RAPIDSOS

Outcomes

Quantifying the Impact of Emergency Response Times

www.RapidSOS.com
info@RapidSOS.com
(415) 340-2224

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i. Executive summary

Over 240 million 9-1-1 calls are placed every year in the United States. Facing life's most difficult circumstances, 9-1-1 dispatchers do extraordinary work, triaging calls, deciphering unclear information, giving life-saving instructions over the phone and dispatching responders. Yet, weighing against the heroic efforts of dispatchers is an antiquated 9-1-1 infrastructure-- preventing key information from reaching 9-1-1 and delaying response. In this white paper, we examine the impact of these delays on the lives of Americans facing life-threatening emergencies. Through conversations with industry experts, time spent in dispatch centers, and extensive review of academic literature, we found that the failing 9-1-1 infrastructure presents a significant challenge to our society by affecting mortality, health care costs and property damage.

We found inaccurate location to be the most important challenge for the existing 9-1-1 infrastructure. Notably, the inability to determine a user's precise location in an emergency often causes calls to be routed to the wrong 9-1-1 dispatch center, wasting valuable time asking a caller to describe their location before help can be sent. This early stage in response time interval is especially critical, as the academic literature concludes that time to first responder (either an ambulance, firefighter, police officer, or bystander) is one of the most important factors in reducing mortality and property damage. Delays in location identification prevent any units from being dispatched and wastes time that could be used to give life-saving first aid instructions on the phone.

The evidence from the literature concludes that for every minute delay in primary response for certain life-threatening medical emergencies, there is a measurable effect on mortality. The research is conclusive especially for the first 5 minutes in the response interval, where rapid intervention makes the greatest difference. Critical medical intervention can be performed by professional responders or bystanders who receive instructions from 9-1-1 call takers over the phone. For critical medical incidents such as cardiac and neurological emergencies, together composing around 5% of 9-1-1 calls, a mere one minute delay in response time increases the mortality rate by 1 to 2%. A solution that could reduce response times by only one minute on average would save thousands of lives per year across the nation.

In addition to affecting mortality, healthcare costs for survivors are also greatly impacted by response times. For the set of medical conditions that limit perfusion of the brain and heart, each minute of delay in response time increases hospital treatment costs by 7%. These costs are associated with longer stays in the intensive care unit, additional complicated and costly procedures, and a slower recovery leading to longer hospital stays. For a typical cardiac emergency, one minute of faster response translates into $1,542 of savings in hospital costs per patient, leading to a $7B reduction in US healthcare expenditures per year and a better quality of life for patients. Apart from medical conditions, delays in response times can also lead to greater property damages in situations like building fires. Building fires typically grow by 20% per minute that response is delayed, resulting in an average of $4,000 in additional damages.

Faster response times matter. RapidSOS has set out to improve response times dramatically by transmitting the precise location of mobile callers in emergency situations and routing the call to the correct 9-1-1 dispatch center. In addition, RapidSOS transmits additional information that is relevant to 9-1-1 telecommunicators, further reducing the response time by allowing the telecommunicators to give better instructions over the phone and dispatch responders more efficiently.

ii. Introduction

i. Purpose and methodology of this paper

We have all heard dramatic stories of when the outdated 9-1-1 infrastructure failed at a time when it mattered the most. Media reports of 9-1-1 failure and its disastrous repercussions are not uncommon. When Denise Amber Lee, daughter of a police sergeant, was abducted, she did everything right and yet the system failed her.[1] Despite multiple calls to 9-1-1, including a direct call from Ms. Lee during the abduction, emergency dispatchers failed to reach her in time due to inadequate location information.[2] Denise Amber Lee's abduction and subsequent homicide is unfortunately not the only example of 9-1-1 failure. Shanell Anderson knew her exact location down to the zip code when her SUV was submerged underwater. Despite this, the out-dated location detection technology routed her call to the incorrect 9-1-1 Public Safety Answering Point (PSAP), and their inability to locate her on their jurisdiction's map ultimately proved fatal.[3]

Both of these cases are tragic and yet are just examples of a wider problem. Coalitions of victims of outdated 9-1-1 infrastructure such as *The Denise Amber Lee Foundation* push for a change. They aren't alone-- the Industry Council for Emergency Response Technologies (iCERT),[4] and the National Emergency Number Association (NENA),[5] all agree that the 9-1-1 system is antiquated and needs change. Ultimately, the result must be a reduction in emergency response times. Logic follows that reduced response times will result in fewer lives lost. Though this is clearly illustrated anecdotally in the cases of Denise Amber Lee and Shanell Anderson, it is important that we also abstract this issue from anecdotes, however tragic they might be. The purpose of this paper is to look beyond individual tragedies and assess 9-1-1 failure from a larger perspective. We want to present the full range of research on how an outdated infrastructure from decades ago is failing us everyday, and what the true cost to society is.

In this white paper, we first assess the issues associated with the dated 9-1-1 infrastructure and discuss how these issues cause delays in response times. We then review the body of research on the impact of these delays on response times, and discuss how early delays related to localization lead to issues in several aspects of the emergency response. We then review 9-1-1 call statistics in order to quantify the impact of delays. After establishing these background facts, we then proceed to discuss the impact of response delays in three areas: mortality, health care costs, and property damage. For each of these three areas, we review the research and perform calculations to quantify the order of magnitude of the problem. We then conclude the paper with a call to action, clarifying the role RapidSOS in addressing this enormous problem to society.

[1] "Our Story", The Denise Amber Lee Story
[2] Avila, Jim, Rena Furuya, and Andrew Parella, "Are Botched 911 Calls to Blame for Denise Lee's Death?" *ABC News*, July 23, 2008
[3] 3 Kelley, John, and Brandon Keefe, "911's Deadly Flaw: Lack of Location Data," *11Alive*
[4] 9-1-1 Industry Alliance, The Overloaded 9-1-1 System, Report, Industry Council for Emergency
[5] "NG9-1-1 Project", NENA, http://www.nena.org/?NG911_Project

ii. Impact of dated infrastructure on emergency response

The original 9-1-1 infrastructure dates to the 1960s[6] and has seen only limited upgrades since. As the New York Times pointed out almost ten years ago, "*the system has not kept pace with the nation's rapidly changing communication habits*".[7] Calling 9-1-1 through a landline is still the most reliable method for connecting to emergency services.[8] 9-1-1 landline calls are automatically directed to the correct emergency services dispatch center, also known as a Public-Safety Answering Point (PSAP). Similar to how counties have specific boundaries, PSAPs are regional centers with distinctive jurisdictions. Each PSAP can only reliably monitor emergency vehicles and maps inside their respective jurisdiction. Calling from a landline minimizes the need for re-routing between PSAPs, and eliminates the need for callers to verbally communicate their location, as this information is automatically sent to the PSAP. This reliable Automatic Location Information (ALI) system was established nationwide in 1986,[9] and has had very little change ever since.

Unfortunately, the reliability of this system built for landlines is no longer as practical as it once was. "*It is now easier than ever for victims to reach 9-1-1, but harder than ever for responders to reach them*," said David Shoar, the sheriff in St. John's County, Florida, writing to the FCC.[10] Location is the single most important piece of information a PSAP needs to know. "*We need to know where you are to send somebody. We don't need to know what; we don't need to know how; we don't need to know when, The 'where' is the No. 1 thing,"*[11] says Steve Souder, director of the Fairfax County Department of Public Safety Communications in Virginia.

The FCC estimates that 73% of 9-1-1 calls are now from mobile devices,[12] which cannot immediately provide accurate location information to PSAPs. A 2015 NBC News investigation revealed that 60% of wireless calls to 9-1-1 cannot be accurately located by emergency dispatchers.[13] A 2014 Washington Post investigation found that 90% of wireless 9-1-1 calls made within Washington D.C. lacked accurate location data,[14] and 63% of wireless 9-1-1 calls made in California had no location data at all.[15, 16] The 2014 National 911 Progress Report[17] shows that several states including Alaska, Arizona, Idaho, Illinois, South Carolina and South Dakota haven't fully implemented the requirements for 'Wireless Phase 2', requiring '*location of the caller within 125 meters 67% of the time and Selective Routing based upon those coordinates.*'[18]

In the 21st century, emergency systems still necessitate clear, verbal communications over mobile 9-1-1 calls in order to accurately determine the caller's location and type of emergency. However, callers are often in

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[6] "9-1-1 Origin & History", NENA, 2014, https://www.nena.org/?page=911overviewfacts
[7] Dewan, Shaila, "An SOS for 911 Systems in Age of High-Tech," *The New York Times*, April 05, 2007
[8] "9-1-1 Basic Information." NENA. https://www.nena.org/?page=911GeneralInfo
[9] Electronic Communications Privacy Act of 1986 (ECPA), §§ 18-2510-2522 (1986)
[10] Kelley and Keefe, "911's Deadly Flaw: Lack of Location Data"
[11] Perkins, Lucy, "Calling 911 On Your Cell? It's Harder To Find You Than You Think," NPR, October 23, 2014
[12] Federal Communications Commission, "Proposes New Indoor Requirements and Revisions to Existing E911 Rules," Federal Communications Commission (FCC), February 20, 2014, https://www.fcc.gov/document/proposes-new-indoor-requirements-and-revisions-existing-e911-rules
[13] Rossen, Jeff, and Charles McLravy, "Many 911 Centers Can't Locate Callers Because of Old Technology," *NBC News*, February 25, 2015
[14] Fung, Brian, "Calling 911 from Your Cellphone in D.C.? Good Luck Getting First-responders to Find You," *Washington Post*, July 10, 2014
[15] Kelley and Keefe, "911's Deadly Flaw: Lack of Location Data"
[16] Thompson, Jim, E9-1-1 Project Manager, "California Wireless E9-1-1: Routing on Empirical Data," March 3, 2010, http://www.calnena.org/communications/CalNENA_2010_Final_03-02-10_.pdf
[17] National Highway Traffic Safety Administration, "2014 National 911 Progress Report," National 911 Program, March 2015, http://www.911.gov/pdf/National-911-Program-2014-ProfileDatabaseProgressReport-031315.pdf
[18] National Highway Traffic Safety Administration, "2014 National 911 Progress Report," March 2015

emergency situations that prevent them from clearly communicating relevant information.[19] They are often in acute distress, and expecting them to clearly communicate their location and emergency has proven to be historically unreliable.[20] College student Brittany Zimmerman's 9-1-1 call moments before her stabbing could not be located because she was incapacitated and unable to communicate her location. Her location was determined almost an hour later, when her boyfriend found her body.[21] An 8-year-old child who had traumatically witnessed her mother being gunned down was unable to communicate her location when she called 9-1-1. A dispatcher had to coax her into following instructions to determine her address while her mother bled out.[22] Both of these cases took first responders longer than necessary to arrive due to the lack of adequate technology. Both cases could have had different outcomes if assistance arrived sooner.

Moreover, beyond the lack of accurate location data, there is a number of other pain points in the flow of a 9-1-1 call. Modern day mobile 9-1-1 calls follow a call flow riddled with opportunities for delay, disconnection, and transfers-- all potentially occurring before any emergency services are dispatched. The unreliability of the infrastructure and its dependence on unreliable third-party sources[23] are cyclic in promoting delays. A report by the 9-1-1 Industry Alliance found that 26% of California's 2009 mobile 911 calls were abandoned due to delays in the system.[24] In Texas, the second most populated state, over 6,000 calls are put on hold every year in Austin alone.[25]

Re-routed calls in particular are a common example of delays in response times. The location detection of mobile calls is dependent upon the nearest cellular tower.[26] In fact, when mobile calls are initially made, the first address that is provisioned to PSAPs is that of the cellular tower the call is associated with.[27] Because the cell phone tower network doesn't follow jurisdictional boundaries, sometimes this cellular tower is associated with a different PSAP than the one in which the caller is located. It usually takes 30 seconds to establish a more precise location meeting the Phase 2 wireless requirements.[28] Therefore, the location inaccuracy is generally noted only after the caller has verbally communicated their location or when the

[19] "Survey of 9-1-1 Dispatchers Finds Many Indoor Callers Cannot Be Located on Wireless Phones." Find Me 9-1-1, April 24, 2014, http://findme911.org/wp-content/uploads/2014/04/PSAP-survey-release_final.pdf
[20] Perkins, "Calling 911 On Your Cell? It's Harder To Find You Than You Think," October 23, 2014
[21] Brueck, Dana, "Zimmermann Murder Case: 911 Call," NBC15 RSS, December 22, 2008
[22] Williams, Corey, "911 Call Reveals Mich. Girl's Pleas to Help Mother," Boston.com, March 5, 2010
[23] Including the caller themselves (example circumstances include when verbal communication is not an option, or the caller is unaware of where they are precisely located), and inadequate location detection technology from cellular towers.
[24] 9-1-1 Industry Alliance, The Overloaded 9-1-1 System, 2011
[25] 9-1-1 Industry Alliance, The Overloaded 9-1-1 System, 2011
[26] Consumer and Governmental Affairs Bureau at Federal Communications Commission, "Consumer Guide 911 Emergency Services," Federal Communications Commission (FCC), February 4, 2014, https://transition.fcc.gov/cgb/consumerfacts/wireless911srvc.pdf
[27] North Carolina 911 Board, "Wireless 911 for Telecommunicators," State of North Carolina 911 Board, January 8, 2009, https://www.nc911.nc.gov/pdf/A_TelecommunicatorReference.pdf
[28] "Location Accuracy and Mobile Phones," Navajo Nation Telecommunications Regulatory Commission

call-taker receives more accurate location information. The caller then has to be manually re-routed to the correct PSAP for his or her actual location. This manual re-routing occurs all over the United States, but is especially frequent in several of the more populated states such as California[29, 30, 31, 32] and Massachusetts.[33 , 34, 35] In some cases, often only a voice connection is transferred during call re-routing, requiring the caller to repeat all of the relevant information.[36] This is precisely what happened to California resident Jordan Soto, who died from a medical emergency despite living less than a mile away from a fire station. Since the 9-1-1 call was made from a mobile device, the call was routed to the incorrect PSAP located over 30 miles away. When Mr. Soto was transferred to the correct PSAP, the location information was not automatically transmitted, ultimately leading to first responders spending precious minutes looking for a non-existent address.[37]

With an increase in mobile 9-1-1 calls by over 26% over the last decade,[38] the current system is not scalable and is long overdue for a makeover. The National Emergency Number Association (NENA) recognized these technological discrepancies and proposed the implementation of Next Generation 9-1-1 (NG911) in the early 2000's.[39] NG911 will eventually be the solution for making wireless 9-1-1 calls become as reliable as landline 9-1-1 calls. NG911 includes mechanisms for accurate geo-location detection and a variety of standardized options, such as capabilities to send texts, images, video, and data,[40] to communicate with emergency services. However, as of today, the rollout of NG911 capable solutions has been fairly limited, with formal legal frameworks having been first submitted to Congress in 2012.[41] As of May 2015, only four states have the status of "NG911 Implemented at State Level", with the majority of the country still labeled as having only "NG911 Planning Started."[42] According to the 2014 National 911 Progress Report, more than half of all states reported '*0 Percent*' NG911 systems that are operational.[43] At RapidSOS, we believe that NG911 will ultimately provide a comprehensive overhaul to the outdated 9-1-1 infrastructure, and we are actively taking part in developing NG911 together with the wider 9-1-1 community. Nevertheless, we strongly believe that improvements that can push additional information into both NG911 and legacy PSAPs are necessary now.

Today, nearly two-thirds of Americans own a smartphone,[44] but only 5.5% of 9-1-1 dispatch centers are even capable of receiving simple text messages.[45] RapidSOS offers a technology that can bridge this gap without requiring additional resources or capital. Through an innovative mobile technology powered by RapidSOS'

[29] 9-1-1 Industry Alliance, The Overloaded 9-1-1 System, 2011
[30] Schaaf, Libby, Oakland City Councilmember, "Emergency Contact Information," Safe Oakland
[31] Jim, "California Wireless E9-1-1: Routing on Empirical Data," March 3, 2010
[32] "Local '9-1-1' Cellular Phone Numbers," University of California: Office of the President, 2015
[33] "Questions Frequently Asked of E911/Dispatch," Chelsea City Hall
[34] Lowell Police Department, "Contacting the Lowell Police Department," City of Lowell, 2015
[35] "A Guide to 9-1-1," Town of Sherborn
[36] Kean, Thomas H., and Lee Hamilton, "Heroism and Horror," I*n The 9/11 Commission Report*, 286, Washington, DC: National Commission on Terrorist Attacks upon the United States, 2004
[37] "State Urged to Fix Fatally Flawed 9-1-1 System," Santa Barbara Independent, November 26, 2014
[38] 9-1-1 Industry Alliance, The Overloaded 9-1-1 System, 2011
[39] NENA, "NG9-1-1 Project"
[40] NENA, "NG9-1-1 Project"
[41] Federal Communications Commission, "Legal and Regulatory Framework for NG911 Services Report to Congress," Federal Communications Commission (FCC), February 23, 2013, https://www.fcc.gov/document/legal-and-regulatory-framework-ng911-services-report-congress
[42] "Status of NG9-1-1 State Activity," NENA, May 18, 2015, https://www.nena.org/?NG911_StateActivity
[43] National Highway Traffic Safety Administration, "2014 National 911 Progress Report," March 2015
[44] Smith, Aaron, "A Portrait of Smartphone Ownership," Pew Research Center, April 01, 2015
[45] Federal Communications Commission, "PSAP Text-to-911 Readiness and Certification Form," *Federal Communications Commission (FCC)*, 5 Oct. 2015

telecom and data analytics engine, we can streamline critical information to emergency dispatchers. This is an affordable and universally compatible solution which bypasses infrastructure bottlenecks without necessitating any installation, retraining, or reinvesting into the existing system.

iii. The importance of response times

In order to assess the measurable benefit of faster response times, we must first attempt to define response times in a meaningful way. Notable literature in the emergency space and data obtained from EMS agencies often defines response times as the time taken between the receipt of the 9-1-1 call and the on-scene arrival of a transport ambulance.[46, 47, 48]

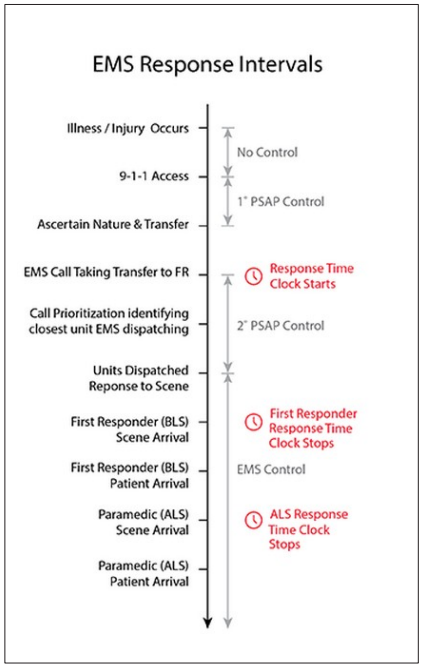

Figure 1. "EMS Response Time Intervals"[50]

Dr. Thomas Blackwell, Professor of Emergency Medicine at the University of South Carolina, has decades of experience as an EMS leader and researcher. He is one of the most quoted experts on EMS response times and analyzes response times by dividing the timeline for EMS Response into specific intervals depicted in *Figure 1* shown on the right. As we can see, the traditional definition fails to take into account the very first response time interval.

This traditional definition is troublesome because it doesn't account for early interventions by other first responders or any medical instructions given by the PSAP to bystanders. As the National EMS Advisory Council states, "*9-1-1 based pre-arrival instructions and medical prioritization systems must be considered an integrated and essential element of the health care system*,"[49] emphasizing the importance of reducing the time until a caller can receive instructions from a 9-1-1 call-taker.

[46] Blackwell, Thomas H., MD, and Jay S. Kaufman, PHD, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System," Academic Emergency Medicine 9, no. 4 (2002): 288-95
[47] Blanchard et al. "Emergency Medical Services Response Time and Mortality in an Urban Setting," Prehospital Emergency Care Prehosp Emerg Care 16, no. 1 (2012): 142-51
[48] Pons, et al. "Paramedic Response Time: Does It Affect Patient Survival?" Academic Emergency Medicine 12, no. 7 (2005): 594-600
[49] National EMS Advisory Council, "EMS Makes a Difference: Improved Clinical Outcomes and Downstream Healthcare Savings," *Position Statement*, December 2009
[50] Blackwell, Tom, MD, FACEP, "Time Is Not of the Essence: Re-Evaluating the Traditional Response Interval," University of South Carolina School of Medicine Greenville

Furthermore, several academic experts who studied the effect of response times on mortality acknowledge that the standard definition of response time is subject to high levels of variability. Blanchard et al. notes, "*[present definitions] of response time may not be closely related to outcome. The more clinically relevant definition [is] time of injury or illness to time of critical prehospital intervention*."[51] Pons et al. mentions that *"a better measure of EMS system performance is measurement from onset of the medical incident to the intervention*."[52] These comments are aligned with our definition of response time which is the time between onset of chief complaint and EMS dispatch.

Focusing specifically on the early response time interval, i.e. the time between the onset of the chief complaint and the dispatch of emergency services is preferable for several reasons:

- The first few minutes are the most critical to patient outcomes in critical medical emergencies[53, 54, 55, 56]
- No emergency responders can be dispatched until an accurate location and the nature of emergency is established[57]
- No professional first aid instructions are given before an accurate location and the nature of emergency is established[58, 59]

RapidSOS focuses on this first response time interval, reducing the time between onset of chief complaint and 9-1-1 dispatch. RapidSOS' role in providing key data early in the process reduces opportunities for wasted time later on in the call flow. The multiple steps during the process of a 9-1-1 call (onset of chief complaint, initial outgoing call, connection to first PSAP call-taker, determination of principal issue and relevant location, and possible re-routing to secondary PSAP) are streamlined into a single step. The consolidation of a multi-step process into a single step not only leads to a reduction in time but also eliminates potential errors within the process. Consequently, appropriate treatment and emergency services can be provided more quickly, whether these services are in the form of instructions over the phone to bystanders or dispatch of the appropriate response unit. Ultimately, the overall response time is reduced, but most importantly, the initial critical minutes between the onset of the incident and its treatment are also reduced.

[51] Blanchard et al. "Emergency Medical Services Response Time and Mortality in an Urban Setting," pg. 148-149, 2012
[52] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" pg. 599, 2005
[53] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System," 2002
[54] Blanchard et al. "Emergency Medical Services Response Time and Mortality in an Urban Setting." Prehospital Emergency Care Prehosp Emerg Care 16.1 (2012): 142-51. Web.
[55] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" 2005
[56] Wilde, Elizabeth Ty, "Do Emergency Medical System Response Times Matter For Health Outcomes?" Health Economics 22, no. 7 (2012): 790-806
[57] Perkins, "Calling 911 On Your Cell? It's Harder To Find You Than You Think," 2014
[58] Note: All modern dispatch protocols (MPDS, FPDS, PPDS) that allow the Telecommunicator to give instructions to the caller start with location as the entry question
[59] National Academy of Emergency Medical Dispatch, "EMD-Q Performance Standards," NAEMD Case Review Performance Standards

iv. 9-1-1 Call Statistics

NENA reports that approximately 240 million 9-1-1 calls are made annually.[60] This equals to roughly 0.75 9-1-1 calls per person per year.[61] It is important to note that since the proliferation of mobile phones, not every 9-1-1 call represents an actual emergency. In order to establish an understanding on how many calls are actually time-sensitive, we need to take a few factors into account. Those factors are depicted in *Figure 2* and described below.

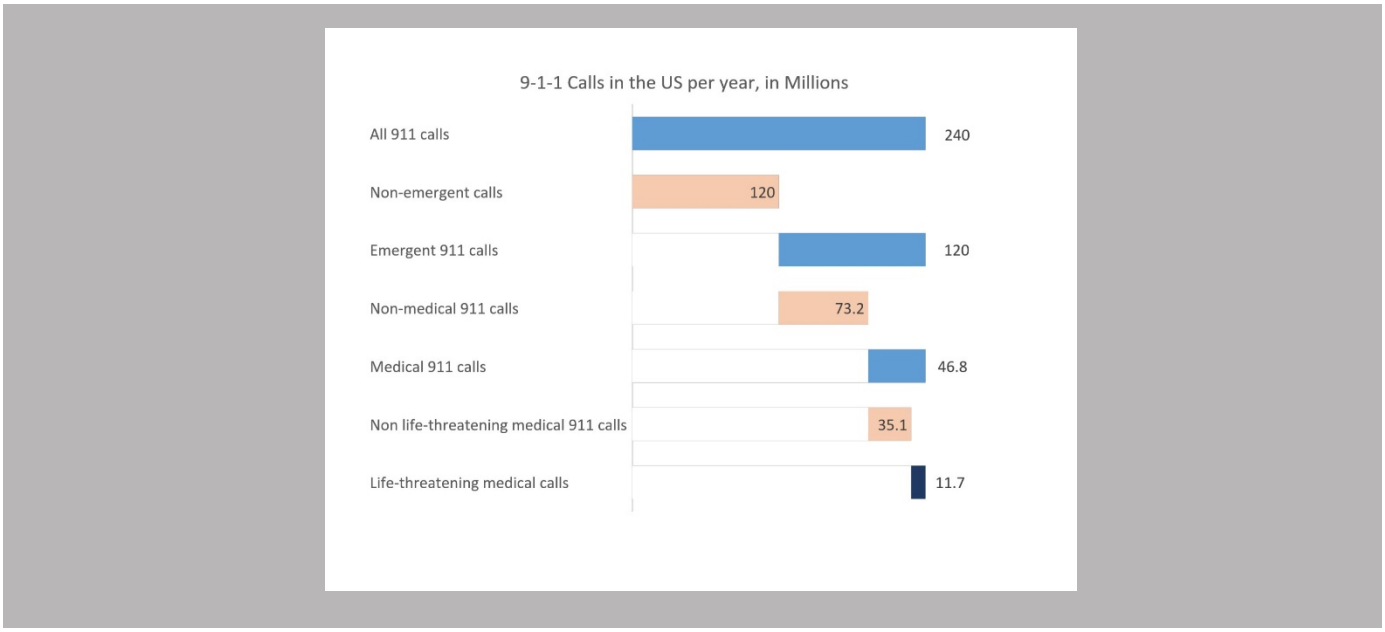

Figure 2. 9-1-1 Call Statistics for the U.S.

Many 9-1-1 centers report a vast number of "phantom calls", "butt dials" and prank calls. According to the Center for Problem-Oriented Policing, there are no nationwide statistics related to the issue of unwanted 9-1-1 calls. However, based on data points from across the country,[62, 63] namely from New York,[64] Wisconsin[65] and California,[66, 67] we estimate that only half of 9-1-1 calls actually represent an emergency situation. The breakdown of those calls into Police, Fire and Medical also varies widely and depends on factors such as population density and demographics. One jurisdiction that provides very detailed data is New York City where we can see that 39% of calls are medical in nature.[68]

[60] "9-1-1 Statistics," NENA, https://www.nena.org/?page=911Statistics
[61] Comparing 9-1-1 Call Statistics with population figures of the US Census Bureau, http://www.census.gov/popclock/
[62] Sampson, Rana, "The Problem of Misuse and Abuse of 911," 2002
[63] O'Rielly, Michael, FCC Commissioner, "Harmful Consumer Wireless Behavior and Practices," Federal Communications Commission (FCC) (blog), October 14, 2014
[64] Zafar, Aylin, "Almost 40% of New York's 911 Calls Are 'Butt Dials'," TIME Magazine, May 10, 2012
[65] Epstein, Reid J, "Cell Calls to 911 Often Made in Error," Milwaukee Journal Sentinel, February 22, 2004
[66] Carlton, Jim, "Phony Calls Plague 911 Centers," Wall Street Journal, April 6, 2014
[67] Dankert, Diana, James Driscoll, and Nancy Torres, "San Francisco's 911 Call Volume Increase," Google 9-1-1 Team, October 2015
[68] "NYC 911 Performance Reporting: End-to-End Detail Report," NYC Analytics: 911, August 24, 2015

Even within medical emergencies, not all calls are actually life-threatening and time-critical. To account for differences in urban and rural environments and different demographics, we analyzed EMS call statistics across the country. For the purpose of this paper, we focused on statistics in New York,[69] Wyoming,[70] Wisconsin[71] and Utah,[72] analyzing individual conditions considered to be life-threatening by the medical community.[73, 74] Based on this comprehensive data analysis, we estimate that life threatening conditions account for 25% of medical 9-1-1 calls (9.7% cardiac, 6.4% neurological, 2.6% trauma, other 6.6% other life-threatening conditions like overdose/allergic reactions/choking/diabetic emergencies.) These life-threatening calls correspond to about 11.8M or 5% all 9-1-1 calls placed per year in the United States.[75]

[69] NYC Analytics: 9-1-1, "NYC 911 Performance Reporting: End-to-End Detail Report," 2015
[70] "Emergency Medical Services System Quick Stats," Wyoming Department of Health, 2002, http://www.health.wyo.gov/sho/ems/emsdata. html
[71] "Wisconsin EMS Statistics," Wisconsin EMS Association, https://www.wisconsinems.com/ems-for-the-general-public/wisconsin-ems- statistics/
[72] Wilde, Elizabeth Ty, "Do Emergency Medical System Response Times Matter For Health Outcomes?" 2012
[73] National EMS Advisory Council, "EMS Makes a Difference: Improved Clinical Outcomes and Downstream Healthcare Savings," December 2009
[74] Racht, Ed, MD, and Lee Turpen, CCEMT-P, "Time Standards for EMS Response," Lecture, AMR Presentation
[75] Calculated based off the figures mentioned above.

iii. Saving lives - Response times and mortality

Ideally, emergency response times would be minimal for every 9-1-1 call. However, certain emergency calls are known to be more time-sensitive than others, and every second counts. Among medical emergencies that are known to be most time sensitive,[76, 77] cardiac incidents are the most frequent. The European Society of Cardiology recommends immediate treatment for cardiac incidents,[78] and the American Heart Association (AHA) states that survival rates for cardiac arrest patients fall 7-10% for every untreated minute.[79] Both the AHA and the European Resuscitation Council (ERC) have changed their resuscitation guidelines in 2015 to highlight the importance of faster response time for patients in cardiac arrest. The AHA states that "emphasis has been increased about the rapid identification of potential cardiac arrest by dispatchers, with immediate provision of CPR instructions to the caller."[80] This is because, as the ERC writes in their 2015 guidelines, "defibrillation within 3–5 min of collapse can produce survival rates as high as 50–70%," adding that "The ERC Guidelines 2015 highlight the critical importance of the interactions between the emergency medical dispatcher, the bystander who provides CPR and the timely deployment of an AED. An effective, co-ordinated community response that draws these elements together is key to improving survival from out-of-hospital cardiac arrest."[81] "*Time is brain*" is a common term used in Emergency Medicine for stroke patients, emphasizing the irreversible loss of neurological tissue as a stroke progresses. According to the AHA, therapeutic interventions should be urgently pursued.[82] Despite disagreements on the exact time window of treatment, there is a clear general consensus applicable to other time-sensitive medical emergencies: the faster the care is provided, the greater the chance of achieving better patient outcomes.

The most prolific research papers on the subject of response times and patient mortality are Blackwell and Kaufman (2002), Pons et al. (2005), and Blanchard et al. (2012). While all three publications conclude that small variations in time savings affecting a longer basic response (greater than the 8 minute EMS guideline) do not have a substantial effect on patient outcomes, they all agree that time reductions affecting the initial response time window have the greatest influence on mortality. Pons states that "*a survival benefit was identified for response times =< 4 mins*,"[83] which Blackwell supplements, saying "*mortality risk appeared*

[76] Remainder as other non-medical emergencies (e.g. fire emergencies, select police emergencies like active shooter events, etc.)
[77] NYC Analytics: 9-1-1, "NYC 911 Performance Reporting: End-to-End Detail Report," 2015
[78] The European Society of Cardiology, and The European Resuscitation Council, "The Pre-hospital Management of Acute Heart Attacks," *European Heart Journal* 19 (1998): 1140-146
[79] Link, M. S. et al. "Part 6: Electrical Therapies: Automated External Defibrillators, Defibrillation, Cardioversion, and Pacing * 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care." *Circulation* 122, no. 18 (2010)
[80] Monsieurs K.G. et al. "European Resuscitation Council Guidelines for Resuscitation 2015" *Resuscitation* 95 (2015): 1–80
[81] Neumar et al. "2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" Circulation 132 (2015): S315-S367
[82] Saver, Jeffrey L., MD. "Time Is Brain-Quantified," *Stroke* 37 (2005): 263-66
[83] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" pg. 597, 2005

sensitive to response times less than 5 minutes."[84] Blanchard emphasizes the importance of rapid response times for high-risk patients,[85] which is in alignment with our conclusion that some medical emergencies matter more than others.

RapidSOS accelerates the arrival of treatment to the scene of incident when it matters most by expediting the data flow from onset of injury/illness to dispatch. This acceleration in treatment is not necessarily limited to the arrival of EMS but also includes other forms of treatment such as the care provided by first responders from other agencies (e.g., a fire engine), and also increasingly assistance provided by bystanders powered by verbal instructions from PSAP professionals over the phone, as well as the proliferation of publicly accessible AEDs.

Intuitively, reduced emergency response times should lead to reduced patient mortality. However, research studies that analyze this relationship have important limitations and are difficult to interpret due to the variabilities in the emergency dispatch process. Elizabeth Ty Wilde, academic researcher at the Mailman School of Public Health at Columbia University, succinctly cites "*the scarcity of good data*" and "*the endogeneity of response times*" as the primary reasons behind the lack of literature on the impact of emergency response times on morbidity and mortality.[86] The mortality risk is intrinsically higher for calls that are assigned a higher priority for dispatch than for calls which are assigned a low priority.[87, 88] This relation between response times and mortality introduces bias into the data. Many high priority calls with fast response times are associated with poor expected patient outcome. Furthermore, cases where the patient passes away prior to hospital arrival are often eliminated from the sample pool entirely[89, 90] and are thus excluded from the analysis of time to dispatch on mortality. These endogenous factors must be taken into account when examining the literature.

All of the authors looking at the relation between response times and mortality used some variation of the traditional definition for response time. Blackwell, Pons, and Blanchard examine the 8 minute guideline for response time, concluding that a change in response time from over to under the 8 minute mark does not have a significant effect on patient mortality. These studies are focusing primarily on response times surrounding the 8 minute guideline. However, all three of these authors found that the first few minutes (4-5 minutes) that immediately follow the event have a significant impact on mortality. Their studies conclude that

[84] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System, " pg. 293, 2002
[85] Blanchard et al. "Emergency Medical Services Response Time and Mortality in an Urban Setting," pg. 142, 2012
[86] Wilde "Do Emergency Medical System Response Times Matter For Health Outcomes?" pg. 791, 2012
[87] The most critical calls labeled "Delta" or "Echo" according to Medical Priority Dispatch Systems
[88] Clawson, Jeff J., MD, and Kate Boyd Dernocoeur, EMT-P. "Excerpts From: The Principles of Emergency Medical Dispatch," *National Academy of Emergency Medical Dispatch* 11, 2001
[89] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System," 2002
[90] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" 2005

there is a positive correlation between response times and mortality rates.

Blanchard et al. found a 1.9% difference in the risk of mortality for response times >=4 minutes,[91] and his data clearly illustrates a positive trend between increased response times and risk of mortality during the early time window. The importance of response times on mortality risk in the early minutes can be observed in *Figure 3*.[92, 93]

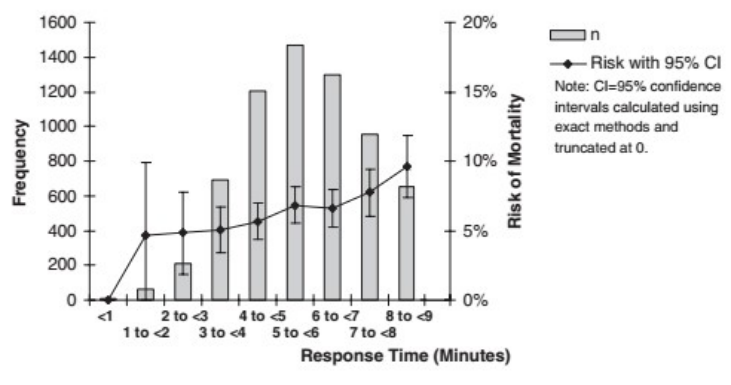

Figure 3. "Crude risk of mortality over response time, in minutes. CI = confidence interval"

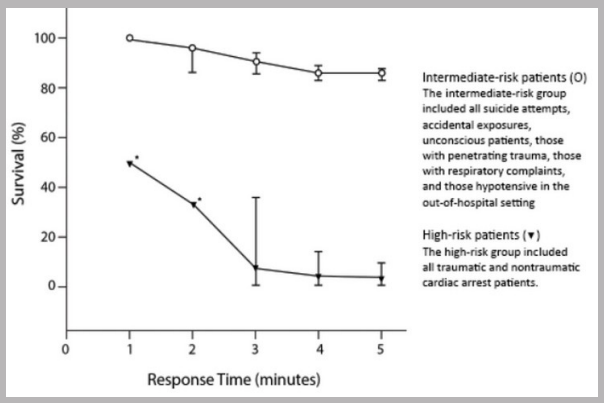

Figure 4. "Percentages of survival to hospital discharge over paramedic response time and stratified by response groups (bars represent 95% CIs)"

Pons et al. calculated an odds ratio for mortality of 0. 70 when response times were less than four minutes, compared to response times over four minutes.[94] This can be interpreted as follows: patients with a response time below 4 minutes are 0.7 times more likely to die compared to patients with a response time above 4 minutes. The same calculation for a cut-off time of 8 minutes did not yield any statistically significant results, indicating that the early minutes of response times are more impactful than any marginal reduction in time for response times over 8 minutes. As we can see in *Figure 4*,[95, 96] the drop in survival rate depends on the type of medical emergency. For low-risk emergencies, the curve is essentially flat and therefore less relevant to our analysis.

[91] Blanchard et al. "Emergency Medical Services Response Time and Mortality in an Urban Setting," pg. 146, 2012
[92] Original graph has been cropped from original Response Time (Minutes) range of <1 minutes to <16 minutes to <1 minutes to <9 minutes, as we are examining impact of early response in the initial minutes (primarily <1 minutes to <5 minutes) upon Risk of Mortality. The 5 minutes to <9 minutes range has been kept as to account for a significant portion of Blanchard's sample size, as shown in the graph (majority of cases are within the 4 to <8 minute range of response time).
[93] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System, " pg. 293, Titled "Figure 2." 2002
[94] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" pg. 596-597, 2005
[95] Original graph has been cropped from original Response Time (Minutes) range of 1 minute to 15 minutes to 1 minute to 5 minutes, as we are examining impact of early response in the initial minutes (primarily 1 minute to 5 minutes) upon Survival (%). The Low Risk curve has been omitted, as we are examining time sensitive emergencies only (intermediate-risk and high-risk patient cases).
[96] Pons et al. "Paramedic Response Time: Does It Affect Patient Survival?" pg. 597, Titled "Figure 1." 2005

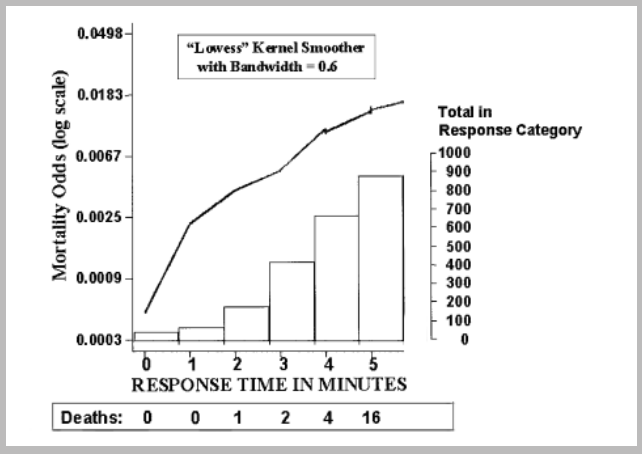

Figure 5. "Smoother mortality odds by emergency medical services (EMS) response time (Call to Scene)"[97, 98]

Blackwell's logarithmic data illustrates a dramatic increase in mortality odds as response time increases during the initial 5 minutes, supporting the importance of an early response for patient outcomes.[99]

Wilde accounts for endogeneity in her research with a novel methodology. By using the distance between the incident and the nearest responding EMS station as a proxy for response time, bias in responder arrival is minimized. Wilde also accounts for other potential confounding variables in emergency response, such as demographical information (age, race, gender, years of education), and EMS experience level (type and certification level).[100]

Wilde's data illustrates the effect of response time[101] on mortality. Reducing response time for various life-threatening emergencies[102] leads to a decline in mortality. The probability of 1-year mortality increases at the rate of 1.26% per minute of delay in response. The long term mortality rate at 4 years increases to 2.22% per minute that response time is delayed. This means that every minute does indeed make a significant measurable difference, and every minute of faster response counts.[103]

[97] Original graph has been cropped from original Response Time (Minutes) range of 0 minutes to 11 minutes to 0 minutes to 5 minutes, as we are examining impact of early response in the initial minutes (primarily 1 minutes to 5 minutes) upon Mortality Odds.
[98] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System," pg. 239, Titled "Figure 3." 2002
[99] Blackwell and Kaufman, "Response Time Effectiveness: Comparison of Response Time and Survival in an Urban Emergency Medical Services System," pg. 292, 2002
[100] ALS (Advanced Life Support) ambulances are typically staffed with Paramedics and advanced medical equipment, whereas BLS (Basic Life Support) ambulances are typically staffed with EMTs and limited medical equipment.
[101] by way of EMS distance to emergency incident
[102] stab and gunshot wounds, strokes, breathing problems, and cardiac arrest
[103] Wilde, "Do Emergency Medical System Response Times Matter For Health Outcomes?" pg. 795, 2012

Projecting a change in mortality of 1.26% to all of the 11.8M time-sensitive medical emergencies,[104] we calculate a total theoretical potential of 149,331 lives saved across the US for an overall reduction of 1 minute in response time for every single emergency. This is a more conservative estimate compared to the 253,032 lives at stake cited by the FCC in its Proposal for New Indoor Location Requirements.[105] Following a similar reasoning as the FCC, we also acknowledge that not all critical emergencies incur delays in response times due to location inaccuracy. The FCC estimates for their indoor requirements that 5% of calls would be affected by better indoor location technology. Based on the 9-1-1 call statistics discussed above, we can assume that inaccurate location on a broader scale amounts to at least twice that percentage, implying a total potential of approximately 15,000 lives at stake. Assuming that RapidSOS could eventually reach half of current mobile callers (i.e., 37% of calls), we would be able to save 5,450 lives. In the short run, with only a million active users, RapidSOS would translate into 468 lives saved annually, assuming that, on average, one minute of primary response time is saved.

Every life lost is a great tragedy for the individual, his or her family and their community. In addition to that, there is an enormous cost to society due to the loss of productivity. Different U.S. government agencies estimate the cost of a life between $7.9M (Food and Drug Administration, according to an article in the New York Times)[106] and $9.1M (Environmental Protection Agency, ibid). From a more practical standpoint, we can also look at these values through a lense of life insurance payouts. According to the American Council of Life Insurers, the average payout for a deceased life insurance customer is $165,000,[107] implying a $15B[108] business opportunity for insurance companies if response times could be reduced by only one minute.

[104] (240M total calls) * (50% emergent calls) * (39% medical calls) * (25% share of time-critical calls) - see *Figure 2* for a visual representation
[105] Federal Communications Commission, "Proposes New Indoor Requirements and Revisions to Existing E911 Rules," February 20, 2014
[106] Appelbaum, Binyamin, "As U.S. Agencies Put More Value on a Life, Businesses Fret," *The New York Times*, February 16, 2011
[107] "Life Insurers Fact Book 2014," American Council of Life Insurers, November 4, 2011
[108] Potential lives saved if all critical emergencies could be responded to one minute faster (149,331) times insurance payout for life insurance ($165,000), assuming 60% of Americans have Life Insurance

iv. Saving money - Health care costs

According to the American Heart Association (AHA), "*Time is myocardium and time is outcomes*",[109] a statement that highlights the importance of shorter time to treatment for patients with myocardial infarction. In fact, there is a general consensus within the medical community that faster treatment of time-sensitive conditions is critical to patient outcomes. When a patient's health is rapidly deteriorating, a quicker intervention not only leads to a higher likelihood of survival, but also results in improved long-term morbidity. Greater patient disability leads to higher healthcare resource utilization, and consequently, higher healthcare costs.

Permanent brain damage can occur in a matter of minutes in a critical emergency. The AHA finds that for every minute a stroke is left untreated, the patient's brain ages at 30,000 times the normal speed.[110] For every minute, 1.9 million neurons, 13.8 billion synapses, and 12 km (7 miles) of axonal fibers are lost. When someone is choking with a resulting blocked airway, lack of oxygen can lead to unconsciousness in less than 15 seconds and permanent brain damage after four minutes.[111] In these cases, one minute can determine whether or not s patient end up with a permanent disability for the rest of their lives.[112, 113]

In addition to healthcare outcomes, healthcare costs are also affected by emergency response times. Medical bills are currently the number 1 cause of bankruptcy in the US.[114] Health care costs have been increasing by 5% annually over the past decade[115] and consume 17.1% of US' gross domestic product.[116] Based on reports from The Agency for Healthcare Research and Quality and the yearly growth rate of healthcare costs,[117, 118] today's hospital costs range between $10,000 and $30,000 depending on the type of illness.[119, 120] In particular, hospital stays for cardiac and trauma emergencies tend to be well over $20,000.

A stroke occurs every 40 seconds,[121] but delays in reaching 9-1-1 by patients experiencing stroke were found

[109] Gibson, "Time Is Myocardium and Time Is Outcomes," pg. 2632-634, 2001
[110] Saver, "Time Is Brain-Quantified," pg. 263-66, 2005
[111] White, Steven, MD, and Richard Morris, MD. "Anoxic Brain Injury," 2015
[112] White and Morris, "Anoxic Brain Injury," 2015
[113] Stiell, I. G. "OPALS Major Trauma Study: Impact of Advanced Life Support on Survival and Morbidity," *Academic Emergency Medicine 12*, no. Supplement 1 (2005): 1141-152
[114] Mangan, Dan "Medical Bills Are the Biggest Cause of US Bankruptcies: Study," CNBC, June 25, 2013
[115] Pfuntner, Anne, Lauren M. Wier, M.PH, and Claudia Steiner, MD, M.PH. Healthcare Cost and Utilization Project, Issue brief no. 146. January 2013
[116] World Health Organization Global Health Expenditure. "Health Expenditure, Total (% of GDP)." The World Bank Group, 2014
[117] Centers for Medicare & Medicaid Services, "Historical: National Health Expenditure Data"
[118] Keehan, Sean P. et al. "National Health Expenditure Projections, 2014–24: Spending Growth Faster Than Recent Trends," *Health Affairs*, 2015
[119] Pfuntner, Anne, Lauren M. Wier, M.PH., and Claudia Steiner, M.D., M.PH. *Costs for Hospital Stays in the United States*, 2011, Report no. 168. Healthcare Cost and Utilization Project, 2013
[120] Pfuntner, Anne, Lauren M. Wier, M.PH, and Claudia Steiner, MD, M.PH. *Costs for Hospital Stays in the United States*, 2010, Report no. 146.
[121] American Heart Association Statistics Committee, and Stroke Statistics Subcommittee, "Heart Disease and Stroke Statistics—2015 Update A Report From the American Heart Association," *Circulation*, 2014. December 17, 2014

to be the "single most important component in failure to provide thrombolytic treatment [in time]."[122] For stroke patients, these delays are likely to occur due to their inability to clearly communicate their location and type of emergency.[123]

While having a stroke, a slurring Mary Thomas had to wait 8 hours for EMS responders to find her.[124] It took the New York City Fire Department, the New York City Police Department, Verizon Wireless, and a 9-1-1 telecommunicator, who patiently stayed on the phone for 8 hours, for Mary Thomas to be found and transported to a hospital where she ultimately passed away.[125] RapidSOS sends caller location information and type of emergency with a single touch, allowing dispatchers to know where to go and what type of emergency to expect. Even if slurred speech (inhibiting voice call) and impaired motor skills (inhibiting texting) prevented effective communication, the automatic transmission of location information would have been enough to dispatch help in a timely manner.

For surviving patients, one of most important endpoints affected by response times is morbidity.[126] The impact of response time on morbidity can be quantified by analyzing the change in quality of life and calculating the resulting additional change in healthcare costs. Quantifying a change in quality of life is subject to high levels of variability and bias since complications vary by cause, type, severity, frequency, and patients' subjective perception of the impact of these complications on their daily lives. An indirect, albeit more objective, way to quantify the impact of response times on healthcare outcomes is the analysis of the change in healthcare costs. Measuring health care costs related to the hospital stay for a given medical emergency can be performed for different types of time-sensitive emergencies and serve as a proxy for severity for each type of medical emergency.

We performed a literature search to identify studies looking at the effect of response times on healthcare costs. Jaldell et al. analyzed the effect of response time for ambulance emergency services on healthcare costs in Thailand.[127] They found that one minute of reduced response time led to a decrease in healthcare costs by 326,000 baht ($10,190). Although this study showed a positive correlation between health care costs and response times, its results should be interpreted with caution in the context of the US healthcare system given that it was based in Thailand.

[122] National EMS Advisory Council, "EMS Makes a Difference: Improved Clinical Outcomes and Downstream Healthcare Savings," December 2009
[123] "Aphasia," American Speech-Language-Hearing Association, 2015
[124] Briquelet, Kate. "Hero EMT Dispatcher Helps Pinpoint Lost Stroke Victim in EIGHT-HOUR Phone Call Marathon," *Nypost.com*, New York Post, 16 June 2013
[125] Fenton, Reuven, "Hero Dispatcher's Stroke Victim Brain Dead." *Nypost.com*, New York Post, 17 June 2013
[126] Athey, Susan, and Scott Stern, "The Impact of Information Technology on Emergency Health Care Outcomes," National Bureau of Economic Research, 2000, September 2000
[127] Jaldell, Henrik, PhD, Prachaksvich Lebnak, MD, and Anurak Amornpetchsathaporn, MD, "Time Is Money, But How Much? The Monetary Value of Response Time for Thai Ambulance Emergency Services," *Value In Health* 17, no. 5 (2014): 555-60.

Susan Athey, professor at the Stanford Graduate School of Business, and Scott Stern, professor at the MIT Sloan School of Management, examined the effect of emergency response technologies on response times and health care hospital costs.[128, 129] They studied different municipalities in Pennsylvania with distinct 9-1-1 systems, namely "No 9-1-1," "Basic 9-1-1," and "Enhanced 9-1-1."

9-1-1 Technology type	Description
No 9-1-1	Individuals call a location-specific 7 digit number to reach an emergency service provider
Basic 9-1-1	Individuals call 9-1-1 and provide their location
Enhanced 9-1-1	Links digital identification from from incoming calls to a database containing location information which appears on the screen of the call taker

Table 1. Definitions of the 3 different levels of 9-1-1 technology analyzed in the Stern et Athey study.

Their primary interest was to determine whether enhanced 9-1-1 technology leads to quicker response times. Their secondary goal was to evaluate whether response times affected healthcare outcomes and healthcare expenditures. Their findings were: (1) The E911 system leads to a decrease in response time by 2.13 minutes; and (2) E911 results in a 15% decline in episode-related hospital costs per patient. In other words, assuming minimal confounding of 9-1-1 technology on hospital costs, a decrease in response time of 2.13 minutes results in a decrease in hospital costs by 15%. Based on these findings and assuming a linear relationship between response time and healthcare costs, hospital costs decrease by 6.9% per minute saved.

It is important to note that compared to the period during which the Stern et Athey study was conducted (1994-1996), cost accounting in today's hospitals has undergone significant change. In addition, health care costs have also dramatically increased since that period. In order to account for the growth in healthcare costs, we used the per-case hospital stay cost reported by the Healthcare Cost and Utilization Project Study[130, 131] and the nominal growth rate reported by the Center for Medicare and Medicaid Services[132] to adjust these costs to today's values. The following cost savings were calculated:

[128] Athey and Stern, "The Impact of Information Technology On Emergency Health Care Outcomes," 2000
[129] Athey, Susan, and Scott Stern, "The Adoption and Impact of Advanced Emergency Response Services," In The Changing Hospital Industry: Comparing For-Profit and Not-for-Profit Institutions, 113-67, National Bureau of Economic Research, 2000
[130] Pfuntner, Wier, Steiner, "Costs for Hospital Stays in the United States, 2011," 2013
[131] Pfuntner, Wier, Steiner, "Costs for Hospital Stays in the United States, 2010," 2013
[132] Centers for Medicare & Medicaid Services, "Historical: National Health Expenditure Data"

	911 related healthcare costs per hospital stay *2015 cost baseline*	*Estimated percent reduction by 1 minute faster response*	*Estimated cost reduction per patient in $*
Cardiac	$22.290	6,92%	$1,542
Neurologic	$11.033	6,92%	$763
Severe trauma	$18.163	5,46%	$992
Other time-critical (e.g., choking, severe anaphylaxis, acute diabetic emergencies)	$10.137	3,53%	$358

Table 2. Estimated healthcare costs saved per minute, categorized by different critical medical emergency types. Base values from Stern/Athey (2000), and Healthcare Cost and Utilization Project (2013)

Disability not only negatively impacts an individual's' quality of life and financial situation, but also affects the quality of life of their close-ones and incurs societal costs by diminishing their productivity. From the health insurance perspective, we estimate that the average savings in healthcare costs per minute of saved response time per individual in the US are $19,[133] representing an opportunity of $5.5B in potential savings for health insurance companies.[134, 135]

[133] Average savings calculated based on frequency of emergency calls, and incidence and healthcare costs of time-sensitive medical conditions (see sections 1, 2 and 4)
[134] Smith, Jessica C., and Carla Medalia, "Health Insurance in the United States: 2014," United States Census Bureau, September 2015
[135] Assuming that 90% of the population has health insurance, ibid

v. Preventing damage - Property damage

"*Every 24 seconds, a U.S. fire department responds to a fire somewhere in the nation*."[136] Fire emergencies account for only 1.1% of emergency calls, and yet are responsible for approximately $12 billion in property damages annually.[137] The National Fire Protection Association notes that fires double in volume every 30 to 60 seconds, making early detection, response times, and suppression technologies particularly important - driving the plethora of building codes around smoke detectors, alarms, and sprinkler systems.[138]

The average response time for fire is less than 6 minutes,[139] which is faster than the national average for EMS response time.[140] Despite this rapid response time, the inefficiencies of the current 911 infrastructure slow down this response when accurate location data cannot be determined. Marvin Jacobs died within his burning home when firefighters were unable to locate his home in time.[141] Lack of automatic location detection technology forced dispatchers to rely upon a frantic neighbor to repeatedly spell the street address, which was ultimately mistaken for another location 19 miles away. It took over twice as long as the average fire response time before first responders were even notified of the correct address. Time wasted in re-routing a 9-1-1 fire call to multiple PSAPs in Salem, Missouri, ultimately cost two women their lives.[142] This shows that even when first responders are capable of arriving on scene within mere minutes, their dependence on the unreliable 9-1-1 infrastructure can create bottlenecks which prevent help from arriving on time.

No two fires are the same, and the volatile nature of fire growth makes it difficult to predict whether it will be seconds or minutes before an uncontrolled fire becomes overwhelming. The National Fire Protection Association reports structural (i.e., building or home) fires as the most common fire emergency type. The general growth curve for structural fires is illustrated below,[143] with flashovers being defined as the "rapid transitions between the growth and fully developed stages", typically characterized as explosive bursts capable of blowing out structures (e.g. windows, doors, and walls).

[136] Haynes, Hylton J.G. *Fire Loss in the United States During 2014*, Report, National Fire Protection Association, 2015
[137] NYC Analytics: 9-1-1, "NYC 911 Performance Reporting: End-to-End Detail Report," 2015
[138] Haynes, *Fire Loss in the United States During 2014,* 2015
[139] Haynes, *Fire Loss in the United States During 2014,* 2015
[140] "National EMS Information System (NEMSIS Data)," NEDARC
[141] "Police Investigating Fatal House Fire," *ABC11 Raleigh-Durham*, August 19, 2009
[142] Dudley, Allyssa D. "Fire Chief: Outdated 911 Deserves Part of Blame for Deaths," *The Salem News,* March 26, 2013
[143] Hartin, Ed, Battalion Chief, MS, EFO, MIFireE, CFO, "Fire Development and Fire Behavior Indicators"

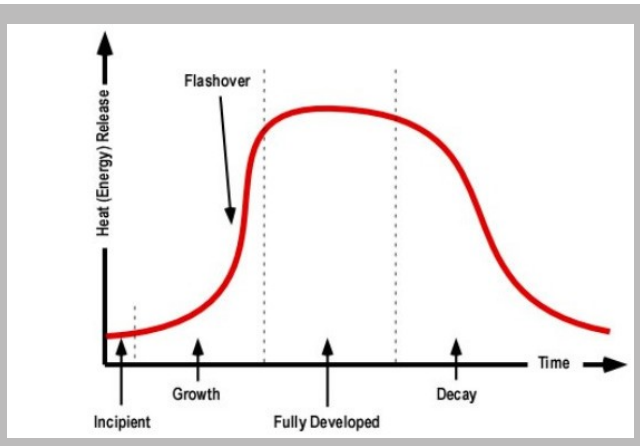

Figure 6. "Fire development in a compartment"[144]

Once flashovers occur, the fully developed fires will be at their peak temperature and resulting destructive force.[145] This stage is the most difficult to extinguish and is also responsible for most of the property damage.[146] Reducing response time could allow firefighters to arrive on scene to fires still within the growth stage", dramatically reducing fire spread and damage. The Fire Brigade Union emphasizes how flames 3 or 4 minutes after ignition would still be "*easily put out*."[147]

Neil Challands is a leading researcher on Fire Safety Engineering and Quantitative Research. Among other publications, he has examined over 27,500 fires to assess the impact of response time on fire outcomes.[148] His study methods were originally designed to measure the benefits of monitored fire alarms and sprinklers, but the logic can be expanded to any means of achieving a faster response to a fire. He explicitly finds that calls originating from mobile phones cause a "*slower response due to delays in locating incidents*", and associates them with higher damage. His findings support that "response time of fire services have a clear correlation with the amount of structural damage", and the resulting property damage costs.[149] His quantitative analysis of 27,500 fires occurring over a three-year period finds a $2,700 cost of damage increases with every minute of delayed response.

Another way to verify this data is to assess average damage and average fire growth to estimate how much damage is added per minute. A study conducted by the National Fire Protection Association found that the average insurance claim for building fires is $19,931,[150] and that the average kitchen fire accounts for

[144] Hartin, "Fire Development and Fire Behavior Indicators," pg. 1, Titled "Figure 1."
[145] "The average gas temperature within a compartment during a fully developed fire ranges from 700° – 1200° C (1292° – 2192° F)", ibid
[146] Hartin, "Fire Development and Fire Behavior Indicators"
[147] "It's About Time," *The Fire Brigades Union*, 2010
[148] Challands, Neil, "The Relationships Between Fire Service Response Time and Fire Outcomes," *Fire Technology* 46, no. 3 (2009): 665-76
[149] Challands, "The Relationships Between Fire Service Response Time and Fire Outcomes," pg. 675, 2009
[150] Haynes, *Fire Loss in the United States During 2014*, 2015

$30,000[151] in damages. Estimating a more moderate progression of damage in line with a slowly moderate fire growth rate (20%),[152, 153] we can estimate that in the US the average damage increase per minute could be in the range of $4,000 to 6,000, an even higher amount than found by Challands.

Fire damage is not just a concern for individuals. According to the Association of British Insurers, it is also an increasing cost item for the insurance industry.[154] Several insurers already give discounts for customers with smoke detectors[155] because they reduce expected building fire claims. Using technology to alert 9-1-1 faster provides a similar opportunity for insurance companies.

[151] "Nationwide: Average Cooking Fire Claim Tops $30,000." *Insurance Journal News*, October 9, 2012
[152] Approximation by British Fire Brigades Union, 2010. Percent fire property damage cost reduced per minute. “Doubles every minute" approximation aligns with fast/medium fire growth rate when response time is close to the median firefighter response time for the US.
[153] The Fire Brigades Union, "It's About Time," 2010
[154] "Record Rise in the Costs of Fire Damage," Association of British Insurers, October 12, 2009
[155] "Nationwide Insurance: Save on Your Insurance With These Home Insurance Discounts," Nationwide

vi. Call to action

As we have seen in this White Paper, there is enough scientific evidence to conclude that response times matter on a large scale. Be it lives saved, or costs saved -- faster response can provide a huge benefit to society. We must also remind ourselves that behind every life lost lies an individual story as tragic as Denise Amber Lee's. Every life lost is a tragedy for a family and a community at large, and we must do everything that is in our power to prevent every single avoidable incident from happening.

Technology has been transforming so many areas of our lives. 21st century mobile technology is ubiquitous, and is impacting every facet of our existence. Our smartphone knows exactly where we are and who we are. We use applications that track our health, monitor our sleep, and allow us to be connected with our friends and family via video, photo, text and voice around the clock, regardless of where we are located. In a world where everything is possible on a smartphone, why should we rely on a technology that hasn't change since the 1960s when it comes to the most critical life events life events? Why can't we transmit crucial information to 911 with the push of a button?

RapidSOS offers significantly reduced response times by providing instant transmission of accurate location information and much more to the correct PSAP. It therefore impacts all aspects of the response time interval and ensures that help is on the way. Be it CPR instructions over the phone, a first responder or an ambulance transport unit: every single part of the "chain of survival" arrives faster if the PSAP knows the caller's exact location. Our technology is ready for immediate integration into the existing 9-1-1 system, without a need for additional infrastructure or training. We can help the existing system become more effective and reliable. With one push of a button, help is on its way.

vii. Sources

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viii. Acknowledgments

We would like to thank everyone in the 9-1-1 community for all the support we have received. We started this journey as a group of computer nerds with experiences around 911 but limited understanding of how it works. Over the last three years and countless hours in dispatch centers, you have taught us how and why the system works the way it does.

The work 9-1-1 dispatchers do is extraordinary. In several incidents we had to excuse ourselves in particularly challenging situations while a dispatcher dealt with a suicide, shooting, or car accident. We admire how hard you work to save lives every day, often in spite of antiquated technology. Without your expertise and willingness to collaborate, we could not have developed our product.

Specifically, we would like to thank everyone at NENA and APCO, and all the Directors, Supervisors, Dispatchers and Telecommunicators in Public Safety Answering Points across the country who have worked with us - you are truly the first first responders.

We would also like to express our gratitude to Susan Athey, Tom Blackwell, Ed Racht, Scott Stern, Lee Turpen and Ty Wilde for taking the time to speak to us and answer our questions about their research. We know how scarce your time is and immensely appreciate your help.

Disclosure regarding potential conflict of interest: We have not received any financial contribution or compensation from any entity cited in this White Paper. We have, however, received non-monetary support in developing our technology by numerous PSAPs and 9-1-1 officials across the nation. RapidSOS is a member of the National Emergency Number Association (NENA ID: RSOS). RapidSOS is a donor of the Denise Amber Lee Foundation.