

Role of EMS in the Stroke System of Care:

Getting the *Right Patient* to the *Right Place* at
the *Right Time*

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Presenter Disclosure Information

- Toby Gropen, MD, FAHA
 - Role of EMS in the Stroke System of Care
- FINANCIAL DISCLOSURE:
 - No relevant financial relationship exists
- UNLABELED/UNAPPROVED USES DISCLOSURE:
 - None

Why is prehospital care of stroke patients important?

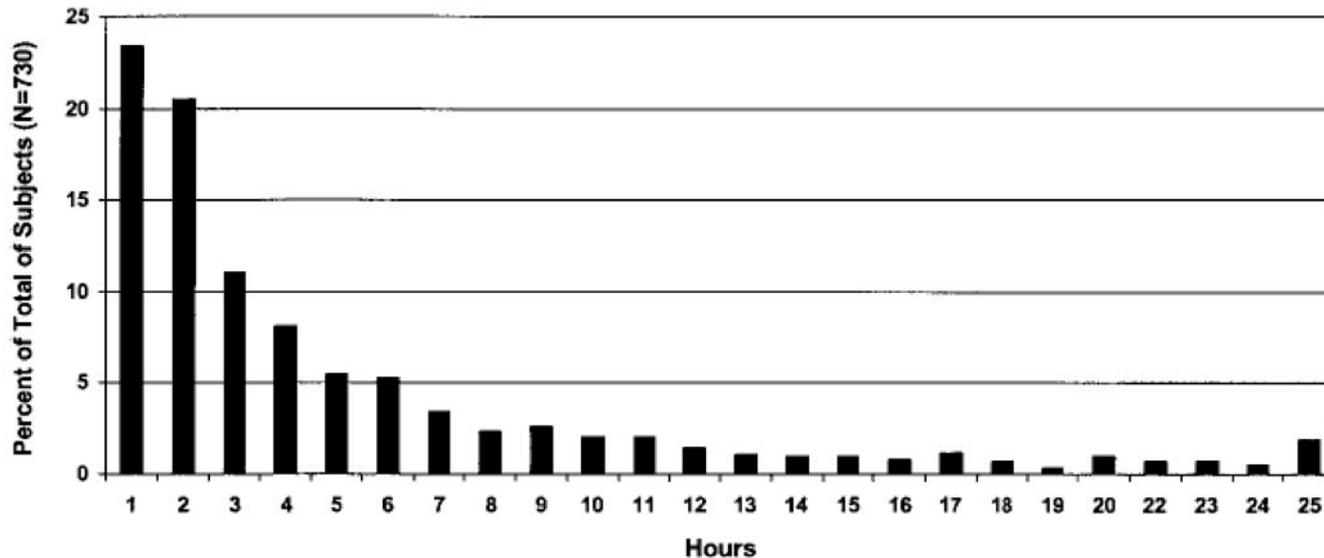
- Only 3–8.5% of all stroke patients receive thrombolytic therapy (Reeves, 2005)
- A systematic review found . . .

Table 3. Commonest reasons for being ineligible for thrombolysis using rt-PA, and the proportions of patients who were ineligible for these reasons

Reason for being ineligible for rt-PA therapy	Proportion (% range)
Delay to treatment >3 hours, or onset time unknown	22–94
CT scan shows haemorrhage or signs of extensive infarction	10–22
Clinical signs of stroke too mild or resolving rapidly	9–19
Medical contraindications to rt-PA	6–10
Refusal to consent to treatment	0.4–10

Delay to Treatment

- A significant percentage of patients arrive to the ED after 3 hours (40 to 80% in recent large multi-center studies)
 - 77% (Harraf, 2002)
 - 75 to 80% (Reeves, 2005)
 - 40% (Saver, 2010)
 - 44% (Morris, 2000)



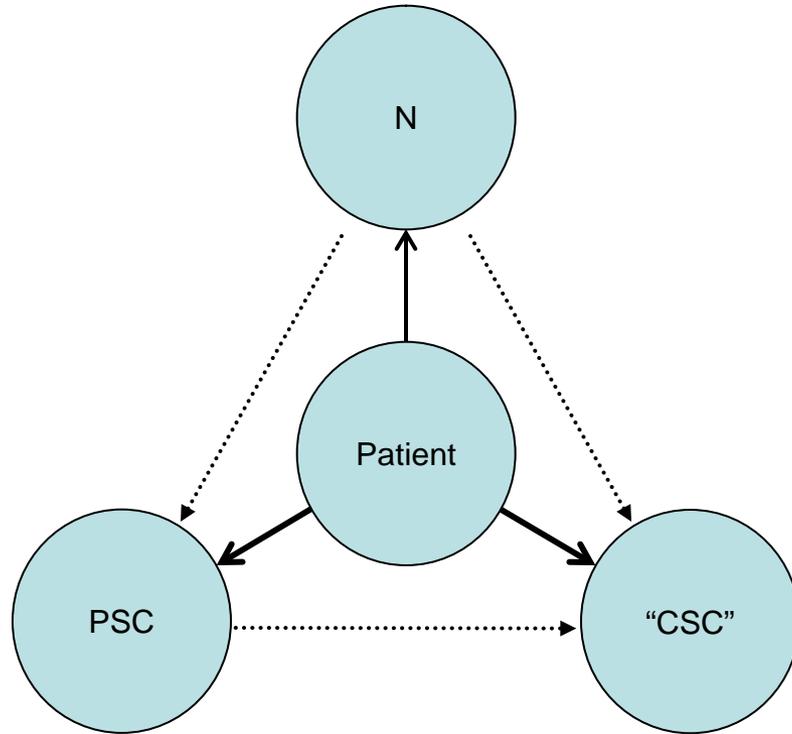
Emergency Medical Service

- Importance of arrival mode
- Selective Triage
- Pre-notification
- EMT and paramedic Diagnosis

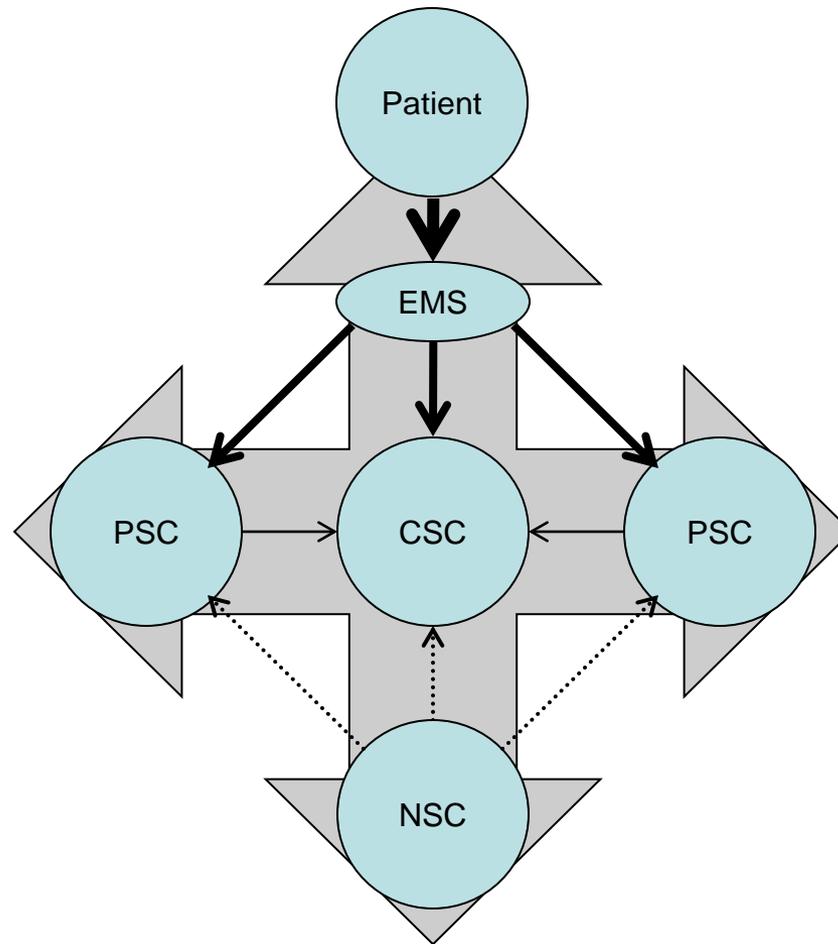
Importance of ED Arrival Mode

- Only 38–65% of patients who experience a stroke decide to call EMS (Harraf, 2002; Kwan, 2004; Bouckaert, 2009)
- In one study (Rosamond, 1998), the only significant predictors of less prehospital delay in a multivariable model were
 - recognition of symptoms by a witness
 - calling EMS

Model of Prehospital Care



Model of Prehospital Care with Selective Triage



NY Selective Triage

- Measured performance before and after BAC-based stroke center designation and selective EMS triage to stroke centers (Gropen, 2006)

Table 2 Performance at baseline vs remeasurement, aggregate data

Time intervals, (min)	Baseline			Remeasurement			<i>p</i>
	n	Median	Range	n	Median	Range	
Door to MD assessment	398	25.0	(0–348)	424	15.0	(0–1,460)	0.001
Door to CT performed, potential t-PA candidates	168	67.5	(2–519)	197	32.0	(3–775)	<0.001
Door to t-PA administration	18	108.5	(45–275)	38	98.0	(40–165)	0.12

Rates	Baseline		Remeasurement		<i>p</i>
	Den	%	Den	%	
Eligible patients who received t-PA	78	21.8	93	38.7	0.02
Infarct patients who received t-PA	763	2.4	728	5.2	0.004
Select t-PA protocol violations	18	11.1	38	7.9	0.69
Post-t-PA hemorrhagic complications	18	27.8	38	18.4	0.43
ED-diagnosed stroke cases admitted to stroke unit	622	15.6	642	38.6	<0.001
Peristroke complications	712	22.9	710	26.5	0.12
Discharge home	1,035	36.3	967	36.7	0.86

NY State Selective Triage

- Subsequent analysis of NY State Data found that admission to a stroke center was associated with a lower stroke mortality compared to admission to a nondesignated hospital (Xian, 2011)

Table 3. Mortality at Designated Stroke Centers and Nondesignated Hospitals

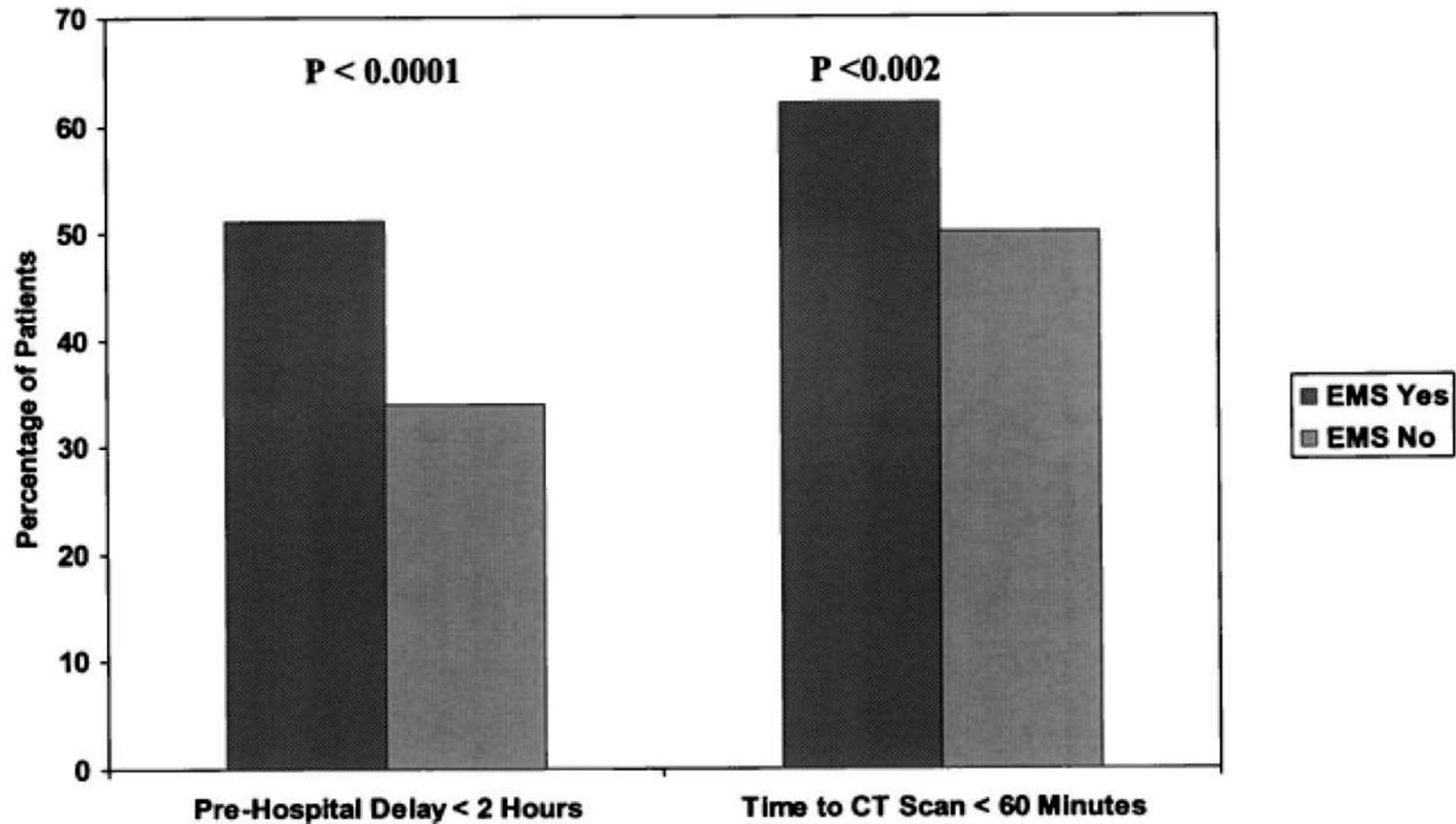
	No. (%)		Adjusted Mortality Difference (95% CI) ^a	P Value
	Designated Stroke Center (n = 15 297)	Nondesignated Hospital (n = 15 650)		
1 d	90 (0.6)	134 (0.9)	-0.3 (-0.6 to -0.0)	.04
7 d	665 (4.3)	842 (5.4)	-1.3 (-2.1 to -0.6)	.001
30 d	1543 (10.1)	1951 (12.5)	-2.5 (-3.6 to -1.4)	<.001
1 y	3412 (22.3)	4067 (26.0)	-3.0 (-4.4 to -1.5)	<.001

Abbreviation: CI, confidence interval.

^aNegative values indicate lower mortality at designated stroke center vs nondesignated hospital. Adjusted for age, sex, race, health insurance status, rural status, 13 Charlson comorbid conditions, atrial fibrillation, hospital teaching status, and total number of hospital beds by using the instrumental variable analysis.

Prenotification and the Connection between EMS and ED care

- Genentech Stroke Presentation Survey (Morris, 2000)



Prenotification, EMS and ED care (Cont.)

- Melbourne study (Mosley, 2007)

Table 3. Timelines of Prehospital Care According to Paramedic Practice (n=187)

	Stroke Not Identified by Paramedics	Stroke Identified by Paramedics—No Notification	Stroke Identified and Hospital Prenotified
Patients	44 (23%)	102 (55%)	41 (22%)
Onset call	97 (28–331)	53 (14–280)	66 (12–243)*
Call arrival	15 (10–24)	12 (9–16)	13 (10–15)*
At scene	17 (11–22)	16 (12–19)	16 (12–20)*
Transport	15 (10–20)	15 (10–20)	13 (9–18)*
Call to hospital	49 (41–57)	43 (37–54)	44 (37–49)*
Door to doctor	33 (17–76)	21 (13–43)	10 (5–20)*
Call to doctor	87 (68–147)	70 (58–95)	52 (45–73)*
Patients residing in care facilities	20%	17%	5%
Age, mean	75	81	75
Male	19 (43%)	46 (45%)	20 (49%)
Austin Hospital	30 (68%)	68 (67%)	38 (93%)
Priority code 1 (lights and sirens) response	25 (56%)	80 (78%)	37 (90%)
Median triage code	3	3	2
Paramedic assessment			
Stroke or transient ischemic attack history	8 (18%)	40 (39%)	16 (39%)
Dementia history	3 (7%)	11 (11%)	1 (2%)
Dysphasia	10 (23%)	72 (72%)	36 (88%)
Facial droop	4 (9%)	45 (44%)	17 (41%)
Grip or arm weakness	14 (32%)	65 (64%)	36 (88%)
Median Glasgow Coma Scale	15	15	11

*Median (interquartile range) minutes.

On multivariate analysis, only GCS<13 (P=0.021) and hospital prenotification (P<0.001) were independently associated with door to Doctor times<10 minutes

Prenotification, EMS and ED care (Cont.)

- MGH study (Abdullah, 2008)
 - Reviewed digital voice recordings of all EMS communications for all acute stroke patients transported by EMS arriving < 6 hours
 - There were no significant differences between those with notification (n = 44) and those without (n = 74) in terms of age, gender, stroke history, median NIHSS score, proportion with mild stroke (NIHSS score ≤ 4), or mean onset-to-ED arrival time
 - Door-to-CT time was 17% shorter (40 vs. 47 minutes, $p = 0.01$) in the advance-notification group, and thrombolysis occurred twice as often (41% vs. 21%, $p = 0.04$)

TABLE 2. Linear Regression Model of Predictors of Shortened Door-to-Computed Tomography Time

Variable	% Decrease in Door-to-CT Time	95% CI	p-Value
Notification	23%	14% to 31%	0.02
Onset-to-ED time	-8%*	-12% to -4%	0.05
NIHSS score >4	27%	18% to 34%	0.005
Diabetes mellitus	-34%	-52% to -34%	0.02

EMS Diagnosis

- Cincinnati study (Kothari, 1995)
 - Reviewed records of 4413 consecutive prehospital records of EMS system for patients with potential stroke
 - There were no published guidelines for prehospital stroke diagnosis
 - Paramedics identified 72% of 86 patients with a subsequent hospital diagnosis of stroke or TIA, i.e., PPV = 72%
 - Did not measure FNs; could not estimate sensitivity of diagnosis
- San Francisco study (Smith, 1998)
 - Also a retrospective review of prehospital records prior to use of a prehospital stroke scale
 - Paramedics identified 49 of 81 patients with a hospital discharge diagnosis of stroke or TIA (sensitivity = $49/81 = 61\%$)
 - Conditions that alter mental status (syncope, seizure, metabolic disorder) caused the most FP and FN diagnoses
 - Of the 53 ischemic strokes, 53% were correctly identified, while 68% of hemorrhagic strokes were identified correctly. The authors related the better diagnostic sensitivity for hemorrhagic strokes to lower mean GCS scores
- San Diego study (Ramanujam, 2008)
 - Retrospectively examined 477 patients from San Diego with a paramedic assessment of stroke using CSS, of whom 193 had a final discharge diagnosis of stroke from 6 San Diego Hospitals
 - Each year, San Diego paramedics receive one hour of formal stroke instruction
 - Found a sensitivity of 44% and a PPV of 40% for paramedics using CSS
 - Were not able to obtain TNs since they did not follow all patients with non-stroke paramedic diagnoses

How accurate is pre-hospital provider diagnosis of stroke?

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Background and Methods

- Previous studies of EMS stroke diagnostic accuracy report sensitivities of stroke diagnosis ranging from 44 to 66%. However, there has been very little examination of factors related to poor diagnostic sensitivity
- We reviewed ambulance and hospital records on all patients transported to Long Island College Hospital between 1-1-2009 and 6-30-2010 by the hospital-based EMS.
- We included patients with ED diagnosis of stroke, syncope, headache, altered mental status, hypoglycemia or seizure.
- We compared EMS diagnosis to discharge diagnosis for admitted patients and ED diagnosis for non-admitted patients.

Results

- Of the 1138 transported patients, 53 (4.7%) had stroke, of which 30 (57%) were incorrectly diagnosed by EMS

	Confirmed Stroke	Confirmed Non-stroke
EMS Stroke	23	11
EMS Non-stroke	30	1074

- Stroke assessment was documented in only 17% of stroke patients
- Sensitivity = 43%; specificity = 98% (p-value<0.0001, $X^2 = 313.45$)
- PPV = 68%; NPV = 97%

Univariate Analysis of Factors Related to Diagnostic Sensitivity

Variable (n)	Sensitivity (%)	p value*
Ethnicity, white (23) vs. non-white (30)	52 vs. 37	0.259
Gender, female (31) vs. male (22)	48 vs. 36	0.384
EMS provider, ALS (11) vs. BLS (38)	45 vs. 42	0.843
Stroke type, hemorrhage (12) vs. ischemia (41)	33 vs 46	0.424
NIHSS \geq 4 (25) vs. $<$ 4 (24)	64 vs. 29	0.015
Lesion side, right (27) vs. left (18)	63 vs. 28	0.021
Motor signs, present (27) vs. absent (26)	59 vs. 27	0.018
Stroke assessment, yes (9) vs. no (44)	78 vs. 36	0.022

* Pearson chi-squared

Univariate Analysis of Factors Related to Diagnostic Sensitivity

Variable	False Negative (mean \pm sd)	True Positive (mean, sd)	p value*
Age	72.9 \pm 14.2	70.9 \pm 14.2	0.62
NIHSS	4.3 \pm 7.9	6.6 \pm 7.9	0.31

* Student's t-Test

Logistic Regression Models of Odds of True Positive EMS Diagnosis

Variable	p value	OR	95.0% C.I. for OR	
			Lower	Upper
Motor signs present	.012	6.60	1.48	38.25
Right-sided lesion	.007	8.25	1.74	55.78
Stroke assessment	.027	7.01	1.27	204.64

Variable	p value	OR	95.0% C.I. for OR	
			Lower	Upper
Motor signs present	.040	5.95	1.08	44.72
Right-sided lesion	.005	9.11	1.85	65.81
Stroke assessment	.041	8.45	1.09	184.03
NIHSS	.706	2.01	.04	85.75

Discussion

- Increased sensitivity of EMS diagnosis in patients with motor findings may reflect
 - the easier diagnosis of stroke in these patients and
 - the motor-weighting of the Cincinnati Pre-hospital Stroke Scale
- Stroke assessment was documented in only 17% of stroke patients, but appears to be a significant predictor of diagnostic sensitivity. This finding suggests that false negative diagnoses of stroke by EMS may partly reflect failure to consider the diagnosis and perform a stroke scale

Discussion

- Increased sensitivity of EMS diagnosis in patients with right-sided lesions was a surprise
- In the age of selective EMS transport of patients to stroke centers, we feel that there needs to be more emphasis on correct diagnosis, not just speed of transport

Conclusions

- Sensitivity of EMS diagnosis of stroke was 43%, with stroke diagnosis missed more frequently when the stroke assessment was not documented, and in patients with left-sided lesions and absence of motor signs
- There is a need for EMS education to lower the threshold for use of pre-hospital stroke scales, improve stroke assessment documentation and increase accuracy of EMS stroke diagnosis in patients without motor signs
- Ongoing work is focusing on developing and assessing an EMS educational program, and exploring the relationship between EMS diagnostic sensitivity and lesion side

Prehospital Stroke Care

- Half of all stroke patients are transported by EMS
- ***EMS plays a critical role.*** Patients transported by EMS arrive sooner, are treated faster in the ED, and are more eligible for treatment
- Selective triage to stroke centers by EMS further improves efficiency of treatment, access to thrombolysis, and lowers mortality
- Prenotification can result in further efficiency of treatment and access to thrombolysis
- We need more study of diagnostic accuracy of EMS in the field using prehospital stroke scales
- We need to improve diagnostic accuracy of EMS
- We need to create systems to facilitate the electronic capture of prehospital data, linking of prehospital data with hospital data, and provision of feedback to EMTs