Received: 8 June 2023 | Accepted: 31 July 2023

DOI: 10.1111/ene.16024

european journal
of neurology
the official journal of the european academy of neurology

ORIGINAL ARTICLE

How registry data are used to inform activities for stroke care quality improvement across 55 countries: A cross-sectional survey of Registry of Stroke Care Quality (RES-Q) hospitals

Oyebola Fasugba[1,2] | **Rupal Sedani**[3] | **Robert Mikulik**[4] | **Simeon Dale**[1,2] | **Miroslav Vařecha**[3] | **Kelly Coughlan**[1,2] | **Benjamin McElduff**[1,2] | **Elizabeth McInnes**[1,2] | **Sabina Hladíková**[3] | **Dominique A. Cadilhac**[5,6] | **Sandy Middleton**[1,2]

[1]Nursing Research Institute, St Vincent's Health Network Sydney, St Vincent's Hospital Melbourne and Australian Catholic University, Sydney, New South Wales, Australia

[2]School of Nursing, Midwifery and Paramedicine, Australian Catholic University, Sydney, New South Wales, Australia

[3]International Clinical Research Centre, St. Anne's University Hospital, Brno, Czech Republic

[4]International Clinical Research Centre, Neurology Department, St. Anne's University Hospital and Masaryk University, Brno, Czech Republic

[5]Stroke and Ageing Research, School of Clinical Sciences at Monash Health, Monash University, Clayton, Victoria, Australia

[6]Stroke Theme, Florey Institute of Neuroscience and Mental Health, University of Melbourne, Heidelberg, Victoria, Australia

Correspondence
Sandy Middleton, Nursing Research Institute, St Vincent's Health Network Sydney, St Vincent's Hospital Melbourne and Australian Catholic University, Victoria Street, Darlinghurst, Sydney, NSW, Australia.
Email: sandy.middleton@acu.edu.au

Funding information
National Health and Medical Research Council Investigator Grant, Grant/Award Number: APP1196352; COST Association, Grant/Award Number: CA18118; Ministry of Education, Youth and Sports of the Czech Republic, Grant/Award Number: LTC20051; State budget of the Czech Republic, Grant/Award Number: LM2018128; European Stroke Organisation

Abstract

Background and purpose: The Registry of Stroke Care Quality (RES-Q) is a worldwide quality improvement data platform that captures performance and quality measures, enabling standardized comparisons of hospital care. The aim of this study was to determine if, and how, RES-Q data are used to influence stroke quality improvement and identify the support and educational needs of clinicians using RES-Q data to improve stroke care.

Methods: A cross-sectional self-administered online survey was administered (October 2021–February 2022). Participants were RES-Q hospital local coordinators responsible for stroke data collection. Descriptive statistics are presented.

Results: Surveys were sent to 1463 hospitals in 74 countries; responses were received from 358 hospitals in 55 countries (response rate 25%). RES-Q data were used "always" or "often" to: develop quality improvement initiatives ($n=213$, 60%); track stroke care quality over time ($n=207$, 58%); improve local practice ($n=191$, 53%); and benchmark against evidence-based policies, procedures and/or guidelines to identify practice gaps ($n=179$, 50%). Formal training in the use of RES-Q tools and data were the most frequent support needs identified by respondents ($n=165$, 46%). Over half "strongly agreed" or "agreed" that to support clinical practice change, education is needed on: (i) using data to identify evidence–practice gaps ($n=259$, 72%) and change clinical practice ($n=263$, 74%), and (ii) quality improvement science and methods ($n=255$, 71%).

Conclusion: RES-Q data are used for monitoring stroke care performance. However, to facilitate their optimal use, effective quality improvement methods are needed. Educating

---

staff in quality improvement science may develop competency and improve use of data in practice.

KEYWORDS
clinical quality registry, data, quality improvement, stroke

INTRODUCTION

Worldwide, stroke is the second leading cause of disability and death [1, 2]. Many countries have introduced stroke clinical registries to identify gaps in stroke practice and areas for improvement [3–5]. Registries are an important approach to improving the quality of stroke care through the systematic collection and analysis of patient data, which can be used to assess their alignment with evidence-based practice and national standards to reduce the impact of stroke [6–8].

The Registry of Stroke Care Quality (RES-Q) is an international web-based platform collecting stroke quality-of-care metrics that provides clinicians with feedback on their data via downloadable quarterly reports, with individual hospital- and national-level benchmarking, and dashboards updated daily [9]. Since its launch, RES-Q has been used to collect data on over 500,000 episodes of care in 83 countries, primarily in Europe, South America and South-East Asia [10]. In seeking to reduce variations in stroke care, RES-Q is also an important tool to assist stroke clinicians with meeting the 2018–2030 Action Plan for Stroke in Europe [11], and the World Stroke Organization (WSO) Global Stroke Services Guideline and Action Plan Roadmap [12]. The WSO encourages hospitals to monitor stroke care quality through participation in RES-Q [13].

The Angels (Acute Networks strivinG for ExceLlence in Stroke) initiative is an important stakeholder in stroke quality improvement, globally [14]. This initiative, endorsed by the WSO and European Stroke Organization (ESO) [15, 16], is a mechanism for supporting hospitals in quality improvement endeavors using RES-Q data. Angels consultants take on a facilitator or “change-agent” role to provide hospital staff with training and support to implement best practice for stroke and to undertake quality monitoring for continuous quality improvement. Hospitals receive motivational tools such as WSO/ESO Angels awards for meeting performance thresholds, another mechanism which promotes quality improvement [9].

Despite widespread uptake of RES-Q, as with other registry data [17], there is limited information on how data are used by hospitals to support improvements in stroke care practice. Further, the education and training needs of stroke clinicians should be identified to improve their use of registry data for quality improvement [9]. Hence, this study aimed to determine if, and how, RES-Q data are being used to inform local quality improvement activities and also to identify the resource and educational needs of stroke clinicians to improve their use of RES-Q data to drive practice change. We also assessed whether hospitals actively participating in RES-Q (determined by the amount of audit data captured in the year of the survey) had better performance in quality improvement activities compared to inactive hospitals.

METHOD

Study design and setting

A cross-sectional, descriptive study using a self-administered online survey was undertaken in hospitals participating in RES-Q across countries in Europe, Oceania, Africa, Asia, Latin America and the Caribbean, and Northern America.

Inclusion and exclusion criteria

All hospitals registered with RES-Q up to August 2021 were eligible for inclusion. Hospitals that captured data on more than 10 patients in 2021 were categorized as active and those capturing data on 10 patients or fewer were classified as inactive. All active and inactive hospitals registered with RES-Q were included in the study. Hospitals that registered with RES-Q after August 2021 were excluded due to study timelines.

Participants

RES-Q country co-ordinators and RES-Q local (hospital) coordinators were approached to complete the survey.

Procedure

An email was sent by the RES-Q team, notifying RES-Q local and national coordinators of the survey, 1 week prior to survey commencement. The online survey was administered from 14 October 2021 to 28 February 2022. The survey link was emailed to participants. A participant information letter asked participants to complete one survey only for their hospital in collaboration with other appropriate staff. Strategies used to maximize the response rate included fortnightly follow-up reminder emails from the project team to non-responders, and email/telephone reminders from the national RES-Q coordinators, RES-Q scientific committee members and/or Angels representatives. Four hospitals requested that their local

Angels representative translate the survey into the Russian language for ease of completion, which was undertaken.

Instrument

An electronic English-language survey was built in REDCap™ [18, 19]. A previous Australian survey on the use of registry data for quality improvement initiatives informed the content of the survey for this study [17]. The survey comprised six sections with closed-ended questions covering the following areas: (i) RES-Q site information; (ii) registry data entry processes; (iii) RES-Q hospital dashboards and reports; (iv) impact of RES-Q data on clinical practice, stroke service enhancements or research; (v) RES-Q resources; and (vi) characteristics of the person completing the survey. The survey was pre-tested with the RES-Q global scientific committee members who included expert stroke clinicians.

Data analysis

Data were analysed using SPSS version 27 [20]. Descriptive statistics assessed respondent characteristics and survey responses. Categorical data were reported as frequencies and percentages. The hospital name and identification number were used to identify hospitals that completed more than one survey. For these hospitals (*N* = 70), the survey with the most complete data was included in the analysis. Survey responses for “always” and “often”; “very satisfied” and “satisfied”; “very likely” and “likely”; “very good” or “good”; and “strongly agree” or “agree” were combined. Variables with missing data were reported in the tables.

Subgroup analysis was undertaken to assess respondents' data by active (>10 patients in RES-Q in 2021) and inactive (10 patients in RES-Q in 2021) RES-Q hospital status. Our subgroup analysis of active and inactive hospital differences used an arbitrary and generously low cut-off of 10 cases, based on the assumption that any hospital participating in RES-Q would have entered data for at least 10 stroke patients in the last 10 months (equating to one patient per month).

The chi-squared test (χ^2) or Fisher's exact test was used to examine associations between hospital characteristics and RES-Q hospital dashboard views, report downloads and use of RES-Q data to develop quality improvement initiatives. Similar comparisons were also undertaken between active and inactive hospitals.

Reporting of this study complied with the cross-sectional study checklist of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [21].

RESULTS

The online survey link was sent via email to 1463 hospitals in 74 countries and was completed by 358 hospitals (response rate: 25%) from 55 countries (Table S1). The survey distribution flowchart is shown in Figure 1.

Respondents' characteristics

Most respondents were doctors (*n* = 264, 74%), had been in their current position for over 10 years (*n* = 124, 35%), and had completed a master's or postgraduate degree (*n* = 137, 38%). Respondents mostly worked in a public tertiary referral or teaching hospital (*n* = 131, 37%) and in the stroke unit (*n* = 210, 59%; Table 1).

Data entry processes for RES-Q

Most respondents (*n* = 171, 48%) had been contributing data to RES-Q for a period of between 1 and 3 years (Table 2). RES-Q data were mainly collected by medical staff (*n* = 272, 76%) and most respondents required 11–20 min per patient to collect and enter data into the registry (*n* = 138, 39%). Most respondents (*n* = 251, 70%) entered data for all stroke patient types (ischemic, hemorrhagic, transient ischemic attack and stroke mimics). The most frequently reported source of clinical data entered in RES-Q was electronic patient medical records (*n* = 185, 52%).

RES-Q hospital dashboards and reports

While most respondents (*n* = 275, 77%) were aware of RES-Q dashboards for their hospital, only 29% (*n* = 80) viewed the dashboards as and when required (Table 3). Fewer than half stated they downloaded quarterly reports, as and when required (*n* = 126, 35%) or once every quarter leading up to the ESO/WSO awards deadline (*n* = 77, 22%). In addition to the local RES-Q coordinator, RES-Q hospital data, dashboards and reports were also accessed by the data entry person who is registered in RES-Q (*n* = 228, 64%) and RES-Q national coordinator (*n* = 94, 26%). Only 10% (*n* = 34) of respondents reported that RES-Q hospital data, dashboards and reports were accessed by their hospital quality unit.

RES-Q hospital dashboards and reports were most often used for comparison and benchmarking (*n* = 154, 43%) and monitoring progress towards achievement of ESO/WSO Angels awards (*n* = 149, 42%). Time to treatment (*n* = 217, 61%), processes of care (*n* = 215, 60%) and delivery of reperfusion therapies (*n* = 179, 50%) were the information in RES-Q hospital dashboards and reports that respondents agreed were of most value to their work.

Monthly feedback about progress in stroke management based on RES-Q data was reported as received by doctors (*n* = 95, 27%), department heads (*n* = 89, 25%), nurses (*n* = 53, 15%) and allied health staff (*n* = 48, 13%). Only 10% (*n* = 35) of hospital quality units/clinical governance teams and 11% (*n* = 38) of hospital administration/executives were sent monthly feedback. Feedback of data

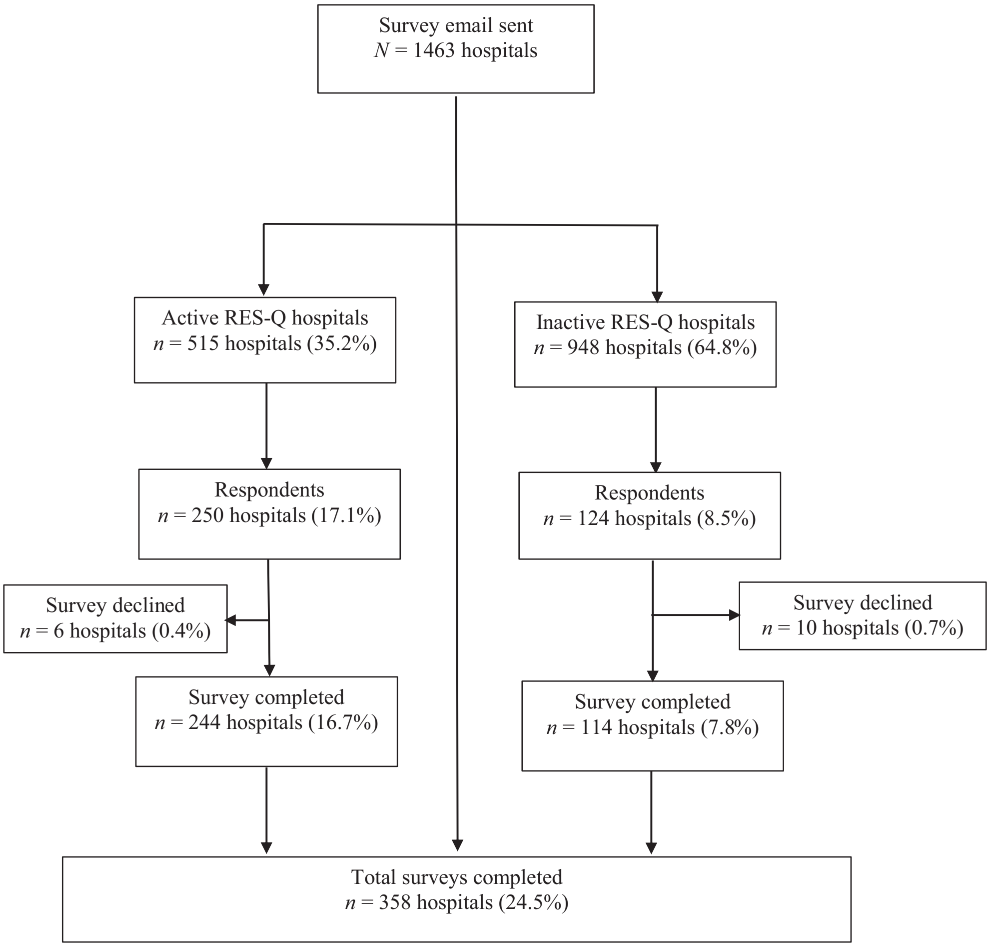

FIGURE 1 Survey response flow diagram. RES-Q, Registry of Stroke Care Quality.

from RES-Q reports was mainly provided to staff via face-to-face meetings (*n* = 217, 61%) and email (*n* = 103, 29%).

Impact of RES-Q data on clinical practice, stroke service enhancements and research

Over half (*n* = 252, 70%) of respondents "strongly agreed" or "agreed" that involvement with RES-Q had led to improvements in stroke care at their hospital (Table 4). Respondents' rating of their hospital's quality of stroke care (scored as "very good" or "good") was highest for *Antihypertensives on discharge* (*n* = 298, 83%) and lowest for *Referral of patients from Spoke hospitals* (delivers full range of medical services) [22] *to respondent hospital* (*if it is a Hub hospital* (provides limited range of medical services) [22]; *n* = 164, 46%).

Over half of respondents reported using RES-Q data "always" or "often" to: develop quality improvement initiatives (*n* = 213, 60%); track and compare progress over time (*n* = 207, 58%); update or develop clinical guidelines, policies, protocols and/or procedures (*n* = 202, 56%); encourage participation in ESO/WSO angels awards and evaluate performance (*n* = 196, 55%); and improve local clinical practice change (*n* = 191, 53%).

Of the 69% (*n* = 246) who reported that their hospital was involved with the Angels initiative, fewer than half (*n* = 164, 46%) had a nominated Angels consultant. Collaboration with the Angels initiative on interactive e-learning modules was the most frequently cited activity by respondents (*n* = 198, 81%). Approximately two-thirds were also working with the Angels initiative on implementation of the Fever, Sugar, Swallowing (FeSS) Protocols (*n* = 160, 65%).

RES-Q participation was not reported by many to be a part of their accreditation processes: hospital accreditation (*n* = 73, 20%); WSO Stroke Centre accreditation (*n* = 55, 15%) and ESO Stroke Unit/ESO Stroke Centre accreditation (*n* = 51, 14%).

Just over one-quarter (*n* = 97, 27%) had used their hospital's data for conference presentations or publications and 41% (*n* = 145) had an interest in future use of data for research.

Resource and educational needs of respondents

Most respondents had received training on how to use the RES-Q website from the Angels consultants (*n* = 157, 44%; Table 5). The most frequently reported type of support required by respondents was formal face-to-face or online training on how to use RES-Q tools and data (*n* = 165, 46%).

TABLE 1 Characteristics of respondents.

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
Job title			
Medical doctor	70 (61.4)	194 (79.5)	264 (73.7)
Nursing staff	4 (3.5)	15 (6.1)	19 (5.3)
Allied health staff	3 (2.6)	5 (2.0)	8 (2.2)
Non-clinical staff	0 (0)	2 (0.8)	2 (0.7)
Other	0 (0)	3 (1.2)	3 (0.8)
Missing	37 (32.5)	25 (10.2)	62 (17.3)
Number of years in position			
Less than 1 year	1 (0.9)	3 (1.2)	4 (1.1)
1–5 years	21 (18.4)	73 (29.9)	94 (26.3)
6–10 years	17 (14.9)	57 (23.4)	74 (20.7)
Over 10 years	38 (33.3)	86 (35.2)	124 (34.6)
Missing	37 (32.5)	25 (10.2)	62 (17.3)
Highest tertiary qualification			
Diploma	11 (9.6)	31 (12.7)	42 (11.7)
Bachelor	6 (5.3)	17 (7.0)	23 (6.4)
Masters/Postgraduate	35 (30.7)	102 (41.8)	137 (38.3)
PhD	24 (21.1)	68 (27.9)	92 (25.7)
I do not have a university qualification	1 (0.9)	1 (0.4)	2 (0.6)
Missing	37 (32.5)	25 (10.2)	62 (17.3)
Principal RES-Q role[a]			
Local RES-Q coordinator	76 (66.7)	168 (68.9)	244 (68.2)
National RES-Q coordinator	10 (8.8)	24 (9.8)	34 (9.5)
Data entry person	25 (21.9)	84 (34.4)	109 (30.4)
Other	7 (6.1)	3 (1.2)	10 (2.8)
Hospital setting			
Public—tertiary referral or teaching hospital	44 (38.6)	87 (35.7)	131 (36.6)
Public—primary, district or community hospital with emergency department	29 (25.4)	90 (36.9)	119 (33.2)
Public—primary, district or community hospital without emergency department	1 (0.9)	2 (0.8)	3 (0.8)
Private	28 (24.6)	54 (22.1)	82 (22.9)
Other	1 (0.9)	2 (0.8)	3 (0.8)
Missing	11 (9.6)	9 (3.7)	20 (5.7)
Ward			
Stroke unit	61 (53.5)	149 (61.1)	210 (58.7)
Intensive care unit	10 (8.8)	22 (9.0)	32 (8.9)
Standard ward with dedicated stroke beds	24 (21.1)	55 (22.5)	79 (22.1)
Rehabilitation unit	2 (1.8)	2 (0.8)	4 (1.1)
Other	6 (5.3)	8 (3.3)	14 (3.9)
Missing	11 (9.6)	8 (3.3)	19 (5.3)

Abbreviation: RES-Q, Registry of Stroke Care Quality.

[a] Percentages may not add up to 100 as respondents could provide multiple responses.

Almost three-quarters "strongly agreed" or "agreed" that education on the following topics would be helpful to support clinical practice change in their hospital: data to identify evidence–practice gaps ($n=259$, 72%) and change clinical practice ($n=263$, 74%), and quality improvement science and methods ($n=255$, 71%).

There were no associations between hospital setting and frequency of RES-Q hospital dashboard views ($\chi^2=15.37$, $p=0.22$), report downloads ($\chi^2=5.56$, $p=0.76$) and use of RES-Q data to develop quality improvement initiatives ($\chi^2=14.03$, $p=0.15$). There were also no associations between respondents' ward and report downloads

TABLE 2 Registry of Stroke Care Quality data entry processes.

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
Number of years contributing to RES-Q			
Less than 1 year	37 (32.5)	35 (14.3)	72 (20.1)
1–3 years	40 (35.1)	131 (53.7)	171 (47.8)
4–6 years	18 (15.8)	68 (27.9)	86 (24.0)
Missing	16 (14.0)	10 (4.1)	26 (7.3)
Do not know	3 (2.6)	0 (0)	3 (0.8)
Person responsible for entering data[a]			
Medical staff	81 (71.1)	191 (78.3)	272 (76.0)
Nursing staff	13 (11.4)	40 (16.4)	53 (14.8)
Allied health staff	5 (4.4)	11 (4.5)	16 (4.5)
Non-clinical staff	3 (2.6)	11 (4.5)	14 (3.9)
Other	4 (3.5)	2 (0.8)	6 (1.7)
Do not know	2 (1.8)	0 (0)	2 (0.6)
Time spent collecting and entering RES-Q data (per patient)			
≤10 min	19 (16.7)	87 (35.7)	106 (29.6)
11–20 min	37 (32.5)	101 (41.4)	138 (38.5)
21–30 min	23 (20.2)	33 (13.5)	56 (15.6)
>30 min	9 (7.9)	12 (4.9)	21 (5.9)
Do not know	10 (8.8)	1 (0.4)	11 (3.1)
Missing	16 (14.0)	10 (4.1)	26 (7.3)
Types of patients with stroke included in RES-Q			
All stroke patients (ischemic and hemorrhagic and TIA and stroke mimics)	65 (57.0)	186 (76.2)	251 (70.1)
Ischemic stroke patients only	11 (9.6)	19 (7.8)	30 (8.4)
Recanalized stroke patients	4 (3.5)	11 (4.5)	15 (4.2)
Selected stroke patients (ischemic or hemorrhagic or TIA or stroke mimics)[a]			
Ischemic	13 (11.4)	18 (7.4)	31 (8.7)
Hemorrhagic	7 (6.1)	12 (4.9)	19 (5.3)
TIA	4 (3.5)	9 (3.7)	13 (3.6)
Stroke mimics	2 (1.8)	3 (1.2)	5 (1.4)
Sources of clinical data entered into RES-Q[a]			
Patient discharge summary	39 (34.2)	100 (41.0)	139 (38.8)
Patient medical records (hardcopy)	44 (38.6)	117 (48.0)	161 (45.0)
Patient medical records (electronic)	53 (46.5)	132 (54.1)	185 (51.7)
Data are collected from different departments and compiled in the RES-Q form (hardcopy)	9 (7.9)	29 (11.9)	38 (10.6)
Do not know	5 (4.4)	1 (0.4)	6 (1.7)
Other	2 (1.8)	4 (1.6)	7 (2.0)

Abbreviation: RES-Q, Registry of Stroke Care Quality.

[a] Percentages may not add up to 100 as respondents could provide multiple responses.

($\chi^2 = 25.63$, $p = 0.06$) and use of RES-Q data to develop quality improvement initiatives ($\chi^2 = 26.05$, $p = 0.16$). However, there was an association between respondents' ward and RES-Q hospital dashboard views ($\chi^2 = 41.38$, $p = 0.02$).

Active and inactive RES-Q hospitals

Only 35% ($n = 515$) of the 1463 hospitals were active (captured data on more than 10 patients in 2021), while 63% ($n = 918$) were inactive.

TABLE 3 Registry of Stroke Care Quality hospital dashboards and reports.

	Inactive	Active	Total
	N = 114	N = 244	N = 358
Characteristics	***n* (%)**	***n* (%)**	***n* (%)**
Awareness of RES-Q hospital dashboards			
Yes	65 (57.0)	210 (86.1)	275 (76.8)
On average, how often do you look at the RES-Q hospital dashboards for your hospital?			
Weekly	3 (4.6)	30 (14.3)	33 (12.0)
Monthly	13 (20.0)	58 (27.6)	71 (25.8)
Once every quarter leading up to the ESO/WSO awards deadline	7 (10.8)	46 (21.9)	53 (19.3)
As and when required	25 (38.4)	55 (26.3)	80 (29.1)
After I have entered a batch of new data into RES-Q	7 (10.8)	19 (9.0)	26 (9.5)
Never	7 (10.8)	2 (0.9)	9 (3.3)
Do not know	3 (4.6)	0 (0)	3 (1.1)
Download quarterly RES-Q data reports			
Yes, once every quarter during ESO/WSO awards deadline	7 (6.1)	70 (28.7)	77 (21.5)
Yes, as and when required	28 (24.6)	98 (40.2)	126 (35.2)
No, I am aware of the RES-Q data reports but have never downloaded them	32 (28.1)	42 (17.2)	74 (20.7)
No, I am not aware of the RES-Q data reports	18 (15.8)	13 (5.3)	31 (8.7)
Missing	26 (22.8)	18 (7.4)	44 (12.3)
Other	3 (2.6)	3 (1.2)	6 (1.7)
Satisfaction with downloaded quarterly reports[a]			
Very satisfied	7 (20.0)	47 (27.9)	54 (26.6)
Satisfied	22 (62.8)	107 (63.7)	129 (63.5)
Neutral	5 (14.4)	12 (7.1)	17 (8.4)
Unsatisfied	1 (2.8)	2 (1.2)	3 (1.5)
What are your reasons for not downloading the quarterly RES-Q data reports?[b]			
I do not know how to download the reports	5 (10.0)	5 (9.1)	10 (9.5)
I have not received training about this	8 (16.0)	13 (23.6)	21 (20.0)
I do not have the time	20 (40.0)	19 (34.6)	39 (37.1)
Reports from RES-Q take too long to get released	0 (0)	5 (9.1)	5 (4.8)
Missing	17 (34.0)	13 (23.6)	30 (28.6)
Who else can access RES-Q data, dashboards and reports apart from local coordinator[c]			
Data entry person	56 (49.1)	172 (70.5)	228 (63.7)
National RES-Q coordinator	15 (13.2)	79 (32.4)	94 (26.3)
Hospital quality unit	11 (9.6)	23 (9.4)	34 (9.5)
Hospital administration	12 (10.5)	18 (7.4)	30 (8.4)
Ethics committee	3 (2.6)	4 (1.6)	7 (2.0)
Do not know	19 (16.7)	19 (7.8)	38 (10.6)
Other	2 (1.8)	6 (2.5)	8 (2.2)
Uses of RES-Q hospital dashboards and reports[c]			
Checking for missing data	26 (22.8)	89 (36.5)	115 (32.1)
Comparison and benchmarking	28 (24.6)	126 (51.6)	154 (43.0)
Department/hospital meetings	22 (19.3)	115 (47.1)	137 (38.3)
WSO/ESO Angels awards	21 (18.4)	128 (52.5)	149 (41.6)
Supporting accreditation processes	16 (14.0)	64 (26.2)	80 (22.3)
Presenting at conferences/forums	25 (21.9)	80 (32.8)	105 (29.3)

(Continues)

TABLE 3 (Continued)

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
Writing publications	17 (14.9)	45 (18.4)	62 (17.3)
Do not know	16 (14.0)	14 (5.7)	30 (8.4)
Information in RES-Q hospital dashboards and reports that is of most value to your work[c]			
Total number of patients admitted with stroke	39 (34.2)	132 (54.1)	171 (47.8)
Comparing the different types of patients with stroke who have ischemic, hemorrhagic or TIA events	39 (34.2)	125 (51.2)	164 (45.8)
Processes of care (i.e., clinical care treatments and the timeliness of these, where relevant)	55 (48.2)	160 (65.6)	215 (60.1)
Delivery of reperfusion therapies	37 (32.5)	142 (58.2)	179 (50.0)
Time to treatment	47 (41.2)	170 (69.7)	217 (60.6)
FeSS management	22 (19.3)	59 (24.2)	81 (22.6)
Length of stay in hospital	35 (30.7)	84 (34.4)	119 (33.2)
Discharge outcomes (e.g. functional independence, discharge destination)	37 (32.5)	126 (51.6)	163 (45.5)
ESO/WSO award dashboard	16 (14.0)	102 (41.8)	118 (33.0)
Do not know	8 (7.0)	5 (2.0)	13 (3.6)
Who receives monthly feedback about progress in stroke management based on RES-Q data[c]			
Nursing staff within unit	9 (7.9)	44 (18.0)	53 (14.8)
Medical staff within unit	21 (18.4)	74 (30.3)	95 (26.5)
Allied health staff within unit	7 (6.1)	41 (16.8)	48 (13.4)
Head of department	15 (13.2)	74 (30.3)	89 (24.9)
Hospital quality unit /clinical governance teams	8 (7.0)	27 (11.1)	35 (9.8)
Hospital administration/executives	11 (9.6)	27 (11.1)	38 (10.6)
How RES-Q reports are shared with staff[c]			
Email	26 (22.8)	77 (31.6)	103 (28.8)
Posters displayed in department/hospital	9 (7.9)	32 (13.1)	41 (11.5)
Face-to-face meeting	45 (39.5)	172 (70.5)	217 (60.6)
Hospital newsletter	3 (2.6)	21 (8.6)	24 (6.7)
Do not know	3 (2.6)	4 (1.6)	7 (2.0)
Results not shared	17 (14.9)	13 (5.3)	30 (8.4)
Other	2 (1.8)	4 (1.6)	6 (1.7)

Abbreviations: ESO, European Stroke Organization; FeSS, Fever, Sugar, Swallowing; RES-Q, Registry of Stroke Care Quality; TIA, transient ischemic attack; WSO, World Stroke Organization.

[a] Respondents who answered yes to “Download quarterly RES-Q data reports”.

[b] Respondents who answered no to “Download quarterly RES-Q data reports”.

[c] Percentages may not add up to 100 as respondents could provide multiple responses.

Of the active and inactive hospitals, 47% ($n = 244$) and 12% ($n = 114$) completed the survey, respectively.

Findings from both active and inactive RES-Q hospitals were similar to the overall results. Comparisons between active and inactive hospitals showed a significant difference between the groups in the frequency of RES-Q dashboard views ($\chi^2 = 30.27$, $p < 0.001$). While respondents from active hospitals mostly viewed the RES-Q dashboards monthly ($n = 58$, 28%), they were mainly viewed as and when required by respondents from inactive hospitals ($n = 25$; 38%). There was also a significant difference in the frequency of report downloads between active and inactive hospitals ($\chi^2 = 39.59$, $p < 0.001$). Most respondents from active hospitals downloaded RES-Q data reports as and when required ($n = 98$, 40%), while those in inactive hospitals had never downloaded the RES-Q data reports although they were aware of them ($n = 32$, 28%; Table 3).

There was no difference between active and inactive hospitals for using RES-Q data to develop quality improvement initiatives

TABLE 4 Impact of Registry of Stroke Care Quality data on clinical practice, stroke service enhancements and research.

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
Involvement with RES-Q has led to improvements in stroke care[a]	58 (50.9)	194 (79.5)	252 (70.4)
Hospital compares well to other hospitals in relation to stroke care[a]	61 (53.5)	194 (79.5)	255 (71.2)
Rate your hospital's quality of stroke care for:[b]			
Availability of thrombolysis treatment	68 (59.7)	204 (83.6)	272 (76.0)
Availability of endovascular treatment	47 (41.3)	125 (51.2)	172 (48.0)
Access to stroke unit/ICU care	64 (56.1)	191 (78.3)	255 (71.2)
Fever management	72 (63.2)	204 (83.7)	276 (77.1)
Hyperglycemia management	72 (63.2)	209 (85.7)	281 (78.5)
Dysphagia management	62 (54.4)	191 (78.3)	253 (70.7)
Availability of early rehabilitation (within 72 h of admission)	54 (47.4)	188 (77.1)	242 (67.6)
Antihypertensives on discharge	77 (67.6)	221 (90.6)	298 (83.2)
Availability of the service provided by a Hub hospital to my hospital (if you are a Spoke hospital)	35 (30.7)	122 (50.0)	157 (43.9)
Referral of patients from Spoke hospitals to my hospital (if you are a Hub hospital)	41 (35.9)	123 (50.4)	164 (45.8)
Use of registry data for clinical practice[c]			
Data are used to track and compare progress over time	43 (37.8)	164 (67.2)	207 (57.8)
Data are used to benchmark against evidence-based policies, procedures and/or guidelines to identify clinical practice gaps	40 (35.1)	139 (57.0)	179 (50.0)
Data are compared to national benchmarks	30 (26.3)	141 (57.7)	171 (47.8)
Data are used to encourage participation in WSO/ESO Angels Awards and evaluate performance	35 (30.7)	161 (65.9)	196 (54.7)
Data are used to develop quality improvement initiatives	48 (42.1)	165 (67.6)	213 (59.5)
Data directly influence clinical practice change in unit	46 (40.3)	145 (59.4)	191 (53.4)
Clinical guidelines, policies, protocols and/or procedures updated or developed	45 (39.5)	157 (64.3)	202 (56.4)
Changes to or introduction of new models of care	41 (36.0)	147 (60.3)	188 (52.5)
Involved now or in the past in any stroke quality improvement activities			
Yes	59 (51.8)	182 (74.6)	241 (67.3)
RES-Q data used for quality improvement activities			
Yes	34 (57.6)	140 (76.9)	174 (72.2)
No	23 (39.0)	33 (18.1)	56 (23.2)
Do not know	2 (3.4)	8 (4.4)	10 (4.1)
Missing	0 (0)	1 (0.6)	1 (0.4)
Respondent directly involved in using RES-Q data for hospital quality improvement activities			
Yes	47 (41.2)	175 (71.7)	222 (62.0)
No	34 (29.8)	46 (18.9)	80 (22.3)
Missing	33 (28.9)	23 (9.4)	56 (15.6)
Hospital involved with the Angels initiative			
Yes, and we have a nominated Angels consultant	36 (31.6)	128 (52.5)	164 (45.8)
Yes, but we do not have a nominated Angels consultant	26 (22.8)	56 (23.0)	82 (22.9)
Activities working on in collaboration with the Angels[d]			
Use of stroke checklists	46 (74.2)	135 (73.4)	181 (73.6)
Simulation training	43 (69.4)	141 (76.6)	184 (74.8)
ESO/WSO Angels awards	29 (46.8)	157 (85.3)	186 (75.6)

(Continues)

TABLE 4 (Continued)

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
Interactive e-learning modules (EMS, nurses, physicians training tools)	48 (77.4)	150 (81.5)	198 (80.5)
Development of stroke care pathway	52 (83.9)	142 (77.2)	194 (78.9)
Implementation of the FeSS protocols	42 (67.7)	118 (64.1)	160 (65.0)
Other	3 (5.8)	5 (2.7)	8 (3.3)
Participation in RES-Q used in any accrediting and/or credentialing processes[d]			
Individual hospital accreditation	15 (13.2)	58 (23.8)	73 (20.4)
WSO Stroke Centre accreditation	9 (7.9)	46 (18.9)	55 (15.4)
ESO Stroke Unit/ESO Stroke Centre accreditation	3 (2.6)	48 (19.7)	51 (14.2)
Angels awards	27 (23.7)	128 (52.7)	155 (43.3)
Continuing professional development hours for staff contributing to registry	14 (12.3)	33 (13.5)	47 (13.1)
No	28 (24.6)	33 (13.5)	61 (17.0)
Do not know	9 (7.9)	25 (10.2)	34 (9.5)
Other	1 (0.9)	1 (0.4)	2 (0.6)
Data from RES-Q are used for research projects			
Yes, we have used our hospital data for conference presentations or publications	23 (20.2)	74 (30.3)	97 (27.1)
Yes, we have used our hospital data to contribute to larger multi-site research projects	4 (3.5)	23 (9.4)	27 (7.5)
No, but we have an interest in doing this in the future	42 (36.8)	103 (42.2)	145 (40.5)
No, and we have no interest in future use of data for research	3 (2.6)	8 (3.3)	11 (3.1)
No, due to data sharing or ethical restrictions	3 (2.6)	4 (1.6)	7 (2.0)
Do not know	6 (5.3)	10 (4.1)	16 (4.5)
Missing	33 (28.9)	22 (9.0)	55 (15.4)
Raw data from RES-Q have been downloaded			
Yes, and we use it regularly	17 (14.9)	95 (38.9)	112 (31.3)
Yes, but it is not useful	6 (5.3)	30 (12.3)	36 (10.1)
No	46 (40.4)	72 (29.5)	118 (33.0)
Do not know	11 (9.6)	25 (10.2)	36 (10.1)
Missing	34 (29.8)	22 (9.0)	56 (15.6)

Abbreviations: EMS, Emergency Medical Services; ESO, European Stroke Organization; FeSS, Fever, Sugar, Swallowing; ICU, intensive care unit; RES-Q, Registry of Stroke Care Quality; WSO, World Stroke Organization.

[a] Respondents who stated “strongly agree” or “agree”.

[b] Respondents who stated “very good” or “good”.

[c] Respondents who stated “always” or “often”.

[d] Percentages may not add up to 100 as respondents could provide multiple responses.

(active: 68% vs. inactive: 42%; $\chi^2 = 10.77$, $p = 0.05$). However, there was a difference between hospitals for involvement with the Angels initiative ($\chi^2 = 8.42$, $p = 0.04$). Fewer than half of respondents from inactive hospitals were involved with the Angels initiative and had a nominated Angels consultant ($n = 36$, 32%) compared to 53% ($n = 128$) in active hospitals (Table 4). Compared to 93% ($n = 227$) of respondents from active hospitals, only approximately half of those from inactive hospitals had received training on how to use the RES-Q website ($n = 61$, 53%; Table 5). This was significantly different if the training was received from the Angels ($\chi^2 = 15.10$, $p < 0.001$) or the RES-Q team ($\chi^2 = 4.83$, $p = 0.03$) but not at a stroke conference ($\chi^2 = 3.32$, $p = 0.07$).

DISCUSSION

This is the first international survey of 55 countries on the use of a large standardized clinical quality registry for monitoring and improving stroke care and provides new knowledge on the use of stroke registry data to inform clinical quality improvement activities. Evidence of the support and educational needs of participants to improve knowledge of RES-Q data use to drive practice change is also highlighted. We found that, while involvement in RES-Q was seen by respondents as important to enhancing stroke care at their hospitals, there was a need to increase hospitals' use of the registry data to drive quality improvement activities and

TABLE 5 Resource and training needs.

Characteristics	Inactive N = 114 n (%)	Active N = 244 n (%)	Total N = 358 n (%)
RES-Q support resources accessed in the past 12 months[a]			
RES-Q data collection form	43 (37.7)	168 (68.9)	211 (58.9)
RES-Q report user guide	13 (11.4)	69 (28.3)	82 (22.9)
RES-Q policies	4 (3.5)	28 (11.5)	32 (8.9)
RES-Q newsletters	22 (19.3)	56 (23.0)	78 (21.8)
Email contact with the RES-Q Office	18 (15.8)	51 (20.9)	69 (19.3)
None	14 (12.3)	26 (10.7)	40 (11.2)
Received training on how to use the RES-Q website[a]			
Yes, at a stroke conference	12 (10.5)	44 (18.0)	56 (15.6)
Yes, by the Angels	33 (28.9)	124 (50.8)	157 (43.9)
Yes, by the RES-Q team	16 (14.0)	59 (24.2)	75 (20.9)
No	28 (24.6)	45 (18.4)	73 (20.4)
Other	1 (0.9)	2 (0.8)	3 (0.8)
Types of support and resources required from RES-Q team[a]			
Formal face-to-face or online training on how to use RES-Q tools and data	40 (35.1)	125 (51.2)	165 (46.1)
How to publish a paper	38 (33.3)	89 (36.5)	127 (35.5)
Success stories from hospitals on quality improvement activities	29 (25.4)	90 (36.9)	119 (33.2)
Latest updates on data published with RES-Q	38 (33.3)	112 (45.9)	150 (41.9)
RES-Q data dictionary	21 (18.4)	56 (23.0)	77 (21.5)
Access to the FeSS data entry page	20 (17.5)	67 (27.5)	87 (24.3)
None	12 (10.5)	15 (6.1)	27 (7.5)
Other	0 (0)	1 (0.4)	1 (0.3)
Training/education topics helpful for unit level clinical practice change[b]			
Data driven evidence–practice gap identification	65 (57.1)	194 (79.5)	259 (72.3)
Data driven practice change	67 (58.8)	196 (80.4)	263 (73.5)
Creating a team-based approach for reducing evidence–practice gaps	65 (57.0)	190 (77.9)	255 (71.2)
Data analysis and interpretation	62 (54.4)	190 (77.9)	252 (70.4)
Quality improvement science and methods	64 (56.1)	191 (78.3)	255 (71.2)
Audit and feedback methods	64 (56.1)	189 (77.5)	253 (70.7)
Clinical leadership training	64 (56.1)	189 (77.5)	253 (70.7)

Abbreviations: FeSS, Fever, Sugar, Swallowing; RES-Q, Registry of Stroke Care Quality.

[a] Percentages may not add up to 100 as respondents could provide multiple responses.

[b] Respondents who stated “strongly agree” or “agree”.

improve clinical practice. Support on how to use RES-Q tools and data including education in data-informed evidence–practice gap identification, clinical practice change and quality improvement science is also needed.

Despite involvement in RES-Q seen as being worthwhile for enhancing stroke care improvement, only 60% of respondents used RES-Q data to drive local quality improvement activities. Limited use of registry data from multiple specialties for local quality improvement has also been noted in research from Australia [17, 23], Denmark and England [24, 25]. While uptake of RES-Q for stroke care monitoring has increased over time, more effort is needed to translate hospitals' quality monitoring into quality improvement. Problems with how and when feedback is provided, low perceived importance of data and poor stakeholder collaboration, have been suggested as possible reasons for registries not reaching their potential as tools for quality improvement [25].

Our findings showed that feedback of RES-Q data to hospital staff including department heads about progress in stroke management was suboptimal. While there was a high awareness of RES-Q hospital dashboards and reports, staff views and downloads, respectively, were low. Further, feedback to hospital quality units was extremely low (10%). Evidence from Sweden's stroke registry identified engagement of the entire stroke team including managers as important factors facilitating successful quality improvement [3]. Incorporating the registry implementation within a local quality management system is also vital to advancing quality improvement [26]. Current RES-Q feedback mechanisms are passive and rely on the active role of users or national stroke societies, which is only partially successful. RES-Q hospital reports and dashboards are only accessible when registered users log in with their credentials. When feedback is "pushed" to individuals, it has the potential to change behavior by drawing attention to or increasing engagement with specific content, as opposed to a "pull" mechanism where individuals only access feedback as and when required [27].

Our results provide novel insight into the support needs of hospital staff involved in RES-Q. and are in line with other studies where staff reported inadequate resources and competencies to use registry data [17, 25]. For registry data to be used to improve stroke care and not merely provide feedback, an understanding of quality improvement is essential [3]. A number of medical and nursing professional organizations have therefore endorsed educating hospital staff in quality improvement science [28]. In addition, role clarity about who should be leading this work is lacking.

Further examination of the data from the subgroup analysis of active and inactive RES-Q hospitals revealed similar findings to the overall results but with some differences between the groups. Unsurprisingly, there was a significantly better performance in active hospitals for self-reported monthly RES-Q dashboard views and report downloads. Although not statistically significant, a higher proportion of active hospitals used RES-Q data to develop quality improvement activities. These hospitals also had significantly more involvement in the Angels initiative, which is likely to be an enabling factor contributing to better data entry and initiation of quality improvement. However, there is still room for improvement. A priority of the Angels initiative is to establish a culture of in-hospital continuous quality monitoring but quality improvement is equally important and there needs to be a greater emphasis on this.

Our findings will be used to inform improvements in the implementation of RES-Q and better support participating hospitals in data-informed quality improvement activities. The results will also serve as a baseline for future research involving RES-Q hospitals and their use of data for quality improvement. A good starting point may be to explore the perceived barriers and enablers of hospital staff to undertaking data-driven quality improvement activities. Future studies on performance feedback mechanisms, particularly around the use of dashboards for quality improvement, are also necessary to evaluate the effectiveness of the current feedback mechanisms used by RES-Q. In addition, the Angels awards program should be used as an incentive for practice change in hospitals. Research on the impact of Angels consultants as facilitators of quality improvement may help improve implementation of RES-Q data in stroke clinical practice globally.

A strength of our study is that it is the first to evaluate, at an international level, the influence of RES-Q data on local quality improvement activities, and provides a baseline for future surveys. Despite the varying health systems globally, we successfully obtained information on the use of stroke registry data to drive improvements in stroke practice from 358 hospitals in 55 countries. The findings should however be interpreted within the context of the study's limitations. The overall survey response rate was relatively low. Various factors may have accounted for this, such as the ongoing global coronavirus (COVID-19) pandemic impacting healthcare staff workload. Our use of an online survey mode for data collection assumed high internet access for all respondents, which may be inaccurate, especially for participants in developing countries [29]. Lack of translation of the survey to multiple languages introduced the potential for non-response bias as respondents from countries with low proficiency in English may have found this a barrier to participation. There was also the possibility for self-reporting bias; however, respondents were encouraged to complete the survey in collaboration with other hospital staff to minimize this bias. Our selection of a cut-off point of 10 was an arbitrary value based on the assumption that any hospital participating in RES-Q would have entered data for at least 10 stroke patients in the last 10 months (approximately one patient per month). Hence, results of the subgroup analysis may not be a true reflection of hospital performance based on active and inactive status.

CONCLUSIONS

In conclusion, RES-Q is the only international tool capturing stroke performance/quality measures with reach across a large number of countries, making comparisons reliable. The standardized clinical quality registry data are a valuable resource for hospitals to use in monitoring the quality of stroke services and identifying areas for improvement. However, as with many registries, more effort is needed to translate hospitals' quality monitoring into quality improvement. By improving the registry implementation process and providing access to quality improvement education for hospital staff, there is potential to increase the use of RES-Q data for local quality improvement activities.

AUTHOR CONTRIBUTIONS

Sandy Middleton, Robert Mikulik, Elizabeth McInnes and Dominique Cadilhac conceived the study. All authors were involved in protocol and survey development. Rupal Sedani, Miroslav Vařecha, Sabina Hladíková, Simeon Dale and Kelly Coughlan were involved in participant recruitment. Oyebola Fasugba and Benjamin McElduff undertook the data analysis. Oyebola Fasugba wrote the first draft of the manuscript. All authors reviewed the manuscript and approved the final version.

ACKNOWLEDGMENTS

We would like to thank the RES-Q Scientific Committee members and participating hospitals for their contribution to this research.

Open access publishing facilitated by Australian Catholic University, as part of the Wiley - Australian Catholic University agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

This work was supported by an National Health and Medical Research Council Investigator Grant [APP1196352] awarded to Sandy Middleton. Robert Mikulik was supported by: project no. CA18118, IRENE COST Action funded by COST Association; the IRIS-TEPUS Project no. LTC20051 from the INTER-EXCELLENCE INTER-COST Program of the Ministry of Education, Youth and Sports of the Czech Republic; and the STROCZECH within CZECRIN Large Research Infrastructure no. LM2018128, funded by the state budget of the Czech Republic. The RES-Q has been supported by grants provided by: the COST Association; the Ministry of Education, Youth and Sports of the Czech Republic; the state budget of the Czech Republic; the Ministry of Health of the Czech Republic; and funding provided by the ESO. In the past, RES-Q development and maintenance were supported by grants from the state budget of the Czech Republic; the European Union 7th Framework Programme; the Research & Development Operational Program funded by the European Union and state budget of the Czech Republic; and the ESO. The funding organizations had no role in the study design, data collection, data analysis, data interpretation, or manuscript writing.

CONFLICT OF INTEREST STATEMENT

No known conflict of interests.

DATA AVAILABILITY STATEMENT

De-identified survey data will be made available on request to the corresponding author (sandy.middleton@acu.edu.au), subject to ethical approval.

ETHICS STATEMENT

Participation in the survey was voluntary and consent was implied by completion and submission of the survey. The Australian Catholic University Human Research Ethics Committee approved this study (HREC number: 2021-174E).

ORCID

Dominique A. Cadilhac https://orcid.org/0000-0001-8162-682X
Sandy Middleton https://orcid.org/0000-0002-7201-4394

REFERENCES

1. Owolabi MO, Thrift AG, Martins S, et al. The state of stroke services across the globe: report of World Stroke Organization–World Health Organization surveys. *Int J Stroke*. 2021;16:889-901.
2. Johnson CO, Nguyen M, Roth GA, et al. Global, regional, and national burden of stroke, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Neurol*. 2019;18:439-458.
3. Eldh AC, Wallin L, Fredriksson M, et al. Factors facilitating a national quality registry to aid clinical quality improvement: findings of a national survey. *BMJ Open*. 2016;6:e011562.
4. Howard G, Schwamm LH, Donnelly JP, et al. Participation in get with the guidelines–stroke and its association with quality of care for stroke. *JAMA Neurol*. 2018;75:1331-1337.
5. Cadilhac DA, Lannin NA, Anderson CS, et al. Protocol and pilot data for establishing the Australian Stroke Clinical Registry. *Int J Stroke*. 2010;5:217-226.
6. Asplund K, Hulter Åsberg K, Appelros P, et al. The Riks-Stroke story: building a sustainable national register for quality assessment of stroke care. *Int J Stroke*. 2011;6:99-108.
7. Cadilhac DA, Kim J, Lannin NA, et al. National stroke registries for monitoring and improving the quality of hospital care: a systematic review. *Int J Stroke*. 2016;11:28-40.
8. Tanne D, Koton S, Bornstein NM. National Stroke Registries: what can we learn from them? *Neurology*. 2013;81:1257-1259.
9. Mikulík R, Caso V, Bornstein NM, et al. Enhancing and accelerating stroke treatment in Eastern European region: methods and achievement of the ESO EAST program. *Eur Stroke J*. 2020;5:204-212.
10. Registry of Stroke Care Quality. RES-Q Live Metrics. Accessed April 30, 2022. https://qualityregistry.eu/mb-aux/public/dashboard/78a1e97d-fe82-4aad-a229-f3044e9999d7
11. Norrving B, Barrick J, Davalos A, et al. Action plan for stroke in Europe 2018–2030. *Eur Stroke J*. 2018;3:309-336.
12. Lindsay M, Norrving B, Furie K, Donnan G, Langhorne P, Davis S. Global stroke guidelines and action plan: a road map for quality stroke care. 2016. Accessed April 30, 2022. https://www.world-stroke.org/assets/downloads/Global_Stroke_Guidelines_and_Action_Plan_All_in_one_English.pdf
13. Lindsay P, Furie KL, Davis SM, Donnan GA, Norrving B. World Stroke Organization global stroke services guidelines and action plan. *Int J Stroke*. 2014;9:4-13.
14. Kilkenny MF, Bravata DM. Quality improvement. *Stroke*. 2021;52:1866-1870.
15. Goodwin R. The Angels Initiative: more and better stroke-ready hospitals across the globe. *CNS-Oruen*. 2018;4:22-30.
16. Boehringer Ingelheim. The Angels Initiative – a unique healthcare initiative to improve acute stroke care. Accessed April 28, 2022. https://www.boehringer-ingelheim.com/cardiovascular/stroke-care/angels-initiative
17. Gawthorne J, Fasugba O, Levi C, et al. Are clinicians using routinely collected data to drive practice improvement? A cross-sectional survey. *International J Qual Health Care*. 2021;33:mzab141.
18. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42:377-381.
19. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019;95:103208.
20. IBM Corp. *IBM SPSS Statistics for Windows, Version 27.0*. IBM Corp; 2020.
21. Von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med*. 2007;147:573-577.
22. Elrod JK, Fortenberry JL. The hub-and-spoke organization design: an avenue for serving patients well. *BMC Health Serv Res*. 2017;17:25-33.
23. Cadilhac DA. The Australian Stroke Clinical Registry: health services research and clinical trials. Accessed April 28, 2022. https://www.monash.edu/__data/assets/pdf_file/0011/1595315/Dominique-Cadilhac_AuSCR_use-for-HSR_clinicaltrials.pdf
24. Egholm CL, Helmark C, Christensen J, et al. Facilitators for using data from a quality registry in local quality improvement work: a cross-sectional survey of the Danish Cardiac Rehabilitation Database. *BMJ Open*. 2019;9:e028291.

25. Egholm CL, Helmark C, Doherty P, Nilsen P, Zwisler AD, Bunkenborg G. “Struggling with practices” – a qualitative study of factors influencing the implementation of clinical quality registries for cardiac rehabilitation in England and Denmark. *BMC Health Serv Res*. 2019;19:1-13.
26. Eldh AC, Fredriksson M, Halford C, et al. Facilitators and barriers to applying a national quality registry for quality improvement in stroke care. *BMC Health Serv Res*. 2014;14:354.
27. Cauchard JR, Frey J, Zahrt O, Johnson K, Crum A, Landay JA. The positive impact of push vs pull progress feedback: a 6-week activity tracking study in the wild. *Proc ACM Interact Mob Wearable Ubiquitous Technol*. 2019;3:1-23.
28. Boonyasai RT, Windish DM, Chakraborti C, Feldman LS, Rubin HR, Bass EB. Effectiveness of teaching quality improvement to clinicians: a systematic review. *Jama*. 2007;298:1023-1037.
29. Fan W, Yan Z. Factors affecting response rates of the web survey: a systematic review. *Comput Human Behav*. 2010;26:132-139.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Fasugba O, Sedani R, Mikulik R, et al. How registry data are used to inform activities for stroke care quality improvement across 55 countries: A cross-sectional survey of Registry of Stroke Care Quality (RES-Q) hospitals. *Eur J Neurol*. 2023;00:1-14. doi:10.1111/ene.16024