



# A Proposed Algorithm for Identifying Patients with Acute Cerebrovascular Syndrome

In British Columbia

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Ministry  
of Health



PARTNERS IN  
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Stroke Recovery  
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## TABLE OF CONTENTS

TABLE OF CONTENTS .....	I
1.0 BACKGROUND .....	1
Primary Health Care Disease-Specific Registers .....	1
2.0 RECOMMENDATIONS FOR THE REVISED BC ACVS ALGORITHM .....	3
ACVS Event-Finding Algorithm .....	3
3.0 PRELIMINARY RESULTS .....	9
Trends .....	9
Key Indicators for Measurement and Evaluation .....	10
4.0 APPENDIX A: A BRIEF OVERVIEW OF THE LITERATURE ASSESSING STROKE CODES .....	15
Key Studies .....	15
Other Selected Studies Using Stroke Codes .....	23
5.0 APPENDIX B: A BRIEF OVERVIEW OF THE LITERATURE ASSESSING RECURRENT STROKE .....	25
6.0 APPENDIX C: RELEVANT ICD-9 CODES .....	29
7.0 APPENDIX D: RELEVANT ICD-10 CODES .....	32

## 1.0 BACKGROUND

### Primary Health Care Disease-Specific Registers

The BC Ministry of Health has established a series of disease-specific registers. The primary purpose of these registers is to identify people with chronic diseases, to measure aspects of their care, and to identify gaps in their care.

As part of this process, there are two types of registers created. Population registers are used to identify residents of British Columbia. Disease-specific registers are used to identify people with a given chronic disease. These two types of registers are used in combination to produce incidence, prevalence and mortality rates as well as for other specific purposes.

A key component of creating these registers is to develop and validate case definitions. The case definition for each disease is determined, in most cases, with input from an expert working group of clinicians and researchers. Peer-review and grey literature are searched for validation studies for the disease of interest and a preliminary case definition is chosen. Data quality checks are performed to determine whether changes in the data resulting from changes in diagnostic coding from ICD-9 to ICD-10, policy changes, or coding practices exist and need to be addressed. The preliminary case definitions are then used to run sensitivity analyses using incidence and prevalence estimates as the comparators. The incidence and prevalence rates are compared with published estimates from other sources to determine whether they have face validity. The data quality analyses and sensitivity analyses are reviewed by the expert working group and the final case definition is chosen.

The case definitions may change over time based on new knowledge gained from using the registers and refinements that are implemented to enhance the accuracy of the registers. The registers may also change if there are changes or additions to the primary data sources.

The case definition for the stroke register used prior to the changes suggested in this document is indicated on the following table.

STROKE		
<b>RULE:</b>	one hospitalization or two medical visits in 365 days with a stroke diagnostic code	
<b>DIAGNOSTIC CODES:</b>		
ICD-9	431	Intracerebral haemorrhage
	434	Occlusion of cerebral arteries
	436	Acute but ill-defined cerebrovascular disease
ICD-10	I61	Intracerebral haemorrhage
	I63	Cerebral infarction
	I64	Stroke, not specified as haemorrhage or infarction

***The B.C. Stroke Strategy Measurement and Evaluation Working Group has reviewed and revised this case definition, as outlined below.***

The Acute Cerebrovascular Syndrome (ACVS) register requires more complex rules than other registers because of three factors:

- 1) There are four different types of ACVS-related events (two types of hospitalized stroke [ischemic and hemorrhagic], hospitalized transient ischemic attack [TIA], and non-hospitalized stroke/TIA).
- 2) Incident ACVS-related events may be identified through hospital or physician billing data. While other disease-specific registers track hospital and physician billing data, the data source (hospital vs. non-hospital) in the current register is important as an indication of the severity of the event.
- 3) Each distinct ACVS event is important, not just the entry date to the register for the patient based on their first-ever ACVS event.

ACVS takes on both chronic and acute characteristics. The ACVS register is planned to be used for analysis of stroke patterns, examining progression or conversion from transient ischemic attack (TIA)/non-hospitalized stroke to hospitalized stroke, recurrence of stroke and so on.<sup>1</sup> It will also provide foundational data to support annual reports on ACVS in the province.

The proposed recommendations for revising the ACVS algorithm are noted below, with background material available in a series of appendixes.

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<sup>1</sup> **Recurrent** stroke admissions are defined as any hospitalization for stroke following an incident hospitalized stroke, with the exception of admissions within 28 days for the same stroke type (ischemic or hemorrhagic), which are considered **readmissions**.

## 2.0 RECOMMENDATIONS FOR THE REVISED BC ACVS ALGORITHM

The following suggested recommendations are based on a review of the relevant literature, input from the BC Stroke Strategy Management and Evaluation Working Group (in particular Drs. Devin Harris and Andrew Penn), and preliminary analysis of the BC data by Mr. Mike Atkinson. The “ACVS event-finding algorithm” identifies all ACVS events in the province in a given time period and then determines whether the event is an incident, readmission or recurring event.

### ACVS Event-Finding Algorithm

1. The following codes have been suggested by Kokotailo and Hill (2005) based on research in Calgary, Alberta.

ICD Acute Cerebrovascular Syndrome Codes (from literature)				
ACVS Type	ICD-9 Code	Definition	ICD-10 Code	Definition
Acute Ischemic Stroke	362.3	Retinal vascular occlusion	H34.1	Central retina artery occlusion
	433.x1	Occlusion and stenosis of precerebral arteries	I63.x	Cerebral infarction
	434.x1	Occlusion cerebral arteries	I64.x	Stroke, not specified as hemorrhage or infarction
	436.x	Acute, but ill-defined cerebrovascular disease		
Intracerebral Hemorrhage	431.x	Intracerebral hemorrhage	I61.x	Intracerebral hemorrhage
Subarachnoid Hemorrhage	430.x	Subarachnoid hemorrhage	I60.x	Subarachnoid hemorrhage
Transient ischemic attack	435.x	Transient cerebral ischemia	G45.x	Transient cerebral ischemic attacks and related syndromes (exclude G45.4 - transient global amnesia)

The co-author of this report, Dr. Michael Hill, is also co-chair of the Canadian Stroke Strategy (CSS) Information & Evaluation Working Group. This group has arrived at the same definitions with some additional details (see Appendix A).

2. We are recommending that the same codes be used in British Columbia with one exception. The code 434.x1 (with the 5<sup>th</sup> digit code 1 indicating infarction present) is rarely used in BC. In fact, ICD-9 434.x1 was used only 260 times by physicians billing MSP in 2007/08, compared to 32,966 uses of 434.x. The tendency is to bill just the general 434 (occlusion of cerebral arteries) code. We will assume that, for MSP billing purposes, the 434.x code is equivalent to the 434.x1 code in identifying stroke cases. Thus the proposed stroke case definition in BC would be as follows.

Proposed ICD Acute cerebrovascular Syndrome Codes to be Used in B.C.				
ACVS Type	ICD-9 Code	Definition	ICD-10 Code	Definition
Acute Ischemic Stroke	362.3	Retinal vascular occlusion	H34.1	Central retina artery occlusion
	433.x1	Occlusion and stenosis of precerebral arteries	I63.x	Cerebral infarction
	434.x	Occlusion cerebral arteries	I64.x	Stroke, not specified as hemorrhage or infarction
	436.x	Acute, but ill-defined cerebrovascular disease		
Intracerebral Hemorrhage	431.x	Intracerebral hemorrhage	I61.x	Intracerebral hemorrhage
Subarachnoid Hemorrhage	430.x	Subarachnoid hemorrhage	I60.x	Subarachnoid hemorrhage
Transient ischemic attack	435.x	Transient cerebral ischemia	G45.x	Transient cerebral ischemic attacks and related syndromes (exclude G45.4 - transient global amnesia)

3. For each type of ACVS, exclude the case if any “traumatic brain injury” ICD-9-CM code (800-804, 850-854) is used or the “rehabilitation care” ICD-9-CM code (V57) is the primary hospital discharge diagnosis.

The equivalent ICD-10 codes are:

- S02.0\* - Fracture of vault of skull
- S02.1\* - Fracture of base of skull
- S02.2\* - Fracture of nasal bones
- S02.3\* - Fracture of orbital floor
- S02.4\* - Fracture of malar and maxillary bones
- S02.6\* - Fracture of mandible
- S02.7\* - Multiple fractures involving skull and facial bone
- S02.8\* - Fractures of other skull and facial bones
- S02.9\* - Fracture of skull and facial bones, part unspecified
- S06\* - Intracranial injury
- Z50.\* - Care involving use of rehabilitation procedures

The same ICD9 codes are used for MSP claims, and are used to exclude MSP stroke diagnoses when the exclusion code occurs on the same day or within the following week of the stroke diagnosis. For MSP diagnoses, the V57 code only excluded stroke diagnoses on the same day.

4. All patients who are hospitalized and assigned one of the codes in #2 above, or have two Medical Service Plan (MSP) visits on different days within a moving 28-day period with an ACVS diagnostic code are included in the register. *(Rationale for 28 rather than the 365-day period used, for example, in the diabetes algorithm – In fiscal 2005/06, 66% of second MSP codes appear within 30 days of the first code. This increases to 77% at 60 days, 83% at 90 days and 87% at 120 days. Only 13% of second codes appear from days 121 to 365. By using 28 days we capture the majority of MSP-identified incident stroke cases while reducing the possibility of false-positives, i.e. two MSP codes more than 28 days apart are not realistically related to the same stroke event. We considered an exception to this rule for claims by Neurologists because MSP rules prevent billing of*

*the higher priced consultation (fee item 410) within 180 days for the same patient. Analysis of Neurologists' paid claims, however, did not find that Neurologists were tending to wait 180 days before seeing patients again. In fact, a slightly higher proportion of MSP billings by Neurologists for stroke-related codes occurred within 30 days in 2007/08 (72.0%) than for non-neurologists (68.5%), suggesting that the majority of stroke patients are seen by Neurologists within 30 days with the Neurologist billing MSP for a non-410 (consultation) fee item for the subsequent visit(s). The use of MSP codes should capture some of the diagnosed stroke patients who are not hospitalized, particularly TIA. The use of at least two codes (rather than just one) should result in the exclusion of the majority of diagnostic rule-outs.*

5. Include all MSP diagnoses occurring while the patient was in hospital in identifying a stroke event. *An analysis of 2007/08 data indicated that there were approximately 1,000 situations in which hospital records (DAD) did not identify stroke but MSP records during the same time as the patient's hospital stay did identify stroke codes. This suggests that these patients were being seen and treated for stroke by their physician (either their neurologist and / or GP) while in hospital. These may be patients admitted to hospital whom hospital discharge abstract coders missed (false-negative cases). This issue will be further reviewed when the proposed chart audit to validate the updated algorithm is completed.*
6. Group all ACVS events into the following four categories: 1) hospitalized ischemic stroke, 2) hospitalized hemorrhagic stroke, 3) hospitalized TIA, and 4) non-hospitalized TIA/ stroke. *There are several reasons for this grouping. By keeping hospitalized stroke separate, results from the registry can be easily compared to other sources which use hospital data exclusively. In addition, patients who are hospitalized probably have had a more severe stroke than those who were not hospitalized. Finally, distinguishing between a TIA and minor, non-hospitalized stroke can be clinically challenging.*
7. Create an ACVS Events table that indicates each date a Stroke or TIA occurred. One reason for this is to see how many patients progress from non-hospitalized TIA/stroke to a hospitalized stroke (and the time between the diagnosis of non-hospitalized TIA/stroke and hospitalized stroke), something that we are trying to prevent.
8. A single MSP ACVS-related diagnosis not followed within 28 days by either another MSP ACVS-related diagnosis or a hospital ACVS-related diagnosis will be placed into the ACVS Events table, but will be marked as Unconfirmed. The inclusion of these single MSP ACVS-related diagnoses (as Unconfirmed) will allow for a comparison of results with other data sets that use just one physician-based code (rather than two within a moving 28-day period) to identify ACVS cases.
9. When two MSP claims appear within the 28-day period, the date of the first of these two claims becomes the date of an ACVS event.

10. An MSP claim occurring within the 7 days prior to a hospital visit is to be considered directly related to the event diagnosed in hospital, unless the MSP diagnosis was TIA and the hospital diagnosis was not TIA. We have higher confidence in the hospital diagnosis, which is used to set the ACVS type. But the date for this ACVS event will be that of the MSP (non-TIA) diagnosis in the week before the hospital admission.
11. When a single MSP diagnosis for TIA occurs within 28 days prior to a hospital stroke diagnosis (even up until the day before the hospital admission), the MSP TIA diagnosis is considered to be a separate, confirmed event. If an MSP TIA occurs within 7 days of a hospital admission for TIA, however, the MSP TIA is not recorded separately and is instead considered the first indication of the same TIA that was diagnosed in hospital (similar to #10 above). In this case, however, the date of the MSP TIA is used in place of the hospital date. *The reasoning for capturing all TIA events is that they will often precede more serious stroke events, and we want to capture when this occurs, even when they occur immediately before the hospital visit.*
12. When a single MSP diagnosis for (non-TIA) stroke occurs within 28 days prior to a hospital stroke-related diagnosis, but not within 7 days, the MSP diagnosis is considered a confirmed stroke event.

*The reasoning behind this is:*

- *Since we have greater confidence in the hospital diagnosis, this becomes an even better confirmation of the earlier MSP diagnosis than a second MSP diagnosis would be.*
  - *While an MSP diagnosis following an MSP diagnosis is likely to be a follow-up visit, the hospital admission will almost certainly represent a stroke event. Thus, the earlier MSP diagnosis was likely a distinct, earlier event for the patient.*
13. When two or more MSP ACVS codes exist within the 28-day window (but no hospital ACVS codes), and the codes are for different types of ACVS, use the ACVS code which appears most frequently to identify the type of ACVS. If there is a tie in the most frequently appearing ACVS category, the lowest category on the scale takes precedence (TIA>acute ischemic>intracerebral hemorrhage>subarachnoid hemorrhage). *The reason for this is that if a stroke is diagnosed differently within MSP (in the absence of hospital admission), it is more likely to be mis-diagnosed up the stroke scale than down. Use the date of the first code as the date for the ACVS occurrence. The exception to this rule is when an acute ischemic or TIA code appears in the context of hemorrhagic codes. Even if the majority of the codes are for hemorrhagic stroke, the presence of one or more ischemic stroke or TIA codes will result in the stroke being coded as ischemic. The reason for this is that most true hemorrhagic stroke cases will be hospitalized. When hospitalization does not occur, it is more likely that the stroke will be acute ischemic rather than hemorrhagic. Ties are awarded to the lower stroke code since a stroke diagnosed using MSP data (and not requiring hospitalization) is more likely to be misdiagnosed up the scale rather than down.*

14. When three or more MSP ACVS codes occur within 28 days of each other, but when the total span between the first and last code exceeds 28 days, these are broken down into portions each spanning 28 days or less, and treated as multiple stroke events. Resulting spans with 2 MSP codes within 28 days are confirmed, and spans with a single MSP code are unconfirmed unless followed by a hospital visit within 28 days.
15. Incidence for TIA/non-hospitalized stroke will be counted in a fiscal year if the first ACVS event occurred in the year and it was a TIA/non-hospitalized stroke. Prevalence for TIA/non-hospitalized stroke will be counted when, as at the close of the fiscal year, a TIA/non-hospitalized stroke has occurred and no hospitalized stroke has yet occurred. If a hospitalized stroke occurs for a person in a future fiscal year, that person will be excluded from TIA/non-hospitalized stroke prevalence counts from the year of the hospitalized stroke onward.
16. For hospitalized stroke, incidence will be counted in the year of the first hospitalized stroke event, and under the stroke sub-type of that first event. Prevalence will be counted under the highest stroke sub-type on the scale that has occurred as at the fiscal year-end. Both incidence and prevalence figures for the hospitalized stroke sub-types (acute ischemic or hemorrhagic) can be added to obtain the total incidence and total prevalence (respectively) for hospitalized stroke.
17. **Recurrent** stroke admissions are defined as any hospitalization for stroke following an incident hospitalized stroke, with the exception of admissions within 28 days for the same stroke type (ischemic or hemorrhagic), which are considered **readmissions**.
18. An ACVS event which involves one or more transfers between hospitals is considered to be one event. This includes care in both an acute or rehabilitation hospital, assuming there was no gap between the acute discharge date and the rehab admit date. That is, the combined acute and rehabilitation stays were considered as a single episode of care. There is a rule that excludes discharge information for long-term rehabilitation stays (over 180 days) at Riverview Hospital.
19. MSP diagnoses within 28 days after an ACVS related admittance to hospital are excluded.
20. A variable which identifies whether the initial entry on to the register was by way of MSP or hospital codes/data is included in the register.
21. For hospital-based data, use both primary (most responsible diagnosis) and all available secondary codes. Include a variable which identifies which position the code was found in. At a minimum, identify primary position vs. all other positions. If a stroke diagnosis was the primary diagnosis (or the primary diagnosis on a transfer within a hospital episode), that diagnosis will be used to set the stroke type. Otherwise, the highest severity stroke diagnosis occurring within the secondary codes will set the stroke type.

22. Whenever possible use ICD-10 codes, particularly for identifying patients with TIA.
23. Include all patients regardless of age. The population registry, mentioned earlier, includes the birth date, from which the age of the patient when the ACVS code occurred can be calculated at the level of year or number of days. For patients less than one year of age, age will be calculated as 'days'. This will allow us to identify and analyze neonatal stroke. Although we can theoretically include newborns, infants, and children, the current incidence and prevalence is based on events for adults aged 20 or older at the time of their event.
24. Keep patients who have died or moved out of province in the register but include the capability of identifying these patients and the date of death or move. These patients will be included up to the last year they are alive or living in the province.
25. Develop the register in the standard MoH fashion, based on the document *Primary Health Care Registers, Rates and Indicators: Methods Documentation*.
26. Using this approach, all patients who meet the case definition will be included in the register from 1992/93 onwards.
27. Incidence (or incidence density) is based on new patients added to the register in a given fiscal year (April 1 to March 31).
28. Prevalence (or period prevalence) is based on all patients in the register at the end of a fiscal year (March 31), excluding those who died or moved out of province.

### 3.0 PRELIMINARY RESULTS

#### Trends

The following table is based on the revised BC ACVS event-finding algorithm for adults living in British Columbia.

Acute Cerebrovascular Syndrome Adults* Residing in British Columbia 2001/02 to 2008/09									
	Fiscal Year								% Change 01/02 to 08/09
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	
<b>Number of Incident ACVS Patients</b>									
Hospitalized Ischemic Stroke	4,032	3,889	3,747	3,836	3,801	3,788	3,799	3,654	-9.4%
Hospitalized Hemorrhagic Stroke	911	822	815	856	856	870	886	872	-4.3%
<b>Sub-total</b>	<b>4,943</b>	<b>4,711</b>	<b>4,562</b>	<b>4,692</b>	<b>4,657</b>	<b>4,658</b>	<b>4,685</b>	<b>4,526</b>	<b>-8.4%</b>
Hospitalized TIA	1,248	1,203	1,124	1,236	1,151	1,102	1,178	1,206	-3.4%
Non-hospitalized TIA/Stroke	3,417	3,846	4,066	4,316	4,508	4,552	4,812	4,907	43.6%
<b>Sub-total</b>	<b>4,665</b>	<b>5,049</b>	<b>5,190</b>	<b>5,552</b>	<b>5,659</b>	<b>5,654</b>	<b>5,990</b>	<b>6,113</b>	<b>31.0%</b>
<b>Readmission (within 28 days) of Hospitalized Stroke Patients</b>									
Number	104	76	81	102	81	80	82		-21.2%
Percent	2.10%	1.61%	1.78%	2.17%	1.74%	1.72%	1.75%		-16.8%
<b>Recurrence (within 365 days) in Hospitalized Stroke Patients</b>									
Number	180	163	140	168	161	150	135		-25.0%
Percent	3.64%	3.46%	3.07%	3.58%	3.46%	3.22%	2.88%		-20.9%
<b>Number of Prevalent ACVS Patients</b>									
Hospitalized Ischemic Stroke	21,843	22,465	23,058	23,631	24,237	24,776	25,190	25,603	17.2%
Hospitalized Hemorrhagic Stroke	4,310	4,539	4,788	5,076	5,333	5,622	5,900	6,174	43.2%
<b>Sub-total</b>	<b>26,153</b>	<b>27,004</b>	<b>27,846</b>	<b>28,707</b>	<b>29,570</b>	<b>30,398</b>	<b>31,090</b>	<b>31,777</b>	<b>21.5%</b>
Hospitalized TIA	8,552	8,952	9,219	9,611	9,814	9,982	10,154	10,467	22.4%
Non-hospitalized TIA/Stroke	21,740	23,466	25,349	27,294	29,230	31,243	33,307	35,269	62.2%
<b>Sub-total</b>	<b>30,292</b>	<b>32,418</b>	<b>34,568</b>	<b>36,905</b>	<b>39,044</b>	<b>41,225</b>	<b>43,461</b>	<b>45,736</b>	<b>51.0%</b>
<b>Age-Standardized Incidence / 1,000 Population</b>									
Hospitalized Ischemic Stroke	0.999	0.934	0.870	0.868	0.833	0.800	0.775	0.723	-27.6%
Hospitalized Hemorrhagic Stroke	0.225	0.197	0.188	0.193	0.188	0.185	0.186	0.177	-21.4%
<b>Sub-total</b>	<b>1.231</b>	<b>1.139</b>	<b>1.066</b>	<b>1.069</b>	<b>1.029</b>	<b>0.993</b>	<b>0.968</b>	<b>0.906</b>	<b>-26.4%</b>
Hospitalized TIA	0.306	0.286	0.259	0.278	0.249	0.231	0.237	0.239	-21.8%
Non-hospitalized TIA/Stroke	0.858	0.939	0.962	0.995	1.011	0.995	1.018	1.009	17.5%
<b>Age-Standardized Prevalence / 1,000 Population</b>									
Hospitalized Ischemic Stroke	5.083	5.076	5.046	5.024	4.996	4.946	4.872	4.790	-5.8%
Hospitalized Hemorrhagic Stroke	1.030	1.060	1.083	1.118	1.145	1.175	1.200	1.218	18.2%
<b>Sub-total</b>	<b>6.113</b>	<b>6.136</b>	<b>6.129</b>	<b>6.143</b>	<b>6.141</b>	<b>6.120</b>	<b>6.072</b>	<b>6.008</b>	<b>-1.7%</b>
Hospitalized TIA	1.994	2.026	2.023	2.047	2.026	1.994	1.961	1.960	-1.7%
Non-hospitalized TIA/Stroke	5.338	5.605	5.865	6.138	6.372	6.599	6.819	6.994	31.0%
<b>Conversion Rate from TIA/Non-hospitalized Stroke to Hospitalized Stroke</b>									
90-Day Conversion Rate	3.79%	2.71%	2.41%	2.74%	2.93%	2.67%	2.27%		-40.2%
365-Day Conversion Rate	5.77%	4.14%	4.08%	4.21%	4.56%	4.03%	3.86%		-33.1%
<b>Utilization of tPA by Incident Acute Ischemic Stroke Patients</b>									
Number Receiving tPA						128	133	156	
Total Number						3,788	3,799	3,654	
Proportion of Incident Hospitalized AIS Patients Receiving tPA						3.38%	3.50%	4.27%	
<b>Utilization of Acute Care by Incident Ischemic Stroke Patients</b>									
Discharges	4,032	3,889	3,747	3,836	3,801	3,788	3,799	3,654	-9.4%
ALOS	28.95	28.67	27.09	26.71	26.77	26.39	26.41	22.49	-22.3%
Patient Days	116,718	111,488	101,491	102,474	101,761	99,965	100,340	82,171	-29.6%
<b>Utilization of Acute Care by Incident Hemorrhagic Stroke Patients</b>									
Discharges	912	823	815	856	856	871	887	872	-4.4%
ALOS	29.43	27.81	28.27	27.52	30.47	32.61	30.07	25.38	-13.8%
Patient Days	26,841	22,885	23,036	23,588	26,083	28,406	26,675	22,127	-17.6%
<b>Discharge Disposition following Acute Admissions for Incident Ischemic Stroke Patients</b>									
Died	26.8%	24.1%	23.5%	22.6%	23.3%	24.5%	24.7%	21.8%	-18.4%
Discharged to Home	46.8%	47.9%	47.6%	49.2%	46.8%	45.9%	45.7%	49.0%	4.7%
Home with Support Services	9.9%	10.1%	10.6%	10.0%	10.1%	9.8%	10.2%	10.5%	5.7%
Continuing Care Facility	13.8%	15.2%	15.9%	15.7%	16.8%	16.2%	15.7%	13.9%	1.0%
Other	2.7%	2.8%	2.5%	2.5%	3.0%	3.6%	3.6%	4.7%	75.1%
<b>Discharge Disposition following Acute Admissions for Incident Hemorrhagic Stroke Patients</b>									
Died	41.1%	42.9%	42.6%	41.1%	36.9%	40.1%	39.1%	35.2%	-14.4%
Discharged to Home	39.8%	38.5%	36.7%	37.3%	40.7%	36.5%	41.0%	40.4%	1.4%
Home with Support Services	5.4%	5.8%	7.4%	5.8%	7.1%	7.1%	6.3%	6.2%	15.3%
Continuing Care Facility	7.3%	9.6%	9.4%	10.5%	11.0%	11.6%	9.8%	10.7%	45.2%
Other	6.4%	3.2%	3.9%	5.3%	4.3%	4.7%	3.7%	7.6%	19.0%
<b>Mortality Following an Incident Stroke</b>									
<b>Hospitalized Ischemic Stroke</b>									
Crude 30-day In-hospital Mortality Rate	21.0%	18.9%	19.0%	18.2%	18.5%	20.0%	20.1%	18.3%	-12.6%
Crude 31-365 Day Mortality Rate in 30-day In-hospital Survivors	20.5%	19.4%	19.4%	19.8%	21.3%	20.7%	20.4%	19.2%	-6.3%
<b>Hospitalized Hemorrhagic Stroke</b>									
Crude 30-day In-hospital Mortality Rate	37.4%	39.5%	39.4%	38.9%	34.1%	36.7%	36.3%	32.5%	-13.3%
Crude 31-365 Day Mortality Rate in 30-day In-hospital Survivors	13.7%	16.3%	15.0%	13.8%	13.5%	19.2%	14.4%	14.6%	6.7%

Grey Shading = Not Applicable  
\* Age 20 and older

## Key Indicators for Measurement and Evaluation

The BC Stroke Strategy Measurement and Evaluation Working Group have suggested five key indicators for tracking progress on ACVS care in the province. The following includes trend data for B.C. for each of these five indicators. The majority of this data is from the updated Acute Cerebrovascular Syndrome (ACVS) Registry, with the exception of data for Indicator #1 which is provided by the Health Authorities. Note that the geographic location is based on the patient's residence, not necessarily the location of their treatment. The only exception to this is Indicator #1 in which the geographic location is based on the location of the clinic.

The focus of the graphs and charts is on provincial trends for the five key ACVS indicators.

1. *Increase the volume of TIA/non-hospitalized strokes processed in TIA Rapid Assessment Clinics by 50% between 2009/10 and 2013/14.*

*Data Source:* Data provided by Health Authorities.

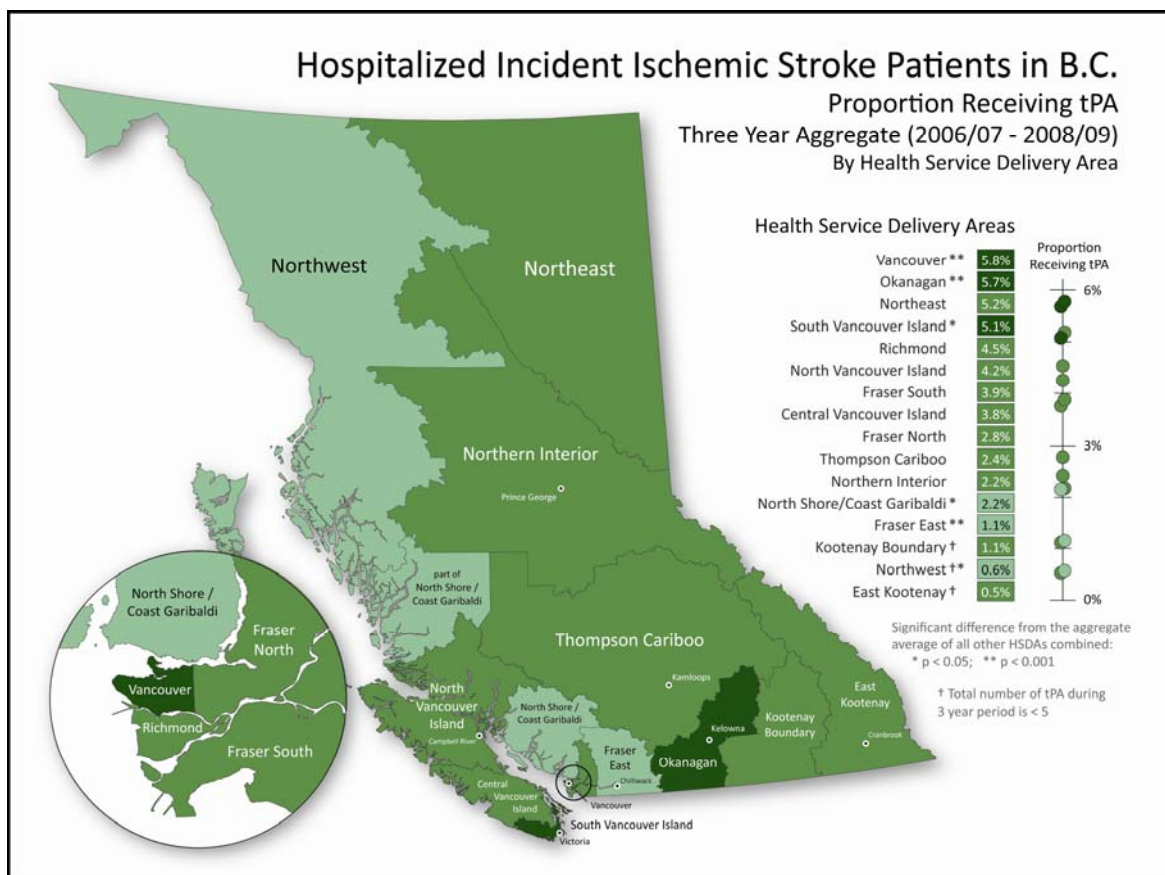
<b>TIA Rapid Assessment Clinics In British Columbia 2008/09 and 2009/10 Estimated</b>				
	<b>2008/09</b>	<b>2009/10</b>	<b>Variance</b>	<b>% Var</b>
<b>New Patients Seen</b>	2,757	5,215	2,458	89.2%
<b>TIA/Stroke Patients Seen</b>	1,211	2,749	1,538	127.0%
<b>Mimic Rate</b>	56.1%	47.3%	-8.8%	-15.7%
<b>Referral Source</b>				
GP/Specialist	43.8%	39.1%	-4.7%	-10.7%
Emergency Department	41.7%	42.9%	1.2%	2.8%
Other	18.0%	17.9%	0.0%	-0.1%
<b>Mean Wait Time</b>				
From Event to 1st Appointment (in days)	6.93	5.26	(1.67)	-24.1%
From Referral to 1st Appointment (in days)	6.15	4.44	(1.71)	-27.9%
# of Patients Seen Within 48 Hours	281	980	699	248.8%
% Seen Within 48 Hours	10.4%	19.5%	9.1%	86.9%

2. Increase the number of incident ischemic stroke patients appropriately receiving tPA to **10%<sup>2</sup>** between 2008/09 and 2013/14.

**Data Source:** The proportion is based on the number of incident hospitalized ischemic stroke patients (based on the updated ACVS Registry definition) with the intervention code 1.ZZ.35.HA-C1 (Pharmacotherapy, total body, percutaneous approach, [intramuscular, intravenous, subcutaneous, intradermal] using antithrombotic agent). This use of this code has only been mandatory in BC since the 2006/07 fiscal year.

- 128 of 3,788 (3.38%) in 2006/07
- 133 of 3,799 (3.50%) in 2007/08
- 156 of 3,654 (4.27%) in 2008/09

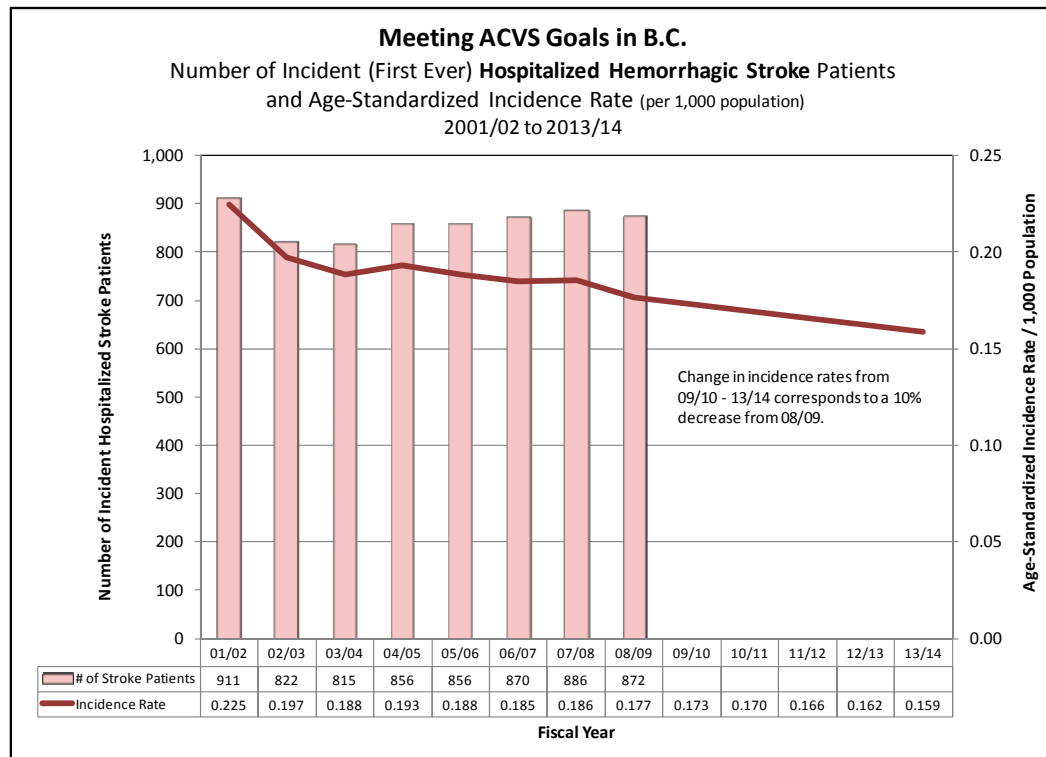
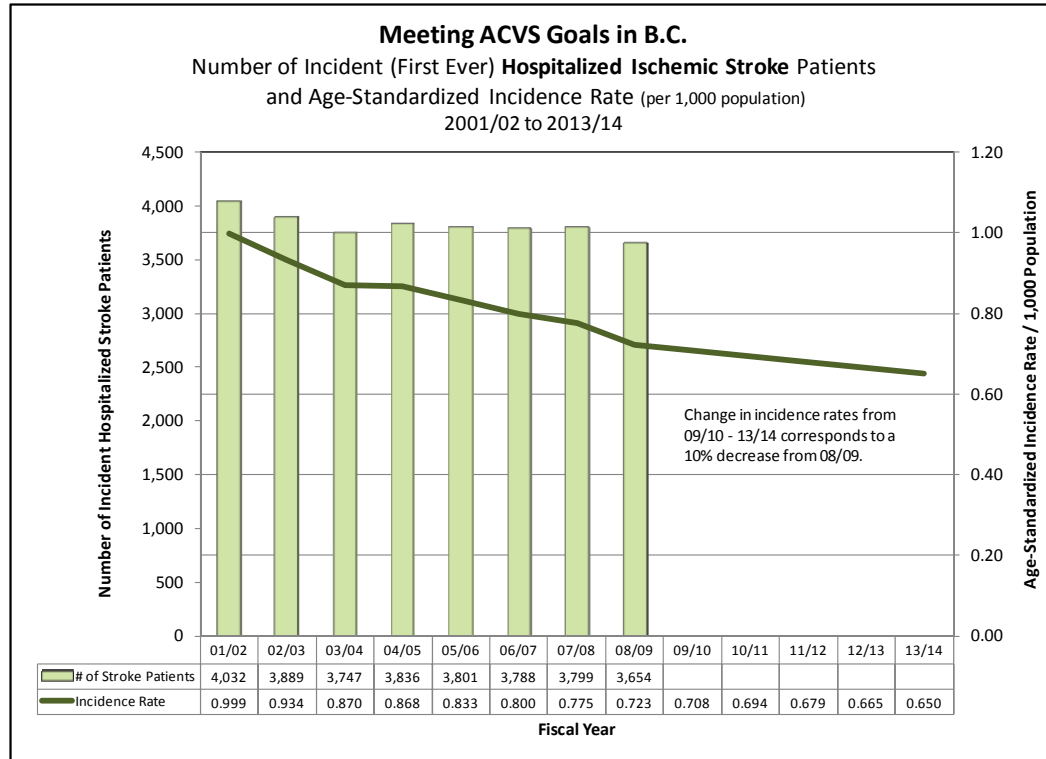
There is considerable variation in the utilization of tPA at the regional level, with a significantly higher proportion of incident ischemic stroke patients living in Vancouver, Okanagan and South Vancouver Island Health Service Delivery Areas (HSDAs) receiving tPA. Patients with an incident ischemic stroke living in the Fraser East, North Shore/Coast Garibaldi and Northwest HSDAs have a significantly lower probability of receiving tPA (see following map).



<sup>2</sup> Note that the original goal set prior to information on current results was 5%. Given a provincial average of 4.27% in 2008/09, the goal has been reset at 10%.

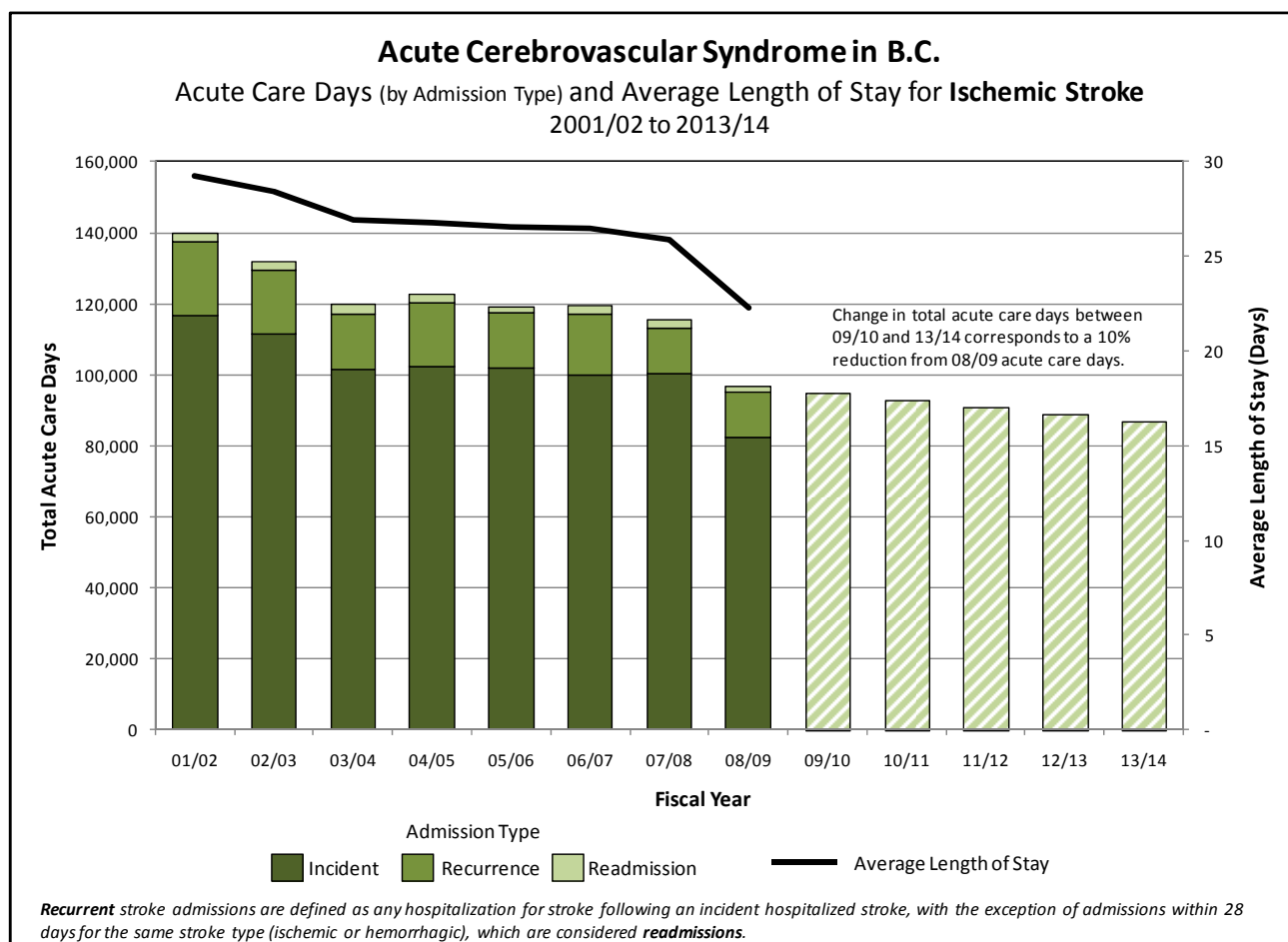
3. Reduce the age-standardized incidence rate of both ischemic and hemorrhagic stroke by 10% between 2008/09 and 2013/14.

Data Source: Updated ACVS Registry.



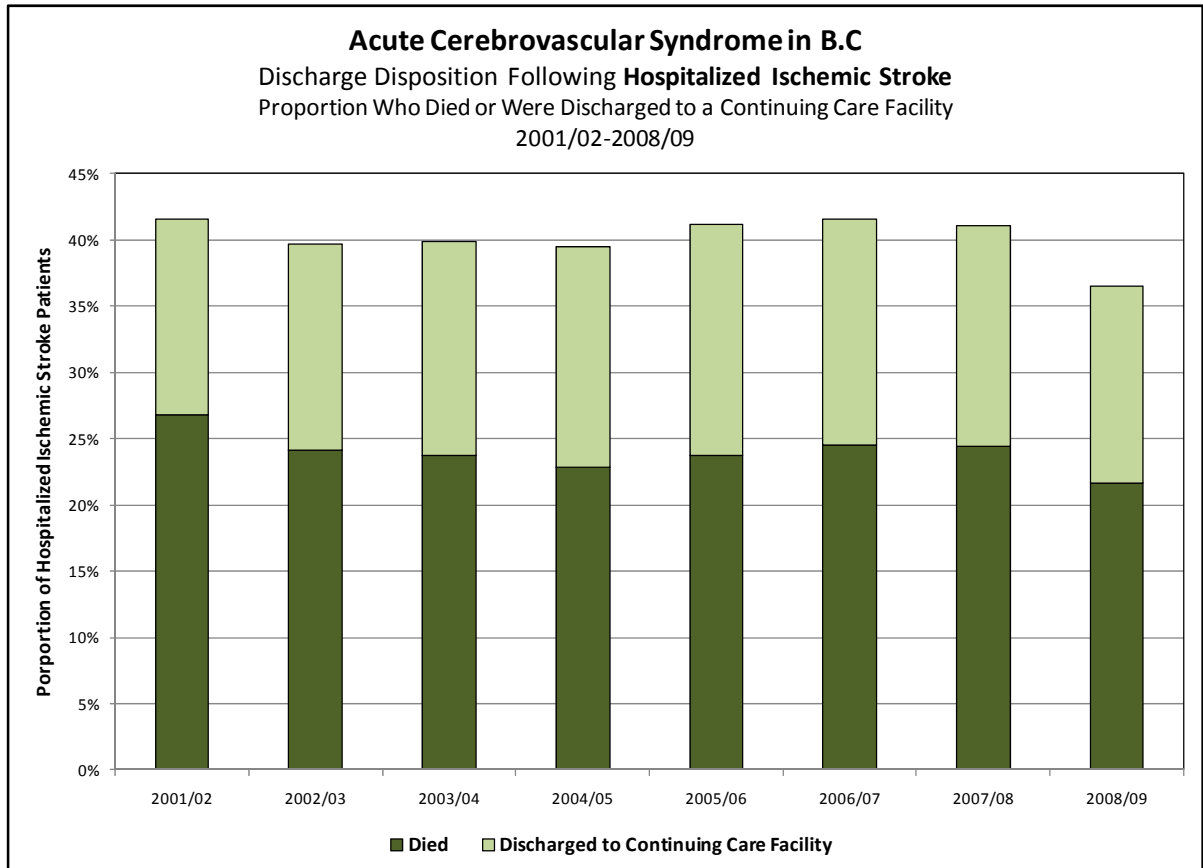
- Reduce acute care days (this includes a combination of reduced discharges and reduced average length of stay) for discharges in which an ischemic stroke is the principal diagnosis by **10%** between 2008/09 and 2013/14.

*Data Source:* Updated ACVS Registry for incident, re-admit and recurrent ischemic stroke discharges. Link to the DAD for the number of hospital days associated with these discharges. **Recurrent** stroke admissions are defined as any hospitalization for stroke following an incident hospitalized stroke, with the exception of admissions within 28 days for the same stroke type (ischemic or hemorrhagic), which are considered **readmissions**.



5. *Reduce the proportion of patients who die in hospital or are sent to a long-term care facility after being admitted/discharged (principal diagnosis) for ischemic stroke. **If only one composite measure is used to assess progress in stroke care, it would be this overall measure of death and dependency.***

*Data Source: Updated ACVS Registry for hospitalized (incident, readmission and recurrent) ischemic stroke discharges. Discharge Abstract Database (DAD) for discharge disposition ('died', 'discharged to a Continuing Care facility').*



## 4.0 APPENDIX A: A BRIEF OVERVIEW OF THE LITERATURE ASSESSING STROKE CODES

### Key Studies

#### 1. Leibson et al. (1994)<sup>3</sup>

- Stroke patients in this study exclude patients with transient ischemic attack (TIA).
- ICD-9-CM (International Classification of Diseases, 9<sup>th</sup> Revision, Clinical Modification) hospital discharge abstract codes tested against the Rochester Stroke Registry - **Cerebrovascular Disease (430-438.9)**
- Initial review indicated:
  - i. Only 86% of first stroke patients were hospitalized.
  - ii. Only 60% of patients hospitalized with a code of 430-438.9 were actually incident or recurrent stroke patients.
- How to enhance validity:
  - i. Increase the number of discharge diagnosis used. Using only the most responsible diagnosis captured just 76% of incident strokes while using all five available diagnosis captured 93% of incident strokes.
  - ii. Be more precise in the codes used. The proportion of 'true' stroke (incident or recurrent) by code are as follows:

ICD9 Code	% 'True' Stroke	
<b>430</b>	100%	11 of 11
<b>431</b>	87%	10 of 23
<b>432</b>	0%	0 of 7
<b>433</b>	15%	3 of 20
<b>434</b>	85%	87 of 102
<b>435</b>	15%	12 of 78
<b>436</b>	86%	55 of 64
<b>437</b>	22%	2 of 11
<b>438</b>	0%	0 of 15

- Despite these enhancements (the researchers ended up excluding codes 432, 435 and 438), however, 23% of incident strokes were unidentified and 21% of

<sup>3</sup> Leibson CL, Naessens JM, Brown RD et al. Accuracy of hospital discharge abstracts for identifying stroke. *Stroke*. 1994; 25(12): 2348-55.

stroke-coded diagnosis were found to be other than incident or recurrent stroke upon review.

2. Williams et al. (1999)<sup>4</sup>

- Combined the results of Liebson et al. (1994) above with those of three other studies<sup>5</sup> to produce the following (each of these four studies used both the primary and available secondary codes):

<b>ICD9 Code</b>	<b>% 'True' Stroke</b>	
<b>430</b>	83%	39 of 47
<b>431</b>	85%	86 of 101
<b>432</b>	4%	1 of 24
<b>433</b>	15%	91 of 607
<b>434</b>	82%	573 of 701
<b>435</b>	12%	43 of 351
<b>436</b>	72%	230 of 318
<b>437</b>	8%	11 of 134
<b>438</b>	1%	5 of 360

- Suggest using this information to correct for over/under ascertainment based on the codes actually utilized.

3. Tirschwell et al. (2002)<sup>6</sup>

- Compared hospital discharge data and medical records review to evaluate 3 different algorithms for classifying stroke patients:
  - Using all 9 potential discharge diagnosis
  - Using the first two discharge diagnosis
  - Using just the primary discharge diagnosis

<sup>4</sup> Williams GR, Jiang JG, Matchar DB et al. Incidence and occurrence of total (first-ever and recurrent) stroke. *Stroke*. 1999; 30(12): 2523-8.

<sup>5</sup> Benesch C, Witter DM, Wilder AL, Duncan PW, Samsa GP, Matchar DB. Inaccuracy of the International Classification of Diseases. (ICD-9-CM) in identifying the diagnosis of ischemic cerebrovascular disease. *Neurology*. 1997;49:660–664.

Broderick J, Brott T, Kothari R, Miller R, Khoury J, Pancioli R, Gebel J, Minneci L, Shukla R. The Greater Cincinnati/Northern Kentucky Stroke Study: preliminary first-ever and total incidence rates of strokes among blacks. *Stroke*. 1998;29:415–421

Rosamond WD, Folsom AR, Chambless LE, Wang CH, McGovern PG, Howard G, Copper LS, Shahar E. Stroke incidence and survival among middle-aged adults; 9-year follow-up of the Atherosclerosis Risk in Communities (ARIC) Cohort. *Stroke*. 1999;30:736–743.

<sup>6</sup> Tirschwell DL, Longstreth WT, Jr. Validating administrative data in stroke research. *Stroke*. 2002; 33(10): 2465-70.

- In October of 1992, a fifth digit was added to ICD-9-CM codes 433 and 434: 0 = **without** cerebral infarction and 1 = **with** cerebral infarction.
  - Ischemic strokes were identified as ICD-9-CM codes 433.x1, 434 (excluding 434.x0), 436
  - Transient ischemic attacks (TIA) were identified as ICD-9-CM code 435
  - Subarachnoid haemorrhage was identified as ICD-9-CM code 430
  - Intracerebral haemorrhage was identified as ICD-9-CM code 431
  - If only codes 432 (other and unspecified intracranial haemorrhage), 437 (other and ill-defined cerebrovascular disease) or 438 (late effects of cerebrovascular disease) were present, the case was coded as “not a stroke”.
  - For each type of stroke, the case was excluded if any “traumatic brain injury” ICD-9-CM code (800-804, 850-854) was used or the “rehabilitation care” ICD-9-CM code (V57) was the primary discharge diagnosis.
  - If both the TIA code and a stroke code appear, the stroke code takes precedence.
  - Assume that haemorrhagic strokes are coded more accurately than ischemic strokes, thus if both codes appear, assign the case to “haemorrhagic stroke”.
  - Overall, stroke classification agreement was the highest when using all 9 potential discharge diagnosis. The one exception was intracerebral haemorrhage in which case just using the primary discharge diagnosis was more accurate.
4. Johnsen et al. (2002)<sup>7</sup>
- Compared stroke cases (using ICD-10 codes I60-69.8, or G45) in the Danish National Registry with medical records.
  - Used both the main and secondary diagnosis.
  - The results were as follows (accuracy of the registry in identifying ‘true’ stroke patients):

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<sup>7</sup> Johnsen SP, Overvad K, Sorensen HT et al. Predictive value of stroke and transient ischemic attack discharge diagnoses in The Danish National Registry of Patients. *Journal of Clinical Epidemiology*. 2002; 55(6): 602-7.

Distribution of Recorded and Verified Cerebrovascular Diagnosis In the Danish National Registry																
Recorded Diagnosis (ICD-10 code)	SAH		ICH		Ischemic Stroke		Unspecified Stroke		TIA		Total Stroke	Other Diseases	Total			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%		
SAH (I60)	14	46.7%	2	6.7%	1	3.3%	-	0.0%	2	6.7%	19	63.3%	11	36.7%	30	100.0%
ICH (I61)	3	8.6%	23	65.7%	4	0.1%	-	0.0%	-	0.0%	30	85.7%	5	14.3%	35	100.0%
Ischemic Stroke (I63)	-	0.0%	-	0.0%	99	87.6%	1	0.9%	6	5.3%	106	93.8%	7	6.2%	113	100.0%
Unspecified Stroke (I64)	-	0.0%	12	6.0%	139	69.5%	1	0.5%	15	7.5%	167	83.5%	33	16.5%	200	100.0%
TIA (G45)	-	0.0%	-	0.0%	5	3.7%	-	0.0%	81	60.4%	86	64.2%	48	35.8%	134	100.0%
Other Cerebrovascular Disease (I62, 65-69.8)	-	0.0%	1	1.9%	20	37.0%	-	0.0%	15	27.8%	36	66.7%	18	33.3%	54	100.0%
<b>Total</b>	<b>17</b>	<b>3.0%</b>	<b>38</b>	<b>6.7%</b>	<b>268</b>	<b>47.3%</b>	<b>2</b>	<b>0.4%</b>	<b>119</b>	<b>21.0%</b>	<b>444</b>	<b>78.4%</b>	<b>122</b>	<b>21.6%</b>	<b>566</b>	<b>100.0%</b>

- Of the 566 patients reviewed, 444 (78.4%) were actually stroke/TIA patients (based on medical record review).
  - The 'accuracy' of the specific codes was as follows:
    - Subarachnoid haemorrhage (I60) – 46.7% (14 of 30)
    - Intracerebral haemorrhage (I61) – 65.7% (23 of 35)
    - Ischemic strokes (I63) – 87.6% (99 of 113)
    - Transient ischemic attacks – 60.4% (81 of 134 cases)
  - The majority of unspecified stroke (I64) were actually ischemic strokes – 69.5% (139 of 200)
5. Gillum (2002)<sup>8</sup>
- Comparison using ICD-9 and ICD-10 codes
  - Found that 6% more deaths were coded with ICD-10 'stroke' codes (I60 to I69) primarily due to a change in coding rules when both 'stroke' and pneumonia codes were listed as the cause of death.
6. Spolaore et al. (2005)<sup>9</sup>
- Compared hospital discharge codes to medical chart review in the Veneto region of Italy (population 4.5 million). The results using the **primary diagnosis only** are shown below.

<sup>8</sup> Gillum RF. New considerations in analyzing stroke and heart disease mortality trends: the Year 2000 Age Standard and the International Statistical Classification of Diseases and Related Health Problems, 10th Revision. *Stroke*. 2002; 33(6): 1717-21.

<sup>9</sup> Spolaore P, Brocco S, Fedeli U et al. Measuring accuracy of discharge diagnoses for a region-wide surveillance of hospitalized strokes. *Stroke*. 2005; 36(5): 1031-4.

ICD9 Code	% 'True' Stroke	
<b>342</b>	36%	78 of 217
<b>430</b>	76%	201 of 264
<b>431</b>	78%	210 of 269
<b>432</b>	54%	139 of 258
<b>433</b>	9%	19 of 215
<b>434</b>	77%	270 of 351
<b>435</b>		
<b>436</b>	61%	190 of 312
<b>437</b>	14%	41 of 296
<b>438</b>	9%	19 of 209

- Note the appearance of a 'new' code, ICD-9 342 *Hemiplegia*.

#### 7. Kokotailo and Hill (2005)<sup>10</sup>

- Compared the accuracy of carefully selected ICD-9 and their equivalent ICD-10 stroke codes using medical chart review in Alberta.

ICD Acute Cerebrovascular Syndrome Codes (from literature)				
ACVS Type	ICD-9 Code	Definition	ICD-10 Code	Definition
Acute Ischemic Stroke	362.3	Retinal vascular occlusion	H34.1	Central retina artery occlusion
	433.x1	Occlusion and stenosis of precerebral arteries	I63.x	Cerebral infarction
	434.x1	Occlusion cerebral arteries	I64.x	Stroke, not specified as hemorrhage or infarction
	436.x	Acute, but ill-defined cerebrovascular disease		
Intracerebral Hemorrhage	431.x	Intracerebral hemorrhage	I61.x	Intracerebral hemorrhage
Subarachnoid Hemorrhage	430.x	Subarachnoid hemorrhage	I60.x	Subarachnoid hemorrhage
Transient ischemic attack	435.x	Transient cerebral ischemia	G45.x	Transient cerebral ischemic attacks and related syndromes (exclude G45.4 - transient global amnesia)

- Using the definitions in the table above, stroke coding was 90% (95% CI of 86% to 93%) accurate with ICD-9 codes and 92% (88% to 95%) accurate with ICD-10 codes.
- The following table provides the % agreement between the hospital discharge abstract information and the medical record review. Note the substantial improvement (from 70% to 97%) in correctly identifying TIA using the ICD-10 code G45 but excluding G45.4 (transient global amnesia).

<sup>10</sup> Kokotailo RA, Hill MD. Coding of stroke and stroke risk factors using international classification of diseases, revisions 9 and 10. *Stroke*. 2005; 36(8): 1776-81.

<b>Stroke Type</b>	<b>ICD-9 % Correct</b>	<b>ICD-10</b>
<b>AIS</b>	85%	88%
<b>ICH</b>	97%	98%
<b>SAH</b>	98%	91%
<b>TIA</b>	70%	97%
<b>Total</b>	<b>90%</b>	<b>92%</b>

8. Roumie et al. (2008)<sup>11</sup>

- Compared the validity of highly specific stroke codes using a medical chart review as the ‘gold standard’.
- The ICD-9- CM codes used were:
  - i. Ischemic stroke – 433.x1, 434 (excluding 434.x0) or 436
  - ii. Intracerebral haemorrhage - 431
  - iii. Subarachnoid haemorrhage - 430
- Hospitalizations with multiple stroke diagnosis were classified in the following priority:
  - i. Subarachnoid haemorrhage
  - ii. Intracerebral haemorrhage
  - iii. Ischemic stroke
- The review of 231 medical records indicated that 205 (89%) were ‘true’ strokes.

9. The Canadian Stroke Strategy (CSS)<sup>12</sup>

The CSS Information & Evaluation Working Group has recommended the following approach to stroke case definitions:

<sup>11</sup> Roumie CL, Mitchel E, Gideon PS et al. Validation of ICD-9 codes with a high positive predictive value for incident strokes resulting in hospitalization using Medicaid health data. *Pharmacoepidemiology and Drug Safety*. 2008; 17(1): 20-6.

<sup>12</sup> The Canadian Stroke Strategy, Performance Measurement Manual, December 2008.

Stroke subcategory	ICD-9 codes*	ICD-10 codes*
1. Acute stroke	430	I60
	431	I61
	434	I63 (excl. I63.6) <sup>a</sup>
	436	I64 <sup>d</sup>
	362.3 <sup>b</sup>	H34.1 <sup>b</sup>
2. Ischemic stroke (includes acute but ill-defined cerebrovascular)	433 <sup>c</sup>	I63 (excl. I63.6) <sup>a</sup>
	434 <sup>c</sup>	I64 <sup>d</sup>
	436	
3. Subarachnoid hemorrhage	430	I60
4. Intracerebral hemorrhage	431	I61
5. Transient ischemic attack	435	G45 (excl. G45.4) <sup>c</sup>
6. Cerebral cortical vein thrombosis or Intracranial venous sinus thrombosis	437.6	I63.6 <sup>a</sup>
		I67.6
7. Arteriovenous malformation (cerebral) Arterial malformation (cerebral)	747.6	I60.8 (ruptured) <sup>f</sup>
	747.81	
8. All cerebrovascular diseases (adult)		I60
		I61
		I62 <sup>e</sup>
		I63 (excl. I63.6)
		I64
		I65
		I66
		I67 (excl. I67.6)
		I68
	I69	

**Notes:**

- \* In all case selections, ICD9 and ICD10 coding should be applied to the 5<sup>th</sup> digit (ICD9) or 4<sup>th</sup> digit (ICD10) where available. See specific notes below regarding exceptions and exclusions to the case codes.
- a. 437.6, I63.6, I67.6 – *Cerebral venous thrombosis*. This is uncommon in adults (<<1% of all stroke) and has a different pathology compared to arterial stroke. In children a much greater proportion of strokes are due to venous thrombosis. Therefore we exclude from the adult acute stroke case definitions and include in the paediatric stroke cases (0 – 18 year age group). [Note: codes 325 and G08 refer to septic intracranial venous thrombophlebitis and are excluded here.]
- b. 362.3/H34.1 - *Central Retinal Artery Occlusion*. Impractical to include retinal vascular occlusion if 4<sup>th</sup> digit coding is not available; include where information is available. Huge variation will exist across provinces for this code, however. Overall impact of including this code may be small.
- c. 433/434 – Both require 5<sup>th</sup> digit coding and should not be used if it is not available; include where information is available and the fifth digit is coded as a ‘1’ indicating infarction present (ie. 433.x1 or 434.x1, where x can be any number).

- d. I64 – *Stroke, not specified as hemorrhage or infarction*. Generally included in overall acute stroke. Cannot be counted on its own as a separate stroke type. Efforts should be made to reduce use of this code as almost all stroke patients receive a CT scan and based on the scan they should be able to be categorized as ischemic or hemorrhagic. Generally, the issue seems to be that health records abstractors are not trained in all the possible terminology that may be used for ischemic stroke, and they look for the word 'infarction' to classify I-63. This term is not used as frequently as the following list: ischaemic stroke, small vessel stroke, lacunar stroke, stroke from atrial fibrillation, ischemic cerebrovascular insult presumably from an embolic location, right MCA stroke, L MCA distribution secondary to small vessel ischemia. Abstractors should be provided with this additional list and efforts made to reduce use of I-64 category.
- e. I62, 432 – Codes for non-specific hemorrhage or subdural hemorrhage are excluded. To be consistent with past coding practices for comparison purposes, these codes are included in the "all cerebrovascular disease" category. Some patients with these codes will have a hemorrhagic stroke syndrome rather than simply a subdural hemorrhage.
- f. Unruptured AV malformations and aneurysms are not considered stroke and are therefore not included in acute stroke case definitions. They are coded as Q28 in ICD\_10, with Q28.2 and Q.28.3 specifically being for the cerebral vessels.

## Other Selected Studies Using Stroke Codes

### 10. May and Kittner (1994)<sup>13</sup>

- Used ICD-9-CM codes 430-438 found in any of the five diagnostic code positions but excluded
  - i. 435 (transient cerebral ischemia)
  - ii. 438 (late effects of cerebrovascular disease)
- Removed recurrent strokes by excluding any patients who had been hospitalized with a principle diagnosis of stroke (defined above) or ICD-9-CM code 438.

### 11. Mayo et al. (1996)<sup>14</sup>

- Used primary/most responsible discharge code only
- Included ICD-9 codes 431, 434 and 436 only.
- Excluded patients less than 15 years of age.

### 12. Kennedy et al. (2002)<sup>15</sup>

- Used primary/most responsible discharge code only
- Included ICD-9 codes 430, 431, 432, 433, 434 and 436.
- Excluded ICD-9 codes 435 (to exclude TIAs), 437 (ill-defined stroke), 438 (late effects of stroke) and patients who had a carotid endarterectomy (code 38.01) performed during the index admission.
- Excluded patients less than 15 years of age.

### 13. Field and Hill (2002)<sup>16</sup>; Field et al. (2004)<sup>17</sup>

- Studies stroke in the Calgary Health Region
- Stroke defined using the following ICD-9-CM codes in the first diagnosis position only:
  - i. Acute ischemic stroke (AIS) – 434 or 436

<sup>13</sup> May DS, Kittner SJ. Use of Medicare claims data to estimate national trends in stroke incidence, 1985-1991. *Stroke*. 1994; 25(12): 2343-7.

<sup>14</sup> Mayo NE, Neville D, Kirkland S et al. Hospitalization and case-fatality rates for stroke in Canada from 1982 through 1991. The Canadian Collaborative Study Group of Stroke Hospitalizations. *Stroke*. 1996; 27(7): 1215-20.

<sup>15</sup> Kennedy BS, Kasl SV, Brass LM et al. Trends in hospitalized stroke for blacks and whites in the United States, 1980-1999. *Neuroepidemiology*. 2002; 21(3): 131-41.

<sup>16</sup> Field TS, Hill MD. Weather, Chinook, and stroke occurrence. *Stroke*. 2002; 33(7): 1751-7.

<sup>17</sup> Field TS, Green TL, Roy K et al. Trends in hospital admission for stroke in Calgary. *The Canadian Journal of Neurological Sciences*. 2004; 31(3): 387-93.

- ii. “Sensitive” AIS – include 433 with 434 and 436
- iii. Subarachnoid haemorrhage – 430
- iv. Intracerebral haemorrhage – 431
- In the 2004 article, they add
  - i. 362.31
  - ii. 435.0 to 435.9
  - iii. 437.6
- And fine-tune 433 (433.00 to 433.91) and 434 (434.00 to 434.91)

#### 14. EUROCISS Project (2003)<sup>18</sup>

- Definition used by stroke registries in Europe
- Registries in Finland, France, Germany, Norway, and Denmark use ICD-9 codes (or the equivalent ICD-10 codes) 430-438
- The registry in Italy uses ICD-9 codes 430-434, 436-438
- Two registries exist in Sweden. One uses ICD-9 430-434, 436 and the other uses 431, 434, 436.

#### 15. Mayo et al. (2007)<sup>19</sup>

- Patient had to be admitted on an emergency basis
- Based on principle discharge diagnosis only
- Cerebral infarction (ICD-9 434 and 436)
- Intracerebral hemorrhage (ICD-9 431)

<sup>18</sup> Coronary and cerebrovascular population-based registers in Europe: are morbidity indicators comparable? Results from the EUROCISS Project. *European Journal of Public Health*. 2003; 13(3 Suppl): 55-60.

<sup>19</sup> Mayo NE, Nadeau L, Daskalopoulou SS et al. The evolution of stroke in Quebec: a 15-year perspective. *Neurology*. 2007; 68(14): 1122-7.

## 5.0 APPENDIX B: A BRIEF OVERVIEW OF THE LITERATURE ASSESSING RECURRENT STROKE

1. Burn et al. (1994)<sup>20</sup>
  - Recurrent stroke defined as any new event occurring more than 21 days after the index stroke, or, if earlier, clearly in another part of the brain.
  - Recurrences of subarachnoid hemorrhage were included even if they occurred within 21 days of the first stroke.
  - There had to be evidence of either a new neurological deficit or an exacerbation of a previous deficit that could not be ascribed to drug toxicity or intercurrent acute illness.
2. Hankey et al. (1998)<sup>21</sup>
  - Recurrent stroke defined as a stroke in which (1) there was clinical evidence of the sudden onset of a new focal neurological deficit with no apparent cause other than vascular origin occurring at any time after the index stroke or (2) there was clinical evidence of the sudden onset of an exacerbation of a previous focal neurological deficit with no apparent cause other than that of vascular origin occurring >21 days after the index stroke.
3. Petty et al. (2000)<sup>22</sup>
  - Recurrent stroke defined as “a new neurological deficit fitting the definitions for ischaemic or haemorrhagic stroke, occurring after a period of unequivocal neurological stability or improvement lasting  $\geq 24$  hours and not attributable to edema, mass effect, brain shift syndrome, or hemorrhagic transformation of the incident cerebral infarction”.
  - All recurrences within 30 days were evaluated by two study neurologists.
4. Kolominsky-Rabas et al. (2001)<sup>23</sup>
  - Recurrent stroke defined as a new neurological deficit that occurred more than 24 hours after the incident stroke and was not attributable to edema, mass effect, brain shift syndrome, or hemorrhagic transformation.

<sup>20</sup> Burn J, Dennis M, Bamford J et al. Long-term risk of recurrent stroke after a first-ever stroke. The Oxfordshire Community Stroke Project. *Stroke*. 1994; 25(2): 333-7.

<sup>21</sup> Hankey GJ, Jamrozik K, Broadhurst RJ et al. Long-term risk of first recurrent stroke in the Perth Community Stroke Study. *Stroke*. 1998; 29(12): 2491-500.

<sup>22</sup> Petty GW, Brown RD, Whisnant JP, et al. Ischemic Stroke Subtypes: A population-based study of functional outcome, survival and recurrence. *Stroke*. 2000; 31: 1062-8.

<sup>23</sup> Kolominsky-Rabas PL, Weber M, Gefeller O et al. Epidemiology of ischemic stroke subtypes according to TOAST criteria: incidence, recurrence, and long-term survival in ischemic stroke subtypes: a population-based study. *Stroke*. 2001; 32(12): 2735-40.

- All recurrences within 21 days were evaluated by study neurologists.
  - Procedure-related strokes were not counted as recurrent strokes.
5. Hillen et al. (2003)<sup>24</sup>
- Stroke was classified as recurrent if it occurred 21 days after the index stroke, or, if earlier, it had to have clearly occurred in another part of the brain
  - To be considered recurrent stroke, there had to be a new neurological deficit or a deterioration of the previous deficit not considered to be due to edema, hemorrhagic transformation, or intercurrent illness.
6. Coull et al. (2004)<sup>25</sup>
- Estimated recurrence of stroke after a TIA was 8.0% at seven days, 11.5% at one month and 17.3% at three months.
  - Estimated recurrence of stroke after a minor stroke was 11.5% at seven days, 15.0% at one month and 18.5% at three months.
  - These estimates are substantially higher than the usually quoted risk of 1-2% at seven days and 2-4% at one month.
7. Coull and Rothwell (2004)<sup>26</sup>
- Recurrent stroke defined as any new acute neurological event with symptoms lasting >24 hours after the initial ictus of the incident stroke (i.e. definite acute worsening of an established nonprogressive deficit) that was not attributable to edema, brain shift, hemorrhagic transformation, intercurrent illness, hypoxia, or drug toxicity.
  - Sudden worsening was required for consideration as a potential recurrent event.
  - Gradual progression of an acute deficit was excluded.
  - Determined risk of recurrent stroke 3 months after a first-ever ischemic stroke according to three different definitions in two population-based studies (Oxford Vascular Study [OXVASC] and Oxfordshire Community Stroke Project [OCSP]). In both OXVASC and OCSP, “a first-ever stroke that happened in a patient with a

<sup>24</sup> Hillen T, Coshall C, Tilling K et al. Cause of stroke recurrence is multifactorial: patterns, risk factors, and outcomes of stroke recurrence in the South London Stroke Register. *Stroke*. 2003; 34(6): 1457-63.

<sup>25</sup> Coull AJ, Lovett JK, Rothwell PM. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: Implications for public education and organisation of services. *British Medical Journal*. 2004; 328:326.

<sup>26</sup> Coull AJ, Rothwell PM. Underestimation of the early risk of recurrent stroke: evidence of the need for a standard definition. *Stroke*. 2004; 35(8): 1925-9.

previous [TIA] was coded as incident, but a first-ever [TIA] in a patient with a previous stroke was coded as recurrent".<sup>27</sup>

<b>Definition</b>	<b>3-month % Risk</b>	
	<b>OXVASC (n=115)</b>	<b>OCSP (n=542)</b>
<b>A. Any recurrence &gt;24 hours not attributable to edema, brain shift or hemorrhagic infarction</b>	18.3	14.5
<b>B. Any recurrence &gt;21 days or if &lt; 21 days, new neurological deficit in different vascular territory</b>	7	8.3
<b>C. Any recurrence &gt; 28 days</b>	5.9	4.8

- They conclude that two of the definitions most widely used in epidemiological studies (B & C) substantially underestimate the risk of recurrence after first-ever ischemic stroke.
  - They believe that the 24-hour exclusion definition (A) is the most clinically valid.
  - Neurological deterioration occurring  $\geq 24$  hours after the incident event should only be included as a potential recurrent stroke if the neurological deficit was clearly different from the index stroke or was of a different clinical subtype, or if it occurred after an unequivocal period of neurological stability for  $\geq 24$  hours.
8. Lovett et al (2004)<sup>28</sup>
- The risk of early recurrent stroke is significantly different by etiologic subtype. 37% of recurrent stroke at 7 days occurs in patients with large-artery atherosclerosis, 3% in patients with small-vessel stroke, 23% in cardioembolic and 33% in undetermined stroke.
9. Shin et al. (2005)<sup>29</sup>
- Recurrent stroke defined as (1) a focal neurological deficit occurring suddenly in a vascular territory, lasting more than 24 hours, and occurring at any time after 1 week from the index stroke and (2) acute infarcts on diffusion-weighted imaging (DWI).

<sup>27</sup> Rothwell PM, Coull AJ, Giles MF et al. Change in stroke incidence, mortality, case-fatality, severity, and risk factors in Oxfordshire, UK from 1981 to 2004 (Oxford Vascular Study). *Lancet*. 2004; 363(9425): 1925-33.

<sup>28</sup> Lovett JK, Coull AJ, Rothwell PM. Early risk of recurrence by subtype of ischemic stroke in population-based incidence studies. *Neurology*, 2004; 62: 569-73.

<sup>29</sup> Shin DH, Lee PH, Bang OY. Mechanisms of recurrence in subtypes of ischemic stroke: a hospital-based follow-up study. *Archives of Neurology*. 2005; 62(8): 1232-7.

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#### 10. Azarpazhooh et al. (2008)<sup>30</sup>

- Recurrent stroke defined as a stroke occurring more than 28 days after the index stroke, or, if earlier, occurring in a different vascular territory than the index stroke.
- Approximately 9% of people with first-ever stroke have a recurrent event.
- Referring to results from the Oxford Vascular Study, in which a high risk of early recurrent stroke was reported (15% at 1 month), authors believe it is likely they substantially underestimated recurrent events in their cohort.
- The proportion of recurrent strokes that are of the same type as the index stroke may also have been underestimated.

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<sup>30</sup> Azarpazhooh MR, Nicol MB, Donnan GA et al. Patterns of stroke recurrence according to subtype of first stroke event: the North East Melbourne Stroke Incidence Study (NEMESIS). *International Journal of Stroke*. 2008; 3(3): 158-64.

## 6.0 APPENDIX C: RELEVANT ICD-9 CODES

Source: International Classification of Diseases: Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, 1975 Revision. 1977; 1. pp. 235,271-273:

- a) Chapter VI: Diseases of the Nervous System and Sense Organs**  
**Block 360-379: Disorders of the eye and adnexa**  
**Relevant stroke codes (see details below): 362.3**

### 362 Other retinal disorders

#### 362.3 Retinal vascular occlusion

Microembolism, retinal	Venous engorgement, retina
Occlusion (partial) (total) (transient):	
retinal artery (branch) (central)	
retinal vein (central) (tributary)	

- b) Chapter VII: Diseases of the Circulatory System**

**Block 430-438: Cerebrovascular disease**  
**Relevant stroke codes (see details below): 430-438**

Includes: with mention of hypertension (conditions in 401 and 405)  
 Use additional code, if desired, to identify presence of hypertension

Excludes: any condition in 430-434, 436, 437 occurring during pregnancy, childbirth or the puerperium, or specified as puerperal (674.0)

### 430 Subarachnoid haemorrhage

Meningeal haemorrhage	Ruptured (congenital) cerebral aneurysm: NOS syphilitic (094.8)
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### 431 Intracerebral haemorrhage

Haemorrhage (of):	Haemorrhage:
basilar	intrapontine
bulbar	pontine
cerebral	subcortical
cerebromeningeal	ventricular
cerebellar	Rupture of blood vessel in brain
cortical	
internal capsule	

### 432 Other and unspecified intracranial haemorrhage

432.0 Nontraumatic extradural haemorrhage  
 Nontraumatic epidural haemorrhage

432.1 *Subdural haemorrhage*  
Subdural haemorrhage (nontraumatic)

432.9 *Unspecified intracranial haemorrhage*

### 433 Occlusion and stenosis of precerebral arteries

Includes:

embolism narrowing obstruction (complete) (partial) thrombosis	}	of basilar, carotid and vertebral arteries
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Excludes: insufficiency NOS of precerebral arteries (435)

433.0 *Basilar artery*

433.1 *Carotid artery*

433.2 *Vertebral artery*

433.3 *Multiple and bilateral*

433.8 *Other*

433.9 *Unspecified*  
Precerebral artery NOS

### 434 Occlusion of cerebral arteries

434.0 *Cerebral thrombosis*  
Thrombosis of cerebral arteries

434.1 *Cerebral embolism*

434.9 *Unspecified*  
Cerebral infarction NOS

### 435 Transient cerebral ischaemia

Basilar artery syndrome	Intermittent cerebral ischaemia
Cerebrovascular insufficiency	Spasm of cerebral arteries
(acute) with transient	Subclavian steal syndrome
focal neurological	Transient ischaemic attack [TIA]
signs and symptoms	Vertebral artery syndrome

Insufficiency:

basilar carotid vertebral	}	artery
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Excludes: acute cerebrovascular insufficiency NOS (437.1)  
when due to conditions in 433.- (433.-)

#### **436 Acute but ill-defined cerebrovascular disease**

Apoplexy, apoplectic: NOS attack seizure	Cerebrovascular accident NOS Stroke
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#### **437 Other and ill-defined cerebrovascular disease**

437.0 *Cerebral atherosclerosis*  
Atheroma of cerebral arteries

437.1 *Other generalized ischaemic cerebrovascular disease*  
Acute cerebrovascular insufficiency NOS  
Cerebral ischaemia (chronic)

437.2 *Hypertensive encephalopathy*

437.3 *Cerebral aneurysm, nonruptured*

437.4 *Cerebral arteritis*

437.5 *Moyamoya disease*

437.6 *Nonpyogenic thrombosis of intracranial venous sinus*

437.8 *Other*

437.9 *Unspecified*

#### **438 Late effects of cerebrovascular disease**

Note: This category is to be used to indicate conditions in 430-437 as the cause of late effects, themselves classifiable elsewhere. The "late effects" include conditions specified as such, as sequelae, or present one year or more after the onset of the causal condition. [See III Late effect, page 723].

## 7.0 APPENDIX D: RELEVANT ICD-10 CODES

Source: <http://www.who.int/classifications/apps/icd/icd10online/>

- a) **Chapter VI:** Diseases of the Nervous System (G00-G99)  
**Block G40-G47:** Episodic and paroxysmal disorders  
**Relevant stroke codes (see details below):** G45, excluding G45.4

- G45**      **Transient cerebral ischaemic attacks and related syndromes**  
***Excludes:*** neonatal cerebral ischaemia (P91.0)  
**G45.0**    **Vertebro-basilar artery syndrome**  
**G45.1**    **Carotid artery syndrome (hemispheric)**  
**G45.2**    **Multiple and bilateral precerebral artery syndromes**  
**G45.3**    **Amaurosis fugax**  
**G45.4**    **Transient global amnesia** ***Excludes:*** amnesia NOS (R41.3)  
**G45.8**    **Other transient cerebral ischaemic attacks and related syndromes**  
**G45.9**    **Transient cerebral ischaemic attack, unspecified**  
             Spasm of cerebral artery  
             Transient cerebral ischaemia NOS

- b) **Chapter VII:** Diseases of the Eye and Adnexa  
**Block H30-36:** Disorders of the choroid and retina  
**Relevant stroke codes (see details below):** H34.1

- H34**      **Retinal vascular occlusions**  
***Excludes:*** amaurosis fugax (G45.3)  
**H34.1**    **Central retinal artery occlusion**

- c) **Chapter IX:** Disease of the Circulatory System (I00-I99)  
**Block I60-I69:** Cerebrovascular diseases  
**Relevant stroke codes (see details below):** I60-I69

***Includes:*** with mention of hypertension (conditions in I10 and I15.-)  
 Use additional code, if desired, to identify presence of hypertension.  
***Excludes:*** transient cerebral ischaemic attacks and related syndromes (G45.-)  
 traumatic intracranial haemorrhage (S06.-)  
 vascular dementia (F01.-)

- I60**      **Subarachnoid haemorrhage**  
***Includes:*** ruptured cerebral aneurysm  
***Excludes:*** sequelae of subarachnoid haemorrhage (I69.0)  
**I60.0**    **Subarachnoid haemorrhage from carotid siphon and bifurcation**  
**I60.1**    **Subarachnoid haemorrhage from middle cerebral artery**  
**I60.2**    **Subarachnoid haemorrhage from anterior communicating artery**  
**I60.3**    **Subarachnoid haemorrhage from posterior communicating artery**  
**I60.4**    **Subarachnoid haemorrhage from basilar artery**

- I60.5 Subarachnoid haemorrhage from vertebral artery**
- I60.6 Subarachnoid haemorrhage from other intracranial arteries**  
Multiple involvement of intracranial arteries
- I60.7 Subarachnoid haemorrhage from intracranial artery, unspecified**  
Ruptured (congenital) berry aneurysm NOS  
Subarachnoid haemorrhage from:
- cerebral } artery NOS
  - communicating }
- I60.8 Other subarachnoid haemorrhage**  
Meningeal haemorrhage  
Rupture of cerebral arteriovenous malformation
- I60.9 Subarachnoid haemorrhage, unspecified**  
Ruptured (congenital) cerebral aneurysm NOS

## **I61 Intracerebral haemorrhage**

**Excludes:** sequelae of intracerebral haemorrhage (I69.1)

- I61.0 Intracerebral haemorrhage in hemisphere, subcortical**  
Deep intracerebral haemorrhage
- I61.1 Intracerebral haemorrhage in hemisphere, cortical**  
Cerebral lobe haemorrhage  
Superficial intracerebral haemorrhage
- I61.2 Intracerebral haemorrhage in hemisphere, unspecified**
- I61.3 Intracerebral haemorrhage in brain stem**
- I61.4 Intracerebral haemorrhage in cerebellum**
- I61.5 Intracerebral haemorrhage, intraventricular**
- I61.6 Intracerebral haemorrhage, multiple localized**
- I61.8 Other intracerebral haemorrhage**
- I61.9 Intracerebral haemorrhage, unspecified**

## **I62 Other nontraumatic intracranial haemorrhage**

**Excludes:** sequelae of intracranial haemorrhage (I69.2)

- I62.0 Subdural haemorrhage (acute)(nontraumatic)**
- I62.1 Nontraumatic extradural haemorrhage**  
Nontraumatic epidural haemorrhage
- I62.9 Intracranial haemorrhage (nontraumatic), unspecified**

## **I63 Cerebral infarction**

**Includes:** occlusion and stenosis of cerebral and precerebral arteries, resulting in cerebral infarction

**Excludes:** sequelae of cerebral infarction (I69.3)

- I63.0 Cerebral infarction due to thrombosis of precerebral arteries**
- I63.1 Cerebral infarction due to embolism of precerebral arteries**
- I63.2 Cerebral infarction due to unspecified occlusion or stenosis of precerebral arteries**
- I63.3 Cerebral infarction due to thrombosis of cerebral arteries**
- I63.4 Cerebral infarction due to embolism of cerebral arteries**

**I63.5 Cerebral infarction due to unspecified occlusion or stenosis of cerebral arteries**

**I63.6 Cerebral infarction due to cerebral venous thrombosis, nonpyogenic**

**I63.8 Other cerebral infarction**

**I63.9 Cerebral infarction, unspecified**

**I64 Stroke, not specified as haemorrhage or infarction**

Cerebrovascular accident NOS

**Excludes:** sequelae of stroke (I69.4)

**I65 Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction**

**Includes:**

<ul style="list-style-type: none"> <li>embolism</li> <li>narrowing</li> <li>obstruction (complete)</li> <li>(partial)</li> <li>thrombosis</li> </ul>	}	of basilar, carotid or vertebral arteries, not resulting in cerebral infarction
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**Excludes:** when causing cerebral infarction (I63.-)

**I65.0 Occlusion and stenosis of vertebral artery**

**I65.1 Occlusion and stenosis of basilar artery**

**I65.2 Occlusion and stenosis of carotid artery**

**I65.3 Occlusion and stenosis of multiple and bilateral precerebral arteries**

**I65.8 Occlusion and stenosis of other precerebral artery**

**I65.9 Occlusion and stenosis of unspecified precerebral artery**  
Precerebral artery NOS

**I66 infarction Occlusion and stenosis of cerebral arteries, not resulting in cerebral**

**Includes:**

<ul style="list-style-type: none"> <li>embolism</li> <li>narrowing</li> <li>obstruction (complete)</li> <li>(partial)</li> <li>Thrombosis</li> </ul>	}	of middle, anterior and posterior cerebral arteries, and cerebellar arteries, not resulting in cerebral infarction
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**Excludes:** when causing cerebral infarction (I63.-)

**I66.0 Occlusion and stenosis of middle cerebral artery**

**I66.1 Occlusion and stenosis of anterior cerebral artery**

**I66.2 Occlusion and stenosis of posterior cerebral artery**

**I66.3 Occlusion and stenosis of cerebellar arteries**

**I66.4 Occlusion and stenosis of multiple and bilateral cerebral arteries**

**I66.8 Occlusion and stenosis of other cerebral artery**

Occlusion and stenosis of perforating arteries

**I66.9 Occlusion and stenosis of unspecified cerebral artery**

- I67**      **Other cerebrovascular diseases**  
*Excludes:* sequelae of the listed conditions (I69.8)  
**I67.0 Dissection of cerebral arteries, nonruptured**  
*Excludes:* ruptured cerebral arteries (I60.7)  
**I67.1 Cerebral aneurysm, nonruptured**  
 Cerebral:  
 • aneurysm NOS  
 • arteriovenous fistula, acquired  
*Excludes:* congenital cerebral aneurysm, nonruptured (Q28.-) ruptured cerebral aneurysm (I60.9)  
**I67.2 Cerebral atherosclerosis**  
 Atheroma of cerebral arteries  
**I67.3 Progressive vascular leukoencephalopathy**  
 Binswanger's disease  
*Excludes:* subcortical vascular dementia (F01.2)  
**I67.4 Hypertensive encephalopathy**  
**I67.5 Moyamoya disease**  
**I67.6 Nonpyogenic thrombosis of intracranial venous system**  
 Nonpyogenic thrombosis of:  
 • cerebral vein  
 • intracranial venous sinus  
*Excludes:* when causing infarction (I63.6)  
**I67.7 Cerebral arteritis, not elsewhere classified**  
**I67.8 Other specified cerebrovascular diseases**  
 Acute cerebrovascular insufficiency NOS  
 Cerebral ischaemia (chronic)  
**I67.9 Cerebrovascular disease, unspecified**
- I68**      **Cerebrovascular disorders in diseases classified elsewhere**  
**I68.0 Cerebral amyloid angiopathy (E85.-+)**  
**I68.1 Cerebral arteritis in infectious and parasitic diseases classified elsewhere**  
 Cerebral arteritis:  
 • listerial (A32.8+)  
 • syphilitic (A52.0+)  
 • tuberculous (A18.8+)  
**I68.2 Cerebral arteritis in other diseases classified elsewhere**  
 Cerebral arteritis in systemic lupus erythematosus (M32.1+)  
**I68.8 Other cerebrovascular disorders in diseases classified elsewhere**
- I69**      **Sequelae of cerebrovascular disease**  
*Note:* This category is to be used to indicate conditions in I60-I67 as the cause of sequelae, themselves classified elsewhere. The "sequelae" include conditions specified as such or as late effects, or those present one year or more after onset of the causal condition.  
**I69.0 Sequelae of subarachnoid haemorrhage**  
**I69.1 Sequelae of intracerebral haemorrhage**  
**I69.2 Sequelae of other nontraumatic intracranial haemorrhage**

- 
- I69.3 Sequelae of cerebral infarction**
  - I69.4 Sequelae of stroke, not specified as haemorrhage or infarction**
  - I69.8 Sequelae of other and unspecified cerebrovascular diseases**

*International Classification of Diseases: Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, 1975 Revision.* World Health Organization; 1977.