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mStroke: Mobile Stroke

Improving Acute Stroke Care with Smartphone Technology

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Abstract

Introduction: The use of mobile electronic care coordination via smartphone technology is a novel approach aimed at increasing efficiency in acute stroke care. One such platform, StopStroke© (Pulsara Inc., Bozeman, MT), serves to coordinate personnel (EMS, nurses, physicians) during stroke codes with real-time digital alerts. This study was designed to examine post-implementation data from multiple medical centers utilizing the StopStroke© application, and to evaluate the effect of method of arrival to ED and time of presentation on these results.

Methods: A retrospective analysis of all acute stroke codes using StopStroke© from 3/2013 - 5/2016 at 12 medical centers was performed. Preliminary unadjusted comparison of clinical metrics (door-to-needle time [DTN], door-to-CT time [DTC], and rate of goal DTN) was performed between subgroups based on both method of arrival (EMS vs. other arrival to ED) and time of day. Effects were then adjusted for confounding variables (age, sex, NIHSS score) in multiple linear and logistic regression models.

Results: The final dataset included 2589 unique cases. Patients arriving by EMS were older (median age 67 vs. 64, $P < 0.0001$), had more severe strokes (median NIHSS score 8 vs. 4, $P < 0.0001$), and were more likely to receive tPA (20% vs. 12%, $P < 0.0001$) than those arriving to ED via alternative method. After adjustment for age, sex, NIHSS score and case time, patients arriving via EMS had shorter DTC (6.1 min shorter, 95% CI [2, 10.3]) and DTN (12.8 min shorter, 95% CI [4.6, 21]) and were more likely to meet goal DTN (OR 1.83, 95% CI [1.1, 3]). Adjusted analysis also showed longer DTC (7.7 min longer, 95% CI [2.4, 13]) and DTN (21.1 min longer, 95% CI [9.3, 33]), and reduced rate of goal DTN (OR 0.3, 95% Cl [0.15, 0.61]) in cases occurring from 1200-1800 when compared to those occurring from 0000-0600.

Conclusions: By incorporating real-time pre-hospital data obtained via smartphone technology, this analysis provides unique insight into acute stroke codes. Additionally, mobile electronic stroke care coordination is a promising method for more efficient and efficacious acute stroke care. Furthermore, early activation of a mobile coordination platform in the field appears to promote a more expedited and successful care process.

Background & Objectives

- Prehospital notification in acute stroke is associated with improved time metrics and outcomes.
- In-ambulance telemedicine and telestroke systems are being utilized in an effort to expedite evaluation and shorten time-to-treatment in acute stroke.
- Mobile stroke (mStroke) utilizes mobile application services to coordinate stroke care between prehospital providers and hospital stroke teams.
- Pulsara StopStroke© is one such mStroke application, with single-center data indicating a 46% improvement in DTN after implementation.
- We tested the hypothesis that in a multi-institution cohort, activation of the Stop Stroke© application by a prehospital provider in the field would be associated with lower DTN compared to activation by an ED provider.

Figure 1: Sample screen images from Pulsara StopStroke© application

Methods

- Retrospective analysis of acute stroke codes utilizing StopStroke© occurring between March 2013 and May 2016 at 12 major medical centers.
- Cases screened for user error and test case status.
- Univariate analysis stratified by method of activation (ED vs. EMS).
- Multiple linear and logistic regression modeling for door-to-CT time, door-to-needle time and rate of goal door-to-needle time (< 60 minutes).

Results

Table 1: Parameters by Method of Activation

	ED (n = 2004)	EMS (n = 585)	P Value
Age, y, median (IQR)	64 (52-76)	67 (56-80)	< 0.0001
Sex, male, n (%)	868 (47%)	253 (47%)	0.882
NIHSS score, median (IQR)	4 (2-9)	8 (3-15)	< 0.0001
Received rt-PA, n (%)	246 (12%)	116 (20%)	< 0.0001
DTC, min, median (IQR)	24 (12-38)	15 (8-30)	< 0.0001
DTN, min, median (IQR)	57.5 (42-75)	47.5 (36.75-66)	0.0004
DTN < 60 min, n (%)	141 (57%)	81 (70%)	0.023
LKN-to-needle, min, median (IQR)	122 (90.25-179.5)	125 (88.5-158.5)	0.567
LKN-to-needle < 3 hrs, n (%)	186 (76%)	99 (86%)	0.023
LKN-to-needle < 4.5 hrs, n (%)	240 (98%)	115 (100%)	0.091

Results

Table 2: Regression Models

	Door-to-CT β (95% CI)	Door-to-Needle β (95% CI)	Door-to-Needle < 60 min OR (95% CI)
ED Activation	Reference	Reference	Reference
EMS Activation	-6.14 (-10.3, -2)**	-12.8 (-21, -4.6)**	1.83 (1.1, 3)*
Age	-0.1 (-0.2, 0.02)	-0.09 (-0.37, 0.19)	1.01 (0.99, 1.03)
Sex (male)	-0.09 (-3.7, 3.5)	-5.44 (-13, 2.2)	1.81 (1.14, 2.86)**
NIHSS score	-0.134 (-0.41, 0.14)	0.08 (-0.56, 0.71)	1.01 (0.97, 1.05)
Case Time (0000 – 0600)	Reference	Reference	Reference
Case Time (0600 – 1200)	7.1 (2.8, 11.4)***	8.88 (0.5, 17.2)*	0.92 (0.56, 1.53)
Case Time (1200 – 1800)	7.7 (2.4, 13)**	21.14 (9.3, 33)***	0.3 (0.15, 0.61)***
Case Time (1800 – 0000)	4.7 (-2.6, 12)	4.11 (-9.9, 18.1)	0.75 (0.33, 1.7)

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Conclusions

1. EMS activation in mStroke cases was associated with shorter DTC and DTN when compared to cases with ED activation.
2. EMS activation in mStroke cases was associated with an increased likelihood of meeting goal DTN when compared to cases with ED activation.
3. Early afternoon (1200 - 1800) case time in mStroke cases was associated with longer DTN and DTC when compared to cases in the early morning (0600 - 1200).
4. Early afternoon (1200 - 1800) case time in mStroke cases was associated with an decreased likelihood of meeting goal DTN when compared to cases in the early morning (0600 - 1200).

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