Rapid Reperfusion Registry: Results and Insights into the Future

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Scenario 1

Within minutes a trained paramedic crew has established the diagnosis of acute myocardial infarction (AMI), and transmits an ECG electronically to a myocardial infarction center, where a coordinator mobilizes the catheter laboratory staff to prepare for angioplasty.

On instruction from the cardiologist coordinator, the trained staff administer drugs (Aspirin and plavix) and consents the patient for coronary intervention. The patient does not go to the nearest ER but rather the PCI capable facility

Scenario 2

An ambulance arrives and the patient is taken to the nearest hospital, where an ECG establishes the diagnosis of an AMI. Intravenous streptokinase is given, but after 90 minutes chest pain continues and the ST segments have not shifted.

A decision is made to transfer the patient to a percutaneous coronary intervention (PCI) center. The process takes several hours

Impact of Time on Outcomes: Inter-facility Transfers and Poor Outcomes

“We have not the time to take our time” Eugene Ionesco

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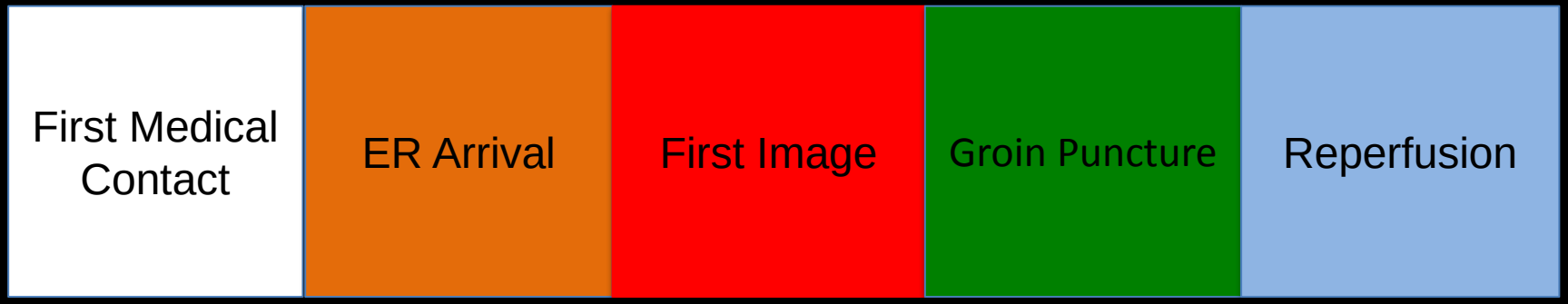
Macro View of Crucial Time Points for IAT



Patients brought directly to the ER

- FMC to CT
- FMC to contact endovascular
- FMC to Groin Puncture/reperfusion

Inter-facility transfers

- Door in to Door out
- D1 to D2
- Picture to puncture (P2P)

Metric 6 of AHA/ASA Scientific statement suggests door to procedure time of 120 minutes for IAT[1]

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[1] Liefer D, et al. Stroke 2011

Rapid Reperfusion Registry

- 478 consecutive patients from 9 hospitals treated between July 1, 2012 – December 31, 2012 (post IMS III completion)
- A QI project to assess door to groin puncture times and impact on outcomes .
- Prospective TURBO/SVIN registry being developed to integrate multiple centers to standardize metrics

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Sun CJ, et al. JAHA 2014.

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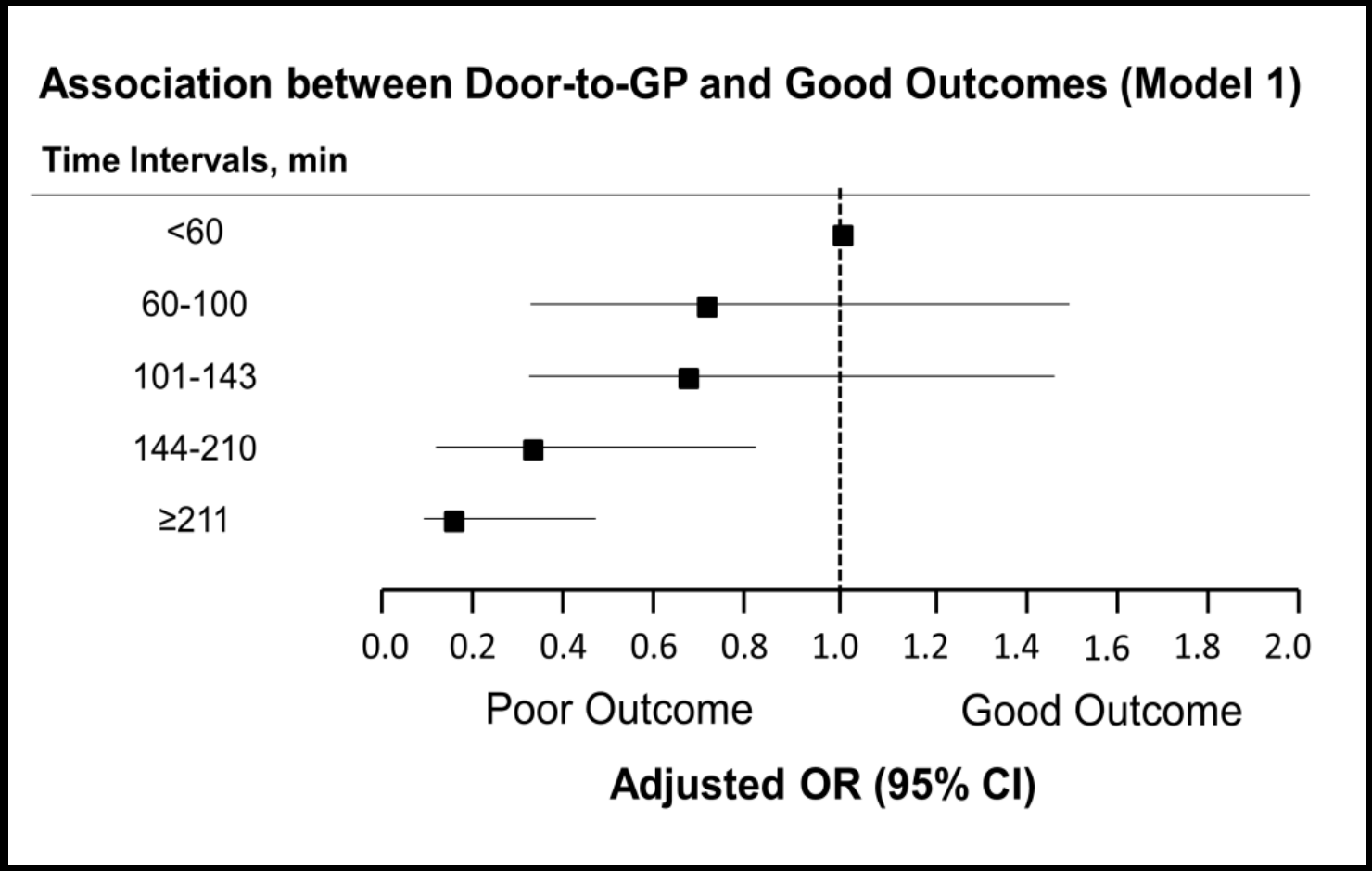
	Study Site 1	Study Site 2	Study Site 3	Study Site 4	Study Site 5	Study Site 6	Other Sites (7 to 9)
Recruitment Period	Dec 2012–Dec 2013	Dec 2012–Dec 2013	July 2013–Dec 2013	July 2013–Dec 2013	July 2013–Dec 2013	July 2013–Dec 2013	July 2013–Dec 2013
Demographics							
Number of patients	n=164	n=142	n=91	n=27	n=20	n=15	n=19
Age, mean (STD)	70.6 (13.5)	65.6 (15.0)	67.6 (13.4)	67.2 (15.3)	71.2 (11.6)	62.3 (15.5)	70.5 (14.0)
Male gender, no. (%)	81 (49)	76 (54)	45 (50)	13 (48)	12 (60)	3 (20)	9 (47)
Hypertension, no. (%)	105 (64)	108 (76)	45 (50)	20 (74)	13 (65)	10 (67)	14 (74)
Atrial fibrillation, no. (%)	69 (42)	54 (38)	29 (32)	14 (52)	9 (45)	3 (20)	8 (42)
Diabetes, no. (%)	32 (20)	40 (28)	15 (16)	5 (19)	4 (20)	6 (40)	6 (32)
Neurological severity							
Pre-treatment NIHSS, median (IQR)	18.5 (17 to 21)	18 (14 to 23)	17 (13 to 21)	14 (11 to 18)	16 (14 to 18)	19 (16 to 23)	19 (15 to 22)
IV tPA given, no. (%)	101 (62)	79 (56)	48 (53)	10 (37)	11 (55)	7 (47)	12 (63)
Radiographic assessment							
ASPECTS, median (IQR) *	10 (9 to 10)	8 (7 to 9)	8 (7 to 9)	9 (7 to 10)	N/A	N/A	8 (6 to 9)
Multimodal imaging, no. (%)†	38 (47)	78 (55)	91 (100)	16 (59)	20 (100)	14 (93)	19 (100)
Clot location							
ICA, no (%)	61 (37)	29 (20)	24 (26)	7 (26)	6 (30)	4 (27)	9 (47)
MCA, no (%)	103 (63)	113 (80)	67 (74)	20 (74)	14 (70)	11 (73)	10 (53)
Successful reperfusion, no. (%)‡	77 (49)	111 (79)	74 (81)	24 (89)	12 (60)	11 (73)	11 (58)
PH1/PH2 hemorrhage, no. (%)	18 (11)	9 (6)	16 (17)	6 (22)	2 (10)	2 (13)	5 (26)

Door to GP times and impact on outcome



Sun CJ, et al.. JAHA 2014.

Door-to-Puncture	Good Outcome/Total	%Good Outcome	Unadjusted Odds Ratio for Good Outcome	Adjusted Odds Ratio for Good Outcome* (Model 1)	Adjusted Odds Ratio for Good Outcome† (Model 2)
<60 minutes	36/77	46.8	Reference	Reference	Reference
60 to 90 minutes	41/85	48.2	1.06 (0.57 to 1.97); *P*=0.85	0.83 (0.37 to 1.85); *P*=0.64	0.72 (0.31 to 1.66); *P*=0.44
91 to 135 minutes	44/83	53.0	1.28 (0.69 to 2.39); *P*=0.43	0.65 (0.28 to 1.50); *P*=0.32	0.64 (0.27 to 1.53); *P*=0.32
136 to 205 minutes	27/82	33.0	0.56 (0.29 to 1.06); *P*=0.076	0.40 (0.17 to 0.93); *P*=0.034	0.47 (0.19 to 1.21); *P*=0.12
≥206 minutes	16/79	20.2	0.29 (0.14 to 0.59); *P*=0.001	0.17 (0.07 to 0.43); *P*<0.001	0.24 (0.09 to 0.67); *P*=0.006
All (per minute)	164/406‡	40.4	0.995 (0.992 to 0.997); *P*<0.001	0.993 (0.990 to 0.996); *P*<0.001	0.995 (0.991 to 0.999); *P*=0.012

12% decline in outcomes for every 30 minute delay to puncture

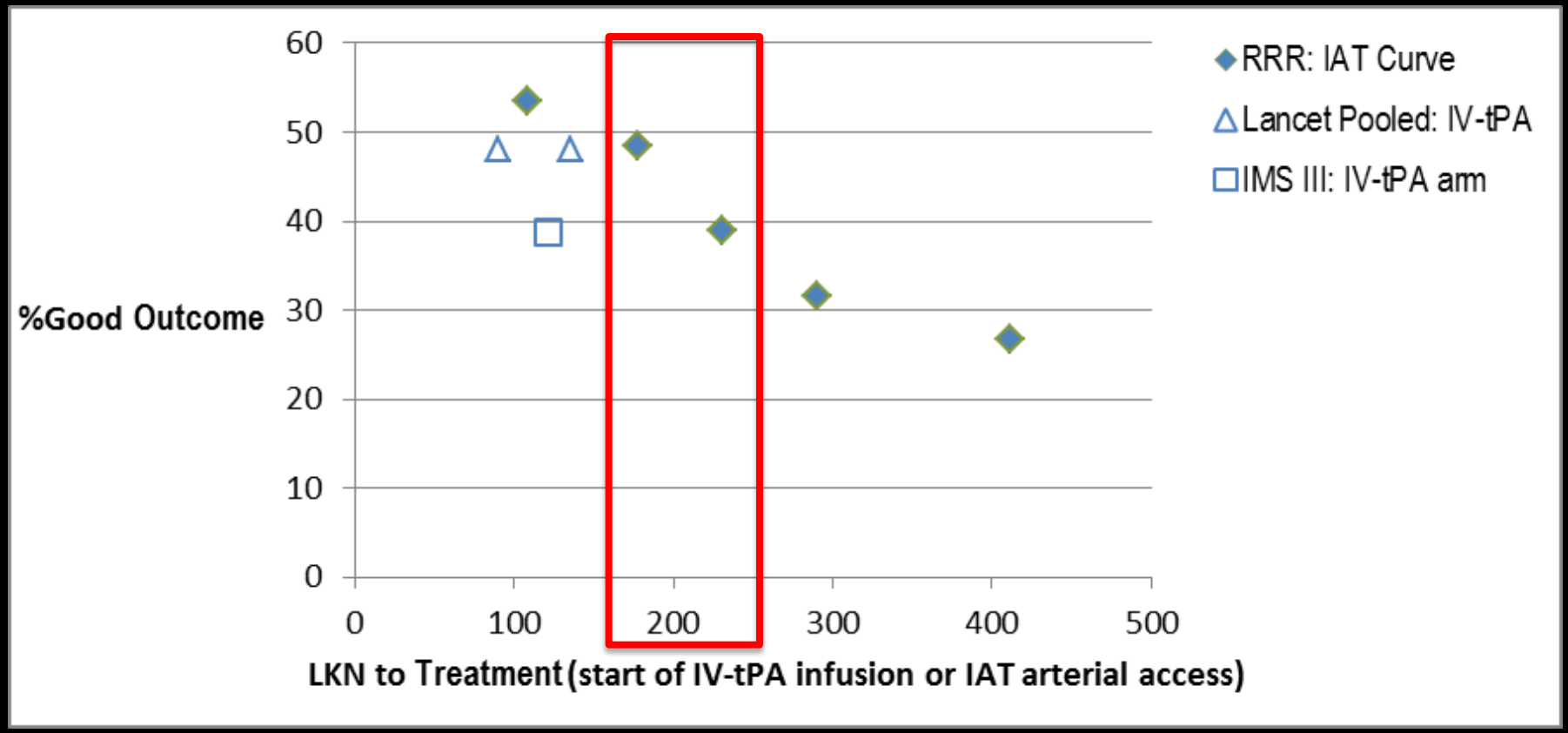
Sun CJ, et al. JAHA 2014.

Predictors of a Good 90 day outcome

Variable	OR (95% CI)	*P* Value
Age	0.96 (0.94 to 0.98)	<0.001
Hypertension	0.69 (0.38 to 1.23)	0.229
NIHSS	0.84 (0.79 to 0.89)	<0.001
Diabetes	0.66 (0.33 to 1.30)	0.225
IV tPA given	1.68 (0.98 to 2.89)	0.062
Successful reperfusion	9.33 (4.69 to 18.57)	<0.001
Symptomatic hemorrhage	0.40 (0.16 to 1.03)	0.059
Door-to-puncture (min)	0.994 (0.990 to 0.998)	0.007
Site no.	Site 1 (reference)	0.460
Site 2	0.68 (0.32 to 1.47)	0.329
Site 3	1.42 (0.65 to 3.08)	0.377
Site 4	0.35 (0.10 to 1.20)	0.095
Site 5	0.60 (0.12 to 2.95)	0.524
Site 6	0.70 (0.09 to 5.59)	0.735
Other sites	0.53 (0.06 to 4.58)	0.560

Sun CJ, et al. JAHA 2014.

LKN to treatment times comparing IV to IAT



180 minutes from LKN to GP = 50% good outcomes → Local ER

> 300 minutes from LKN to GP = < 30% good outcomes → Inter-facility Transfer

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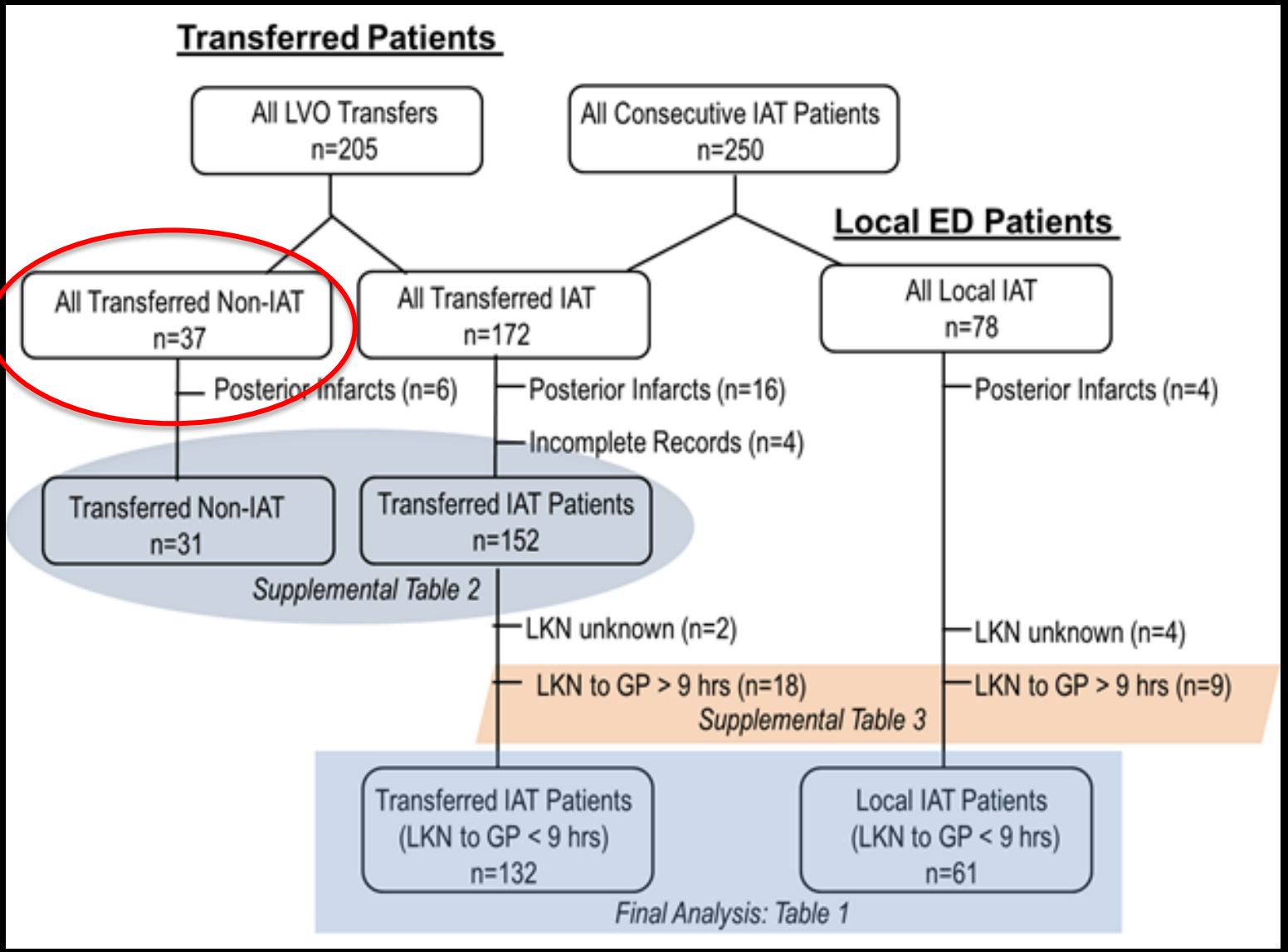
Sun CJ, et al. JAHA 2014.

Picture to Puncture (P2P)

- Retrospective study performed at single center from 2010-2012 comparing transferred patients to patients presenting to local ER
- Aim was to determine if transfer delays impacted neurological outcomes and opportunities to reduce transfer delays
- Defining a new metric “Picture to Puncture” (P2P) defined as time from CT to groin puncture

Sun CJ, et al. Circulation 2013

Flow of Patients



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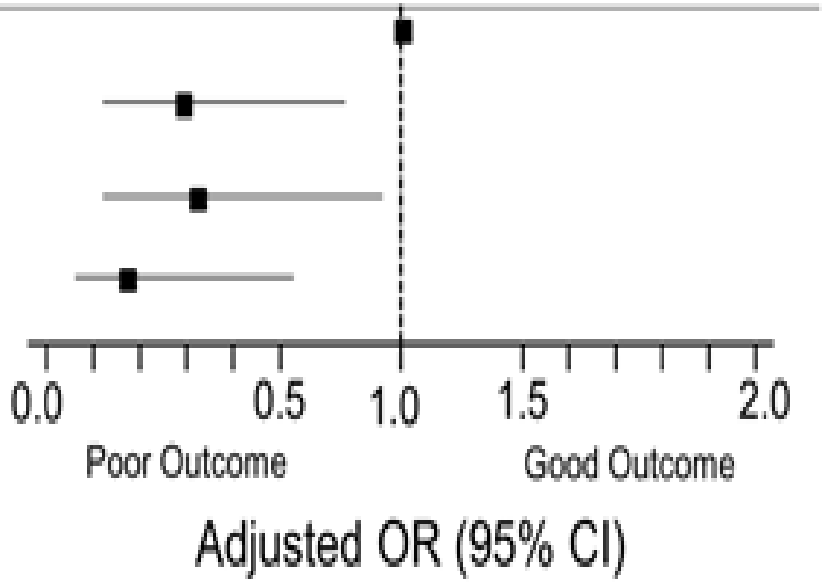
Inter-facility Transfer Delays Associated with Poor Outcomes

Association of P2P with Good Outcomes

P2P Time, min	Patients/Total (%)	Adjusted OR (95% CI)
≤90	17/31 (55.8)	Reference
91-180	24/73 (32.9)	0.30 (0.11-0.81)
181-270	18/52 (34.6)	0.32 (0.11-0.93)
>270	10/37 (27.0)	0.18 (0.05-0.64)



Adjusted Odds Ratios with Outcomes relative to P2P

Sun CJ, et al. Circulation 2013

	Arrival Status at Comprehensive Stroke Center		
	Local ED Admissions (n=61)	Outside Hospital Transfers (n=132)	*P*
Demographics			
Age, mean (SD), y	64.2 (15.0)	66.5 (14.3)	0.30
Male sex, No. (%)	28 (46)	66 (50)	0.60
Hypertension, No. (%)	51 (84)	91 (69)	0.03
Diabetes mellitus, No. (%)	16 (26)	41 (31)	0.49
Hyperlipidemia, No. (%)	12 (20)	36 (27)	0.26
Atrial fibrillation, No. (%)	17 (28)	46 (35)	0.34
Laboratory values			
HbA_{1c}, mean (SD)	6.3 (1.2)	6.3 (1.3)	0.68
LDL, mean (SD)	87.3 (36.2)	89.0 (36.5)	0.77
Clinical assessment at CSC			
NIHSS score, median (IQR)	19 (16–22)	19 (15–23)	0.80
THRIVE score, median (IQR)	5 (4–6)	5 (3–6)	0.70
Intravenous tPA given, No. (%)	39 (64)	77 (58)	0.46
Radiographic findings			
Favorable ASPECTS >7, No. (%)*	46 (76)	53 (50)	<0.001
Reperfusion success, No. (%)	50 (82)	95 (72)	0.135
Symptomatic hemorrhage PH type 1/2, No. (%)	1 (2)	12 (9)	0.07
Postprocedure infarct volume, median (IQR), cm^3	29 (12–83)	44 (22–105)	0.002
Time metrics, min			
P2P, median (IQR)	89 (70–119)	205 (162–274)	<0.001
LKN to groin puncture, median (IQR)	177 (145–268)	301 (252–362)	<0.001
Procedure time, median (IQR)	57 (41–104)	68 (48–106)	0.28
Outcomes			
Good outcome mRS score 0–2, No. (%)	31 (51)	38 (29)	0.003
Transportation			
Air transport, No. (%)		83 (63)	
Distance traveled, median (IQR), miles		20 (14–40)	

ASPECTS indicates Alberta Stroke Program Early CT Score; CSC, comprehensive stroke center; ED, emergency department; HbA_{1c}, hemoglobin A_{1c}; IQR, interquartile range; IR, Interventional Radiology; LDL, low-density lipoprotein; LKN, last known normal; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; PH, parenchymal hematoma; P2P, picture to puncture; THRIVE, Totaled Health Risks in Vascular Events; and tPA, tissue plasminogen activator.

*Twenty-six patients went directly to IR (no ASPECTS obtained before intervention).

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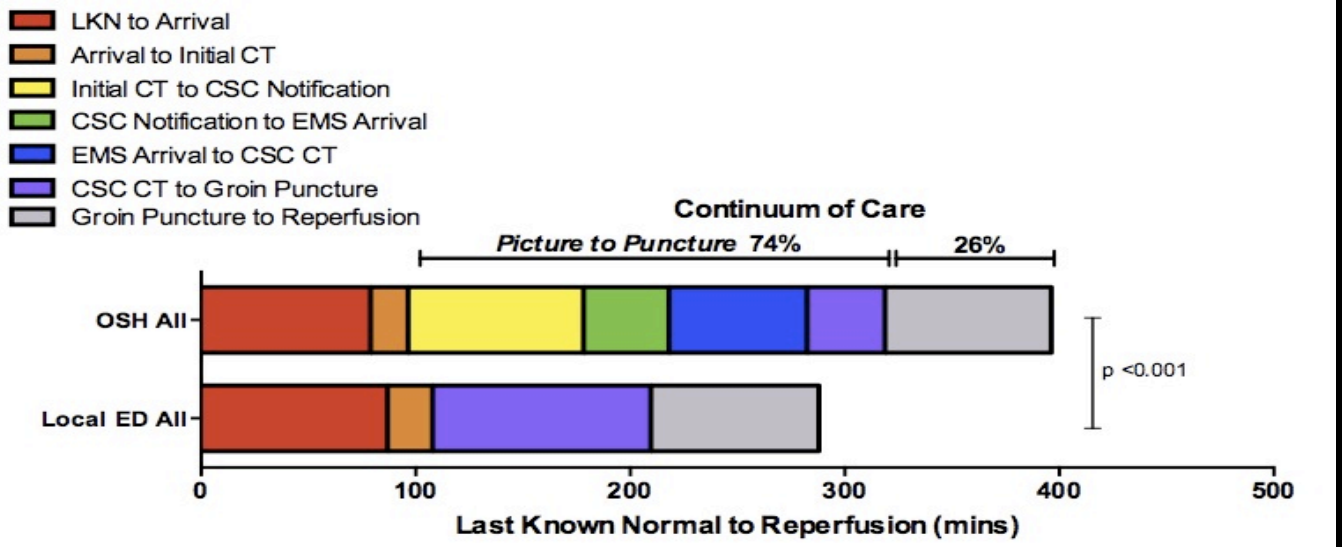

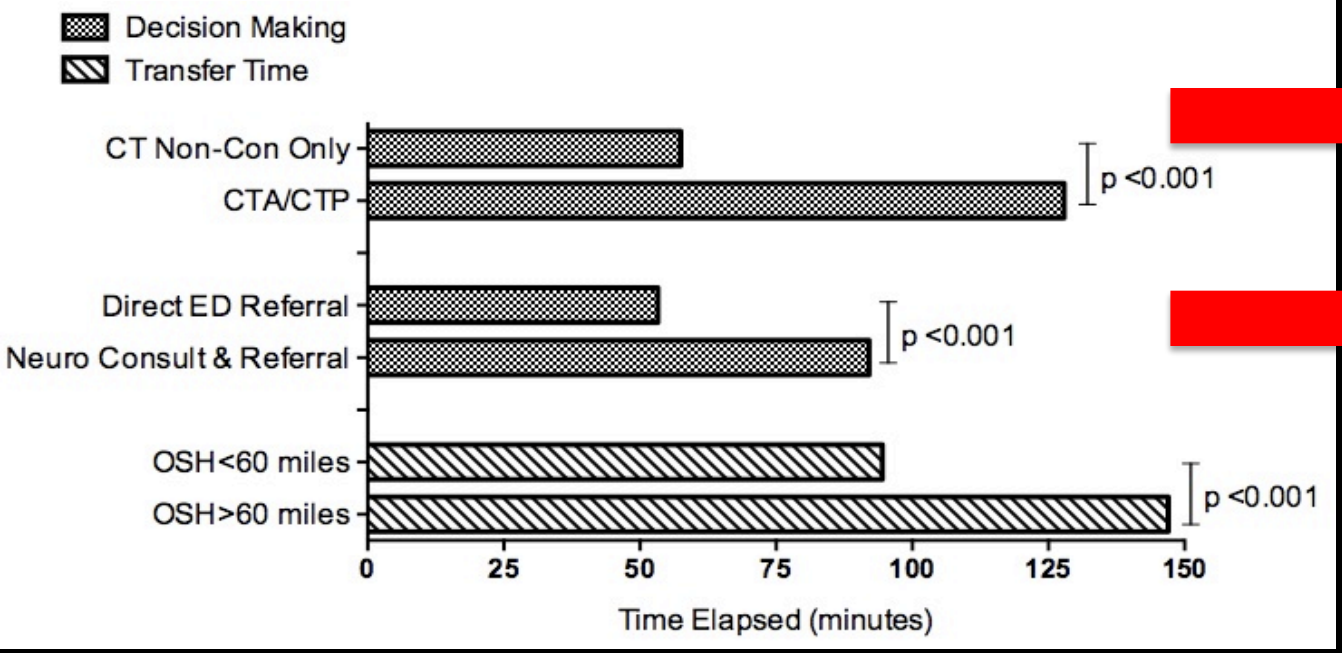

74 minute delay

51 minute delay

Sun CJ, et al. Circulation 2013

Strategies to Improve Systems of Care and Reduce times to Treatment

"Improvement makes roads straight; but the crooked roads without improvement are roads of genius." – William Blake

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AHA/ASA Guidelines Statement

- Stroke patients are dispatched at the highest level of care available in the shortest time possible

- EMS response time is <8 minutes (time elapsed from the receipt of the call by the dispatch entity to the arrival on the scene of a properly equipped and staffed ambulance)

- The on-scene time is <15 minutes (barring extenuating circumstances such as extrication difficulties)

- Travel time is equivalent to trauma or acute myocardial infarction calls

- No time suggestions for inter-facility transfer of stroke patients

Jauch EC, et al Stroke 2013

Strategies to Consider

1) Interventional physicians covering more than one hospital (physician transfer)

2) Improving pre-hospital triage in the field analogous to STEMI vs. NSTEMI (use of clinical exam)

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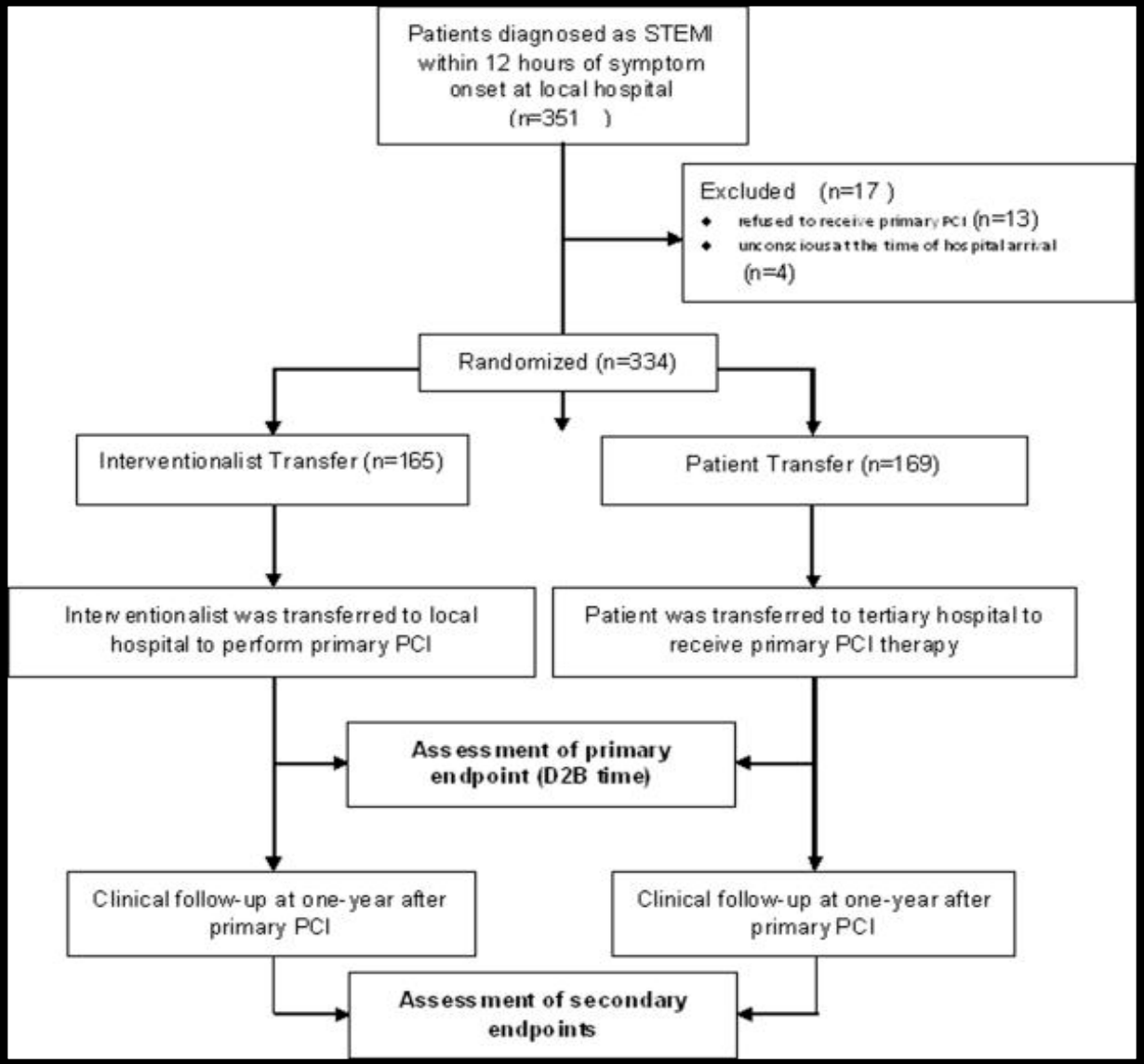
Interventionalist Transfer vs. Patient Transfer Protocol



Zhang, Qi; et al Circulation: Cardiovascular Quality & Outcomes. May 2011.

Table 2. Time to Reperfusion Treatment

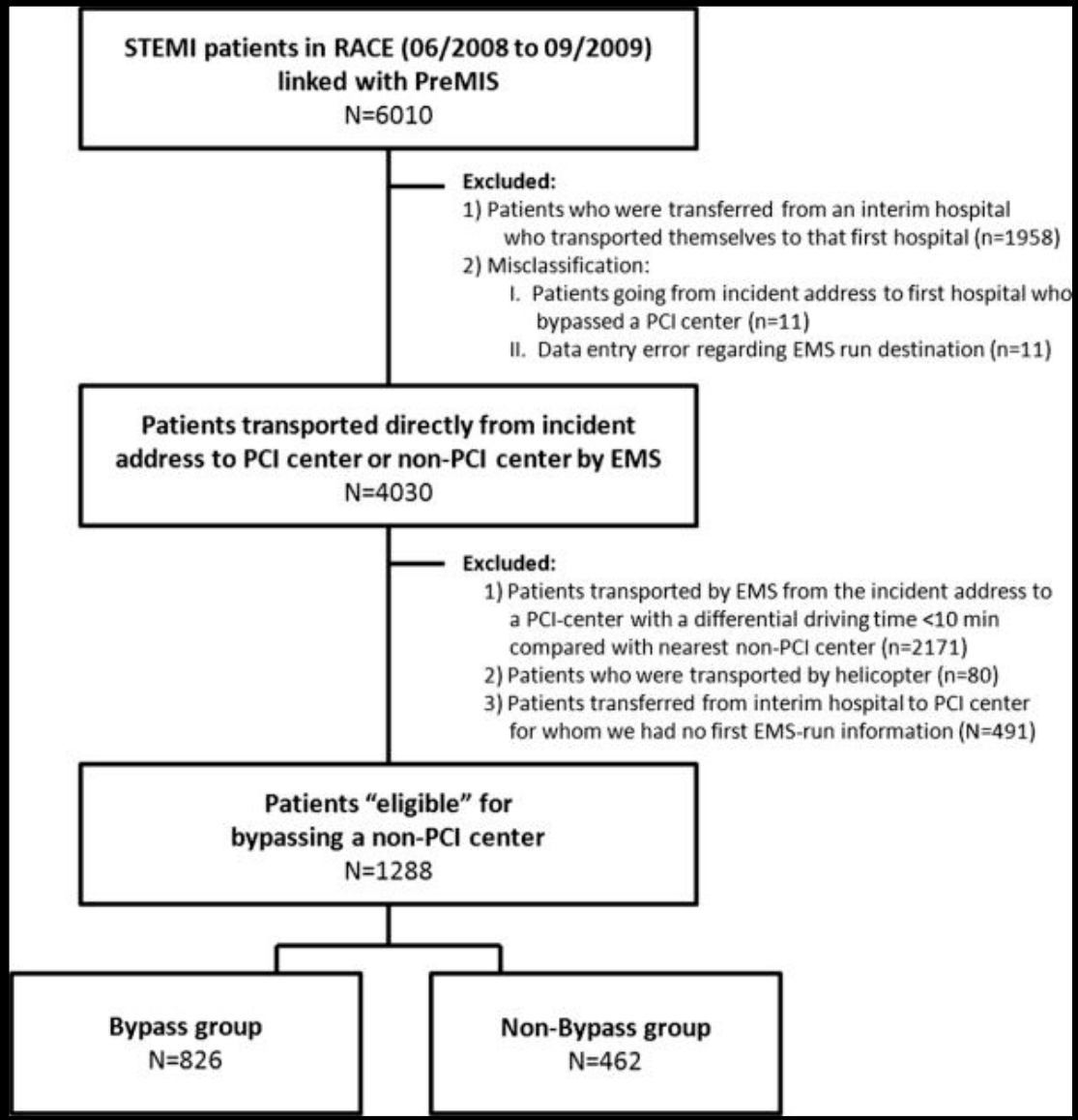
Variable	Interventionalist- Transfer Group (n=165)	Patient-Transfer Group (n=169)	*P*
Symptom onset to local hospital, min	211 (264±156)	185 (241±167)	0.38
Diagnosis to randomization, min	29 (29±6)	28 (28±6)	0.25
Call ambulance to local hospital, min	…	21 (22±7)	NA
Interventionist or patient transfer time, min	33 (34±5)	35 (35±4)	0.08
Arrival at tertiary-care hospital to catheter laboratory, min	…	15 (15±3)	NA
Door to balloon, min	92 (95±20)	141 (147±29)	<0.0001
Door to balloon <90 min, n (%)	35 (21.2)	13 (7.7)	<0.001

Data are presented as median (mean±SD), unless otherwise indicated. NA indicates not available.

Nearly 50 minute reduction in D2B times by not transferring patient for PCI

Zhang, Qi; et al Circulation: Cardiovascular Quality & Outcomes. May 2011.

Bypass Non-PCI Center to PCI Center



Fosbol, Emil; et al. Circulation. 127(5):604-612, February 5, 2013.

	Transport to Non-PCI Hospital (min [IQR])	Transport to PCI Hospital (min [IQR])	Difference in Time, Non-PCI vs. PCI* (min)	*P* value
FMC to arrival at first hospital†	26 (19–33)	42 (32–55)	16	<0.0001
FMC to arrival at PCI center	137 (109–199)	42 (32–55)	95	<0.0001
FMC to PCI among patients treated with only PCI	161 (124–220)	93 (76–115)	68	<0.0001
FMC to PCI in all patients	179 (137–287)	94 (76–116)	85	<0.0001
FMC to any reperfusion therapy‡	124 (67–179)	93 (75–115)	31	<0.0001
Interim hospital arrival to fibrinolytic therapy (door-to-needle time)	30 (19–50)	—	—	—

IQR indicates interquartile range; FMC, first medical contact; and PCI, percutaneous coronary intervention.
*Difference in time between non-PCI and PCI was calculated as the median difference between median times.
†First hospital indicates the interim hospital for the nonbypass group and the PCI center for the bypass group.
‡Reperfusion therapy refers to fibrinolysis or PCI, whichever came first.

30 minute reduction in time to reperfusion when patient taken to a PCI ready hospital

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Fosbol, Emil; et al. Circulation. 127(5):604-612, 2013.

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Cincinnati stroke scale

Interpretation: if any of these 3 signs is abnormal, the probability of a stroke is 72%

Arm Drift

The patient closes eyes and extends both arms straight out, with palms up for 10 seconds

- Normal – both arms move the same or both arms do not move at all (other findings, such as pronator drift, may be helpful)
- **Abnormal – one arm does not move or one arm drifts downward**

Facial Droop

The patient shows teeth or smile

- Normal – both sides of the face move equally
- **Abnormal – one side of the face does not move as well as the other side**

Abnormal Speech

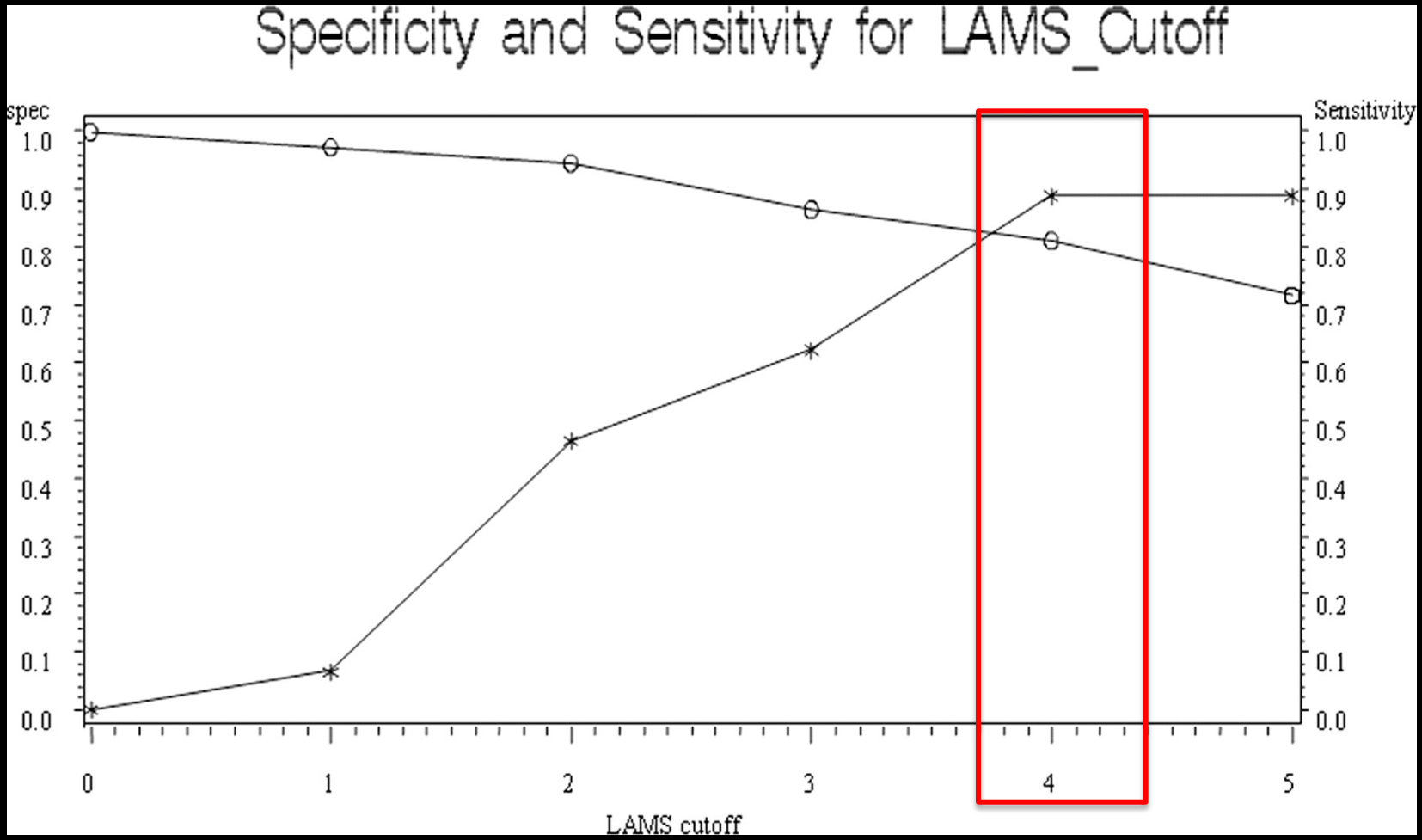
The patient repeats "you can't teach an old dog new tricks"

- Normal – patient uses correct words with no slurring
- **Abnormal – patient slurs words, uses the wrong words, or is unable to speak**

Los Angeles Motor Scale

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

Nazliel B et al. *Stroke*. 2008;39:2264-2267



85% accuracy with LAMS of 4 or 5 in detecting LVO

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Nazliel B et al. *Stroke*. 2008;39:2264-2267

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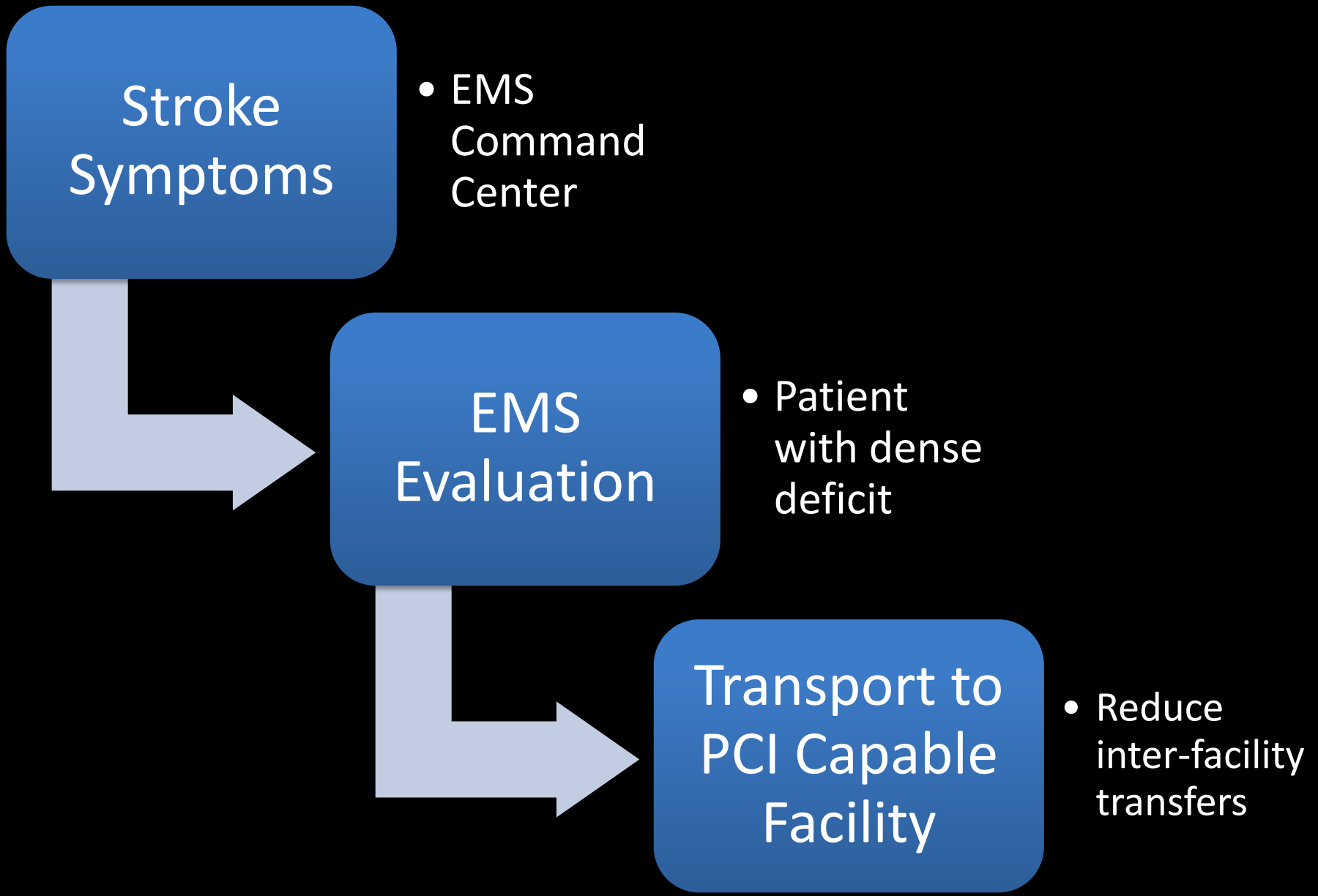
770-793-5680
Stroke Notification

	L MCA, M2											EMS / Triage:	Airlife						
Date:	10/9/2014					VI on site:	Y					ED Physician:	Noohani						
Patient Name:						NIHSS OA:	10					Interventionalist:	Gupta						
Demographics:	75 year old female					D/C NIHSS:						Code FAST/SA prenotific	Y						
LKW	23:00					Neurology:	Owada					Neuro paged PTA	Y						
Presentation	Global Aphasia, Mild senory deficit, Mild gaze											VI activated PTA	Y						

Comments: Primary RN and Stroke Coordinator met on helipad. Pt flown from field Murphy, NC for comp stroke services. NIH=10 OA, NIH=4 at d/c. Pt d/c'd home with home health, able to swallow and ambulate with walker, moderate aphasia	Time	Time of First Medical Contact	Time of Pre-Notification	Time Everbridge Page	**Arrival Time**	ED MD at bedside	CT Start Time	Neurology at bedside	CT Read	tPA ordered	tPA given	Intervention team called	VI Room Ready	Patient Arrival in VI	Interventionalist Arrival in VI	Procedure Start Time	Arterial Access Time	**Reperfusion Time**	Arrival to ICU
Time of First Medical Contact	10:20																		
Time of Pre-Notification	11:02	42																	
Time Everbridge Page	11:07	47	5																
Arrival Time	11:23	63	21	16															
ED MD at Bedside	11:28	68	26	21	5														
CT Start Time	11:38	78	36	31	15	10													
Neurology at bedside	11:23	63	21	16	0	-5	-15												
CT Read	12:00	100	58	53	37	32	22	37											
tPA ordered																			
tPA given																			
Intervention team Called	11:40	80	38	33	17	12	2	17	-20										
VI Room Ready	11:40	80	38	33	17	12	2	17	-20			0							
Patient Arrival in VI	11:50	90	48	43	27	22	12	27	-10			10	10						
Interventionalist Arrival in VI	11:50	90	48	43	27	22	12	27	-10			10	10	0					
Procedure Start Time	12:02	102	60	55	39	34	24	39	2			22	22	12	12				
Arterial Access Time	12:05	105	63	58	42	37	27	42	5			25	25	15	15	3			
Reperfusion Time	12:40	140	98	93	77	72	62	77	40			60	60	50	50	38	35		
Arrival to ICU/Neuro Unit	14:24	244	202	197	181	176	166	181	144			164	164	154	154	142	139	104	


Stroke Symptoms
• EMS Command Center
EMS Evaluation
• Patient with dense deficit
Transport to PCI Capable Facility
• Reduce inter-facility transfers

Suggested Time Metrics

- Door to CT: 5 minutes
- Door to Endovascular Contact: 30 mins.
- Door to Groin Puncture: 90 mins.
- Door to TICI 2B Reperfusion: 120 mins.
- First Medical Contact to Groin Puncture < 120 minutes.

Conclusions

- Rapid Reperfusion Registry shows D2P times correlate with outcomes
- Heterogeneity exists in treatment times across centers
- Inter-facility transfers currently associated with poor outcomes likely secondary to time delays
- Need agreed upon standard time metrics for FMC to groin puncture
- Opportunities to examine pre-hospital triage of patients that ultimately will have maximal impact on time reduction

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