Clinical Outcomes After Mobile Stroke Unit Care

October 2, 2020

Andrew N. Russman, DO, FAAN, FAHA
Head, Stroke Program
Medical Director, Comprehensive Stroke Center
Staff, Vascular Neurology
Cleveland Clinic
russmaa@ccf.org

Disclosures

- Consultant, Boston Scientific

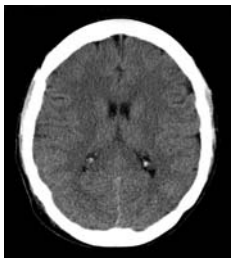
Time is Brain!

	Neurons Lost	Synapses Lost	Accelerated Aging
Per Stroke	1.2 billion	8.3 trillion	36 yrs
Per Hour	120 million	830 billion	3.6 yrs
Per Minute	1.9 million	14 billion	3.1 weeks
Per Second	32,000	230 million	8.7 hrs

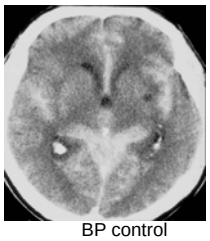
(Total number of neurons in the average human brain is 130 billion)

Stroke 2006;37:263-266

Hyperacute Stroke Treatment Decisions Hinge on the CT Scan



BP control
IV tPA (clot buster)
Transport to PSC/TSC/CSC

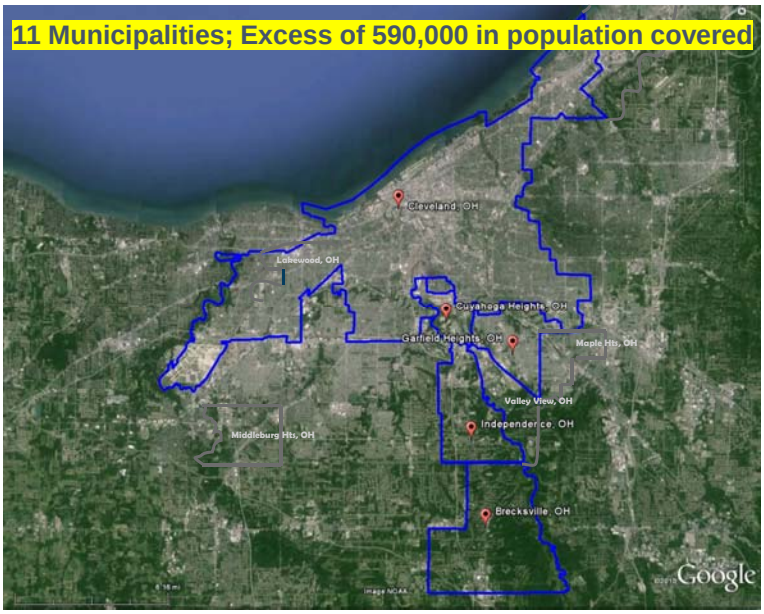


BP control
Warfarin reversal
Mannitol
Anti-epiletic medications
Transport to C

Cleveland Clinic Mobile Stroke Unit

- Cleveland Clinic MSU became operational on July 18, 2014
- Our MSU is active 12 hours daily 7 days a week from 8 am to 8 pm
- Mobile CT, Portable point-of-care Lab equipment, Telemedicine system
- On board team consists of a critical care nurse, paramedic, emergency medical technician, and CT technologist
- A vascular neurologist evaluates patients via telemedicine, and a neuroradiologist remotely assesses CT/CTA images
- Thrombolysis decision-making and initiation occurs during transport

Bringing Stroke Expertise to the Patient



Portable CT Scanner: CereTom, Neurologica, Inc. (Samsung)

INR: CoaguChek XS Pro, Roche Diagnostics; Chemistry: i-STAT System, Abbott Laboratories

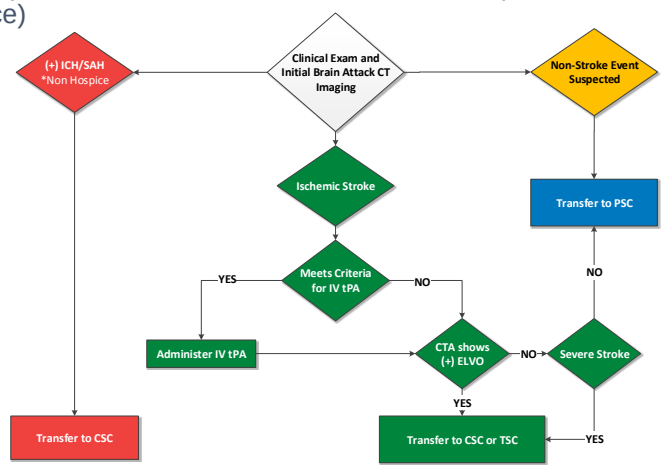
Telemdedicine equipment: InTouch Xpress (InTouch Health)

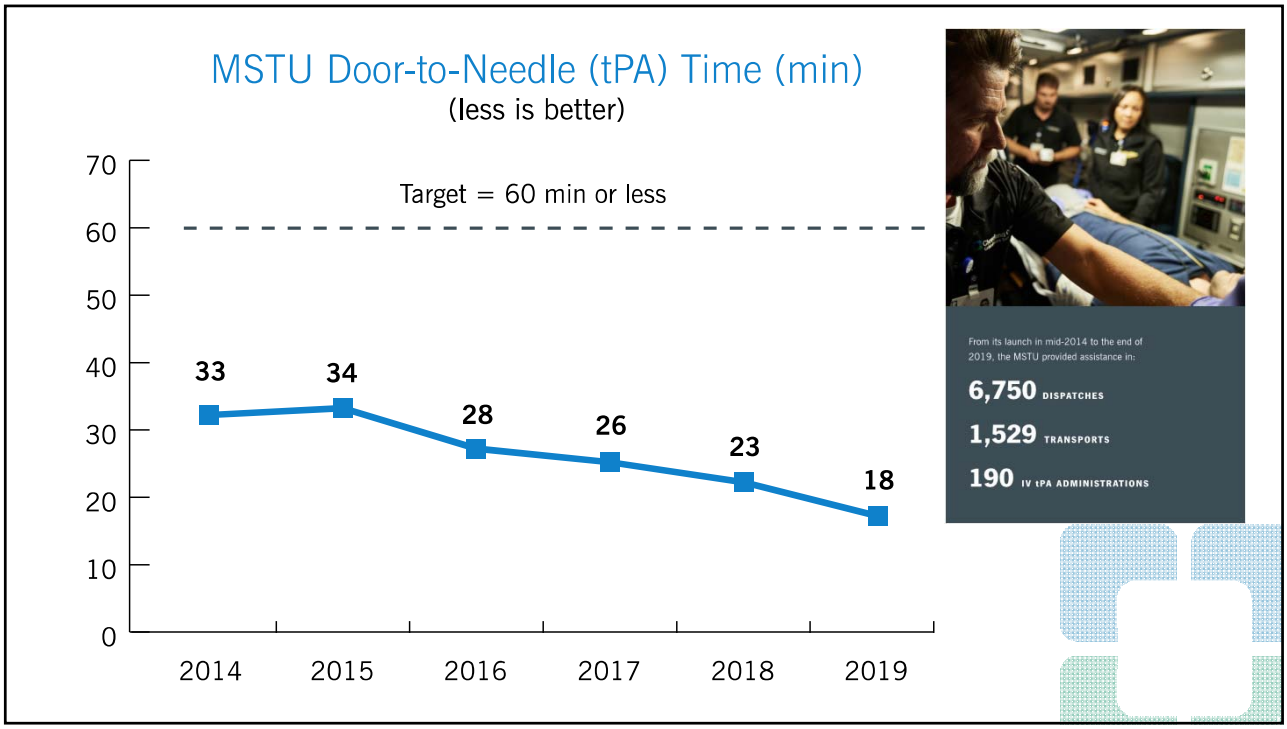
Program Operations - Clinical

MSTU Operation

Stroke Severity and Patient Preference Destination Model

- Patient Condition identifies Hospital resources needed to effectuate subsequent care
  - Patient Transport effectuated to nearest Hospital with clinical resources available to meet care needs
  - Patient request will override the default mechanism (Care Continuity, Community Preference)





Clinical Outcomes After Pre-hospital Thrombolysis on a Mobile Stroke Unit

Andrew N. Russman, DO[1], Daisuke Shimbo[1] ,MD, Lila Sheikhi, MD[1], Kerri Maselli[1], Nicolas R. Thompson, MS[2], Andrew P. Reimer, RN[2], Muhammad S. Hussain, MD[1], Ken Uchino, MD[1], on behalf of the Cleveland Pre-Hospital Acute Stroke Treatment Study Group

1 Cleveland Clinic, Cerebrovascular Center, Cleveland OH, USA.

2 Cleveland Clinic, Department of Quantitative Health Sciences, Cleveland OH, USA

Cleveland Clinic

CCF MSTU Outcomes Study

- **A mobile stroke unit (MSU) can shorten the time to thrombolytic therapy in patients with ischemic stroke**

Itrat et al. JAMA Neurology, 2016
Ebinger et al. JAMA Neurology, 2015
Walter et al. The Lancet Neurology, 2012

Methods

- We reviewed patients received tPA from 2014 to 2017

Patients evaluated on MSU and transported to Cleveland Clinic

VS

Patients transported to Cleveland Clinic EDs directly via Emergency Medical Services (EMS)

Methods

- Primary outcomes:
  - **90-day modified Rankin Scale (mRS) score of 0-1**
- Secondary outcomes:
  - 90-day mRS of 0-2
  - Mortality at 7day or 90 day
  - Symptomatic Intracranial hemorrhage (sICH)
- 90-day mRS was assessed by standardized telephone interview and reviewing medical records

Results

Demographics

Variables	EMS group (n=169)	MSU group (n=93)	P Value
Age, median (IQR)	72 (60-83)	66 (56-81)	0.075
Female gender, n (%)	77 (45.6%)	54 (58.1%)	0.053
Risk factors, n (%)			
Hypertension, n (%)	142 (84.0%)	79 (84.9%)	0.844
Diabetes, n (%)	57 (33.7%)	26 (28.0%)	0.337
Atrial fibrillation, n (%)	49 (29.0%)	49 (47.3%)	0.003
Premorbid mRS of 0-1, n (%)	121 (71.6%)	62 (66.7%)	0.405
Initial NIHSS, median (IQR)	9 (5-15)	11 (7-17)	0.386
Endovascular treatment (EVT), n (%)	19 (11.2)	22 (23.7)	0.008

MSU patients had a higher rate of female gender, Afib and EVT

Results

Time from stroke onset to thrombolysis

	EMS group (n=169)	MSU group (n=93)	P Value
Time from onset to tPA, minute, median (IQR)	117 (86-157)	83 (59-137)	<0.001
Time from onset to tPA within 90 minutes, n, %	49 (29.0%)	50 (53.8%)	<0.001

MSU patients received IV tPA 34 minutes faster than EMS patients

Results

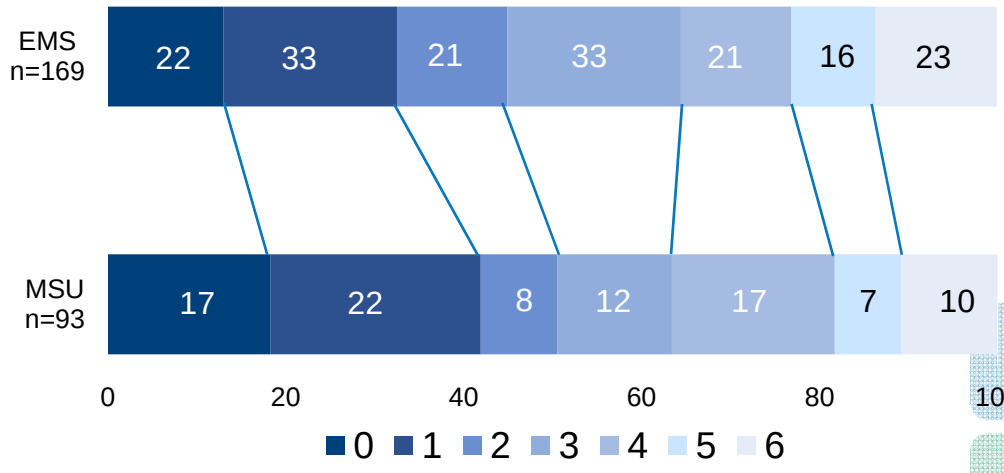
Time from stroke onset to thrombolysis

	EMS group (n=169)	MSU group (n=93)	P Value
Time from onset to tPA, minute, median (IQR)	117 (86-157)	83 (59-137)	<0.001
Time from onset to tPA within 90 minutes, n, %	49 (29.0%)	50 (53.8%)	<0.001

54% of MSU patients received IV tPA within 90 minutes

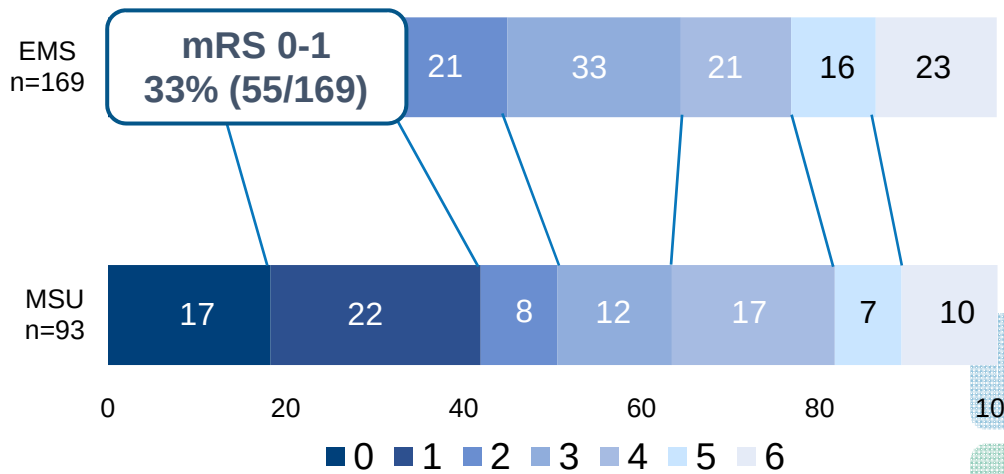
Results

The proportion of 90-day mRS



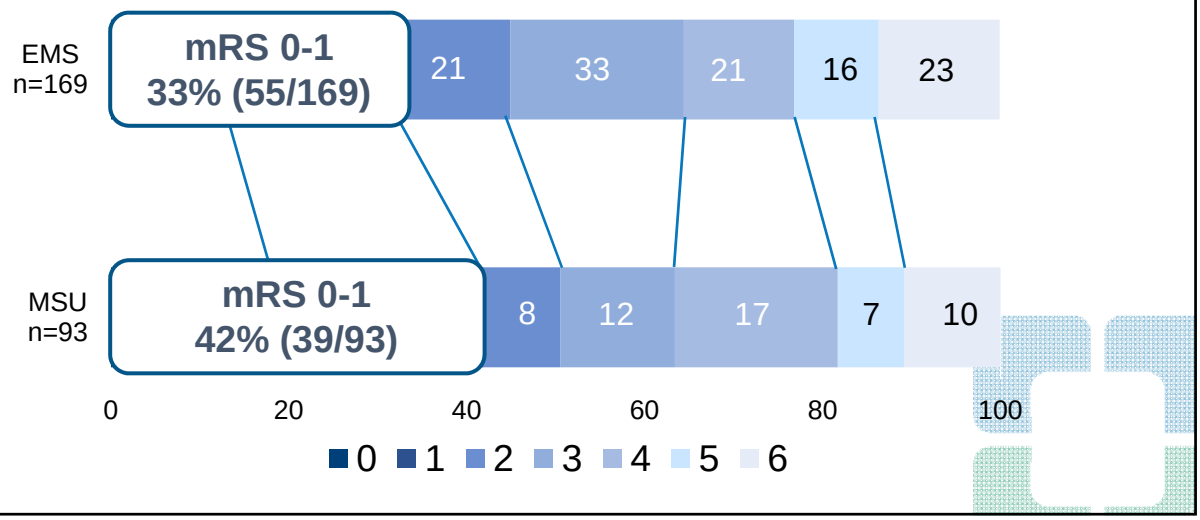
Results

The proportion of 90-day mRS



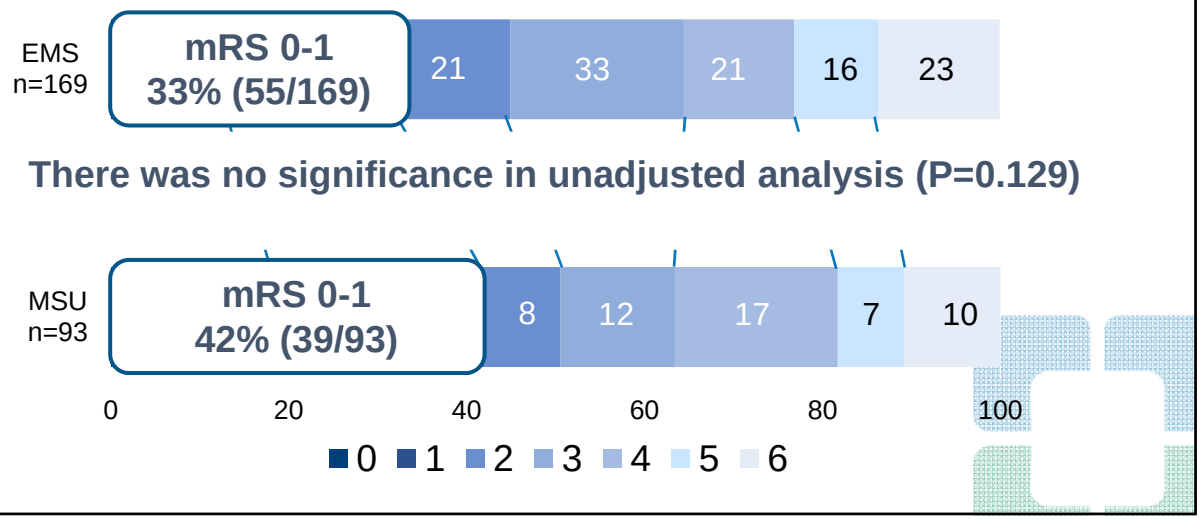
Results

The proportion of 90-day mRS



Results

The proportion of 90-day mRS



Results

Binary logistic regression analysis (90-day mRS 0-1 vs mRS 2-6)

Variables	Odds Ratio	95% CI	P value
Age	0.97	0.95-0.99	0.011
Female	0.76	0.40-1.44	0.397
Initial NIHSS	0.86	0.80-0.91	<0.001
Premorbid mRS of 0-1	13.2	4.38-39.9	<0.001
Atrial fibrillation	0.52	0.24-1.11	0.089
EVT	2.37	0.88-6.34	0.087
MSU	2.06	1.01-4.19	0.046

Thrombolysis on MSU was significantly associated with 90-day mRS of 0-1

Conclusions

- Pre-hospital thrombolysis on the Cleveland Clinic MSU shortened the time to thrombolytic treatment compared to conventional EMS care
- Cleveland Clinic MSU care was associated with improved functional outcomes in patients with acute ischemic stroke

DFG Deutsche Forschungsgemeinschaft

CSB Center for Stroke Research Berlin

SPONSORED BY THE Federal Ministry of Education and Research

The effects of Mobile Stroke Units on functional outcome after acute cerebral ischemia

B_PROUD

Heinrich J Audebert, Dept. of Neurology, Center for Stroke Research Berlin, Charité Berlin, Germany on behalf of

Ebinger, M, Siegerink B , Kunz, A, Wendt M Weber JE, Schwabauer E, Geisler F, Freitag E, Lange J, Behrens J, Erdur H, Ganeshan R, Liman T, Scheitz J, Schlemm L, Harmel P, Lorenz-Meyer I, Napierkowski I, Waldschmidt C, Nolte CH, Grittner U, Bohner G, Nabavi D, Schmehl I, Ekkernkamp A, Jungehülsing GJ, Mackert BM, Hartmann A, Bousser MG, Lees KR, Schwamm LH, Endres M,

B_PROUD

Background and purpose

- Effects of thrombolysis in acute ischemic stroke are time-dependent.
- Mobile Stroke Units (MSU) are ambulances equipped with computed tomography and point-of-care lab to allow prehospital thrombolysis[1]
- MSU shorten time to treatment[2,3]
- So far, it is unclear whether or not MSUs improve functional outcome

Purpose of the Berlin Prehospital or Usual Delivery of stroke care (B_PROUD) trial:

To investigate whether MSU care improves outcome in patients with acute cerebral ischemia compared to conventional care.

B_PROUD Design and inclusion

- Pragmatic, controlled trial using random allocation by availability of MSUs
- Blinded outcome assessment
- Comparing functional outcomes by shift analysis of 3-month modified Rankin Scale in "treatment candidates"

Inclusion criteria

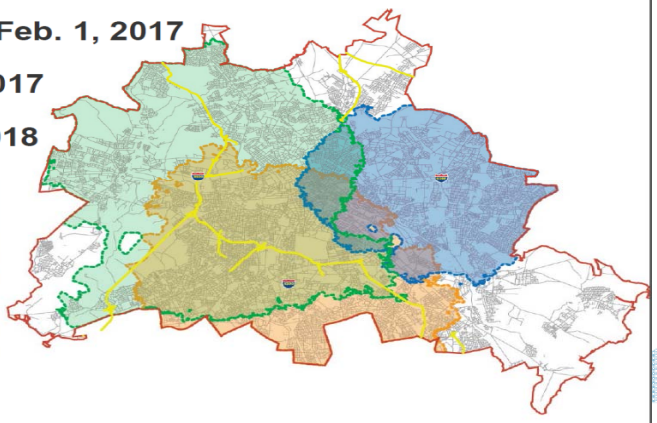
- Emergency calls within MSU catchment area
- Code stroke with onset-to-alarm ≤ 4 hours at time of dispatch
- Final diagnosis of ischemic stroke (ICD-10: I63) or TIA (G45)
- ≥18 years with pre-stroke mRS ≤ 3
- No symptom resolution before ambulance arrival
- No absolute contraindication for thrombolysis and thrombectomy

Blinded adjudication of study enrolment in uncertain cases

B_PROUD Intervention

Catchment areas:

- **1st MSU (STEMO) since Feb. 1, 2017**
- **2nd MSU since Sept. 1, 2017**
- **3rd MSU since Sept. 1, 2018**

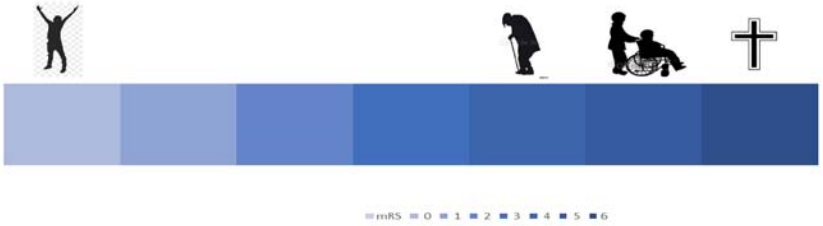


Patient recruitment during MSU operation times from 7:00am to 11:00pm

B_PROUD

Outcome definitions

modified Rankin Scale (mRS)



3-month follow-up

- preferentially via telephone interview with recording of mRS assessment
  - ➔ blinded mRS rating by 3 independent neurologists
- If opted for by patients: Questionnaire based mRS assessment

CHARITÉ CSB

B_PROUD

Outcome definitions

Secondary outcomes:

- Thrombolysis and thrombectomy rates
- Time from alarm to treatment
- Time from onset to treatment
- Secondary hemorrhage within 36h
- Death within 7 days
- Quality of life assessed with EQ-5D at 3 months

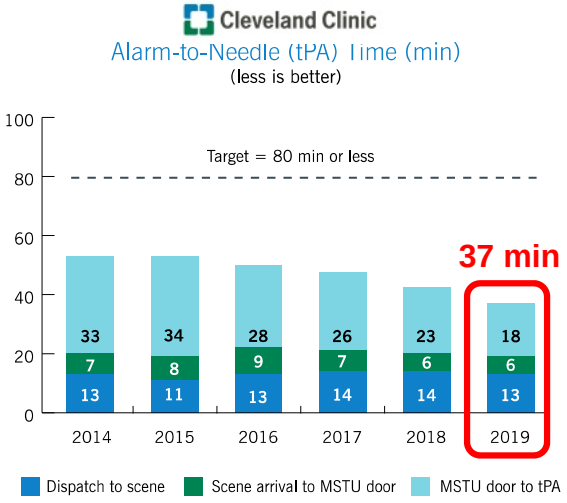
CHARITÉ CSB

B-PROUD Baseline characteristics

	MSU not available N=794	MSU available N=749	Standardized mean difference
Demographics			
Age, years, mean	74	73	0.11
Gender, female	48%	46%	0.03
Comorbidities			
Atrial Fibrillation	26%	29%	0.06
Diabetes mellitus	25%	26%	0.004
Functional status pre-stroke			
Living at home without need of assistance	79%	80%	0.04
Living in nursing institution	12%	11%	0.03
Neurological deficits documented at EMS arrival	80%	89%	0.25
Time onset / last-seen-well to alarm, median	39min	36min	0.01
First NIHSS, median (IQR)	4 (2-9)	4 (2-9)	0.03

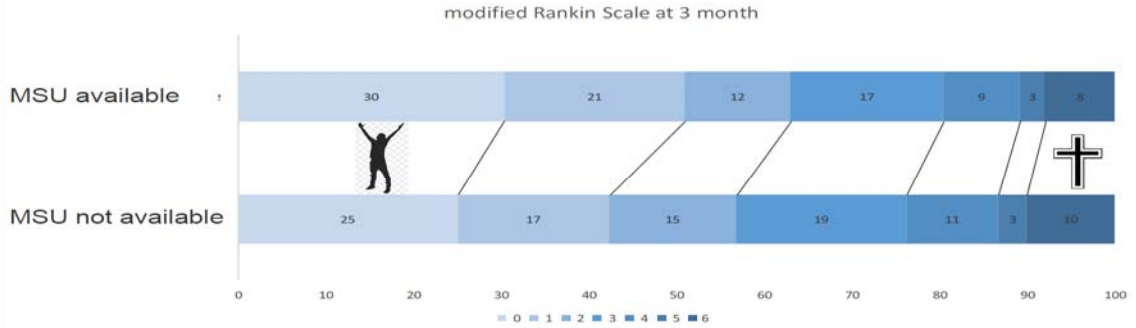
B-PROUD Process parameters

	MSU not available N=794	MSU available N=749	p-value
Treated on Mobile Stroke Unit	0%	74%	
tPA treatment rate	**48%**	**60%**	**<0.01**
Time alarm to start of tPA, median	**70min**	**50 min**	**<0.01**
Time onset / last-seen-well to start of tPA, median	110min	95min	<0.01
tPA treatment start within 60min	4%	13%	<0.01
Thrombectomy treatment rate	13%	14%	0.65
Time alarm to start of thrombectomy, median, min (SD)	125min	137min	0.12



Primary outcome

Intention-to-treat analysis: Full data set with multiple imputations using baseline plus mRS at discharge



Mann-Whitney-U-Test: p=0.001

Multivariable ordinal regression: Odds ratio: 0.74 (95%-CI: 0.60-0.90: p=0.003)

Unchanged in sensitivity analysis excluding pts w/o documentation of deficits at EMS arrival

CHARITÉ CSB

Secondary outcomes

	MSU not available	MSU available	p-value adjusted
Symptomatic haemorrhage	2.6%	3.6%	0.31
Death within 7d	3.0%	1.7%	0.099
Discharge home	56%	61%	0.077
Dichotomised mRS#	45%	52%	0.004
Quality of life at 3 month (EQ-5D total score), mean	55	60	0.004

#Defined as modified Rankin Scale 2-6 in patients ≤80y or modified Rankin Scale 3-6 in patients >80y

B_PROUD

Discussion

Possible explanations

- Earlier and more frequent thrombolytic treatment responsible for majority of effects
- Other effects may have contributed:
  - Earlier neurological assessment, continuous monitoring and complication management during prehospital care
  - Second medical assessment at hospital arrival

Limitations:

- Conducted in a metropolitan area in Germany ➔ Generalizability?
- High number of MSU dispatches in relation to number of treatment candidates ➔ improvement of dispatch quality needed

B_PROUD

Summary and Conclusions

Dispatch of MSU was associated with

- higher rate of thrombolysis
- reduced time to treatment
- improved functional outcome after 3 months

in patients with acute cerebral ischemia w/o contraindication for thrombolysis

Our Conclusions:

There may be different ways to advance treatment into the prehospital field

Just waiting until patients arrive at hospital is not enough anymore

Acknowledgements

Cleveland Pre-Hospital Acute Stroke Treatment (PHAST) Study Group

- **Cleveland Clinic Cerebrovascular Center:** A Blake Buletko, Maureen Buttrick, Russell Cerejo, Sung-Min Cho, Megan Donohue, Joao Gomes, M Shazam Hussain, Ahmed Itrat, Seby John, Mei Lu, Edward Manno, Jason Mathew, Naresh Mullaguri, N Organek, R Santosh Ramanathan, Peter Rasmussen, Lila Sheikhi, Daisuke Shimbo, Wendy Smith, Jayashree Sundararajan, Gabor Toth, Ather Taqui, Tapan Thacker, Ken Uchino, Daniel Vela-Duarte, Stacey Winners, Dolora Wisco, Atif Zafar
- **Cleveland Clinic Radiology**: Jonathan Lee, Tom Masaryk, Paul Ruggieri, Sarah Stock,
- **Cleveland Clinic Critical Care Transport:** Andrew Reimer , Fredric Hustey, Abigail Brown, Damon Kralovic
- **Fairview Hospital**
- **Marymount Hospital**
- **South Pointe Hospital**
- **Euclid Hospital**
- **Case Western Reserve University:** Farren Briggs
- **City of Cleveland**: N Carlton, EJ Eckart
- **MetroHealth:** Jon Schrock

Questions?