America's Emergency Medical Service System:
A primer commissioned by AcademyHealth
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I. Introduction

Emergency Medical Services (EMS) serve as the point of entry for millions of Americans seeking medical care in the United States every year. Since its inception, US Emergency Medical Services has evolved into a robust system of coordinated care specialized in disease recognition, initial stabilization, treatment and transport of the acutely ill. For time-sensitive conditions like acute cardiovascular events or sepsis, EMS often serves as the first medical contact. Thus, quick recognition and prehospital initiation of treatment may significantly impact clinical outcomes.

The objective of this Primer is to provide an overview of EMS systems in the United States, how these systems vary across the country and how EMS systems may contribute to delays in the diagnosis of acute cardiovascular events, sepsis and cancer. Specifically, this Primer aims to i.) provide a basic definition of the EMS system and its components, ii.) review the way the EMS is organized around the country including the services provided, the types of personnel employed and their scopes of practice, ownership and governance and financing, iii.) describe the role that EMS can play in the care journey of patients potentially experiencing acute cardiovascular events, sepsis and cancer, iv.) provide a brief introduction to EMS as a topic of health services research including overviews of the available data sources, areas of research inquiry, important insights and significant unanswered questions relevant to diagnostic delay.

II. Emergency Medical Services

Born out of necessity

Prehospital emergency services were born during the Civil War, out of necessity.[1] A systematic, organized method of field care was required to care for the many injured and dying on the battlefield. In 1865, the first civilian ambulance roared

through the streets of Cincinnati. New York followed suit a few years later.[2] In the latter case, a mobile surgeon provided a quart of emergency brandy for every patient.

As the character of traumatic injuries inflicted during wartime changed, so did the prehospital emergency care system. In the 1950's and 60's, funeral hearses were joined by fire departments, rescue squads and private ambulances to transport the sick and injured.[2] Yet, services rendered were inadequate. As detailed by a damning white paper prepared by the National Academy of Sciences and the President's Commission on Highway Safety, the prehospital system of care was inadequate to treat patients suffering from critical traumatic injuries.[3] Americans were "more likely to survive a gunshot wound in the Vietnam War" than in the streets of American cities.

The care shortcomings were not unique to trauma, however. In 1966, Peter Safar, father of CPR and the founder of Freedom House Ambulance Service lost his daughter to an asthma attack because she didn't get the right help between her house and the hospital.[1] He coped with this devastating loss by designing the modern ambulance, the world's first comprehensive course to train paramedics and establishing the Freedom House ambulance service.[4]

Freedom House transformed from a group of Black men delivering vegetables to an Ambulance service serving the Hill District of Pittsburgh.[2] By 1972, the trained professionals of Freedom House ambulance service were caring for a wide range of pathology from heart attacks, seizure, stroke and even assisting with child birth. Unlike established police and volunteer ambulance services who lacked formal prehospital training and delivered the "right care" in only one third of cases, the Freedom House ambulance service rendered the correct care 89% of the time.[4]

Inspired by the work of Freedom House, The EMS Systems Act of 1973 funded the creation of more than 300 EMS systems across the nation and established a line of funding for future planning and growth.[5] This funding was later augmented by the Omnibus Budget Reconciliation Act, which expanded resources available to prehospital systems by temporarily earmarking state funds for Emergency Medical Services.[6] In 1996 EMS Agenda for the Future and the EMS Education Agenda for the Future helped integrate prehospital emergency services into established systems of medical care and developed a formal curriculum, scope of practice and certification for EMS professionals.[7,8] Finally, the EMS Agenda 2050, released in 2019, is a framework and vision for the advancement of EMS systems over the next 3 decades.[9]

Since its infancy in the days of horse and buggy, the Emergency Medical Services System has evolved into a robust infrastructure, delivering advanced, innovative care at the forefront of medicine.

Overview

Emergency Medical Services (EMS) is a coordinated system of response involving professionals from a diverse mix of agencies who provide prehospital medical care.[9] In the United States, there are currently 21,280 active EMS agencies employing over 826,000 EMS professionals. Every year, the EMS system receives 37 million calls for service and transport 28 million patients. The services and capabilities, personnel and training required, funding source and communication infrastructure varies significantly from community to community.

Services and capabilities

In the United States, EMS agencies vary in the types of care rendered.[10] Agency-types are summarized by five categories: i) 911 Response services without transport services, ii.) Ground specialty services, iii.) Air medical services, iv.) Non-ambulance medical transport services and v.) Community paramedicine-type services. The number of each agency-type differs by state. (**Fig**. 1) The responsibilities and capabilities of each service type also varies widely (**Table** 1).

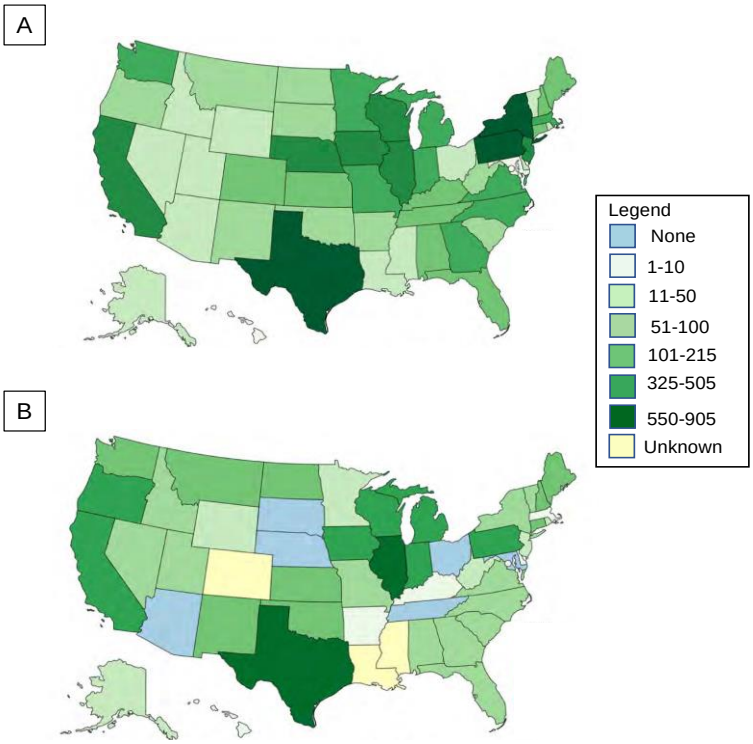

Figure 1. Number of EMS agency type per state (A) EMS response with transport, (B) EMS response without transport. *Adapted from 2020 National Emergency Medical Services Assessment.*

Table 1. Summary of EMS agencies

Agency type	Description	Examples
911 Response without transport services	Respond to scene of a call before the ambulance.	Fire trucks from a closer station, medic response bringing personnel with advanced skills
Ground Specialty Care Services	Ambulance services licensed by state EMS offices.	Scene transport, interfacility or critical care transport services
Air Medical Services	Provide critical care air transport.	Air medevac
Non-ambulance medical transport services	Services intended to transport patients without urgent medical needs.	Wheelchair vans, ambulettes
Community Paramedicine-type services	EMS agencies that provide personnel and resources to meet unmet needs in communities.	Blood pressure monitoring, or supplemental oxygen

A concept of increasing import, Community paramedicine-type (CP) services are used to address care gaps among vulnerable populations (**Fig**. 2).[10,11] For example, by providing EMS personnel and resources, CP services provide a bridge between primary and emergency care (**Table** 2).[12] CP programs increase access to primary and preventive care, provide wellness interventions, decrease emergency department utilization, save healthcare costs, and improve patient outcomes by using EMS providers in an expanded role.[13-15] In the United States, CP services administer immunizations, monitor diabetic and post-myocardial infarction patients, assist with advanced mental health issues and facilitate referral,

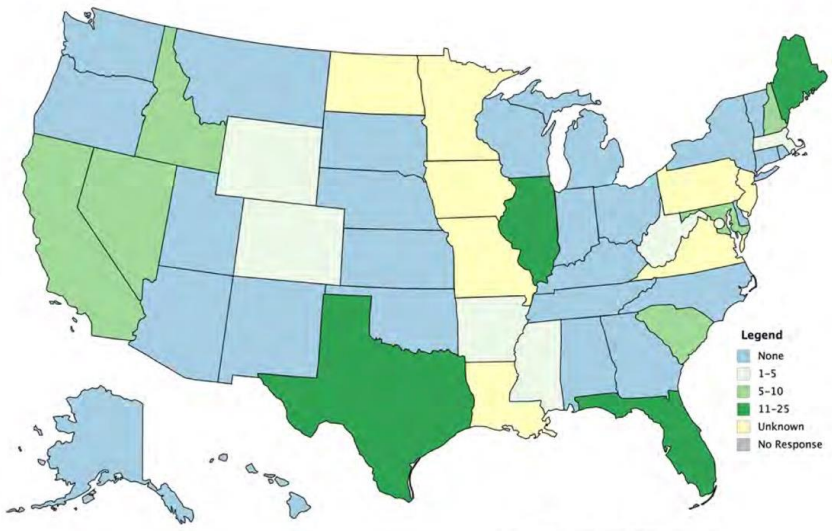

Figure 2. Number of Community paramedicine services per state. *Adapted from 2020 National Emergency Medical Services Assessment.*

wound care and community-based safety programs.[14] Additionally, CP services assist frequent users of 911 and Emergency Departments. In one example, CPs routinely contact patients with frequent EMS transports, identify and remediate factors associated with increased utilization of acute care services. CP clients receive education regarding appropriate EMS use and are connected with social and mental health services, primary care, equipment, housing and transportation.[16]

Table 2. Community paramedicine programs

Program	Program components	Skills	Staff	Target Population
Ambulance service of New South Wales (Australia)[a]	Treat patients on-site, provide self-management advice, refer to outpatient services	• Physical exam • Administration of IV medications • Phlebotomy • Urinalysis • Wound care and suturing • Splinting and plastering • System assessments (e.g., home, ADL, mobility, falls) • Vaccinations	Paramedics	Rural/remote communities
Nurse practitioner-paramedic-physician model (Nova Scotia)[b,c]	Provide 24/7 paramedic coverage	• CHF assessment • Fall prevention and home safety assessment • Venipuncture • Phlebotomy • Urinalysis • Suture/staple removal • Wound care • Immunizations • Medication compliance • Glucose checks/diabetic compliance • Antibiotic administration • Health promotion activities	Team of on-site nurse practitioner and paramedic; offsite family physician	Elderly patients with increased healthcare needs
Community referral by EMS (Ontario)[d]	Referrals by paramedics responding to 911 calls; referrals made to Community Care Access Center who will then follow up to coordinate home-based nursing, personal support, physical and occupational therapy, cleaning, social work, nutrition counseling, medical supplies and equipment	• Determine if 911 caller requires additional support or services	Paramedic	911 callers
Treat-and-release protocol	Assess patients, provide treatment after consulting with	• On-site treatment of minor trauma, minor epistaxis, minor seizure,	Paramedics	Residents with minor disease/conditions

(Alberta, CA)[e,f]	central on-call physicians, refer patients for further treatment, develop follow-up plans	hypoglycemia, supraventricular tachycardia		
Emergency care practitioners (United Kingdom)[g]	Provide assessment and treatment of patients with minor illness/injury within the community without necessarily transporting to hospital	• Carry out/interpret diagnostic tests • routine assessments of chronic conditions at home • refer patients to social care services • directly admit patients to specialized units	Coordinated team of physicians, nurses and paramedics	Patients with minor disease/injury
Resource Access Program (California, US)[h,i]	EMS surveillance, case management, referral to identify and modify medical and psychocial factors that fuel repeated ED and 911 utilization; educate clients on appropriate EMS use; hospital follow-up	• Coordinate health and social service needs • Investigate factors underlying excessive acute care resource use (e.g., lack of transport, social support and health literacy) • Interface with primary care physicians, homeless services, street outreach programs, hospital social workers and case management, adult protective services	Paramedics	Frequent users of cute care resources

[a] Blacker N and W. T. (2009). Redesigning paramedic models of care to meet rural and remote community needs. 10th National Rural Health Conference.

[b] Martin-Misener R, et al. (2009). "Cost effectiveness and outcomes of a nurse practitioner-paramedic-fami physician model of care: The Long and Brier Islands Study." Primary Health Care Research and Developm **10**(1): 14-25.

[c] Government of Novia Scotia, E. H. S. (2016). "Emergency health services paramedic competency templa from http://www.novascotia.ca/dhw/ehs/policies/2016_03_17_1_nocp_comparison_template.pdf.

[d] Services, T. P. (2017). "Community paramedicine." from http://torontoparamedicservices.ca/special-units teams/community-paramedicine/.

[e] (CADTH), C. A. f. D. a. T. i. H. (2014). "Emergency medical service “treat and release” protocol: A review clinical and cost-effectiveness, safety and guidelines." from https://www.cadth.ca/emergency-medical-servi treat-and-release-protocols-review-clinical-and-cost-effectiveness-safety.

[f] Minhas R, et al. (2015). "A prehospital treat-and-release protocol for supraventricular tachycardia." CJEM 395-402.

[g] Raven S, et al. (2006). "An exploration of expanded paramedic healthcare roles for Queensland." from http://espace.library.uq.edu.au/view/UQ:121008.

[h] Tadros AS, et al. (2012). "Effects of an emergency medical services-based resource access program on frequent users of health services. ." Prehosp Emerg Care **16**(4): 541-547.

[i] Jensen AM and D. J.; (2013). "Putting the ‘rap’ in ‘rapport’." JEMS **38**(1): 38-41.

Abbreviations: IV, intravenous; ADL, Activities of Daily Living; CHF, Congestive Heart Failure; EMS, Emerg Medical Services;

Personnel and training

The National EMS Scope of Practice Model defines four levels of EMS licensure in the United States: Emergency Medical Responders (EMR), Emergency Medical Technicians (EMT), Advanced EMT (AEMT) and Paramedics.[17] Each level is distinguished by its unique skills and knowledge, practice environment, services provided, level of supervisory responsibility and degree of autonomy.[18]

Emergency Medical Responders (EMR) are the most basic-level responder. EMRs are often the first to arrive on scene, thus their skill set includes patient assessment and triage, as well as basic, immediate lifesaving care while awaiting additional resources. EMT provide most out-of-hospital care, and in many systems, are the highest-level pre-hospital professionals. EMT assess and triage emergency, urgent and non-urgent requests for medical care, apply basic knowledge and skills, and facilitate patient transport. Advanced EMT encompasses the skill sets of EMR and EMT but can also conduct limited advanced invasive and pharmacologic interventions. The AEMT allows provision of more skilled care and is of particular import to systems that cannot support paramedic-level care. Paramedics are the most advanced prehospital professional. Paramedics are an out-of-hospital allied health professional certified to conduct invasive and pharmacological interventions.

To ensure uniform quality of prehospital professionals across states, *The National EMS Scope of Practice* requires standardized prehospital education and certification.[18] First, The Scope requires national accreditation of all training programs by the National Highway Traffic and Safety Administration. This ensures compliance with National EMS Education Standards and National EMS Core Content.[19,20] Next, The Scope defines 4 required domains for prehospital

professionals including, i.) education, ii.) certification, iii.) licensure, and iv.) credentialing.

Education: The National EMS Education Standard delineates expected knowledge and clinical skills required for each level of licensure across the US.[19] The Standards include four components including i.) minimum competency required, ii.) clinical knowledge, iii.) clinical behaviors and judgment and iv.) education infrastructure or support standards necessary for each EMS licensure level.

Certification: Once a learner successfully completes coursework and requirements defined by the Education domain, she can sit for the verification of competency evaluation. National Registry of EMTs verify competency in most states.

Licensure: Distinct from certification, licensure refers to state-granted legal authority to perform the duties of their level of licensure as delineated by the State. State Licensure produces an entry-level clinician ready for credentialing.

Credentialing: The responsibility of an individual EMS organization and its Medical Director, credentialing ensures that a certified and licensed professional can operate safely and follow clinical and operational guidelines defined by the agency Medical Director. Once credentialed, a professional is "job-ready".

Governmental oversight and funding

Each state and territory in the United States has a lead EMS agency that is typically under direct oversight by the State Health Department. However, the lead EMS agency may be housed within a multidisciplinary state public safety

department or may be an independent state agency. Lead EMS agencies are responsible for the planning, coordination, regulation and licensing of individual EMS agencies across the state.

Local EMS agencies and services are the smallest operational units licensed by the State. Local agencies provide service to a specific location or service area that can be as large as a geopolitical boundary (i.e., county, city or municipality) or as small as the local service area surrounding an EMS station.[21]

At the agency level, Medical Directors are physicians responsible for direct clinical oversight and development of policies and care guidelines. The primary role of the EMS medical director is to promote patient-centered delivery of out-of-hospital medical care and ensure continuous quality improvement. Thus, EMS directors are responsible for training, verification of provider competency and credentialing. Medical Director governance includes not only direct care delivery, but emergency dispatch operators and telecommunications.[22]

The cost of maintaining of a ready EMS system in the US is very high, yet poorly funded.[23] Despite the essential public service provided, EMS agencies are not reliably funded by federal or state funding strategies. Instead, funding of EMS agencies has been relegated to local and state initiatives, resulting in significant heterogeneity of services and quality. Further, reimbursement for EMS services by Center for Medicare and Medicaid Services and most private payers is dependent on patient transport to a medical facility. This reimbursement model not only fails to compensate EMS agencies for sophisticated care provided on-scene, but also discourages EMS personnel from providing basic care that may prevent unnecessary transport and ED crowding. Further, EMS reimbursement for transport is quite low -- $25 in some states – regardless of complexity or resources used.

EMS Communications infrastructure

9-1-1

Across all states and territories in the US, 9-1-1 serves as the Public Safety Answering Point (PSAP) for anyone in need of Emergency Medical Services.[24] The National 911 Program is a federal initiative housed within the National Highway Traffic Safety Administration Office of Emergency Medical Services designed to coordinate and promote optimal 911 services across all states and territories in the United States. Locally, 911 centers are responsible for dispatching first responders.

Though the National 911 Program coordinates PSAPs across the nation, individual call centers are managed at the state and/or local level. The National 911 program has recommended minimum training guidelines for public safety telecommunicators, however, certification requirements and training vary by agency.[25] Various types of certifications exist including Emergency Medical Dispatchers (EMDs), Emergency Fire Dispatchers (EFDs) or Emergency Police Dispatchers (EPDs). Supervisors may be uniquely certified as Emergency Number Professionals (ENPs) or Certified Public-Safety Executives (CPEs).[26] These certifications are available through a number of organizations including, International Academies of Emergency Dispatch (IAED), the National Emergency Number Association (NENA), among others.[27,28]

Emergency Communications Centers

Once a PSAP has been notified of a need for help, a first responder will assess the scene, and request an array of equipment or personnel. Emergency Communications Center (ECC) is responsible for coordination of additional resources (e.g., air medical transport) and hospital pre-notification.[29] In addition, ECC may facilitate online medical command with a command physician and on-scene resources.

Telecommunications

Telemedicine/telehealth has facilitated real-time video communication with medical command. Though currently uncommon – only 22% of states reporting use of video communication on rare occasions (<10% of missions)– initiatives such as the CMS pilot project on Emergency Triage, Treatment and Transportation requires video telehealth in some patient care scenarios.[10] In this model, CMS will pay participants to either i.) transport patients to an alternative destination partner, such as a primary care office, urgent care clinic or mental health center or ii.) facilitate treatment in place with a referring physician via telehealth.[30]

III. Opportunities for innovation

Overview

In 1966, the National Academy of Sciences released *Accidental Death and Disability: The Neglected Disease of Modern Society*, a White Paper outlining the importance of developing a robust infrastructure of local, regional, state and national resources to improve trauma care.[3] From this report, a prehospital trauma system included voluntary categorization of facilities and resources for specialized trauma care. Over time, using evidence-based recommendations on field triage from the CDC, these voluntary trauma designations became expert centers of specialized trauma care.[31-33]

Using the trauma system of prehospital care as a model, the Institute of Medicine later released three reports on *the Future of Emergency Care in the United States Health System*, calling for a 'regionalized, coordinated and accountable' system of emergency care for time-sensitive conditions.[31,32,34] Specifically, 4 high-risk conditions were identified: sepsis, cardiac arrest, ST-elevation myocardial infarction

and stroke. All conditions dependent on early recognition and timely response, yet all with widely disparate resources in urgent need of organization.

In 2017, the Specialty Systems of Care Committee was developed to address this need.[35] The goal of the Committee to develop coordinated, timely, and expert systems of care that include 7 key elements, integrated at the state level (**Table** 3). To date, the Committee reports State coordinated systems of care to address trauma, stroke and cardiac care in all 50 states.

Table 3. Key components of specialty systems of prehospital care

Address a condition that is frequently encountered/transported by EMS personnel
Model clinical guidelines that are used to improve statewide consistency of care
Standards for patient care are available through an accreditation process
Agency/facility inspections are conducted to ensure compliance to standards
Focused data collection or state registry of specific condition
Use of consensus-based measures to improve patient care quality
Ongoing evaluation and monitoring of benchmarks

Definitions

The following definitions by Kocher et al. summarize contemporary prehospital systems of coordinated care:[36]

- **Categorization**: process for inventorying the emergency care resources, capabilities and capacities of facilities in a community/region, using a criteria-based classification system over a range of emergency care conditions. This process is used to assist physicians, hospitals, health departments and EMS agencies in making informed decisions on how to develop, organize and appropriately utilize health care resources for the emergency care system. Categorization may be accomplished using self-survey and self-declaration by facilities, or by external agency survey and verification or both.

- **Accreditation**: attestation by an outside professional organization or agency that a medical facility has met certain consensus standards. These standards may involve the type and quality of care, safety, efficiency, cost-effectiveness and accessibility.
- **Designation:** charter as a preferred prehospital receiving facility and/or local or regional referral facility for a certain medical condition. Fulfillment of a charter is predicated on meeting and maintaining certain capacity, capability and performance standards and on the commitment of the facility to continually improve the care of patients with these medical conditions. This process is usually implemented by a governmental organization responsible for local or regional planning and oversight of EMS and may entail funding from a governmental body.
- **Regionalization:** matching of medical resources to patient needs to maximize health benefits and outcomes while minimizing cost and use of resources over a specified geographic area. In general, this process implies a level of organization beyond the local level, but below the national level.
- **Verification**: service offered by the state or accrediting agency to attest to a health care facility's compliance with predefined standards. May include a comprehensive review of documentation with on-site inspection.

Note: Accreditation by a professional organization or agency may be voluntarily pursued by any healthcare facility. In contrast, Designation is executed at the state-level and may or may not be available for each condition (i.e., sepsis, cardiac arrest, ST-elevation myocardial infarction and stroke) in every state.

Case study: Specialty stroke care

Background

Stroke is a major cause of death and disability in the United States. Every year, 795,000 people have a stroke.[37] In 2020, 1 in 6 deaths from cardiovascular disease was due to a stroke.[38] Among those who survive, strokes reduce mobility in more than half of survivors aged 65 and older. In addition, stroke is a major strain on public health resources, costing over $50 billion annually for acute services, post-stroke care and missed days of work.[39]

Prevention of death and disability from stroke is dependent on quick symptom recognition and treatment.[40] For example, patients who arrive at the Emergency Department within 3 hours of symptom onset often have less disability at 3 months than those who received delayed care.[41] Because 87% of strokes are ischemic, the majority of stroke patients may benefit from timely treatment with thrombolytics and/or reperfusion.[38] However, only a minority of eligible ischemic stroke patients receive recanalizing therapies.[42] This is likely due to poor symptom recognition and significant variation in US population access to stroke center hospitals.[41,43]

Stroke symptom awareness among US adults is poor, particularly among Hispanics and blacks.[44] Thus, patients often do not know to seek care. However, even once stroke symptoms are recognized, only 50-60% of hospitalized stroke patients arrive at the hospital via EMS.[45-47] Racial and ethnic minorities are even less likely to use ambulance services.[48] Then, even when EMS is activated, substantial limitations in the accuracy of prehospital stroke assessment tools and in the timeliness of prehospital care hinder timely definitive stroke care.[49]

Thus, there has been substantial investment by governmental agencies and professional organizations to increase stroke symptom awareness, enhance prehospital coordination of care, increase the number of certified and accredited stroke centers and expand use of Telestroke services.[50]

Prehospital stroke screening tools and pre-notification

Prompt recognition of stroke symptoms by EMS is key to timely, definitive stroke intervention.[47,51-53] However, stroke recognition by EMS -- from dispatch to providers of on-scene care -- is quite variable.[54,55] To aid in diagnosis, there are several prehospital stroke screening tools in current use across the US. However, utilization and performance of each is variable (**Table** 4). [56,57]

Table 4. Prehospital stroke screening tools

Tool	**States utilizing tool*** (%)	**Performance**[a] (AUC)
Boston (Massachusetts) Stroke Scale	0	
Cincinnati Prehospital Stroke Scale (CPSS)	73	0.79 (95% CI 0.75-0.83)
Los Angeles Motor Score (LAMS)	28	0.79 (95% CI 0.75-0.83)
Miami emergency neurologic deficit (MEND) checklist	20	
Face Arm Speech Time (FAST)	73	0.80 (95% CI 0.76-0.84)
NIH Stroke Scale	5	0.86 (95% CI 0.83-0.89)
Prehospital acute stroke severity (PASS)	10	0.76 (95% CI 0.72-0.80)
Rapid arterial occlusion evaluation (RACE)	20	0.83 (95% CI 0.79-0.86)
Vision-Aphasia-Neglect (VAN)	10	
Other	25	

*States may report use of more than one scale
[a]Duvekot MHC, et al. (2021). "Comparison of eight prehospital stroke scales to detect intracranial large-ve occlusion in suspected stroke (PRESTO): a prospective observational study." Lancet Neurology **20**(3): 21

Once recognized, pre-notification of a stroke patient by EMS is associated with improved stroke recognition and increased access to appropriate stroke treatment.[46,58-64] Currently, 80% of states indicate that their receiving hospitals use clinical information provided by EMS to initiate a team response for incoming patients.[35,65,66] For example, Wyoming EMS providers must issue a “Notification of Stroke Alert” to the receiving Stroke center as soon as possible for patients with a positive FAST prehospital stroke screening.[67]

Specialized stroke centers

Certification of specialized stroke centers is associated with improved outcomes following ischemic stroke.[68-74] In 2003, the American Heart Association (AHA), the American Stroke Association (ASA) and The Joint Commission (TJC) established a process for certification of specialized stroke centers.[68] Since, Det Norske Veritas and Germanischer Lloyd (DNV), and the Healthcare Facilities Accreditation Program (HFAP) have joined the AHA, ASA and TJC as organizations approved by CMS to certify stroke centers nationally.[75] Additionally, individual states are empowered to certify stroke centers.

To date, there remains no universally-applied standard for stroke center certification or designation.[70] For example, 21 states recognize a national certification/accreditation process, while 6 states establish state specific criteria and perform their own site visits; 13 states use a hybrid approach including national and state elements.[35]

There are currently 4 tiers of nationally-recognized specialty stroke centers in the US (**Table** 5). Additionally, 9 states have identified intermediate levels including Emergent Stroke Ready Hospital, non-emergent stroke ready hospital, primary stroke center with endovascular capability but not certified by an external body, Stroke bypass hospitals, Primary stroke Services, Stroke referral centers, Stroke support hospitals and Certification of stroke rehabilitation.[35]

Table 5. Specialty stroke centers

Tier	Description	States with access (%)
Comprehensive Stroke Center	Highest designation; requires advanced neuroimaging, endovascular intervention, minimum annual patient volume, QI database, participation in patient-centered research	95

Primary Stroke Center	Administer IV thrombolytics and provide advanced, evidence-based medical management	93
Acute Stroke Ready Hospital	May identify and initiate stroke care, but patients require transfer	85
Thrombectomy Capable Stroke Center	Similar requirements to comprehensive stroke centers; able to perform thrombectomies (with required minimum annual case count), but not required to participate in research	40

Prehospital stroke transport

In all 50 states, EMS personnel are authorized to redirect transport to the closest specialized stroke treatment facility.[35] Routing algorithms are intended to always seek the center of highest capability when travel times differences are short. Such EMS triage and transport protocols are associated with improved symptom recognition, increased access to appropriate stroke treatment and decreased time to definitive therapy.[47,62,76-78]

For patients with suspected large vessel occlusion, the Mission Lifeline Severity-Based Stroke Triage Algorithm for EMS currently recommends avoiding *additional* travel time of > 15 minutes to reach a specialized stroke center with endovascular thrombectomy capabilities.[79] This recommendation may be superseded by new data forthcoming on acceptable extra travel distance when transporting suspected stroke patients for advanced therapies.[80-84] Additional recommendations on EMS point of entry in the Stroke System of Care, especially focusing on rural and urban/suburban boundary regions are forthcoming.[85]

Prehospital stroke data registries

EMS participation in prehospital stroke registries provide critical insight into clinical practice and disparities in healthcare delivery. Additionally, data collected assist with surveillance of trends in care quality, evaluation of clinical effectiveness, quality improvement and guideline implementation/adherence. Not surprisingly, EMS participation with stroke registries is associated with increased adherence to stroke performance measures resulting in improved outcomes.[86,87]

Two national stroke registries exist: Get With the Guidelines -- Stroke, sponsored by the American Heart Association and the Paul Coverdell National Acute Stroke Registry, sponsored by the CDC. In 2020, 68% of states report EMS participation in a stroke registry.[35] Among states participating in stroke registries, 52% participate in the Get With the Guidelines – Stroke database. The Paul Coverdell National Acute Stroke Registry is supported by 30% of states. 44% of states have established state-based stroke registries.[35]

Case study: Prehospital care of chest pain

Background

Chest pain is one of the most common chief complaints EMS professionals encounter, accounting for 10-15% of all ground missions.[88,89] Though ST-segment-elevation myocardial infarctions (STEMI) represent a small proportion of all patients with chest pain, the consequences of delayed diagnosis include substantial morbidity and even death.[90]

STEMI is a time-sensitive condition in which survival and morbidity is dependent on the time from vessel occlusion to restoration of coronary perfusion.[91,92] If performed timely, percutaneous coronary intervention (PCI) is the preferred method of reperfusion. However, a major barrier to successful PCI is delayed time to reperfusion, particularly among patients undergoing hospital transfer. [93,94]

In 2009, the American College of Cardiology/AHA STEMI guidelines recommended that "each community should develop a STEMI system of care".[95] To facilitate STEMI systems, the American Heart Association developed *Mission:Lifeline* to improve prehospital STEMI recognition and response. The overall goal to increase the number of patients with timely access to primary PCI.[96,97]

Funding for prehospital STEMI systems of care is most frequently from PCI-capable hospitals.[98] As CMS mandates public reporting of timely reperfusion for PCI hospitals, institutions are motivated to improve time to coronary reperfusion by enhancing prehospital recognition and response, in part.[99,100] Payers are also stimulated to enhance prehospital STEMI care as expedient definitive management is associated with less morbidity and, thus, fewer downstream costs.[101] Additional funding for prehospital STEMI systems is derived from industry, government and foundation sources.[98]

Prehospital ST-elevation myocardial infarction screening and pre-notification

Among patients with STEMI, 60% use EMS transport. Older patients, females, patients who live >10 miles from the hospital, and those with hemodynamic compromise use EMS most often. Patients of Hispanic ethnicity are less likely to use EMS along with patients with private insurance (vs. patients with government-funded or no insurance coverage). There is no significant association between race, neighborhood education/income levels and EMS use in the setting of STEMI.[102]

The first step in prehospital detection of STEMI is recognition of signs and symptoms, acquisition and interpretation of a prehospital 12-lead electrocardiogram (ECG), stabilization (e.g., supplemental oxygen, blood pressure management), administration of aspirin, prehospital notification with or without transmission of a 12-lead ECG and determination of optimal transport destinations.[103,104] Of particular import is the quick acquisition of a 12-lead ECG by EMS personnel at the time of first medical contact.[105] Accurate interpretation of the ECG by either a computer algorithm, trained paramedic or physician/advanced practice professional is critical.[106] ECG interpretation is included in the National EMS Scope of Practice Model as a necessary skill for paramedics[18]

Once a STEMI is identified, prehospital notification triggering a cardiac catheterization team activation is associated with reduced time to treatment and improved outcomes.[107-109] 86% of states report recognition of EMS-based team activation criteria for STEMI.[35]

Specialized chest pain centers

The American Heart Association is the single most influential accreditation body for cardiac centers, recognizing three levels of STEMI-receiving hospitals, i.) Comprehensive heart attack center (CHAC), ii.) primary heart attack center (PHAC),

iii.) acute heart attack-ready (**Table** 6).[103] The Joint Commission, American College of Cardiology, The Society for Cardiovascular Patient Care, and Det Norske Veritas are also authorized to accredit cardiac centers in the US. Additional example state-level hospital designations include Cardiac Ready Communities, Cardiac receiving and Cardiac referral centers, EKG transmission capable, Levels I-III emergency cardiac care center, STEMI receiving/referring centers, STEMI levels I/II, and heart attack receiving/referring center.[35]

Table 6. Specialty chest pain centers

Tier	Description[a]	States with access (%)[b]
Level I Comprehensive Heart Attack Center	Highest level designation; requires cardiac catheterization lab with interventional cardiologist available within 30 minutes of STEMI activation. Also requires robust targeted temperature management program and formation of a multidisciplinary resuscitation committee. Must maintain a "no diversion policy" for out-of-hospital cardiac arrest	23
Level II Primary Heart Attack Center	Requires cardiac catheterization lab with interventional cardiologist available within 30 minutes of STEMI activation for care of patients with/without an intra-aortic balloon pump	55
Level III Acute Heart Attack-ready	Hospitals without consistent primary PCI coverage; require robust referral protocol to address transfer procedures and/or fibrinolytic therapy if expected first medical contact to intervention time >120 minutes. Participate in Get With the Guidelines—Coronary Artery Disease Program for data collection to monitor adherence and quality improvement	27

Abbreviations: PCI, primary coronary intervention; STEMI, ST-segment elevation myocardial infarction

[b]Jacobs AK, et al. (2021). "Systems of care for ST-segment-elevation myocardial infarction: a policy statement the American Heart Association." Circulation **144**: e310-e327.

[a]Administration, N. H. S. (2020). Specialty Systems of Care: An analysis of statewide practices related to time sensitive emergencies. Department of Transportation.

Prehospital STEMI transport

All states enable EMS-directed hospital bypass to facilitate care at a specialty cardiac center.[35] If direct transport to a STEMI *referring* hospital is required due to patient acuity, eligibility for fibrinolytic therapy should be assessed. STEMI referring facilities have established reperfusion strategies that include either transfer for PCI or

administration of fibrinolytics. Mission:Lifeline requires reporting of door-in door-out time (i.e., arrival/registration to transfer out of the ED), with established benchmark standard of < 30 minutes. Delays at STEMI referring centers have been associated with higher mortality.[110] EMS Protocols may direct EMS professionals to physically remain at the STEMI referring center during patient stabilization to minimize door-in door-out time prior to transfer to a primary PCI center.[111]

In an acute STEMI, PCI is the preferred approach over fibrinolytic therapy if intervention can be performed within 120 minutes of first medical contact.[112] In circumstances in which transfer to a PCI facility is not possible, patients remaining at the STEMI referring hospital should receive guideline-directed medical therapy and eventual referral to a cardiac rehabilitation program.[103]

Thrombolytics for treatment of STEMI

Prehospital thrombolytics can reduce time from vessel occlusion to coronary reperfusion in patients with STEMI. Percutaneous coronary intervention (PCI) is the preferred treatment of patients with STEMI. However, when transport times to a PCI center is prolonged, thrombolysis is a viable option.[113]

For STEMI patients without contraindications, the American Heart Association recommends initiation of prehospital thrombolytic therapy in patients with i.) ischemic symptoms for < 12 hours and ii) total time from STEMI identification to PCI is > 120 minutes.[114] Agencies require 7 key components to administer prehospital thrombolytics including, i.) ECG capability, ii.) ability to transmit prehospital ECG to a physician, iii.) reperfusion checklist, iv.) standard STEMI pharmacotherapy (e.g., antiplatelet agents, beta-blockers, nitroglycerin, heparin, etc.) v.) destination transport plan, vi.) quality assurance/improvement plan, vii.) stakeholder support and oversight up (e.g., receiving facilities, community partners, Medical Director, etc).

Studies investigating effectiveness of prehospital thrombolysis have demonstrated quicker reperfusion, resolution of infarction and mortality benefit in some settings.[115-118] However, the occurrence of STEMI amendable to prehospital thrombolysis is infrequent; estimates suggest ~ 5% of all STEMI cases. Thus, financial and logistical implications make therapy uncommon in the US.[119]

Prehospital chest pain data registries

Prehospital data registries are critical for monitoring STEMI care, identifying disparities in care, and ensuring appropriate quality improvement. There are currently 5 national STEMI data registries: Cardiac Arrest Registry to Enhance Survival (CARES), the National Cardiovascular Data Registry (NCDR), Society of Thoracic Surgery (STS), Intervention Outcomes Network (ACTION), and Get With the Guidelines, sponsored by the AHA. Across the United States, 12 states report participation in a national cardiac care registry.[35]

BOX 1
Prehospital Care of Sepsis and Cancer

EMS professionals are critical to the recognition and treatment of time-sensitive conditions such as Sepsis. Sepsis is a life-threatening emergency, caused by dysregulated immune response to infection.[a] Sepsis is a common complication of oncology patients due to the modulation of the immune system by cancer-directed treatment. Indeed, the incidence of sepsis in cancer patients is 4 times greater than patients who do not have cancer.[b] Sepsis is associated with 8.5% of all cancer deaths.[b]

Recognition of sepsis by EMS professionals in the prehospital setting has been associated with improved downstream care in the Emergency Department.[c] Development of sepsis alerts that notify receiving hospitals of an incoming septic patients have demonstrated quicker treatment initiation.[d] Thus, like STEMI and stroke alerts, some EMS protocols have adopted Sepsis alerts, prompting rapid triage and treatment upon Emergency Department arrival.

Once sepsis is recognized, prehospital treatment using IV fluids and broad spectrum anti-microbials is associated with improved outcomes. Data support prompt resuscitation of sepsis patients by EMS using IV fluids, particularly among patients with septic shock.[e] However, data on prehospital administration of prehospital antibiotics have been mixed.[f] Randomized studies across the globe are ongoing, but no standard protocol for prehospital antibiotics has been adopted.

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[b] Williams MD, et al. (2004). "Hospitalized cancer patients with severe sepsis: analysis of incidence, mortality and associated costs of care." Crit Care **8**(7): R291-298.

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IV. EMS data

The National EMS Information System (NEMSIS) is a national EMS database, collecting over 30 million records from EMS missions across 49 states.[120] NEMSIS was developed in 2002 with the goal of creating a framework for collecting, storing and sharing standardized EMS data to assess EMS performance, compare prehospital clinical interventions and facilitate cost effectiveness analyses.[121] NEMSIS is maintained by the National Highway Traffic Safety Administration in collaboration with the University of Utah, which maintains the Technical Assistance Center.

NEMSIS uses Extensible Markup Language (XML) for data interoperability. Most EMS agencies across the US use electronic patient care records (ePCR) that send and receive EMS data in the proper XML format to the National NEMSIS database. Local EMS agencies are then able to request data elements from the national NEMSIS dataset for research, training and quality improvement projects.

Though the development of NEMSIS has significantly enhanced prehospital data collection, there is no national standard for data interoperability between EMS ePCR and hospital electronic health records (EHRs). For example, upon arrival to the Emergency Department, most EMS professionals provide an oral debrief of prehospital interventions or a paper or electronic patient care report summarizing the mission. Further, EMS professionals cannot routinely access vital patient care information, such as past medical history, medications or allergy data from the EHR while on-scene.

Several key challenges have been cited limiting data interoperability between EMS and inpatient records. In addition to data challenges (i.e., data element harmonization, data type and data flow), accurate patient matching and privacy concerns are major hurdles. For example, in the prehospital setting, specific patient identifiers are often unknown. Though an EMS professional may use identifying documents such as driver's license, this information may not be enough to positively identify a patient when scanning a national EHR database. National Patient Identifiers have been proposed to resolve this issue, however, arguments linked to privacy concerns have stymied progress.[122] Next, legal and technical complexities have limited development of a network of bidirectional data flow. For example, though the Health Insurance Portability and Accountability Act (HIPAA) is designed to promote sharing of patient information for the purpose of medical care, EMS

agencies widely report that HIPAA concerns have severely limited data sharing between hospitals and EMS.[123] Finally, typical practices hospitals use to ensure privacy and security of EHR -- such a provider credentialing -- would be too unwieldy if EHR access was expanded to include prehospital professionals across several agencies.

Work at the state and national level is ongoing to expand data interoperability from prehospital to inpatient settings (**BOX** 2). Indeed, one of the pillars of the EMS Agenda 2050 is establishing integrated data systems to allow for seamless flow of critical health data that will ensure safer, more effective and more efficient patient care.[124]

BOX 2
SAFR Model of Data Interoperability

One model for health information exchange is the Search, Alert, File and Reconcile (SAFR) Model, developed by the California EMS system and in current use in a few states across the US.[a] The SAFR Model offers a common framework for bi-directional data exchange from a health information exchange (HIE) organization and an EMS clinician. SAFR uses the NEMSIS infrastructure, thus, any prehospital ePCR software can be used to access the SAFR system. In this model, EMS professionals can enter demographic information into SAFR and pull vital health record information. The EMS professional can then push ePCR data to the patient's EHR to create a longitudinal patient record. Despite this technology, over two-thirds of EMS agencies in the US report no health information exchange with hospitals.[b]

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[a] *The Office of the National Coordinator for Health Information Technology (2017). Emergency Medical Services (EMS) data integration to optimize patient care. US Department of Health and Human Services. Washington, DC.*

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V. Summary

Emergency Medical Services (EMS) serve as the point of entry for millions of Americans seeking medical care in the United States every year. EMS clinicians with different levels of training, certification and capabilities are often a patient's first medical contact. Quick recognition and prehospital initiation of

treatment, especially for patients with time-sensitive conditions like acute cardiovascular events and sepsis, impacts clinical outcomes.

Given the important role of EMS in the US health system, the prehospital interval represents a key opportunity to impact clinical care through research and innovation. Potential opportunities include the Public Safety Answering Point (PSAP), EMS clinician training and certification, optimization of telecommunications and data sharing, streamlined specialized downstream care, among others.

Born out of necessity in times of war, inspired by the professionals of Freedom House, the Emergency Medical Services System delivers advanced, innovative care at the forefront of medicine for millions of Americans.

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Appendix:

Supplemental Methods: Scoping Literature Review

Overview
The primary objective of this scoping review is to provide an overview of the existing literature describing EMS systems in the United States, how these systems vary across the country and how EMS systems may contribute to delays in the diagnosis of acute cardiovascular events, sepsis and cancer. The primary objective will be achieved through completion of three specific sub-objectives including, i.) conduct a systematic search of the published literature for papers describing Emergency Medical Services (EMS) in the United States, ii.) examine the published EMS literature to determine what is known about prehospital care of acute cardiovascular events, sepsis and cancer, and iii.) map out the characteristics and range of methodologies used in published primary research papers.

The findings of this scoping review will then be used to develop the primer outlined above that aims to,

1. Provide a basic definition of the EMS system and its components
2. Describe the role that EMS system can play in the care journey of patients potentially experiencing acute cardiovascular events, sepsis and cancer
3. Review the way the EMS is organized around the country including, (1) services provided; (2) types of personnel employed and their scopes of practice; (3) ownership and governance; and (4) financing
4. Provide a brief introduction to EMS as a topic of health services research including overviews of (1) available data sources; and (2) areas of research inquiry, important insights, and significant unanswered questions relevant to diagnostic delay

The methodology for this scoping review was based on framework outlined by Arksey and O'Malley[125] and included five key phases, i.) identifying the research question, ii.) identifying relevant studies, iii.) study selection, iv.) charting the data, and v.) collating and summarizing the results. A detailed review protocol is included here.

Research Question
This review will be guided by the questions, **'What are the infrastructures and characteristics of Emergency Medical Services in the United States?'** and **'How does prehospital care impact delays in the diagnosis of acute cardiovascular events, sepsis and cancer?'** For the purposes of this Primer, a scoping review is defined as a synthesis of research that aims to map the literature on a particular topic or research area and provide an opportunity to identify key concepts; gaps in the research; and types and sources of evidence to inform practice, policymaking and research.[126]

Data sources and search strategy
The initial search was implemented on April 1, 2022 in MEDLINE/PubMed (2010-present). English language studies with available full text describing adults were searched, The search query (Appendix 1) consisted of terms considered to describe and address the review objectives.

Eligibility criteria
Studies will be eligible for inclusion if they broadly describe EMS in the US or discuss the prehospital care of acute cardiovascular events, sepsis or cancer. For the first level of

screening, only the title and abstracts of citations will be reviewed. All citations deemed relevant will be procured for subsequent review of the full-text article. Only those full text articles available through institutional holdings will be collected.

Scoping review search strategy

Concept 1: Prehospital care

Keywords: “Emergency medical service*”[tw] OR “Emergency Service Medical”[tw] OR “Emergency Service*”[tw] OR “Prehospital emergency care”[tw] OR “Emergency Care, prehospital”[tw] OR “Emergency Health Service*”[tw]

MeSH: Ambulance [mesh] OR “Early diagnosis”[mesh] OR “Emergency medical services”[mesh] OR “Emergency medical technicians”[mesh] OR “Emergency Treatment”[mesh] OR “Point-of-care systems”[mesh] OR “Time factors”[mesh] OR “Time-to-treatment”[mesh] OR “transportation of patients”[mesh]

Search strategy: Ambulance [mesh] OR “Early diagnosis”[mesh] OR “Emergency medical services”[mesh] OR “Emergency medical technicians”[mesh] OR “Emergency Treatment”[mesh] OR “Point-of-care systems”[mesh] OR “Time factors”[mesh] OR “Time-to-treatment”[mesh] OR “transportation of patients”[mesh] OR “Emergency medical service*”[tw] OR “Emergency Service Medical”[tw] OR “Emergency Service*”[tw] OR “Prehospital emergency care”[tw] OR “Emergency Care, prehospital”[tw] OR “Emergency Health Service*”[tw]

Concept 2: Prehospital care of sepsis

Sepsis-specific Keywords: “Bloodstream infection*”[tw] OR “Infection, bloodstream”[tw] OR septicemia[tw] OR “poisoning, blood”[tw] OR “blood poisoning*”[tw] OR “Severe sepsis”[tw] OR “sepsis, severe”[tw] OR bacteremia[tw] OR endotoxemia[tw] OR fungemia[tw] OR “shock, septic”[tw]

Sepsis-specific MeSH: “Acute disease”[mesh] OR “Anti-infective agents”[mesh] OR “antibiotic prophylaxis”[mesh] OR “fluid therapy”[mesh] OR “lactic acid”[mesh] OR “multiple organ failure/epidemiology”[mesh] OR “sepsis”[mesh] OR “shock, septic”[mesh]

Search strategy: [Ambulance [mesh] OR “Early diagnosis”[mesh] OR “Emergency medical services”[mesh] OR “Emergency medical technicians”[mesh] OR “Emergency Treatment”[mesh] OR “Point-of-care systems”[mesh] OR “Time factors”[mesh] OR “Time-to-treatment”[mesh] OR “transportation of patients”[mesh] OR “Emergency medical service*”[tw] OR “Emergency Service Medical”[tw] OR “Emergency Service*”[tw] OR “Prehospital emergency care”[tw] OR “Emergency Care, prehospital”[tw] OR “Emergency Health Service*”[tw]] **AND**
“Acute disease”[mesh] OR “Anti-infective agents”[mesh] OR “antibiotic prophylaxis”[mesh] OR “fluid therapy”[mesh] OR “lactic acid”[mesh] OR “multiple organ failure/epidemiology”[mesh] OR “sepsis”[mesh] OR “shock, septic”[mesh] OR “Bloodstream infection*”[tw] OR “Infection, bloodstream”[tw] OR septicemia[tw] OR “poisoning, blood”[tw] OR “blood poisoning*”[tw] OR “Severe sepsis”[tw] OR “sepsis, severe”[tw] OR bacteremia[tw] OR endotoxemia[tw] OR fungemia[tw] OR “shock, septic”[tw]

Concept 3: Prehospital care of acute cardiovascular events

ACE-specific Keywords: “Cardiovascular Disease*”[tw] OR “heart disease*”[tw] OR “cardiac

arrhythmia*"[tw] OR "Cardiac conduction system disease" [tw] OR "Cardiac output"[tw] OR "cardiac tamponade" [tw] OR "cardiomyopathy*"[tw] OR "heart aneurysm" [tw] OR "heart arrest" [tw] OR "heart failure" [tw] OR "heart rupture" [tw] OR "myocardial ischemia" [tw] OR "post-cardiac arrest syndrome" [tw] OR "ventricular dysfunction"[tw] OR "vascular disease*"[tw] OR aneurysm*[tw] OR "aortic disease*"[tw] OR "cerebrovascular disorder*"[tw] OR "brain ischemia"[tw] OR "intracranial arterial disease*" OR "intracranial embolism and thromb*"[tw] OR "intracranial hemorrhage*"[tw] OR stroke[tw]

ACE-specific MeSH: "Acute disease" [mesh] OR "Acute disease"[mesh] OR angina[mesh] OR "arterial occlusive diseases" [mesh] OR "brain ischemia" [mesh] OR "cardiovascular diseases"[mesh] OR Electrocardiography[mesh] OR "fibrinolytic agents" [mesh] OR "heart arrest" [mesh] OR "ischemic stroke" [mesh] OR "myocardial infarction" [mesh] OR "Non-ST elevated myocardial infarction" [mesh] OR "out-of-hospital cardiac arrest" [mesh] OR "percutaneous coronary intervention" [mesh] OR "ST elevation myocardial infarction" [mesh] OR stroke[mesh] OR "thrombolytic therapy" [mesh] OR "troponin/blood" [mesh]

Search strategy: [Ambulance [mesh] OR "Early diagnosis"[mesh] OR "Emergency medical services"[mesh] OR "Emergency medical technicians"[mesh] OR "Emergency Treatment"[mesh] OR "Point-of-care systems"[mesh] OR "Time factors"[mesh] OR "Time-to-treatment"[mesh] OR "transportation of patients"[mesh] OR "Emergency medical service*"[tw] OR "Emergency Service Medical"[tw] OR "Emergency Service*"[tw] OR "Prehospital emergency care"[tw] OR "Emergency Care, prehospital"[tw] OR "Emergency Health Service*"[tw]] **AND** "Cardiovascular Disease*"[tw] OR "heart disease*"[tw] OR "cardiac arrhythmia*"[tw] OR "Cardiac conduction system disease" [tw] OR "Cardiac output"[tw] OR "cardiac tamponade" [tw] OR "cardiomyopathy*"[tw] OR "heart aneurysm" [tw] OR "heart arrest" [tw] OR "heart failure" [tw] OR "heart rupture" [tw] OR "myocardial ischemia" [tw] OR "post-cardiac arrest syndrome" [tw] OR "ventricular dysfunction"[tw] OR "vascular disease*"[tw] OR aneurysm*[tw] OR "aortic disease*"[tw] OR "cerebrovascular disorder*"[tw] OR "brain ischemia"[tw] OR "intracranial arterial disease*" OR "intracranial embolism and thromb*"[tw] OR "intracranial hemorrhage*"[tw] OR stroke[tw] OR "Acute disease" [mesh] OR "Acute disease"[mesh] OR angina[mesh] OR "arterial occlusive diseases" [mesh] OR "brain ischemia" [mesh] OR "cardiovascular diseases"[mesh] OR Electrocardiography[mesh] OR "fibrinolytic agents" [mesh] OR "heart arrest" [mesh] OR "ischemic stroke" [mesh] OR "myocardial infarction" [mesh] OR "Non-ST elevated myocardial infarction" [mesh] OR "out-of-hospital cardiac arrest" [mesh] OR "percutaneous coronary intervention" [mesh] OR "ST elevation myocardial infarction" [mesh] OR stroke[mesh] OR "thrombolytic therapy" [mesh] OR "troponin/blood" [mesh]

Concept 4: Prehospital care of cancer

Cancer-specific Keywords: "Neoplasm"[tw] OR "cancer"[tw] OR "malignant neoplasm"[tw] OR "malignancy"[tw] OR "neoplasm, malignant"[tw] OR "benign neoplasm"[tw]

Cancer-specific MeSH: "Cancer care facilities"[mesh] OR "early detection of cancer"[mesh] OR "neoplasm staging"[mesh] OR "neoplasms"[mesh]

Search strategy: “Cancer care facilities”[mesh] OR “early detection of cancer”[mesh] OR “neoplasm staging”[mesh] OR “neoplasms”[mesh] OR : “Neoplasm”[tw] OR “cancer”[tw] OR “malignant neoplasm”[tw] OR “malignancy”[tw] OR “neoplasm, malignant”[tw] OR “benign neoplasm”[tw] **AND**
Ambulance [mesh] OR “Early diagnosis”[mesh] OR “Emergency medical services”[mesh] OR “Emergency medical technicians”[mesh] OR “Emergency Treatment”[mesh] OR “Point-of-care systems”[mesh] OR “Time factors”[mesh] OR “Time-to-treatment”[mesh] OR “transportation of patients”[mesh] OR “Emergency medical service*”[tw] OR “Emergency Service Medical”[tw] OR “Emergency Service*”[tw] OR “Prehospital emergency care”[tw] OR “Emergency Care, prehospital”[tw] OR “Emergency Health Service*”[tw]