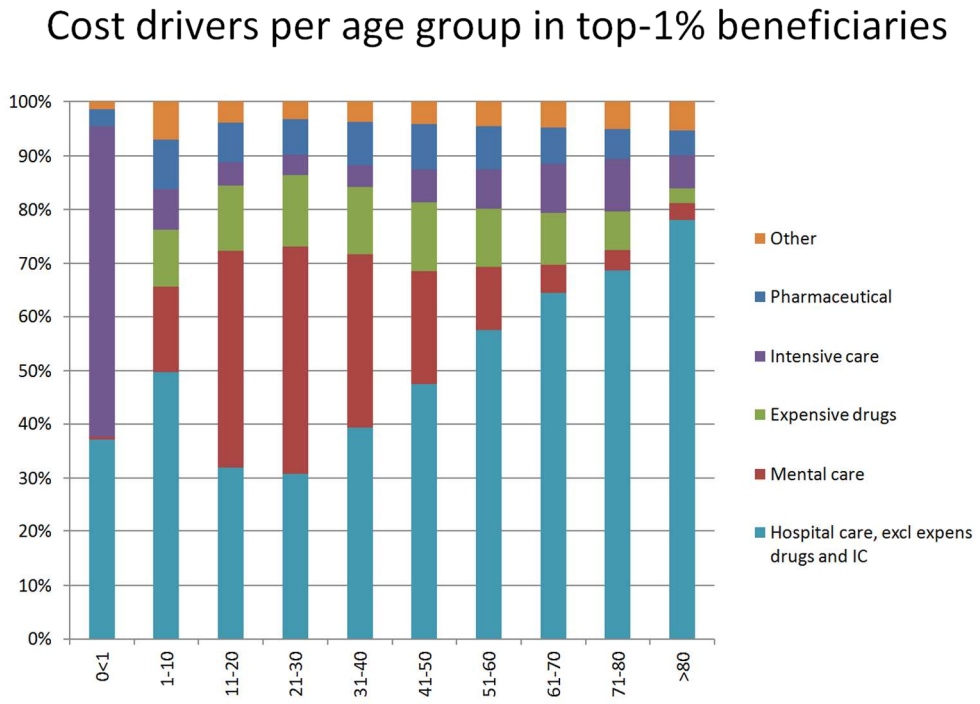
ICD10-chapter	Prevalence[a]	% most cost-incurring ICD10-chapter	Average age	Percentage dying	Percentage men	Average number of comor (ICD-chapter)	Average cost (*€1000)	Expensive drugs (*€1000)	Intensive care (*€1000)	Neoplasm (*€1000)	Mental and behavioural disorders (*€1000)	Diseases circulatory system (*€1000)	Diseases genitourinary system (*€1000)
Certain infectious and parasitic diseases	10.2%	1.0%	60.3	16.8%	60.4%	5.5	54	2,515	3,407	407	247	382	400
Neoplasms	36.8%	23.2%	62.0	16.4%	49.5%	3.9	56	111,927	27,734	295,902	2,062	7,629	4,991
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	4.4%	1.0%	42.1	3.7%	65.9%	3.3	103	33,535	531	143	62	213	91
Endocrine, nutritional and metabolic diseases	21.5%	1.3%	39.2	6.1%	49.2%	4.0	67	8,452	3,025	191	228	432	224
Mental and behavioural disorders	32.2%	14.7%	41.1	1.2%	51.8%	2.7	55	4,487	4,292	841	135,431	1,746	787
Diseases of the nervous system	29.3%	2.6%	54.7	8.4%	52.2%	4.6	56	9,303	6,185	845	682	1,064	442
Diseases of the eye and adnexa	18.2%	0.2%	62.4	1.1%	43.6%	4.0	47	974	112	45	15	13	9
Diseases of the ear and mastoid process	5.4%	0.3%	44.5	1.6%	48.8%	3.4	60	200	232	25	14	59	23
Diseases of the circulatory system	52.8%	22.3%	68.7	9.5%	60.9%	4.6	49	7,564	63,668	5,992	2,519	269,394	4,709
Diseases of the respiratory system	24.1%	4.4%	62.8	16.7%	48.9%	4.8	53	5,258	20,204	1,865	801	2,628	801
Diseases of the digestive system	20.0%	4.0%	55.2	12.0%	51.2%	4.7	55	10,359	19,343	1,717	873	1,523	1,013
Diseases of the skin and subcutaneous tissue	10.0%	0.5%	59.5	7.2%	48.3%	4.8	51	1,371	1,009	103	60	234	82
Diseases of the musculoskeletal system and connective tissue	19.4%	4.1%	66.0	4.1%	34.8%	4.8	47	10,750	3,104	1,090	862	2,359	699
Diseases of the genitourinary system	24.4%	7.2%	63.4	10.5%	58.0%	5.2	82	5,000	12,307	2,546	691	8,921	171,360
Pregnancy, childbirth and the puerperium	0.5%	0.2%	31.0	0.0%	0.0%	3.8	44	159	182	8	60	28	18
Certain conditions originating in the perinatal period	0.1%	0.0%	0.2	0.0%	60.0%	6.0	239	1	874	1	4	13	0
Congenital malformations, deformations and chromosomal abnormalities	3.1%	0.7%	8.2	6.3%	54.3%	3.6	73	1,262	9,230	9	69	285	51
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	49.2%	2.1%	55.4	14.1%	50.8%	4.6	60	9,824	9,086	482	460	1,034	387
Injury, poisoning and certain other consequences of external causes	22.3%	6.8%	71.5	9.7%	39.5%	4.7	50	2,986	15,169	1,813	1,789	5,668	1,055
Factors influencing health status and contact with health services	31.7%	3.6%	30.5	2.1%	55.3%	3.9	67	3,417	30,951	1,388	447	3,234	636

[A] Prevalence of ICD10-chapters among the total population. All other columns apply for beneficiaries with the selected most cost-incurring ICD10-chapter per row.

Table 4. Top-1% beneficiaries according to age group, and total expenditure per ICD10-chapter[†].

Age group	<1	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	>80
Number	938	1125	1793	1892	2506	4670	6856	9811	9815	5801
Average per capita costs	€ 81,458	€ 69,576	€ 68,220	€ 62,428	€ 59,161	€ 59,546	€ 55,569	€ 55,253	€ 52,123	€ 47,166
	Factors influencing health status and contact with health services 13.5%	Neoplasms 15.5%	Mental and behavioral disorders 21.2%	Mental and behavioral disorders 18.8%	Mental and behavioral disorders 14.1%	Neoplasms 12.9%	Neoplasms 16.0%	Neoplasms 17.2%	Diseases of the circulatory system 20.1%	Diseases of the circulatory system 21.1%
	Congenital malformations, deformations and chromosomal abnormalities 5.2%	Mental and behavioral disorders 11.0%	Neoplasms 9.1%	Neoplasms 5.8%	Neoplasms 8.9%	Mental and behavioral disorders 9.1%	Diseases of the circulatory system 9.9%	Diseases of the circulatory system 14.7%	Neoplasms 11.9%	Injury, poisoning and certain other consequences of external causes 15.0%
	Diseases of the digestive system 2.5%	Factors influencing health status and contact with health services 4.6%	Factors influencing health status and contact with health services 2.1%	Diseases of the genitourinary system 4.0%	Diseases of the genitourinary system 6.1%	Diseases of the genitourinary system 7.3%	Diseases of the genitourinary system 8.1%	Diseases of the genitourinary system 7.8%	Diseases of the genitourinary system 5.5%	Diseases of the genitourinary system 9.8%
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 1.8%	Congenital malformations, deformations and chromosomal abnormalities 2.9%	Injury, poisoning and certain other consequences of external causes 1.6%	Injury, poisoning and certain other consequences of external causes 2.2%	Diseases of the circulatory system 3.5%	Diseases of the circulatory system 5.9%	Mental and behavioral disorders 5.2%	Injury, poisoning and certain other consequences of external causes 2.5%	Injury, poisoning and certain other consequences of external causes 5.1%	Neoplasms 6.1%
	Neoplasms 1.6%	Diseases of the nervous system 2.4%	Diseases of the genitourinary system 1.5%	Factors influencing health status and contact with health services 2.2%	Factors influencing health status and contact with health services 2.6%	Factors influencing health status and contact with health services 2.6%	Factors influencing health status and contact with health services 2.6%	Diseases of the respiratory system 2.5%	Diseases of the musculoskeletal system and connective tissue 2.9%	Diseases of the musculoskeletal system and connective tissue 4.9%

[†] Total costs per ICD-chapter were summed per age group. In the table, the five ICD10-chapters with highest costs per age group are presented. I.e. among beneficiaries 1-10 years old, 15.5% of total costs were accounted for by neoplasm care.



Cost drivers per age group in top-1% beneficiaries

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Appendix 1a. Five parameters for top-1% beneficiaries.

ICD10-subchapter (condition)	Prevalence	% as most cost incurring condition	% most cost incurring / prevalence	% of costs by most cost incurring condition	% of total costs
A00-A09 Intestinal infectious diseases	0,9%	0,1%	8,9%	19,4%	0,1%
A15-A19 Tuberculosis	0,2%	0,0%	23,4%	36,6%	0,0%
A20-A28 Certain zoonotic bacterial diseases	0,0%				0,0%
A30-A49 Other bacterial diseases	2,9%	0,7%	22,7%	23,8%	0,3%
A50-A64 Infections with a predominantly sexual mode of transmission	0,1%				0,0%
A65-A69 Other spirochaetal diseases	0,0%				0,0%
B00-B09 Viral infections characterized by skin and mucous membrane lesions	0,4%				0,0%
B15-B19 Viral hepatitis	0,3%	0,1%	18,5%	10,4%	0,0%
B20-B24 Human immunodeficiency virus [HIV] disease	5,0%	0,2%	4,7%	16,8%	0,1%
B25-B34 Other viral diseases	0,3%	0,0%	8,6%	12,2%	0,0%
B50-B64 Protozoal diseases	0,0%				
B85-B89 Pediculosis, acariasis and other infestations	0,0%				0,0%
B99-B99 Other infectious diseases	0,9%	0,1%	12,5%	22,5%	0,1%
C00-C14 Malignant neoplasms of lip, oral cavity and pharynx	1,2%	0,5%	42,4%	40,8%	0,2%
C15-C26 Malignant neoplasms of digestive organs	7,5%	5,4%	71,2%	47,9%	2,4%
C30-C39 Malignant neoplasms of respiratory and intrathoracic organs	5,9%	3,5%	59,1%	52,5%	1,7%
C40-C41 Malignant neoplasms of bone and articular cartilage	0,4%	0,1%	28,1%	56,0%	0,2%
C43-C44 Melanoma and other malignant neoplasms of skin	3,0%	0,3%	9,9%	16,2%	0,1%
C45-C49 Malignant neoplasms of mesothelial and soft tissue	0,7%	0,3%	44,1%	36,8%	0,2%
C50-C50 Malignant neoplasm of breast	5,0%	3,7%	75,4%	42,8%	1,4%
C51-C58 Malignant neoplasms of female genital organs	1,3%	0,8%	62,0%	50,0%	0,4%
C60-C63 Malignant neoplasms of male genital organs	2,2%	0,8%	37,9%	34,8%	0,3%
C64-C68 Malignant neoplasms of urinary tract	3,5%	1,3%	36,9%	44,6%	0,6%
C69-C72 Malignant neoplasms of eye, brain and other parts of central nervous system	1,1%	0,2%	14,7%	41,1%	0,2%
C73-C75 Malignant neoplasms of thyroid and other endocrine glands	0,2%	0,1%	31,8%	50,1%	0,1%
C76-C80 Malignant neoplasms of ill-defined, secondary and unspecified sites	4,2%	1,1%	25,6%	40,4%	0,6%
C81-C96 Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue	5,6%	4,1%	74,3%	41,4%	3,0%

D00-D09 In situ neoplasms	1,5%	0,0%	0,4%	2,6%	0,0%
D10-D36 Benign neoplasms	4,5%	0,2%	3,4%	20,8%	0,1%
D37-D48 Neoplasms of uncertain or unknown behaviour	3,2%	1,1%	32,5%	41,6%	0,7%
D50-D53 Nutritional anaemias	1,4%	0,1%	5,5%	22,7%	0,1%
D55-D59 Haemolytic anaemias	0,3%	0,1%	31,8%	25,2%	0,0%
D60-D64 Aplastic and other anaemias	0,5%	0,1%	12,7%	35,1%	0,1%
D65-D69 Coagulation defects, purpura and other haemorrhagic conditions	1,2%	0,5%	39,4%	6,1%	0,1%
D70-D77 Other diseases of blood and blood-forming organs	0,4%	0,0%	12,9%	28,5%	0,0%
D80-D89 Certain disorders involving the immune mechanism	0,7%	0,3%	41,4%	15,1%	0,1%
E00-E07 Disorders of thyroid gland	4,2%	0,0%	0,7%	16,0%	0,0%
E10-E14 Diabetes mellitus	13,8%	0,3%	2,1%	24,2%	0,2%
E20-E35 Disorders of other endocrine glands	1,1%	0,2%	19,5%	6,6%	0,0%
E40-E46 Malnutrition	1,5%	0,1%	7,6%	11,6%	0,0%
E50-E64 Other nutritional deficiencies	0,0%	0,0%	14,4%	12,3%	0,0%
E65-E68 Obesity and other hyperalimentation	0,4%	0,1%	24,4%	23,8%	0,0%
E70-E90 Metabolic disorders	2,6%	0,7%	25,9%	18,1%	0,2%
F00-F09 Organic, including symptomatic, mental disorders	6,5%	0,6%	9,7%	20,9%	0,2%
F10-F19 Mental and behavioural disorders due to psychoactive substance use	5,0%	2,7%	54,0%	34,0%	0,9%
F20-F29 Schizophrenia, schizotypal and delusional disorders	5,7%	3,5%	60,7%	32,9%	1,1%
F30-F39 Mood [affective] disorders	12,7%	3,0%	23,5%	35,4%	1,1%
F40-F48 Neurotic, stress-related and somatoform disorders	2,8%	1,1%	39,0%	43,2%	0,5%
F50-F59 Behavioural syndromes associated with physiological disturbances and physical factors	0,6%	0,3%	52,3%	51,9%	0,2%
F60-F69 Disorders of adult personality and behaviour	2,4%	1,4%	58,5%	42,1%	0,6%
F70-F79 Mental retardation	0,1%	0,0%	12,6%	8,4%	0,0%
F80-F89 Disorders of psychological development	1,3%	0,9%	68,7%	46,3%	0,4%
F90-F98 Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1,6%	0,7%	41,8%	58,0%	0,3%
F99-F99 Unspecified mental disorder	13,1%	0,6%	4,8%	32,7%	0,5%
G00-G09 Inflammatory diseases of the central nervous system	0,8%	0,2%	27,5%	30,7%	0,1%
G10-G14 Systemic atrophies primarily affecting the central nervous system	0,2%	0,0%	17,7%	16,1%	0,0%
G20-G26 Extrapyramidal and movement disorders	9,2%	0,2%	2,3%	12,0%	0,0%

G35-G37 Demyelinating diseases of the central nervous system	0,5%	0,2%	37,4%	14,0%	0,0%
G40-G47 Episodic and paroxysmal disorders	8,4%	0,7%	8,5%	33,8%	0,4%
G50-G59 Nerve, nerve root and plexus disorders	2,0%	0,0%	2,2%	22,0%	0,0%
G60-G64 Polyneuropathies and other disorders of the peripheral nervous system	1,5%	0,3%	19,4%	15,6%	0,1%
G70-G73 Diseases of myoneural junction and muscle	0,7%	0,2%	24,8%	32,2%	0,1%
G80-G83 Cerebral palsy and other paralytic syndromes	0,0%	0,0%	21,6%	3,9%	0,0%
G90-G99 Other disorders of the nervous system	3,2%	0,4%	12,2%	34,7%	0,2%
H00-H06 Disorders of eyelid, lacrimal system and orbit	1,1%	0,0%	1,2%	3,1%	0,0%
H10-H13 Disorders of conjunctiva	1,1%				0,0%
H15-H22 Disorders of sclera, cornea, iris and ciliary body	0,7%	0,0%	1,5%	6,5%	0,0%
H25-H28 Disorders of lens	4,1%	0,1%	2,7%	4,4%	0,1%
H30-H36 Disorders of choroid and retina	5,7%	0,1%	1,2%	24,5%	0,1%
H40-H42 Glaucoma	3,3%	0,0%	0,3%	1,4%	0,0%
H43-H45 Disorders of vitreous body and globe	0,6%	0,0%	0,4%	0,1%	0,0%
H46-H48 Disorders of optic nerve and visual pathways	0,9%	0,0%	0,2%	0,2%	0,0%
H49-H52 Disorders of ocular muscles, binocular movement, accommodation and refraction	0,9%	0,0%	1,3%	9,3%	0,0%
H53-H54 Visual disturbances and blindness	0,4%	0,0%	0,6%	0,6%	0,0%
H55-H59 Other disorders of eye and adnexa	2,2%	0,0%	0,4%	0,6%	0,0%
H60-H62 Diseases of external ear	1,5%	0,0%	1,5%	33,9%	0,0%
H65-H75 Diseases of middle ear and mastoid	1,4%	0,0%	3,5%	9,0%	0,0%
H80-H83 Diseases of inner ear	0,7%	0,0%	1,6%	7,6%	0,0%
H90-H95 Other disorders of ear	2,3%	0,2%	9,8%	81,4%	0,2%
I00-I02 Acute rheumatic fever	0,0%				0,0%
I05-I09 Chronic rheumatic heart diseases	0,4%	0,4%	95,0%	50,8%	0,2%
I10-I15 Hypertensive diseases	6,4%	0,0%	0,5%	15,0%	0,0%
I20-I25 Ischaemic heart diseases	12,7%	3,7%	29,0%	41,9%	1,6%
I26-I28 Pulmonary heart disease and diseases of pulmonary circulation	1,5%	0,3%	18,1%	13,7%	0,1%
I30-I33 Pericarditis/endocarditis	1,3%	0,2%	18,1%	42,4%	0,2%
I34-I39 Valve disorders	6,1%	0,7%	11,0%	62,5%	0,5%
I40-I41 Myocarditis	0,1%	0,0%	20,1%	19,3%	0,0%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	11,8%	2,9%	24,3%	58,5%	1,6%
I50 Heart failure	9,3%	2,6%	28,4%	57,1%	1,5%
I51-I52 Complications/ill-defined descriptions, other heart disorders	9,6%	3,2%	33,1%	50,3%	1,6%

I60-I69 Cerebrovascular diseases	7,9%	4,2%	53,1%	52,7%	2,1%
I70-I79 Diseases of arteries, arterioles and capillaries	9,6%	4,1%	42,7%	47,3%	2,0%
I80-I89 Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	5,9%	0,1%	1,2%	15,4%	0,2%
I95-I99 Other and unspecified disorders of the circulatory system	5,7%	0,1%	1,2%	30,6%	0,1%
J00-J06 Acute upper respiratory infections	0,6%	0,0%	5,1%	18,2%	0,0%
J09-J18 Influenza and pneumonia	6,4%	1,2%	19,0%	20,4%	0,5%
J20-J22 Other acute lower respiratory infections	0,8%	0,1%	15,6%	20,0%	0,1%
J30-J39 Other diseases of upper respiratory tract	1,8%	0,1%	3,6%	13,1%	0,0%
J40-J47 Chronic lower respiratory diseases	14,1%	1,8%	13,1%	26,2%	0,6%
J60-J70 Lung diseases due to external agents	0,0%				
J80-J84 Other respiratory diseases principally affecting the interstitium	0,8%	0,2%	19,1%	24,5%	0,1%
J85-J86 Suppurative and necrotic conditions of lower respiratory tract	0,2%	0,0%	17,7%	25,1%	0,0%
J90-J94 Other diseases of pleura	2,2%	0,2%	8,4%	33,6%	0,1%
J95-J99 Other diseases of the respiratory system	2,9%	0,5%	15,8%	42,2%	0,3%
K00-K14 Diseases of oral cavity, salivary glands and jaws	0,4%	0,0%	1,8%	6,4%	0,0%
K20-K31 Diseases of oesophagus, stomach and duodenum	3,9%	0,3%	6,6%	18,7%	0,2%
K35-K38 Diseases of appendix	0,2%	0,0%	23,3%	21,9%	0,0%
K40-K46 Hernia	1,6%	0,1%	8,6%	17,1%	0,1%
K50-K52 Noninfective enteritis and colitis	2,4%	0,8%	32,4%	23,6%	0,2%
K55-K64 Other diseases of intestines	5,0%	0,9%	18,4%	31,3%	0,4%
K65-K67 Diseases of peritoneum	1,0%	0,3%	31,7%	27,1%	0,1%
K70-K77 Diseases of liver	1,7%	0,4%	24,8%	43,1%	0,3%
K80-K87 Disorders of gallbladder, biliary tract and pancreas	2,2%	0,5%	24,0%	34,8%	0,3%
K90-K93 Other diseases of the digestive system	7,0%	0,7%	9,8%	26,5%	0,4%
L00-L08 Infections of the skin and subcutaneous tissue	3,4%	0,3%	9,3%	25,1%	0,2%
L10-L14 Bullous disorders	0,7%	0,0%	1,7%	15,0%	0,0%
L20-L30 Dermatitis and eczema	2,4%	0,0%	0,7%	20,7%	0,0%
L40-L45 Papulosquamous disorders	0,7%	0,1%	10,2%	10,2%	0,0%
L50-L54 Urticaria and erythema	0,1%	0,0%	4,7%	1,2%	0,0%
L60-L75 Disorders of skin appendages	0,6%	0,0%	1,1%	12,0%	0,0%
L80-L99 Other disorders of the skin and subcutaneous tissue	3,2%	0,1%	4,6%	27,8%	0,1%
M00-M03 Infectious arthropathies	0,1%	0,0%	23,2%	31,7%	0,0%
M05-M14 Inflammatory polyarthropathies	5,0%	0,4%	8,0%	22,6%	0,1%
M15-M19 Arthrosis	4,5%	1,7%	37,4%	51,4%	0,8%

M20-M25 Other joint disorders	2,3%	0,3%	12,2%	34,4%	0,1%
M30-M36 Systemic connective tissue disorders	1,5%	0,3%	18,0%	26,9%	0,1%
M40-M43 Deforming dorsopathies	0,4%	0,1%	34,1%	55,1%	0,1%
M45-M49 Spondylopathies	1,7%	0,3%	17,8%	28,9%	0,1%
M50-M54 Other dorsopathies	3,9%	0,5%	12,2%	39,2%	0,2%
M60-M63 Disorders of muscles	0,1%	0,0%	1,6%	2,3%	0,0%
M65-M68 Disorders of synovium and tendon	0,3%	0,0%	2,0%	12,3%	0,0%
M70-M79 Other soft tissue disorders	1,9%	0,1%	3,3%	12,7%	0,0%
M80-M85 Disorders of bone density and structure	1,4%	0,0%	1,3%	20,8%	0,0%
M86-M90 Other osteopathies	1,0%	0,1%	12,2%	33,1%	0,1%
M91-M94 Chondropathies	0,0%	0,0%	12,6%	82,9%	0,0%
M95-M99 Other disorders of the musculoskeletal system and connective tissue	0,1%	0,0%	5,5%	56,1%	0,0%
N00-N08 Glomerular diseases	0,3%	0,0%	14,2%	31,0%	0,0%
N10-N16 Renal tubulo-interstitial diseases	1,1%	0,1%	11,6%	30,1%	0,1%
N17-N19 Renal failure	12,2%	6,4%	52,4%	66,0%	6,8%
N20-N23 Urolithiasis	0,8%	0,1%	14,4%	28,3%	0,1%
N25-N29 Other disorders of kidney and ureter	1,8%	0,1%	4,1%	21,0%	0,1%
N30-N39 Other diseases of urinary system	6,5%	0,4%	5,7%	21,9%	0,2%
N40-N51 Diseases of male genital organs	3,4%	0,1%	1,9%	15,9%	0,1%
N60-N64 Disorders of breast	0,6%	0,0%	1,1%	7,7%	0,0%
N70-N77 Inflammatory diseases of female pelvic organs	0,4%	0,0%	3,0%	3,9%	0,0%
N80-N98 Noninflammatory disorders of female genital tract	2,4%	0,1%	3,0%	12,0%	0,0%
O00-O08 Pregnancy with abortive outcome	0,1%	0,0%	5,2%	1,1%	0,0%
O20-O29 Other maternal disorders predominantly related to pregnancy	0,0%				0,0%
O60-O75 Complications of labour and delivery	0,0%				0,0%
O80-O84 Delivery	0,4%	0,0%	7,6%	27,0%	0,0%
O94-O99 Other obstetric conditions, not elsewhere classified	0,4%	0,2%	43,9%	59,1%	0,1%
P20-P29 Respiratory and cardiovascular disorders specific to the perinatal period	0,0%	0,0%	23,9%	9,2%	0,0%
P50-P61 Haemorrhagic and haematological disorders of fetus and newborn	0,0%	0,0%	25,1%	26,9%	0,0%
Q00-Q07 Congenital malformations of the nervous system	0,2%	0,0%	17,7%	16,8%	0,0%
Q10-Q18 Congenital malformations of eye, ear, face and neck	1,0%	0,0%	0,7%	1,2%	0,0%

Q20-Q28 Congenital malformations of the circulatory system	1,2%	0,5%	42,4%	39,8%	0,2%
Q30-Q34 Congenital malformations of the respiratory system	0,0%	0,0%	23,9%	27,9%	0,0%
Q35-Q37 Cleft lip and cleft palate	0,0%	0,0%	18,3%	24,6%	0,0%
Q38-Q45 Other congenital malformations of the digestive system	0,1%	0,0%	5,2%	53,9%	0,0%
Q50-Q56 Congenital malformations of genital organs	0,1%	0,0%	7,2%	6,6%	0,0%
Q60-Q64 Congenital malformations of the urinary system	0,1%	0,0%	6,6%	14,6%	0,0%
Q65-Q79 Congenital malformations and deformations of the musculoskeletal system	0,4%	0,0%	10,8%	34,6%	0,0%
Q80-Q89 Other congenital malformations	0,2%	0,0%	10,9%	13,4%	0,0%
Q90-Q99 Chromosomal abnormalities, not elsewhere classified	0,2%	0,0%	10,9%	9,1%	0,0%
R01 Cardiac murmurs and other cardiac sounds	0,0%	0,0%	15,1%	8,0%	0,0%
R04 Haemorrhage from respiratory passages	1,2%	0,0%	2,3%	19,3%	0,0%
R05 Cough	0,3%	0,0%	4,2%	11,1%	0,0%
R06 Abnormalities of breathing	3,8%	0,6%	16,4%	32,7%	0,3%
R07 Pain in throat and chest	0,5%	0,0%	1,8%	21,9%	0,0%
R09 Other symptoms and signs involving the circulatory and respiratory systems	0,0%	0,0%	5,0%	9,8%	0,0%
R10 Abdominal and pelvic pain	2,3%	0,1%	2,4%	21,5%	0,1%
R11 Nausea and vomiting	0,0%	0,0%	9,1%	30,3%	0,0%
R13 Dysphagia	1,3%	0,0%	0,9%	2,8%	0,0%
R15 Faecal incontinence	0,1%	0,0%	43,1%	43,1%	0,0%
R22.1 Localized swelling, mass and lump, neck	0,2%	0,0%	2,1%	11,6%	0,0%
R26 Abnormalities of gait and mobility	0,1%	0,0%	2,3%	40,9%	0,0%
R29 Other symptoms and signs involving the nervous and musculoskeletal systems	1,2%	0,0%	2,9%	14,3%	0,0%
R31 Unspecified haematuria	0,1%	0,0%	7,7%	5,7%	0,0%
R32 Unspecified urinary incontinence	0,0%	0,0%	7,7%	5,3%	0,0%
R35 Polyuria	0,0%	0,0%	50,3%	73,5%	0,0%
R39 Other symptoms and signs involving the urinary system	0,2%				0,0%
R40 Somnolence, stupor and coma	0,0%				0,0%
R42 Dizziness and giddiness	0,1%	0,0%	3,1%	44,1%	0,0%
R43 Disturbances of smell and taste	0,0%				0,0%
R47 Speech disturbances, not elsewhere classified	0,0%				0,0%
R49 Voice disturbances	1,2%	0,0%	0,9%	3,2%	0,0%
R50 Fever of other and unknown origin	1,1%	0,0%	3,6%	27,4%	0,1%

R51 Headache	0,0%	0,0%	5,3%	0,5%	0,0%
R52 Pain, not elsewhere classified	2,6%	0,1%	4,9%	45,9%	0,1%
R53 Malaise and fatigue	1,2%	0,1%	4,5%	16,2%	0,0%
R54 Senility	3,1%	0,7%	24,5%	31,8%	0,3%
R55 Syncope and collapse	1,5%	0,0%	3,2%	14,3%	0,0%
R56 Convulsions, not elsewhere classified	0,6%	0,1%	11,5%	40,4%	0,0%
R59 Enlarged lymph nodes	0,5%	0,0%	2,3%	52,9%	0,0%
R60 Oedema, not elsewhere classified	0,2%	0,0%	4,5%	10,2%	0,0%
R62 Lack of expected normal physiological development	0,1%	0,0%	23,2%	68,9%	0,0%
R63 Symptoms and signs concerning food and fluid intake	0,9%	0,1%	10,0%	28,0%	0,1%
R68 Other general symptoms and signs	12,8%	0,1%	0,5%	21,4%	0,1%
R69 Unknown and unspecified causes of morbidity	32,5%	0,3%	0,8%	13,7%	0,3%
R70-R79 Abnormal findings on examination of blood, without diagnosis	2,3%	0,1%	3,4%	22,1%	0,1%
R87 Abnormal findings in specimens from female genital organs	0,3%	0,0%	2,5%	5,2%	0,0%
R95-R99 Ill-defined and unknown causes of mortality	0,0%				0,0%
S00-S09 Injuries to the head	3,2%	0,4%	11,4%	29,4%	0,2%
S10-S19 Injuries to the neck	0,4%	0,0%	8,1%	21,9%	0,0%
S20-S29 Injuries to the thorax	0,6%	0,2%	27,9%	31,5%	0,1%
S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis	0,8%	0,3%	41,6%	36,7%	0,1%
S40-S49 Injuries to the shoulder and upper arm	1,1%	0,1%	12,2%	19,3%	0,1%
S50-S59 Injuries to the elbow and forearm	0,3%	0,0%	7,3%	16,6%	0,0%
S60-S69 Injuries to the wrist and hand	1,2%	0,0%	4,0%	13,4%	0,0%
S70-S79 Injuries to the hip and thigh	4,3%	2,8%	64,2%	55,2%	1,4%
S80-S89 Injuries to the knee and lower leg	0,7%	0,2%	27,7%	17,3%	0,0%
S90-S99 Injuries to the ankle and foot	1,0%	0,2%	16,5%	16,6%	0,0%
T00-T07 Injuries involving multiple body regions	2,0%	0,5%	25,6%	39,1%	0,3%
T08-T14 Injuries to unspecified part of trunk, limb or body region	7,5%	0,3%	4,0%	26,1%	0,2%
T15-T19 Effects of foreign body entering through natural orifice	0,2%	0,0%	1,0%	0,3%	0,0%
T20-T32 Burns and corrosions	0,3%	0,1%	41,7%	61,2%	0,1%
T33-T35 Frostbite	0,0%				0,0%
T36-T50 Poisoning by drugs, medicaments and biological substances	1,5%	0,0%	1,3%	13,8%	0,0%
T51-T65 Toxic effects of substances chiefly nonmedicinal as to source	0,1%				0,0%
T66-T78 Other and unspecified effects of external causes	0,7%	0,1%	7,9%	9,4%	0,0%
T79-T79 Certain early complications of trauma	0,0%				0,0%
T80-T88 Complications of surgical and medical care, not elsewhere	2,0%	0,6%	32,1%	47,5%	0,4%

classified					
T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes	0,9%	0,1%	12,0%	24,6%	0,0%
Z00-Z13 Persons encountering health services for examination and investigation	5,5%	0,2%	4,2%	30,2%	0,2%
Z20-Z29 Persons with potential health hazards related to communicable diseases	0,0%				0,0%
Z30-Z39 Persons encountering health services in circumstances related to reproduction	3,9%	1,2%	29,5%	26,6%	0,4%
Z40-Z54 Persons encountering health services for specific procedures and health care	16,3%	2,0%	12,0%	42,4%	1,4%
Z80-Z99 Persons with potential health hazards related to family and personal history and certain conditions influencing health status	13,9%	0,3%	2,4%	56,2%	0,5%

Appendix 1b. Five parameters for top-2-5% beneficiaries.

ICD10-subchapter (condition)	Prevalence	% as most cost incurring condition	% most cost incurring / prevalence	% of costs by most cost incurring condition	% of total costs
A00-A09 Intestinal infectious diseases	0,5%	0,2%	32,6%	32,5%	0,1%
A15-A19 Tuberculosis	0,1%	0,0%	22,5%	32,3%	0,0%
A20-A28 Certain zoonotic bacterial diseases	0,0%				
A30-A49 Other bacterial diseases	1,0%	0,6%	61,2%	39,8%	0,3%
A50-A64 Infections with a predominantly sexual mode of transmission	0,2%	0,0%	8,9%	9,2%	0,0%
A65-A69 Other spirochaetal diseases	0,0%	0,0%	14,8%	23,3%	0,0%
B00-B09 Viral infections characterized by skin and mucous membrane lesions	0,4%	0,0%	2,4%	4,8%	0,0%
B15-B19 Viral hepatitis	0,3%	0,1%	22,3%	13,8%	0,0%
B20-B24 Human immunodeficiency virus [HIV] disease	3,5%	2,2%	61,4%	13,3%	0,3%
B25-B34 Other viral diseases	0,1%	0,0%	29,4%	38,2%	0,0%
B50-B64 Protozoal diseases	0,0%	0,0%	50,6%	16,2%	0,0%
B85-B89 Pediculosis, acariasis and other infestations	0,0%	0,0%	23,8%	40,0%	0,0%
B99-B99 Other infectious diseases	0,3%	0,1%	42,5%	43,8%	0,1%
C00-C14 Malignant neoplasms of lip, oral cavity and pharynx	0,5%	0,2%	47,5%	45,8%	0,1%
C15-C26 Malignant neoplasms of digestive organs	3,8%	2,5%	67,2%	56,7%	1,8%
C30-C39 Malignant neoplasms of respiratory and intrathoracic organs	2,7%	1,6%	59,1%	52,1%	1,1%
C40-C41 Malignant neoplasms of bone and articular cartilage	0,1%	0,0%	28,6%	56,8%	0,0%
C43-C44 Melanoma and other malignant neoplasms of skin	3,0%	0,4%	12,2%	25,5%	0,2%
C45-C49 Malignant neoplasms of mesothelial and soft tissue	0,3%	0,2%	54,7%	47,6%	0,1%
C50-C50 Malignant neoplasm of breast	3,8%	2,5%	65,6%	60,1%	1,8%
C51-C58 Malignant neoplasms of female genital organs	0,9%	0,6%	64,3%	59,1%	0,4%
C60-C63 Malignant neoplasms of male genital organs	2,2%	0,7%	32,3%	53,2%	0,5%
C64-C68 Malignant neoplasms of urinary tract	2,8%	1,5%	53,6%	57,0%	1,0%
C69-C72 Malignant neoplasms of eye, brain and other parts of central nervous system	0,3%	0,1%	30,6%	50,3%	0,1%
C73-C75 Malignant neoplasms of thyroid and other endocrine glands	0,2%	0,1%	49,4%	57,0%	0,1%
C76-C80 Malignant neoplasms of ill-defined, secondary and unspecified sites	1,5%	0,5%	34,4%	46,6%	0,4%
C81-C96 Malignant neoplasms, stated or presumed to be primary, of	1,6%	0,8%	53,3%	40,1%	0,4%

lymphoid, haematopoietic and related tissue					
D00-D09 In situ neoplasms	1,8%	0,1%	4,1%	10,8%	0,1%
D10-D36 Benign neoplasms	4,6%	0,5%	11,8%	34,2%	0,4%
D37-D48 Neoplasms of uncertain or unknown behaviour	1,6%	0,6%	38,4%	50,3%	0,4%
D50-D53 Nutritional anaemias	1,0%	0,2%	18,1%	33,2%	0,1%
D55-D59 Haemolytic anaemias	0,2%	0,1%	35,0%	37,6%	0,0%
D60-D64 Aplastic and other anaemias	0,3%	0,1%	21,0%	33,6%	0,0%
D65-D69 Coagulation defects, purpura and other haemorrhagic conditions	0,4%	0,1%	22,5%	32,3%	0,0%
D70-D77 Other diseases of blood and blood-forming organs	0,2%	0,0%	20,5%	34,0%	0,0%
D80-D89 Certain disorders involving the immune mechanism	0,3%	0,1%	36,0%	24,3%	0,0%
E00-E07 Disorders of thyroid gland	4,8%	0,1%	2,4%	34,3%	0,1%
E10-E14 Diabetes mellitus	12,2%	1,1%	9,3%	33,5%	0,5%
E20-E35 Disorders of other endocrine glands	1,1%	0,3%	31,5%	11,7%	0,1%
E40-E46 Malnutrition	0,3%	0,1%	16,8%	21,4%	0,0%
E50-E64 Other nutritional deficiencies	0,0%	0,0%	16,9%	40,7%	0,0%
E65-E68 Obesity and other hyperalimentation	1,4%	1,0%	70,5%	72,4%	0,6%
E70-E90 Metabolic disorders	2,3%	0,4%	16,1%	33,2%	0,2%
F00-F09 Organic, including symptomatic, mental disorders	3,0%	0,5%	17,3%	38,6%	0,3%
F10-F19 Mental and behavioural disorders due to psychoactive substance use	3,3%	1,8%	55,4%	51,5%	1,1%
F20-F29 Schizophrenia, schizotypal and delusional disorders	3,7%	2,1%	55,2%	59,0%	1,3%
F30-F39 Mood [affective] disorders	12,5%	2,7%	22,0%	49,8%	1,5%
F40-F48 Neurotic, stress-related and somatoform disorders	2,9%	1,6%	57,7%	53,9%	1,0%
F50-F59 Behavioural syndromes associated with physiological disturbances and physical factors	0,5%	0,3%	54,6%	65,7%	0,2%
F60-F69 Disorders of adult personality and behaviour	2,3%	1,6%	71,8%	57,7%	1,0%
F70-F79 Mental retardation	0,1%	0,0%	14,8%	11,6%	0,0%
F80-F89 Disorders of psychological development	1,0%	0,7%	70,8%	67,0%	0,5%
F90-F98 Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1,6%	0,8%	47,7%	74,0%	0,6%
F99-F99 Unspecified mental disorder	7,9%	1,0%	12,8%	43,6%	0,8%
G00-G09 Inflammatory diseases of the central nervous system	0,3%	0,1%	42,7%	50,3%	0,1%
G10-G14 Systemic atrophies primarily affecting the central nervous system	0,1%	0,0%	22,6%	21,3%	0,0%

G20-G26 Extrapyramidal and movement disorders	8,4%	0,2%	2,3%	27,7%	0,1%
G35-G37 Demyelinating diseases of the central nervous system	1,1%	0,6%	58,9%	10,7%	0,1%
G40-G47 Episodic and paroxysmal disorders	7,6%	1,3%	16,5%	33,7%	0,8%
G50-G59 Nerve, nerve root and plexus disorders	2,0%	0,2%	8,9%	23,4%	0,1%
G60-G64 Polyneuropathies and other disorders of the peripheral nervous system	0,8%	0,1%	10,3%	31,6%	0,1%
G70-G73 Diseases of myoneural junction and muscle	0,3%	0,1%	19,4%	30,3%	0,0%
G80-G83 Cerebral palsy and other paralytic syndromes	0,0%	0,0%	18,4%	7,5%	0,0%
G90-G99 Other disorders of the nervous system	1,6%	0,3%	16,2%	41,5%	0,2%
H00-H06 Disorders of eyelid, lacrimal system and orbit	1,4%	0,1%	4,2%	14,5%	0,0%
H10-H13 Disorders of conjunctiva	1,2%	0,0%	1,1%	6,2%	0,0%
H15-H22 Disorders of sclera, cornea, iris and ciliary body	0,9%	0,1%	8,8%	18,1%	0,0%
H25-H28 Disorders of lens	4,6%	0,5%	11,0%	16,6%	0,3%
H30-H36 Disorders of choroid and retina	6,3%	0,8%	12,3%	39,9%	0,4%
H40-H42 Glaucoma	3,8%	0,0%	1,3%	5,2%	0,0%
H43-H45 Disorders of vitreous body and globe	0,7%	0,0%	3,8%	19,2%	0,0%
H46-H48 Disorders of optic nerve and visual pathways	0,6%	0,0%	2,0%	10,4%	0,0%
H49-H52 Disorders of ocular muscles, binocular movement, accommodation and refraction	0,9%	0,0%	1,5%	11,1%	0,0%
H53-H54 Visual disturbances and blindness	0,4%	0,0%	1,2%	1,0%	0,0%
H55-H59 Other disorders of eye and adnexa	1,8%	0,0%	0,9%	1,2%	0,0%
H60-H62 Diseases of external ear	1,4%	0,1%	6,2%	37,9%	0,1%
H65-H75 Diseases of middle ear and mastoid	1,3%	0,2%	13,6%	43,5%	0,1%
H80-H83 Diseases of inner ear	0,7%	0,1%	7,1%	25,8%	0,0%
H90-H95 Other disorders of ear	1,9%	0,1%	3,5%	34,5%	0,1%
I00-I02 Acute rheumatic fever	0,0%	0,0%	28,9%	61,4%	0,0%
I05-I09 Chronic rheumatic heart diseases	0,0%	0,0%	72,3%	82,8%	0,0%
I10-I15 Hypertensive diseases	6,6%	0,1%	1,9%	23,2%	0,1%
I20-I25 Ischaemic heart diseases	11,0%	5,4%	49,1%	51,9%	3,3%
I26-I28 Pulmonary heart disease and diseases of pulmonary circulation	0,8%	0,3%	33,4%	34,0%	0,1%
I30-I33 Pericarditis/endocarditis	0,4%	0,1%	30,2%	50,9%	0,1%
I34-I39 Valve disorders	2,6%	0,2%	7,9%	35,8%	0,2%
I40-I41 Myocarditis	0,0%	0,0%	57,9%	36,0%	0,0%
I44-I49 Atrial fibrillation, rhythm and conduction disorders	8,9%	3,1%	35,0%	59,1%	2,2%

I50 Heart failure	4,6%	1,7%	36,7%	43,7%	1,0%
I51-I52 Complications/ill-defined descriptions, other heart disorders	3,3%	0,2%	7,2%	60,0%	0,3%
I60-I69 Cerebrovascular diseases	3,6%	2,2%	60,2%	55,4%	1,5%
I70-I79 Diseases of arteries, arterioles and capillaries	5,1%	2,0%	39,6%	59,0%	1,5%
I80-I89 Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	3,3%	0,3%	9,6%	26,9%	0,2%
I95-I99 Other and unspecified disorders of the circulatory system	3,7%	0,1%	3,7%	20,9%	0,2%
J00-J06 Acute upper respiratory infections	0,5%	0,0%	10,1%	21,0%	0,0%
J09-J18 Influenza and pneumonia	3,1%	1,6%	53,0%	38,4%	0,8%
J20-J22 Other acute lower respiratory infections	0,5%	0,2%	32,2%	32,4%	0,1%
J30-J39 Other diseases of upper respiratory tract	1,8%	0,2%	12,6%	32,6%	0,1%
J40-J47 Chronic lower respiratory diseases	13,6%	1,8%	13,6%	35,4%	0,9%
J60-J70 Lung diseases due to external agents	0,0%				
J80-J84 Other respiratory diseases principally affecting the interstitium	0,5%	0,2%	31,8%	40,1%	0,1%
J85-J86 Suppurative and necrotic conditions of lower respiratory tract	0,1%	0,0%	24,5%	47,7%	0,0%
J90-J94 Other diseases of pleura	0,9%	0,3%	36,7%	51,2%	0,2%
J95-J99 Other diseases of the respiratory system	1,3%	0,2%	17,1%	38,4%	0,2%
K00-K14 Diseases of oral cavity, salivary glands and jaws	0,2%	0,0%	2,7%	21,6%	0,0%
K20-K31 Diseases of oesophagus, stomach and duodenum	2,9%	0,5%	16,4%	32,0%	0,3%
K35-K38 Diseases of appendix	0,3%	0,2%	54,8%	47,3%	0,1%
K40-K46 Hernia	1,3%	0,4%	32,5%	39,5%	0,2%
K50-K52 Noninfective enteritis and colitis	2,6%	1,3%	50,0%	21,5%	0,4%
K55-K64 Other diseases of intestines	4,0%	1,1%	27,6%	42,5%	0,7%
K65-K67 Diseases of peritoneum	0,3%	0,2%	59,0%	49,0%	0,1%
K70-K77 Diseases of liver	1,0%	0,4%	35,7%	42,1%	0,2%
K80-K87 Disorders of gallbladder, biliary tract and pancreas	2,3%	1,4%	62,2%	53,2%	0,8%
K90-K93 Other diseases of the digestive system	3,5%	0,8%	22,0%	42,6%	0,5%
L00-L08 Infections of the skin and subcutaneous tissue	2,1%	0,5%	24,1%	38,1%	0,3%
L10-L14 Bullous disorders	0,5%	0,0%	4,6%	22,2%	0,0%
L20-L30 Dermatitis and eczema	2,0%	0,1%	3,9%	24,2%	0,1%
L40-L45 Papulosquamous disorders	1,1%	0,3%	28,4%	7,8%	0,0%
L50-L54 Urticaria and erythema	0,1%	0,0%	3,2%	32,7%	0,0%
L60-L75 Disorders of skin appendages	0,7%	0,0%	3,0%	9,3%	0,0%

L80-L99 Other disorders of the skin and subcutaneous tissue	2,4%	0,2%	8,4%	22,5%	0,1%
M00-M03 Infectious arthropathies	0,1%	0,0%	38,5%	44,5%	0,0%
M05-M14 Inflammatory polyarthropathies	6,6%	2,0%	31,1%	11,7%	0,4%
M15-M19 Arthrosis	9,3%	6,7%	72,4%	71,5%	4,5%
M20-M25 Other joint disorders	3,6%	0,7%	20,6%	41,2%	0,4%
M30-M36 Systemic connective tissue disorders	1,3%	0,3%	19,9%	34,0%	0,1%
M40-M43 Deforming dorsopathies	0,3%	0,1%	31,2%	68,8%	0,1%
M45-M49 Spondylopathies	2,4%	0,9%	37,5%	36,5%	0,4%
M50-M54 Other dorsopathies	5,5%	1,7%	30,3%	45,3%	1,0%
M60-M63 Disorders of muscles	0,2%	0,0%	6,0%	9,5%	0,0%
M65-M68 Disorders of synovium and tendon	0,5%	0,0%	6,5%	16,2%	0,0%
M70-M79 Other soft tissue disorders	2,6%	0,4%	14,5%	34,3%	0,2%
M80-M85 Disorders of bone density and structure	1,4%	0,1%	6,2%	18,9%	0,1%
M86-M90 Other osteopathies	1,0%	0,2%	19,4%	45,3%	0,1%
M91-M94 Chondropathies	0,1%	0,0%	27,4%	57,0%	0,0%
M95-M99 Other disorders of the musculoskeletal system and connective tissue	0,2%	0,0%	22,7%	45,3%	0,0%
N00-N08 Glomerular diseases	0,2%	0,1%	31,9%	45,5%	0,0%
N10-N16 Renal tubulo-interstitial diseases	0,7%	0,3%	38,2%	47,5%	0,2%
N17-N19 Renal failure	3,8%	1,1%	28,8%	36,4%	0,6%
N20-N23 Urolithiasis	1,0%	0,5%	45,7%	51,8%	0,3%
N25-N29 Other disorders of kidney and ureter	0,8%	0,1%	14,4%	39,5%	0,1%
N30-N39 Other diseases of urinary system	4,9%	1,0%	20,1%	28,5%	0,5%
N40-N51 Diseases of male genital organs	2,9%	0,5%	16,1%	38,0%	0,3%
N60-N64 Disorders of breast	0,9%	0,0%	4,8%	17,0%	0,0%
N70-N77 Inflammatory diseases of female pelvic organs	0,6%	0,0%	6,7%	27,8%	0,0%
N80-N98 Noninflammatory disorders of female genital tract	3,9%	1,0%	25,2%	42,8%	0,5%
O00-O08 Pregnancy with abortive outcome	0,5%	0,1%	21,0%	35,7%	0,1%
O20-O29 Other maternal disorders predominantly related to pregnancy	0,3%	0,0%	0,2%	15,5%	0,0%
O60-O75 Complications of labour and delivery	0,2%	0,0%	23,1%	28,4%	0,0%
O80-O84 Delivery	3,3%	1,6%	48,0%	35,2%	0,7%
O94-O99 Other obstetric conditions, not elsewhere classified	3,2%	1,3%	40,8%	45,9%	0,7%
P20-P29 Respiratory and cardiovascular disorders specific to the perinatal period	0,0%	0,0%	22,5%	24,5%	0,0%

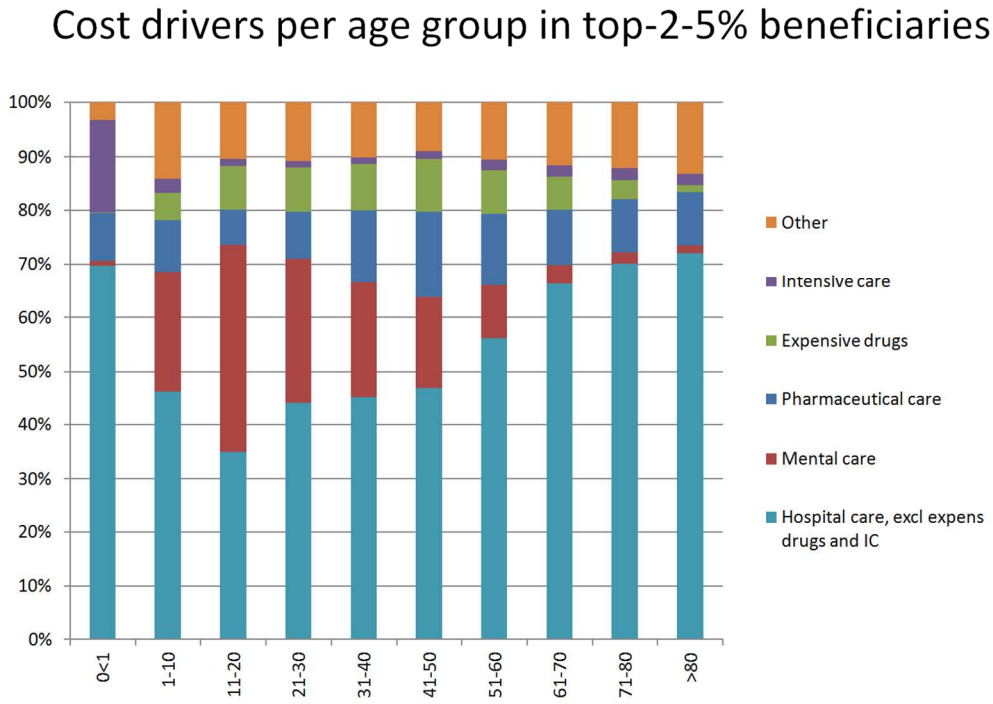
P50-P61 Haemorrhagic and haematological disorders of fetus and newborn	0,0%	0,0%	35,4%	33,5%	0,0%
Q00-Q07 Congenital malformations of the nervous system	0,1%	0,0%	23,6%	24,0%	0,0%
Q10-Q18 Congenital malformations of eye, ear, face and neck	0,6%	0,0%	4,5%	21,5%	0,0%
Q20-Q28 Congenital malformations of the circulatory system	0,4%	0,2%	44,2%	46,4%	0,1%
Q30-Q34 Congenital malformations of the respiratory system	0,0%	0,0%	16,5%	50,5%	0,0%
Q35-Q37 Cleft lip and cleft palate	0,0%	0,0%	58,5%	41,8%	0,0%
Q38-Q45 Other congenital malformations of the digestive system	0,0%	0,0%	38,0%	54,5%	0,0%
Q50-Q56 Congenital malformations of genital organs	0,1%	0,0%	31,8%	50,0%	0,0%
Q60-Q64 Congenital malformations of the urinary system	0,1%	0,0%	25,4%	50,8%	0,0%
Q65-Q79 Congenital malformations and deformations of the musculoskeletal system	0,3%	0,1%	39,6%	56,5%	0,1%
Q80-Q89 Other congenital malformations	0,1%	0,0%	15,5%	15,2%	0,0%
Q90-Q99 Chromosomal abnormalities, not elsewhere classified	0,1%	0,0%	24,3%	9,4%	0,0%
R01 Cardiac murmurs and other cardiac sounds	0,0%	0,0%	23,0%	27,1%	0,0%
R04 Haemorrhage from respiratory passages	0,7%	0,1%	9,9%	27,6%	0,0%
R05 Cough	0,2%	0,0%	9,2%	16,1%	0,0%
R06 Abnormalities of breathing	1,8%	0,3%	17,2%	45,1%	0,2%
R07 Pain in throat and chest	0,3%	0,0%	6,7%	26,6%	0,0%
R09 Other symptoms and signs involving the circulatory and respiratory systems	0,0%	0,0%	41,6%	34,8%	0,0%
R10 Abdominal and pelvic pain	1,7%	0,2%	9,6%	30,7%	0,1%
R11 Nausea and vomiting	0,0%				0,0%
R13 Dysphagia	0,8%	0,0%	4,1%	17,7%	0,0%
R15 Faecal incontinence	0,1%	0,1%	45,9%	61,1%	0,0%
R22.1 Localized swelling, mass and lump, neck	0,1%	0,0%	7,8%	16,0%	0,0%
R26 Abnormalities of gait and mobility	0,1%	0,0%	13,7%	24,2%	0,0%
R29 Other symptoms and signs involving the nervous and musculoskeletal systems	1,1%	0,1%	6,1%	35,1%	0,1%
R31 Unspecified haematuria	0,0%	0,0%	8,3%	21,1%	0,0%
R32 Unspecified urinary incontinence	0,0%	0,0%	5,6%	2,3%	0,0%
R35 Polyuria	0,0%	0,0%	28,9%	19,2%	0,0%
R39 Other symptoms and signs involving the urinary system	0,2%	0,0%	9,4%	26,9%	0,0%
R40 Somnolence, stupor and coma	0,0%	0,0%	25,3%	25,4%	0,0%
R42 Dizziness and giddiness	0,1%	0,0%	9,8%	34,2%	0,0%

R43 Disturbances of smell and taste	0,0%	0,0%	4,0%	70,7%	0,0%
R47 Speech disturbances, not elsewhere classified	0,0%	0,0%	2,5%	11,9%	0,0%
R49 Voice disturbances	0,8%	0,0%	4,8%	20,0%	0,0%
R50 Fever of other and unknown origin	0,4%	0,1%	24,3%	38,8%	0,1%
R51 Headache	0,0%	0,0%	5,8%	36,0%	0,0%
R52 Pain, not elsewhere classified	1,2%	0,1%	10,4%	31,1%	0,1%
R53 Malaise and fatigue	0,8%	0,1%	14,8%	35,6%	0,1%
R54 Senility	2,1%	1,0%	45,4%	49,8%	0,6%
R55 Syncope and collapse	0,7%	0,1%	14,3%	31,2%	0,1%
R56 Convulsions, not elsewhere classified	0,5%	0,1%	22,5%	44,5%	0,1%
R59 Enlarged lymph nodes	0,2%	0,0%	8,3%	27,2%	0,0%
R60 Oedema, not elsewhere classified	0,1%	0,0%	14,8%	28,4%	0,0%
R62 Lack of expected normal physiological development	0,0%	0,0%	30,3%	33,6%	0,0%
R63 Symptoms and signs concerning food and fluid intake	0,5%	0,1%	21,3%	33,5%	0,1%
R68 Other general symptoms and signs	5,3%	0,1%	2,3%	33,9%	0,1%
R69 Unknown and unspecified causes of morbidity	13,6%	0,3%	1,9%	34,5%	0,3%
R70-R79 Abnormal findings on examination of blood, without diagnosis	1,1%	0,2%	14,3%	33,3%	0,1%
R87 Abnormal findings in specimens from female genital organs	0,6%	0,0%	6,5%	18,1%	0,0%
R95-R99 Ill-defined and unknown causes of mortality	0,0%				0,0%
S00-S09 Injuries to the head	2,0%	0,3%	13,9%	37,0%	0,2%
S10-S19 Injuries to the neck	0,1%	0,0%	21,4%	48,5%	0,0%
S20-S29 Injuries to the thorax	0,4%	0,2%	41,0%	49,7%	0,1%
S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis	0,4%	0,2%	51,1%	40,1%	0,1%
S40-S49 Injuries to the shoulder and upper arm	1,0%	0,3%	35,3%	41,5%	0,2%
S50-S59 Injuries to the elbow and forearm	0,3%	0,1%	36,9%	41,5%	0,1%
S60-S69 Injuries to the wrist and hand	1,3%	0,2%	18,6%	31,5%	0,1%
S70-S79 Injuries to the hip and thigh	2,5%	2,2%	85,2%	62,4%	1,5%
S80-S89 Injuries to the knee and lower leg	0,7%	0,3%	46,6%	46,8%	0,2%
S90-S99 Injuries to the ankle and foot	1,1%	0,4%	34,8%	47,3%	0,2%
T00-T07 Injuries involving multiple body regions	0,9%	0,2%	22,4%	38,0%	0,1%
T08-T14 Injuries to unspecified part of trunk, limb or body region	5,1%	0,4%	8,3%	34,1%	0,3%
T15-T19 Effects of foreign body entering through natural orifice	0,1%	0,0%	8,5%	27,6%	0,0%
T20-T32 Burns and corrosions	0,1%	0,0%	28,3%	59,6%	0,0%
T33-T35 Frostbite	0,0%	0,0%	50,6%	2,7%	0,0%

T36-T50 Poisoning by drugs, medicaments and biological substances	0,6%	0,0%	7,4%	22,1%	0,0%
T51-T65 Toxic effects of substances chiefly nonmedicinal as to source	0,0%	0,0%	5,8%	18,4%	0,0%
T66-T78 Other and unspecified effects of external causes	0,4%	0,1%	17,7%	25,6%	0,0%
T79-T79 Certain early complications of trauma	0,0%	0,0%	33,8%	48,6%	0,0%
T80-T88 Complications of surgical and medical care, not elsewhere classified	1,2%	0,7%	54,8%	66,7%	0,5%
T90-T98 Sequelae of injuries, of poisoning and of other consequences of external causes	0,8%	0,2%	20,1%	43,1%	0,1%
Z00-Z13 Persons encountering health services for examination and investigation	3,8%	0,3%	8,6%	28,7%	0,2%
Z20-Z29 Persons with potential health hazards related to communicable diseases	0,0%	0,0%	4,1%	1,5%	0,0%
Z30-Z39 Persons encountering health services in circumstances related to reproduction	4,1%	0,7%	17,3%	46,4%	0,5%
Z40-Z54 Persons encountering health services for specific procedures and health care	10,6%	2,7%	25,7%	49,2%	1,8%
Z80-Z99 Persons with potential health hazards related to family and personal history and certain conditions influencing health status	9,6%	0,3%	3,0%	22,1%	0,5%

Appendix 2. Cross table describing patterns of health care use and demographics of top-2-5% beneficiaries.

ICD10-chapter	Prevalence	% most cost incurring ICD10-chapter	Average age	Percentage dying	Percentage men	Average number of comor (ICD-chapter)	Average cost (*€1000)	Expensive drugs (*€1000)	Intensive care (*€1000)	Neoplasm (*€1000)	Mental and behavioural disorders (*€1000)	Diseases circulatory system (*€1000)	Diseases musculoskeletal system (*€1000)
Certain infectious and parasitic diseases	6.3%	3.2%	53.6	5.0%	70.8%	3.4	15	794	1,597	656	723	955	432
Neoplasms	27.4%	13.0%	65.9	14.8%	46.8%	3.2	17	28,980	6,602	224,741	2,120	6,267	2,829
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	2.4%	0.6%	57.3	5.7%	46.6%	4.1	16	2,138	242	244	124	351	157
Endocrine, nutritional and metabolic diseases	20.2%	2.9%	42.3	2.0%	38.0%	3.4	15	6,748	1,122	518	1,051	955	662
Mental and behavioural disorders	26.6%	13.1%	41.1	1.0%	48.4%	2.6	16	4,216	2,067	1,597	217,204	3,339	3,022
Diseases of the nervous system	23.4%	2.8%	52.9	4.5%	44.7%	3.7	16	5,475	1,737	617	1,071	1,575	949
Diseases of the eye and adnexa	19.2%	1.5%	71.9	1.5%	42.4%	3.7	14	4,875	194	494	201	790	487
Diseases of the ear and mastoid process	4.9%	0.4%	48.4	1.1%	50.5%	3.4	14	654	70	72	176	116	88
Diseases of the circulatory system	40.3%	16.0%	69.3	8.1%	56.4%	3.7	17	5,085	17,064	5,430	3,416	267,652	4,555
Diseases of the respiratory system	19.2%	4.7%	66.6	13.0%	48.3%	3.9	16	4,054	6,835	2,491	1,582	4,232	1,431
Diseases of the digestive system	15.7%	6.1%	57.0	5.3%	44.4%	3.7	16	28,002	5,754	2,491	1,971	3,481	1,937
Diseases of the skin and subcutaneous tissue	8.2%	1.1%	58.7	3.5%	50.9%	3.5	15	8,449	217	271	250	566	336
Diseases of the musculoskeletal system and connective tissue	27.4%	13.4%	62.8	0.6%	35.1%	3.1	15	55,769	1,011	2,948	2,428	5,520	187,982
Diseases of the genitourinary system	17.0%	4.5%	59.3	4.8%	43.9%	3.8	15	3,545	1,993	2,235	1,259	2,411	1,445
Pregnancy, childbirth and the puerperium	4.0%	3.2%	31.0	0.0%	0.0%	2.7	13	884	564	178	1,661	413	348
Certain conditions originating in the perinatal period	0.0%	0.0%	0.0	0.0%	37.5%	2.6	18	0	26	0	0	0	0
Congenital malformations, deformations and chromosomal abnormalities	1.8%	0.5%	14.5	0.5%	54.7%	3.0	16	945	743	63	127	145	80
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	28.2%	3.0%	66.4	15.1%	40.9%	4.0	16	2,223	2,390	1,266	1,354	2,338	1,066
Injury, poisoning and certain other consequences of external causes	15.9%	6.1%	67.8	9.2%	36.4%	3.5	16	1,957	4,388	1,497	2,283	3,554	3,483
Factors influencing health status and contact with health services	24.2%	3.9%	37.9	0.9%	40.8%	3.3	15	3,409	5,022	1,495	1,549	2,180	1,749



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Appendix 4. Top-2-5% beneficiaries according to age group[†].

Age group	<1	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	>80
Number	1902	4311	6451	10612	14757	20971	26916	34047	33895	26964
Average per capita costs	€ 15,668	€ 15,704	€ 68,220	€ 14,900	€ 14,926	€ 15,648	€ 15,811	€ 15,971	€ 16,087	€ 16,038
Most important ICD-subchapters in terms of costs and share of total costs among the age group.	Factors influencing health status and contact with health services 33.8%	Mental and behavioral disorders 22.3%	Mental and behavioral disorders 35.5%	Mental and behavioral disorders 22.2%	Mental and behavioral disorders 17.6%	Mental and behavioral disorders 14.0%	Diseases of the circulatory system 10.2%	Neoplasms 13.8%	Diseases of the circulatory system 15.6%	Diseases of the circulatory system 17.0%
	Congenital malformations, deformations and chromosomal abnormalities 7.6%	Factors influencing health status and contact with health services 8.5%	Factors influencing health status and contact with health services 3.9%	Pregnancy, childbirth and the puerperium 12.9%	Pregnancy, childbirth and the puerperium 12.9%	Neoplasms 6.6%	Neoplasms 10.2%	Diseases of the circulatory system 13.7%	Neoplasms 12.2%	Injury, poisoning and certain other consequences of external causes 10.9%
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 5.2%	Endocrine, nutritional and metabolic diseases 3.7%	Endocrine, nutritional and metabolic diseases 3.8%	Diseases of the digestive system 3.7%	Factors influencing health status and contact with health services 4.2%	Diseases of the circulatory system 6.1%	Diseases of the musculoskeletal system and connective tissue 8.2%	Diseases of the musculoskeletal system and connective tissue 11.0%	Diseases of the musculoskeletal system and connective tissue 10.8%	Neoplasms 7.2%
	Diseases of the digestive system 3.3%	Congenital malformations, deformations and chromosomal abnormalities 3.6%	Injury, poisoning and certain other consequences of external causes 3.1%	Factors influencing health status and contact with health services 3.5%	Diseases of the musculoskeletal system and connective tissue 3.3%	Diseases of the musculoskeletal system and connective tissue 5.6%	Mental and behavioral disorders 8.0%	Diseases of the digestive system 3.4%	Injury, poisoning and certain other consequences of external causes 4.8%	Diseases of the musculoskeletal system and connective tissue 6.1%
	Diseases of the respiratory system 2.7%	Diseases of the nervous system 2.7%	Diseases of the musculoskeletal system and connective tissue 2.9%	Diseases of the musculoskeletal system and connective tissue 2.3%	Diseases of the genitourinary system 3.2%	Factors influencing health status and contact with health services 2.6%	Diseases of the digestive system 3.5%	Injury, poisoning and certain other consequences of external causes 3.4%	Diseases of the respiratory system 3.7%	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified 5.1%

[†] Total costs per ICD-chapter were summed per age group. In the table, the five ICD10-chapters with highest costs per age group are presented. I.e. among beneficiaries 1-10 years old, 22.3% of total costs were accounted for treatments for mental and behavioral disorders.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3	Cross-sectional claim database study.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3	Design, setting, participants, measures and results are described in abstract.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5	High-cost beneficiaries are the sickest and most complex populations. High-cost beneficiaries are a useful group to focus efforts of quality improvement and cost containment.
Objectives	3	State specific objectives, including any prespecified hypotheses	5	The primary aim of this study was to determine medical needs, demographic characteristics and healthcare utilization patterns of high-cost beneficiaries in the Netherlands.
Methods				
Study design	4	Present key elements of study design early in the paper	6	We conducted a cross-sectional study using claims data from 2013 in the Netherlands.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6	Analyses were done in-house with Zilveren Kruis, a health insurer covering 4.5 million beneficiaries who were

				primarily living in central, eastern and western parts of the Netherlands.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7	All insured in 2013 were included in this study.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		Not applicable.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-11	Several beneficiary characteristics were obtained from the insurer's databases, including gender, socio-economic status based on income estimates per postal code, date of birth and date of death. Outcomes are described in detail in the methods section. Outcomes include annual total costs through hospital, intensive care unit use, expensive drugs, other pharmaceuticals, mental care, and others; demographics; most cost- incurring and secondary conditions; inpatient stay; number of morbidities;

				costs per ICD10-chapter; and expensive treatment use (including dialysis, transplant surgery, expensive drugs, intensive care unit and DRGs >€30,000).
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,10	We defined the beneficiaries with the top-1% and the top-2%-5% of total costs as two groups of high-cost beneficiaries. For each high-cost beneficiary we identified the most cost cost-incurring ICD10-(sub)chapter. For both top-1% and top-2-5% beneficiaries, we first determined the prevalence of each ICD10-subchapter. Second, for both high-cost groups we summed treatment cost per ICD10-subchapter, and divided this with the sum of total costs.
Bias	9	Describe any efforts to address potential sources of bias	11	Beneficiaries were selected by the most cost incurring ICD10-chapter, to prevent that beneficiaries with multimorbidity would be counted several times.
Study size	10	Explain how the study size was arrived at	7	All insured in 2013 were included in this study, covering

				4.5 million beneficiaries.

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Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8	We categorized and analyzed hospital and mental care costs, according to the ICD10 international classification of diseases. To compute treatment costs per diagnosis, the DRGs were categorized using a link table provided by the Dutch Health Care Authority. This link table (version 22 December 2014) was developed to categorize hospital claims to specific health care needs, following the ICD10 classification. We developed dummy variables for specific types of care.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10	We explored the composition of expenditures across health sectors for both top-1% and top-2-5% beneficiaries. Demographics, medical characteristics and (expensive) health care use were analyzed using descriptive statistics.
		(*b*) Describe any methods used to examine subgroups and interactions	11	Beneficiaries were selected by the most cost-incurring ICD10-chapter, to prevent that beneficiaries with multimorbidity would be counted

				several times. Finally, we compared utilization patterns and conditions across age groups. We examined total costs, spending per sector and we identified the five most cost incurring ICD10-chapters per age group.
		(*c*) Explain how missing data were addressed		Not applicable.
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	-	Not applicable; all 4.5 million beneficiaries of the health insurer were included.
		(*e*) Describe any sensitivity analyses	-	Not applicable.
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6/22	Analyses were done in-house with Zilveren Kruis, a health insurer covering 4.5 million beneficiaries who were primarily living in central, eastern and western parts of the Netherlands.
		(b) Give reasons for non-participation at each stage	-	Not applicable.
		(c) Consider use of a flow diagram	-	Not applicable.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11,12	Estimates are described throughout the results section. Table 1 provides general characteristics of included beneficiaries.
		(b) Indicate number of participants with missing data for each variable of interest	-	Not applicable; no missing data.
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	-	Not applicable.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		

		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	11,12	Estimates are described throughout the results section. Table 1 describes indicators for health care use for three distinct cost groups. Table 2 presents ten conditions with highest total costs among top-1% beneficiaries.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-15	Estimates are described throughout the results section. Table 3 provides a cross table describing patterns of health care use and demographics of top-1% beneficiaries.
		(*b*) Report category boundaries when continuous variables were categorized	14,15	Estimates are described throughout the results section. Table 4 describes top-1% beneficiaries according to age group, and total expenditure per ICD10-chapter.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-	Not applicable.

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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15	Subgroup analyses are described throughout the results section.
Discussion				
Key results	18	Summarise key results with reference to study objectives	15	We found that expensive care use (expensive drugs, ICU treatment, dialysis, transplant care, DRG >

				€30,000) contributed to high costs in one third of top-1% beneficiaries and in less than ten percent10% of top-2-5% beneficiaries. High-cost beneficiaries were overwhelmingly treated for diseases of circulatory system, neoplasms, and mental disorders. However, neoplasms and mental disorders were mainly found as most cost incurring condition for a beneficiary, whereas circulatory disorders were mainly found as secondary condition. Finally, more than 50% of high-cost beneficiaries were under age 65 years of age or younger, and average costs decreased sharply with higher age within the top-1% population.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16	Despite the limited number of variables, our data allowed detailed identification of health care use and categorization of costs towards conditions. We chose to use expensive treatments, most cost incurring condition and age as variables for further analyses as such analyses were lacking in the literature and we regarded these most informative for policy and practice. One limitation is that our analysis was restricted to one year only. Consequently, we could not

				discern persistent high-cost users from episodic high-cost users (those with single a high-cost event).
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19	In conclusion, our findings show that high-cost beneficiaries are usually treated for several conditions and use care from multiple providers. Expensive treatments, the most cost -incurring condition, and age proved to be informative variables for studying this heterogeneous population. Tailored interventions are needed to meet the needs of high-cost beneficiaries, and to avoid waste of scarce resources.
Generalisability	21	Discuss the generalisability (external validity) of the study results	16	We used data from one health insurer with a market share of approximately 27%, and the data are representative for the Dutch population.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20	The study was conducted as part of a research program funded through the Dutch Ministry of Health. The funding source had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the manuscript for publication.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.