

## Improving regional comparative analysis of quality and efficiency

Initial results using a needs-based population classification system (PopGrouper)

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## Problem & Background

- Significant variations in medical practice and outcomes documented internationally (Corallo et al. 2014, OECD 2014, Belau et al. 2023)
- Regional variations caused by (OECD et al. 2014, Wennberg 2005)
  - Variations in care needs or preferences
  - Variations in medical practice, supply-induced demand, unequal access



Unwarranted variations  
→ Raise questions regarding quality, equity & efficiency



Can a population-based classification system (**PopGrouper**) help adjust morbidity-related care needs in regional analyses?



## Development of the PopGrouper (V0.4)

The PopGrouper is a **population-based classification system** that assigns individuals with similar medical needs and costs to **mutually exclusive PopGroups** based on their diagnoses and characteristics.

The PopGrouper development drew inspiration from other international classification systems, such as the Clinical Risk Groups (CRGs)<sup>1</sup>, Adjusted Clinical Groups (ACGs)<sup>2</sup>, and Canadian POP Grouper<sup>3</sup>.

Macro PopGroup (MPG)	No. of Base PopGroups (N = 640)	No. of PopGroups (N = 781)
1 Newborns	16	18
2 Pregnancy, childbirth and puerperium	15	15
3 Severe, high-cost cases	72	95
4 Actively treated malignant neoplasms	84	101
5 At least one severe disease	208	263
6 At least one moderate disease	117	148
7 At least one minor disease	96	108
8 At least one very mild disease	30	31
9 Healthy users	1	1
10 Non-users	1	1

### PopGroup example (from MPG 5):

Cerebral hemorrhage or cerebral infarction with number of severe comorbidities from other MDGs  $\leq 2$  and mechanical ventilation  $\leq 48$ h

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1: (3M 2022)  
2: (Johns Hopkins University 2015)  
3: (CIHI 2023)

MDG: Macro Disease Group



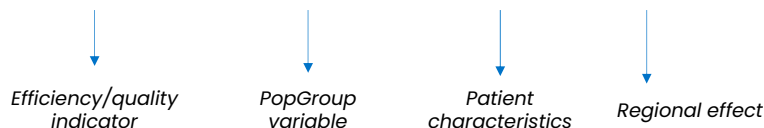
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## Methods

1. Visualize variation in efficiency and quality indicators by region and PopGroup
2. Estimate the PopGroup effect on efficiency and quality indicators by region

→ Multilevel random effects model for patient  $i$  in region  $j$ :

$$y_{ij} = \alpha + \delta PG_{ij} + \sum_{n=1}^N \beta_n X_{ij} + u_j + \varepsilon_{ij}$$



Patient characteristics (X)
Gender
Type of stroke
Age (grouped)

3. Compare cost and care utilization between regions of high and low efficiency/quality



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## Definition of study population & regions – Example: stroke patients

- Data source: claims data from BARMER sickness fund (2019/2020)
  - approx. 9 million insured persons, assigned to PopGroups
- Definition of study population (Jeschke & Günster 2022, WIdO 2022):
  - Principal diagnosis in 2019:
    - intracerebral hemorrhage (I61), cerebral infarction (I63), unspecified stroke (I64)
  - Age > 30 years
  - No hospitalization due to stroke in the previous year
- Regional unit of analysis:
  - 400 administrative districts in Germany (“Kreise”)
- Minimum number of observations in groups:
  - (Macro) PopGroups:  $\geq 1\%$  of initial study population (n=290)
  - Regions:  $\geq 30$  persons



## Definition of quality & efficiency indicators

Category	Indicator	Definition
Efficiency	Inpatient treatment days	Number of days per person 365 days from principal diagnosis
	Cost of care	Total cost of care per person 365 days from principal diagnosis
Quality	30-day mortality	Deceased within 30 days from principal diagnosis
	365-day mortality	Deceased within 365 days from principal diagnosis
	Stroke unit treatment	Stroke unit treatment (procedure codes 8-981, 8-98b)



## Description of study population and regions

### Study population

	N	%
<b>N total</b>	26,689	100

	N	%
<b>Sex</b>		
male	11,913	44.6
female	14,776	55.4
<b>Type of stroke</b>		
Intracerebral hemorrhage (I61)	2,730	10.2
Cerebral infarction (I63)	23,756	89.0
Unspecified stroke (I64)	203	0.8
<b>Age category</b>		
31-64	4,824	18.1
65-74	5,250	19.7
≥ 75	16,615	62.3

### Regions

	N	%
<b>N total</b>	301	100.0

<b>Urbanization status</b>	N	%
Independent large city	62	20.6
Urban district	112	37.2
Rural district with signs of densification	66	21.9
Sparsely populated rural district	61	20.3

<b>German Index of Socioeconomic Deprivation (GISD) – Quintiles</b>	N	%
Lowest deprivation	63	20.9
Second lowest deprivation	52	17.3
Medium deprivation	61	20.3
Second highest deprivation	68	22.6
Highest deprivation	57	18.9

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## PopGroup distribution in study population

PopGroup	PopGroup Name	N	%	cum. %
<b>P05041BB</b>	At least one severe disease: <b>Cerebral hemorrhage or cerebral infarction</b> with number of severe comorbidities from other MDGs ≤ 2 and mechanical ventilation ≤ 48h	18,021	67.52	67.5
<b>P03042BB</b>	Severe, high-cost cases: <b>Multidrug-resistant bacteria</b> with number of severe comorbidities from other MDGs ≤ 6 and mechanical ventilation ≤ 999h	734	2.75	70.3
<b>P03033BB</b>	Severe, high-cost cases: <b>Cerebral edema</b> with number of severe comorbidities from other MDGs ≤ 4 and mechanical ventilation ≤ 249h	670	2.51	72.8
<b>P05036BB</b>	At least one severe disease: <b>Central paralysis and lung disease</b> with number of severe comorbidities from other MDGs ≤ 2 and mechanical ventilation = 0h	637	2.39	75.2
<b>P05037BB</b>	At least one severe disease: <b>Acute renal failure</b> with number of severe comorbidities from other MDGs ≤ 3 and mechanical ventilation ≤ 95h	539	2.02	77.2
<b>P05041AZ</b>	At least one severe disease: <b>Cerebral hemorrhage or cerebral infarction</b> with number of severe comorbidities from other MDGs > 2	499	1.87	79.1
<b>P03027BB</b>	Severe, high-cost cases: <b>Gram-negative bacteria or staphylococcal pneumonia</b> with number of severe comorbidities from other MDGs ≤ 7 and mechanical ventilation ≤ 1799h	374	1.40	80.5
<b>P03035BB</b>	Severe, high-cost cases: <b>SIRS with organ complications</b> with number of severe comorbidities from other MDGs ≤ 6 and mechanical ventilation ≤ 999h	305	1.14	81.6

Macro PopGroup	Macro PopGroup Name (residual groups)	N	%	cum. %
<b>P05</b>	At least one severe disease	2,768	10.4	92.0
<b>P03</b>	Severe, high-cost cases	1,138	4.3	96.2
<b>P04</b>	Actively treated malignant neoplasms	1,004	3.8	100.0

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## Description of outcomes in study population

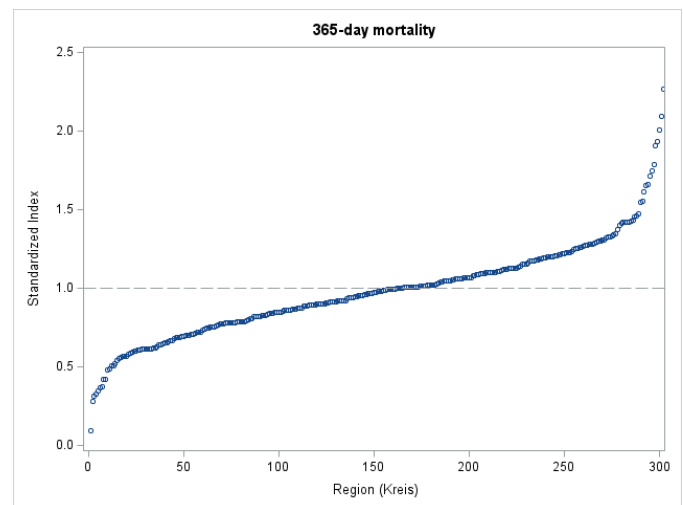
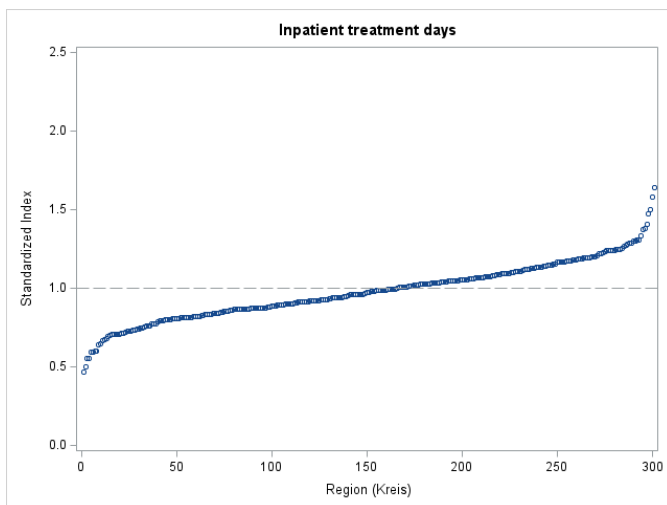
Efficiency	Mean	SD	Min	Max
Inpatient treatment days	22.2	27.0	1.0	410.0
Cost of care	106,143	80,591	710	2,087,860

Quality	N	%
30-day mortality	3,126	11.7
365-day mortality	6,165	23.1
Stroke unit treatment	18,512	69.4

## Regional variation in efficiency and quality: age-sex standardized index

### Efficiency example: Inpatient treatment days

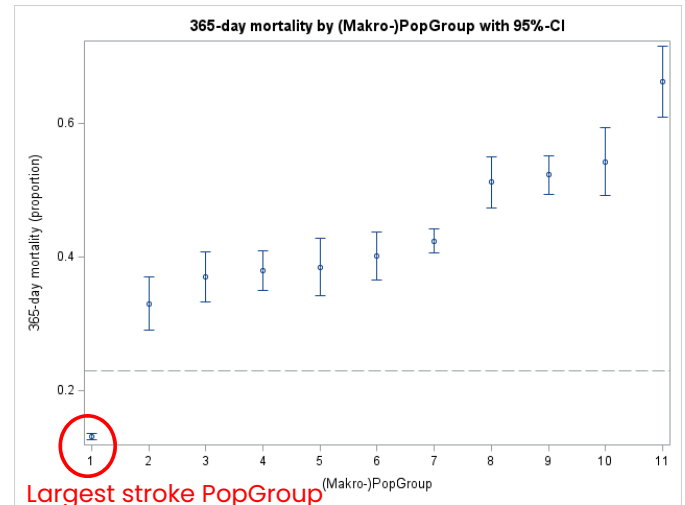
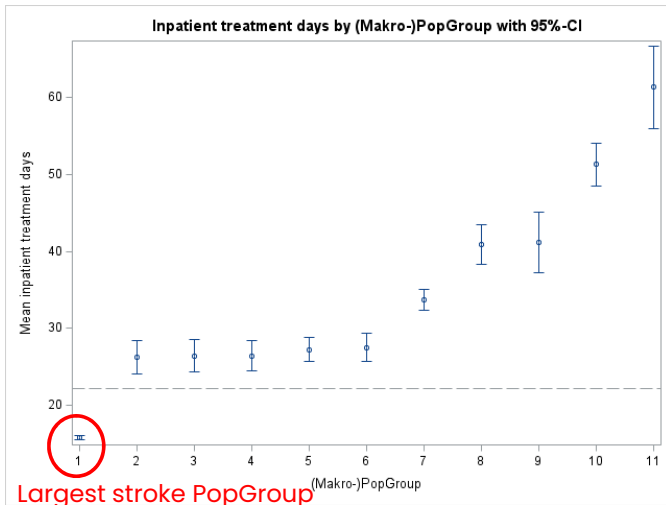
### Quality example: 365-day mortality



# Variation in efficiency and quality by (Macro) PopGroup

## Efficiency example: Inpatient treatment days

## Quality example: 365-day mortality



- 1: P05041BB      5: P04                      9: P03035BB
- 2: P03033BB    6: P05036BB            10: P03
- 3: P05041AZ    7: P05                    11: P03027BB
- 4: P05037BB    8: P03042BB

- 1: P05041BB      5: P05041AZ            9: P03
- 2: P05037BB    6: P03042BB            10: P03027BB
- 3: P05036BB    7: P05                    11: P03035BB
- 4: P04                      8: P03033BB



## Estimating the PopGroup-effect on efficiency and quality outcomes

PopGroup	Inpatient treatment days			Cost		
	Estimate	SE	p-value	Estimate	SE	p-value
P05041BB	Reference					
P03	1.080	0.029	<.0001	0.226	0.025	<.0001
P03027BB	1.342	0.050	<.0001	0.215	0.042	<.0001
P03033BB	0.288	0.038	<.0001	-0.278	0.032	<.0001
P03035BB	0.953	0.056	<.0001	-0.109	0.046	0.019
P03042BB	0.971	0.036	<.0001	0.218	0.030	<.0001
P04	0.580	0.031	<.0001	0.420	0.026	<.0001
P05	0.676	0.020	<.0001	0.101	0.016	<.0001
P05036BB	0.577	0.039	<.0001	0.009	0.032	0.789
P05037BB	0.566	0.042	<.0001	-0.010	0.035	0.786
P05041AZ	0.532	0.044	<.0001	0.110	0.036	0.003

→ PopGroups have significant explanatory power

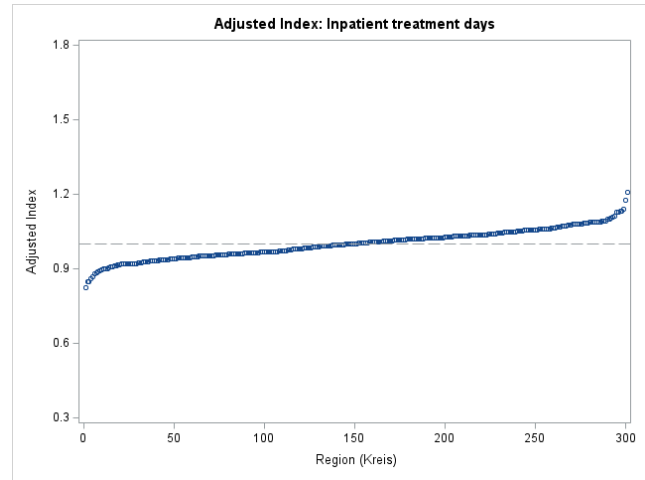
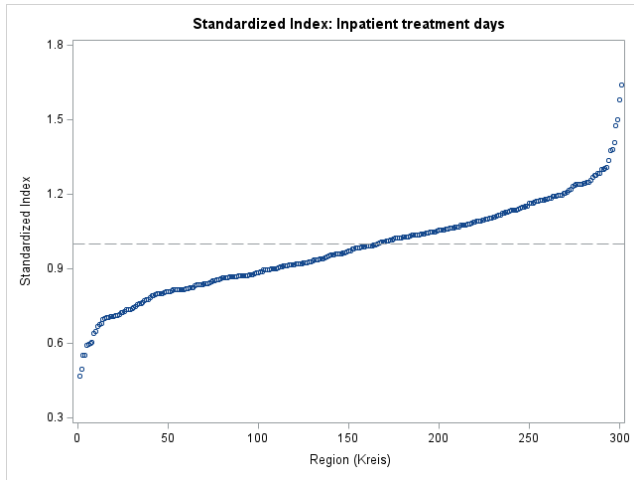
### Quality

PopGroup	30-day mortality			365-day mortality			Stroke unit treatment		
	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
P05041BB	Reference								
P03	1.175	0.079	<.0001	1.983	0.064	<.0001	-0.809	0.064	<.0001
P03027BB	1.500	0.121	<.0001	2.061	0.107	<.0001	-1.290	0.108	<.0001
P03033BB	2.003	0.085	<.0001	1.940	0.081	<.0001	-0.952	0.082	<.0001
P03035BB	1.603	0.130	<.0001	2.563	0.123	<.0001	-0.602	0.121	<.0001
P03042BB	0.639	0.113	<.0001	1.492	0.079	<.0001	-0.391	0.082	<.0001
P04	0.466	0.104	<.0001	1.396	0.069	<.0001	-0.261	0.072	0.000
P05	1.225	0.054	<.0001	1.586	0.045	<.0001	-0.648	0.043	<.0001
P05036BB	1.131	0.103	<.0001	1.359	0.085	<.0001	0.082	0.095	0.387
P05037BB	0.941	0.118	<.0001	1.182	0.094	<.0001	-0.115	0.099	0.246
P05041AZ	1.007	0.120	<.0001	1.420	0.095	<.0001	-0.306	0.100	0.002



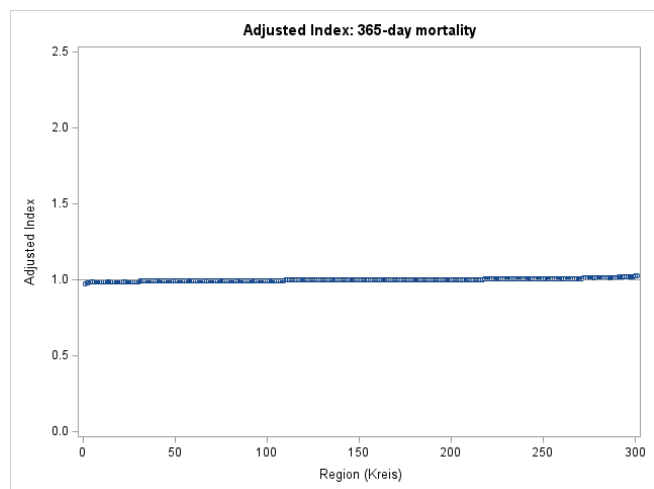
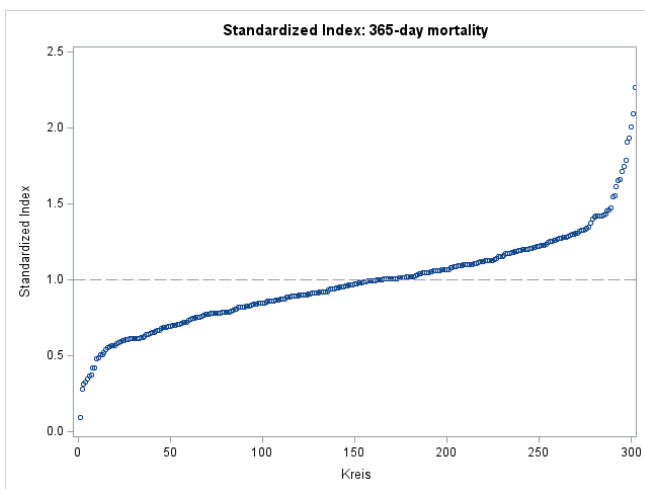
## Comparison of standardized vs. PopGroup-adjusted regional variation

Inpatient treatment days



## Comparison of standardized vs. PopGroup-adjusted regional variation

365-day mortality



## Comparison of cost and care utilization in 2019 for PopGroup "P05041BB"

### Regions ranked by efficiency

Rank	Region	Region Name	N study pop.	Costs							Inpatient treatment days	Ambulatory contacts				
				Total	Inpatient	Rehabilitation	Ambulatory	GPs	Drugs	Therapies		Medical aids	Total	GPs	Neuro	
Nationwide average (all PopGroups)				27,246	15,286	1,861	1,213	478	1,851	526	589	25	13	5	1	
Nationwide average P05041BB				16,020	9,513	1,730	944	447	1,234	460	381	16	12	5	1	
<b>Highest efficiency (Top 5)</b>				<b>156</b>	<b>16,052</b>	<b>8,395</b>	<b>1,659</b>	<b>829</b>	<b>395</b>	<b>1,476</b>	<b>478</b>	<b>321</b>	<b>11</b>	<b>12</b>	<b>5</b>	<b>0</b>
1	08115	Böblingen	35	16,343	8,307	1,286	1,069	347	1,477	598	462	10	13	5	1	
2	09565	Schwabach, Stadt	26	20,950	10,250	2,118	804	412	797	469	132	11	13	6	1	
3	16063	Wartburgkreis	41	14,436	8,491	2,456	786	424	1,489	358	489	13	12	5	0	
4	07141	Rhein-Lahn-Kreis	30	13,877	7,210	1,068	750	362	2,920	319	282	12	10	5	0	
5	09677	Main-Spessart	24	14,655	7,718	1,369	736	429	698	646	240	10	10	6	0	
<b>Lowest efficiency (Bottom 5)</b>				<b>698</b>	<b>16,073</b>	<b>9,618</b>	<b>1,728</b>	<b>954</b>	<b>449</b>	<b>1,217</b>	<b>464</b>	<b>387</b>	<b>16</b>	<b>13</b>	<b>5</b>	<b>1</b>
297	12072	Teltow-Fläming	70	14,559	10,156	1,523	976	398	1,126	302	285	18	15	5	1	
298	10044	Saarlouis	43	16,799	10,220	1,782	868	410	993	298	286	17	13	6	0	
299	14612	Dresden, Stadt	125	18,814	10,542	2,981	1,017	438	1,416	664	478	19	14	4	1	
300	02000	Hamburg, Stadt	397	15,483	9,852	705	1,194	518	1,340	539	359	18	14	6	1	
301	12054	Potsdam, Stadt	63	15,821	10,612	1,488	1,090	434	1,298	443	350	20	15	5	1	

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## Comparison of cost and care utilization in 2019 for PopGroup "P05041BB"

### Regions ranked by quality

Rank	Region	Region Name	N study pop.	Costs							Inpatient treatment days	Ambulatory contacts				
				Total	Inpatient	Rehabilitation	Ambulatory	GPs	Drugs	Therapies		Medical aids	Total	GPs	Neuro	
Nationwide average (all PopGroups)				27,246	15,286	1,861	1,213	478	1,851	526	589	25	13	5	1	
Nationwide average P05041BB				16,020	9,513	1,730	944	447	1,234	460	381	16	12	5	1	
<b>Highest quality (Top 5)</b>				<b>474</b>	<b>16,380</b>	<b>9,892</b>	<b>1,789</b>	<b>966</b>	<b>481</b>	<b>1,157</b>	<b>434</b>	<b>490</b>	<b>15</b>	<b>13</b>	<b>5</b>	<b>1</b>
1	08416	Tübingen	29	19,371	12,053	2,711	868	415	1,407	569	891	13	13	6	0	
2	14627	Meißen	50	14,348	8,647	2,097	955	434	1,632	503	264	14	14	5	1	
3	09162	München, Stadt	275	19,145	10,331	2,034	1,174	545	895	296	333	17	14	6	1	
4	01051	Dithmarschen	47	13,148	8,321	554	991	586	906	465	489	14	11	5	1	
5	06440	Wetteraukreis	73	15,887	10,107	1,549	839	423	947	339	472	16	12	5	1	
<b>Lowest quality (Bottom 5)</b>				<b>455</b>	<b>16,059</b>	<b>9,511</b>	<b>1,714</b>	<b>939</b>	<b>447</b>	<b>1,233</b>	<b>461</b>	<b>381</b>	<b>16</b>	<b>12</b>	<b>5</b>	<b>1</b>
297	09772	Augsburg	76	16,541	9,821	1,725	1,134	548	1,020	338	391	16	14	7	1	
298	14626	Görlitz	91	16,788	9,296	1,450	941	445	1,435	572	427	18	13	5	0	
299	05117	Mülheim an der Ruhr, Stadt	45	14,263	9,527	550	944	410	895	214	503	17	14	5	1	
300	03251	Diepholz	31	36,221	11,849	1,487	955	536	1,028	615	443	19	12	5	1	
301	05111	Düsseldorf, Stadt	212	18,100	8,947	1,275	953	410	1,083	449	287	16	12	4	1	

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## Summary & next steps

- Regional variation in efficiency and quality indicators observed
- PopGroups have significant explanatory power for regional variation
- Regional variations remain significant, even after controlling for PopGroups and patient characteristics

## Next steps

1. Perform analyses for further diseases
2. Analyze and compare treatment pathways within one PopGroup between regions (focus on rehabilitation)
3. Discuss results in workshops with experts
4. Compare PopGroup performance to other comorbidity measures (e.g. Charlson Index)

**Thank you for your attention!**

## Questions & Discussion



## References

Belau, M.H., Becher, H., Riefflin, M. et al. The impact of regional deprivation on stroke incidence, treatment, and mortality in Germany. *Neurol. Res. Pract.* 5, 6 (2023). <https://doi.org/10.1186/s42466-023-00232-0>

(CIHI 2023): Canadian Institute for Health Information. CIHI's Population Grouping Methodology 1.4 – Overview and Outputs, 2023. Ottawa, ON: CIHI; 2023

Corallo AN, Croxford R, Goodman DC, Bryan EL, Srivastava D, Stukel TA. A systematic review of medical practice variation in OECD countries. *Health Policy* 2014; 114:5–14.

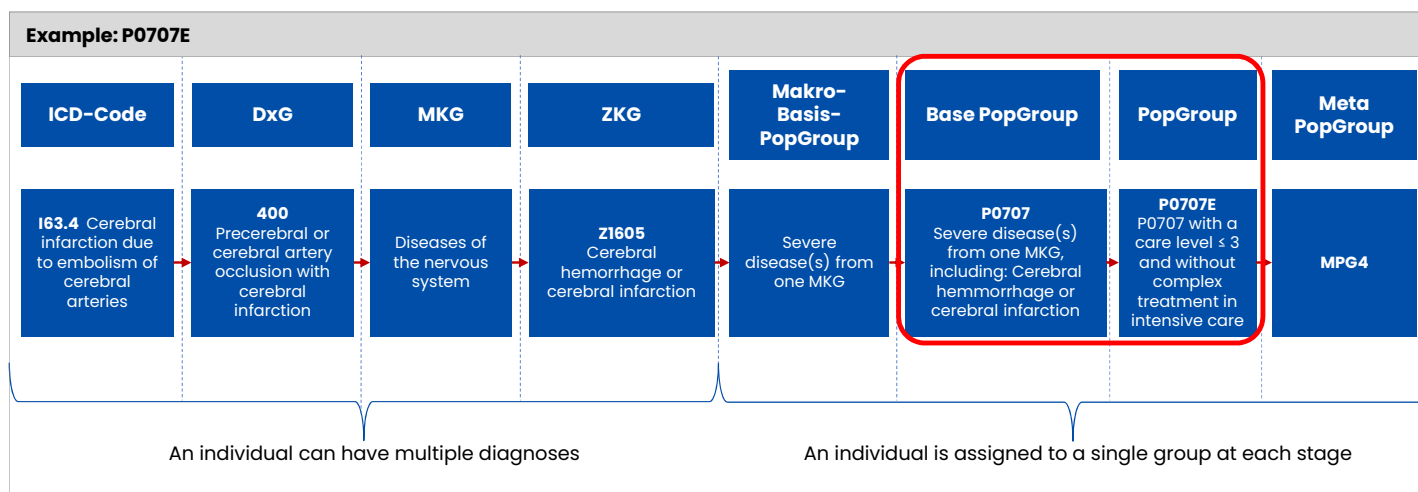
Johns Hopkins University. The Johns Hopkins ACG System. Excerpt from Version 11.0 Technical Reference Guide. November 2014.

OECD. Geographic variations in health care: What do we know and what can be done to improve health system performance? In: OECD Publishing, editor. *OECD Health Policy Studies*, 2014.

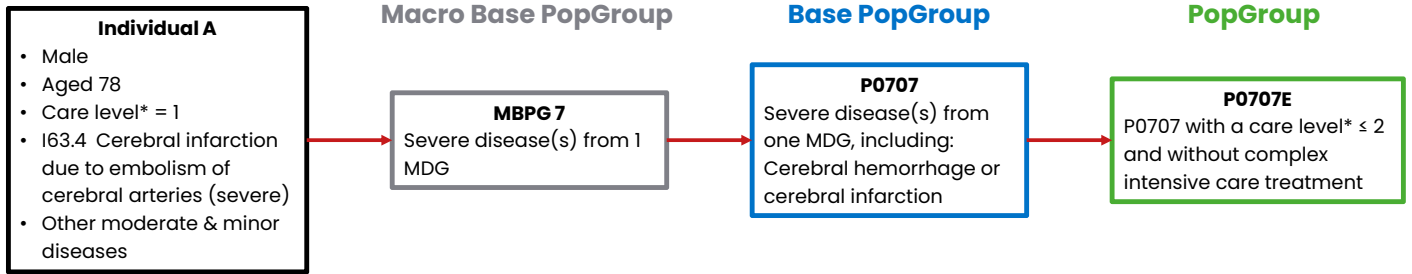
(SVR 2000): Sachverständigenrat zur Begutachtung der Entwicklung im Gesundheitswesen. Gutachten 2000–2001, Band III.2 Über-, Unter- und Fehlversorgung. Ausgewählte Erkrankungen: ischämische Herzerkrankungen, Schlaganfall und chronisch, obstruktive Lungenerkrankungen.

(3M 2022): 3M Clinical Risk Groups (CRG) Classification System. Methodology Overview. Software version 2.2. February 2022.

# Back-up

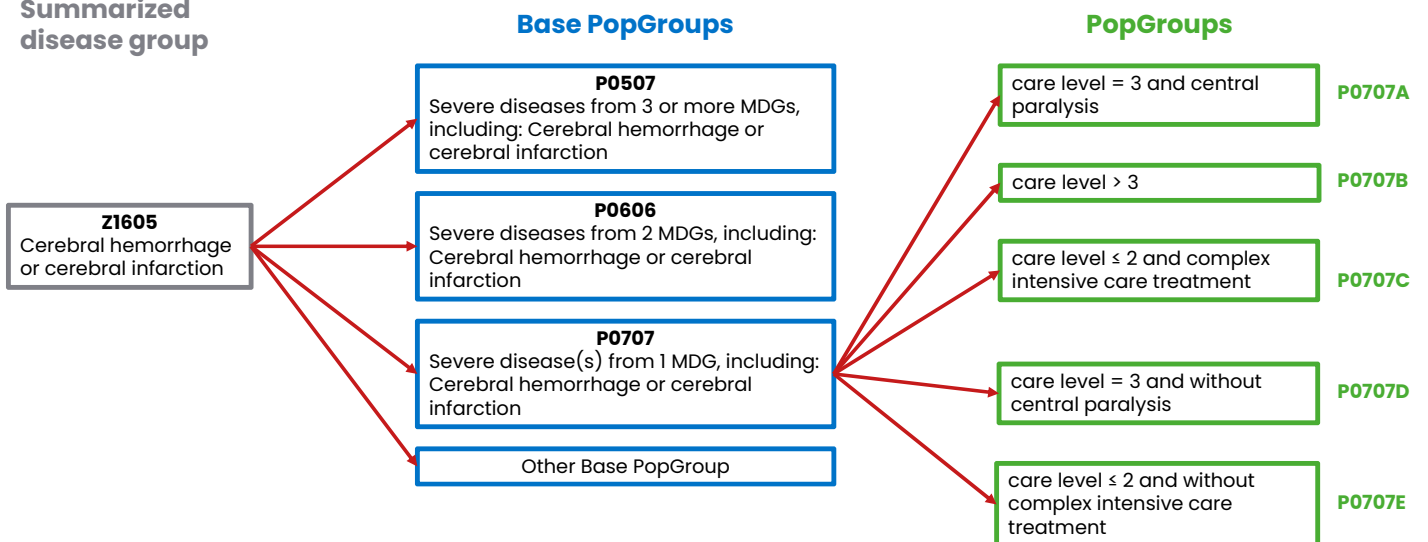


**Example: Individual A is assigned to PopGroup P0707E based on his dominant diagnosis and characteristics**



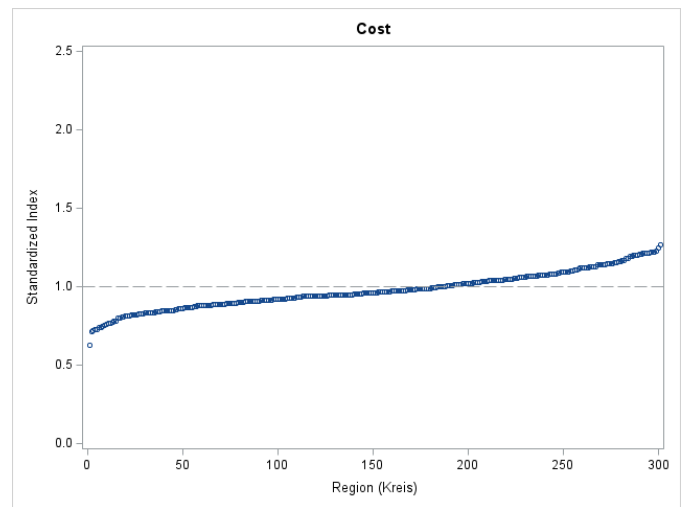
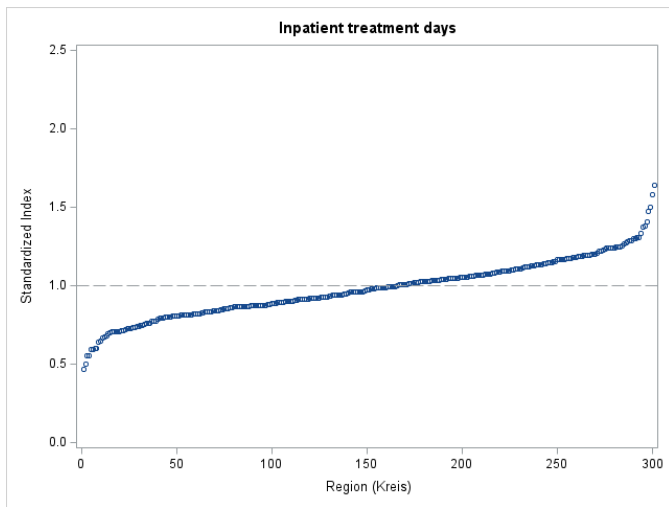
MDG: Macro Disease Group  
 \*Care levels: Levels of nursing care dependency, from 0 (no dependency) to 5 (highest impairment of autonomy)

**Summarized disease group**



MDG: Macro Disease Group  
 \*Care levels: Levels of nursing care dependency from 0 (no dependency) to 5 (highest impairment of autonomy)

## Regional variation in efficiency: age-sex standardized index



## Regional variation in efficiency: age-sex standardized index

