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External quality monitoring facilitates improvement in already well-performing stroke units: insights from RES-Q Poland

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ABSTRACT

Introduction. The Registry of Stroke Care Quality (RES-Q) is used in Poland for quality monitoring by numerous hospitals participating in the Angels Initiative. Our aim was to assess the degree of improvement in highly stroke-oriented centres that report cases to the RES-Q each year.

Material and methods. This retrospective analysis included Polish stroke units that from January 2017 to December 2020 contributed to the RES-Q at least 25 patients annually.

Results. Seventeen out of 180 Polish stroke units reported patients each year (2017, n = 1,691; 2018, n = 2,986; 2019, n = 3,750; 2020, n = 3,975). The percentage of ischaemic stroke patients treated with alteplase remained stable (26%, 29%, 30% and 28%, respectively). The door-to-needle time progressively decreased, from a median 49 minutes to 32 minutes. The percentage of patients treated ≤ 60 minutes and ≤ 45 minutes significantly increased (from 68% to 86% and from 43% to 70%, respectively), with no change observed between 2019 and 2020. Despite a general improvement in dysphagia screening (81%, 91%, 98% and 99%), screening performed within the first 24h from admission became less frequent (78%, 76%, 69% and 65%). In-hospital mortality significantly increased (11%, 11%, 13% and 15%), while the proportion of patients discharged home remained stable.

Conclusions. Quality-oriented projects facilitate the improvement of stroke care, even in centres demonstrating good baseline performance. Polish stroke units that consistently reported cases to the RES-Q demonstrated improvement in terms of door-to--needle time and dysphagia screening. However, there is still a need to shorten the time to dysphagia screening, and carefully monitor stroke unit mortality following the COVID-19 pandemic.

Keywords: acute stroke, quality monitoring, stroke care management, outcome, registry, Poland

Introduction

Stroke is a leading cause of death and disability worldwide [1]. In Poland, the annual number of acute ischaemic stroke admissions ranges from 70,000 to 74,000 [2]. Ischaemic strokes constitute over 80% of all stroke cases, making them potentially eligible for highly effective reperfusion therapies [3–5]. The efficacy of intravenous thrombolysis and mechanical thrombectomy is very time-sensitive [3–5]. Achieving the shortest possible door-to-needle and door-to-groin times requires optimisation of logistics not only from neurologists but also from the ambulance service, Accident & Emergency Department personnel, and radiologists [3–8]. An example from Czechia proves that the national recombinant tissue plasminogen activator (rtPA) rate can exceed 20% of all ischaemic strokes, with a median door-to-needle time of 20 minutes [6].

Stroke care extends beyond the hyperacute phase and encompasses a well-functioning stroke unit, access to rehabilitation, and long-term outpatient care. Therefore, optimising and coordinating the entire chain of care is essential from a public health perspective. This poses a major challenge for each national healthcare system, which has been properly addressed in the Stroke Action Plan for Europe (SAP-E) 2018–2030 [9]. This approach aligns with the objectives of the Angels Initiative, an international stroke improvement programme endorsed by the European Stroke Organisation (ESO) and the Cerebrovascular Section of the Polish Neurological Society (CSPNS) [10].

Both the ESO and the CSPNS strongly support the implementation of registries, considering them to be a powerful tool (i) to confirm that the evidence from randomised controlled trials is transferable to routine services, (ii) to address questions that could never be tested in a randomised setting, and (iii) to measure actual stroke care quality [9].

The core features of a stroke registry, such as having a clear purpose, limiting the number of items to the necessary minimum, and a long lifespan, were defined over 50 years ago and continue to be relevant today [11]. The key performance measures for modern national stroke care quality programmes were agreed upon in 2014 [12]. These measures formed the foundation for the development of the international Registry of Stroke Care Quality (RES-Q) [13]. The RES-Q has gained increasing global recognition as a free-to-use tool for identifying gaps in hospital processes and facilitating their subsequent optimisation [14–19]. For reasons of feasibility, the RES-Q in its original version consciously refrained from capturing detailed information about clinical outcomes, especially the long-term functional outcomes. In Poland, the registry was introduced in 2017 through the collaborative efforts of the CSPNS and the Angels Initiative [14].

Clinical rationale for the study

To maximise the likelihood of delivering the best healthcare services, it is necessary to ensure: (i) feedback and transparency; (ii) intervention sustainability; (iii) adherence to clinical practice guidelines; (iv) productive partnerships; and (v) a whole-team approach. These strategies work together synergistically and rely on reliable evidence obtained from non-opportunistic registries [21].

Within the Polish healthcare system, it is obligatory to report every acute stroke case directly to the electronic registry run by the National Health Fund (NHF) immediately after discharge from the stroke unit. However, the registry's data completeness is below the optimal level, accounting for c.70% of all eligible cases in 2020–2021 [2]. Nonetheless, the registry still serves as a valuable tool for NHF analysts to identify gaps in stroke care quality, assess overall performance, and provide assistance to policymakers [2].

In addition to being a valuable resource for research purposes, the national stroke registry holds the potential to enhance local stroke care quality [20]. However, in order to facilitate improvement in an individual hospital or at the regional level, the registry must provide convenient access to up-to-date and processed information to all relevant stakeholders, including individual hospitals, PNS, and Regional Consultants in Neurology [21, 22]. The RES-Q fulfills these requirements by offering features such as the ability to monitor one's own performance through user-friendly graphical presentation, and to benchmark against national averages. It is important to note that there is considerable overlap between the data collected in the RES-Q and the data that has been required for the NHF registry since 2020.

Previous analyses of the Polish RES-Q data showed that the registry is likely to exhibit a bias towards well-performing centres, and therefore cannot be considered fully representative of the general population. Nonetheless, it remains a valuable source of information for individual hospitals in their pursuit of quality improvement programmes [14].

The aim of our study was to indirectly investigate the usefulness of the RES-Q in supporting quality improvement programmes in stroke-oriented and well performing Polish hospitals, by assessing the overall degree of improvement captured in the RES-Q data from 2017 to 2020.

Material and methods

This retrospective analysis included all stroke patients reported to the RES-Q registry by Polish stroke units from January 2017 to December 2020, provided that a stroke unit contributed at least 25 patients each year. The methodology of the RES-Q has been described in detail elsewhere [23]. Briefly, the RES-Q is an open-access registry capturing major performance measures of a single stroke unit that voluntarily reports series of cases with acute stroke or transient ischaemic attack. Over the years, the registry has evolved and currently includes items describing neurological and functional outcomes, both at discharge from the stroke unit and three months after stroke. However, this data was not collected throughout the whole studied period. Patients with the final diagnosis of a transient ischaemic attack were excluded from analysis so as to reduce heterogeneity.

The key metrics of interest were grouped into three domains. As the major measures of performance, we used (i) the proportion of patients receiving intravenous thrombolysis, or (ii) any acute reperfusion therapy, (iii) door-to-needle time (DNT), and (iv) early dysphagia screening. As the major measures of proper secondary prevention, we used the proportions of stroke survivors who at discharge from the stroke unit received (i) antihypertensives, (ii) statins, (iii) oral anticoagulants in cases of atrial fibrillation, (iv) advice about smoking cessation in cases of being an active smoker, and (v) were recommended to see a stroke specialist for follow-up. The main safety measure was stroke unit mortality.

This study was conducted in accordance with the Declaration of Helsinki. Due to its observational character and the anonymisation of data, approval from the Ethics Committee and additional consents were not required.

Data supporting the findings is available from the corresponding author upon reasonable request.

Statistical analysis

Categorical variables are reported as the number of valid observations, and proportions are calculated with exclusion of unknown values from the denominator. Continuous variables are presented as a median with an interquartile range (1st quartile to 3rd quartile, Q1–Q3) due to the non-normal distribution.

Comparisons were made initially using the overall chi-square test or Kruskal-Wallis test to identify the presence of intergroup differences in the whole study population. Only if the overall tests were significant, pairwise comparisons be-tween particular years were attempted. For that purpose, the chi-square test, or the two-tailed exact Fisher's test, or the Mann-Whitney U test was used, as appropriate. As the annual samples from individual centres could be small and biased by patient selection, we limited intra-centre and inter-center comparisons.

All tests were two-sided, and $P < 0.05$ was considered statistically significant. Calculations were carried out using STATISTICA 13.3 software package (TIBCO Software Inc., Palo Alto, CA, USA).

Results

Seventeen of 180 Polish stroke units reported patients each year (2017, n = 1,691; 2018, n = 2,986; 2019, n = 3,750; 2020, n = 3,975) (Suppl. Tab. 1). Overall, there were no significant changes in patient age (median 72 to 73 years) or in the proportion of ischaemic strokes (89% to 91%) (Table 1). Despite significant fluctuations, the occurrence of atrial fibrillation (AF) did not change between 2017 and 2020 (Table 1). Fluctuations were also observed in the proportions of patients with diagnosed AF prescribed with oral anticoagulants at discharge (77%, 83%, 79%, and 74%). The prescription rates for statins and the use of antihypertensives were very high throughout the whole study period (Table 1). The proportion of active smokers significantly decreased (from 28–30% to 20–21%) alongside an increase in providing advice about smoking cessation for stroke survivors (from 72–79% to 89–85%) (Table 1).

Table 1. Overall changes in patient characteristics and stroke care quality indicators 2017 to 2020

	2017 (n = 1,691)	2018 (n = 2,986)	2019 (n = 3,750)	2020 (n = 3,975)	Overall P	17 v. 18	17 v. 19	17 v. 20	18 v. 19	18 v. 20	19 v. 20
Demographics											
Male sex, n (%)	815/1,691 (48.2)	1,531/2,986 (51.3)	1,921/3,750 (51.2)	1,887/3,975 (47.5)	**0.001**			+		+	+
Age (years), median (Q1; Q3)	72 (63; 82)	72 (64; 82)	73 (64; 82)	73 (65; 82)	**0.101**						
Active smokers, n/N (%)	474/1,692 (28.0)	906/2,986 (30.3)	784/3,747 (20.9)	778/3,975 (19.6)	**< 0.001**		+	+	+	+	
Current stroke											
Ischaemic stroke, n/N (%)	1,527/1,691 (90.3)	2,717/2,986 (91.0)	3,351/3,750 (89.4)	3,582/3,975 (90.1)	0.169						
Brain CT within 60 minutes of admission, n/N (%)	1,478/1,676 (88.2)	2,733/2,963 (92.2)	3,470/3,644 (95.2)	3,675/3,834 (95.9)	**< 0.001**	+	+	+	+	+	
NIHSS at admission, median (Q1; Q3)	7 (4; 13)	7 (4; 13)	7 (4; 14)	8 (4; 15)	**< 0.001**		+	+	+		
Reperfusion therapy for ischaemic stroke, n/N (%)	406/1,527 (26.6)	794/2,717 (29.2)	1,104/3,351 (33.0)	1,245/3,582 (34.8)	**< 0.001**		+	+	+	+	
Intravenous thrombolysis for ischaemic stroke, n/N (%)	399/1,527 (26.1)	785/2,717 (28.9)	1,002/3,351 (29.9)	1,014/3,582 (28.3)	0.055		+				
Mechanical thrombectomy, n/N (%)	10/1,527 (0.7)	31/2,717 (1.1)	150/3,351 (4.5)	317/3,582 (8.8)	**< 0.001**		+	+	+	+	+
Door-to-needle time (min), median (Q1; Q3)	49 (35; 74)	40 (25; 60)	34 (20; 50)	32 (20; 50)	**< 0.001**	+	+	+	+		
Door-to-needle time ≤60 min, n/N (%)	263/387 (68.0)	594/773 (76.8)	875/996 (87.9)	868/1,013 (85.7)	**< 0.001**	+	+	+	+	+	
Door-to-needle time ≤45 min, n/N (%)	168/387 (43.4)	445/773 (57.6)	715 (71.8)	710/1,013 (70.1)	**< 0.001**	+	+	+	+	+	
Dysphagia screening at any time, n/N (%)	1,354/1,676 (80.8)	2,696/2,952 (91.3)	3,615/3,689 (98.0)	3,897/3,920 (99.4)	**< 0.001**	+		+	+	+	+
Dysphagia screening within first 24 hours, n/N (%)	1,324/1,691 (78.3)	2,268/2,986 (76.0)	2,569/3,750 (68.5)	2,573/3,975 (64.7)	**< 0.001**		+	+	+	+	+
Stroke unit stay (days), median (Q1; Q3)	10 (8; 14)	9 (8; 12)	9 (8; 13)	9 (8; 12)	**< 0.001**	+	+	+			
Secondary prevention											
Atrial fibrillation, n/N (%)	472/1,532 (30.8)	837/2,788 (30.0)	1,039/3,609 (28.8)	1,270/3,975 (32.0)	**0.026**						+
Anticoagulant for atrial fibrillation at discharge in survivors, n/N (%)	266/346 (76.9)	551/661 (83.4)	679/862 (78.8)	756/1,020 (74.1)	**< 0.001**	+			+	+	+
Antihypertensive at discharge in survivors, n/N (%)	1,324/1,496 (88.5)	2,263/2,561 (88.4)	2,852/3,188 (89.5)	2,971/3,214 (92.4)	**< 0.001**			+		+	+
Statin at discharge, n/N (%)	1,328/1,401 (94.8)	2,396/2,455 (97.6)	2,806/2,933 (95.7)	2,911/3,037 (95.9)	**< 0.001**	+			+	+	
Advice about smoking cessation for surviving smokers, n/N (%)	291/407 (71.5)	650/819 (79.4)	605/676 (89.5)	594/697 (85.2)	**< 0.001**	+	+	+	+	+	+
Recommended follow-up by a stroke specialist in survivors, n/N (%)					**< 0.001**				+	+	+
– visit advised and scheduled	NA	49/628 (7.8)	510/1,943 (26.3)	444/3,372 (13.2)							
– visit advised only	NA	20/628 (3.2)	527/1,943 (27.1)	2,487/3,372 (73.8)							
Stroke outcome											
Stroke unit death, %	191/1,691 (11.3)	329/2,986 (11.0)	491/3,750 (13.1)	603/3,975 (15.2)	**< 0.001**			+	+	+	+
Discharge destination in survivors					**< 0.001**		+	+	+	+	+
– patient's home	991/1,500 (66.1)	1,721/2,657 (64.8)	2,253/3,259 (69.1)	2,308/3,372 (68.5)							
– other ward in same hospital	311/1,500 (20.7)	608/2,657 (22.9)	604/3,259 (18.5)	431/3,372 (12.8)							
– another hospital	74/1,500 (4.9)	134/2,657 (5.0)	203/3,259 (6.2)	446/3,372 (13.2)							

CT — computed tomography; NIHSS — National Institutes of Health Stroke Scale + indicates significant differences in year-to-year pairwise comparisons

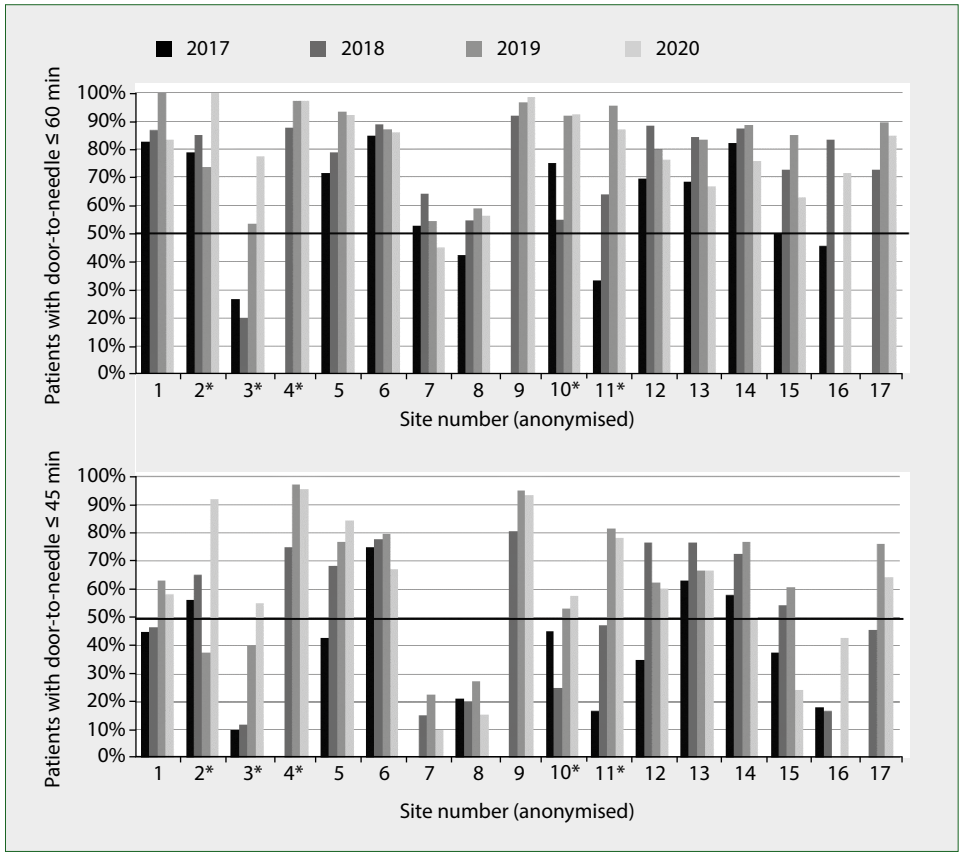

Figure 1. Changes in door-to-needle time in individual hospitals from 2017 to 2020
*overall p value within one site < 0.05
Site numbers are not related to the order of co-authors

The thrombolysis rate remained stable (ranging from 26% to 30%), but with marked hospital-to-hospital variability (Table 1, Suppl. Tab. 1). However, the overall use of reperfusion therapy became more frequent (from 27% to 35%), especially in the case of mechanical thrombectomy (from 0.7% to 9%). There was also a gradual and significant improvement in DNT (from a median of 49 min to 32 min) (Table 1). Significantly more patients received rtPA with door-to-needle time of ≤ 60 minutes and ≤ 45 minutes (from 68% to 86% and from 43% to 70%, respectively), with a marked variability between hospitals, but no overall decrease between 2019 and 2020 (Table 1, Figure 1).

There was a significant increase in the proportion of patients undergoing formal screening for dysphagia at the stroke unit (from 81% to 99%), again with a marked hospital-to-hospital variability (Table 1, Figure 2). However, the proportion of patients screened for dysphagia within 24 hours of admission actually decreased (from 78% to 65%) (Table 1). The year-on-year changes in dysphagia screening and the hospital-to-hospital variability are shown in Figure 2.

The median length of stroke unit stay decreased from 10 to nine days. However, stroke unit mortality became higher (from 11% in 2017–2018 to 15% in 2020), which can also be observed at the level of individual hospitals (Table 1, Suppl. Tab. 1). The structure of discharge destination in survivors also changed, while the proportion of patients discharged home showed only minor fluctuations (66%, 65%, 69% and 69%). Follow-up visits in the neurological outpatient clinic were advised significantly more often (NA, 3%, 27% and 74%). However, no such trend was observed for those visits that were actually scheduled (NA, 8%, 26% and 13%) (Table 1).

Discussion

As previously mentioned, the Polish RES-Q data tends to overrepresent high-performing hospitals [14]. This observation is indirectly confirmed by the thrombolysis and mechanical thrombectomy rates that are clearly superior to the national average reported by the NHF (approximately 13% and < 1% in 2017; 15% and < 1% in 2018; 17% and 2% in 2019; 16% and 3.5% in 2020) [2, 24].

In our study, the observed overall increase in the availability of reperfusion therapies was from 27% in 2017 to 35% in 2020. According to the NHF, the Polish national average rose over the same time from 13% to 19% [2]. It is worth emphasising that this improvement was not driven

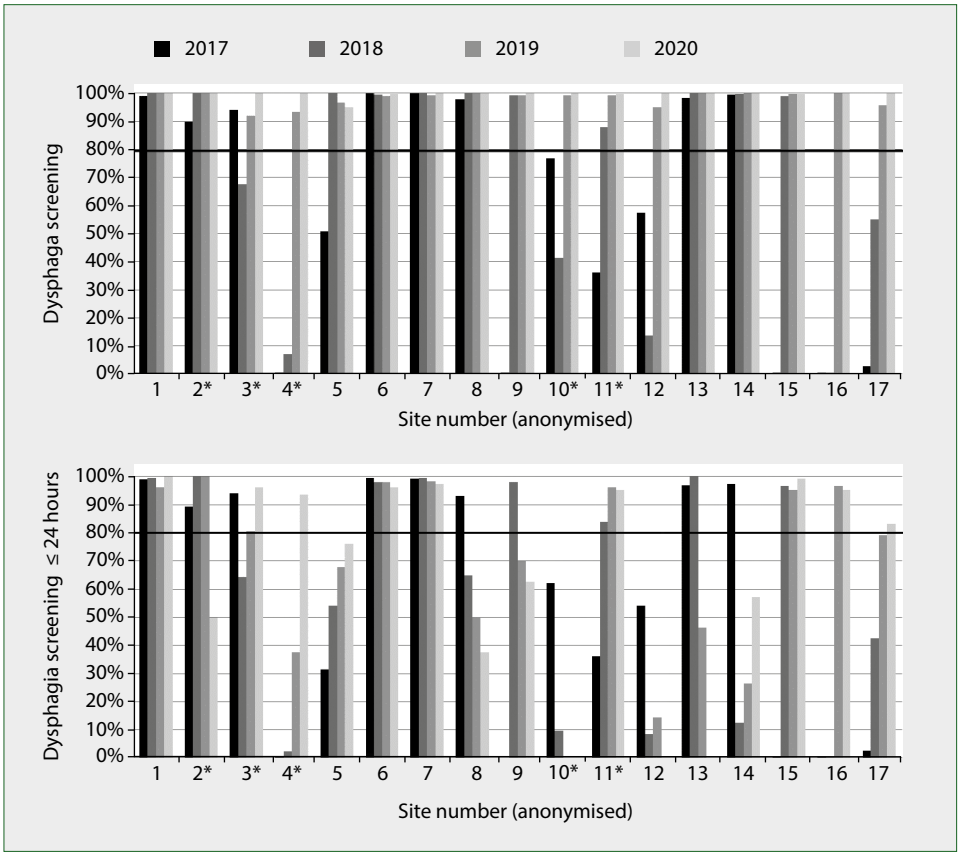

Figure 2. Changes in dysphagia screening in individual hospitals from 2017 to 2020
*overall p value within one site < 0.05
Site numbers are not related to the order of co-authors

by the increased use of intravenous thrombolysis. Several overlapping factors may explain this phenomenon. Firstly, the well-performing stroke centres may have encountered a 'near-ceiling' effect regarding the use of rtPA, meaning that they had already reached a saturation point in terms of rtPA usage. Secondly, the organisational challenges imposed by the COVID-19 pandemic may have impacted upon the administration of rtPA. And lastly, the introduction of the National Pilot Programme for Thrombectomy played a significant role in promoting the wider availability of mechanical thrombectomy [7, 25].

An analysis of the Polish RES-Q registry data made in 2018 identified the key areas requiring improvement, namely dysphagia screening, door-to-needle time, and the availability of carotid endarterectomy or stenting [14]. As a consequence, the proper diagnosis and management of dysphagia was prioritised by the Angels-Poland Initiative. The Initiative, with the collaboration of PNS, attempted to implement routine dysphagia screening into clinical practice.

Our findings confirm that significant progress has been achieved, even in the skewed population of well-performing stroke units. Dysphagia screening has become an established part of everyday clinical routine in this subset of Polish stroke units.

Furthermore, the RES-Q registry captured an important gap in terms of not performing the dysphagia screening within the first 24 hours from admission. This finding should tailor further interventions to ensure that screening takes place prior to the patient's first meal. This is crucial for minimising the risk of aspiration and pneumonia which can affect about 15% of stroke unit patients [25].

It is essential to prioritise and promote the establishment of comprehensive post-stroke outpatient services to ensure that stroke survivors receive appropriate follow-up care and interventions aimed at preventing recurrent events. The initiation of secondary stroke prevention measures in the analysed stroke units has shown satisfactory results since 2017. However, the availability of post-stroke outpatient care remains suboptimal and probably needs major systematic changes. By actively encouraging and facilitating the development of this particular service, the NHF can contribute significantly to improving the overall continuum of care for stroke patients.

The high-performing hospitals regularly reporting cases to the RES-Q seemed to have a shorter duration of stroke-unit stay than the national average in 2017, and were able to reduce it even further to nine days. Across 2013 to 2018,

the mean length of stroke unit stay in Poland was 13.0 days, showing a high region-to-region variability (from 10 to 18 days) [27].

National data on post-stroke mortality has revealed two major patterns. Firstly, the mortality rates are clearly lower in stroke units than in other wards (6% *vs.* 13%). Secondly, there is considerable interregional variability in standardised stroke unit mortality (ranging from 3% to 9%) and 90-day mortality (ranging from 12% to 19%) [2]. The significant increase in overall mortality in analysed hospitals observed in 2019 and 2020 raises a red flag. This increase may be partly attributable to the COVID-19 pandemic [26–30]. However, an increase in average post-stroke mortality in Poland started in 2020, not in 2019 [2]. It is possible that the implementation of thrombectomy has also skewed the population of patients treated in comprehensive stroke units towards a higher proportion of severe cases. Special attention is needed to ensure that this finding is not indicative of a systematic trend, but rather represents a temporary fluctuation.

Study limitations

Our analysis is based on declarative data of samples of consecutive patients reported to the registry from multiple centres on a voluntary basis. As a result, there was a high variability observed in the annual numbers of contributed cases, both among different hospitals and across different years.

It was also not possible to determine how many patients, and for what reasons, were not reported to the registry, nor to ascertain the causes of missing values in particular variables. For instance, site no. 2 in 2019 evidently reported almost exclusively cases treated with rtPA, rather than all consecutive patients within a predefined timeframe. This selection bias may affect statistical analyses on a year-to-year basis in individual hospitals or comparisons between hospitals. Therefore, we graphically present data about DNT and dysphagia screening (Figures 1 and 2), refraining from comparisons between hospitals. This source of bias has also been reported in RES-Q-based analyses of stroke care in Greece and Estonia [17, 18]. It is vital to recognise that the performance metrics used in high quality registries like the RES-Q are formulated based on expert consensus and scholarly agreement [12, 31]. While these metrics function as surrogate markers presumed to have a major impact on clinical outcomes, they do not serve as direct substitutes for clinical endpoints.

Despite the aforementioned limitations, the overall sample size is sufficiently large to derive meaningful conclusions regarding changes in stroke performance within the subset of Polish stroke units that exhibit relatively high baseline performance. These findings hold significance for international benchmarking purposes, and can provide informative insights for policymakers, almost matching the requirements of the Achievable Benchmark of Care methodology [31].

Clinical implications/future directions

The overall performance of Polish stroke units that consistently reported series of cases to the RES-Q registry between 2017 and 2020 improved in several respects, particularly in terms of the availability of mechanical thrombectomy, the door-to-needle time, and dysphagia screening. There was no evident deleterious effect of the COVID-19 pandemic in 2020. However, it is still necessary to shorten the time to dysphagia screening, to reduce disparities in rtPA logistics across different hospitals, and to ensure effective outpatient follow-up care.

External quality-oriented projects have the potential to drive improvement, even in centres with already good baseline performance. However, it is crucial to encourage continuous data reporting and the use of collected data for the purpose of planning interventions to improve performance at local and national levels. This would encompass the ESO-EAST effort to show the real picture of stroke care quality by reporting complete series of cases for one month in Spring and one month in Autumn, each year.

To effectively achieve the goals outlined in the SAP-E, it would be optimal to make practical use of the data that is mandatorily reported to the NHF. This could involve feedback to individual hospitals through quarterly reports, or integrating the data with validated registries such as the RES-Q, enabling transparent and international benchmarking.

Article information

Data availability statement: *The data supporting the findings is available from the corresponding author upon reasonable request.*
Ethics statement: *This study was conducted in accordance with the Declaration of Helsinki. Due to its observational character and the anonymisation of data, approval from the Ethics Committee and additional consents were not required.*
Authors' contributions: *Michal Karlinski conceived and designed study, collected data, performed statistical analysis, interpreted results, drafted manuscript and approved final version for publication; All co-authors participated in data collection, revised manuscript for important intellectual content, and approved final version for publication.*
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