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# Efficacy of Advanced Prehospital Communication in Acute Ischemic Stroke Treatment

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# Efficacy of Advanced Prehospital Communication in Acute Ischemic Stroke Treatment

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by

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## Executive Summary

In possible ischemic stroke victims recognized by emergency medical technicians (P), how does the use of an advanced prehospital communication tool (I) compared to not pre-alerting receiving facilities (C) affect time to treatment in ischemic stroke victims (O) within three months of implementation. (T)?

Almost all prehospital emergency providers have access to mobile technology that can be used to securely communicate pertinent information to a receiving facility. Ischemic stroke treatments and outcomes are heavily dependent on the time it takes to receive said treatment. When considering the improvement of stroke care there are multiple approved interventions that will affect time to treatment in stroke care victims.

At the proposed facility, which is a comprehensive stroke center, there are still instances of delayed or incomplete incident reports, lack of a central stroke database, and no umbrella to quantify stroke treatment time-metrics reliably. This is where the need for a new digital communication tool becomes apparent. With a secure digital application, pre-hospital providers may alert the facility to the incoming potential stroke victim as well as relay valuable information surrounding the event in a structured, consistent manner that continues with the case well after hospital arrival. According to Mckinney, et al., (2013), providing only an advanced system prenotification yielded a statistically significant improvement in time to stroke team arrival, time to CT scan completion, time to CT scan interpretation, and time to ECG.

By utilizing a system that provides pre-notification, includes a structured report, timers that remind providers of target times, live updates of the case as it unfolds, and the software to efficiently evaluate case outcomes, the clarity and efficiency of stroke care provided is significantly affected. With advancing technology, it is feasible to significantly reduce time to

treatment in victims of ischemic stroke and ultimately improve the outcome of this traumatic life event, even in a recognized stroke center.

## Background and Significance

According to the American Heart Association, a person in the United States suffers from an acute stroke every forty seconds (Henry-Morrow et al., 2017). Implementing communication improvements and streamlining care is a step forward in the evolution of stroke management. An acute stroke, whether hemorrhagic or ischemic in nature requires time sensitive intervention to reduce potentially lasting effects. There is a window of four and one-half hours from a known time of onset to administer intravenous alteplase in effort to minimize chronic deficit. This intervention in conjunction with invasive vascular reperfusion in cases of proximal large vessel occlusion in the anterior circulation are the standard of care for acute ischemic stroke (Bendszus & Hacke, 2016). Ischemic stroke is considered a leading cause of disability, cognitive impairment, and death in the United States (Ovbiagele et al., 2013). Because there is no cure for this seemingly indiscriminate condition, emphasis is placed on improvement of timely interventions and their ability to minimize chronic devastation. Without the use of an advanced prehospital communication tool the risk of lasting debilitation from an ischemic event increases and stroke treatment at the facility remains stagnant.

## Literature Review

Dickson et al. (2017) compared door to needle times before and after implementation of the mobile communication application “Stop Stroke” by Pulsara. After utilization of the application, which allowed EMS to provide the receiving facility with pertinent patient information prior to arrival, the door to needle times decreased by 21 minutes, thus improving efficiency by 28%. Overall door to needle times of less than or equal to 60 minutes improved

from 32% to 82% after the applications implementation. The utilization of a hospital pre-alert system according to Sheppard et al. (2013) increased the likelihood of a quick CT by 77%, while Bae et. al (2010) observed a decrease in door to needle times of 29.4% when compared to treatment prior to a prehospital communication program. Andrew et al., (2020) and Kelly (2020) synthesized through retrospective analysis statistically significant improvements in pre-alerting, door to CT times, and door to needle times in patients who were treated in a system with advanced communication in place. Berglund et al., (2012) evaluated the implementation of level one pre-alerting in the case of possible stroke in a randomized control trial and cut the study short due to efficacy and improved outcomes with no apparent risk of harm to other lower priority calls with implementation. Studencan et al. (2018) outlines a similar intervention for STEMI (ST elevation myocardial infarction), in which a program is implemented that allows prehospital providers to transmit an ECG and patient report to a cardiologist at the receiving facility. This allows for activation of the percutaneous coronary intervention team and decreased the average total ischemic interval from 241 minutes to 181 minutes, or nearly 25%. This study, while not directly related to stroke care, demonstrates the consistent improvement in time to treatment when prehospital communication is adopted. While improving the time to treatment indicates improved patient outcomes, how is this quantified? According to Jahan et al. (2019), when considering a population of 1000 people, decreasing time to endovascular recanalization by a factor of 15 minutes improved independent ambulation by 1.14% or 11 people. Freedom from disability at discharge was increased by .98% or 10 people. Hospital mortality rates decreased by 0.77% or 8 people, and discharge to home (versus a skilled nursing facility or rehabilitation center) increased by 1.15% or 12 people. These figures are doubled for every 15 minutes time to treatment is reduced. Requiring and educating use of an application that

promotes prehospital communication adds another element to job responsibilities of both prehospital and intrahospital providers. This increased workload is offset by the effective ability to streamline patient reports, interventions, and interdisciplinary communication. Munich et al. (2017) observed through a survey that 82.5% of stroke-team employees involved in the use of an application recommended the continued use of the tool as an efficient and easy to use means of communication. The available literature indicates significant improvement in time to treatment and patient outcomes when an advanced prehospital communication system is implemented.

## Stakeholders

Zhang et al., (2020), identifies the scarcity of evaluative research in implementation of preshospital commnunication technologies that leads to increased barriers, lack of end user acceptance, and decreased efficacy of implemented technology. The proposed technology must be evaluated at the end-user level before, during, and after implementation. The patients providers including nurses, physicians, radiology team members, and all other aspects represented by the interdisciplinary team are key stakeholders. Other key members include clinical researchers within the facility, neuro-interventionalists, medical directors, stroke coordinator, and director of local emergency medical services.

To effectively sort and expose previously identified data, a clinical researcher with expertise in navigating the facilities electronic medical record is invaluable. To identify current treatment options for incoming patients, a neuro-interventionalist employed at the facility may provide insight on best practice to get these patients to the treatment table. The facility medical director or stroke coordinator will be a source of policy review and ultimately a decision maker in the implementation of a program. Finally, associating the director of local or regional

emergency medical services will give insight to the feasibility of implementing a program heavily relying on pre-hospital providers.

## Implementation

Barriers to implementing this intervention include maintenance of patient privacy and increased responsibility of care providers. To ensure patient privacy the application would need to operate on a secure private network. The software required to implement this change exists in daily digital technology and would only require the secure download and use of the application by involved parties. Additional hardware (such as tablets) may be utilized by the facility to promote consistency of use and eliminate reliance on staff to utilize personal devices for work.

After presenting the potential for interprofessional change and having it accepted by the facility and EMS community, the steps that compile the implementation process are as follows.

- First, the appropriate software must be procured. There are options available and the determination of the appropriate program for the system relies on facility researchers, stroke coordinator, and medical directors to diagnose the needs of the facility and coordinate a program that fits best. This process requires input of multiple parties but should take less 2 weeks to secure a chosen application.

- Once a program has been chosen, the infrastructure for implementation is initiated. This means supplying the involved units and providers with hardware (such as a tablet) and software required to implement the change. With the help of hospital technical support, the procurement and distribution of hardware for this process requires a timeline of 1 week or less.

- After the infrastructure is in place, staff training is required. The interface should be user friendly and geared specifically for rapid utilization. Considering our current digital age, the learning curve will be minimal and formal education of staff should not exceed one

mandatory 4-hour training session, with all employees having attended the training by the end of week 4. If complete compliance with required training is not achieved by the end of week 4, it would be acceptable to move on and evaluate formal training rates after implementation.

- Once these steps are complete, the facility and prehospital providers can begin using the program. Once the program has been utilized for a period of two months, data reflecting time to imaging and treatment times will be evaluated and compared to pre-program results to gauge effectiveness. Staff surveys should be completed monthly during the implementation phase to evaluate receptiveness and end user concerns. If the implementation of this change is not feasible, alternatives include amendment to interfacility communication between departments in hopes of decreasing treatment times, but the effectiveness of this in comparison to the proposed intervention seems minimal. Please refer to appendix A for a flow chart outlining the implementation process.

## Evaluation

The root of evaluation for this intervention is retrospective analysis. Taking data from pre-implementation and comparing it to post implementation data determining the presence of statistically significant changes. This process will require utilization of an SPSS software by nurse researchers and quantitative statistical analysis of time to treatment in the target population. Measured time to treatment statistics include door to first NIHHS, door to CT scan, door to CT scan interpretation, and finally door to needle (DTN). DTN may be split be cover both door to tPA or tissue plasminogen activator, and or door to puncture by interventional radiology. Secondary evaluation should include weekly qualitative analysis through staff survey evaluating end user acceptance and identifying potential areas of improvement. While the priority is to improve time to treatment in acute ischemic stroke victims identified by EMS,

secondary aims include streamlining communication between all involved providers, incorporating application driven stroke data that is readily accessible for audit and review, and providing a competent medium for providers and caregivers that eliminates repetitive diagnostics, assessments, and unclear communication from the patient care process.

## Cost/Benefits

Implementation or program initiation costs will vary by facility based on ER volume and logistical complexities. A competing intervention that arose during assessment of improving prehospital stroke treatment was mobile stroke units. When pitting a digital communication application against mobile stroke units (MSU), the cost is considerably greater with each MSU requiring over $1M in capital. A digital application can be standardized and available to every patient in every ambulance. It is a more effective way to speed time to treatment (Bukata, 2017). Insurance reimbursement for prehospital treatment in the case of MSU is not established at this time either. Employee training and procurement and maintenance of software are main sources for repeat costs of the intervention. These costs may be offset by decreased length of stays, boosting of employee satisfaction and retainment, and improved efficiency of care leading to increased funding and recognition from the community and regulatory agencies. According to Good Shepherd Medical Center (2015), after implementing a program known as Pulsara an increase in revenue of $259,738 was realized from higher rates of tPA administration. Length of stay for STEMI patients was decreased by 26% and revenue from PCI based interventions increased by $494,000. These were realized over a two-year period after initial implementation. This intervention demonstrates promise for significant return on investment if managed appropriately.

## Conclusions/Recommendations

The ability to improve a stroke victim's quality of life is as simple as improving the communication between medical professionals. If decreasing time to treatment at a designated stroke facility is a priority, the utilization of a digital communication tool indicates significant improvement. There is no proposal of treatment alteration, yet a proposal in methods that allow current practices to be initiated sooner. The risk of this intervention is minimal, with the reward being potential greater quality of life for the patient and improved metrics for the facility. After reviewing available data, weighing cost/benefit, and exploring other options for improvement, the goal of significantly decreasing time to treatment through use of common technology appears remarkably achievable. The intervention is noted as widely successful according to compiled data, is an integral part of the technological evolution of health care, and it is strongly recommended for implementation.

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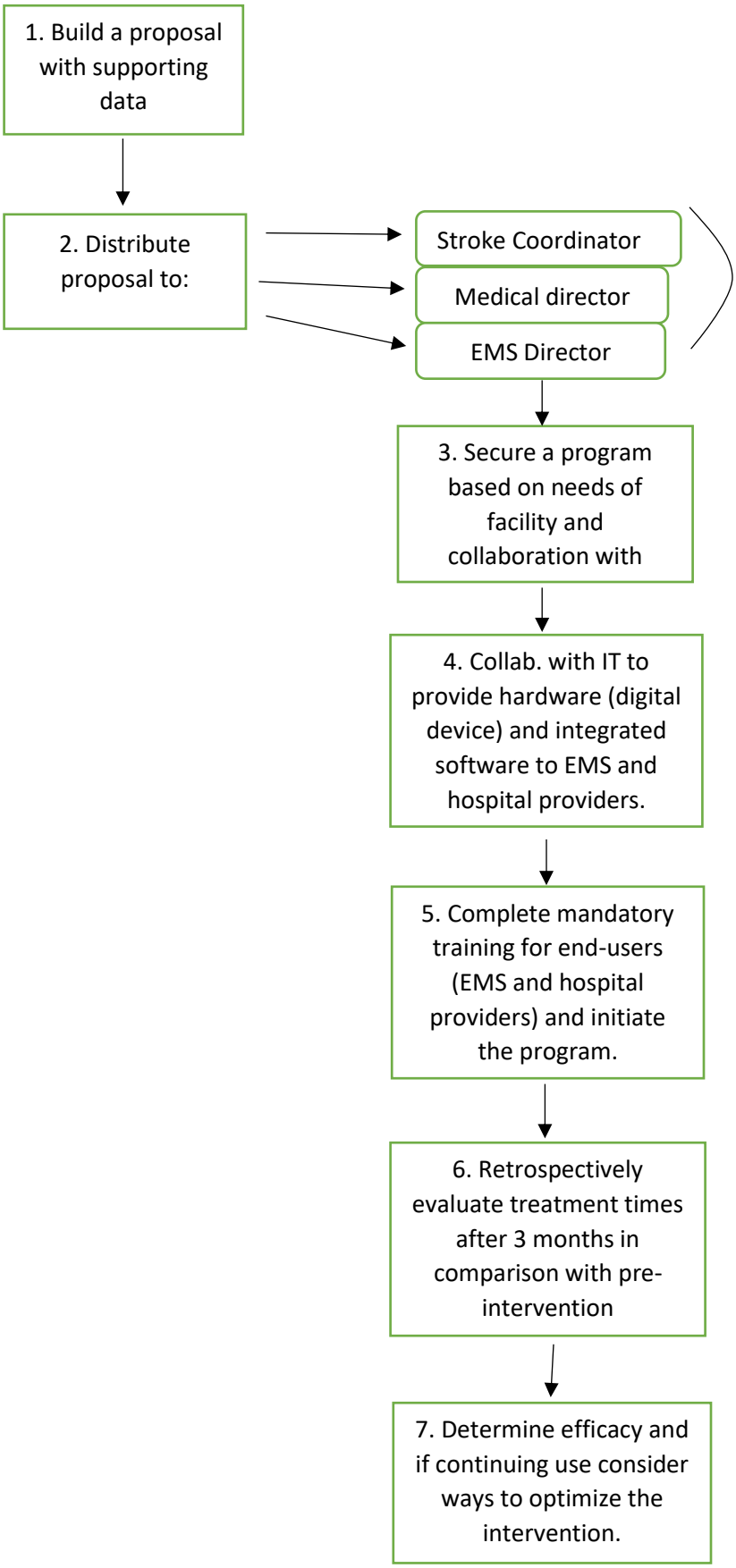
Appendix A


1. Build a proposal with supporting data
2. Distribute proposal to:
Stroke Coordinator
Medical director
EMS Director
3. Secure a program based on needs of facility and collaboration with
4. Collab. with IT to provide hardware (digital device) and integrated software to EMS and hospital providers.
5. Complete mandatory training for end-users (EMS and hospital providers) and initiate the program.
6. Retrospectively evaluate treatment times after 3 months in comparison with pre-intervention
7. Determine efficacy and if continuing use consider ways to optimize the intervention.

Appendix B

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| **PICOT Question:** In possible ischemic stroke victims recognized by emergency medical technicians (P), how does the use of an advanced prehospital communication tool (I) compared to not pre-alerting receiving facilities (C) affect time to treatment in ischemic stroke victims (O) within three months of implementation. (T)? |
| **PICOT Question Type** (Circle): Intervention Etiology Diagnosis or Diagnostic Test Prognosis/Prediction Meaning |

Place your APA References here (Use correct APA reference format including the hanging indentation):

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| **Citation: (i.e., author(s), date of publication, & title)** | **Conceptual Framework** | **Design/ Method** | **Sample/ Setting** | **Major Variables Studied and Their Definitions** | **Measurement of Major Variables** | **Data Analysis** | **Study Findings** | **Strength of the Evidence (i.e., level of evidence + quality [study strengths and weaknesses])** |
|---|---|---|---|---|---|---|---|---|
| **Author, Year, Title** | **Theoretical basis for study**<br><br>**Qualitative Tradition** | | **Number, Characteristics of the sample (not Inclusion/exclusion criteria), Attrition rate & why?** | **Independent variables (e.g., IV1 = IV2 =)**<br><br>**Dependent variables (e.g., DV = )** | **What scales were used to measure the outcome variables (e.g., name of scale, author, reliability info [e.g., Cronbach alphas])** | **What methods were used to answer the clinical question (i.e., all stats do not need to be put into the table)** | **Statistical findings (i.e., for every statistical test you have in the data analysis column, you should have a finding) or qualitative findings (themes and subthemes)** | • **Strengths and limitations of the study (Consider the validity of the study and/or flaws In the method not just what Is stated as limitations)**<br>• **Risk of harm if study intervention or findings implemented**<br>• **Feasibility of use in your practice**<br>• **Remember: level of evidence (See Melnyk & Finout-Overholt handout) + quality of evidence = strength of evidence & confidence to act**<br>• **Use the USPSTF grading schema http://www.ahrq.gov/clinic/3rduspstf/ratings.htm** |

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| Article #1 Dickson, et al., (2017) | None | Retrospective cohort/quanti tative. | Sample: 85 Attrition: 17 ("not meeting CMS reporting criteria"). Total: 68 | IV: Use of precommunicati on tool (Pulsara). DV: door to needle time. | Standardized abstraction form used to retrieve data from med. records: CMS criteria used to narrow field of data by only including reportable cases. Excel software statistics package to analyze door and thrombolytic times (Microsoft) | T tests | 28% improvement in door to needle time after app. (p≤.001, CI: 95%)<br><br>Benchmark of <60 min. post app- 82% vs 32% (155% improvement p=.0001) | Strengths: Strong data representing improvement<br><br>Limitations: Potential bias due to singular facility/small study numbers (68 total participants.)<br><br>Risk of harm: minimal to nonexistent<br><br>Feasibility: Moderate<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #2 Jahan, et al., (2019) | None | Retrospective Cohort | -191,971 patients in the GWTG-stroke database -185,215 patients were excluded from participation (did not undergo catheter based reperfusion, missing or incomplete data in medical records fig. 1), -6756 total participants. -3454 (51.1%) arrive by EMS. | IV: Time to endovascular reperfusion of acute ischemic stroke. DV: Functional ability including 1.ambulatory status, 2. global disability, 3. destination at discharge, 4. in-hospital mortality/discha rge to hospice. | Modified Rankin Scale: an ordinal measure of global disability with 7 levels ranging from 0 (no symptoms, best) to 5 (severe disability-bedridden) and 6 (dead). (Dr. John Rankin) | Chi Squared<br><br>One-Way ANOVA<br><br>Multivariable logistic regression analysis<br><br>Kruskal-Wallis test | Among every 1000 patients for every 15 minutes onset to puncture time is decreased:<br>-Independent ambulation at discharge improved 1.14% (95% CI), or 11 more patients<br>- lower hospital mortality/hospice discharge decrease 0.77% (95% CI) or 8 less patients.<br>- discharge to home improved 1.15% (95% CI) or 12 more patients.<br>- freedom from disability at discharge 0.98% [95% CI) or 10 more people | Strengths: Strong data representing improved functional status and decrease adverse events with shorter onset to needle times.<br><br>Limitations: 1: data reported depends on completeness and accuracy of data from medical records. 2: data missingness, specifically mRs at discharge and 3 month follow up. 3: time to arterial puntcture and not actual tissue reperfusion was evaluated. 4: No data regarding advanced imaging (CT perfusion) was represented.<br><br>Risk of harm: moderate to minimal<br><br>Feasibility: moderate: Enfovascular reperfusion requires a robust stroke care program and a capable facility.<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #3 Munich, et al., (2017) | None | Quality Improvement Project, not a research article | 40 care team members questioned about use of | IV: Use of the Join application in interfacility and prehospital communication. | General survey designed by author(s) (table 1) | None | 87.5% of respondents found the application easy to use and 82.5% of respondents recommended | Strengths: Positive feedback on use of mobile application for patient communication<br><br>Limitations: QI project with no statistical data or qualitative information |

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| | | | The Join application | DV: Team member satisfaction and receptiveness to application. | | | continuing to use the application as a method of team communication.<br><br>No legitimate/significant statistics due to QI format. | Risk of harm: minimal to nonexistent<br><br>Feasibility: Moderate (implementing such program is feasible)<br><br>Level of evidence for the PICOT question type: Level VII (quality improvement project)<br><br>Quality of the evidence: Poor<br><br>USPSTF: Grade: I Level of Certainty: Indeterminate based on lack of research and QI format. |
| Article #4 Bae et al., (2010) | None | Retrospective cohort | Total 102.<br>-Patients true acute stroke: 82.<br>-55 patients notified via "TPA call" prior to arrival<br>-47 were not.<br>-Patients that the hospital was not pre-notified of by EMS that *received IVTPA*: 33.<br>-Patients that were pre-notified by EMS and *received IVTPA*: 18. | IV: Pre-hospital EMS notification and communication of incoming stroke patient via 1339 program.<br><br>DV: 1.) Door to imaging times and 2.) door to needle (TPA) times. | No scales were described in the article. Outcome variables=time | t-test<br><br>Chi Square<br><br>Fisher's exact test | - patients receiving TPA:<br>-door to imaging time decreased from a mean of 26.9 minutes WITHOUT to 17.8 (p0.01) minutes WITH 1339<br>-Door to needle time (TPA) decreased from a mean of 42.1 minutes WITHOUT to 29.7 (p0.01) WITH use of 1339 | Strengths: Strong data representing significant time decrease when advanced communictation I utilized.<br><br>Limitations: Small study population/population bias 33 without prenotification and only 18 with.<br><br>Risk of harm: minimal to nonexistent (use of prehospital communication)<br><br>Feasibility: Moderate<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #5 Sheppard, et al., (2013) | None | Retrospective Cohort | -500 strokes originally identified<br>-335 were approached as candidates<br>-247 were recruited.<br>-160 traveled by EMS to the hospital | IV: 1.) Use of FAST prehospital assessment to identify stroke.<br><br>2.) Recording of a specific symptom onset time.<br>3.) Hospital pre-alerting by incoming EMS | Manual data extraction from medical records Outcome variables=time | Likelihood index<br><br>Goodness-of-fit statistic<br><br>Cox proportional hazards model | *(CT request time–CT completion time).<br>1.FAST positive (39min.–57min.) / Fast negative or not recorded (120min.–155min.) Likelihood of quick CT increased by 46%.<br><br>2.Onset time documented (37min.-50min)/Not documented (97min.-121min.) | Strengths: significant evidence and detailed results<br><br>Limitations: Potential bias towards greater positive outcomes due to recruitment of those only able to consent. Only final diagnosis of stroke was included, limiting ability to conclude efficacy of FAST assessment.<br><br>Risk of harm: minimal to nonexistent<br><br>Feasibility: Moderate |

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| | | | -151 patients were finally included Attrition d/t: stroke while in hospital, lack of complete medical records/data, lack of consent, arrival method other than EMS (Fig. 1) | with stroke symptoms.<br><br>DV: 1.) Time to CT request/order after hospital arrival.<br>2.) Time to CT completion after CT request. | | | Likelihood of quick CT increased by 33%.<br><br>3.Hospital pre-alerted (26min.-39min.)/Not pre-alerted (125min.-185min.)<br>Likelihood of quick CT increased by 77%. | Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #6 Studencan, et al. (2018) | None | Retrospective Cohort | 184 ECG consultations via "STEMI" by EMS.<br>50 received PCI from this population.<br>128 confirmed STEMI to the facility via private vehicle or other EMS transport.<br>Total population 2016: 178<br>Comparison population 2015: 67<br>Patients populations include STEMI treated with PCI at facility in 2015 and 2016 with documented ischemic interval | IV: Use of "STEMI" prehospital communication tool.<br><br>DV1: Incidence of secondary transport to PCI center.<br><br>DV2: Effect on total ischemic interval. | Manual data extraction from medical records.<br><br>Outcome variable=time And (unnecessary) secondary transports<br><br>No reliability/vailidity data available. | Chi square<br><br>Mann-Whitney U | Decrease in secondary transports to PCI facility from 34.3% to 12.9%<br><br>Decrease in average length of ischemic interval from 241 min. to 181 min. (p=0.03) | Strengths: Evidence demonstraing improved time to treatment with use of prehospital communiaiton. Statistically insignificant differences between compared groups.<br><br>Limitations: singular facility study with limited study population.<br><br>Risk of Harm: minimal<br><br>Feasbility: Moderate. The internetion implemented and performed without significant alteration in facility process or difficulty indicate feasibility.<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #7 McKinney et al., (2013) | None | Retrospective Cohort | 229 consecutive patients who presented to RWJUH ED for evaluation | IV: Activation of a brain attack prehospital notification prior to patient | Manual data extraction from medical records/stroke data base at facility. | Chi Square<br><br>Independent group t-tests | Decrease in time to first 4 DV. No significant changes in DV5 orDV6. | Strengths: Evidence demonstraing improved time to treatment, specifically diagnostics with use of prehospital communication. Statistically insignificant differences between compared groups. |

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| | | | and treatment of a possible acute stroke between January 1, 2009 and June 30, 2010. | arrival at RWJUH ED.<br><br>DV1: time to stroke team arrival<br>DV2: time to CT scan completion<br><br>DV3: time to CT scan interpretation<br><br>DV4: time to ECG completion<br><br>DV5: time to laboratory results<br><br>DV6: time to treatment decision<br><br>DV7: time to IV tPA | Reliability/validity not documented. | | | Limitations: singular facility study with limited study population.<br><br>Risk of Harm: minimal<br><br>Feasbility: Moderate. The intervention implemented and performed without significant alteration in facility process or difficulty indicate feasibility.<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #8 Kelly (2020) | None | Quantitative/ Retrospective Cohort | 15 years or older with traumatic cardiac arrest. Convenience sampling used via 2 baltimore trauma centers. 43 total pts. Included in analysis with 36 being pre alerted via citizen app. | IV: Hospital prenotification of incoming traumatic cardiac arrest patient via citizen application.<br><br>DV: Prehospital notification time difference when comparing citizen application to traditional EMS radio. | Manual data extraction from 2 urban trauma facilities.<br><br>Reliability and validity information not documented. | Chi squared<br><br>Goodness of fit<br><br>paired t-tests<br><br>Pearson correlation coefficient | Improved prehospital notification time of target population by 12.9 minutes. (CI: 95%, $p<0.001$). Pearson's $R= 0.64$. | Strengths: Evidence demonstraing improved improved prehospital notification time. Multiple facility sources decreasing bias.<br><br>Limitations: patient outcomes not considered, application strictly reviewed, but not implemented by facilities during data collection. Possible bias due to lack of complete medical records in some cases.<br><br>Risk of Harm: minimal<br><br>Feasbility: Moderate. Would require constant surveillance in this circumstance.<br><br>Level of evidence for the PICOT question type: Level IV<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |

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| Article #9 Berglund et al., (2012) | None | Randomized Control trial | Total population: 942 Intervention: 488 Control: 454 : 446 DC with non stroke diagnosis. : 84 total received thrombolysis | IV: Implementing priority level 1 at dispatch when patients meet criteria.<br><br>DV1: call to dispatch<br>DV2: dispatch to scene arrival<br>DV3: scene departure<br>DV4: hospital prenotification<br>DV5: time to stroke unit<br>DV6: Use of thrombolysis | Data were analyzed with PASW Statistics, Version 18<br>All involved personell were educated prior to start of study.<br><br>Altman's nomogram used for sample size. (Altman 1982).<br><br>FAST ( developed 1998 by group of providers in the UK) tool was used in field as means of possible stroke identification. | Mann Whitney U<br><br>Fisher Exact<br><br>Chi Square | EMCC intervention group reached stroke unit within 3 hours (61%) Control: (46%) p=0.008.<br><br>Thrombolysis given intervention group: (24%) Control: (10%) p<0.001. | Strengths: Randomized format. Moderate population size. Accurate data and validity of results.<br><br>Limitations: Study not complete due to early intervention implementation after no negative effects on other emergencies demonstrated.<br><br>Risk of Harm: nonexistent<br><br>Feasbility: High. No significant changes/cost other than reprioritization.<br><br>Level of evidence for the PICOT question type: Level I<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: A Level of Certainty: High |
| Article #10 Zhang et al., (2020) | None | Systematic Review | Total articles identified: 918. Full text review: 48. Final articles for inclusion: 17. | IV: End user-centered design approach to prehospital communication technology.<br><br>DV: Socio-technical barriers to implementation and user acceptance including technical, usability, and organizational. | Selective sampling through Key words/article review. PRISMA for search and screen.<br><br>Reliability/validity not documented. | | Scarcity of evaluative research in implementation of preshospital commnunication technologies leads to increased barriers, lack of end user acceptance, and decreased efficacy of implemented technology. | Strengths: Thorough literature review of evaluative research and identification of lacking end user inclusion in design process.<br><br>Limitations: Lack of quantitative data, evaluated studies limited from 2000-2019. Difficulty with article identification using key words.<br><br>Risk of Harm: none<br><br>Feasbility: Moderate. Including end user evaluative research in design of technology will increase cost and time to complete.<br><br>Level of evidence for the PICOT question type: Level III<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: Moderate |
| Article #11 Andrew et al., (2020) | None | Retrospective Cohort/quantitative | Total cases: 4953 obtained from stop stroke database between march 2013 – may 2016. Attrition due | IV: Use of Stop Stroke (Pulsara) digital communication application in acute stroke by EMS. | Convenience sampling via Stop Stroke data base. Data from 12 unnamed stroke facilities was used. | Chi square<br><br>Mann-Whitney U<br><br>Kruskal-Wallis Rank Sum | Cases activated by EMS were more severe (median NIHSS score 8 versus 4, $P < .0001$) and more likely to receive rTPA (20% versus 12%, $P < .0001$) than those with ED activation. | Strengths: Large data pool with specified parameters documented in the Stop Stroke data base. Data from 12 facilities<br><br>Limitations: Lack of follow up data due to only information from application database used. No facility data. Limited available data set decreases ability to adjust for confounding parameters. |

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| | | | to incomplete data, duplicate, or erroneous entries: 2364 Total included cases: 2589 | DV1: Door to needle time.<br><br>DV2: Door to CT time.<br><br>DV3: Rate of DTN less than or equal to 60 minutes (goal time).<br><br>DV3: Rate of thrombolysis in EMS vs hospital activation. | NIHSS was used to determine case severity (1995)<br><br>Bonferroni correction was used for multiple comparison correction (Bonferroni 1936) | | cases with EMS activation had shorter DTC (6.1 minutes shorter, 95% CI [−10.3, −2]) and DTN (12.8 minutes shorter, 95% CI [−21, −4.6]) and were more likely to meet goal DTN (OR 1.83, 95% CI [1.1, 3]). | Risk of Harm: Minimal<br><br>Feasbility: Moderate. Will require upfront hardware/software costs, user training, and interfacility policy change.<br><br>Level of evidence for the PICOT question type: Level II.<br><br>Quality of the evidence: Good<br><br>USPSTF: Grade: B Level of Certainty: High |

Legend:
IV: Independent variable
DV: Dependent variable
CI: Confidence interval
CMS: Center for Medicare and Medicaid Services
mRs: modified Rankin score

PCI: Percutaneous Coronary Intervention
RWJUH ED: Robert Wood Johnson University Hospital Emergency Department
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-AnalysesDTN: Door to Needle
DTC: door to CT