EMS Subspecialty Certification

2.2.2 Design of System Components
2.4.4 System Status Management

2025

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Question 1

Which of the following statements is true with respect to documents that have significantly influenced EMS system design?

a. Accidental Death and Disability: The Neglected Disease of Modern Society (1966) emphasized the integration of EMS into the overall healthcare system.
b. The Emergency Medical Services System Act (1973) stressed system development but lacked funding to support EMS systems.
c. The EMS for the Future (1996) was the first document to emphasize clinical care and integration of EMS into the healthcare system.
d. EMS at the Crossroads from the Institute of Medicine (2003) identified the consequences of errors in the prehospital setting and the tens of thousands of patients harmed each year as a result of these errors.

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ADD identified inadequacies and EMS was just a means of transportation

Emergency Medical Services act provided $300 million No emphasis on patient

EMS for the future focused on integration and clinical care

Crossroads focused on lifesaving and gatekeeper functions

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Question 2

Which of the following is true for high performance systems?

a. High performance systems only respond to emergencies, leaving the non emergency calls for other EMS services
b. A diverse fleet of ambulances and other resources to assign to various BLS and ALS responses
c. A sole EMS provider for a community with accountable response times, sophisticated maximized billing practices and typically all ALS with flexible production model
d. Systems using System Status Management with a tiered response

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HP EMS systems
cover both non emergency and emergency
Have a flexible production strategy
single fleet of ALS

HP EMS is not specific to one system type

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Learning Objectives

Upon the completion of this program participants will be able to:

- Discuss the importance of knowing system design and the consequences of poor system design.
- Identify key components of an EMS system.
- Discuss historical documents that have influenced system design.
- Identify essential system measures.
- List key features of High Performance Systems
- List methods of system assessment

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Introduction

"If you know one EMS System, you know one EMS System"

- Diverse groups of professionals providing care in every imaginable circumstance
- Knowing your system is key to success
  - Who is providing care?
  - Where are they delivering care?
  - How does EMS fit in the "Big Picture?"

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Ambulance Standards

- Type I, II and III
- National standards for ambulance design
  - Federal Specification for the Star-of Life Ambulance (KKK-A-1822)
  - NFPA 1917 Standard for Automotive Ambulances

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Ambulance Types

kindpng.com

Type 1: Truck chassis w box
Can re-chassis: long life
Heavier, wider, thirsty

Type II: reconfigured van
Smaller, lighter, shorter life

Type III: van chassis w box
Similar to Type I but w
Van chassis

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Single vs Multiple Ambulance Service Provider in a Community

- Monopoly of a single providing has efficiencies that are lost w having multiple agencies (duplication)
- Multiple providers: economic competition
- Multiple providers: not enough to go around: everyone loses?
- A community can both limit the number of providers AND provide healthy competitive dynamics…HOW?

Allow competition *for* the market
rather than *within* the market

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Term: Allocation of Ambulance Service Market Rights

- Community attaches a wide range of requirements and performance standards that must be met to retain contract
- Competitive
  - May allow bids by both governmental and private
- Winner must provide value proposition that benefits the community
- Escalating consequences for non-performance
- Periodically can be re-bid

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ALS or ALS/BLS

- Pro ALS
  - All response types are covered
  - Response time performance may improve (clock time for getting the right unit assigned is always covered)
  - Incremental cost for established ALS agency is minimal
- Pro BLS w some ALS
  - Concentrates procedures for ALS (< dilution)
  - Does ALS have a benefit over BLS (SOP has increased for non paramedic)

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Fire Based EMS

- Pro
  - Infrastructure and staffing in place for rapid response
    - Can be very cost effective
  - Rescue/ICS familiarity
- Con
  - Salaries typically higher than privates
  - Usually fixed base response and less peak time staffing flexibility
  - Potential cultural EMS "demotion": suppression is king

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Municipal EMS (Third Service)

- Pro
  - Complete focus on EMS
  - Managers are devoted to a single service line
  - Manager selected on ability to manage EMS
  - Single role EMS clinician: sole EMS focus
- Con
  - At greater risk for budget cuts than fire (EMS not an essential service)
  - Competing with other government agencies for $
  - Busier than Fire but may be paid less

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Private EMS

- Pro
  - Can be self-sustaining or minimal subsidy
  - Offloads EMS from municipal government

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Public Utility Model

- Designates a single ambulance service for emergency and non-emergency response
- Government unit does the billing
- The Government unit owns the capital equipment: if contractor is fired, capital equipment is there and ready for next contractor
- Medical Director: preferable to be appointed by third party (not beholden to contractor)

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Hospital-based EMS

- Pro
  - Part of healthcare organization
    - Leverage clinical and cultural assets of the hospital system
    - Career ladder vs e.g. fire-based or private
- Con
  - Additional legal issues re billing and patient destinations
  - May have limited administrative competencies for EMS management (EMS treated as another department in the hospital)

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Deployment Planning

- Static
- Dynamic
  - Location of units based upon "geotemporal" trends
- Real time
- Hybrid

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Dynamic Deployment

- Geographic analysis: where calls occur
- Temporal analysis: when calls occur
- Geo+temporal: each hour of a week analyzed for how many calls are in progress during that hour
- "Queuing Analysis": how many units are required for that hour
  - If, at a given hour, a total of 17 ambulances are needed and 9 are anticipated to be in use, then where should the available be optimally stationed given geotemporal info?
  - May build for different months of the year, anticipated special events

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Dynamic Deployment

- Pro
  - Fewer hours of service response from response units (unit hours) needed to provide the same level of response interval performance compared to static
  - $$ saving
- Con
  - Busier crews: burnout, fatigue, poor work environment
  - GIGO

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Real Time Deployment

- Leverages current and evolving GPS technologies
- Combines historic/dynamic plan with real time traffic data
- Allows accurate prediction of the actual time-distance availability of a unit to meet response requirements (based up road and traffic conditions)
- Dispatch can then make "on the fly" changes in dynamic plan

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Hybrid

- Combination of some fixed, some dynamic
- Rotate dynamic crews to fixed locations for break time

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Performance Standards

- "A community can have whatever level of performance it is willing to pay for"
- Medical Director: voice of the likely effect of response interval performance, medical equipment, certification levels on clinical outcomes
- Time response to cardiac arrest was the basic response standard historically used
- Evolving evidence shows that response time not as critical for majority of calls
- Evidence-based performance standards can improve unit availability without affecting outcomes

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First Hour Quintet

- Diseases where EMS "makes a difference"
  - —Out-of-Hospital Cardiac arrest*
  - —Severe respiratory difficulty*
  - —Severe trauma*
  - —Chest pain including ACS
  - —Stroke*

*leading causes of death in US

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Influences on EMS System Design

1966 1973 1996 2006

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Definition

- *An EMS system is defined as consisting of those organizations, individuals, facilities, and equipment whose participation is required to ensure timely and medically appropriate responses to each request for prehospital care and medical transportation.*

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Delivery Models

- Fire Based
- Hospital Based
- Private service
- Third service
- Public Utility model
- Franchise model

- Paid
- Volunteer
- Unionized
- QRS
- Wilderness
- Disaster Response
- Many more….

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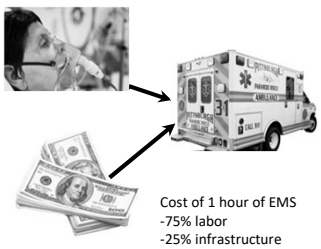
Input

Output



Assessment
Treatment
Transport

Patient
Outcome

Cost of 1 hour of EMS
-75% labor
-25% infrastructure

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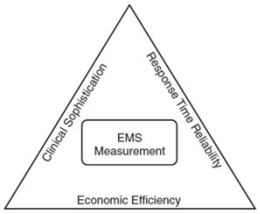
Essential System Measures



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2.4.4.1 Response Times

- The time it takes for an EMS unit to arrive at a call for service
  - No consistency nationally when clock starts and stops
  - Can start when call received or when unit is dispatched
  - Can stop upon arrival at call address or at patient side
- Response times are one of the three essential measures of an EMS system

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2.4.4.1 Response Times

- Many systems today use an 8 minute standard
- Based upon survival from v-fib arrest
  - 4 minutes for first responders with BLS and defibrillation
    - 3rd link in chain of survival
  - 8 minutes for ALS
    - 4th link in chain of survival

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2.4.4.1 Response Times

- This 8 minute standard has never been clearly defined
- Huge variations between start and stop of clock
- Recent studies indicate quicker responses improve outcomes
- Response time standards contribute to significant system costs for deployment

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2.4.4.1 Response Times

- Measurement of times
  - —Average time delivers poorer service
  - —Fractile times better meets patient needs
- Penalties often tied to poor response time reliability
- Better to measure response time intervals
  - —Call received until dispatch
  - —Dispatch to en route

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TABLE 11.2

Fractile Response Time Distribution

Response Time (min)	Runs (#)	Total (%)	Cumulative (%)
0:00 – 0:59	31	1.55	1.55
1:00 – 1:59	57	2.85	4.40
2:00 – 2:59	140	7.01	11.41
3:00 – 3:59	221	11.06	22.47
4:00 – 4:59	301	15.07	37.54
5:00 – 5:59	339	16.97	54.50
6:00 – 6:59	299	14.96	69.47
7:00 – 7:59	253	12.66	82.13
8:00 – 8:59	172	8.61	90.74
9:00 – 9:59	58	2.90	93.64
10:00 – 10:59	41	2.05	95.70
11:00 – 11:59	28	1.40	97.10
12:00 – 12:59	13	0.65	97.75
13:00 – 13:59	14	0.70	98.45
14:00 – 14:59	8	0.40	98.85
15:00 +	3	1.15	100.00

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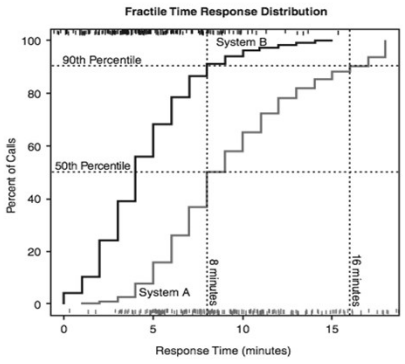

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Unit Hour Utilization

Number of transports

Total Hours Unit is staffed

$$\frac{\text{U (Utilization)}}{\text{UH (Unit Hours)}} = \text{Unit Hour Utilization}$$

- Basic measure of efficiency
  - –Optimal .55-.45*
  - –Average .35-.25
  - *varies urban vs. rural, geography, administrative policies, etc.
- Poor predictor of quality and cost/transport

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System Design Factors

- Service Area Definition
  - –Population, Geography, Politics
- First Response
  - –Value -> Delivered by existing Fire/Police
- Ambulance Service
  - –Diverse range of delivery models
  - –Set priorities and know expectations
- Medical Oversight

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Service Area Definition
- Population, Geography, Politics
- Ideal = ~200,000 population served by 1 provider
- Economy of scale
- Rivers, bridges mountains can influence unit placement
- Politics-

First Response
- Value -> Delivered by existing Fire/Police
- Low marginal cost at adding an AED, training and fuel costs

Ambulance Service
- Diverse range of delivery models
  - Priorities must be established
    - Clinical sophistication
    - Response time reliability
    - Performance accountability
  - Economic efficiency
- Patient and public expectations
  - Positive outcome
    - Excellent response time at a reasonable cost
    - Credibility

Medical Oversight (next Slide)
The minimum requirement
for a high-performance operation is a service
area population of approximately 200,000 people
exclusively served (emergency and nonemergency)
by a single ambulance service provider.32,33

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Effective Medical Oversight

- Medical oversight
  - Internal vs. External
  - Advisory or Authoritative
  - Scope of authority (Narrow vs. Broad)
  - Funding (Volunteer vs. Funded)

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The book would suggest that effective medical oversight is best obtained by a funded, external, authoritative medical director with a broad scope of authority.

Medical oversight
- Internal vs. External – the medical director is neither hired nor compensated by any organization whose work is the subject of medical oversight.
- Advisory or Authoritative – the medical director directs; he or she does not advise.
- Scope of authority – a single medical director oversees all organizations and individuals participating in the EMS system i.e., First responders, rescue, tactical medics..
- Funding – effective medical oversight requires commitment and continuing level of funding.

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Impacts of Inferior Design

- A poorly designed system working at maximum performance may not meet goals
  - Unequal socioeconomic services
  - Unequal response times
  - No incentive for growth
  - Failure to match right patient with right resources

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High Performance System

- Sole provider
- Control center operations
- Accountability
- Revenue maximization
- Flexible production strategy
- System Status Management

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Though the Institute of Medicine found no single type superior the following characteristics are found in High Performance Systems

Sole provider
Exclusive market rights to furnish emergency and nonemergency ambulance Service often competitively selected provider.
Local ordinance or state law bans "cream skimming" or "cherry picking" of nonemergency patients or facilities with contracts that have guaranteed payment mechanisms.

Control center operations
The ambulance provider has control of the dispatch center allowing the deployment and redeployment of resources based on soundly developed algorithms.
The dispatchers are Emergency Medical Dispatch-certified, perform priority dispatch interrogation, deliver dispatch life support using prearrival instructions

Accountability
Performance requirements as part of ordnances or contracts with penalties.

Revenue maximization
HPEMS systems incorporate a business function into their operations. Understanding fee-for-service billings and maximizing revenues from Medicare,

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Flexible production strategy
Rather than operating specialized ambulance fleets, HPEMS systems employ a single fleet of ALS unitscapable of handling any type of service request.
system guarantees that every patient, regardless of the presumptively coded dispatch, will receive the highest level of care, and the system will beneft from
productivity levels significantly higher than those relying on the specialized (two-tier)production strategy.

System Status Management
fixed-post locations make sense when deploying fire suppression. In contrast, temporal and geographic patterns of demand for EMS vary widely, based on the movements
of people and their changing patterns of activity. To meet that demand, high-performance systems have developed a flexible deployment technique that allows for the movement of ambulances in anticipation of where each ambulance will be needed next.

HPEMS is not specific to any one type of EMS system. It could be fire-based, third service, hospital based, or private. However, because one of the essential
key features, which were also emphasized by the IOM, is accountability, it is rare that an HPEMS system would be implemented without an oversight body or function continually monitoring its performance indicators. For that reason, most of the HPEMS operate under a contractor regulatory language that includes penalties for poor performance.

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2.4.4 System Status Management

- An ambulance deployment model based on anticipation of need
  - No fixed base stations
  - Posting locations based on temporal and geographical patterns of demand
- Rational for SSM
  - Timely transport of emergency and non-emergency patients
  - Manage deployment of resources to meet response time requirements

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2.4.4 System Status Management

- System Status Plan
  - Protocol for deployment of system unit hours
    - Continuous deployment of units throughout the day
    - Peak load staffing
  - Statistical basis for protocol utilizing historical call volume for each hour of each day of the week
  - Considers geographical barriers
    - Rivers, traffic congested areas, time of day

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2.4.4 System Status Management

- Success of SSM is a balance of
  - Adequate coverage of high-volume areas and peak-load periods
  - Adequate coverage of low-volume areas and off-peak periods
  - Concern for employee health, safety, skill, and job satisfaction
  - Concern for economic efficiency and financial stability

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System Assessment

- Accreditation
  - Commission on Accreditation of Ambulance Services (CAAS)
  - Commission on Accreditation of Medical Transportation Systems (CAMTS)
  - Joint Commission International (JCI)
- Forward thinking documents
  - National EMS Education and Research Agendas
  - EMS Agenda for the future
- Assessment systems
  - i.e., Baldridge Healthcare Criteria for Performance Excellence

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Take-Home Points

- System Status Management is a dynamic deployment model of EMS based upon needs.
- Response times are a measure of which EMS success is based with little consistency or science to justify their importance.

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Take Home Points

- **System Design** is part of the EMS core content
  - Medical Oversight of EMS - 30% Test questions
- **Key points**
  - EMS System: Infrastructure + Ambulances + Personnel
  - EMS Measures: Sophistication Reliability Efficiency
  - Effective Medical Oversight
  - High Performance Systems

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