Health services research using clinical indicators

Søren Paaske Johnsen

(Selected) Challenges

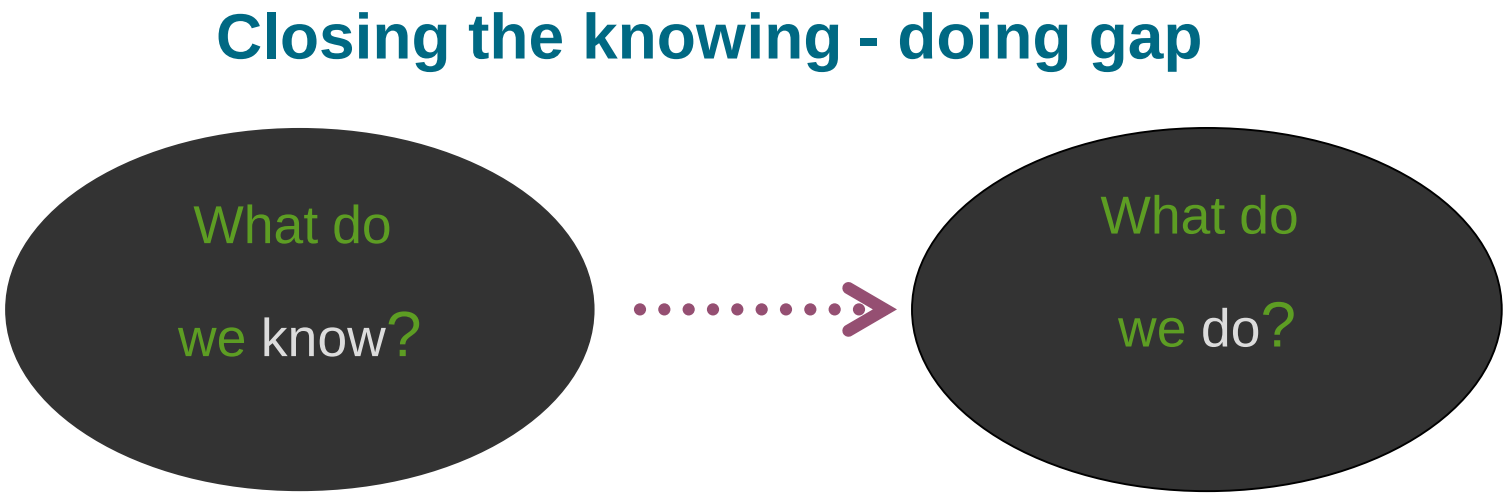
- Unadressed questions about the organisation of care.
- Uncertain relationships between structure, process and outcomes.
- Uncertainties about the magnitude of inequalities in health across patient groups (age, gender, socioeconomic status, comorbidity etc.) and the mechanisms driving these differences.
- Insufficient knowledge about the efficacy/effectiveness of quality improvement initiatives.

Clinical registries-status

- An increasing number of clinical registries are established across health care systems
- The registries usually have multiple aims (quality improvement, accountability, transparency, research infrastructure etc.) and many stakeholders.
- A large amount of resources (including money, time of staff, administrators, and patients etc.) are spent on establishing and running the registries.
- Benchmarking of individual institutions and administrative units is often the primary way of making (systematic) use of the collected information.
- No pre-planned strategy for research when establishing new clinical registries or quality improvement initiatives in Denmark.

The objective with data collection for quality is not…..

The data collection itself – but the use of data by appropriate action:



How to change clinical behaviour and organisation – with data

The adverse effect of being (to) late……

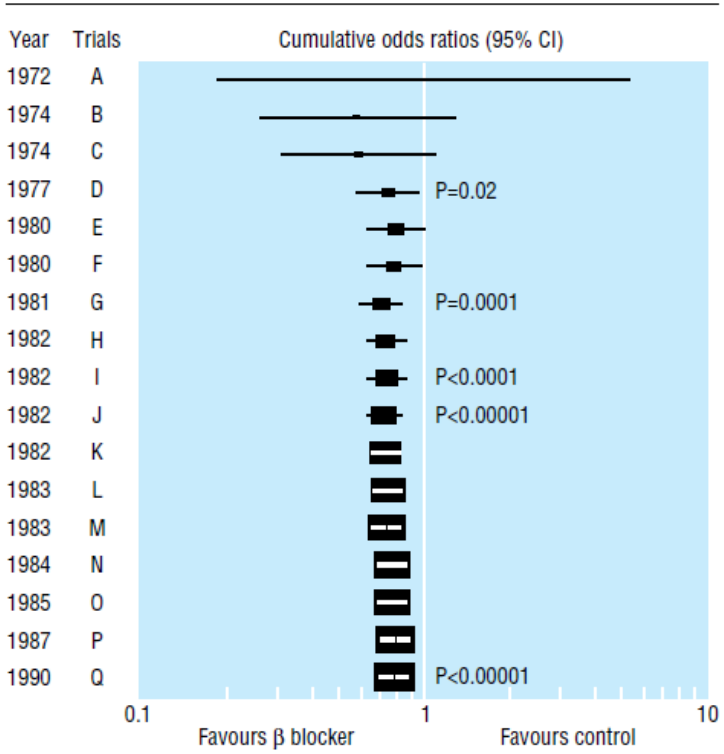


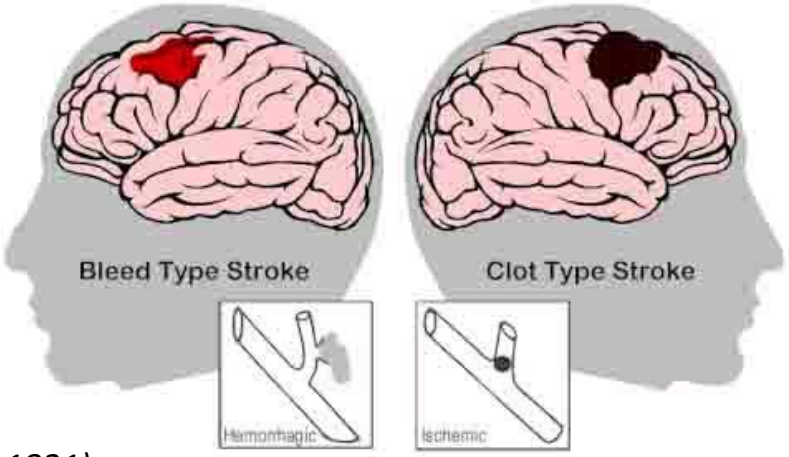
Fig 3 Cumulative meta-analysis of total mortality results from randomised controlled trials of oral β blockers after myocardial infarction. The size of the square reflects the amount of statistical information available at a given point in time

BMJ 1997; 315: 1371-4.

An example: Stroke

Stroke

- Ischemic stroke (~85%)
- Hemorrhagic stroke (~15%)



Epidemiology

- The second leading cause of death
  (Lancet. 2006;367:1747)
- The leading cause of disability *(Lancet.2009;374:1821)*
- Associated with high economic costs (*Stroke. 2004;35:1209)*

Medical care

- Consensus recommendations:
  - Patients should be treated at specialized stroke units
  - Early initiation of treatment, care, and rehabilitation is important

  (e.g., The European Stroke Organization and the American Heart Association)

Core elements for improving acute stroke care in Denmark

- Danish Stroke Society: Founded 2003
- National clinical guidelines on acute care
  - First published in 2003. Updated in 2009 and 2013
  - Published by the Danish Stroke Society
- Danish Stroke Registry: Established 2003

The Danish Stroke Registry

- Aim: documentation and development of quality of stroke care in the Danish health care system
- Indicator monitoring based on process-, and outcome indicators
- Data collection initiated in 2003, fully implemented from 2004.
- Nationwide clinical registry
- Reporting is mandatory for all hospital departments treating patients with acute stroke.
- Approximately 140.000 cases of stroke/TIA have been registered.
- Coverage (sensitivity): >90%

Organisation of stroke care

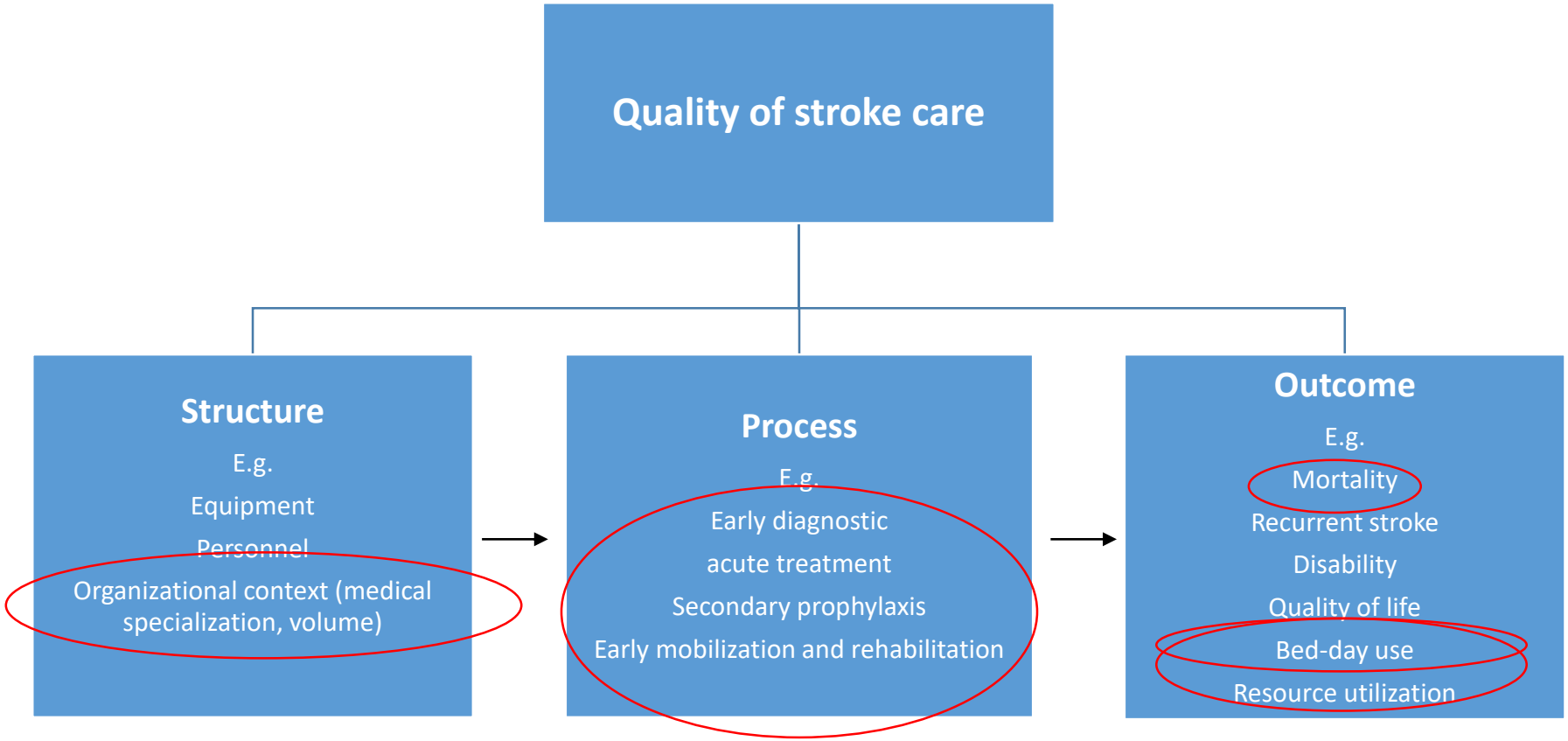
- 5 administrative regions
- >90% of all patients treated at stroke units
- Increasing centralization:
  - Number of stroke units:
    - 2004: 52
    - 2018: 20 (including neurosurgery)
- Stroke units primarily located within departments of neurology

Process indicators used in the Danish Stroke Register

Processes of care	Time limit, hours/days
Time to admission	3 hours
Stroke unit	2. day
Thrombolysis (door to needle time)	1 hour
Antiplatelet therapy	2.day
ONLY FOR PATIENTS CONSIDERED ELIGIBLE FOR THE SPECIFIC PROCESSES OF CARE BY THE STAFF	
Nutritional assessment	2. day
Swallowing assessment	Day of admission
Mobilization	Day of admission
Ultrasound examination of the carotids	4. day
Carotid endarterectomy	14. day

Aim

Figure. Modified Donabedian model
(JAMA. 1988;260:1743-8)



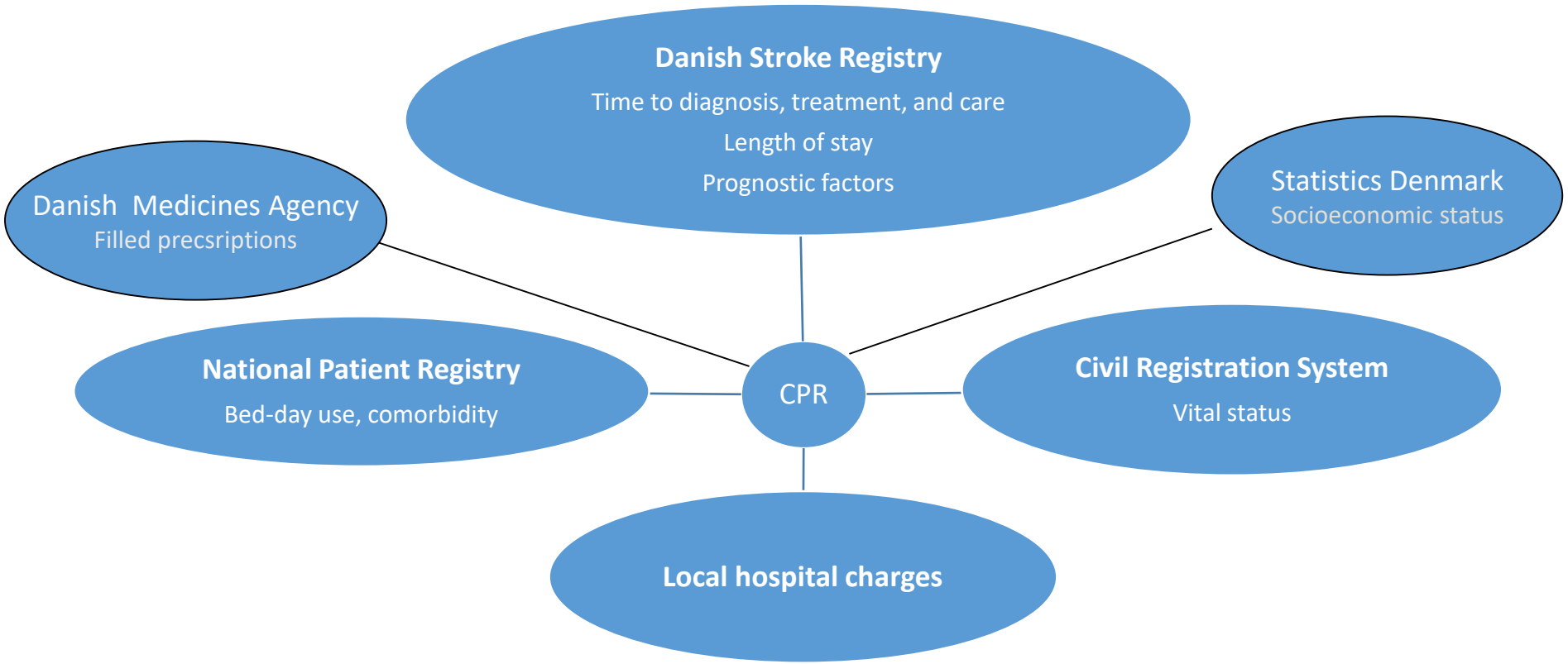
Overview of studies

Structure
- Stroke unit setting (neurological vs. non-neurological)
- Patient volume

Effectiveness
- Mortality
- Medical complications
- Length of stay
- Readmissions
- Costs

Inequality
- Age
- Gender
- Socioeconomic status (education, income, occupation)

Data sources



Structure: Care processes in high- vs. low-volume stroke units

Process of care (time limit, days) in high-volume vs. low-volume stroke units	**Unadjusted OR**
Stroke unit (2)	3.44 (1.69-7.00)
Antiplatelet therapy (2)	1.45 (0.66-3.21)
Anticoagulant therapy (14)	0.62 (0.35-1.09)
CT/MRI scan (1)	1.66 (1.02-2.70)
Physiotherapy (2)	1.53 (0.87-2.72)
Occupational therapy (2)	1.42 (1.11-1.84)
Nutritional assessment (2)	1.98 (1.14-3.44)

Structure: Outcome in high- vs. low-volume stroke units

Outcome in high-volume vs. low-volume stroke units	Unadjusted ratio	Adjusted ratio
30-day mortality	0.98 (0.82-1.17)	1.10 (0.91-1.33)
1-year mortality	0.89 (0.77-1.02)	1.03 (0.86-1.22)
Length of stay	0.46 (0.32-0.65)	0.49 (0.41-0.59)
1-year bed-day use	0.68 (0.59-0.78)	0.79 (0.70-0.87)

Effects of centralizing acute stroke services

S. Hastrup[1,2], S.P. Johnsen[2], T. Terkelsen[1], H. Hundborg[2], P. von Weitzel[1], C.Z. Simonsen[1], N. Hjort[1], A.T. Møller[1], T. Harbo[1], M. S. Poulsen[1], N. Ruiz de Morales Ayudarte[1], D. Damgaard[1], G. Andersen[1].

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[2]Aarhus University, Department of Clinical Epidemiology, Denmark.

Aarhus University Hospital

Aarhus University

DSC
Danish Stroke Centre

Stroke Care Reform in Central Region Denmark

”To save costs, and at the same time improving quality of care”

1st May 2012

1. Specialization and centralization of acute stroke treatment
2. A reduced length of hospital stay
3. Improved early discharge home care and use of community-based rehabilitation

Background

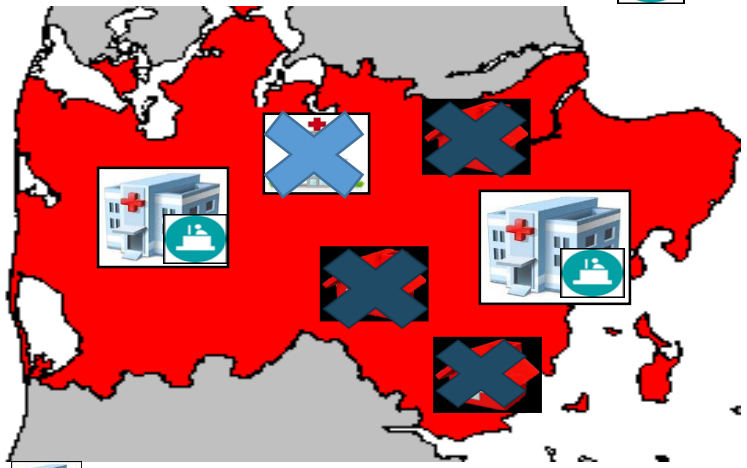
- Quality of stroke care was not equal in the Region
- Aarhus University Hospital vs. regional hospitals:
  - Higher quality of care
  - Highest thrombolysis rate in Denmark (DK)
  - Lower mortality
  - Shorter use of acute bed days

- Politicians: Wanted same high quality of stroke care for all inhabitants in Central Region DK and at the same time wanted to save money (USD 10 mill).

Acute stroke services in Central Region Denmark in May 2012

2012: 6 units→ 2 Acute Stroke units: 54→ 26 beds

2012: 2 units→ 7-day outpatients clinics

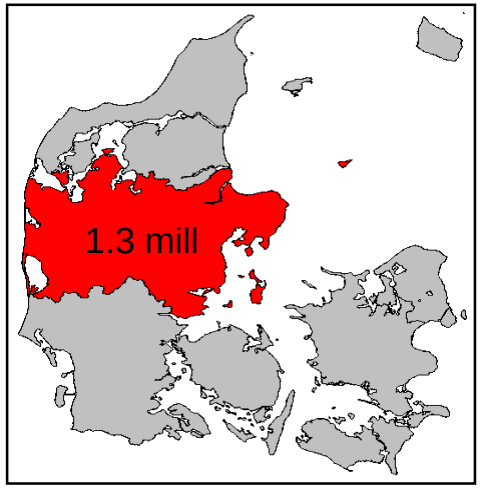


Hyper-acute stroke unit - stroke neurology + IV tPA/EVT

Primary stroke unit - neurology

Tertiary stroke unit - general medicine

Denmark 5.6 mill. inh.



Central Region Denmark

Rest of Denmark (Controls)

Prospective before and after registry study

Predefined purpose:

- Length of acute hospital stay
- Symptom onset to admission
- Rates and timing of revascularization
- Quality of clinical care

Safety measures:

- Mortality ≤ 30 days
- Readmissions ≤ 30 days

Methods:

Before: 1 May 2011 – 30 April 2012

After: 1 May 2013 – 30 April 2014

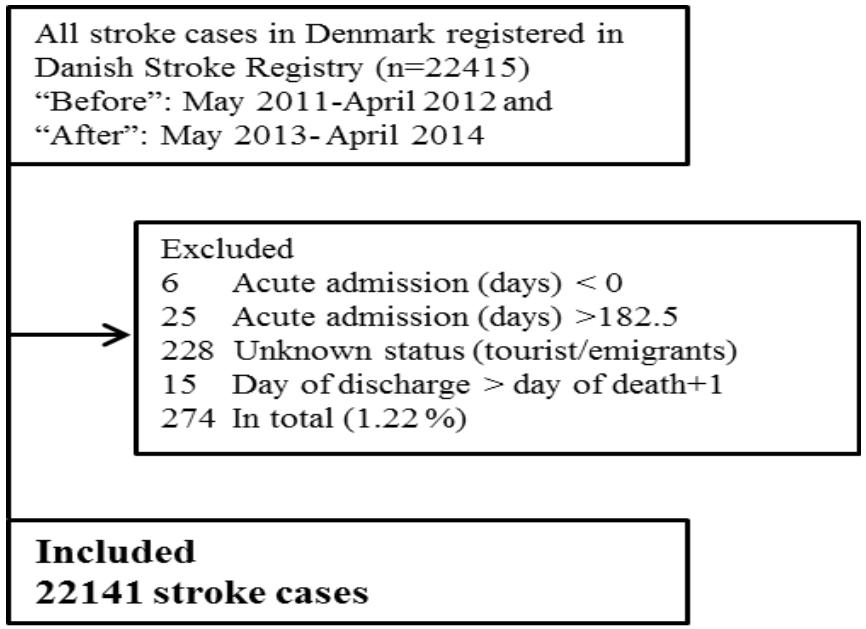
Study cohort: All stroke cases from Central Region DK

→Centralization and specialization

Controls: All stroke cases from ‘rest of Denmark’

→General changes in stroke care

Flow chart


All stroke cases in Denmark registered in Danish Stroke Registry (n=22415)
"Before": May 2011-April 2012 and
"After": May 2013- April 2014
Excluded
6 Acute admission (days) < 0
25 Acute admission (days) >182.5
228 Unknown status (tourist/emigrants)
15 Day of discharge > day of death+1
274 In total (1.22 %)
Included
22141 stroke cases

Baseline	Central Region Denmark (CRD)		Rest of Denmark (Control)	
	Before	After	Before	After
Stroke cases	2290	2355	8802	8694
Stroke incidence				
Stroke cases/m.in.>18/y	2342	2370	2606	2538
Age				
Year, mean (SD)	72 (14)	71 (13)	72 (13)	72 (13)
Sex				
Female, n (%)	1038 (45)	1046 (44)	4135 (47)	4014 (46)
Stroke severity				
SSS score, median (IQR)	48 (25)	48 (21)	50 (21)	50 (20)
Unknown, n (%)	116 (5)	46 (2)	588 (7)	308 (4)
Stroke type, n (%)				
Intracerebral bleeding	315 (13)	283 (12)	897 (10)	1021 (12)
Cerebral infarction	1822 (80)	2063 (87)	7492 (85)	7345 (84)
Type not specified	153 (7)	9 (0)	413 (5)	328 (4)

Length of hospital stay

	Central Region Denmark (CRD)			Rest of Denmark (Control)		
	Before	After	RL	Before	After	RL
			Acute hospital stay - days medians (IQR)			
Unadjusted	5.00 (7)	2.00 (3)	0.55 (0.38-0.79)	5.00 (9)	5.00 (8)	0.93 (0.79-1.09)
Adjusted*			0.53 (0.38-0.75)			0.94 (0.80-1.10)

RL; Relative Length (Compared with a generalised linear model)
Multivariable analyses: Adjusted for age, gender, living arrangement, previous stroke, diabetes, atrial fibrillation, hypertension, smoking habits, alcohol use, stroke severity and subtype of stroke

Thrombolysis and timing

	Central Region Denmark (CRD)			Rest of Denmark (Control)		
	Before	After	RR	Before	After	RR
Thrombolysis of all ischaemic strokes						
Unadjusted	14.9	17.8	1.20 (0.55-2.58)	9.0	14.1	1.56 (1.27-1.91)
Thrombolysis within 1 hour						
Unadjusted	64.4	84.2	1.31 (1.19-1.43)	65.0	83.9	1.29 (1.18-1.41)
Admission ≤ 4.5 hours of all strokes						
Unadjusted	33.7	45.4	1.35 (0.86-2.12)	27.9	41.1	1.47 (1.41-1.54)

Quality of care:
"All or none" of 11 process indicators fulfilled

	Central Region Denmark (CRD)			Rest of Denmark (Control)		
	Before	After	RR	Before	After	RR
Unadjusted	50.58	62.31	1.23 (1.01-1.51)	48.54	59.97	1.24 (1.11-1.38)

Process-indicators included in all-or-none
Admitted to specialised stroke unit ≤ 2 days
Antiplatelet therapy ≤ 2 days
Brain imaging (CT or MRI) ≤ 0 days
Physiotherapy (assessment) ≤ 2 days
Occupational therapist (assessment) ≤ 2 days
Mobilisation ≤ 0 days
Nutrition (assessment) ≤ 2 days
Indirect swallow test ≤ 2 days
Direct swallow test ≤ 2 days
Imaging of the carotids ≤ 4 days
Anticoagulation therapy ≤ 14 days

Mortality and readmissions <30 days

	Central Region Denmark (CRD)			Rest of Denmark (Control)		
	Before	After	OR	Before	After	OR
Mortality at 30 days - All stroke types (%)						
Unadjusted	10.35	8.20	0.77 (0.62-0.96)	10.83	9.98	0.91 (0.81-1.03)
Adjusted*			0.97 (0.72-1.30)			0.91 (0.78-1.08)
Readmissions 0-30 days – All cause acute (%)						
Unadjusted	9.13	10.19	1.10 (0.92-1.31)	10.22	10.82	1.05 (0.97-1.14)
Adjusted*			1.18 (1.02-1.35)			1.07 (1.00-1.15)

*Age, gender, living arrangement, previous stroke, diabetes, atrial fibrillation, hypertension, smoking habits, alcohol use, stroke severity and subtype of stroke

Conclusions

The overall purpose was fulfilled

- Acute stroke bed days were cut down from 5 to 2 days compared to 5 days in Denmark
- The quality of care improved and was comparable to the rate of improvement in general in Denmark
- No safety concerns; mortality and readmissions were unchanged as in rest of Denmark

Effectiveness: Processes of care and 30 days mortality (*Med Care 2008;46:63-69*)

Number of Process Indicators fullfilled	Mortality (%)	Adjusted MRR (95% CI)
0	51 / 626 (8.2)	*1.00 (reference)*
1	103 / 1323 (7.8)	1.07 (0.65 to 1.49)
2	111 / 1950 (5.7)	0.83 (0.51 to 1.15)
3	95 / 2305 (4.1)	0.60 (0.36 to 0.84)
4	109 / 2450 (4.5)	0.63 (0.38 to 0.87)
5	81 / 2581 (3.1)	0.48 (0.29 to 0.68)
6	46 / 1519 (3.0)	0.45 (0.24 to 0.66)

Effectiveness: Selected processes of care and length of stay/hospital costs

Process of care (time limit, days)	Adjusted ratio, length of stay	Adjusted ratio, hospital cost	Potential bed-day savings (USD)
Stroke unit (2)	0.71 (0.65-0.77)	0.65 (0.50-0.85)	3351 (2537-4165)
Antiplatelet therapy (2)	0.80 (0.73-0.87)	0.77 (0.66-0.90)	2169 (1295-3043)
Anticoagulant therapy (14)	0.78 (0.62-0.98)	0.84 (0.55-1.30)	2178 (-667-5024)
CT/MRI scan (2/1)	0.82 (0.74-0.91)	0.86 (0.72-1.02)	1099 (471-1727)
Physiotherapy (2)	0.87 (0.81-0.93)	0.80 (0.73-0.87)	1414 (1124-1703)
Occupational therapy (2)	0.85 (0.80-0.91)	0.80 (0.74-0.87)	1442 (1095-1789)
Nutritional assessment (2)	0.83 (0.77-0.90)	0.79 (0.69-0.91)	2489 (1917-3062)
Swallowing assessment (2/1)	0.78 (0.69-0.87)	0.78 (0.69-0.88)	2257 (1946-2569)
Mobilization (2/1)	0.67 (0.61-0.73)	0.70 (0.62-0.79)	3527 (2847-4207)

Med Care. 2009;47:575-82

Effectiveness: Processes of care and medical complications

Complication	Pneumonia	Urinary infection	Decubitus	Falls after stroke	Venous tromboembolism	Constipation	Any complication
Proportion of processes of care received	**Adjusted OR * (95% CI)**	**Adjusted OR * (95% CI)**	**Adjusted OR * (95% CI)**	**Adjusted OR* (95% CI)**	**Adjusted OR* (95% CI)**	**Adjusted OR * (95% CI)**	**Adjusted OR* (95% CI)**
0 – 24	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
25 – 49	0.88.(0.70 to 1.10)	0.81 (0.67 to 0.97)	0.82 (0.50 to 1.34)	0.84 (0.62 to 1.34)	1.01 (0.41 to 2.53)	0.91 (0.75 to 1.11)	0.76 (0.67 to 0.70)
50 - 74	0.66 (0.52 to 0.83)	0.62 (0.50 to 0.78)	0.40 (0.25 to 0.63)	0.68 (0.43 to 1.07)	0.84 (0.40 to 1.73)	0.78 (0.57 to 1.05)	0.57 (0.46 to 0.70)
75 - 100	0.62 (0.43 to 0.89)	0.56 (0.39 to 0.79)	0.41 (0.23 to 0.73)	0.59 (0.40 to 0.85)	0.41 (0.16 to 1.04)	0.60 (0.41 to 0.88)	0.48 (0.36 to 0.66)
Test for trend p-value	0.0000	0.0007	0.0009	0.0127	0.1250	0.0787	0.0000

*All the analyses are corrected for clustering of patients by department and for age, sex, marital status, housing, profession, alcohol intake, smoking habits, atrial fibrillation (except for criteria on antiplatelet and anticoagulant therapy), previous stroke, Charlson Comorbidity Index, Scandinavian Stroke Scale Score on admission and fulfillment of one or more of the other quality of care criteria .

Stroke. 2011;42:167-72

An example: Effectiveness of thrombolysis

Acute Ischemic Stroke and Long-Term Outcome After Thrombolysis

Nationwide Propensity Score–Matched Follow-Up Study

Marie Louise Schmitz, MD; Claus Z. Simonsen, PhD; Heidi Hundborg, MSc; Hanne Christensen, DMSc; Karsten Ellemann, MD; Karin Geisler, MD; Helle Iversen, DMSc; Charlotte Madsen, MD; Mary-Jette Rasmussen, MD; Karsten Vestergaard, MD; Grethe Andersen, DMSc; Soeren P. Johnsen, PhD

Background and Purpose—Data on long-term outcome after intravenous tissue-type plasminogen activator (tPA) in ischemic stroke are limited. We examined the risk of long-term mortality, recurrent ischemic stroke, and major bleeding, including intracranial and gastrointestinal bleeding, in intravenous tPA-treated patients when compared with intravenous tPA eligible but nontreated patients with ischemic stroke.

Methods—We conducted a register-based nationwide propensity score–matched follow-up study among patients with ischemic stroke in Denmark (2004–2011). Cox regression analysis was used to compute adjusted hazard ratios for all outcomes.

Results—Among 4292 ischemic strokes (2146 intravenous tPA-treated and 2146 propensity score–matched nonintravenous tPA-treated patients), with a follow-up for a median of 1.4 years, treatment with intravenous tPA was associated with a lower risk of long-term mortality (adjusted hazard ratio, 0.66; 95% confidence interval, 0.49–0.88). The long-term risk of recurrent ischemic stroke (adjusted hazard ratio, 1.05; 95% confidence interval, 0.68–1.64) and major bleeding (adjusted hazard ratio, 0.59; 95% confidence interval, 0.24–1.47) did not differ significantly between the intravenous tPA-treated and nontreated patients.

Conclusions—Treatment with intravenous tPA in patients with ischemic stroke was associated with improved long-term survival. **(*Stroke*. 2014;45:3070-3072.)**

An example: Effectiveness of thrombolysis

	No. of Outcome Events* (%)	Crude HR (95% CI)	Adjusted† HR (95% CI)
Death	633 (14.7)	0.70 (0.59–0.82)	0.66 (0.49–0.88)
Recurrent ischemic stroke	244 (5.7)	0.90 (0.69–1.18)	1.05 (0.68–1.64)
Major bleeding	98 (2.3)	0.62 (0.40–0.97)	0.59 (0.24–1.47)
Intracranial bleeding‡	36 (0.8)	0.76 (0.37–1.57)	...
Gastrointestinal bleeding	64 (1.5)	0.53 (0.30–0.94)	0.33 (0.01–8.02)

Total number of patients, n=4292 (2146 IV-tPA–treated patients and 2146 non–IV-tPA-treated patients with ischemic stroke). CI indicates confidence interval; HR, hazard ratio; and IV-tPA, intravenous tissue-type plasminogen activator.

*Median follow-up period: 1.4 y (range, 0–7.6 y).

†Adjusted for age, sex, Scandinavian Stroke Scale score, time from onset to admission, Charlsons comorbidity index, atrial fibrillation, diabetes mellitus, hypertension, previous stroke, smoking, housing, living arrangement, quality of in-hospital stroke care, and stroke prevention drugs during follow-up.

‡Adjusted analysis not possible because of low number of intracranial bleedings.

Overall principle: Explore and document results

Reducing Delay of Carotid Endarterectomy in Acute Ischemic Stroke Patients

A Nationwide Initiative

Agnes Hauschultz Witt, MD; Soren Paaske Johnsen, MD, PhD; Leif Panduro Jensen, MD, MHM; Allan Kornmaaler Hansen, MD; Heidi Holmager Hundborg, MSc, PhD; Grethe Andersen, MD, DMSc

Background and Purpose—Guidelines recommend carotid endarterectomy (CEA) within 2 weeks from an ischemic event. However, previous studies have shown that only a minority of patients undergo CEA within this period. The aim of this study was to examine the effect of a multidisciplinary nationwide initiative aimed at reducing time to CEA after acute ischemic stroke.

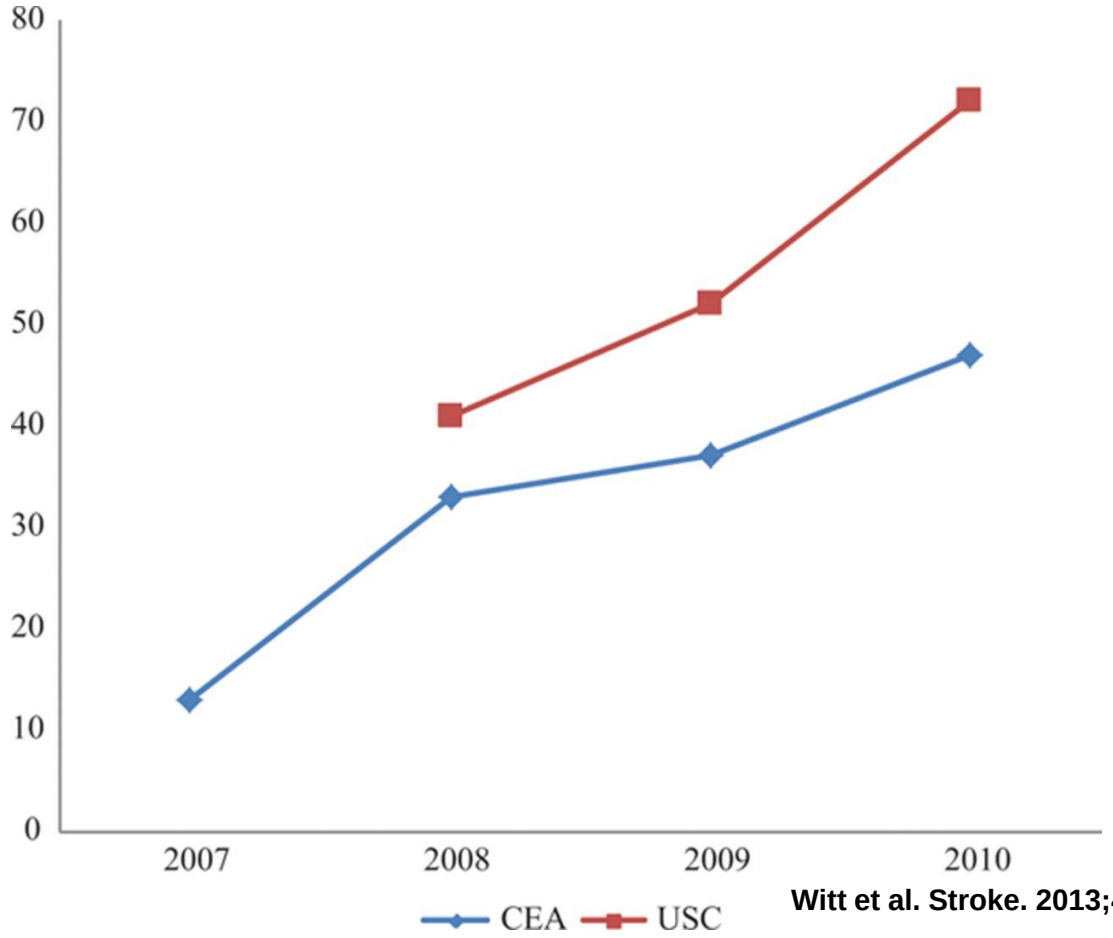
Methods—We examined a historic population-based observational cohort based on individual patient-level records from the Danish Stroke Registry and the Danish Vascular Registry. The implementation of early ultrasound examination of the carotids (within 4 days from admission) in medical departments coupled with fast CEA after referral to a department of vascular surgery were monitored and audited systematically from 2008 and onward.

Results—A total of 813 acute ischemic stroke patients underwent CEA during 2007-2010. The percentage of patients undergoing CEA within 2 weeks increased from 13% in 2007 to 47% in 2010 (adjusted odds ratio, 5.8 [95% CI, 3.4–10.1]). The overall median time decreased from 31 days to 16 days. The percentage of relevant acute ischemic stroke patients receiving early ultrasound examination of the carotids increased from 41% in 2008 to 72% in 2010. The time from referral to operation at a vascular department was reduced by ≈40%.

Conclusions—Establishing time limits of 4 days to ultrasound examination of the carotids and of 2 weeks to CEA from onset of stroke followed by a systematic multidisciplinary monitoring and auditing of processes was associated with a substantial increase in the proportion of acute ischemic stroke patients who undergo CEA within 2 weeks in Denmark. (***Stroke.*** **2013;44:686-690.**)

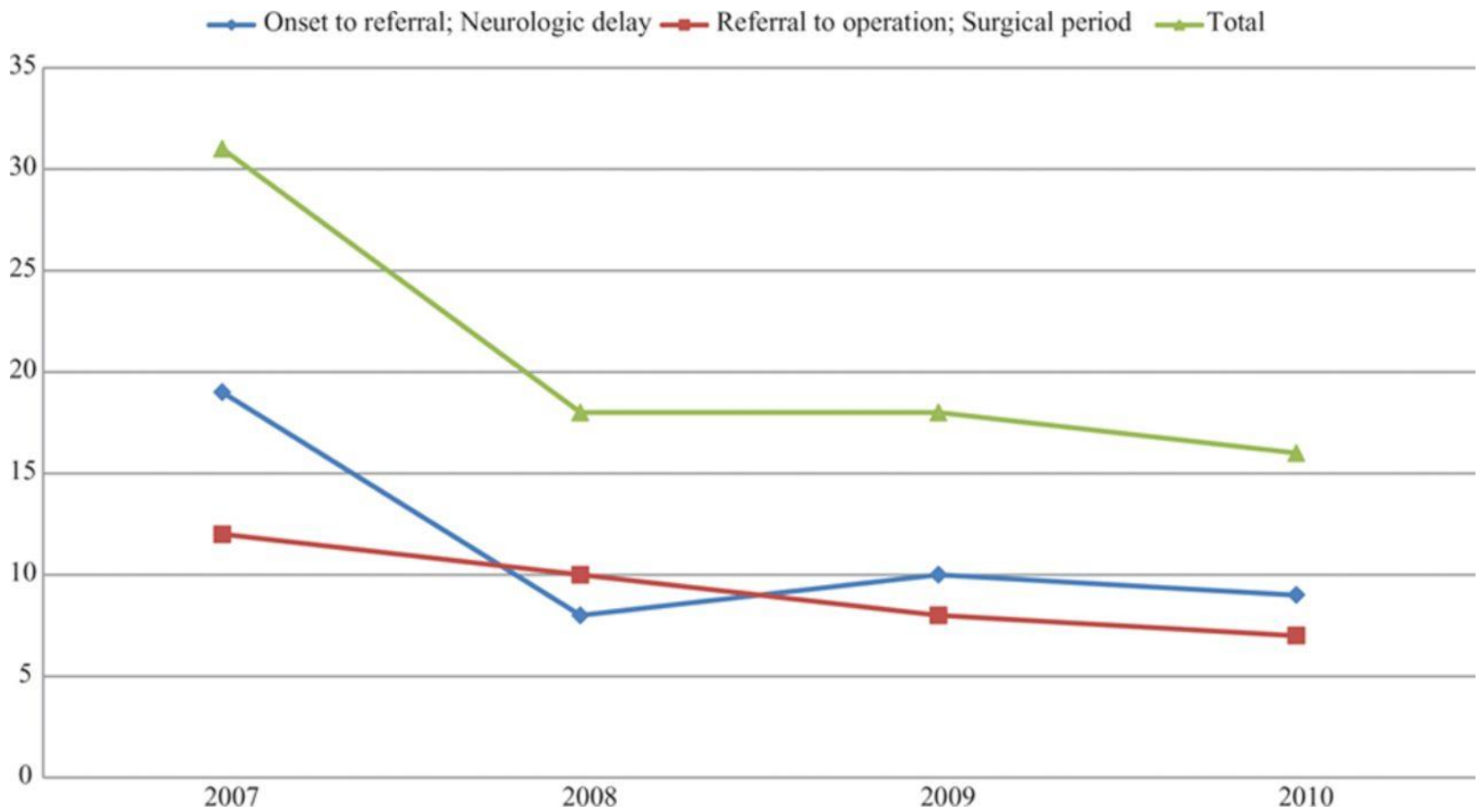
Key Words: carotid endarterectomy ■ carotid stenosis ■ stroke ■ time delay

Percentage of carotid endarterectomy (CEA) procedures performed within 2 weeks and ultrasound examination of the carotids (USC) examinations performed within 4 days.



Witt et al. Stroke. 2013;44:686-690

Median waiting time from admission to carotid endarterectomy (CEA).

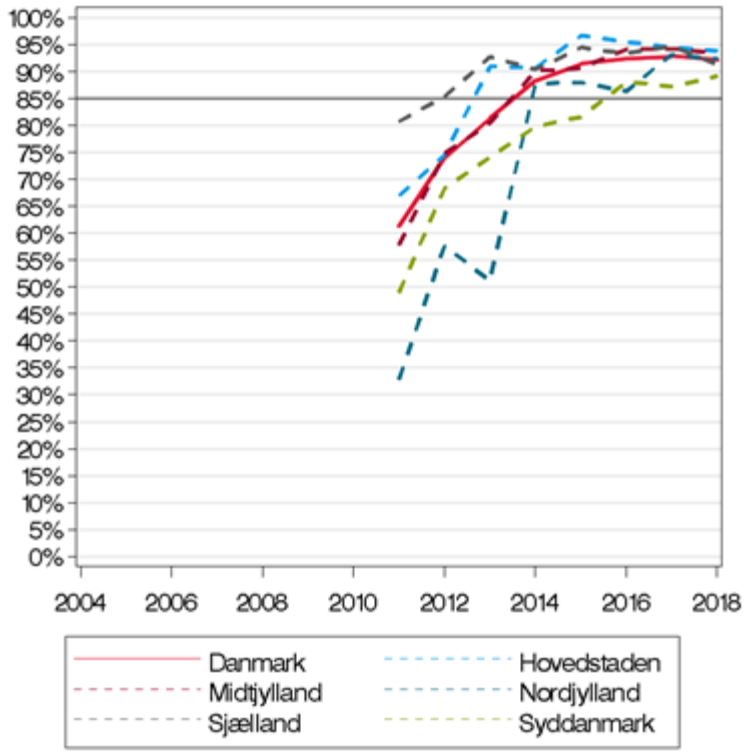


Witt et al. Stroke. 2013;44:686-690

I.v. thrombolysis

- 2008: Nationwide implementation
- 11 centers offering i.v. trombolysis
- 2018: 22% of patients with ischemic stroke
- Door-to-needle time:
  - Median: 27 minutes
  - <=1 hour: 92%

Proportion of patients with door-to-needle time <= 1 hour



ORIGINAL ARTICLE

Acute endovascular reperfusion treatment in patients with ischaemic stroke and large-vessel occlusion (Denmark 2011–2017)

T. Truelsen[a], K. Hansen[a], G. Andersen[b], L. Sørensen[c], C. Madsen[d], A. Diaz[e], T. Stavngaard[f], H. H. Hundborg[g], J. Højgaard[a], N. Hjort[b], H. K. Iversen[a], S. P. Johnsen[h] and C. Z. Simonsen[b]

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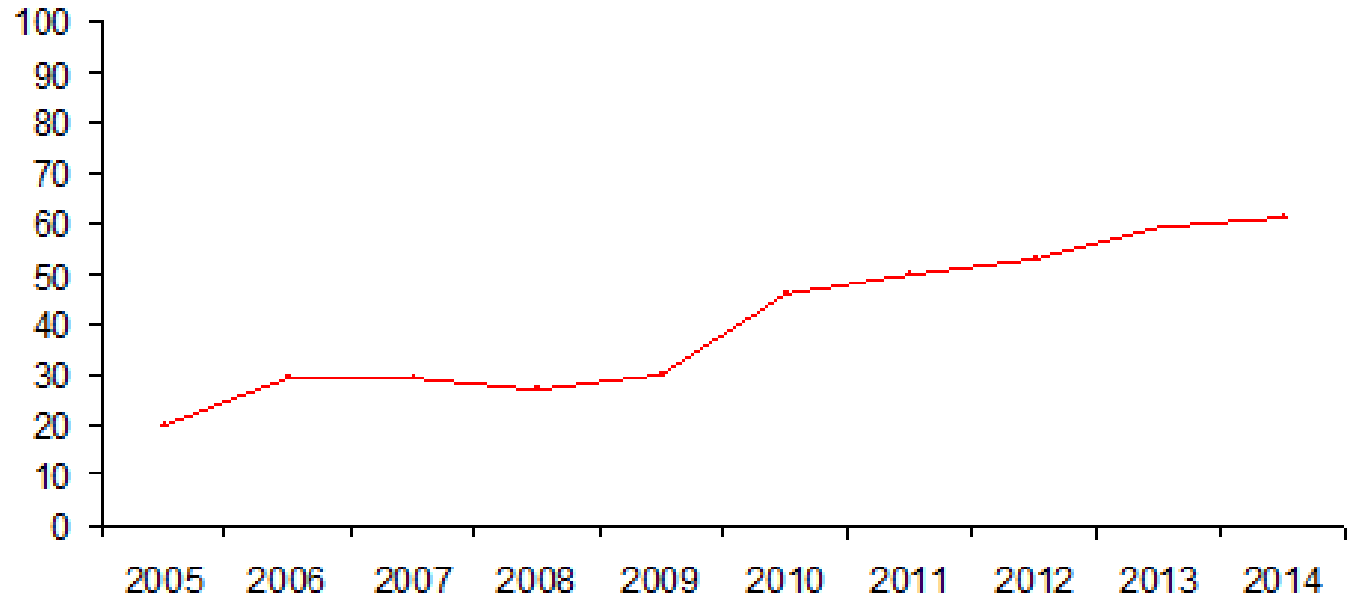
Table 4 The 3-month modified Rankin Scale (mRS) score and 1-year survival in patients treated with endovascular reperfusion treatment (Denmark, discharged 2011–2016) complying with key MRCLEAN criteria

	2011–2016 (n = 658)	MRCLEAN (n = 233)
3-month mRS score		
0	61 (9)	7 (3)
1	145 (22)	21 (9)
2	138 (21)	49 (21)
3	65 (10)	42 (18)
4	98 (15)	51 (22)
5	37 (6)	14 (6)
6	86 (13)	49 (21)
Missing	28 (4)	NA
1-year survival		
Alive	532 (81)	NA
Deceased	116 (18)	NA
Missing	10 (2)	

Data are given as n (%). NA, not applicable.

Trends in QoC of early stroke in Denmark

The proportion of patients fullfilling all process indicators (≈ ”perfect care”)



So - All problems are solved?

FOLKETINGET
RIGSREVISIONEN

Januar 2019

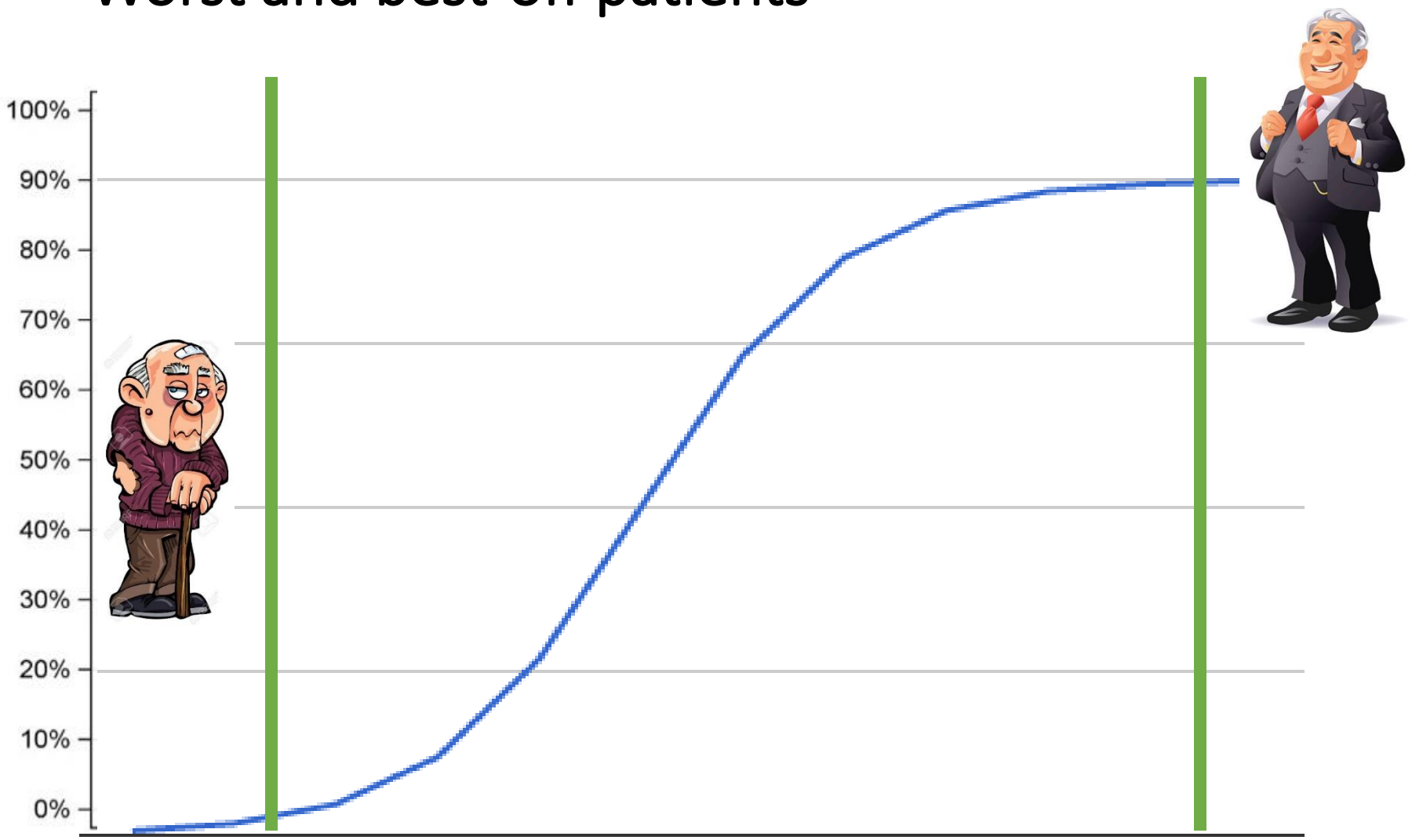
Rigsrevisionens beretning
afgivet til Statsrevisorerne

Forskelle i behandlings-kvaliteten på sygehusene

Who is Rigsrevisionen?

“Rigsrevisionen audits public spending on behalf of the Danish parliament and seeks to strengthen the accountability of public administration to the benefit of the citizens. We audit the government accounts and financial statements of publicly funded enterprises, and verify the legality and effective use of public funds. We conduct our audits in compliance with the Danish standards for public-sector auditing.”

Worst and best-off patients



Characteristics of best off and worst off patients

Best off patients

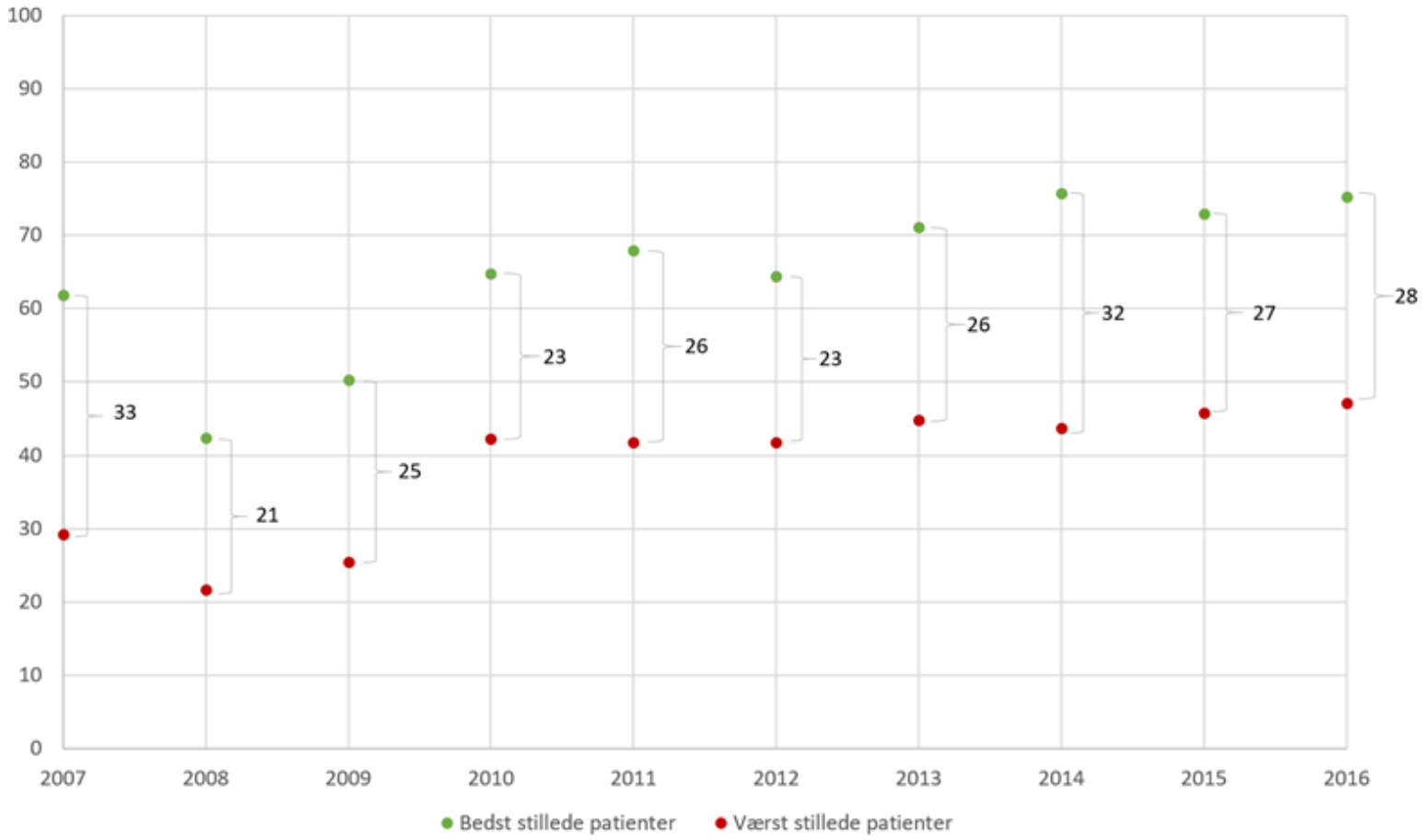
- Male
- Age: 45-64 years
- High income
- Medium length education
- Cohabitating
- No comorbidity
- Mild stroke severity

Work off patients

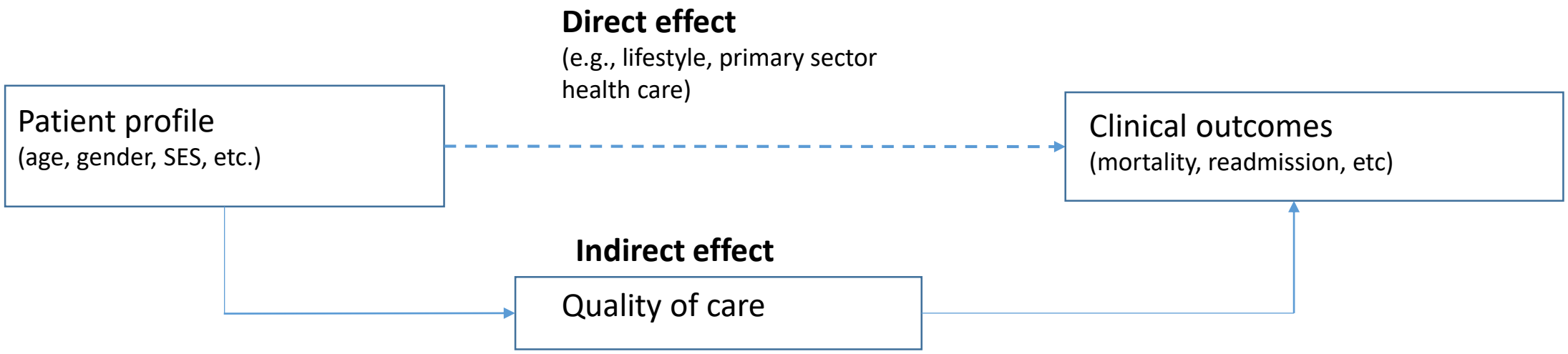
- Female
- Age: 75-85 years
- Short education
- Low income
- Living alone
- Medium to high level of comorbidity

Disparities in QoC

All-or-none QoC among best off-vs. worst off patients



Mediation analysis



Total effect= indirect effect + direct effect

Results: Mediation analysis

All numbers are odds ratios

	Total effect	*Direct effect*	*Indirect effect*
Readmission	3.16	3.13	1.01
Mortality (30 days)	24.60	20,00	1.23
Mortality(1 year)	19.84	16.67	1.19

How have the findings been received?

Overview of findings

Structure

- *Stroke unit setting (neurological vs. non-neurological):* Minor differences in care. No differences in mortality, length of hospital stay and readmissions.
- *Patient volume:* Higher volume associated with improved quality of early care, shorter length of stay. No difference in mortality.

Effectiveness

Receiving evidence-based processes of care in the early phase of stroke was associated with:

- Lower mortality

- Fewer medical complications

- Shorter length of hospital stay and potential hospital cost savings

Inequality

- *Age:* Lower quality of care among elderly, in particularly in the use of secondary medical prophylaxis.
- *Gender:* No differences in care
- *Socioeconomic status (education, income, occupation):* Lower quality of care among patients with low income and disability

Conclusions

- Huge amounts of data are collected everyday in clinical registries.
- The scope of the use of these data are, however, in most registries limited.
- The value and impact of the clinical registries could be substantially increased by using the data much more actively.
- Many outstanding questions on how to organize high-performing and effective health care systems can only be addressed using clinical registries.
- A stronger and more formalized collaboration between quality improvement organisations and academic institutions is essential.