

# Is Arrival by EMS and EMS Stroke Pre-Notification Associated with Increased Odds of Receiving IV-tPA Among Eligible Stroke Patients in Massachusetts?

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## INTRODUCTION

Administration of Tissue Plasminogen Activator (IV-tPA) in eligible acute ischemic stroke patients is critical to reduce morbidity and mortality. A primary goal of the Massachusetts (MA) Coverdell stroke program is to increase rates of IV-tPA administration.

One strategy to increase use of IV-tPA is to support hospitals in developing Stroke Systems of Care (SSoC), which in part aims to improve collaboration between emergency medical services (EMS) and hospitals. Collaboration with EMS increases IV-tPA use via two pathways:

- **Timely Care:** transport via EMS is faster than private transportation, while stroke pre-notification by EMS field staff to the Emergency Department (ED) facilitates quicker intervention. This is essential, since IV-tPA can only be administered in a narrow time window from onset of stroke symptoms.
- **Last Known Well:** EMS stroke pre-notification includes ED notification of time last known well (LKW), a key factor in determining IV-tPA eligibility. However, only approximately 55% of MA stroke patients arrive by EMS and some eligible patients do not receive IV-tPA. Through community awareness, evidence gathering, and partnership building, the MA Coverdell program works to increase these numbers.

## METHODS

We explored whether arrival by EMS and EMS pre-notification is associated with receipt of IV-tPA among strokes occurring in non-hospital settings.

**Data Source:** we analyzed 6 years (2012-2017) of MA Coverdell stroke registry data, which contain detailed demographic, clinical, and quality of care data on all stroke patients admitted to the 50 MA Coverdell hospitals.

**Inclusion and Exclusion Criteria:** patients with a diagnosis of acute ischemic stroke, excluding transient ischemic attacks (ICD-9 codes 433\*-434\*; ICD-10 codes I63\*, I65\*-I66\*), were at least 18 years of age at presentation, and had a stroke outside of a hospital setting were included. Patients were excluded for the following:

- Any indication of hemorrhage on computed tomography (CT) scan.
- Any documented contra-indications or warnings against use of IV-tPA, regardless of time window.
- Comfort measures only (CMO) on day of or day after hospital admission.
- Hours between last known well to ED triage was greater than 4.5 hours.

**Analysis Methods:** we applied generalized estimating equations with logit link function to predict receipt of IV-tPA. We controlled for patient sex, age (18-44, 45-54, 55-64, 65+ years), race/ ethnicity, insurance type, time trends, NIH stroke scale (NIHSS) at presentation, and hours between last known well to ED arrival. Hospital stroke volume (small, medium, large, and extra-large) was included as a clustering variable.

## RESULTS

FIGURE 1. GENERAL TRENDS IN ARRIVAL BY EMS AND EMS STROKE PRE-NOTIFICATION  
Coverdell Hospital Stroke Registry Data

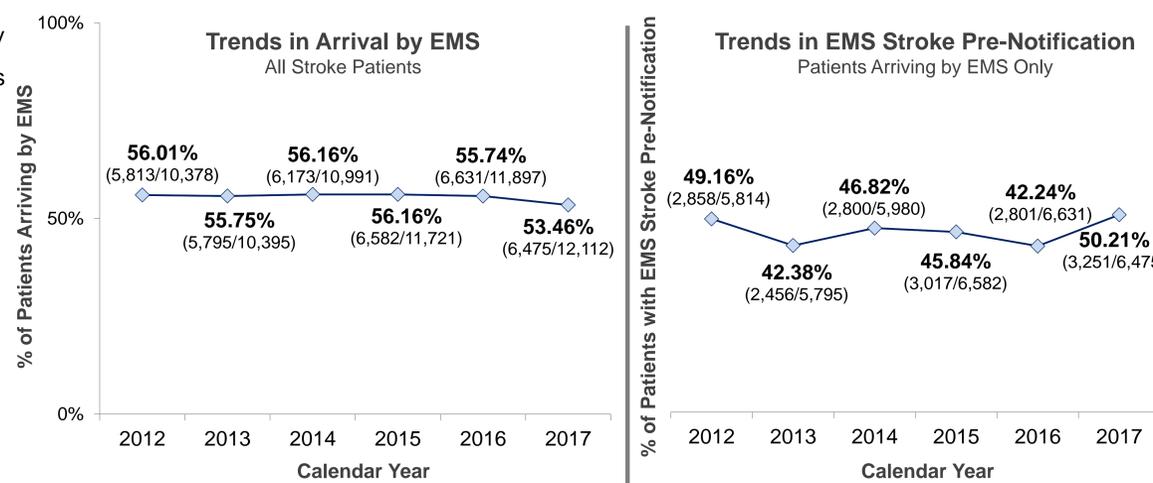


FIGURE 2. CONSORT FLOW DIAGRAM: COVERDELL HOSPITAL STROKE REGISTRY DATA  
Association Between Arrival by EMS, EMS Stroke Pre-Notification, and IV-tPA

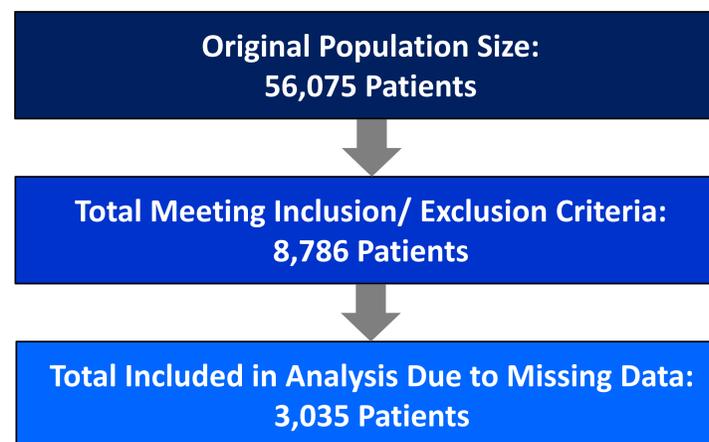


TABLE 1. SELECT MODEL RESULTS  
NH = Non-Hispanic,  $\alpha = 0.05$

Variable	Odds Ratio (OR)	95% Confidence Interval	P-Value
Arrival by EMS	2.92	2.11 – 4.03	< 0.01
EMS Pre-Notification	1.68	1.17 - 2.40	< 0.01
Race/ Ethnicity			
White, NH (ref)	-	-	-
Black, NH	0.87	0.50 - 1.52	< 0.64
Asian, NH	1.66	0.42 - 6.57	< 0.46
Hispanic	1.40	0.93 - 2.09	< 0.09
Female Sex	0.72	0.56 - 0.92	< 0.01
Age Group			
18 - 44 Years (ref)	-	-	-
45 - 54 Years	1.41	1.02 - 1.94	< 0.03
55 - 64 Years	0.84	0.47 - 1.50	< 0.56
65+ Years	0.47	0.36 - 0.62	< 0.01

## DISCUSSION

Controlling for key variables, arrival by EMS and EMS stroke pre-notification were associated with a statistically significant 2.92 and 1.68 increased odds of receipt of IV-tPA, respectively. In addition, older patients and female patients were less likely to receive IV-tPA, a finding that was also statistically significant. These trends have been previously noted in the literature.

Although these results suggest a meaningful increase in IV-tPA associated with arrival by EMS and EMS stroke pre-notification, there are important limitations to note:

- This analysis does not indicate a causal relationship.
- Over half of eligible patients were excluded from the model due to missing data. As such, these results must be interpreted with caution.

Despite these limitations, these results make important contributions in demonstrating that the SSoC improves patient care.

### Next Steps

Addressing missing data is critical to accurately assess the true association between arrival by EMS and EMS pre-notification with receipt of IV-tPA. This analysis should be repeated using validated methods of handling missing data:

- Weighted GEE (could not be implemented here due to software limitations).
- Multiple Imputation (MI).
- Maximum Likelihood Estimation (MLE).

In addition, the reduced odds of receiving IV-tPA among older patients and female patients should be explored to determine if this is a true association and, if so, why these patient subgroups are less likely to receive IV-tPA.

## CONCLUSION

- Providing a rigorous evidence base to support the importance of SSoC in improving patient outcomes is essential to drive implementation.
- A key component of SSoC is partnership with EMS agencies. This facilitates patient arrival by EMS, EMS stroke pre-notification, and documentation of last known well, key factors in eligibility for IV-tPA.
- This analysis suggests that arrival by EMS and EMS stroke pre-notification are associated with increased odds of receiving IV-tPA.
- Results such as these can drive implementation of the SSoC by facilitating buy-in from clinicians, hospital staff, emergency medical responders, and other medical professionals providing stroke care.
- These results should be interpreted with caution due to missing data, nor can these data assert causality.

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