



# Five Year Trend in the Secondary Transfer of Acute Stroke Patients within a Large Urban Stroke System

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## Abstract

**Background and Purpose:** Stroke systems of care include pre-hospital identification of stroke and transport to Approved Stroke Centers (ASC). We sought to characterize the frequency of Emergency Medical Services (EMS) -transported stroke patients transferred from initial ASC to another acute care hospital over a 5-year period. We hypothesized an increase in transfers given the recent emphasis on thrombectomy treatment.

**Methods:** Los Angeles County EMS Agency (LAC-EMS) operates a regional stroke system of care with transport of patients with suspected acute stroke to the closest ASC. Each ASC provided data on patient characteristics, treatment, outcome, and final disposition to the LAC-EMS. We identified all cases of secondary transfer over a 5-year period (2012 to 2016).

**Results:** Among 23,586 EMS transports, there were 943 transfers to another acute care hospital. Transferred patients had a mean age of 66 (SD 16) and were 49% female, 59% White race, and 27% Hispanic ethnicity. Final diagnoses were cerebral ischemia (62%), intracerebral hemorrhage (19%), subarachnoid hemorrhage (14%), and non-stroke diagnosis (5%). The number of transfers increased steadily from 91 in 2012 to 296 in 2016, with a higher rate of increase among patients with a final diagnosis of cerebral ischemia.

**Conclusion:** Secondary transfer of EMS-triaged stroke patients increased from 2012 to 2016. The higher frequency of ischemic stroke patient transfers may reflect increased utilization of thrombectomy.

## Introduction

Stroke systems of care include pre-hospital identification of stroke patients and primary Emergency Medical Services (EMS)/ambulance transport from the field to an Approved Stroke Center (ASC). Among Acute Cerebral Ischemia (ACI) patient, thrombectomy treatment for Large Vessel Occlusion (LVO) strokes can be performed only in Comprehensive Stroke Centers (CSC) with thrombectomy capacity [1]. Furthermore, Intracranial Hemorrhage (ICH) patients routinely undergo hospital-to-hospital transfers for higher level of care [2]. Patients may also self-present to a hospital that is not appropriately equipped to provide emergent stroke care. Therefore, secondary transfer of stroke patients to a Primary or Comprehensive Stroke Center (PSC or CSC) may be necessary to initiate or improve treatment [3,4].

Since 2014, multiple prospective randomized trials have proven the benefit of thrombectomy treatment in acute ischemic stroke [5-9]. Due to specific facility requirements and medical expertise that endovascular therapy demands, patients have access to this treatment only at the Endovascular Capable Centers (ECCs). In the drip-and-ship model, patients, who initially arrive to a non-ECCs and receive IV-tPA, are then transferred to ECC for mechanical thrombectomy [10]. The success of endovascular therapy and implementation of drip-and-ship model adds a new dimension to stroke systems of care and may drive the transfer of stroke patients to thrombectomy-capable centers.

In this paper, we sought to characterize the frequency of Emergency Medical Services (EMS)-transported stroke patients transferred from initial ASC to another acute care hospital over a 5-year

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**Table 1:** Characteristics of transferred vs. non-transferred patients.

	Transferred (N=943)	Not Transferred (N=22,643)
Age (mean, standard deviation)	66 (16)	72 (15)
Female	51%	52%
Race		
White	60%	65%
Black	14%	10%
Asian	13%	10%
Missing/not determined	6%	3%
Other	7%	12%
Hispanic Ethnicity	26%	27%
Final Clinical diagnosis		
Cerebral Ischemia	65%	66%
Intracranial Hemorrhage	34%	15%
Non-Stroke	5%	18%
Undetermined/missing	0%	1%
Thrombolytic Therapy (cerebral ischemic cases only)	50%	16%
NIHSS (N=18,376, median, interquartile range)	16 (9-23)	8 (4-18)

period. We hypothesized an increase in secondary stroke transfers given the recent success of thrombectomy treatment following the publication of positive clinical trial data since December 17, 2014. The frequency of secondary transfers is an essential metric that should be tracked and examined more closely on a systems-wide basis and serves as subject of this study.

## Methods

Los Angeles County Emergency Medical Services Agency (LAC-EMS) serves a population of 10.1 million across 4,084 square miles with over 18,000 EMS personnel and 40 ambulance operators handling approximately 4,000 transports per month [11]. There are 49 ASCs within the regional stroke system as of June 2017 [12]. Los Angeles County's regional stroke system of care involves transport of patients with suspected acute stroke identified by EMS in the field to the closest ASC. ASC designation did not distinguish primary from comprehensive stroke centers for the period of study.

LAC-EMS paramedics use the modified Los Angeles Pre-hospital Stroke Screen (mLAPSS) to evaluate patients presenting with focal neurologic signs or symptoms. Patients with positive mLAPSS and those who, by paramedic and/or Base Hospital judgment, may be having an acute stroke are routed to the closest ASC. Per policy, each ASC reports data to the LAC-EMS on all EMS-transported patients who screen positive for acute stroke in the pre-hospital setting. Data include patient characteristics, treatment, outcome, and final disposition. We identified all cases of secondary transfer over the 5-year period, from January 1<sup>st</sup> 2012 to December 31<sup>st</sup> 2016. All patients routed for possible stroke are included in the study sample. This study was reviewed and approved by the institutional review board.

## Statistical Analysis

Demographic characteristics and stroke time metrics were abstracted from the LAC-EMS stroke registry. Characteristics included age, gender, race, Hispanic ethnicity, National Institutes of Health Stroke Scale (NIHSS), final diagnosis, and disposition. We

identified all cases with a stroke diagnosis that were transferred from the primary receiving ASC Emergency Department (ED) to another acute care hospital, and the subset of patients transferred for "higher level/specialized care." We provide descriptive analyses and do not provide statistical significance values when comparing transferred and non-transferred cases given the inability to adjust for the inherent differences between the two groups.

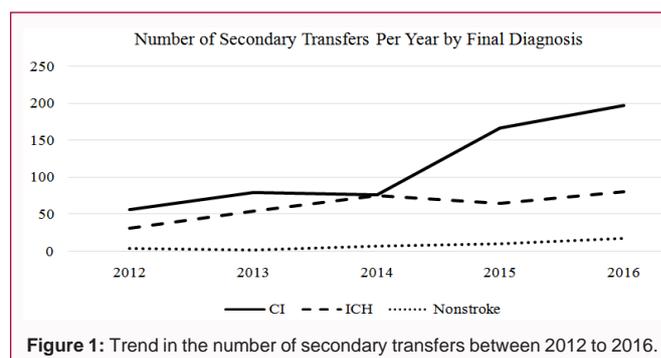
## Results

There were 23,586 stroke screen positive transports recorded in the LAC-EMS database for the years 2012-2016. There were 943 transfers out of the initial receiving ASC to another acute care hospital, accounting for 4% of all transports. Ninety-eight percent of patients were transferred for higher level of care. Transferred patients had a mean age of 66 (SD 16) and were 49% female, 59% White race, and 27% Hispanic ethnicity. Final diagnoses were cerebral ischemia (62%), intracerebral hemorrhage (19%), subarachnoid hemorrhage (14%), and non-stroke diagnosis (5%). NIHSS on initial presentation was recorded in 723 cases (77%). The median NIHSS at initial presentation was 16 (IQR 9-23) and 50% of patients with cerebral ischemia were treated with intravenous thrombolytic therapy. Compared with non-transferred patients, transferred patients were younger, had higher stroke severity, and lower rates of non-stroke diagnosis (Table 1).

The number of transfers increased steadily from 91 in 2012, 135 in 2013, 159 in 2014, 243 in 2015, to 296 in 2016 (Figure 1). Transfers for ischemic stroke increased at a greater rate than those for Intracerebral Hemorrhage (ICH). The mean number of transfers per year for cerebral ischemic increased from 70 in the first three years of the study (2012-2014) to 180 in the last two years (2015-2016) and the proportion of transfers for cerebral ischemic increased from 55% to 68%. The use of IV-tPA also increased in the last two years (2015-2016) with 25.8% of patients getting IV-tPA in 2012, 30.8% in 2013, 20.8% in 2014, 39.9% in 2015, and 35.5% in 2016, which may contribute to the rising number of transfers over time.

## Discussion

From 2012-2016, secondary transfers out of initial receiving ASCs accounted for a small but important proportion (4%) of all LAC-EMS transports. The vast majority of transfers were for higher level of care. We found a 225% increase in the number of secondary transfers between 2012 (91) and 2016 (296). Secondary transfer of patients with a final diagnosis of cerebral ischemia, in particular, increased at a higher rate than the secondary transfer of patients with ICH. The timing of this increase follows the publication of positive trial data on thrombectomy treatment in December of 2014. The number of transfers continued to increase in the two years subsequent and the



**Figure 1:** Trend in the number of secondary transfers between 2012 to 2016.

proportion of transfers with the final diagnosis of cerebral ischemia increased as well.

We found no previous studies that have characterized system-wide secondary transfer of acute stroke patients. The STRATIS study recently published data from a multicenter registry and demonstrated worse functional outcomes in patients who were transferred for mechanical thrombectomy compared to those who were direct presentations [13]. While secondary transfer for thrombectomy may lead to delayed or missed opportunities for successful thrombectomy treatment, direct transport to thrombectomy-capable centers may come at the expense of timely t-PA administration. Secondary transfer of stroke patients from receiving hospitals to higher-level of care centers may be a viable approach that can be implemented in a regional stroke network but may require door-in-door-out time less than or equal to 30 minutes in order to be optimal [14].

Limitations of this study include the lack of more specific documentation on the reason for transfer, beyond “higher level of care”. Secondary transfer of acute stroke patients may be initiated for a variety of reasons, including clinical deterioration and tertiary care for conditions unrelated to stroke. Although we observed a steady growth in the number of secondary transfers between 2012 to 2016, given the retrospective data, we cannot determine the cause of this change. Further, LA-EMS database includes only direct EMS transported patients and the sending or receiving hospital data does not go into the database. Based on these limitations, while half of patients diagnosed with cerebral ischemia were treated with intravenous thrombolytic therapy at the initial receiving ASC, it is unclear how many of these patients actually underwent thrombectomy treatment at the final receiving stroke center.

This study highlights the importance of developing regional registries of acute stroke in order to allow for more detailed analyses of stroke systems of care, including secondary transfers of patients between stroke centers. Future studies are needed to examine the indications for and outcomes of secondary transfer, and thus help develop evidence-based protocols for stroke systems.

## Conclusion

We observed a steady growth in the number of secondary transfers over five years, with secondary transfers of cerebral ischemia patients increasing at a higher rate than those of patients with hemorrhagic stroke. Given the timing of this change, we suggest that this increase may be due to the publication of data demonstrating the benefit of thrombectomy treatment at the end of 2014.

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## Disclosures

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