Thomas Hemmen

Stroke Systems of Care Update 2018

UC San Diego
HEALTH SCIENCES

Where discoveries are delivered.SM

Why?

Thomas Hemmen, Stroke Director at UCSD since 2009, many years of acute stroke research experience and knowledge and understanding of systems of care and process improvement.

Over **5,000 San Diegans** have a stroke every year. It is the leading cause of adult disability.

Pre-hospital care is essential in the **chain of brain survival**. Stroke is a complex and highly time sensitive disorder.

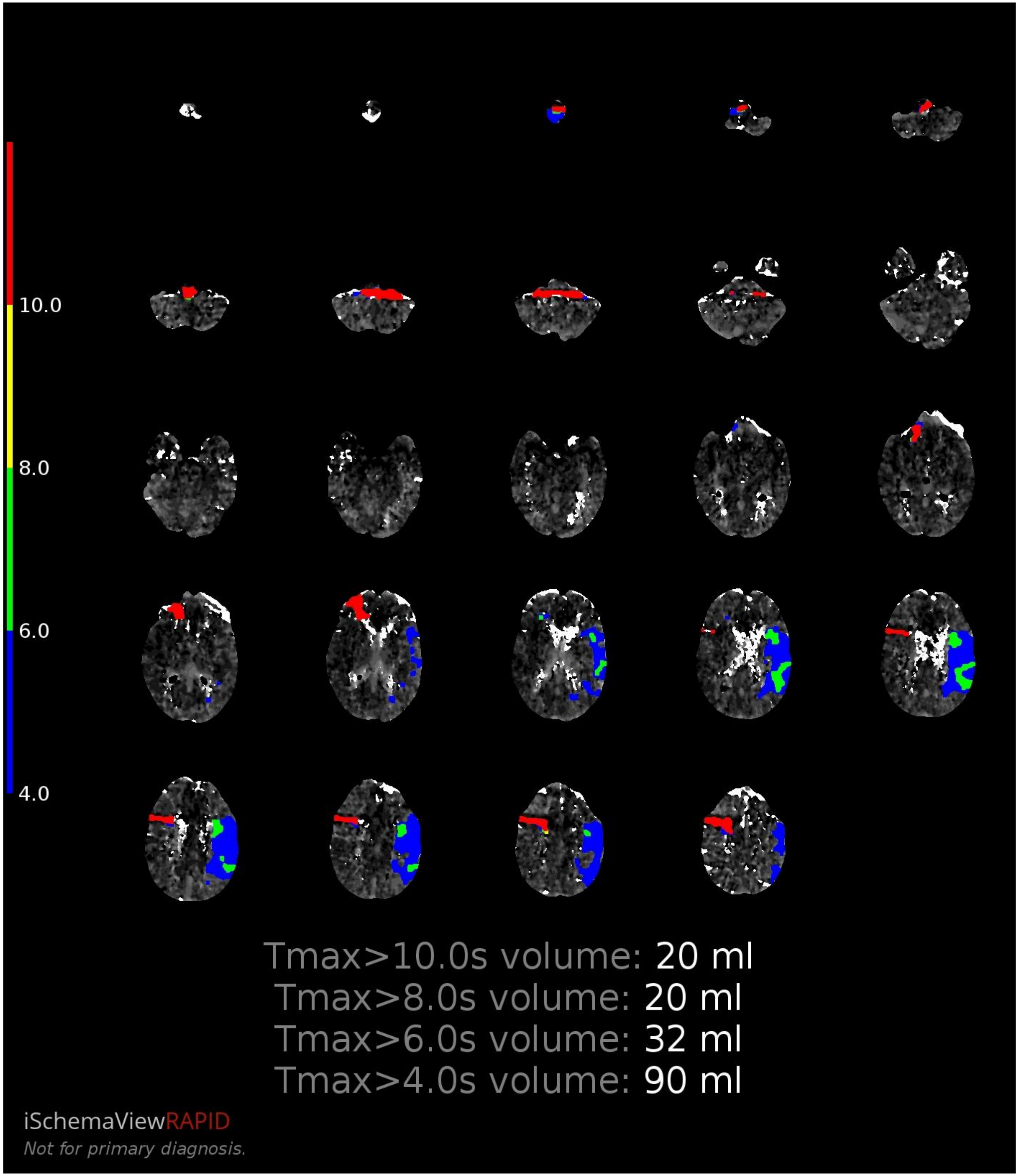
Pre-hospital care makes a difference.

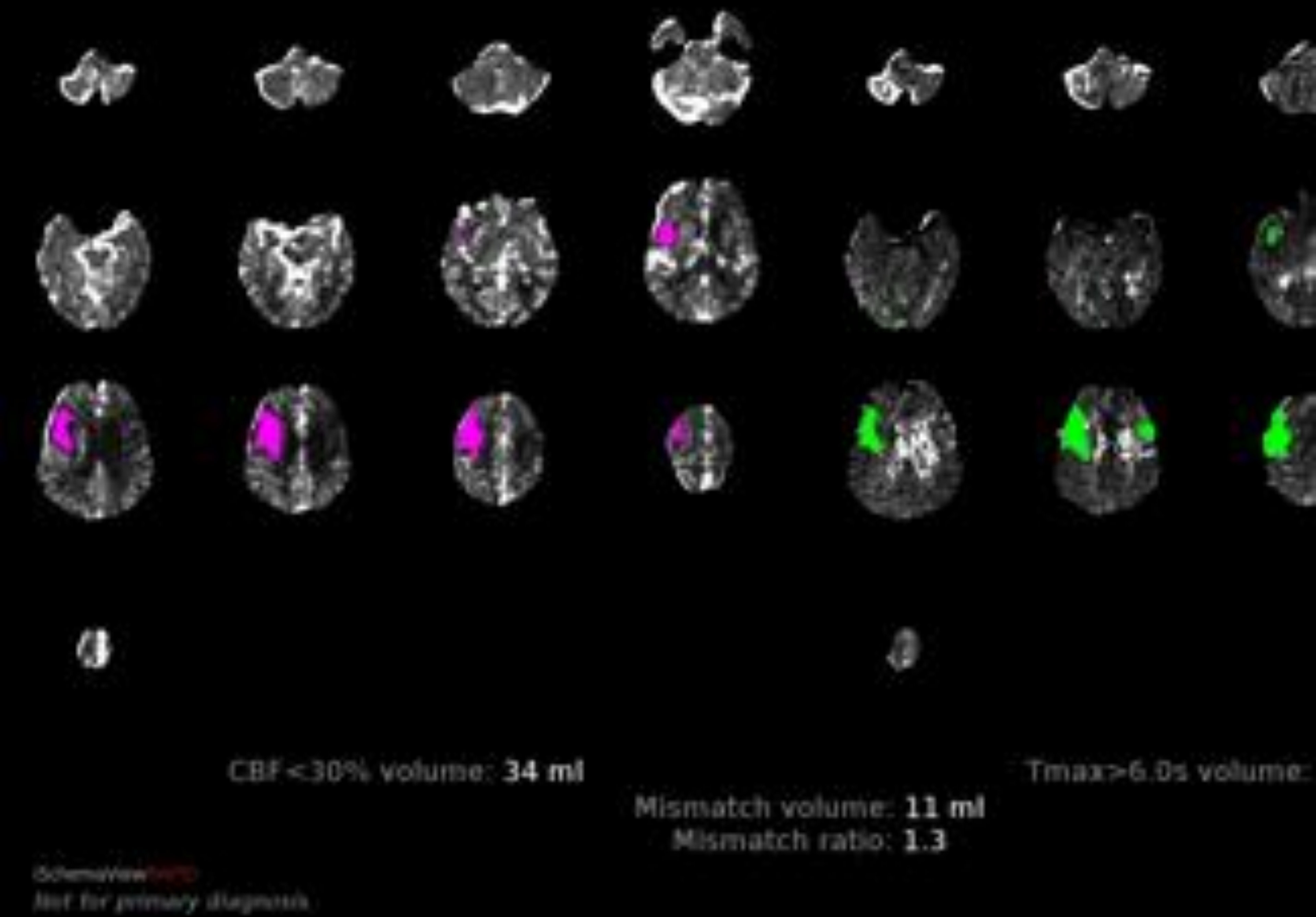
It matters how **fast** you receive your stroke care.

It matters **where** you receive your stroke care.

May 12, 2019

70 year old man
Warfarin for afib
Went to bed at 10pm
Woke up with aphasia
NIHSS 5
UCSD scan at 10:30am




CBF<30% volume: 34 ml
Tmax>6.0s volume:
Mismatch volume: 11 ml
Mismatch ratio: 1.3

Before 1995

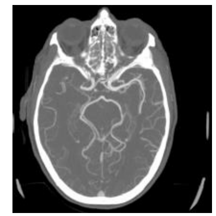
- No specific care to reverse stroke
- Most interventions focused on recovery and reduction of medical complications such as pneumonia and UTI

1995 - 2014

- Reversal agent (tPA) for acute ischemic stroke (AIS) patients within 4.5 hours of stroke onset

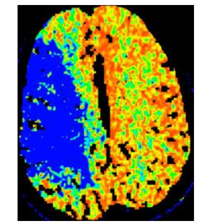
2014 - 2017

- Endovascular therapy for AIS within 6 hours

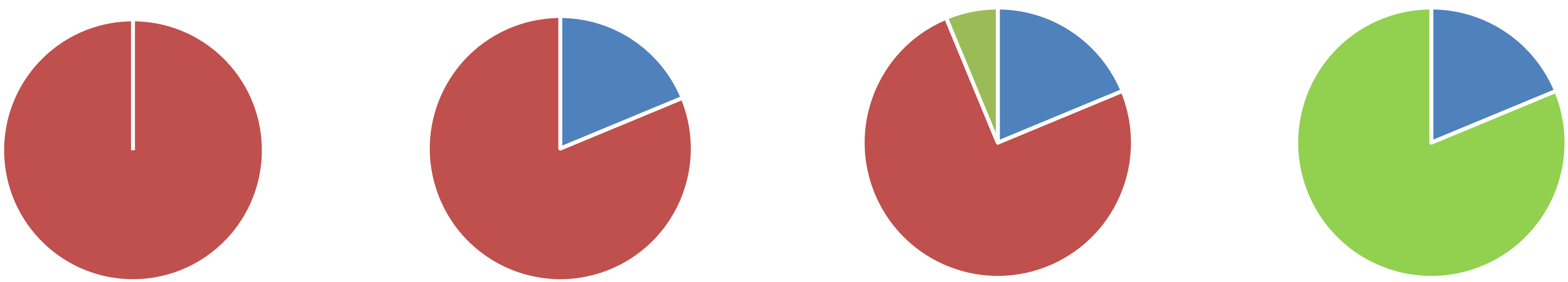


2018 -

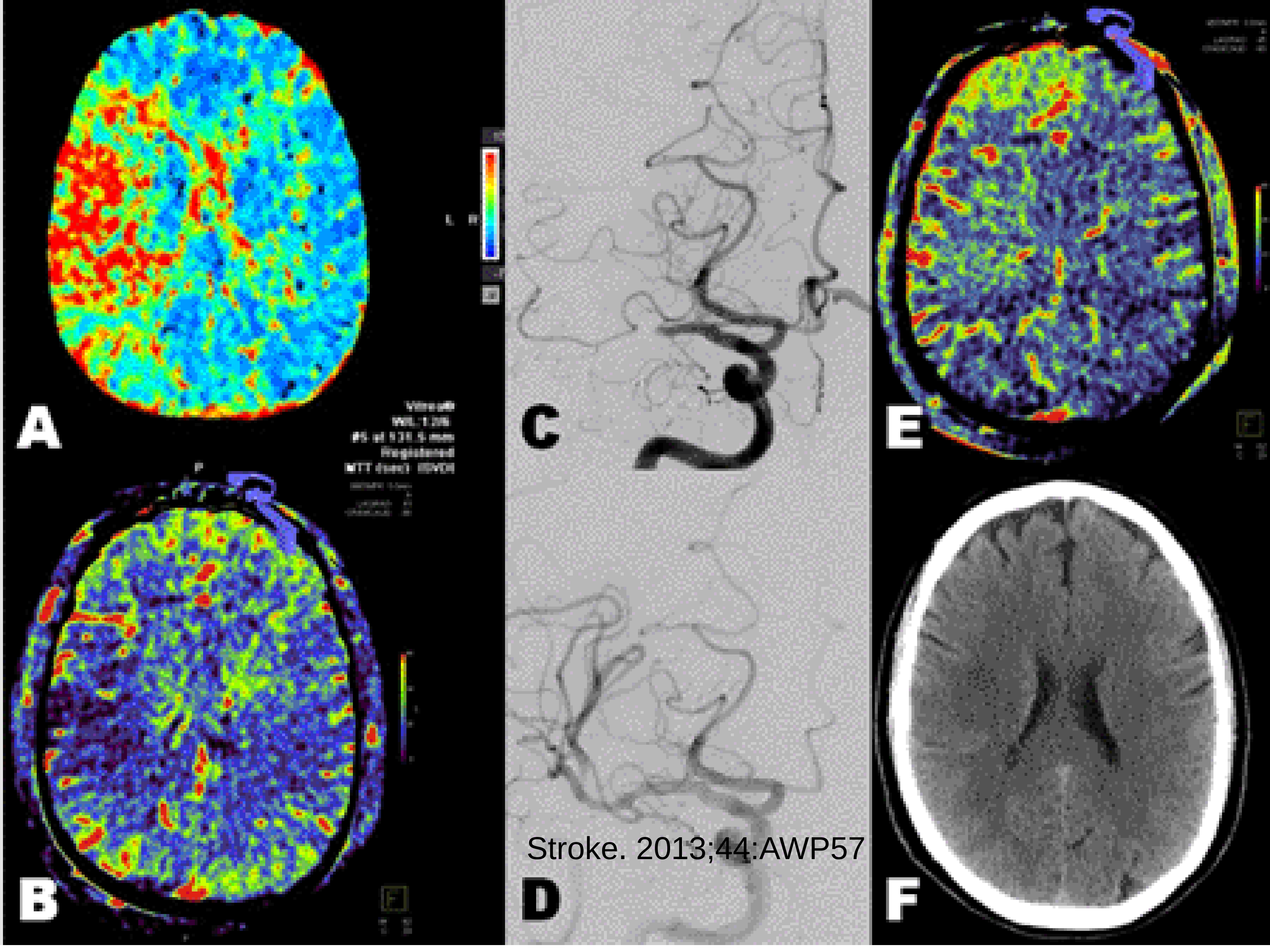
- Endovascular therapy for AIS within 24 hours



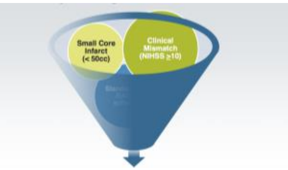
Time

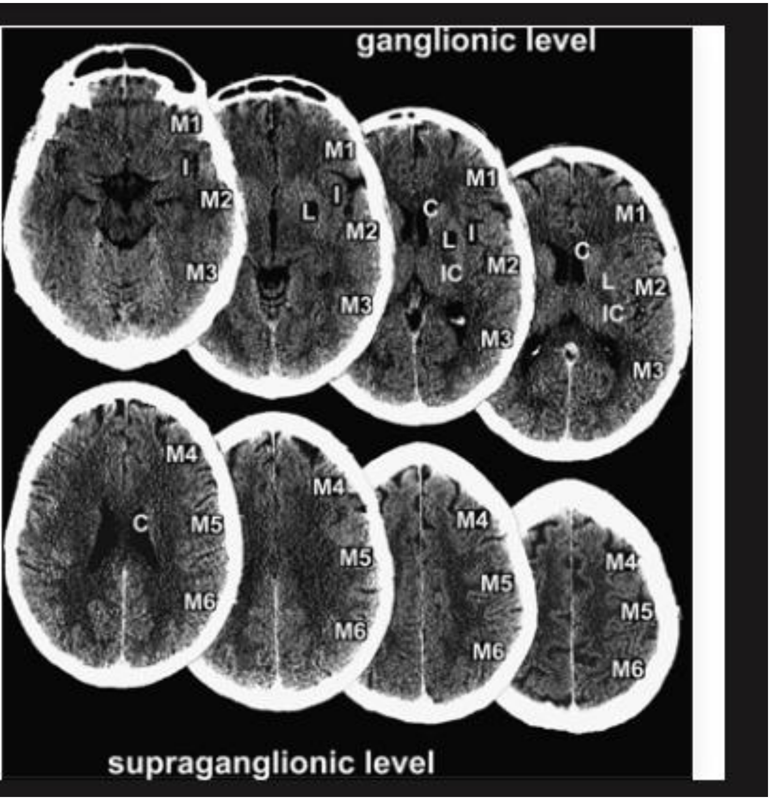


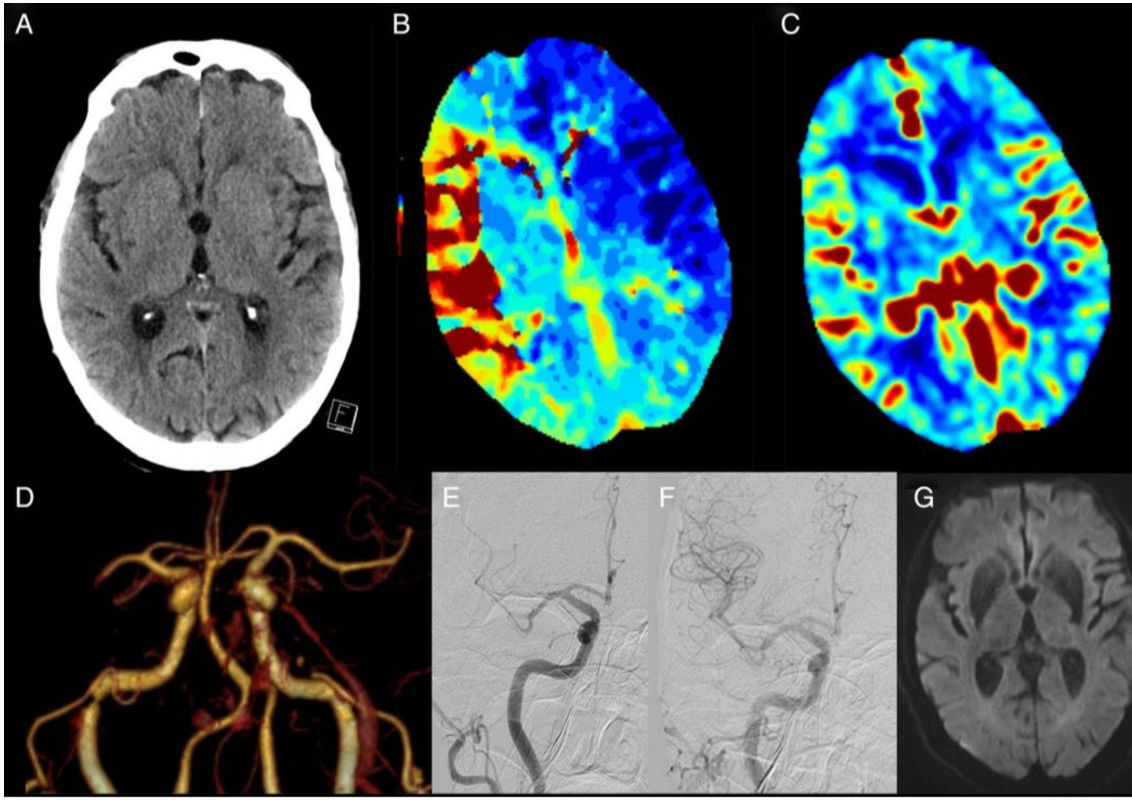
Stroke type	AIS	AIS	CT Angiogram	Perfusion CT
Scan	CT	CT	CT+CTA	CT+CTA+CTP
NIHSS	0-42		7-42	
Frequency	all	2-9%	10%	2%?


A
B
C
D
E
F
Stroke. 2013;44:AWP57

Neuroimaging





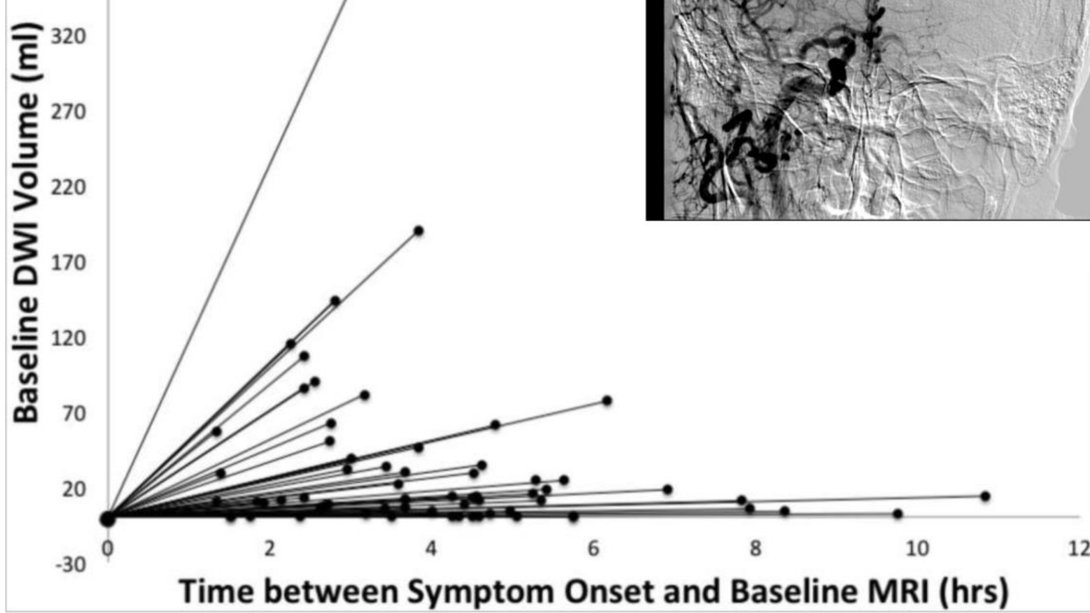


DOI: 10.1136/svn-2015-000004

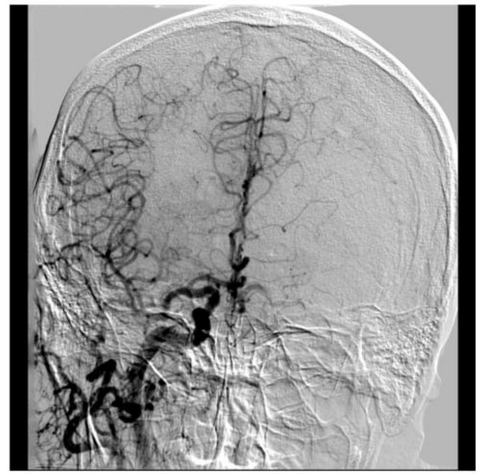
ASPECT
Every stroke patient can get this
6-10 yes
0-5 ?

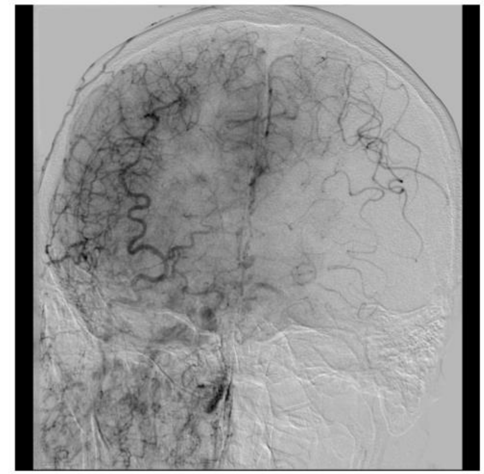
Multimodal
Who can get this?
All stroke codes
All confirmed strokes
?

Some patients' brain survive longer after stroke



Initial DWI growth rate for the 65 patients with known time of stroke onset. Graphed based on the assumption of infarct volume of 0 ml just prior to symptom onset and linear growth (based on initial findings in Part I of this study). Overall, median initial growth rate was 3.1 ml/hr, with a range from 0 ml/hr to 117 ml/hr.





Wheeler et al. Int J Stroke 2015

New Methods Aim to Speed Stroke Care

By Thomas M. Burton

Thousands of stroke victims are disabled every year because the right treatment comes too slowly. Some emerging technologies may change that.

The technologies use computer algorithms to cross-reference a stroke patient's brain scan with a vast database of scans from other victims, allowing a precise diagnosis in minutes.

It can be done by less-experienced doctors in outlying hospitals or by paramedics with portable scanning devices in an ambulance. The scans and results can be quickly sent to a specialist at a regional stroke treatment center who can confirm the diagnosis.

The result: Victims of strokes—an interruption of the brain's blood supply that deprives brain tissue of oxygen—can be rushed to a stroke center with the most-skilled doctors who can remove blood clots. That contrasts with a too-common scenario: languishing for hours at a less-equipped hospital waiting for a diagnosis that often comes too late to help.

"There is no more time-sensitive treatment in all of medicine than treating the stroke victim," said Thomas G. Devlin, chairman of neurology at the University of Tennessee's Erlanger Medical Center in Chattanooga, a top stroke-treatment center. "The new technology has the potential for shaving off critical minutes, sometimes even hours, in the diagnosis, triage and treatment of stroke."

Companies developing different forms of this new technology include Viz.ai Inc. of San Francisco and Neural Analytics Inc. of Los Angeles. Both have been testing their new imaging at Erlanger and elsewhere. Another important new technology, called RAPID from IschemaView Inc. of Redwood City, Cal., produces automated images showing how much brain tissue is salvageable after a severe stroke.

At issue with the technologies are the most severe blockages in major arteries caused by clots.

Under current protocols, patients with severe strokes are typically rushed to the nearest hospital, regardless of the facility's ability to treat the most-severely ill patients. Once there, such patients undergo tests and scans for a diagnosis that often takes hours.

With the clock ticking, many patients find their best chance for survival and recovery is an innovative procedure called a thrombectomy, which allows doctors to remove a clot to restore blood flow, according to doctors, medical records and journal articles.

The thrombectomy has proven highly effective and is transforming stroke treatment. But many stroke patients lack timely access to the complex procedure.

Many hospitals don't have the expertise or the facilities, leaving them with two choices: Lose precious time transferring a patient to a better-equipped stroke center, or treat the patient with a clot-dissolving drug. This drug works well for some moderately ill stroke patients. But the therapy often fails for thousands with large clots blocking major arteries.

A study in the journal Circulation last year of 984 such patients showed that treatment delays for them led to worse outcomes if they were transferred between hospitals instead of going straight to a hospital that could pull clots out with a thrombectomy.

Erlanger treated 1,721 patients last year with clot-based strokes, 180 of whom got thrombectomies. The hospital employs a far-flung network of helicopters and ambulances that can rush stroke patients from up to 150 miles away. But like most top stroke centers, Erlanger depends on fast referrals from other hospitals for optimal treatment. Minutes make all the difference.

In one case during January, a 64-year-old stroke patient arrived at another Chattanooga hospital at 1:07 p.m. After two brain scans, she was transferred to Erlanger at 8:06 p.m., too late for a thrombectomy, Dr. Devlin said. She now resides in a nursing home, unable to speak or use her right leg and arm, her husband said.

The University of Tennessee's Erlanger Medical Center is testing new technologies that could help diagnose stroke patients more quickly.

Doctors Put Faith in Artificial Intelligence

Chris Mansi, a British neurosurgeon, helped develop the idea for Viz.ai Inc.'s technology after participating in a 2014 operation on a brain-injured woman who died because it took four hours to get her to the right hospital.

Dr. Mansi later enrolled in Stanford Business School where he developed technology to speed such patients to the right specialist for better outcomes.

He also took a course on venture capital for entrepreneurs, taught by former Google chief Eric Schmidt. At the course's end, Dr. Mansi made a presentation that impressed Mr. Schmidt. His venture-capital fund and others invested $7.5 million in what became Viz.ai, where Dr. Mansi is CEO.

"I like the medical imaging area, as I think AI will lead to much better outcomes," Mr. Schmidt said.

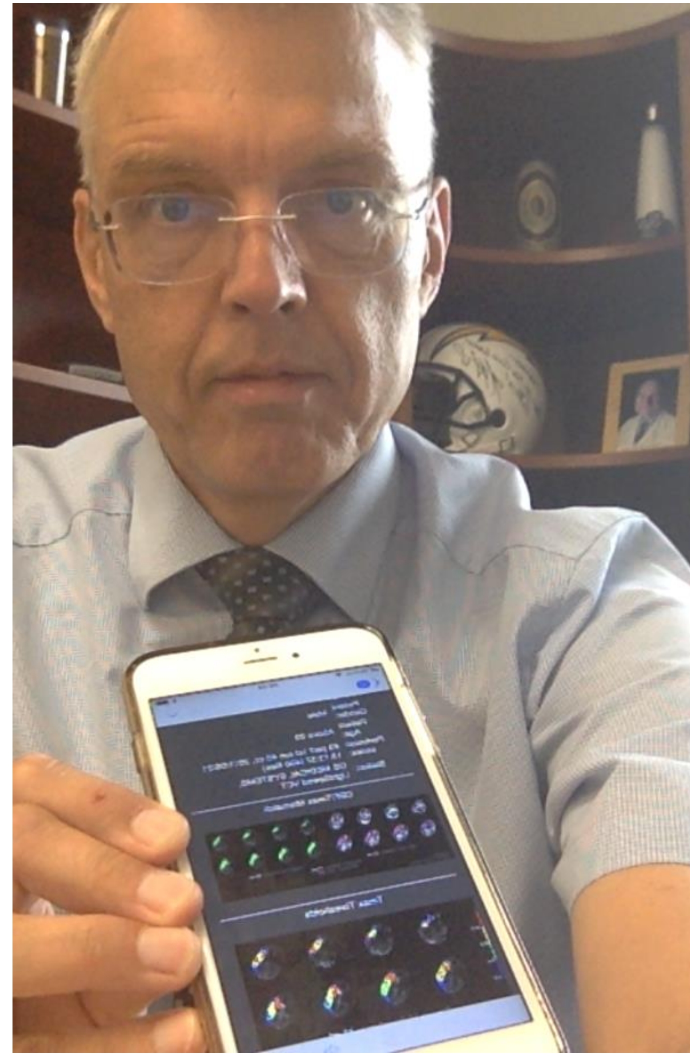
The technology from Viz.ai (The ai is for artificial intelligence) recently gained Food and Drug Administration approval. The company is talking to hospitals about installing its diagnostic software, which would let neurologists see brain scans almost simultaneously.

A Viz.ai study of 300 patients, which prompted the FDA approval, showed that the company's software was able to notify a stroke neurologist on average 7.3 minutes after the brain imaging took place. That compared with the hours that it can take otherwise.

The other company developing similar stroke technology, Neural Analytics, uses ultrasound devices that would attach to the patient's head in the ambulance to produce images that measure blood flow in the brain, comparing it with a database of thousands of such images to quickly pinpoint the problem. Paramedics could quickly send the image to a stroke hospital.

Robert Hamilton, the company's chief scientific officer, was a Ph.D. student in bioengineering at UCLA when he and colleagues thought of this technology for other types of brain injuries. They realized that it could be used to rapidly detect strokes caused by blood clots. Neural Analytics' most recent study showed its technology detects 97% of large-artery strokes.

It is seeking FDA approval.




PARAMEDICS
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254
AMERICAN MEDICAL RESPONSE
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Prehospital System Overview - Advanced Life Support (ALS) Calls

Leading Provider Impression Categories by Age Group in San Diego County, 2013

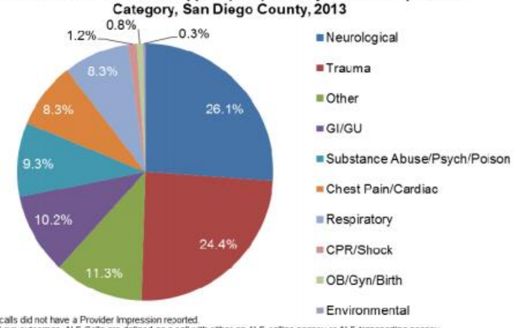
Age Group				
0-14	**15-24**	**25-64**	**65+**	**Total**
Trauma 4,162	Trauma 7,095	Neurological 22,917	Neurological 24,201	Neurological 53,678
Neurological 2,697	Substance Abuse/ Psych/Poison 3,917	Trauma 21,846	Trauma 16,998	Trauma 50,101
Respiratory 1,991	Neurological 3,863	Substance Abuse/ Psych/Poison 13,049	Other 8,766	Other 23,183
Other 1,826	GI/GU 1,800	GI/GU 11,347	Respiratory 8,163	GI/GU 20,875
GI/GU 636	Other 1,465	Other 11,126	GI/GU 7,092	Substance Abuse/ Psych/Poison 19,079
Substance Abuse/Psych/Poison 571	Respiratory 736	Chest Pain/Cardiac 9,490	Chest Pain/Cardiac 6,871	Chest Pain/Cardiac 17,110
Chest Pain/Cardiac 128	Chest Pain/Cardiac 621	Respiratory 6,165	Substance Abuse/ Psych/Poison 1,542	Respiratory 17,055
Environmental 91	OB/Gyn/Birth 524	CPR/Shock 956	CPR/Shock 1,329	CPR/Shock 2,386
CPR/Shock 60	Environmental 118	OB/Gyn/Birth 914	Environmental 67	OB/Gyn/Birth 1,509
OB/Gyn/Birth 22	CPR/Shock 41	Environmental 290	OB/Gyn/Birth 49	Environmental 566

N=206,617; 1,075 calls did not have an age or a Provider Impression reported.
Note: ALS Calls are defined as a call with either an ALS calling agency or ALS transporting agency.
Source: County of San Diego Health & Human Services Agency, Emergency Medical Services Prehospital QCS MICN Database, 2013.

In 2013, overall, there were nearly 2,650 more neurological related ALS calls than in 2012, and it remained the leading Provider Impression (PI) category. Among the 15-24 year age group, the substance abuse/psych/ poison related PI category moved from the 3rd leading PI category in 2012 to the 2nd leading PI category in 2013. Otherwise, the rankings remained the same from 2012 to 2013.

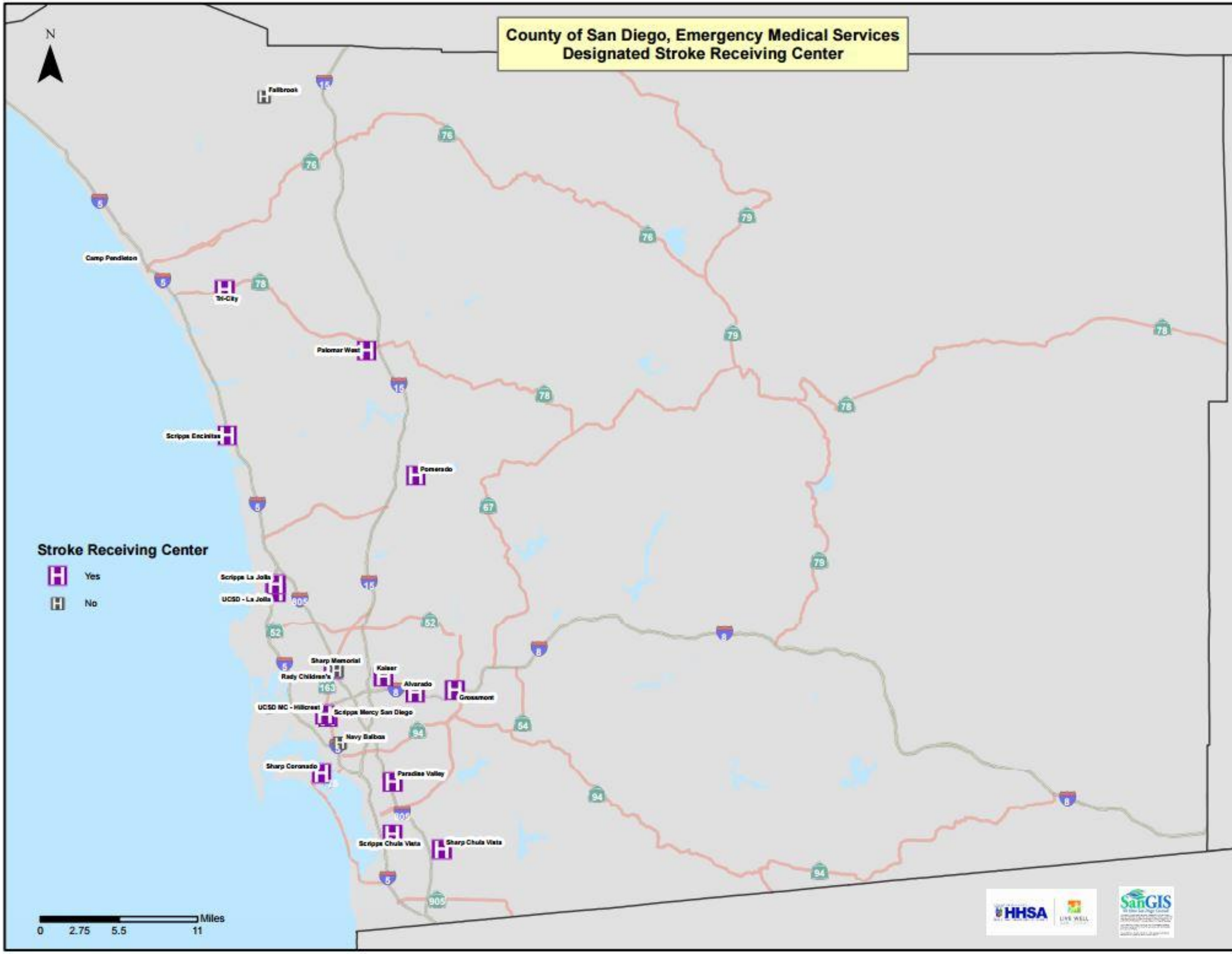
Prehospital System Overview - Advanced Life Support (ALS) Calls

Percent of Advanced Life Support (ALS) Calls by Provider Impression Category, San Diego County, 2013

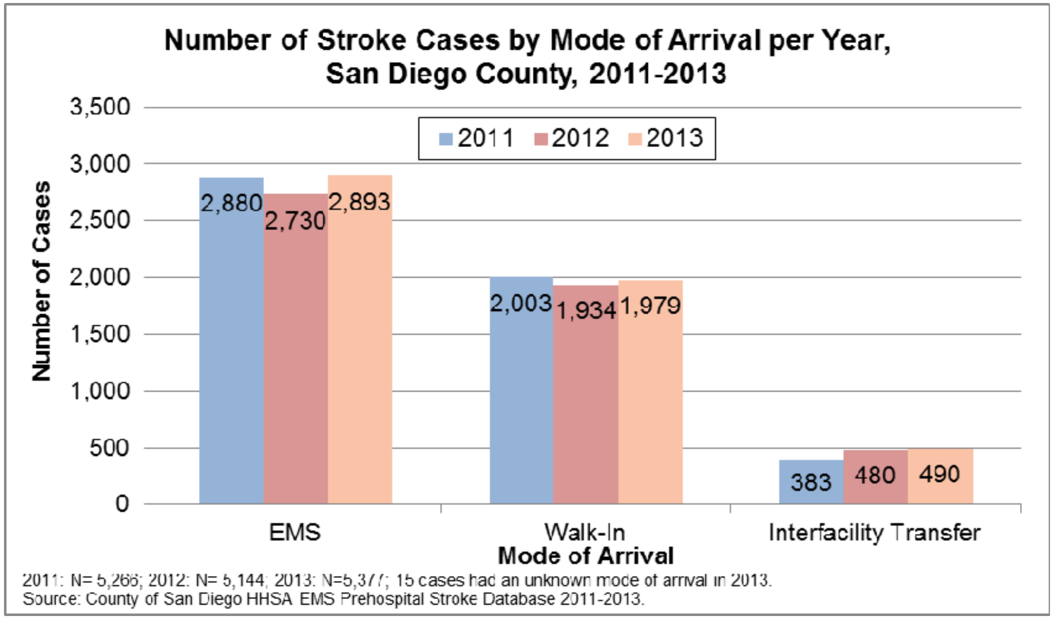


N=206,617. 729 calls did not have a Provider Impression reported.
Note: Includes all run outcomes. ALS Calls are defined as a call with either an ALS calling agency or ALS transporting agency.
Source: County of San Diego Health & Human Services Agency, Emergency Medical Services Prehospital QCS MICN Database, 2013.

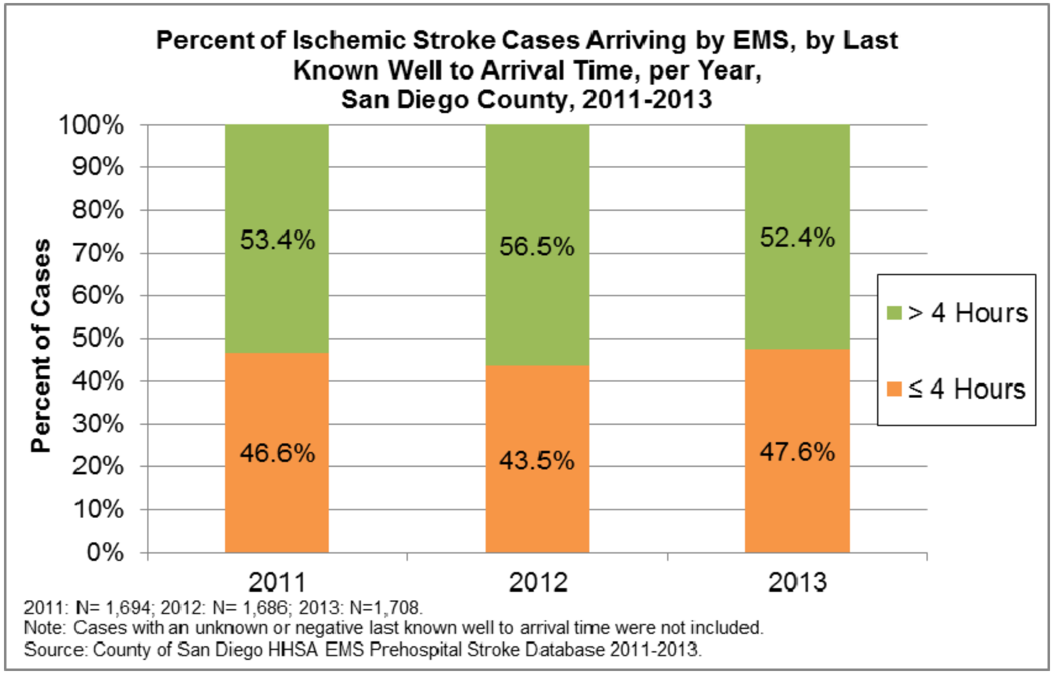
In 2013, more than one fourth of ALS calls were neurological related, and another 24.4% were trauma related.


County of San Diego, Emergency Medical Services
Designated Stroke Receiving Center
N
Fallbrook
Camp Pendleton
Tri-City
Palomar West
Scripps Encinitas
Pomerado
Scripps La Jolla
UCSD - La Jolla
Sharp Memorial
Rady Children's
Kaiser
Alvarado
Grossmont
UCSD MC - Hillcrest
Scripps Mercy San Diego
Navy Balboa
Sharp Coronado
Paradise Valley
Scripps Chula Vista
Sharp Chula Vista
Stroke Receiving Center
Yes
No
Miles
0
2.75
5.5
11
HHSA
SanGIS

EMS SYSTEM REPORT



5,377 cases
53.8% per EMS
No change over time



47.5% of all EMS transported stroke patients arrive <4 hours from LKN

Using San Diego County Stroke Receiving System Data to Identify Areas in Need of Public Health Intervention

Lindsay Olson-Mack, FNP-BC[1]; Amelia Kenner Brininger, MPH[2]; Diane Royer, RN[2]; Bruce Haynes, M.D[2]; Thomas Hemmen, M.D.[3]
1. Scripps Health, 2. County of San Diego Emergency Medical Services, 3. University of California, San Diego

BACKGROUND

Annually, over 790,000 Americans suffer a stroke of which 130,000 die. Locally, in San Diego County, there are more than 6,700 stroke hospitalizations and about 1,000 stroke deaths each year. Chances of full recovery or decreased disability increase when treatment is received shortly after stroke symptoms start. The emergency medical system plays an important role in getting patients to care quickly. However, since 2010, each year approximately 50% of stroke cases treated at a San Diego County Stroke Receiving Center arrived by emergency medical services (EMS).

In 2009, the San Diego County Stroke Receiving System was established to enhance communication between emergency medical service providers and hospital staff and to designate hospitals as Stroke Receiving Centers by County of San Diego EMS. Initially, the system was comprised of 15 designated Stroke Receiving Centers, and has grown to now include 17 designated hospitals. In addition, the San Diego County Stroke Receiving System Database was created for surveillance and quality assurance.

Beginning with 2014 stroke cases, Stroke Receiving Centers began submitting patient zip code, along with the 16 other stroke case data elements, to County of San Diego EMS. The regional distribution of the EMS arrival for stroke cases throughout San Diego was investigated. The aim was to document regional difference that may provide opportunities for improvement in community outreach.

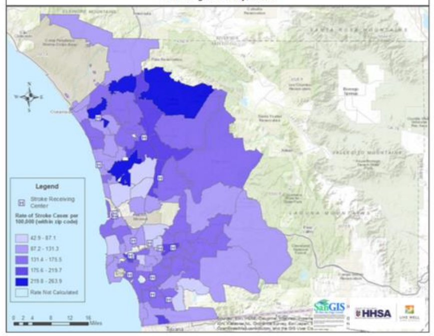
METHODS

Case inclusion criteria was based on cases with a principle discharge diagnosis of stroke, age 18 years and older, stroke that occurred outside of the discharging hospital, and arrival date between 1/1/2015 and 12/31/2015. Stroke incidence was analyzed by zip code, in cases per 100,000 population, along with the percent of cases utilizing EMS out of all stroke discharges by zip code.

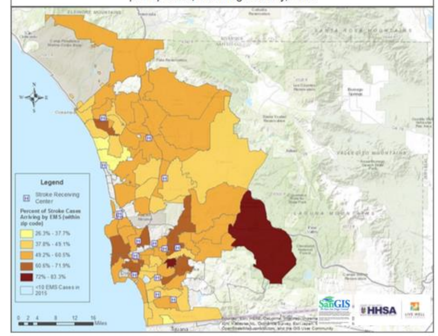
Each zip code was characterized by race/ethnicity, age, use of prescriptions for high blood pressure, diabetes, and smoking from ESRI Community Analyst. Zip codes with fewer than 10 EMS stroke cases were excluded.

Pearson correlation with significance level of $p<0.05$ was used to test for associations.

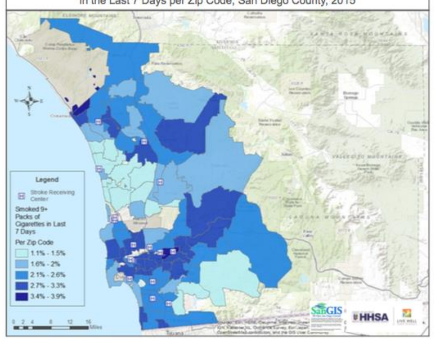
Rate of Stroke Cases per 100,000 Residents per Zip Code, San Diego County, 2015



Percent of Stroke Cases Arriving by Emergency Medical Services per Zip Code, San Diego County, 2015



Percent of Residents Smoking 9+ Packs of Cigarettes in the Last 7 Days per Zip Code, San Diego County, 2015



Correlation Results

		Rate of Stroke Case per 100,000^	Percent of Stroke Cases Arriving by EMS^
Percent Non-White	Pearson Correlation	-0.048	-0.151
	Sig. (2-tailed)	0.677	0.19
	N	77	77
Percent Age 50 Years and Older	Pearson Correlation	.338**	0.05
	Sig. (2-tailed)	0.003	0.663
	N	77	77
Percent Hispanic	Pearson Correlation	0.125	-0.197
	Sig. (2-tailed)	0.279	0.086
	N	77	77
Percent used prescription drug for high blood pressure	Pearson Correlation	.241*	0.15
	Sig. (2-tailed)	0.034	0.194
	N	77	77
Percent used prescription drug for diabetes (non-insulin dependent)	Pearson Correlation	.233*	0.153
	Sig. (2-tailed)	0.042	0.185
	N	77	77
Percent smoked 9+ packs of cigarettes in last 7 days	Pearson Correlation	0.126	.266*
	Sig. (2-tailed)	0.274	0.02
	N	77	77

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).
^not including zip codes with < 10 cases

RESULTS

Of the 5,302 stroke discharges submitted to the San Diego County Stroke Receiving System Database in 2015, 4,163 (78.5%) matched to 77 zip codes in San Diego County. The rate of stroke incidence ranged from 42.9 to 263.9 cases per 100,000 residents per zip code. The frequency of accessing EMS ranged from 26.3% to 83.3%.

The rate of stroke was positively correlated with older age ($p=0.003$), use of prescription drugs for high blood pressure ($p=0.034$) and use of prescription drugs for diabetes ($p=0.042$).

EMS utilization was correlated with zip codes with increased smoking ($p=0.02$). No other variable correlated with EMS use within zip codes.

CONCLUSIONS

It was determined that rate of stroke was positively correlated with population characteristics, which are well established as risk factors for stroke. This initial finding supported further investigation regarding relationship between these same risk factors and EMS utilization rates.

Markedly variant rates in EMS utilization across the region. Although this was correlated with increased smoking, the finding was not a robust enough predictor for higher EMS use within a zip code. These data suggest that further studies are needed to best understand the variance in EMS use. However, the regional difference justifies a targeted community outreach program to improve EMS utilization after occurrence of a stroke.

Additionally, this first study using system-level data for research purposes supports the collaborative efforts of the Stroke Receiving Centers and County of San Diego EMS to look for predictors of stroke, EMS utilization, and system performance in and for our community.

ACKNOWLEDGEMENTS

Thank you to the members of the San Diego County Stroke Consortium, San Diego County EMTs, Paramedics, and all health care professionals providing care to stroke patients.

CONTACT INFORMATION

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February 2017

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Lindsay, Amelia, Diane, Kristi, Thomas M Hemmen

Background:
Intravenous tPA has been proven the improve outcomes after acute ischemic stroke (AIS). The general use, however, has been lagging and most data from high use centers focused on large and academic medical centers. We established a comprehensive stroke registry within the County of San Diego to help benchmark stroke care, including tPA use and treatment times in 2010. We analyzed the change in tPA use frequency, distribution of treatment variance and treatment rate over time in a one of the largest community based stroke registries.

Methods:
The registry includes all out-of-hospital stroke patients from 16 stroke-receiving centers throughout San Diego County. We excluded hospitals with a rate of IV tPA per years under 5, and analyzed mode of arrival (EMS, walk-in), door to tPA and treatment rate per stroke-receiving center and system wide.. tPA treatment rate was calculated as ischemic stroke cases receiving tPA divided by all ischemic stroke cases.

Results:
From 2010 to 2016, a total of 22,191 patients were included (Table 1 shows patients per year). Of these patients, 58.5% arrived via EMS and 41.5% arrived as a walk-in to a stroke-receiving center. System-wide, in 2010, tPA treatment rate was 7.5%. In 2016, the tPA treatment rate was 16.2%. The number of AIS cases has increased by 6.1% in the same timeframe. The mean (+/- SD) arrival to treatment time was 128.8 minutes (+/- 426.2) in 2010. In 2016, the mean (+/- SD) arrival to treatment time was 60.7 minutes (+/- 32.0).

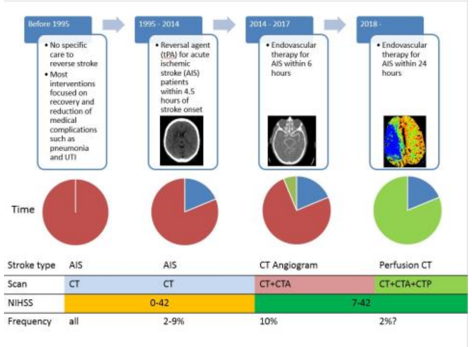
	2010	2011	2012	2013	2014	2015	2016
Total AIS (walk-in and EMS only)	3065	3109	3078	3320	3088	3279	3252
System-wide Treatment Rate	7.5%	8.8%	11.5%	14.1%	13.8%	15.1%	16.2%
Mean Minutes from Arrival to tPA (+/- SD)	128.8 (426.2)	89.2 (95.1)	112.5 (319.4)	91.8 (296.3)	78.2 (252.6)	61.0 (35.4)	60.7 (32.0)

Conclusion:
Over the past 7 years, tPA use in our community increased, while door to tPA decreased. Additionally, the variability of time to treatment across our system has decreased over this time. The use of a community based EMS stroke registry helped monitor and shape acute stroke treatment in our county. Through collaborative data-sharing, analysis and internal benchmarking, overall tPA treatment rates and times improved.

Chain of survival needs

- Most strokes occur outside the hospital
- Better tools to diagnose stroke in the field
- Assess stroke severity early to better triage
- Bridge between out-of-hospital and in-hospital care

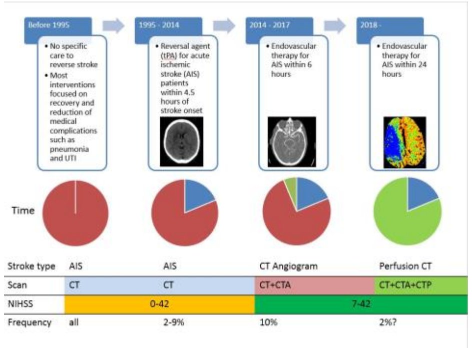
Acute Stroke 1995-2014



- Identify who has an acute stroke
- Find out the time the patient was last normal
- Transport to the nearest stroke center

- Hospital: Get CT, give tPA

Acute Stroke since 2014

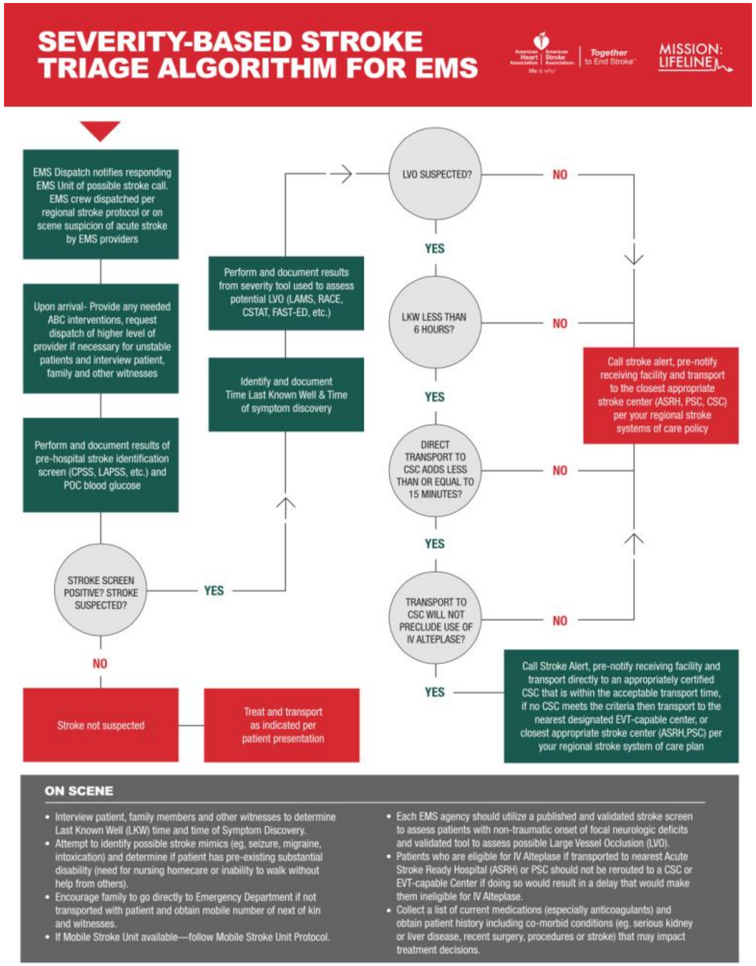


- Identify who has an acute stroke
- Find out the time the patient was last normal
- (Transport to the nearest stroke center)

- Hospital: Get CT, give tPA (<4.5 hours), get CTA, remove clot (<6 hours), if 6-24 hours get perfusion scan an assess ability to remove clot late

What if not all stroke centers are equal?

- Triage in the field
  - tPA hospital
  - Embolectomy hospital



Race Scale

The Rapid Arterial oCclusion Evaluation*

Table 1. RACE Scale

Item	RACE Score
Facial palsy	
Absent	0
Mild	1
Moderate to severe	2
Arm motor function	
Normal to mild	0
Moderate	1
Severe	2
Leg motor function	
Normal to mild	0
Moderate	1
Severe	2
Head and gaze deviation	
Absent	0
Present	1
Aphasia* (if right hemiparesis)	
Performs both tasks correctly	0
Performs 1 task correctly	1
Performs neither tasks	2
Agnosia† (if left hemiparesis)	
Patient recognizes his/her arm and the impairment	0
Does not recognized his/her arm or the impairment	1
Does not recognize his/her arm nor the impairment	2
Score total	0–9

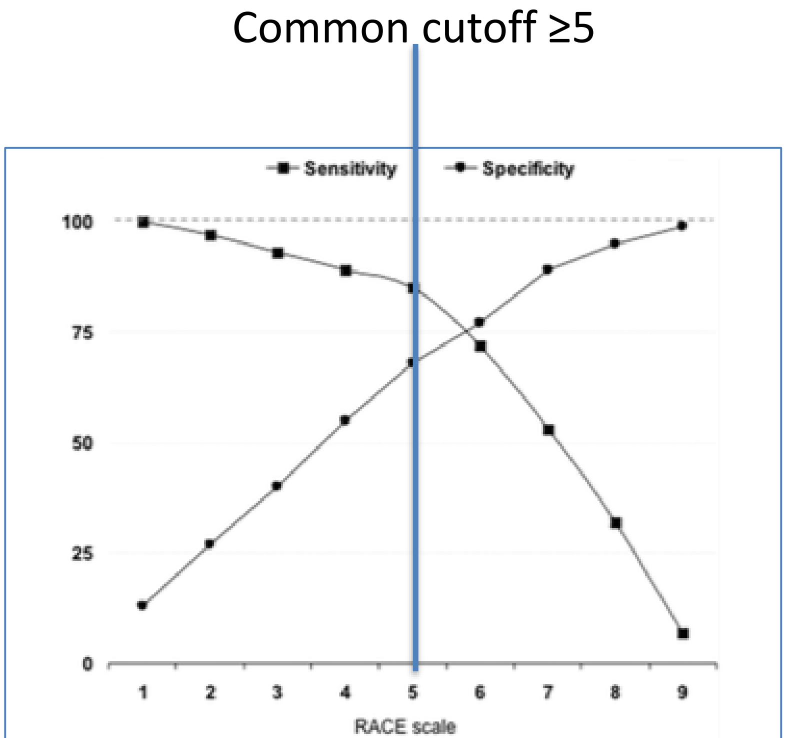
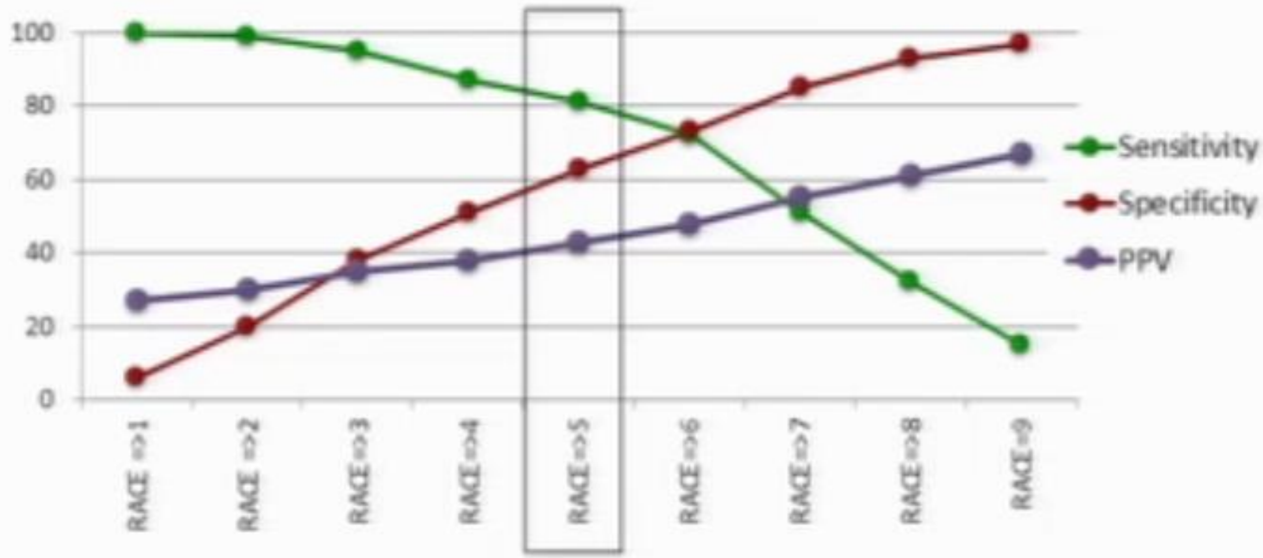


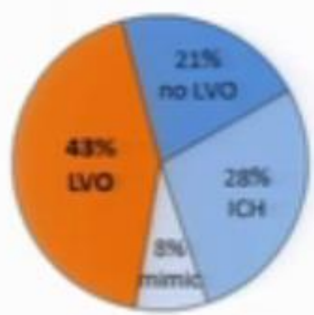
Figure 1. Sensitivity (squares) and specificity (circles) of different cutoff values of the Rapid Arterial oCclusion Evaluation (RACE) scale for the detection of large vessel occlusion.

*Stroke. 2014;45:87-91.

Results

1. Identification of LVO





Missed 19% of LVO

External Validation of the RACE scale, International Stroke Conference 2017

Los Angeles Prehospital Stroke Screen (LAPSS)*

1. Patient Name: ______________ Last ______________ First
2. Information/History from:
   - [ ] Patient
   - [ ] Family Member
   - [ ] Other

   ______________ Name Phone: ______________
3. Last known time patient was at baseline or deficit free and awake: Military Time: ________ Date: ________

SCREENING CRITERIA:

		Yes	Unknown	No
4.	Age > 45	[ ]	[ ]	[ ]
5.	History of seizures or epilepsy **absent**	[ ]	[ ]	[ ]
6.	Symptom duration **less than** 24 hours	[ ]	[ ]	[ ]
7.	At baseline, patient is **not** wheelchair bound or bedridden	[ ]	[ ]	[ ]

		Yes	No
8.	Blood glucose between 60 and 400:	[ ]	[ ]

9. Exam: **LOOK FOR OBVIOUS ASYMMETRY**

	Normal	Right	Left
Facial Smile/Grimace:	☐	☐ Droop	☐ Droop
Grip:	☐	☐ Weak Grip ☐ No Grip	☐ Weak Grip ☐ No Grip
Arm Strength:	☐	☐ Drifts Down ☐ Falls Rapidly	☐ Drifts Down ☐ Falls Rapidly

Based on exam, patient has **only unilateral** (and not bilateral) weakness: Yes [ ] No [ ]

10. ***Items 4,5,6,7,8,9 all YES's (or unknown) → LAPSS screening criteria met:*** Yes [ ] No [ ]

11. If LAPSS criteria for stroke met, call receiving hospital with a "code stroke", if not then return to the appropriate treatment protocol. (Note: the patient may still be experiencing a stroke even if LAPSS criteria are not met.)

*Stroke. 2000;31:71-76

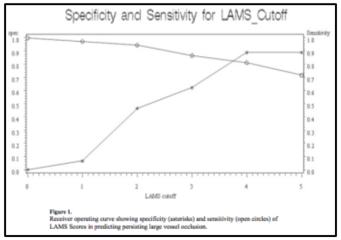
LAPSS (to detect any stroke)	
Sensitivity	59-91%
Specificity	48-97%
PPV	73-98%
NPV	45-98%

Emerg Med J 2016;33:818–822

The Los Angeles Motor Scale (LAMS)*

Table. The Los Angeles Motor Scale (LAMS)

Facial droop	
Absent	0
Present	1
Arm drift	
Absent	0
Drifts down	1
Falls rapidly	2
Grip strength	
Normal	0
Weak grip	1
No grip	2



*Stroke. 2008;39:2264-2267

Existing Tools for EMS

Stroke Scales	Stroke Scores
Cincinnati Prehospital Stroke Scale (CPSS / FAST)	National Institute of Health Stroke Scale (NIHSS)
Los Angeles Prehospital Stroke Screen (LAPSS)	sNIHSS –5 / 8
Melbourne Ambulance Stroke Screen (MASS)	Cincinnati Prehospital Stroke Severity Screen (CPSSS)
Miami Emergency Neurologic Deficit (MEND)	Field Assessment Stroke Triage for Emergency Destination (FAST-ED)
Recognition of Stroke in the Emergency Room Score (ROSIER)	Los Angeles Motor Scale (LAMS)
	Rapid Arterial Occlusion Evaluation Score (RACE)
	Three Item Stroke Scale (3ISS)

Los Angeles Prehospital Stroke Screen (LAPSS)

1. Patient Name: ____________________ Last ____________________ First
2. Information/History from:
   - [ ] Patient
   - [ ] Family Member ____________________ Name
   - [ ] Other

   Phone: ____________________
3. Last known time patient was at baseline or deficit free and awake: *Military Time:* __________ *Date:* __________

SCREENING CRITERIA:

	Yes	Unknown	No
4. Age > 45	[ ]	[ ]	[ ]
5. History of seizures or epilepsy **absent**	[ ]	[ ]	[ ]
6. Symptom duration **less than** 24 hours	[ ]	[ ]	[ ]
7. At baseline, patient is **not** wheelchair bound or bedridden	[ ]	[ ]	[ ]

	Yes	No
8. Blood glucose between 60 and 400:	[ ]	[ ]

9. Exam: **LOOK FOR OBVIOUS ASYMMETRY**

	Normal	**Right**	**Left**
Facial Smile/Grimace:	☐	☐ Droop	☐ Droop
Grip:	☐	☐ Weak Grip ☐ No Grip	☐ Weak Grip ☐ No Grip
Arm Strength:	☐	☐ Drifts Down ☐ Falls Rapidly	☐ Drifts Down ☐ Falls Rapidly

	Yes	No
Based on exam, patient has **only unilateral** (and not bilateral) weakness:	[ ]	[ ]
10. ***Items 4,5,6,7,8,9 all YES's (or unknown) → LAPSS screening criteria met:***	[ ]	[ ]

11. If LAPSS criteria for stroke met, call receiving hospital with a "code stroke", if not then return to the appropriate treatment protocol. (Note: the patient may still be experiencing a stroke even if LAPSS criteria are not met.)

Chelsea S. Kidwell et al. Stroke. 2000;31:71-76

Next steps

- Tele-stroke in San Diego
- What are the goals?
    - Expedite within the current system, or shape triage?
- Who staffs?
- Who trains?
- What tools do we use?
- County, City, General use or study
- Funding
- Staffing
- Data acquisition
- Technological support
- Who can help?

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LVO Scales

Table 1. RACE Scale

Item	RACE Score	NIHSS Score Equivalence
Facial palsy		
Absent	0	0
Mild	1	1
Moderate to severe	2	2–3
Arm motor function		
Normal to mild	0	0–1
Moderate	1	2
Severe	2	3–4
Leg motor function		
Normal to mild	0	0–1
Moderate	1	2
Severe	2	3–4
Head and gaze deviation		
Absent	0	0
Present	1	1–2
Aphasia* (if right hemiparesis)		
Performs both tasks correctly	0	0
Performs 1 task correctly	1	1
Performs neither tasks	2	2
Agnosia† (if left hemiparesis)		
Patient recognizes his/her arm and the impairment	0	0
Does not recognized his/her arm or the impairment	1	1
Does not recognize his/her arm nor the impairment	2	2
Score total	0–9	

Stroke. 2014;45:87-91.

TABLE 1. The 3-Item Stroke Scale*

Item		Score
Disturbance of consciousness	no	0
	mild	1
	severe	2
Gaze and head deviation	absent	0
	incomplete gaze/head deviation	1
	forced gaze/head deviation	2
Hemiparesis	absent	0
	moderate	1
	severe	2
Score (total)		0–6

*For detailed scoring criteria, see Materials and Methods.

Stroke. 2005;36:773-776.

Prehospital Acute Stroke Severity scale	Yes	No
Incorrect month and/or age?*	☐	☐
Gaze palsy and/or deviation?†	☐	☐
Arm weakness?‡	☐	☐

*NIHSS LEVEL OF CONSCIOUSNESS (age/month) >0
†NIHSS GAZE >0
‡NIHSS MOTOR ARM >0

Figure 2. Prehospital Acute Stroke Severity Scale's individual items and corresponding National Institutes of Health Stroke Scale (NIHSS) scores.

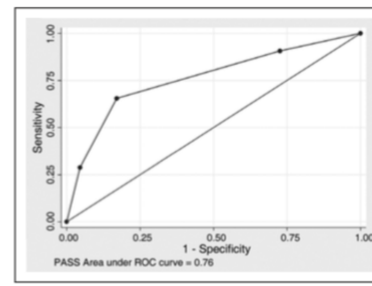


Figure 3. Receiver operating characteristic (ROC) curve of the Prehospital Acute Stroke Severity (PASS) Scale in predicting intracranial large artery occlusion (in derivation).

Stroke. 2016;47:1772-1776.

Cincinnati Prehospital Stroke Severity Scale

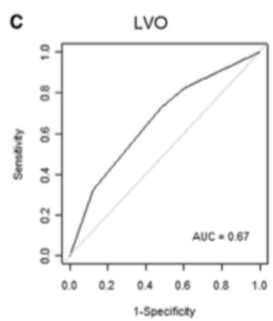
2 points: Conjugate gaze deviation (≥ 1 on NIHSS item for Gaze)

1 point: Incorrectly answers at least one of two level of consciousness questions on NIHSS (age or current month) **and** does not follow at least one of two commands (close eyes, open and close hand) (≥ 1 on the NIHSS item for Level of Consciousness 1b and 1c)

1 point: Cannot hold arm (either right, left or both) up for 10 seconds before arm(s) falls to bed (≥ 2 on the NIHSS item for Motor Arm)

Figure 1. The Cincinnati Prehospital Stroke Severity Scale's individual items and scoring. NIHSS indicates National Institutes of Health Stroke Scale.

C



Stroke. 2015

LVO Identification in SITS-ISTR

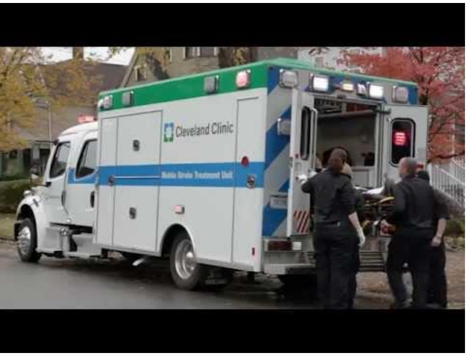
Table 3. Sensitivity, Specificity, PPV, and NPV for Presence of LAVO at Certain Cutoffs of the NIHSS, Simplified NIHSS Scores, and NIHSS Symptom Profiles

	n/N (%)	Sensitivity	Specificity	PPV	NPV	Accuracy
Statistically optimal cutoffs						
NIHSS≥12	1420/3505 (40.5)	72.1	69.2	42.0	88.9	69.9
FAST=3	2207/3505 (63.0)	84.0	43.5	31.5	89.9	53.1
G-FAST≥3	2363/3505 (67.5)	88.7	39.1	31.0	91.8	50.8
C-STAT≥2	1461/3505 (41.7)	71.3	67.5	40.4	88.4	68.4
3I-SS≥2†	1283/3505 (36.6)	65.0	72.2	41.9	87.0	70.5
PASS≥2	1763/3505 (50.3)	78.7	58.5	36.9	89.9	63.3
RACE≥5	1442/3505 (41.1)	71.2	68.2	40.8	88.5	68.9
NIHSS symptom profile A or B	1568/3505 (44.7)	75.9	64.9	40.1	89.7	67.5

(Scheitz, *Stroke.* 2017; 48:290-297)

What if not all stroke centers are equal?
Can we take tPA to the patient – mobile stroke unit

CT Scanner on the ambulance



- Interesting concepts, but:
- Expensive
- Unable to scale to regional coverage
- Outcomes not different in European studies

WITNESS CONTACT CARD

Scripps

A Neurologist at Scripps Memorial Hospital in La Jolla requests to speak to you **urgently** to evaluate for treatment as soon as possible.

Please call the number below **now** to provide the best chance of recovery.

For your safety, we recommend you ride in the ambulance if possible. Please do **NOT** drive while calling Neurologist.

[redacted]

Feasibility of AmbulanCe-Based Telemedicine (FACT) Study: Safety, Feasibility and Reliability of Third Generation In-Ambulance Telemedicine

Laetitia Yperzeele[1,2]*, Robbert-Jan Van Hooff[1,2], Ann De Smedt[1,2], Alexis Valenzuela Espinoza[2], Rita Van Dyck[1], Rohny Van de Casseye[3], Andre Convents[2], Ives Hubloue[4,5], Door Lauwaert[4,5], Jacques De Keyser[1,2,6], Raf Brouns[1,2]

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Abstract

Background: Telemedicine is currently mainly applied as an in-hospital service, but this technology also holds potential to improve emergency care in the prehospital arena. We report on the safety, feasibility and reliability of in-ambulance teleconsultation using a telemedicine system of the third generation.

Methods: A routine ambulance was equipped with a system for real-time bidirectional audio-video communication, automated transmission of vital parameters, glycemia and electronic patient identification. All patients (≥18 years) transported during emergency missions by a Prehospital Intervention Team of the Universitair Ziekenhuis Brussel were eligible for inclusion. To guarantee mobility and to facilitate 24/7 availability, the teleconsultants used lightweight laptop computers to access a dedicated telemedicine platform, which also provided functionalities for neurological assessment, electronic reporting and prehospital notification of the in-hospital team. Key registrations included any safety issue, mobile connectivity, communication of patient information, audiovisual quality, user-friendliness and accuracy of the prehospital diagnosis.

Results: Prehospital teleconsultation was obtained in 41 out of 43 cases (95.3%). The success rates for communication of blood pressure, heart rate, blood oxygen saturation, glycemia, and electronic patient identification were 78.7%, 84.8%, 80.6%, 64.0%, and 84.2%. A preliminary prehospital diagnosis was formulated in 90.2%, with satisfactory agreement with final in-hospital diagnoses. Communication of a prehospital report to the in-hospital team was successful in 94.7% and prenotification of the in-hospital team via SMS in 90.2%. Failures resulted mainly from limited mobile connectivity and to a lesser extent from software, hardware or human error. The user acceptance was high.

Conclusions: Ambulance-based telemedicine of the third generation is safe, feasible and reliable but further research and development, especially with regard to high speed broadband access, is needed before this approach can be implemented in daily practice.

Citation: Yperzeele L, Van Hooff R-J, De Smedt A, Valenzuela Espinoza A, Van Dyck R, et al. (2014) Feasibility of AmbulanCe-Based Telemedicine (FACT) Study: Safety, Feasibility and Reliability of Third Generation In-Ambulance Telemedicine. PLoS ONE 9(10): e110043. doi:10.1371/journal.pone.0110043

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Data Availability: The authors confirm that all data underlying the findings are fully available without restriction. All relevant data are within the paper and its Supporting Information files.

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Competing Interests: The authors have declared that no competing interests exist.

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Feasibility of Prehospital Teleconsultation in Acute Stroke – A Pilot Study in Clinical Routine

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Abstract

Background: Inter-hospital teleconsultation improves stroke care. To transfer this concept into the emergency medical service (EMS), the feasibility and effects of prehospital teleconsultation were investigated.

Methodology/Principal Findings: Teleconsultation enabling audio communication, real-time video streaming, vital data and still picture transmission was conducted between an ambulance and a teleconsultation center. Pre-notification of the hospital was carried out with a 14-item stroke history checklist via e-mail-to-fax. Beside technical assessments possible influences on prehospital and initial in-hospital time intervals, prehospital diagnostic accuracy and the transfer of stroke specific data were investigated by comparing telemedically assisted prehospital care (telemedicine group) with local regular EMS care (control group). All prehospital stroke patients over a 5-month period were included during weekdays (7.30 a.m. – 4.00 p.m.). In 3 of 18 missions partial dropouts of the system occurred; neurological co-evaluation via video transmission was conducted in 12 cases. The stroke checklist was transmitted in 14 cases (78%). Telemedicine group (n = 18) vs. control group (n = 47): Prehospital time intervals were comparable, but in both groups the door to brain imaging times were longer than recommended (median 59.5 vs. 57.5 min, p = 0.6447). The prehospital stroke diagnosis was confirmed in 61% vs. 67%, p = 0.8451. Medians of 14 (IQR 9) vs. 5 (IQR 2) stroke specific items were transferred in written form to the in-hospital setting, p<0.0001. In 3 of 10 vs. 5 of 27 patients with cerebral ischemia thrombolytics were administered, p = 0.655.

Conclusions: Teleconsultation was feasible but technical performance and reliability have to be improved. The approach led to better stroke specific information; however, a superiority over regular EMS care was not found and in-hospital time intervals were unacceptably long in both groups. The feasibility of prehospital tele-stroke consultation has future potential to improve emergency care especially when no highly trained personnel are on-scene.

Trial Registration: International Standard Randomised Controlled Trial Number Register (ISRCTN) ISRCTN83270177

Citation: Bergrath S, Reich A, Rossaint R, Rörtgen D, Gerber J, et al. (2012) Feasibility of Prehospital Teleconsultation in Acute Stroke – A Pilot Study in Clinical Routine. PLoS ONE 7(5): e36796. doi:10.1371/journal.pone.0036796

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LifeBot 5 : The Future of Telemedicine

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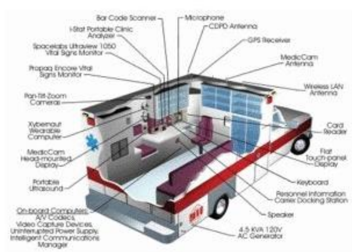

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> With more information LifeBot DREAMS enables one to do something definitive to make a difference.
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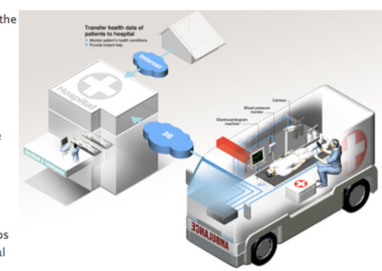
Ambulance-based Telemedicine Saving Lives in Real-Time

Like 0

For disaster relief operations or emergency medical services (EMS), time is much more than a matter of money—it's a matter of life and death. An ambulance-to-hospital based telemedicine system is the best example of how mobile technology can help save lives, by providing real time patient information to the hospital via wireless communications, enabling remote diagnoses and primary care, and reducing rescue response time.

Telemedicine, as defined by the American Telemedicine Association (ATA), is the use of medical information exchanged from one site to another via electronic communications, to improve a patient's clinical health status.



Telemedicine includes a growing variety of applications and services—from remote health monitoring to medical education. Among these applications, ambulance-based telemedicine uses the most up-to-date vehicle electronics and mobile communications technology, aimed at providing a significant time advantage, expediting critical treatment and improving patient outcomes.

For example, when rescuing car crash victims, with a telemedicine system onboard an ambulance, the vital signs of the wounded (e.g. ECG, blood pressure, respiratory rate) can be measured and transmitted to the hospital instantly via a wireless (3G/Wi-Fi) communication network. Additionally, videos taken by digital cameras installed in the ambulance can be sent to the hospital in real-time.

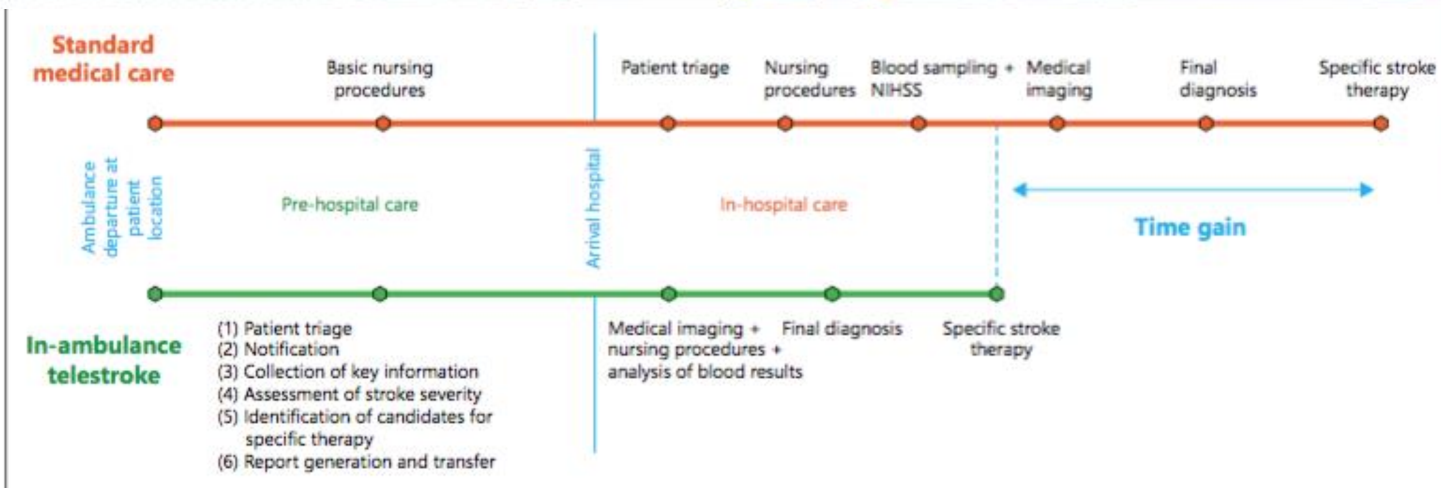
On the hospital side, emergency room physicians and nurses can receive and review the incoming data at a desktop PC or on a mobile device such as a tablet or smartphone, and make preliminary assessments before the arrival of the patient. The ER docs can also zoom-in to see the wounds, discuss the situation with the emergency medical technicians (EMTs), and instruct the EMTs to administer primary care or emergency medical services, such as giving injections or fracture treatment.

The emergency and trauma physicians can also triage cases remotely, and start to prepare a surgery team if needed, prior to the patient's arrival. If they decide the available medical resources of the hospital are insufficient for the situation, they can refer the case to an alternative medical care center, to save time.

Ambulance telemedicine is aimed at sparing every minute that can possibly be used to save lives. Such pre-hospital systems are also vital for patients suffering from a stroke or cardiac diseases. Earlier assessment and treatment of strokes during critical moments can save lives and minimize aftereffects.

Ambulance-based telemedicine is particularly valuable for residents living in remote areas, a long distance from hospitals and clinics, as well as for casualties in remote locations.

Color version available online



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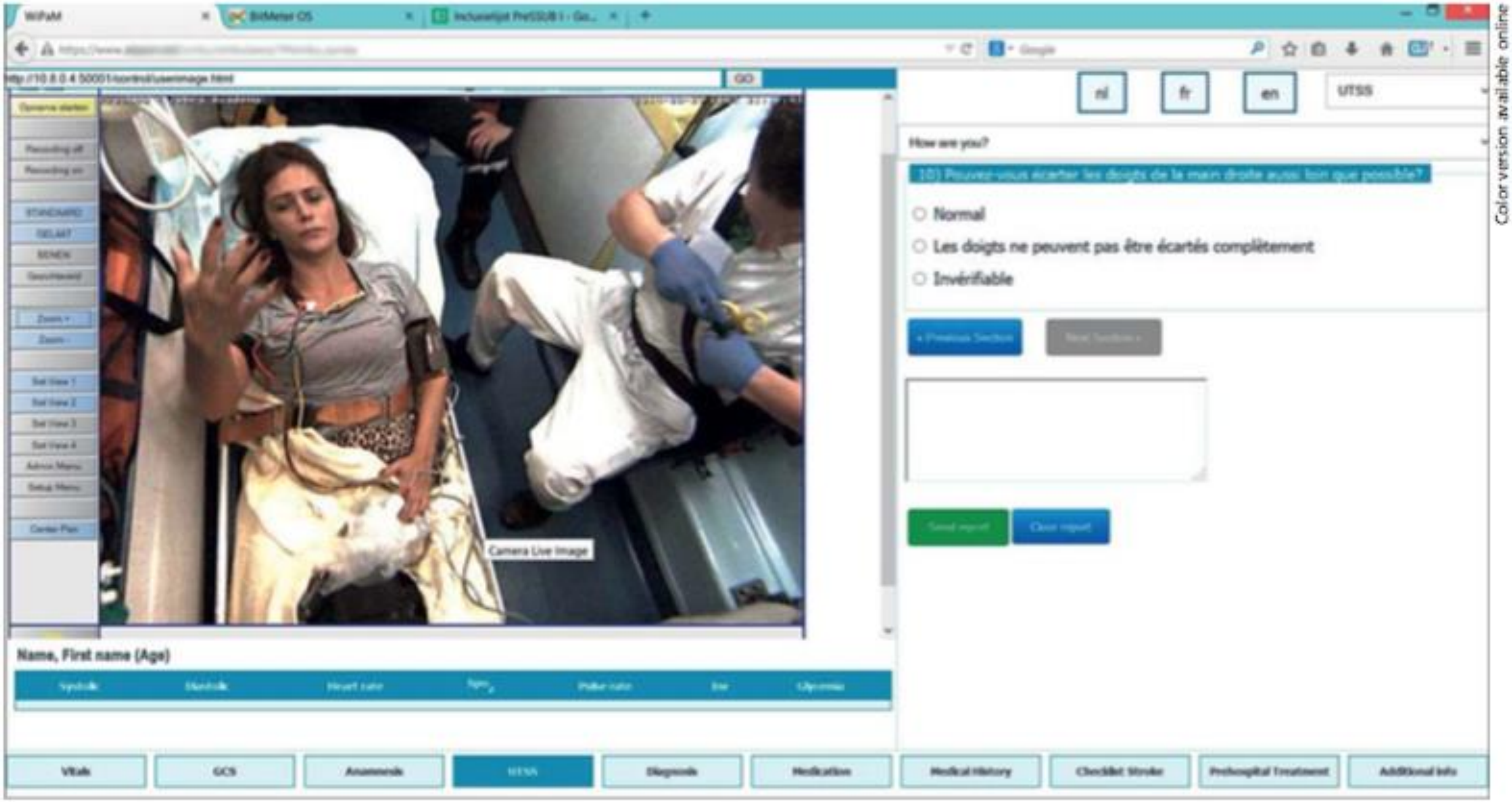

187 runs, 16 stroke alerts, confirmed 12 (verified 10 in hospital)
No missed stroke, technical success in 94%
Median time for the consultation was 9 minutes IQR 8-13)

In-Transit Telemedicine Speeds Ischemic Stroke Treatment
Preliminary Results

Gary H. Belt, MD; Robert A. Felberg, MD; Jane Rubin, MBA; John J. Halperin, MD

Background and Purpose—Time to treatment is critically important in ischemic stroke. We compared the efficacy and cost of teleneurology evaluation during patient transport with that of mobile stroke transport units.

Methods—Using cellular-connected telemedicine devices, we assessed 89 presumptive stroke patients in ambulances in transit. Paramedics assisted remote teleneurologists in obtaining a simplified history and examination, then coordinating care with the receiving emergency department. We prospectively assessed door-to-needle and last-known-well-to-needle times for all intravenous alteplase–treated stroke patients brought to our emergency departments by emergency medical services' transport, comparing those with and without in-transit telestroke.

Results—From January 2015 through March 2016, 111 stroke patients received intravenous alteplase at study emergency departments. Mean door to needle was 13 minutes less with in-transit telestroke (28 versus 41; P=0.02). Although limitations in cellular communication degraded transmission quality, this did not prevent the completion of satisfactory patient evaluations.

Conclusions—Improvement in time to treat seems comparable with in-transit telestroke and mobile stroke transport units. The low cost/unit makes this approach scalable, potentially providing rapid management of more patients. **(*Stroke*. 2016;47:00-00. DOI: 10.1161/STROKEAHA.116.014270.)**

Mobile Telestroke During Ambulance Transport Is Feasible in a Rural EMS Setting: The iTREAT Study

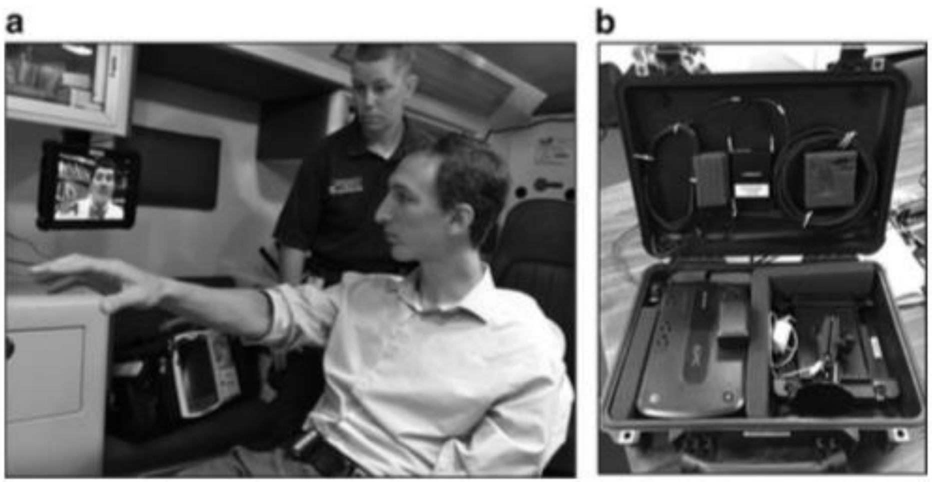

Table 1. iTREAT Mobile Telestroke Platform Component List with Associated Undiscounted Costs

COMPONENT	COST (USD)
Apple II iPad with retina display	500.00
iPad protective case	54.95
RAM mount	20.07
RAM tablet cradle	16.99
Antennae	240.00
Uninterruptible power supply	54.99
CradlePoint modem	599.99
CradlePoint 6-foot cable	14.49
Modem set-up	35.00
SIM card	8.00
Pelican case	111.95
Total	1,656.43

USD, U.S. dollars.

Telemed J E Health. 2016 Jun;22(6):507-13

Summary

- Stroke is now more complex
- In-hospital advances in imaging and interventional therapies
- Need to better pre-hospital diagnosis and triage

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