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Relationship of Patient Volume and Stroke Outcomes: A Rapid Review

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Conflict of Interest Statement

All reports prepared by the Division of Evidence Development and Standards at Health Quality Ontario are impartial. There are no competing interests or conflicts of interest to declare.

Rapid Review Methodology

Clinical questions are developed by the Division of Evidence Development and Standards at Health Quality Ontario in consultation with experts, end-users, and/or applicants in the topic area. A systematic literature search is then conducted to identify relevant systematic reviews, health technology assessments, and meta-analyses; if none are located, the search is expanded to include randomized controlled trials (RCTs), and guidelines. Systematic reviews are evaluated using a rating scale developed for this purpose. If the systematic review has evaluated the included primary studies using the GRADE Working Group criteria (http://www.gradeworkinggroup.org/index.htm), the results are reported and the rapid review process is complete. If the systematic review has not evaluated the primary studies using GRADE, the primary studies included in the systematic review are retrieved and a maximum of two outcomes are graded. If no well-conducted systematic reviews are available, RCTs and/or guidelines are evaluated. Because rapid reviews are completed in very short timeframes, other publication types are not included. All rapid reviews are developed and finalized in consultation with experts.

Disclaimer

This rapid review is the work of the Division of Evidence Development and Standards at Health Quality Ontario, and is developed from analysis, interpretation, and comparison of published scientific research. It also incorporates, when available, Ontario data and information provided by experts. As this is a rapid review, it may not reflect all the available scientific research and is not intended as an exhaustive analysis. Health Quality Ontario assumes no responsibility for omissions or incomplete analysis resulting from its rapid reviews. In addition, it is possible that other relevant scientific findings may have been reported since completion of the review. This report is current to the date of the literature search specified in the Research Methods section, as appropriate. This rapid review may be superseded by an updated publication on the same topic. Please check the Health Quality Ontario website for a list of all publications: http://www.hqontario.ca/evidence/publications-and-ohtac-recommendations.

About Health Quality Ontario

Health Quality Ontario is an arms-length agency of the Ontario government. It is a partner and leader in transforming Ontario's health care system so that it can deliver a better experience of care, better outcomes for Ontarians, and better value for money.

Health Quality Ontario strives to promote health care that is supported by the best available scientific evidence. Health Quality Ontario works with clinical experts, scientific collaborators, and field evaluation partners to develop and publish research that evaluates the effectiveness and cost-effectiveness of health technologies and services in Ontario.

Based on the research conducted by Health Quality Ontario and its partners, the Ontario Health Technology Advisory Committee (OHTAC)—a standing advisory subcommittee of the Health Quality Ontario Board—makes recommendations about the uptake, diffusion, distribution, or removal of health interventions to Ontario's Ministry of Health and Long-Term Care, clinicians, health system leaders, and policy makers.

Rapid reviews, evidence-based analyses and their corresponding OHTAC recommendations, and other associated reports are published on the Health Quality Ontario website. Visit http://www.hqontario.ca for more information.

About Health Quality Ontario Publications

To conduct its rapid reviews, Health Quality Ontario and/or its research partners reviews the available scientific literature, making every effort to consider all relevant national and international research; collaborates with partners across relevant government branches; consults with clinical and other external experts and developers of new health technologies; and solicits any necessary supplemental information.

In addition, Health Quality Ontario collects and analyzes information about how a health intervention fits within current practice and existing treatment alternatives. Details about the diffusion of the intervention into current health care practices in Ontario can add an important dimension to the review. Information concerning the health benefits, economic and human resources, and ethical, regulatory, social, and legal issues relating to the intervention may be included to assist in making timely and relevant decisions to optimize patient outcomes.

Permission Requests

How to Obtain Rapid Reviews From Health Quality Ontario

All rapid reviews are freely available in PDF format at the following URL:
http://www.hqontario.ca/evidence/publications-and-ohtac-recommendations/rapid-reviews.

Table of Contents

Table of Contents **4**
List of Abbreviations **5**
Background **6**
Objective of Analysis 6
Clinical Need and Target Population 6
Rapid Review **7**
Research Question 7
Research Methods 7
Literature Search *7*
Inclusion Criteria *7*
Exclusion Criteria *7*
Outcomes of Interest *7*
Expert Panel *8*
Quality of Evidence 9
Results of Literature Search 10
Conclusions **13**
Acknowledgements **14**
Appendices **17**
Appendix 1: Literature Search Strategies 17
Appendix 2: GRADE Tables 22
References **24**

List of Abbreviations

HQO	Health Quality Ontario
RCT	Randomized controlled trial

Background

As legislated in Ontario's *Excellent Care for All Act*, Health Quality Ontario's mandate includes the provision of objective, evidence-informed advice about health care funding mechanisms, incentives, and opportunities to improve quality and efficiency in the health care system. As part of its Quality-Based Funding (QBF) initiative, Health Quality Ontario works with multidisciplinary expert panels (composed of leading clinicians, scientists, and administrators) to develop evidence-based practice recommendations and define episodes of care for selected disease areas or procedures. Health Quality Ontario's recommendations are intended to inform the Ministry of Health and Long-Term Care's Health System Funding Strategy.

For more information on Health Quality Ontario's Quality-Based Funding initiative, visit www.hqontario.ca.

Objective of Analysis

The objective of this rapid review is to investigate whether there is a minimum or appropriate annual patient volume that optimizes clinical outcomes in stroke patients.

Clinical Need and Target Population

Stroke is a leading cause of death and disability. (1;2) The relationship between higher patient volume and better clinical outcomes has been established for several medical conditions and interventions, (3) but this association has not been adequately assessed for stroke. In addition, if a positive volume to outcome relationship exists, it is important to determine the critical mass volume that is required in hospitals to optimize outcomes for stroke patients.

Rapid Review

Research Question

What is the minimum or appropriate number of stroke patients that need to be treated in hospitals in 1 year to optimize clinical outcomes?

Research Methods

Literature Search

A literature search was performed October 31, 2012, using OVID MEDLINE, OVID MEDLINE In-Process and Other Non-Indexed Citations, OVID EMBASE, EBSCO Cumulative Index to Nursing & Allied Health Literature (CINAHL), the Wiley Cochrane Library, and the Centre for Reviews and Dissemination database, for studies published from January 1, 2008, until October 31, 2012. Abstracts were reviewed by a single reviewer and, for those studies meeting the eligibility criteria, full-text articles were obtained.

Inclusion Criteria

- English language full-reports
- published between January 1, 2008, and October 31, 2012
- health technology assessments, systematic reviews, meta-analyses, randomized controlled trials (RCTs), and guidelines

Exclusion Criteria

- studies where quantitative results on stroke patient volume cannot be abstracted
- studies that did not assess the outcomes of interest

Outcomes of Interest

- Mortality
- Readmission
- Length of hospital stay
- Quality of life
- Institutionalization
- Dependency

Expert Panel

In October 2012, an Expert Advisory Panel on Stroke was struck. Members of the expert panel included physicians specialized in physical medicine and rehabilitation, members of the Ontario Stoke Network, physicians treating stroke patients, experts from academic health economic centres, and personnel from the Ministry of Health and Long-Term Care.

The Expert Advisory Panel on stroke suggested that the Evidence Development and Standards unit of Health Quality Ontario (HQO) conduct a "Rapid Review" to provide the evidence for the relationship between annual hospital volume and clinical outcomes for stroke patients. However, the statements, conclusions, and views expressed in this report do not necessarily represent the views of Expert Advisory Panel members.

Quality of Evidence

The quality of the body of evidence for each outcome was examined according to the GRADE Working Group criteria. (4) The overall quality was determined to be very low, low, moderate, or high using a step-wise, structural methodology. Only published articles were evaluated for quality.

Study design was the first consideration; the starting assumption was that randomized controlled trials are high quality, whereas observational studies are low quality. Five additional factors—risk of bias, inconsistency, indirectness, imprecision, and publication bias—were then taken into account. Limitations in these areas resulted in downgrading the quality of evidence. Finally, 3 main factors that may raise the quality of evidence were considered: large magnitude of effect, dose response gradient, and accounting for all residual confounding factors. (4) For more detailed information, please refer to the latest series of GRADE articles. (4)

As stated by the GRADE Working Group, the final quality score can be interpreted using the following definitions:

High	Very confident that the true effect lies close to the estimate of the effect
Moderate	Moderately confident in the effect estimate—the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Confidence in the effect estimate is limited—the true effect may be substantially different from the estimate of the effect
Very Low	Very little confidence in the effect estimate—the true effect is likely to be substantially different from the estimate of effect

Results of Literature Search

The database search yielded 770 citations published between January 1, 2008, and October 31, 2012 (with duplicates removed). Articles were excluded based on information in the title and abstract. The full texts of potentially relevant articles were obtained for further assessment.

One study (1 conference abstract) met the inclusion criteria. Three additional citations (2 observational studies and 1 conference abstract) were found through an initial scoping review in a non-systematic fashion and were included for a total of 4 included citations.

For each included study, the study design was identified and is summarized below in Table 1, which is a modified version of a hierarchy of study design by Goodman. (5)

Table 1: Body of Evidence Examined According to Study Design

Study Design	Number of Eligible Studies
RCT Studies	
Systematic review of RCTs	
Large RCT	
Small RCT	
Observational Studies	
Systematic review of non-RCTs with contemporaneous controls	
Non-RCT with non-contemporaneous controls	
Systematic review of non-RCTs with historical controls	
Non-RCT with historical controls	
Database, registry, or cross-sectional study	2
Case series	
Retrospective review, modelling	
Studies presented at an international conference	2
Expert opinion	
Total	4

Abbreviation: RCT, randomized controlled trial.

Table 2: Studies Included in the Rapid Review

Author, Year	Country	Study Design	Sample Size	Outcomes
Saposnik et al, 2007 (6)	Canada	Retrospective population-based study	26,676	In-hospital mortality (7-day and at discharge) after ischemic stroke
Svendsen et al, 2012 (7)	Denmark	Retrospective population-based study	63,995	Mortality after 30 days or 1 year; length of stay from admission to death or discharge; Hospital readmission after 1 year for all causes
Alvarez-Sabin et al, 2010 (8)	Spain	Observational cohort study	1297	Mortality and disability at discharge in hospitals without stroke units
Hall et al, 2012 (9)	Canada	Retrospective population-based study	71,856	All-cause mortality after 30 days

Table 3: Results of Studies Included in the Rapid Review

Author, Year	Objective	Study Design and Methods	Results	Limitations
Saposnik et al, 2007 (6)	To determine whether annual stroke volume is associated with in-hospital mortality after ischemic stroke	Retrospective study using administrative health data	Reduced mortality (7-day and at discharge) in high-volume facilities (> 100 patients/year) versus low-volume facilities (< 50 patients/year)	Administrative health data lack information on stroke severity and clinical factors to adjust for case mix
Svendsen et al, 2012 (7)	To examine whether annual stroke volume is associated with 30-day and 1-year mortality, length of hospital stay, and readmission in 1 year	Retrospective study using administrative health data	Higher annual volume was associated with reduced length of stay and 1-year hospital readmission; no association was found between volume and mortality	Non-randomized design cannot exclude presence of residual or unmeasured confounding
Alvarez-Sabin et al, 2010 (8)	To determine if annual stroke volume influences patient outcomes	Observational cohort study of consecutive stroke patients	Low annual stoke volume (< 300 patients) was independently associated with mortality and disability at discharge	Non-randomized design; only hospitals without stroke units
Hall et al, 2012 (9)	To examine the relationship between volume and 30-day mortality among ischemic stroke patients	Retrospective study using administrative health data	Low-volume hospitals (15–120 patients/year) have a 26% higher mortality rate than high-volume (201–456 patients/year) hospitals; no difference was found between high-volume and medium-volume hospitals	Administrative health data lack information to adjust for all potential confounding or bias

Conclusions

There is low-quality evidence that higher hospital volume is associated with fewer adverse outcomes in stroke patients.

There is a lack of evidence on the minimum or appropriate annual number of stroke patients required to optimize clinical outcomes.

Acknowledgements

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Expert Panel for Health Quality Ontario: 'Episode of Care' for Stroke

Name	Role	Organization
Dr. Mark Bayley	Medical Director, Brain and Spinal Cord Rehabilitation Program, Associate Professor, Division of Physiatry	Toronto Reheabilitation Institute, University Health Network
Ms. Christina O'Callaghan	Executive Director	Ontario Stroke Network
Dr. Gustavo Saposnik	Director, Stroke Outcomes Research Centre, Associate Professor of Medicine, Division of Neurology, St. Michael's Hospital	Institute for Clinical Evaluative Sciences, University of Toronto
Dr. Richard Swartz	Director, University of Toronto Stroke Program Medical Director, NE-GTA Regional Stroke Program, Associate Professor, Division of Neurology, Department of Medicine,	Sunnybrook Health Sciences Centre, University of Toronto
Dr. Robert Teasell	Professor of Physical Medicine and Rehabilitation, Schulich School of Medicine	Western University Lawson Research Institute St. Joseph's Health Care London
Dr. Paul E. Cooper	Senior Medical Director – Medicine, Chief, Department of Clinical Neurological Sciences	London Health Sciences Centre
Dr. Paul Ellis	Emergency Physician	University Health Network

Dr. Andrew Samis	Physician Stroke Champion and Staff Intensivist, Division of Critical Care	Quinte Health Care, Belleville Ontario
Dr. Moira Kapral	Division of General Internal Medicine & Clinical Epidemiology, Associate Professor, Department of Medicine, Scientist	University of Toronto Institute for Clinical Evaluative Sciences (ICES)
Dr. Murray Krahn	Director, THETA, F. Norman Hughes Chair and Professor, Department of Medicine and Faculty of Pharmacy	University of Toronto
Dr. Daniel Brouillard	Stroke Survivor/Internist	Kingston Heart Clinic
Dr. R. Loch MacDonald	Keenan Endowed Chair in Surgery Head, Division of Neurosurgery, Professor of Surgery, University of Toronto	St. Michael's Hospital
Dr. Ruth Hall	OSN Evaluation Lead and Adjunct Scientist	Ontario Stroke Network, Institute for Clinical Evaluative Sciences
Linda Kelloway	Best Practices Leader	Ontario Stroke Network
Rhonda Whiteman	Clinical Nurse Specialist, Stroke Best Practice Coordinator	Hamilton Health Sciences Centre
Rebecca Fleck	Occupational Therapist, Regional Stroke Education and Research Coordinator, Central South Regional Stroke Network	Hamilton Health Sciences Centre
Deborah Willems	Regional Rehabilitation Coordinator, Southwestern Ontario Stroke Network	London Health Sciences Centre
Holly Sloan	Speech-Language Pathologist	Trillium Health Centre Site,

		Credit Valley Hospital and Trillium Health Centre
Matthew Meyer	Project Coordinator	Ontario Stroke Network
Kathleen Lee	Social Worker	Health Sciences North
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Lori Marshall	Executive Vice President, Strategy, Performance and Aboriginal Health	Thunder Bay Regional Health Sciences Centre
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Ministry Representatives		
Peter Biasucci	Manager, Acute and Rehabilitative Care Unit, Health Policy and Care Standards Branch, Health System Strategy and Policy Division	Ministry of Health and Long-Term Care
Jason Lian	Senior Methodologist, Health System Funding Policy Branch	Ministry of Health and Long-Term Care
Thomas Smith	Acting Program Manager, Provincial Programs Branch	Ministry of Health and Long-Term Care

Appendices

Appendix 1: Literature Search Strategies

Search date: October 31, 2012
Databases searched: OVID MEDLINE, MEDLINE In-Process and Other Non-Indexed Citations, EMBASE; CINAHL; Cochrane Library; CRD

Q: What is the minimum or appropriate number of stroke patients required in 1 year to optimize patient outcomes?
Limits: 2007-current; English
Filters: health technology assessments, systematic reviews, meta-analyses, randomized controlled trials and guidelines

Database: Ovid MEDLINE(R) <1946 to October Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <October 30, 2012>, Embase <1980 to 2012 Week 43>

Search Strategy:

1	exp Stroke/ or exp brain ischemia/
2	exp intracranial hemorrhages/ use mesz
3	exp brain hemorrhage/ use emez
4	exp stroke patient/ use emez
5	(stroke or tia or transient ischemic attack or cerebrovascular apoplexy or cerebrovascular accident or cerebrovascular infarct* or brain infarct* or CVA or (brain adj2 isch?emia) or (cerebral adj2 isch?emia) or (intracranial adj2 hemorrhag*) or (brain adj2 hemorrhag*)).ti,ab.
6	or/1-5
7	exp Hospital Units/ use mesz
8	exp Stroke Unit/ use emez
9	exp Skilled Nursing Facilities/ use mesz
10	((stroke adj2 ward*) or (stroke adj2 unit*)).ti,ab.
11	exp Patient Care Team/ use mesz
12	Cooperative Behavior/ use mesz
13	exp Nursing, Team/ use mesz
14	exp "Delivery of Health Care, Integrated"/ use mesz
15	exp interdisciplinary communication/
16	exp TEAM NURSING/ use emez
17	exp Cooperation/ use emez
18	exp TEAMWORK/ use emez
19	exp Integrated Health Care System/ use emez
20	((transitional or multidisciplin* or multifacet* or multi-disciplin* or multi-facet* or cooperat* or co-operat* or interdisciplin*or inter-disciplin* or collaborat* or multispecial* or multi-special* or share or sharing or shared or integrat* or joint or multi-modal or multimodal) adj2 (care or team*)).ti,ab.
21	or/7-20

22 6 and 21
23 Meta Analysis.pt.
24 Meta Analysis/ use emez
25 Systematic Review/ use emez
26 exp Technology Assessment, Biomedical/ use mesz
27 Biomedical Technology Assessment/ use emez
28 (meta analy* or metaanaly* or pooled analysis or (systematic* adj2 review*) or published studies or published literature or medline or embase or data synthesis or data extraction or cochrane).ti,ab.
29 ((health technolog* or biomedical technolog*) adj2 assess*).ti,ab.
30 exp Random Allocation/ use mesz
31 exp Double-Blind Method/ use mesz
32 exp Control Groups/ use mesz
33 exp Placebos/ use mesz
34 Randomized Controlled Trial/ use emez
35 exp Randomization/ use emez
36 exp Random Sample/ use emez
37 Double Blind Procedure/ use emez
38 exp Triple Blind Procedure/ use emez
39 exp Control Group/ use emez
40 exp Placebo/ use emez
41 (random* or RCT).ti,ab.
42 (placebo* or sham*).ti,ab.
43 (control* adj2 clinical trial*).ti,ab.
44 exp Practice Guideline/ use emez
45 exp Professional Standard/ use emez
46 exp Standard of Care/ use mesz
47 exp Guideline/ use mesz
48 exp Guidelines as Topic/ use mesz
49 (guideline* or guidance or consensus statement* or standard or standards).ti.
50 (controlled clinical trial or meta analysis or randomized controlled trial).pt.
51 or/23-50
52 22 and 51
53 limit 52 to english language
54 limit 53 to "all adult (19 plus years)" [Limit not valid in Embase; records were retained]
55 limit 54 to yr="2007 -Current"
56 remove duplicates from 55
57 from 55 keep 1-878
58 from 56 keep 1-743

CINAHL

#	Query	Limiters/Expanders
S26	S21 and S24	Limiters - Published Date from: 20070101-20121231; English Language; Age Groups: All Adult Search modes - Boolean/Phrase
S25	S21 and S24	Search modes - Boolean/Phrase
S24	S22 or S23	Search modes - Boolean/Phrase
S23	((health technology N2 assess*) or meta analy* or metaanaly* or pooled analysis or (systematic* N2 review*) or published studies or medline or embase or data synthesis or data extraction or cochrane or random* or sham*or rct* or (control* N2 clinical trial*) or guideline* or guidance or consensus statement* or standard or standards or placebo*)	Search modes - Boolean/Phrase
S22	(MH "Random Assignment") or (MH "Random Sample+") or (MH "Meta Analysis") or (MH "Systematic Review") or (MH "Double-Blind Studies") or (MH "Single-Blind Studies") or (MH "Triple-Blind Studies") or (MH "Placebos") or (MH "Control (Research)") or (MH "Practice Guidelines") or (MH "Randomized Controlled Trials")	Search modes - Boolean/Phrase
S21	S6 and S20	Search modes - Boolean/Phrase
S20	(S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19)	Search modes - Boolean/Phrase
S19	(MH "Nurse Liaison") OR "liaison"	Search modes - Boolean/Phrase
S18	(MH "Collaboration")	Search modes - Boolean/Phrase
S17	(MH "Interinstitutional Relations")	Search modes - Boolean/Phrase
S16	(MH "Interprofessional Relations+")	Search modes - Boolean/Phrase
S15	transitional N2 care or multidisciplin* N2 care or multifacet* N2 care or multi-disciplin* N2 care or multi-facet* N2 care or cooperat* N2 care or co-operat* N2 care or interdisciplin* N2 care or inter-disciplin* N2 care or collaborat* N2 care or multispecial* N2 care or multi-special* N2 care or share N2 care or sharing N2 care* or shared N2 care or integrat* N2 care or joint N2 care or multi-modal N2 care or multimedia N2 care or speciali* N2 care or dedicated N2 care	Search modes - Boolean/Phrase
S14	transitional N2 team* or multidisciplin* N2 team* or multifacet* N2 team* or multi-disciplin* N2 team* or multi-facet* N2* team* or cooperat* N2 team* or co-operat* N2 team* or interdisciplin* N2 team* or inter-disciplin* N2 team* or collaborat* N2 team* or multispecial* N2 team* or multi-special* N2 team* or share N2 team* or sharing N2 team* or shared N2 team* or integrat* N2 team* or joint N2 team* or multi-modal N2 team* or multimedia N2 team* or speciali* N2 team* or dedicated N2 team*	Search modes - Boolean/Phrase
S13	(MH "Health Care Delivery, Integrated")	Search modes - Boolean/Phrase
S12	(MH "Team Nursing")	Search modes - Boolean/Phrase
S11	(MH "Cooperative Behavior")	Search modes - Boolean/Phrase
S10	(MH "Multidisciplinary Care Team+")	Search modes - Boolean/Phrase
S9	(stroke N2 ward*) or (stroke N2 unit*)	Search modes - Boolean/Phrase
S8	(MH "Skilled Nursing Facilities")	Search modes - Boolean/Phrase
S7	(MH "Stroke Units")	Search modes - Boolean/Phrase
S6	S1 OR S2 OR S3 OR S4 OR S5	Search modes - Boolean/Phrase

S5	(MH "Stroke Patients")	Search modes - Boolean/Phrase
S4	(stroke or tia or transient ischemic attack or cerebrovascular apoplexy or cerebrovascular accident or cerebrovascular infarct* or brain infarct* or CVA or (brain N2 isch?emia) or (cerebral N2 isch?emia) or (intracranial N2 hemorrhag*) or (brain N2 hemorrhag*)	Search modes - Boolean/Phrase
S3	(MH "Intracranial Hemorrhage+")	Search modes - Boolean/Phrase
S2	(MH "Cerebral Ischemia+")	Search modes - Boolean/Phrase
S1	(MH "Stroke")	Search modes - Boolean/Phrase

Cochrane Library

ID	SEARCH
#1	MeSH descriptor: [Stroke] explode all trees
#2	MeSH descriptor: [Brain Ischemia] explode all trees
#3	MeSH descriptor: [Intracranial Hemorrhages] explode all trees
#4	(stroke or tia or transient ischemic attack or cerebrovascular apoplexy or cerebrovascular accident or cerebrovascular infarct* or brain infarct* or CVA or (brain near/2 isch?emia) or (cerebral near/2 isch?emia) or (intracranial near/2 hemorrhag*) or (brain near/2 hemorrhag*)):ti or (stroke or tia or transient ischemic attack or cerebrovascular apoplexy or cerebrovascular accident or cerebrovascular infarct* or brain infarct* or CVA or (brain near/2 isch?emia) or (cerebral near/2 isch?emia) or (intracranial near/2 hemorrhag*) or (brain near/2 hemorrhag*)):ab
#5	#1 or #2 or #3 or #4
#6	MeSH descriptor: [Hospital Units] explode all trees
#7	MeSH descriptor: [Skilled Nursing Facilities] explode all trees
#8	((stroke near/2 ward*) or (stroke near/2 unit*)):ti and ((stroke near/2 ward*) or (stroke near/2 unit*)):ab
#9	MeSH descriptor: [Patient Care Team] explode all trees
#10	MeSH descriptor: [Cooperative Behavior] explode all trees
#11	MeSH descriptor: [Nursing, Team] explode all trees
#12	MeSH descriptor: [Delivery of Health Care, Integrated] explode all trees
#13	MeSH descriptor: [Interdisciplinary Communication] explode all trees
#14	((transitional or multidisciplin* or multifacet* or multi-disciplin* or multi-facet* or cooperat* or co-operat* or interdisciplin*or inter-disciplin* or collaborat* or multispecial* or multi-special* or share or sharing or shared or integrat* or joint or multi-modal or multimodal) near/2 (care or team*)):ti and ((transitional or multidisciplin* or multifacet* or multi-disciplin* or multi-facet* or cooperat* or co-operat* or interdisciplin*or inter-disciplin* or collaborat* or multispecial* or multi-

	special* or share or sharing or shared or integrat* or joint or multi-modal or multimodal) near/2 (care or team*)):ab
#15	MeSH descriptor: [Interinstitutional Relations] explode all trees
#16	MeSH descriptor: [Interprofessional Relations] explode all trees
#17	#6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16
#18	#5 and #17 from 2007 to 2011

CRD

Line	Search
1	MeSH DESCRIPTOR stroke EXPLODE ALL TREES
2	MeSH DESCRIPTOR brain ischemia EXPLODE ALL TREES
3	MeSH DESCRIPTOR intracranial hemorrhages EXPLODE ALL TREES
4	(stroke or tia or transient ischemic attack or cerebrovascular apoplexy or cerebrovascular accident or cerebrovascular infarct* or brain infarct* or CVA or (brain adj2 isch?emia) or (cerebral adj2 isch?emia) or (intracranial adj2 hemorrhag*) or (brain adj2 hemorrhag*))
5	#1 OR #2 OR #3 OR #4
6	MeSH DESCRIPTOR Hospital Units EXPLODE ALL TREES
7	MeSH DESCRIPTOR Skilled Nursing Facilities EXPLODE ALL TREES
8	(((stroke adj2 ward*) or (stroke adj2 unit*)))
9	MeSH DESCRIPTOR Patient Care Team EXPLODE ALL TREES
10	MeSH DESCRIPTOR Cooperative Behavior EXPLODE ALL TREES
11	MeSH DESCRIPTOR Nursing, Team EXPLODE ALL TREES
12	MeSH DESCRIPTOR Delivery of Health Care, Integrated EXPLODE ALL TREES
13	MeSH DESCRIPTOR interdisciplinary communication EXPLODE ALL TREES
14	MeSH DESCRIPTOR Interinstitutional Relations EXPLODE ALL TREES
15	MeSH DESCRIPTOR interprofessional relations EXPLODE ALL TREES
16	(((transitional or multidisciplin* or multifacet* or multi-disciplin* or multi-facet* or cooperat* or co-operat* or interdisciplin*or inter-disciplin* or collaborat* or multispecial* or multi-special* or share or sharing or shared or integrat* or joint or multi-modal or multimodal) adj2 (care or team*)))
17	#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
18	#5 AND #17
19	(#18) FROM 2007 TO 2012

Appendix 2: GRADE Tables

Table 1: GRADE Evidence Profile for Comparison of Patient Volume and Stroke Outcomes

No. of Studies (Design)	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Upgrade Considerations	Quality
Mortality							
2 (observational) (6;7)	Serious limitations (-1)[a]	No serious limitations	No serious limitations	No serious limitations	Undetected	Dose-response gradient (+1)[b]	⊕⊕ Low
Length of hospital stay							
1 (observational) (7)	Serious limitations (-1)[a]	No serious limitations	No serious limitations	No serious limitations	Undetected	Dose-response gradient (+1)[b]	⊕⊕ Low
Readmission							
1 (observational) (7)	Serious limitations (-1)[a]	No serious limitations	No serious limitations	No serious limitations	Undetected	Dose-response gradient (+1)[b]	⊕⊕ Low

Abbreviation: No., number.

[a]Non-randomized design cannot preclude the presence of residual confounding or unmeasured confounders.

[b]Higher hospital volume was associated with fewer adverse outcomes across categories (6) and quartiles (6;7).

Table 2: Risk of Bias Among Observational Trials for the Comparison of Patient Volume and Stroke Outcomes

Author, Year	Appropriate Eligibility Criteria	Appropriate Measurement of Exposure	Appropriate Measurement of Outcome	Adequate Control for Confounding	Complete Follow-Up
Saposnik et al., 2007 (6)	No limitations	No limitations	No limitations	Limitations[a]	No limitations
Svendsen et al., 2012 (7)	No limitations	No limitations	No limitations	Limitations[b]	No limitations

[a]Administrative health data lacked information on factors for case-mix adjustment.
[b]Non-randomized design cannot exclude the presence of unmeasured or residual confounding.

References

(1) Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. Lancet Neurol. 2003 Jan;2(1):43-53.

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