Determination of Last Known Well Time in the Michigan Stroke Coverdell Registry

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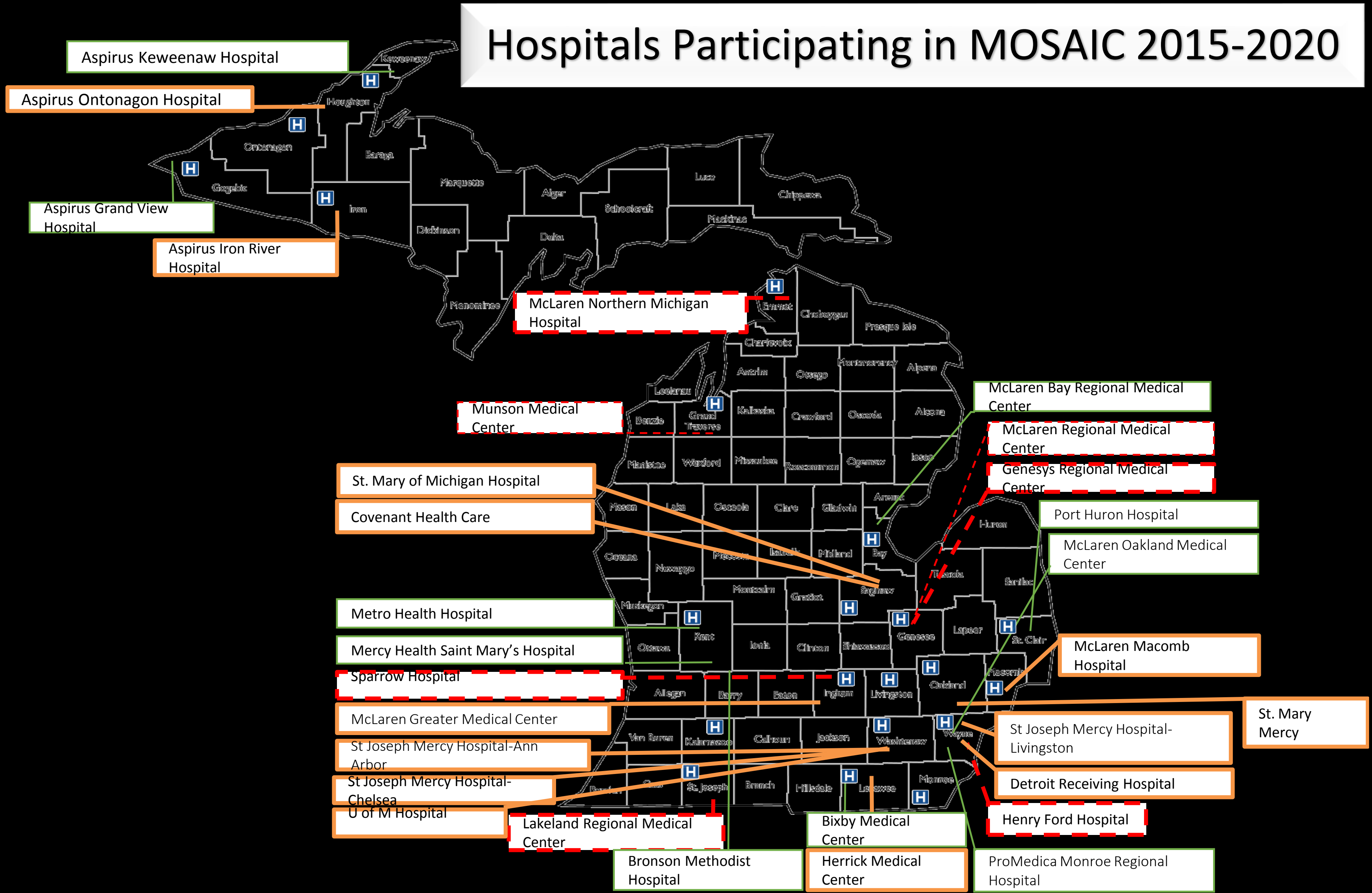
The Coverdell Program

- In 2001, Congress provided funding to the CDC to establish the Paul Coverdell National Acute Stroke Registry (PCNASR)
- Named after US Senator Paul Coverdell of GA, who suffered a fatal stroke in 2000 while serving in Congress
- 2012, renamed the PCNASP
- The registries, leg by academic principal investigators and medical institutions, collected data on the quality of stroke care
  - Initial Emergency response through hospital discharge
- Results from the prototype phase indicated that many patients were not receiving optimal care

MASCOTS → MiSRQIP → MOSAIC

- The state of MI has been participating in the Coverdell Program since its inception in 2001
- During the prototype phase (2001 – 2004) → Michigan Acute Stroke Care Overview and Treatment Surveillance System (MASCOTS)
- 2007, Michigan Department of Comunity Health was awarded a new grant → Michigan Stroke Registry and Quality Improvement Program (MiSRQIP)
  - 36 hospitals began tracking their delivery of acute stroke care in GWTG
- 2012, MDCH received additional funding by the CDC to continue its work to improve the quality of stroke care → Michigan's Ongoing Stroke Registry to Accelerate the Improvement of care (MOSAIC)

MOSAIC Dataset Allows for Robust Sampling Throughout MI



Last Known Well Time and Data Missingness

- Last known well (LKW) time is critical information when determining eligibility for acute stroke treatments, but is often either unknown or not documented.
- Missing data may be subject to selection bias (i.e. missing not at random (MNAR). Data MNAR can have a significant impact on statistical analysis leading to biased estimates, increased standard errors, weakened generalizability of findings and decreased statistical power[1,2].
- Missing LKW may be related to key patient characteristics (time of presentation, stroke severity, diagnostic certainty, witnessed event) as well as hospital characteristics. These factors may also correlate with a lack of treatment.

Objective

- Our aim was to use the Michigan Stroke Coverdell Registry to identify independent predictors of missing LKW times.

- **We hypothesized that the location of stroke occurrence, arrival mode and stroke symptoms of aphasia and altered level of consciousness would correlate with higher rates of missingness.**

Methods

- Forty hospitals contributed data to MOSAIC via the *Get With The Guidelines–Stroke* Patient Management Tool between 2008- Q1 2017.
- Adult patients with any stroke type who presented to the emergency room were included.
- Means and percents, were generated to describe the study population. Chi-square statistics were used to compare characteristics between patients that had a missing LKW time vs. those that had a recorded time.
- Independent factors associated with missing LKW time were identified using multivariable logistic regression. Potential confounding variables with a significant bivariate association (P<0.2 to enter) were and retained if they remained significant in the final model (P<0.05 to stay).
- To account for hospital-level clustering, we generated logit models using general estimating equations.
- All analyses were conducted using Version 9.2.

Methods

Total number of patients in registry
2008 - March 2017
N=63,412

Exclusions:
Patients with in-hospital strokes: N=1,531
Transferred patients: N=10,815

Final sample for analysis:
N=51,066

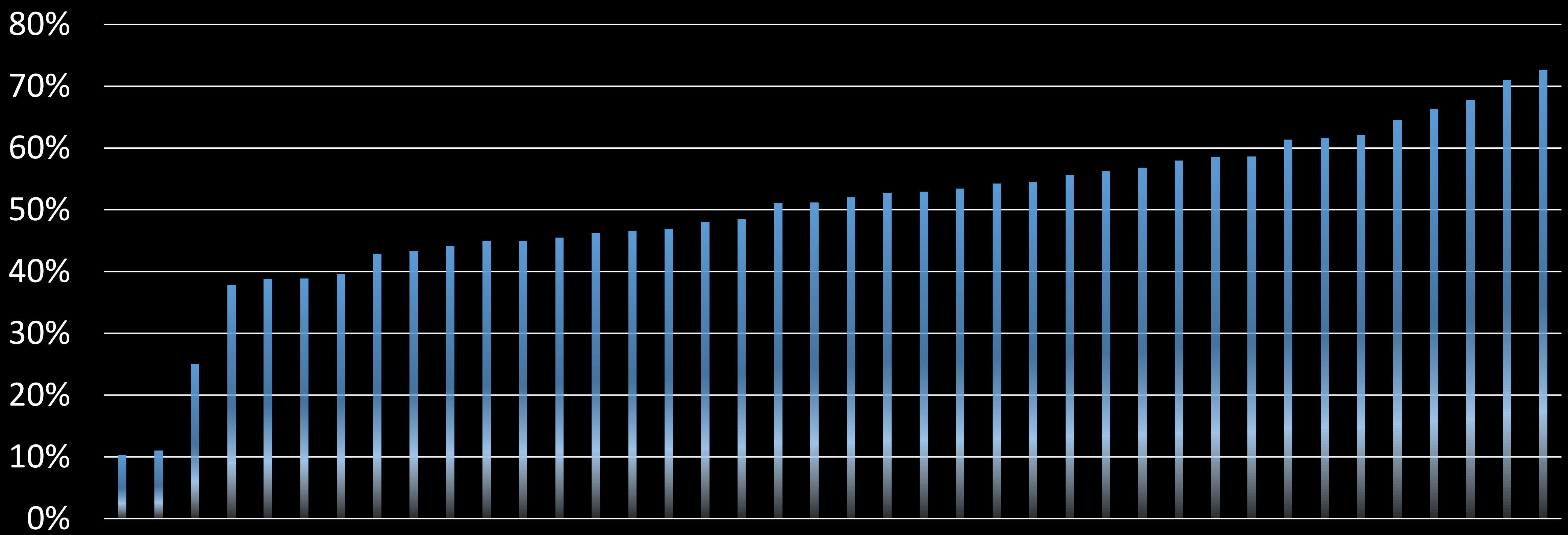
Results

Characteristics of Patients and Association with Missing Last Known Well Time in the Michigan Stroke Coverdell Registry

	Total N = 51,066 (%)	LKW missing N % 24,675 (48.3%)§	LKW recorded N (%) 26,391 (51.7) &	Adjusted OR (95%CI)* &
Age (median)	72.0	72.0	72.0	
Sex				
Female	26865 (52.6)	13126 (48.9)	13739 (51.1)	1.04 (0.99, 1.10)
Race				
Caucasian	37162 (72.8)	17592 (47.4)	19570 (52.6)	ref
Non-Caucasian	13904 (27.2)	7083 (50.9)	6821 (49.1)	1.16 (1.06, 1.27)
Place stroke occurred				
Home	46751 (91.5)	22287 (47.7)	24464 (52.3)	Ref
Acute care facility	718 (1.4)	465 (64.8)	253 (35.2)	1.64 (1.31, 2.05)
Chronic care facility	2789 (5.5)	1505 (54.0)	1284 (46.0)	1.58 (1.42, 1.76)
Outpatient setting	632 (1.2)	317 (50.2)	315 (49.8)	1.15 (0.91, 1.45)
Unknown	176 (0.34)	101 (57.4)	75 (42.6)	1.52 (0.57, 4.04)
Arrival mode				
EMS	26806 (52.5)	11564 (43.1)	15242 (56.9)	Ref
Private	23193 (45.4)	12466 (55.4)	10727 (44.6)	1.71 (1.54, 1.90)
Unknown	1067 (2.1)	645 (60.5)	422 (39.5)	1.81 (1.35, 2.43)
Stroke Type				
Ischemic	34655 (67.9)	16531 (47.7)	18124 (52.3)	Ref
Hemorrhagic	5371 (10.5)	2933 (54.6)	2438 (45.4)	1.48 (1.29, 1.70)
TIA	10116 (19.8)	4606 (45.5)	5510 (54.5)	0.75 (0.67, 0.85)
Stroke Not Specified	924 (1.8)	605 (62.5)	422 (37.5)	1.12 (0.94, 1.33)
Stroke risk factor				
Atrial fibrillation	8674 (17.0)	3834 (44.2)	4840 (55.6)	0.85 (0.82, 0.89)
Prior stroke	12503 (24.5)	5968 (47.7)	6535 (52.3)	1.06 (1.02, 1.09)
CAD/MI	14499 (28.4)	7099 (49.0)	7400 (51.0)	NS**
HTN	39189 (76.7)	19133 (48.8)	20056 (51.2)	NS
Prior TIA	6037 (11.8)	2595 (43.0)	3442 (57.0)	0.85 (0.79, 0.92)
Diabetes	16720 (32.7)	8400 (50.2)	8320 (49.8)	1.13 (1.09, 1.17)
Smoking	10047 (19.7)	5011 (49.9)	5036 (50.1)	1.15 (1.10, 1.19)
Hyperlipidemia	27437 (53.7)	11306 (47.8)	12323 (52.2)	NS
Symptoms				
Aphasia	184 (0.4)	122 (66.3)	62 (33.7)	2.11 (1.53, 2.91)
Altered LOC	1505 (3.0)	742 (49.3)	763 (50.7)	NS
Weakness/paresis	9228 (18.1%	4714 (51.1)	4514 (48.9)	1.37 (1.25, 1.51)

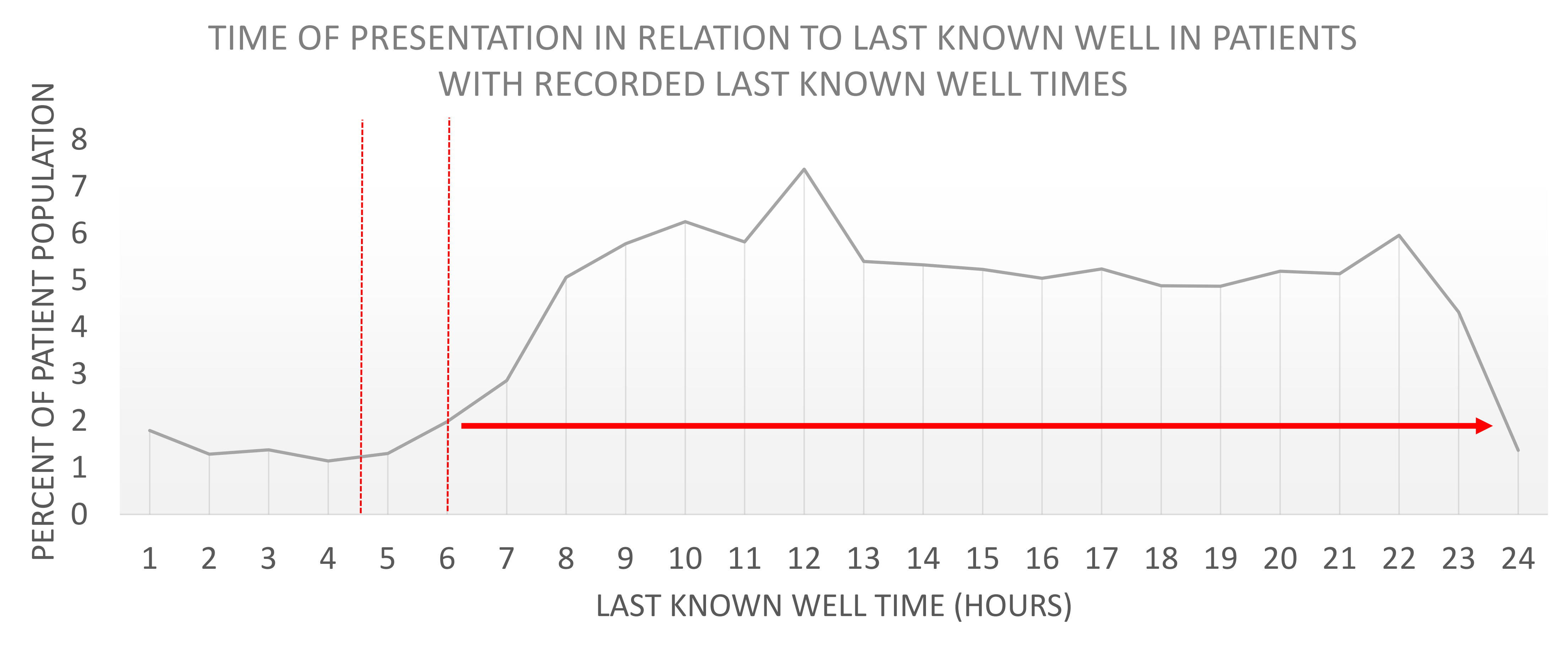
*Adjusted odds ratios and 95% CIs generated from a multivariable logistic regression model.
**NS= non-significant (P> 0.05) . Variable dropped from final multivariable model
§The second column includes column percents; &The third and fourth columns include row percents
TIA – transient ischemic attack, CAD – coronary artery disease, MI – myocardial infarction, LOC – level of consciousness

Percent of Cases with Missing LKW Data by Participating Hospital is Highly Variable



Percent of cases with missing LKW data per hospital (range 10.3 – 72.5%; median 51.1%; N = 40).

The Majority of Strokes Present Outside of the IV Alteplase and 6 Hour Thrombectomy Window



Implications of ‘Data Missingness’

- Missing completely at random
- Missing at random
- Missing not at random
  - Missingness is specifically related to what is missing
  - Examples: aphasic patients, patients coming from home as opposed to EMS
- Several strategies which can be applied to improve data missingness
  - Obtain the missing data
  - Leave out incomplete cases
  - Replace missing data by a conservative estimate
  - Try to estimate the missing data from the other data on the person

Summary

- Last known well data was missing in 48.3% of cases
- Characteristics of cases associated with LKW missingness are non-Caucasian race, stroke occurrence in acute or chronic care facility, arriving via private vehicle, hemorrhagic stroke, prior stroke, diabetes, smoking, aphasia and paresis
- The percent of cases with missing LKW data vary widely from hospital to hospital
- Most patients with LKW documented presented outside a treatment window

Conclusions

- LKW missingness occurred in approximately 50% of strokes presenting to the emergency room, and characteristics associated with missing LKW suggest that available LKW data are likely MNAR.
- These results indicate areas where hospitals can try to improve documentation rates (e.g. patients presenting from other health care facilities, private transport, etc).
- Understanding patterns of data missingness, how informative the missing data are, and the potential impact on acute stroke care and stroke outcomes continues to be an important aspect to interpreting stroke epidemiological studies.

References

1. Dong Y and Peng C-Y J. Principled missing data methods for researchers. Methodology. 2013.
2. Tooth L. et al. Quality of Reporting of Observational Longitudinal Research. American Journal of Epidemiology. 2005.

Thank you!

- Mat Reeves
- Adrienne Nickles
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