Building the next generation of emergency care systems

Ensuring health systems have the right building blocks to develop effective emergency care systems for the future

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Arthur D Little

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Executive summary

Delivering emergency care is an integral part of the health system, and the quality of emergency care has a key role in determining health outcomes for patients. Emergency care systems operate within the larger healthcare ecosystem and can only be as effective as the overall system. Across the world, emergency care systems increasingly use technology to increase their efficiency and provide faster access to care. However, while today's emergency and trauma care systems offer significantly more medical capability than was available in years past, they continue to suffer from severe fragmentation, an absence of systemwide coordination, and limited accountability.

This Report outlines the trends in emergency care and proposes key building blocks for developing a best-in-class and customized emergency care system to serve future needs.


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1. Emergency care systems – key trends

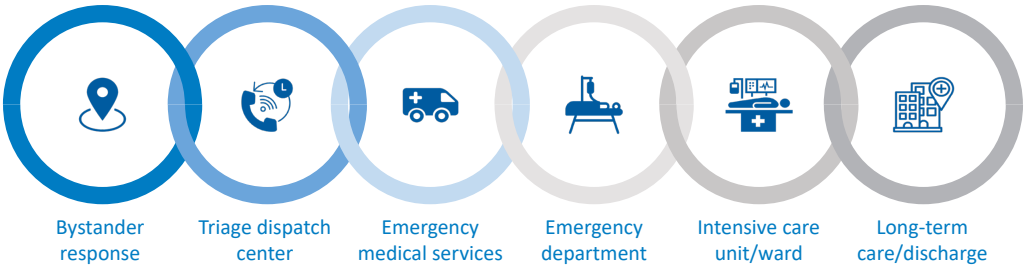
Emergency care includes all immediate and unscheduled care with varying degrees of acuity:

1. **Life-threatening emergencies**. Immediate medical assistance is required to protect the patient from a potentially fatal injury, disability, or death.
2. **Emergencies**. Medical assistance is required to protect the patient from further complications.
3. **Urgent care**. A delay in immediate intervention and patient conveyance does not impact the medical outcome.
4. **Crisis/disaster management**. The number, severity, and diversity of injuries overwhelm local medical resources and require a cooperative, multidisciplinary effort.

The scope for emergency care is best described using the "chain of survival" shown in Figure 1, which starts with bystander response and ends when the patient is finally discharged or transferred to acute/long-term care. The various components of this chain are response by bystanders, triaging of emergency calls, provision of emergency medical services, treatment in the emergency department, inpatient and intensive care treatment (if needed), and the discharge of patients or their transfer to long-term care. The chain is only as strong as its weakest link, so health systems should focus on all of the components.

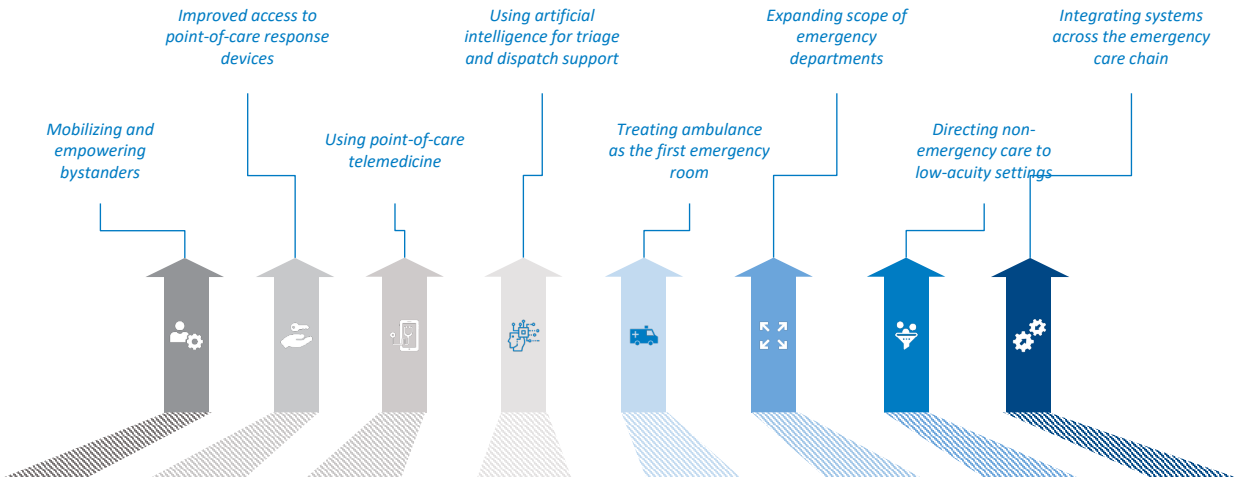
Based on the extensive research Arthur D. Little has conducted in collaboration with health authorities, providers, and industry experts, we have identified eight distinct emerging insights and innovations that are transforming the way health systems are reimagining the key building blocks of effective emergency care ecosystems (see Figure 2).

Figure 1: Chain of survival



Source: Arthur D. Little analysis

Figure 2: Global trends in emergency care



Source: Arthur D. Little analysis

1. Mobilizing and empowering bystanders

Countries across the globe are focusing on improving bystander response through methods of mobilization and empowerment, including:

- Awareness campaigns (e.g., the US "Stop the Bleed" campaign).
- Compulsory training (e.g., Denmark has implemented mandatory resuscitation training for elementary school students and residents applying for a driver's license).
- Bystander applications (e.g., Sweden launched the Heartrunner application to alert bystander volunteers of a nearby medical emergency).
- Supporting legal environment with bystander-focused laws and regulations (such as the Good Samaritan Law, a version of which is in place in several countries across the globe, encouraging volunteers to provide assistance by offering legal protection).

2. Improved access to point-of-care response devices

Apart from educating and encouraging bystanders, time to first response is being improved by increasing the accessibility of automated external defibrillators (AEDs) that are being placed near high-risk population areas where people are more susceptible to heart conditions. Further, AEDs are being made publicly available via initiating AED registries, enabling privately owned AEDs to be used by bystanders in cases of emergencies. Medical drones may also soon be used to deliver AEDs to bystanders at the site of incident.

3. Using point-of-care telemedicine

Trained bystander populations and faster response mechanisms are augmented with point-of-care telemedicine systems that empower and enable more advanced care on site. For example:

- Project ETHAN in Houston, Texas, gives fire and rescue responders a video link to emergency doctors, enabling doctors to direct patients to the right care and preventing unnecessary trips by ambulance.
- Medical drones are currently being tested in Sweden that will be equipped with audio and video support to enable bystanders to get in touch with emergency physicians for guidance and assistance.
- In Copenhagen, Denmark, doctors/nurses/paramedics answer emergency calls and provide guidance to bystanders handling emergencies until the ambulance arrives.

4. Using AI for better triage and dispatch support

Triage and dispatch centers increasingly use software to detect medical emergencies, optimize planning, and improve prioritization (see Figure 3).

Business intelligence software is being used to provide a real-time overview of resources at hand and to track accurate caller location. Triage centers in Copenhagen, as an example, are using Corti, artificial intelligence (AI) designed to detect cardiac arrests. Corti can help dispatchers reach 92% accuracy when detecting out-of-hospital cardiac arrests and can detect cardiac arrest an average of 30 seconds faster than human operators.

Figure 3: Uses of software and AI in triage and dispatch centers

Source: Arthur D. Little analysis

5. Treating the ambulance as the first emergency room

To reduce time to treatment, various countries equip ambulances with specialist nurses, systems to transfer pre-hospital data to hospitals' electronic records, miniature CT scanners, point-of-care blood test labs, as well as telemedicine that enables paramedics to address conditions such as arrhythmia, myocardial infarctions, and ischemic strokes.

6. Expanding scope of emergency departments

As emergency departments are expected to continue to be a key gateway into the overall health system in the future, they are expected to expand their scope to include observation units, intensive care units, telemedicine services, access centers, and home hospitals (see Figure 4). This will enable emergency departments to develop more patient care settings to better triage and treat emergency patients.

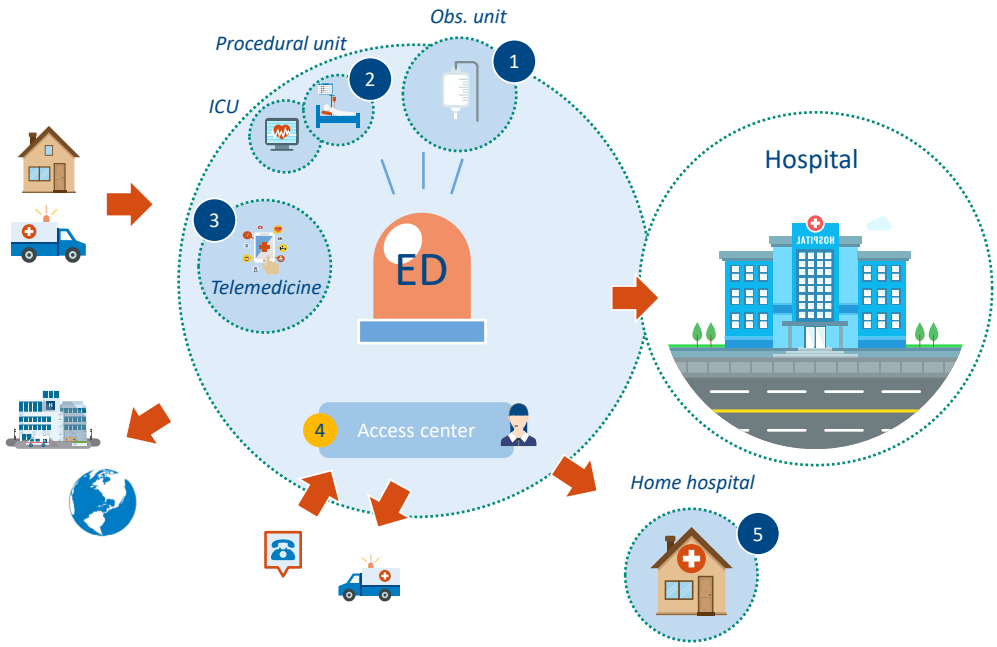
- AI is being used in emergency departments for predictive modeling, patient monitoring, and day-to-day running of emergency departments. The University of Virginia Medical Center uses AI for discrete event simulation and optimizes its emergency physician schedule to reduce waiting times in the emergency department. Such use of AI can assist emergency departments in improving care by decreasing errors and increasing efficiency.

7. Directing nonemergency care to low-acuity settings

Countries across the globe are implementing various initiatives to direct nonemergency patients to the right care, including:

- **Online primary clinics**. Mobile applications provide access to a general practitioner, 24/7. This reduces the number of nonemergency care patients who visit an emergency department due to the unavailability of a primary care physician.
- **Co-location of emergency departments and primary care clinics**. In the Netherlands, all emergency departments cooperate with primary care clinics, and around 30% of primary care clinics and emergency departments are integrated with a common triage process.
- **Flexible emergency lines**. While many countries have separate numbers for emergency and nonemergency requests, in Copenhagen, these numbers are different but their lines are integrated, thereby enabling dispatchers to swiftly adjust the level of help required at any given point in time.

Figure 4: Expanding scope of emergency departments



Source: Arthur D. Little analysis

8. Integrating systems across the emergency care chain

Patient data, reports, and health status are shared by pre-hospital settings (e.g., by ambulance) with emergency departments to enable the emergency department to be ready to receive patients and ensure optimal prioritization of the department's resources. For example, the Pulsara application in the US allows emergency medical technicians and paramedics in the ambulance to share all patient information and data with the emergency department. Along with the estimated time of arrival, paramedics are able to share other critical patient data with emergency departments prior to arrival, such as electrocardiogram results and reports of injuries. This enables the emergency departments to prepare and provide better and faster treatment to the patients when they arrive on site.

Similarly in Dubai, the Dubai Health Authority has launched an application for stroke and myocardial infarction diagnosis. The Join medical communication app provides faster communication between paramedics and hospitals, including sharing patients' condition, medical history, health card, and pictures/videos. This information enables hospitals to be better prepared to receive and treat patients when they arrive.

2. Emergency care systems and best practices

Arthur D. Little studied the emergency care systems of eight regions – Sweden, the Netherlands, Germany, the UK, Singapore, Denmark, Boston (US), and Seattle (US) – and identified their leading practices. We have highlighted the key learnings from four of those regions below.

The Netherlands

The Netherlands uses incident prediction software to estimate the number of emergency calls and to relocate emergency services based on the predicted demand. A distinguishing feature of the emergency care system is its strong emphasis on educational requirements for its medical staff and its focus on their continuous upskilling.

In the Netherlands, every ambulance is required to have a specialist nurse and a trained driver technician onboard who can assist the nurse. Specialist nurses are required to have a four-year nursing degree and one and a half years of emergency room nursing training. Additionally, to be eligible, nurses must have a year of experience in emergency department in addition to at least a year of nursing experience. The driver technician is required to have a diploma in first aid. Continuing education is provided at the national as well as the regional level to upskill the workforce regularly.

This combination of ambulance staff allows the emergency medical services of the Netherlands to effectively treat patients at the scene and during transportation, while also being cost-effective.

Denmark

Denmark has ensured a high level of integration across the chain of survival and delivers a swift and coordinated Emergency Medical Services (EMS) response.

The Denmark system has high adaption of technology, including telemedicine and AI. Denmark introduced various national-level initiatives to improve bystander response, such as requiring mandatory training for elementary school students and people who are getting a driver's license, distributing instructional kits, and offering tele-guidance to bystanders. As a result of these initiatives, Denmark has a strong bystander response, which is reflected in an increase in survival rates (increasing from 4% in 2001 to 12% in 2019, according to a study published in *The New England Journal of Medicine*).

Medical dispatchers in Copenhagen are supported by Corti AI, which not only has a high rate of accuracy for detecting out-of-hospital cardiac arrests, but also offers a pre-hospital record system developed by Amphi Systems. This record system automatically transfers pre-hospital data to the hospital's electronic records, enabling emergency departments to prepare for patients' treatment before they arrive at the hospital. The system also has access to the patient's medical history to enable optimal treatment on site.

England (UK)

NHS England's disaster management plan provides clear leadership pathways to effectively and efficiently manage crisis situations. England deploys the Hazardous Area Response Team (HART), comprising paramedics who work alongside police and fire rescue services to preserve life at the early stages of an incident (see Figure 5). HART uses the Major Incident Medical Management System (MIMMS) to strategically, tactically, and operationally manage mass casualty incidents.

Members of HART undergo continuous training and are based in every one of England's 11 NHS ambulance trusts (providing ambulance services in England and Wales) and are interoperable.

HART deployment ensures that patients are triaged, and casualties treated, at the earliest time possible – thereby resulting in lives saved that otherwise might have been lost.

Seattle (US)

Seattle has one of the highest out-of-hospital cardiac arrest (OHCA) survival rates in the world due to its outstanding bystander training. (80% of King County's population are trained in cardiopulmonary resuscitation [CPR] and are able to respond to OHCAs.)

Seattle launched the "Shockingly Simple: Restart a Heart" media campaign to increase the placement and registration of AEDs. Within the first month of the campaign's launch, 62 new AEDs were registered. The King County EMS division undertakes several CPR education initiatives:

- **Community-based hands-on CPR education**. Training is made available to groups such as seniors, people with limited English proficiency, other vulnerable populations, etc.
- **Student CPR program**. Provides training to around 11,000 students each year.
- **King County employee training**. Targets employees who work directly with the public.
- **City employee training**. Training to all employees who work directly with the public.

The above initiatives have resulted in 67% of all out-of-hospital cardiac arrests to be revived by bystander CPR in King County.

Figure 5: HART response capabilities and specialist training

Source: Arthur D. Little analysis
*IRU: Incident Response Unit; USAR: Urban Search and Rescue

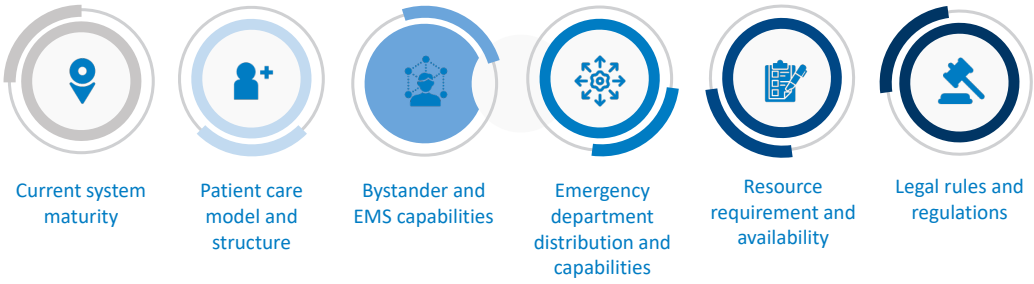
3. Building next-generation emergency care systems

Studying these emergency care systems has enabled Arthur D. Little to determine the best practices across the chain of survival as well as to identify the ecosystem's key enablers. Health systems can use such information to build a customized best-in-class emergency care system.

Emergency care systems should apply these insights in the context of the current system and specific needs of an area. There are a number of key building blocks and components that must be taken into consideration for building a customized best-in-class system (see Figure 6).

Further, departments must identify the structure of delivering emergency care (i.e., whether it is in close collaboration with the fire department and/or police department or as an independent medical unit), along with examining the pros and cons of such a model and structure. Health organizations should also consider the degree of involvement and readiness of the private sector to support the delivery of such services.

Figure 6: Considerations for building a customized best-in-class emergency system



Source: Arthur D. Little analysis

Current system maturity

Health organizations must study the maturity and fully understand the capabilities of the current system to transform a system to best-in-class. They must accurately capture key metrics such as the survival rates in different stages of the chain of care, time to triage, time to doctor, and so on, and benchmark these metrics against other mature systems to gain insight into priority areas for improvement.

Present care model and structure

There are two main types of emergency care models: Anglo-American and Franco-German. While in the Anglo-American model the patient is brought to the doctor in an emergency department, in the Franco-German model the doctor is usually brought to the patient, and patients are thereafter admitted directly into inpatient wards. Different regions usually adopt different care delivery models, and health organizations must study and recognize the implications of the adopted model.

Bystander and EMS capabilities

Emergency care systems should also consider the population's readiness in terms of awareness and training in first aid and overall culture to provide help. The challenges bystanders face (such as unavailability of AEDs, directions from call center paramedics, and so on) must be understood and identified. Additional considerations, such as an assessment of the current use of technology for the provisioning of emergency medical services, training of paramedics, policies and procedures followed, equipment used in ambulances, and so on, should be carried out and methods to increase accuracy and speed must be identified in line with international best practices.

Emergency department distribution and capabilities

It is imperative that health systems study the present geographical distribution and specialization, if any, of emergency departments to understand whether they under/overserve specific areas and conditions. Moreover, they must gather

insight into the current capabilities of emergency departments in terms of emergency department doctors, nurses, equipment, beds, time to triage, and so on.

Resource requirement and availability

Health organizations should identify resource requirements and availability for the system across three key dimensions: financial, human resources, and fixed assets. They should also keep in mind the constraints with respect to resources while laying the foundation for the vision of the best-in-class emergency care system. It is vital as well to determine methods to procure/ create the required funds or talent.

Legal rules and regulations

During system development, consideration must also be given to current legislation acts, policies, and procedures in place to guide the provisioning of emergency care services. The new system's vision should be in line with the existing legal scope of service of various players in the chain of survival.

4. Key enablers for the system

Developing a best-in-class system requires the support of a few key enablers that drive the system's implementation.

Governance and regulation

Integration of the health department(s) and EMS ensures the delivery of consistently high-quality services. To facilitate this integration, one central healthcare body at a regional level should govern the entire chain of survival. Moreover, developing and implementing a robust emergency care system requires a supportive regulatory framework with clear definitions and standards for emergency care, protection for bystanders (e.g., the Good Samaritan Law), and consistency in guidelines and regulations.

Supportive leadership

The presence of strong and supportive leadership at the regional level is a key factor for system development. Supportive leadership not only ensures the availability of the right type and amount of resources for the system but also effects a positive change in the culture and mindset across the general public with regards to bystander duties. Furthermore, the push for fair policies and standards supports employee motivation and retaining citizens' faith in the system.

Technology and infrastructure

Technology plays an important role in ensuring the timely delivery of services and improving efficiency across the chain of care. Similarly, the right infrastructure is necessary to provide pre-hospital and emergency department services. A best-in-class system is one that adopts emerging technology to optimize the system and ensures that ambulances and emergency departments are well-equipped and geographically well-distributed to efficiently provision emergency services.

Coordination and integration

In a typical continuum of care, emergency care starts with bystander response and ends when the patient is discharged from the hospital. Coordination among the various stakeholders involved in the delivery of care ensures high-quality care. Integrating IT systems across the chain of survival positively influences these coordination efforts.

Performance monitoring and continuous improvement

Key performance indicators must be set for quality as well as performance to ensure effective emergency care service delivery. To ensure there is no conflict of interest, the body that defines standards and audits and regulates performance should be different from the body that provides services. Continuous monitoring and performance management are necessary to ensure that the system is improved periodically and that a consistently high level of care is provided across the entire system.

Notes

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Building the next generation of emergency care systems

Ensuring health systems have the right building blocks to develop effective emergency care systems for the future

Arthur D. Little

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