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KASSENÄRZTLICHE VERSORGUNG
IN DEUTSCHLAND

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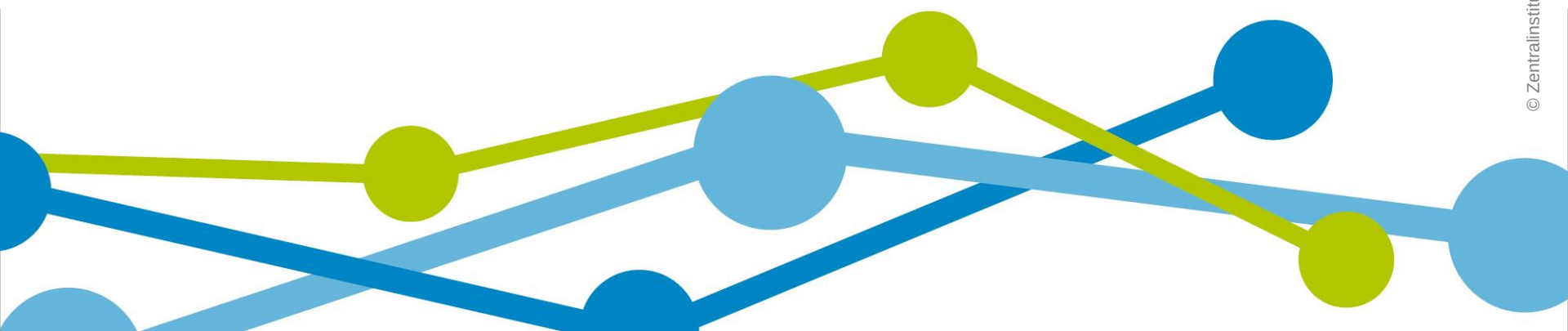
Analysis of Patient Sharing Networks in Ambulatory Care in Germany

Thomas Czihal, Tatiana Ermakova, Frank Ng, Marie-Luise Rosenbusch, Clarissa Gerber, Michael Erhart, Dominik von Stillfried



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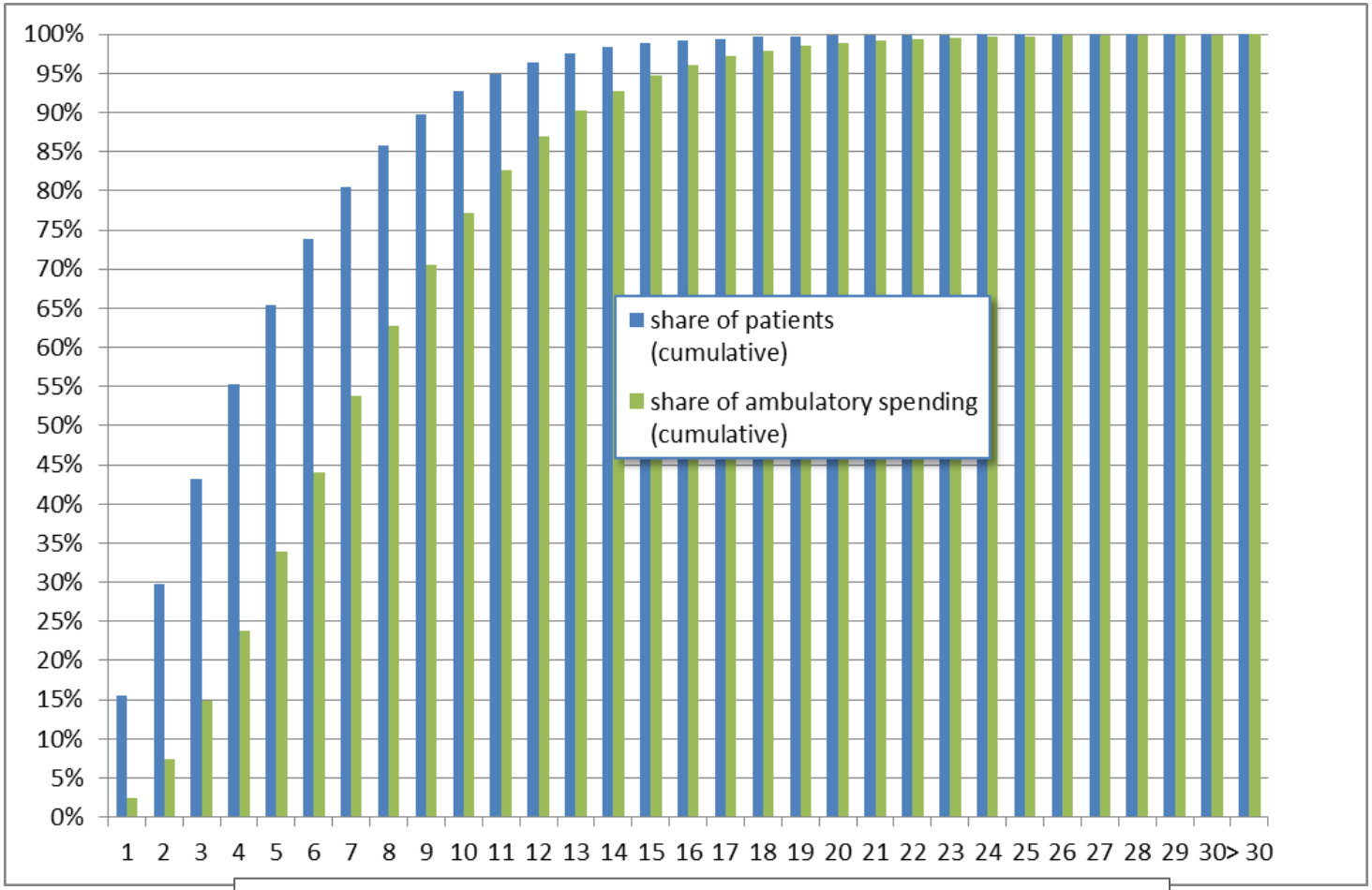
Just 15% of patients are being treated by only one physician



Data: ambulatory claims data 2016 for all statutorily insured patients in Germany (~ 72 million)
includes ambulatory treatments in EDs excludes non-users

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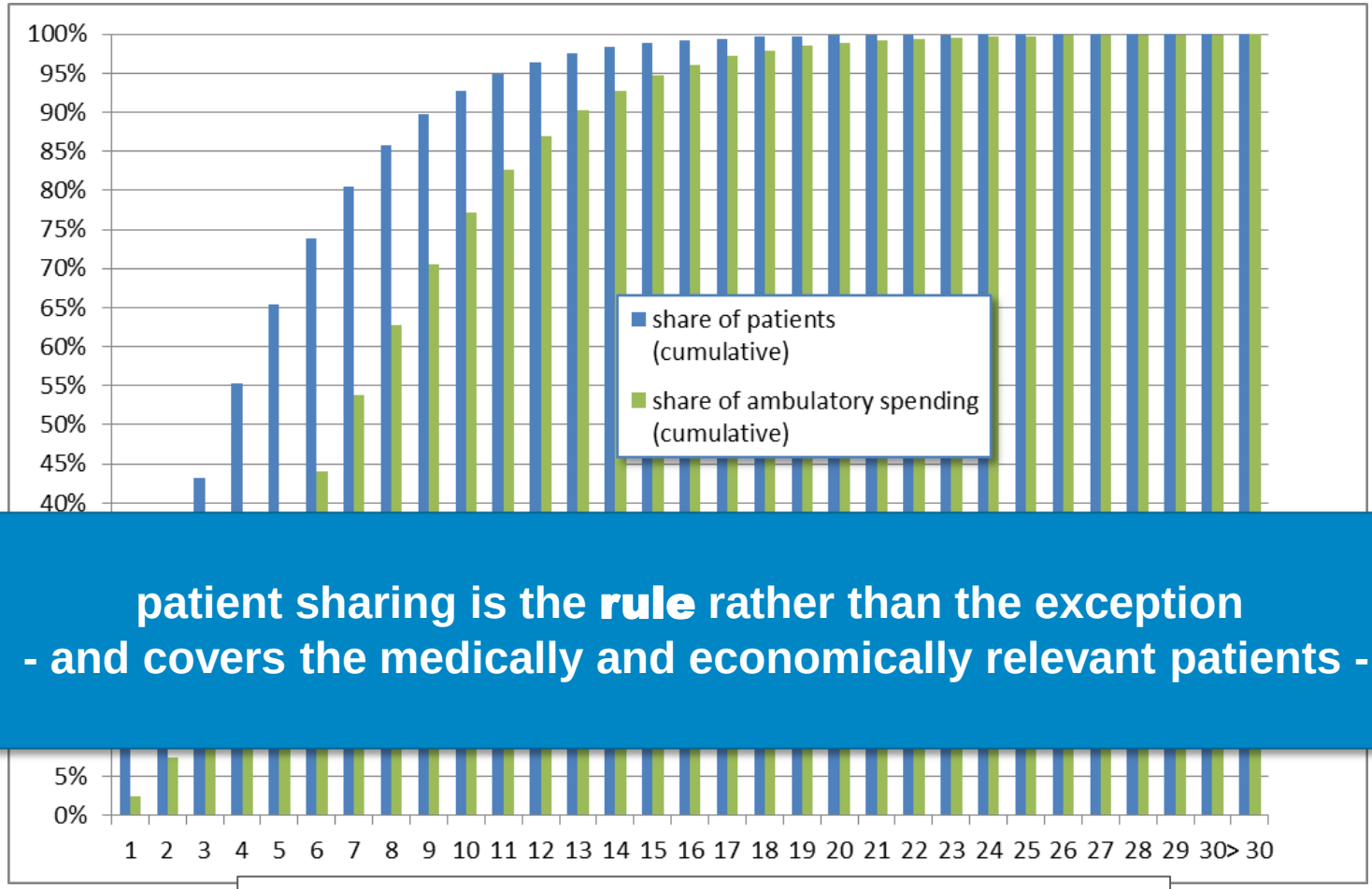


patient sharing is the rule rather than the exception
- and covers the medically and economically relevant patients -

Data: ambulatory claims data 2016 for all statutorily insured patients in Germany (~ 72 million)
includes ambulatory treatments in EDs excludes non-users

What‘s the regional outcome got to do with me?

How to establish accountability in Germany? Patients may access any number of practices and EDs (no financial disincentive, no registration with a GP).

- **assumption:** if most patients are cared for by a virtual „network“ of practices; outcomes must be attributed to this „network“ (rather than to individual practices)
- **method:** every patient is allocated to the GP who provided most services (or the highest case load) for this patient
- all other physician contacts of this patient are aggregated so that all of this patient‘s physicians „join the network“ around the GP
- **results:** while physicians can be part of several networks, each network has treated a specific patient population (all services came from this network)
- patient-sharing networks can be compared with respect to the outcomes achieved for its respective patient population
- mean outcomes per network can be aggregated geographically (either based on patient residence or on practice location) – or geographic means can be broken down to variation between local networks

GP-centered patient-sharing networks (PSN)

total no of PSN

effect of restricting network size to a minimum of ≥ 10; 50 or 100 shared patients

		all patients	≥ 10 P	≥ 50 P	≥ 100 P
N	valid	38711	38711	38711	38711
	missing	0	0	0	0
avg no. of practices		**701,54**	**94,54**	**25,70**	**12,06**
median		621,00	88,00	24,00	10,00
modal value		538	83	22	3
std. deviation		345,168	43,006	15,050	8,764
variance		119140,964	1849,510	226,501	76,810
min		47	1	1	1
max		3878	495	161	97
percentiles	25	467,00	67,00	15,00	5,00
	50	621,00	88,00	24,00	10,00
	75	848,00	115,00	34,00	17,00

mean network size (practices)

variation in network size

Data: ambulatory claims data 2014 for all statutorily insured patients (N ~ 72 million)

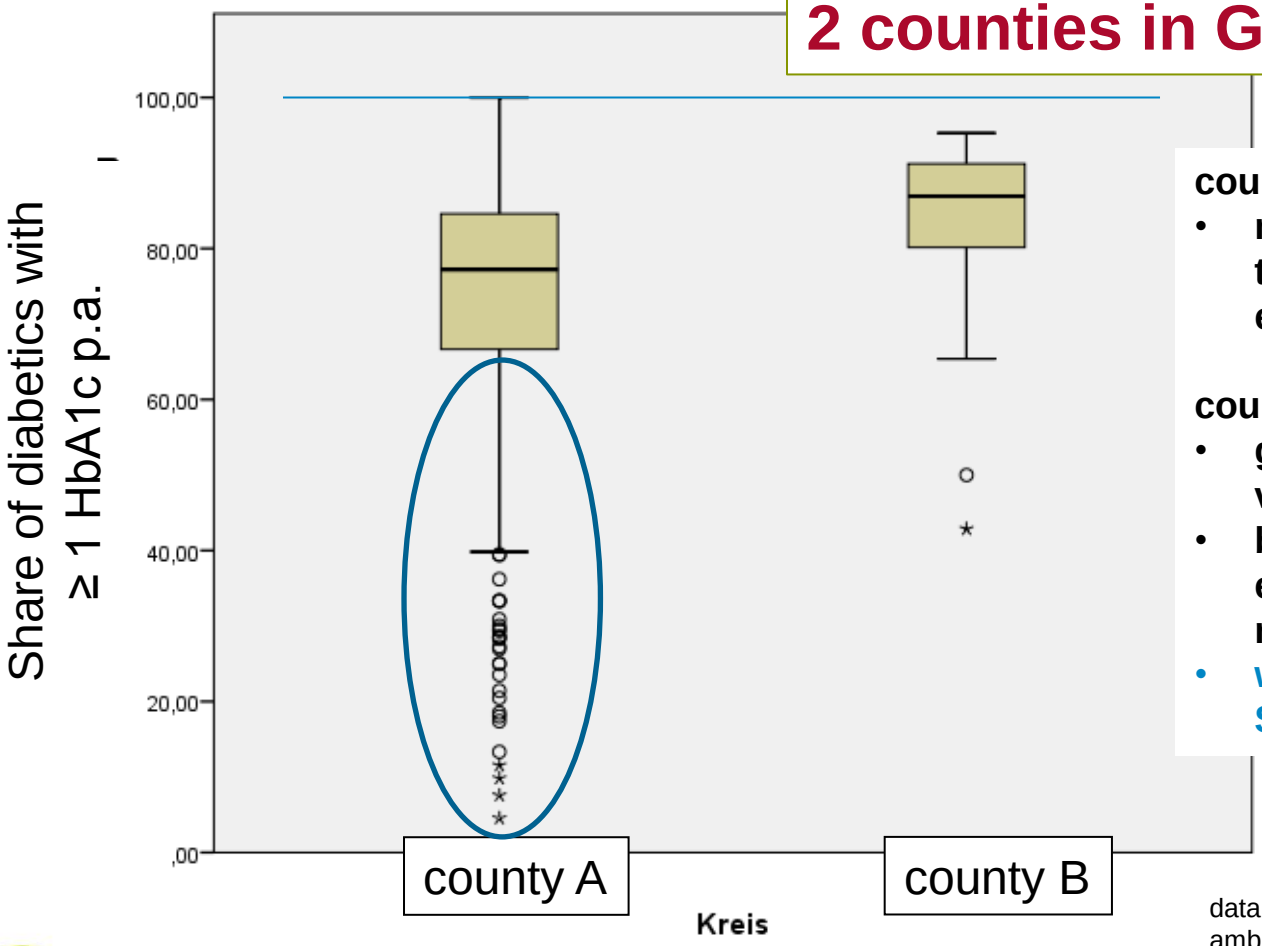
Understanding regional averages

share of diabetes patients with ≥ 1 HbA1c-test p.a. in GP-centered PSN and in the regions (county)

county A
median: 78%

county B
median: 86%

2 counties in Germany



county B:

- **median is more relevant to patient and physician experience**

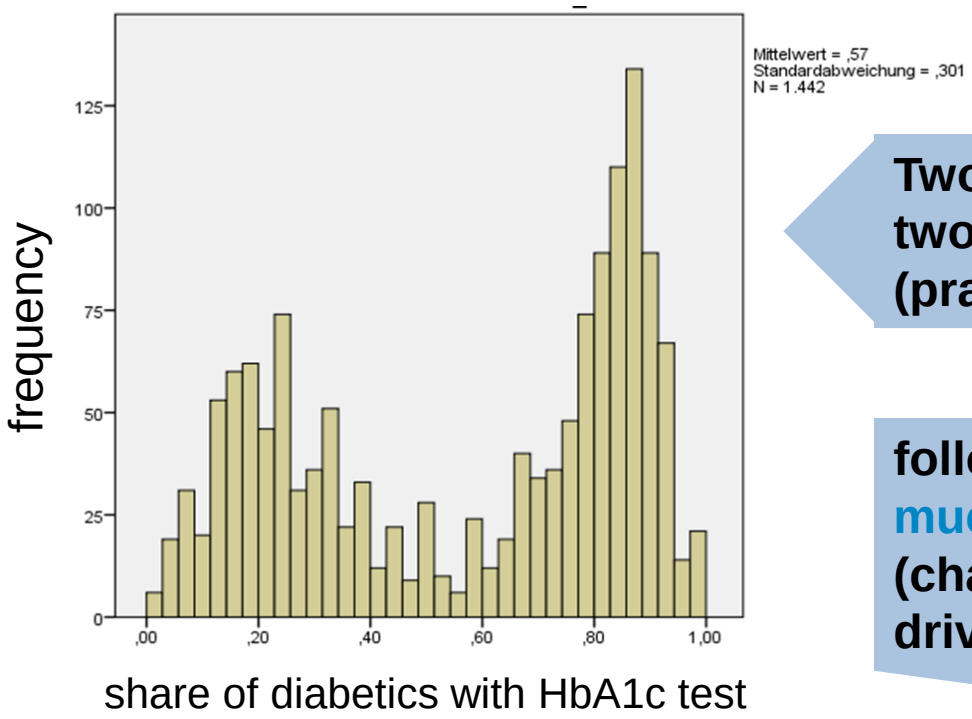
county A:

- **greater intra-regional variation between PSN;**
- **best and worst practice examples within same region**
- **what happens here? Scope for intervention**

data source:
ambulatory claims database 2010

Time trends: do we see change in practice patterns at PSN level?

N = 38,711 networks 2012 - 2014



Two peaks suggest:
two distinct practice patterns
(practice style/social structure …)

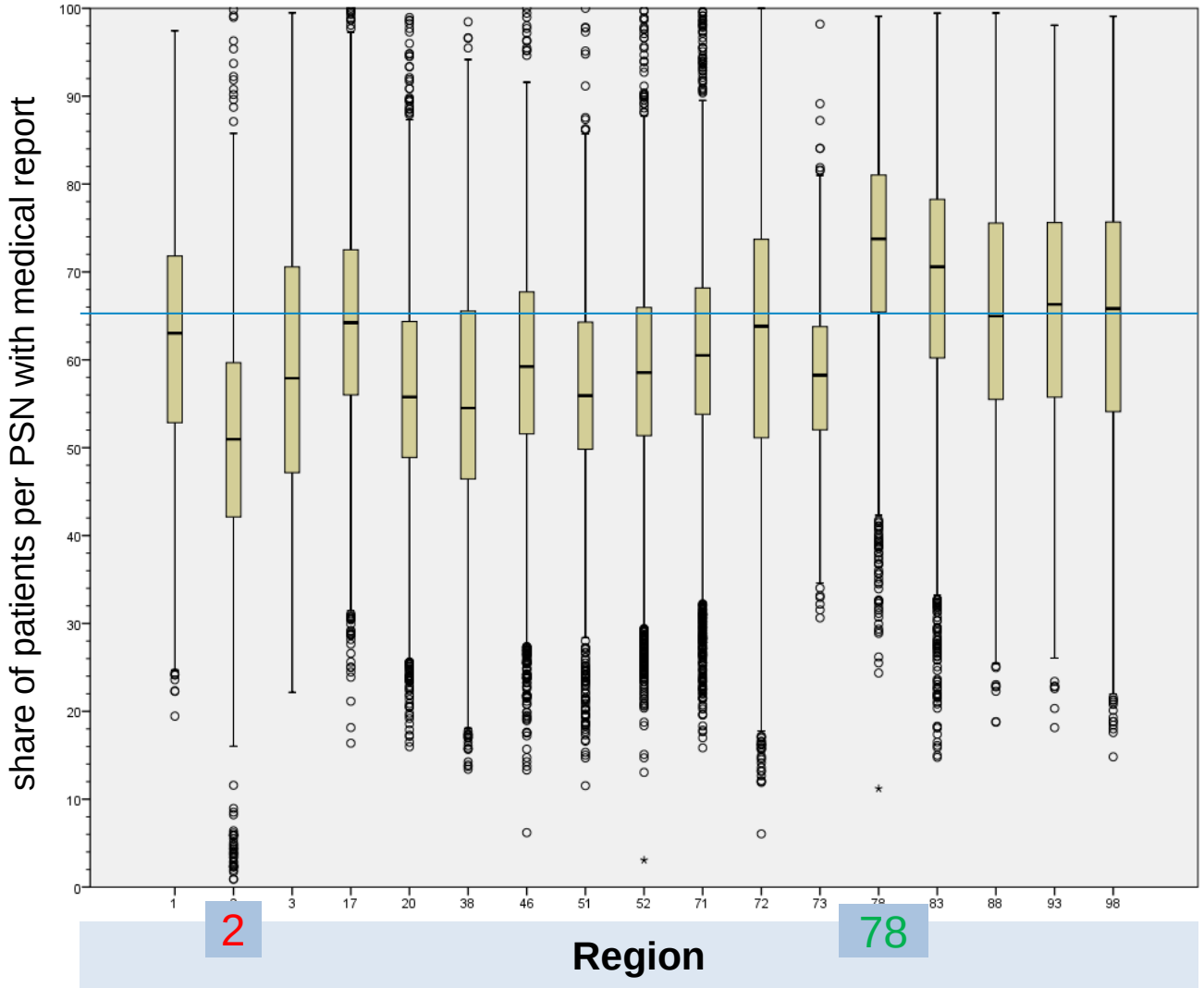
follow-up shows: many PSN get much better, only few get worse
(change is possible – but what drives the change …?)

networks	diabetics with HbA1c test in 2012				diabetics with HbA1c test in 2014			
	mean	max	median	min	mean	max	median	min
25 percentile	18%	25%	19%	1%	57%	100%	68%	1%
25% - 50%	39%	50%	40%	25%	59%	100%	56%	6%
50% - 75%	67%	75%	68%	50%	70%	100%	72%	4%
75 percentile	87%	100%	87%	75%	85%	100%	87%	11%
all networks	**76%**	**100%**	**82%**	**1%**	**79%**	**100%**	**83%**	**1%**

Data: ambulatory claims database 2012-2014, GP-centered PSN

Cooperation within PSN varies between PSN and regions

(share of patients per PSN with a written communication for another doctor)

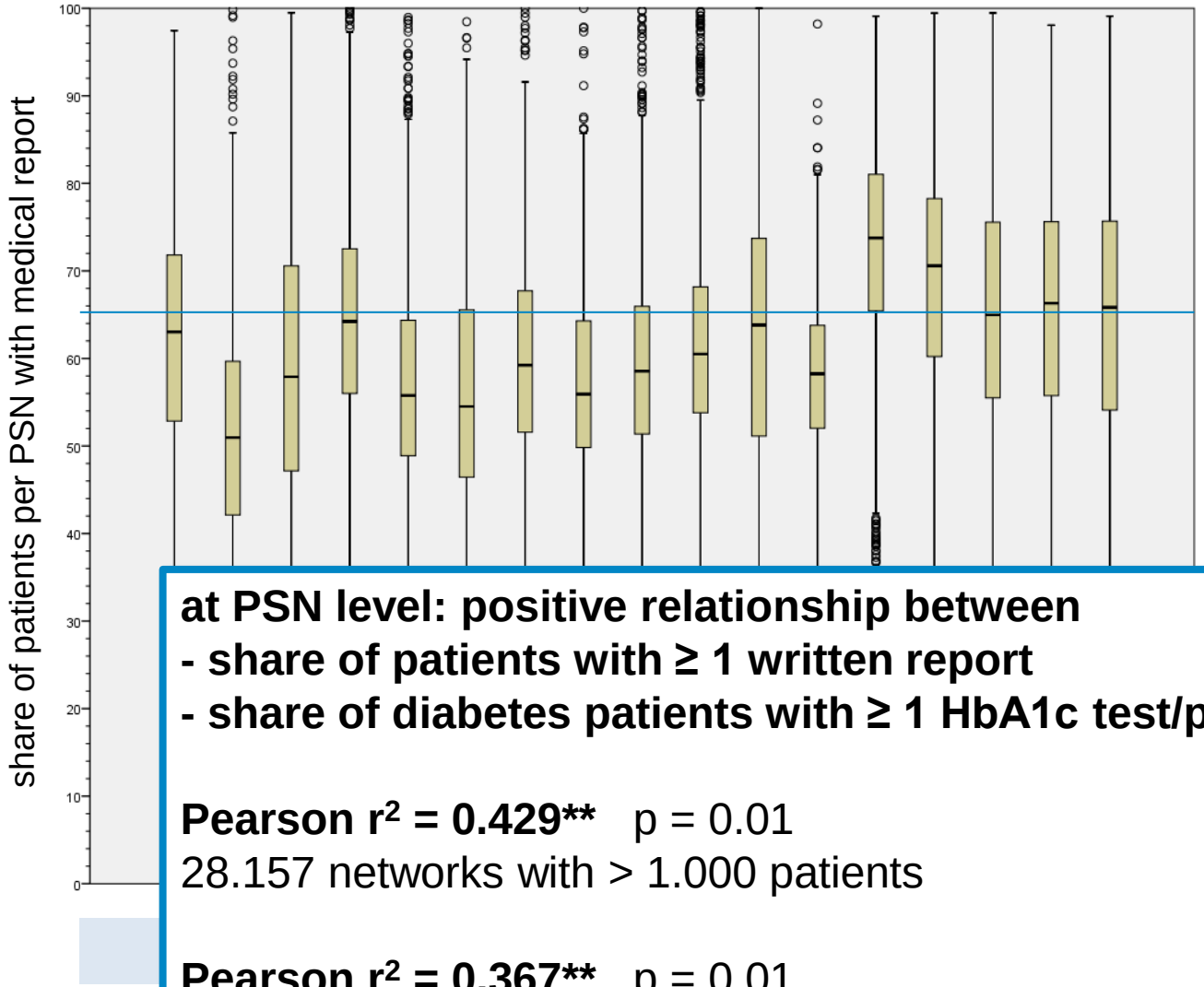


Region	
1	Schleswig-Holstein
2	Hamburg
3	Bremen
17	Niedersachsen
20	Westfalen-Lippe
38	Nordrhein
46	Hessen
51	Rheinland-Pfalz
52	Baden-Württemberg
71	Bayerns
72	Berlin
73	Saarland
78	Mecklenburg-Vorpommern
83	Brandenburg
88	Sachsen-Anhalt
93	Thüringen
98	Sachsen

Data: ambulatory claims database 2015, GP-centered PSN with ≥ 200 patients

Patterns of cooperation within PSN vary geographically

(share of patients per PSN with a written communication for another doctor)



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	Saarland
	Mecklenburg-Vorpommern
	Brandenburg
	Sachsen-Anhalt
	Thüringen
	Sachsen

at PSN level: positive relationship between
- share of patients with ≥ 1 written report
- share of diabetes patients with ≥ 1 HbA1c test/pa

Pearson r^2 = 0.429** p = 0.01
28.157 networks with > 1.000 patients

Pearson r^2 = 0.367** p = 0.01
39.679 networks with > 200 patients

Data: ar

Patterns of cooperation within PSN vary geographically

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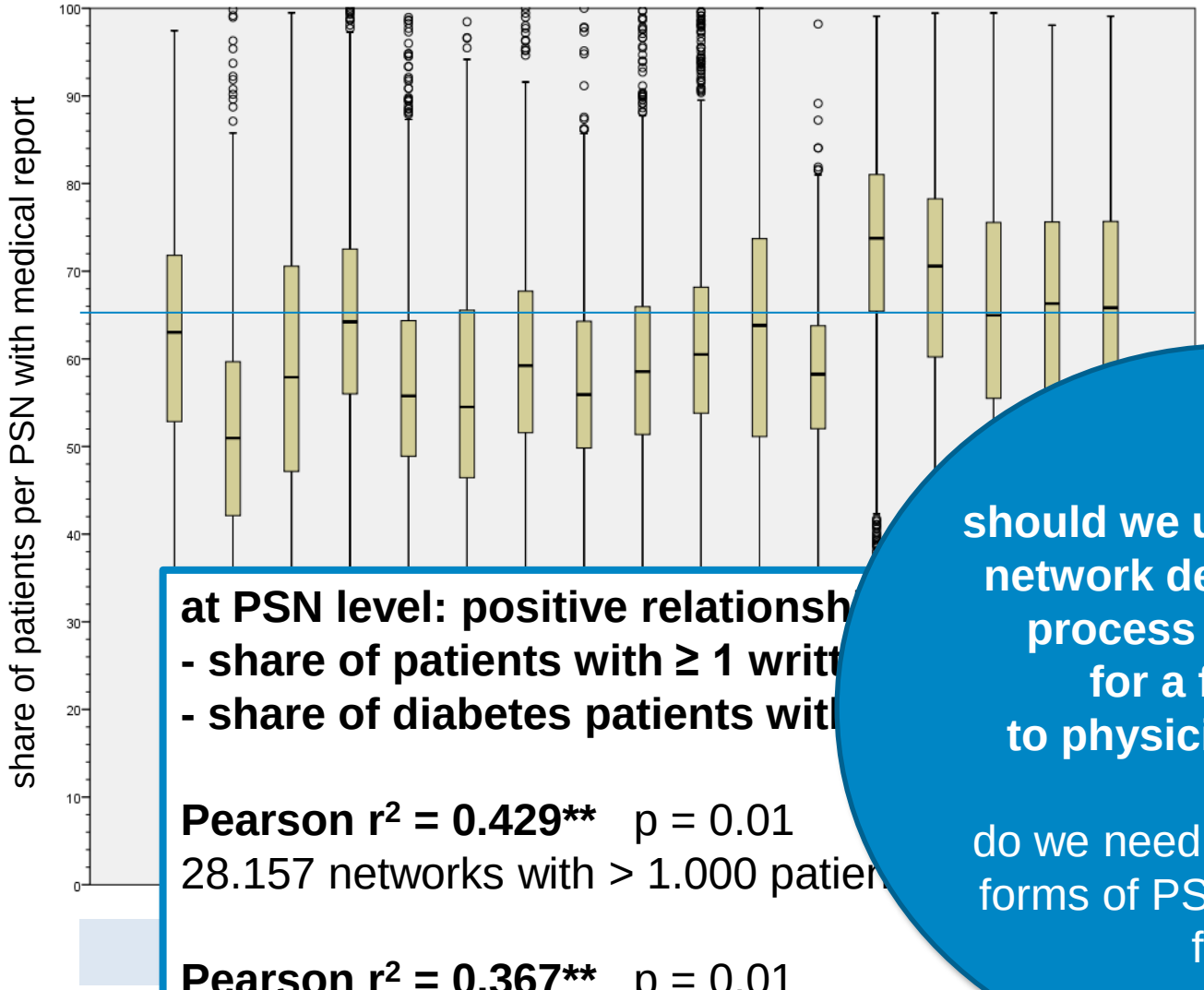

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should we use this kind of network description and process information for a feedback to physicians in PSN?

do we need to look at other forms of PSN identification first?

Data: ar

Background: Social Networks Analysis (SNA)

Formally, **a network (or graph)** is defined through

- **nodes and edges**, each connecting a pair of nodes
  (Leskovec et al. 2014, p. 343; Liu 2011, p. 270; Zaki and Meira 2014, p. 93).

In a social (e.g. healthcare) context,

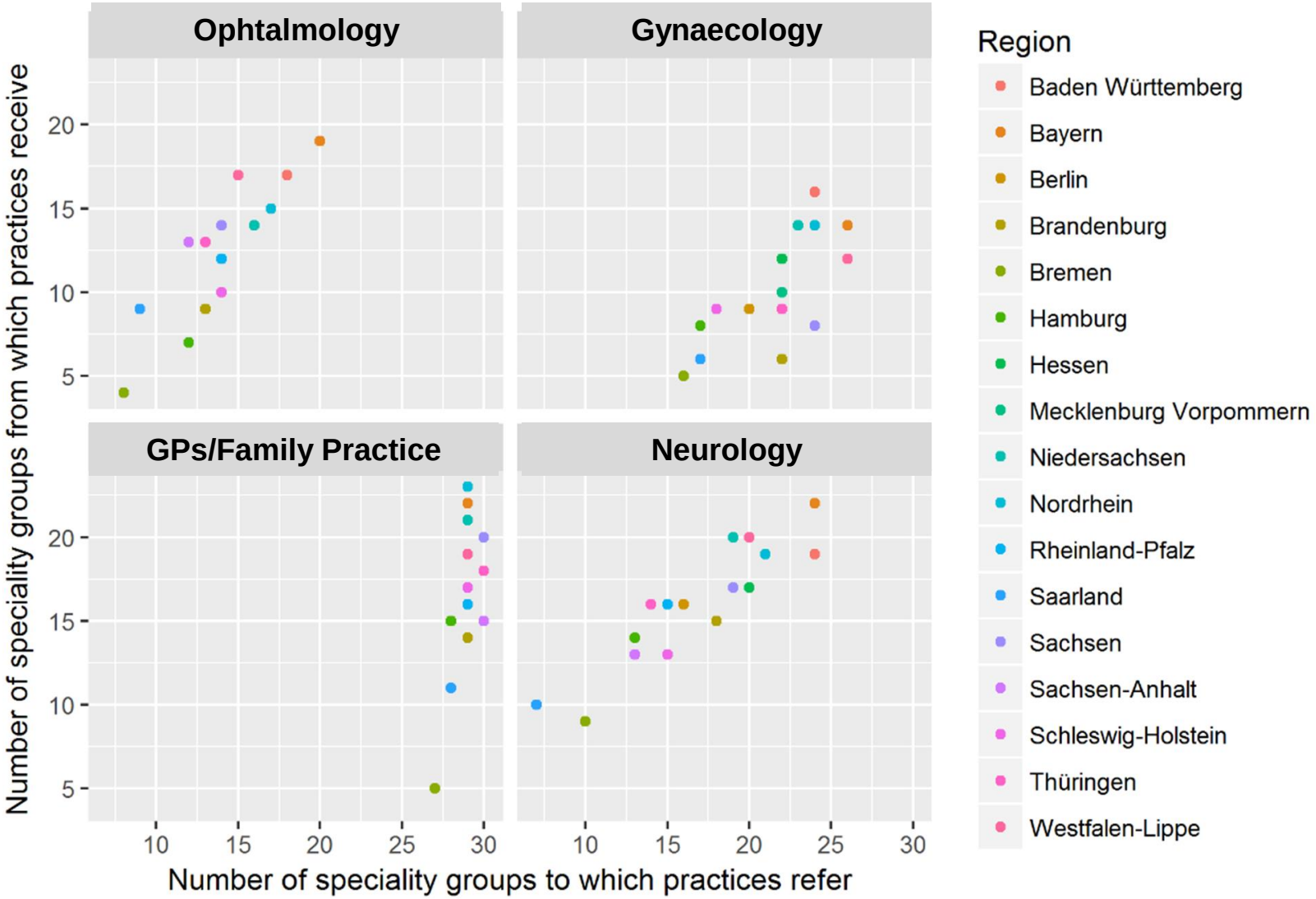
- **each node** can represent **an actor** (e.g., a doctor; a medical specialist group),
- **each edge a relationship** (e.g., patient referral) (Liu 2011, p. 270).

Social network analysis enables gaining insights into

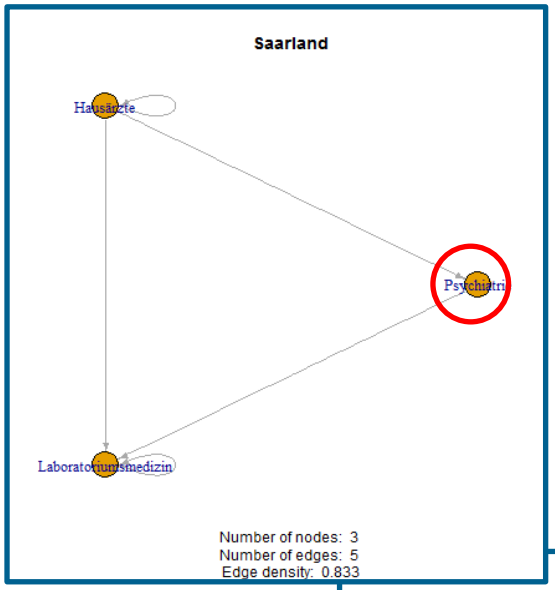
- a network's **overall structure**,
- **the role of each individual actor** within the network

Source: theseosystem.com

Using referrals as a proxy for (some) cooperation – results by specialty: geographic variation



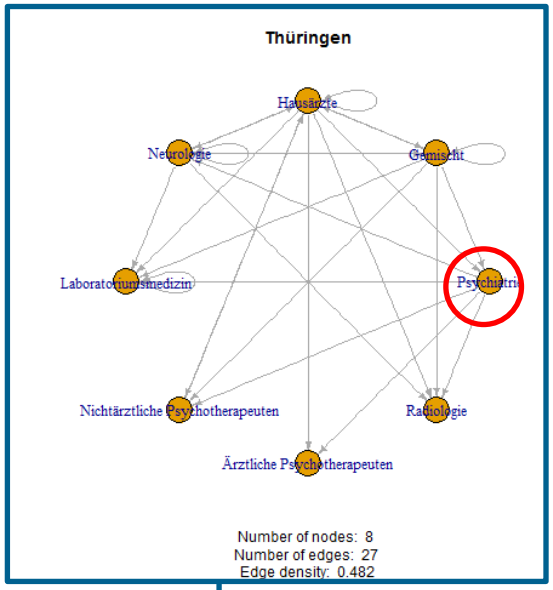
Using referrals as a proxy for (some) cooperation - results: regional graph structures

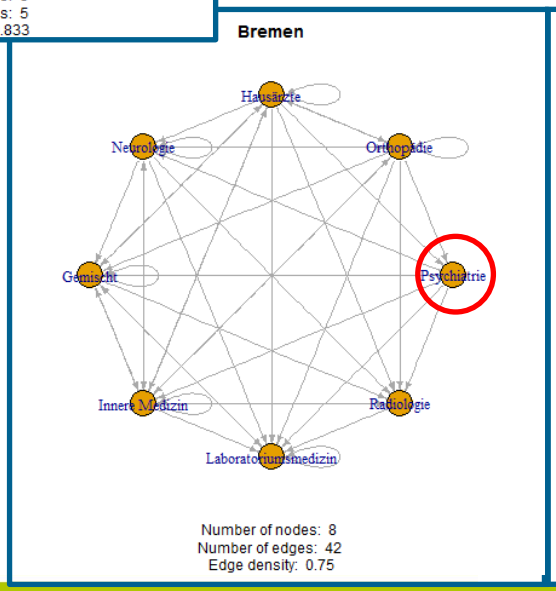


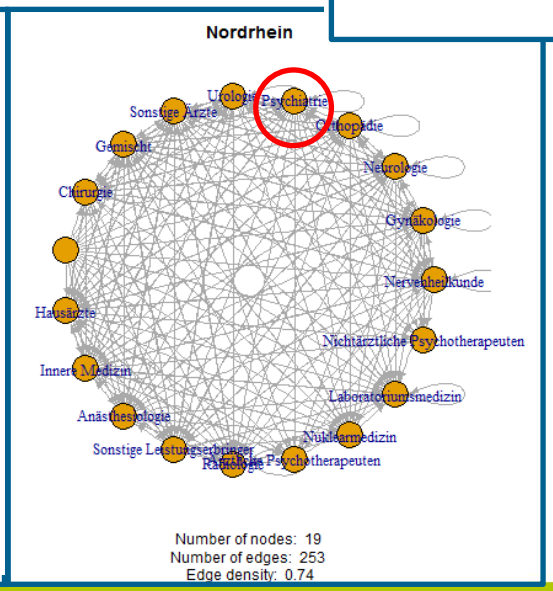
example

Psychiatrists

how they are connected to other specialty groups & the interaction among the other specialties in the region

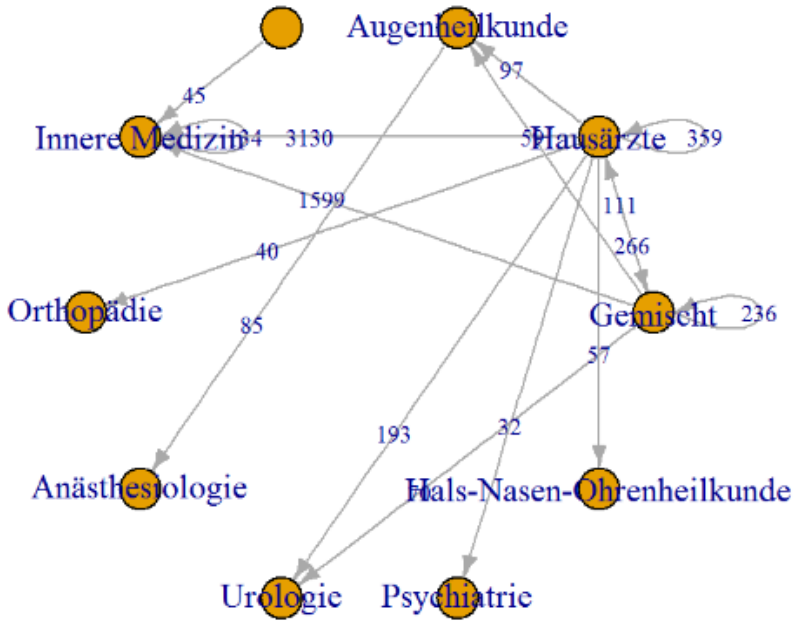




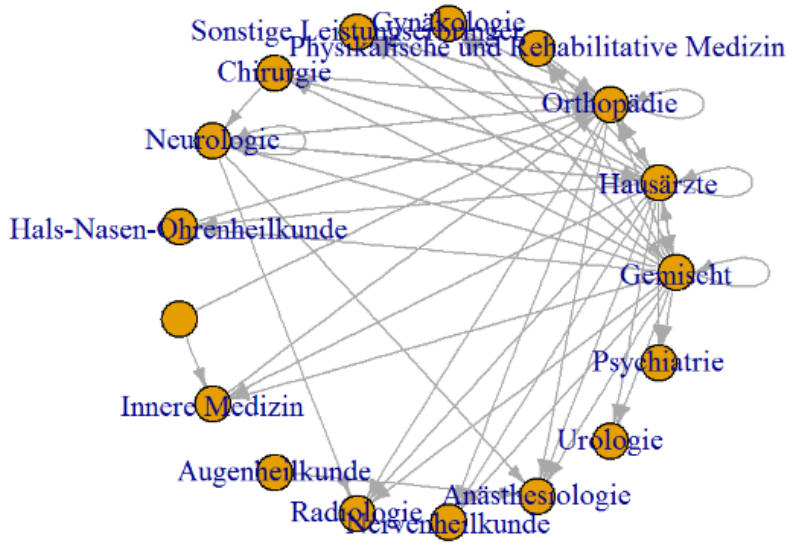


Using referrals as a proxy for (some) cooperation
- results: disease drives also graph structure (same region)

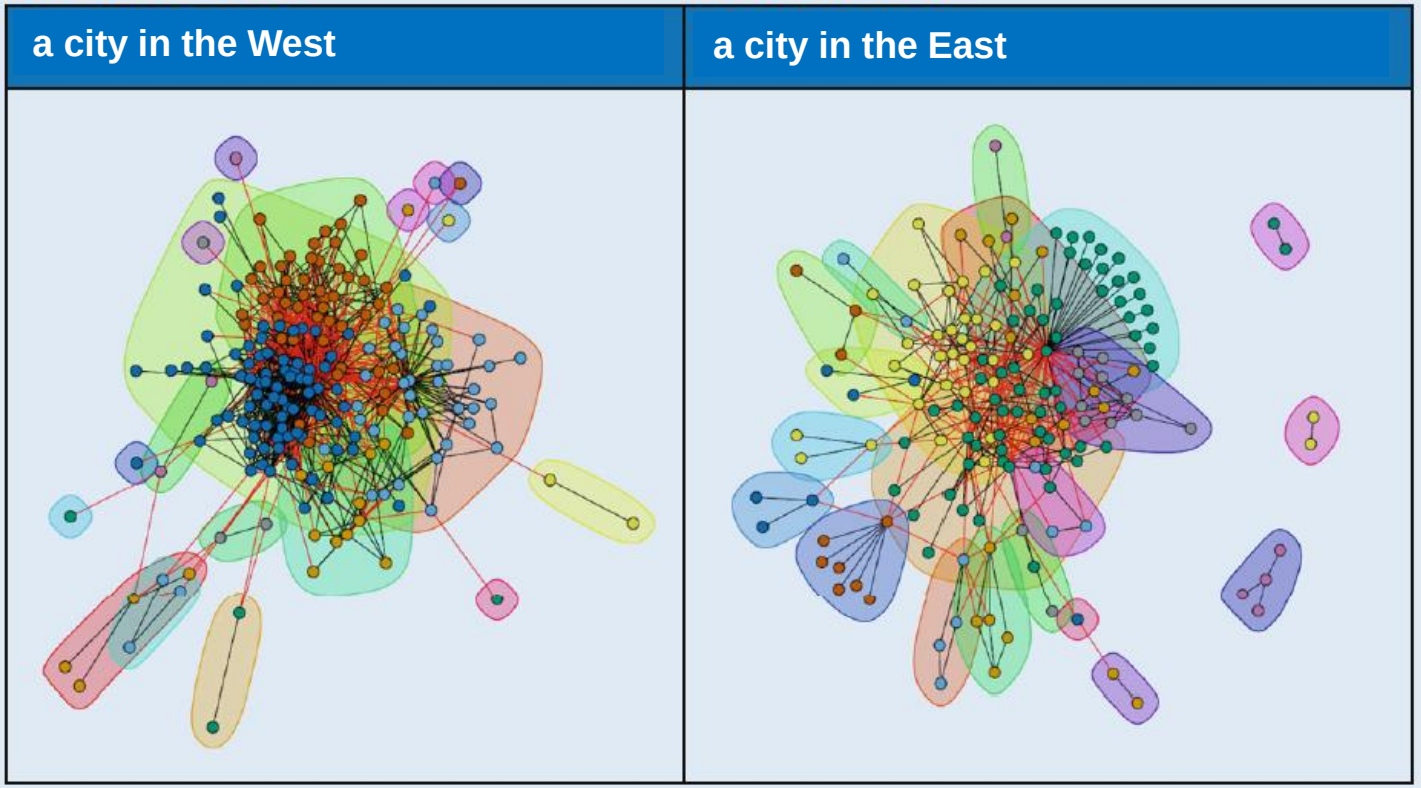
CHF



backpain



Comparing the PSN-structure of two cities by SNA



patients	**82,314**	**78,988**
physicians	**201**	**163**
PSN	**20**	**22**

data: ambulatory claims database 2015; patients with referrals only
method: walk-trap community detection algorithm, modularity > 0.3

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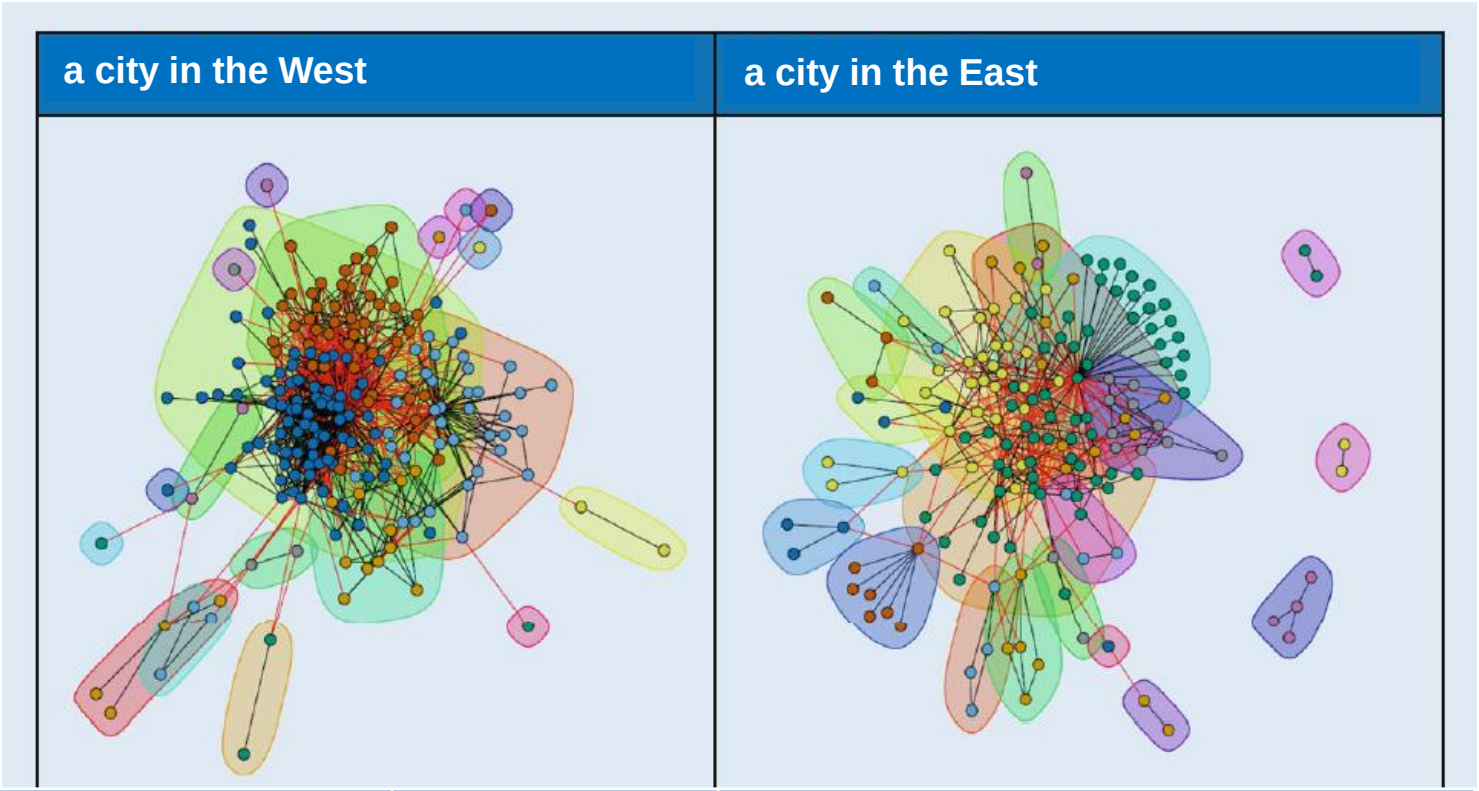
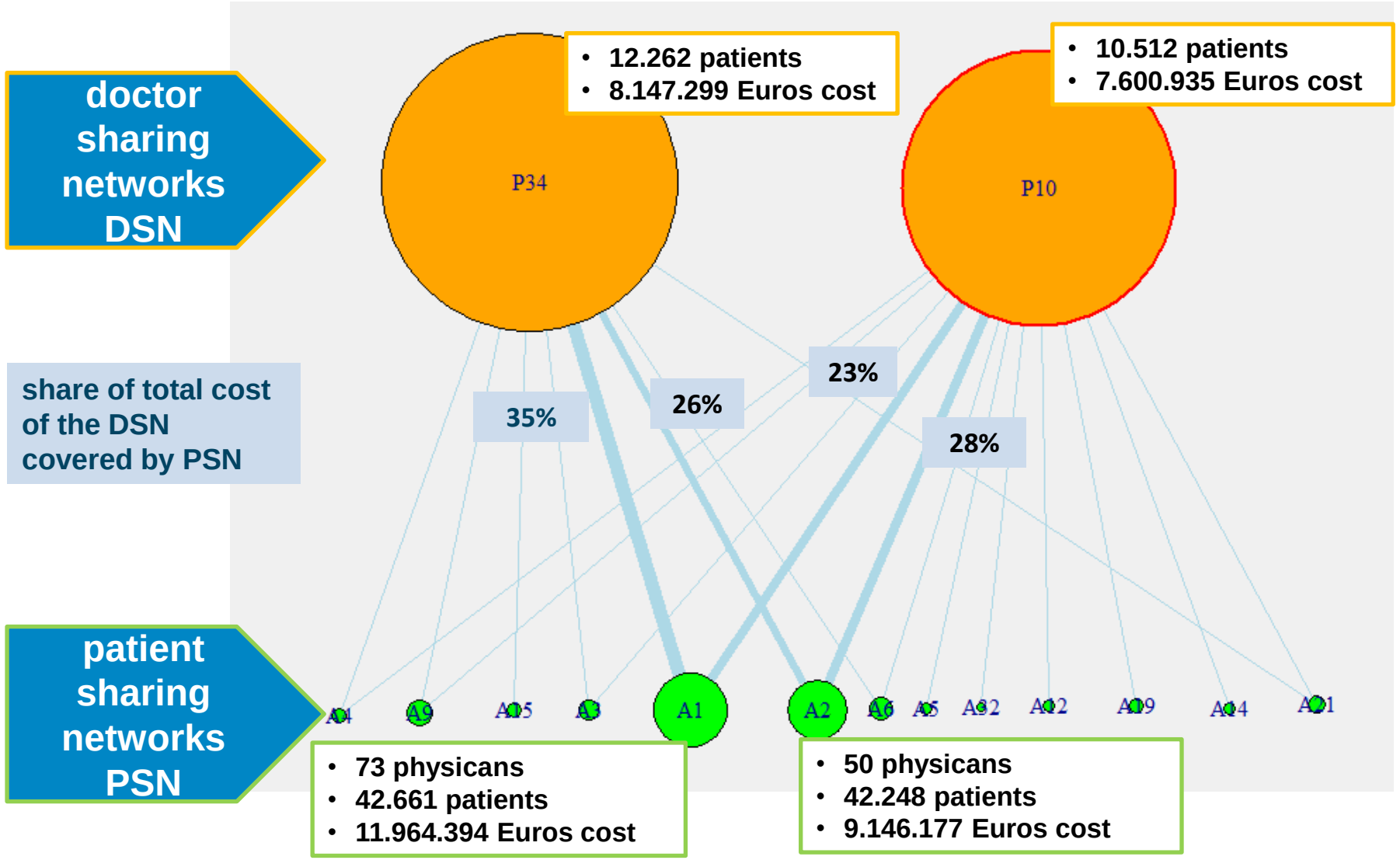


min no. of shared patients	≥ 15	≥ 25
large PSN / physicians	2 with > 50	4 with > 30 physicians (all sp.)
patients in only 1 PSN	26.4%	29,6%
patients in ≥ 4 PSN	18.8%	20.1%

data: ambulatory claims database 2015; patients with referrals only
method: walk-trap community detection algorithm, modularity > 0.3

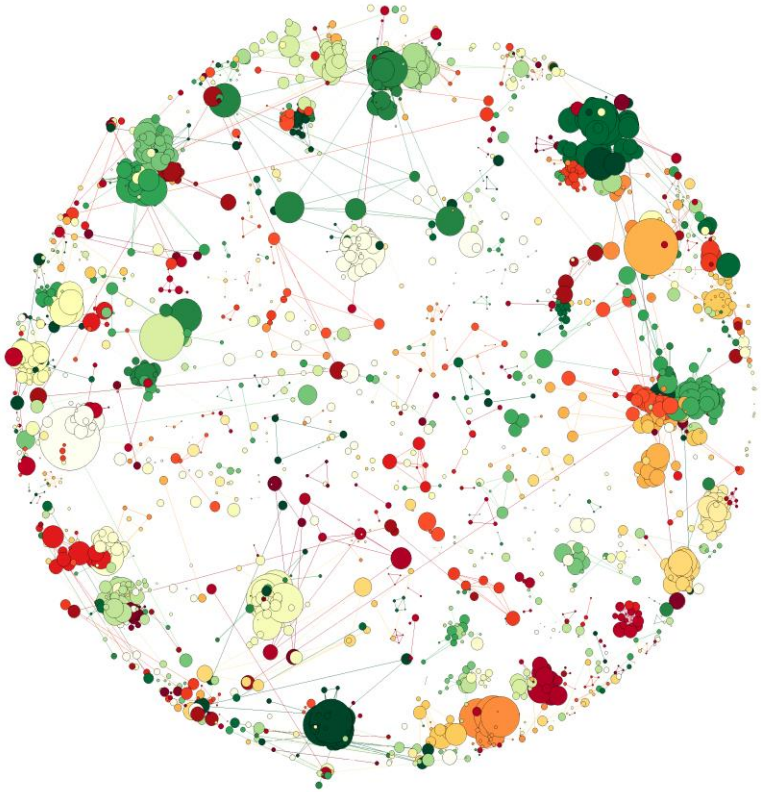
SNA and the problem of ‚accountability' (city in the West)



data: ambulatory claims database 2015; patients with referrals only
method: walk-trap community detection algorithm, modularity > 0.3

SNA, weighing nodes with no. of patients:
e.g. patients with depression

region in the North



PSN

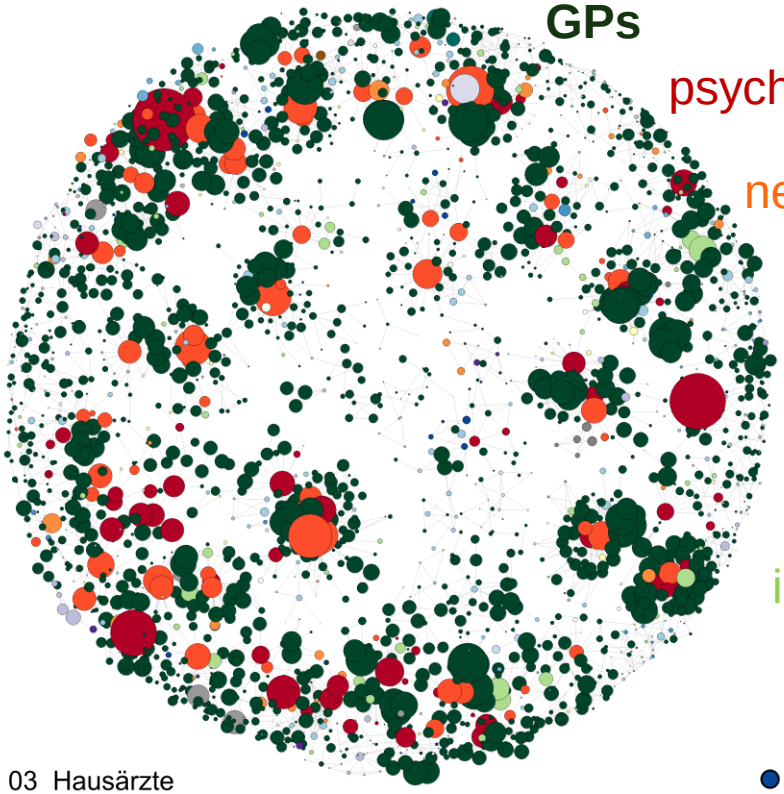
region in the West

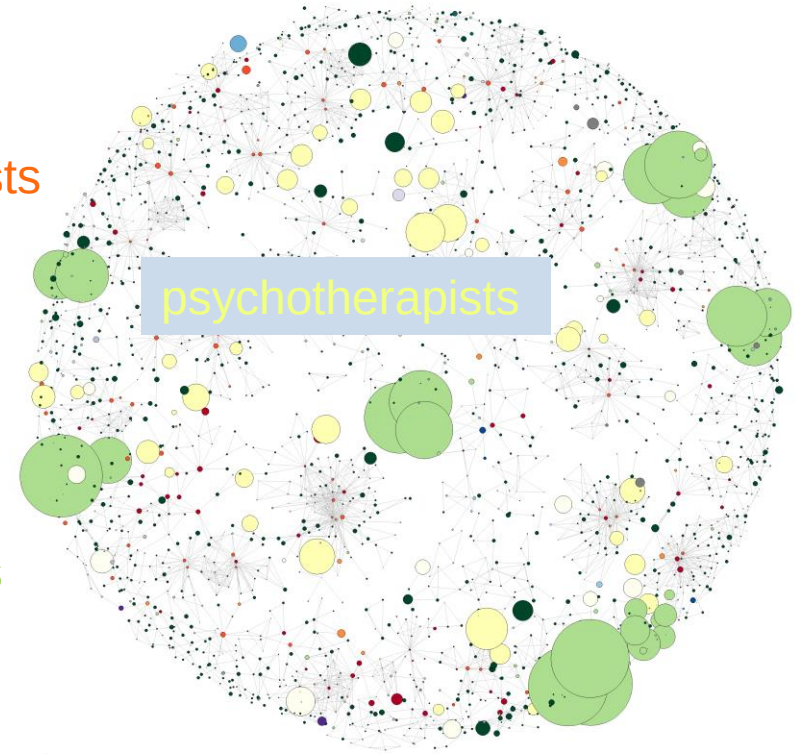
data: ambulatory claims database 2016; patients 18-79 yrs with depression (ICD10 F32, F33 or F34.1)
N patients = 3,7 million, N physicians = 62K for all 17 regions
method: community detection by cluster walk-trap, modularity > 0.3 (≥10 shared patients)
image: R igraph, layout-algorithm based on Kamada-Kawai

SNA for patients with depression / northern region – who cares?

weighing nodes with no. of patients

weighing nodes with cost per patient





- 03 Hausärzte
- 04 Kinder− und Jugendmedizin
- 13 Innere Medizin
- 16 Neurologie
- 30 Nervenheilkunde
- 14 Kinder− und Jugendpsychiatrie und −psychotherapie
- 21 Psychiatrie
- 22 Ärztliche Psychotherapeuten
- 23 Nichtärztliche Psychotherapeuten

- 09 Hals−Nasen−Ohrenheilkunde
- 20 Phoniatrie und Pädaudiologie
- 10 Hautärzte
- 06 Augenheilkunde
- 08 Gynäkologie
- 26 Urologie
- 05 Anästhesiologie
- 15 Mund−Kiefer−Gesichtschirurgie
- 07 Chirurgie
- 18 Orthopädie
- 27 Physikalische und Rehabilitative Medizin

- 12 Laboratoriumsmedizin
- 11 Humangenetik
- 24 Radiologie
- 17 Nuklearmedizin
- 25 Strahlentherapie
- 19 Pathologie

- 93 Sonstige Ärzte
- 99 Sonstige Leistungserbringer

Discussion

- **Geography** remains important – but it seems less like destiny when we look at variation between **patient-sharing networks (PSN)**
- Making PSN visible could help provide a link between individual behavior and outcomes observed at regional level – this could lead to **population-based quality improvement**
- **But there are many ways to look at PSN - more research** needs to go into analysis of PSN
  - how can PSN affect outcomes?
  - how can we establish accountability for outcomes?
  - what are relevant indicators of cooperation?
  - what is caused by individual behavior, what by environmental factors?
  - …
- Providing **feedback to PSN** and **discussing with PSN-members** potential reasons for variation may be **instrumental** to better understanding - while also causing behavioral change

Thank you for your attention!

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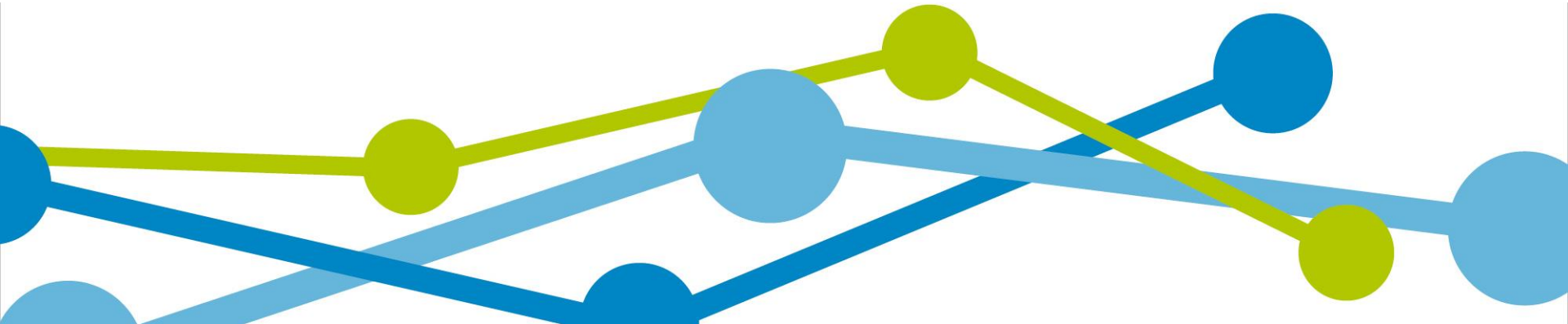
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