# EMC 445 EMS SYSTEMS MANAGEMENT

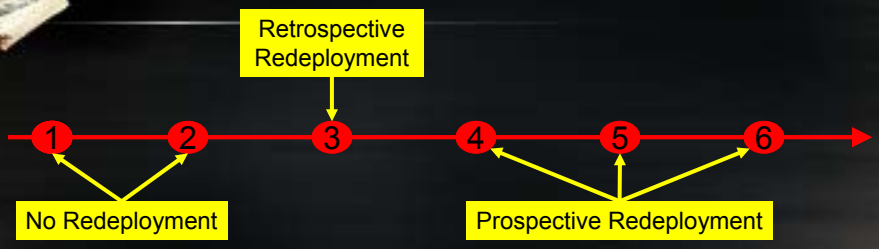
## Facility Location



## Unit Objectives

- Upon completion of this unit, you should be able to do the following:
  - Describe the 6 main ambulance deployment strategies.
  - Distinguish between retrospective and prospective deployment strategies and describe the advantages and disadvantages of each.
  - Describe the use of a non-transporting “Medic” unit in EMS system design.
  - Compare and contrast “descriptive” and “prescriptive” computer models for EMS deployment, and provide examples of each.
  - Discuss how computer models are used in EMS system design and ambulance deployment and staffing.

# Deployment Strategies




1. Single base houses all ambulances
2. Multiple bases, no redeployment
3. Multiple bases, redeployment ex post facto (retrospective)
4. Multiple bases, redeployment ex ante facto (prospective)
5. No bases, System Status Management
6. No bases, Dynamic Redeployment



# Deployment Strategies continued

- Single base houses all ambulances
  - Only appropriate when the base is located in a relatively small city with a concentrated, non-migratory population, and adequate response times to all areas of the city.
  - Very efficient to house all staff and vehicles in single building.
  - Natural disaster could destroy your entire fleet, equipment, and supply cache.
  - Unlikely to produce good response times system-wide.

# Deployment Strategies continued

- Multiple bases, no redeployment
  - Better than single base, but still an antiquated system.
  - Each district is considered an island, separate and apart from the system as a whole.
  - If all the ambulances within a district become busy, there is no redeployment of ambulances from other districts for coverage.
  - Because all secondary responses are out-of-district, leads to prolonged response times for secondary responses.
  - Eliminates crew fatigue from redeployment.
  - Reduces wear on vehicles from redeployment, but this may be offset by emergency responses out-of-district.
  - Geographically dispersed ambulances reduces response times to primary calls.



# Deployment Strategies continued

- Multiple bases, redeployment ex post facto (retrospective)
  - Benefits from geographically dispersed ambulances
  - Redeploys ambulances **AFTER** a call is received.
  - Better than no redeployment strategy.
  - Some improvement in response times to secondary calls.
  - May or may not redeploy ambulance into district. May move to an intermediate point.
  - Typically, redeployment plans are activated as soon as one district becomes uncovered.
  - Additional plans provide for system-wide coverage for successively fewer ambulances are available, until there are no ambulances available.
  - Underlying strategy is to reduce **SYSTEM-WIDE** response time, even if it requires sacrificing response times at a district level.

# Deployment Strategies continued

- Multiple bases, redeployment ex ante facto (prospective)
  - Based on historical data, redeploys ambulance from one district to another, **BEFORE** the next call in that district is received.
  - Typically, ambulances are redeployed for a large block of time.
  - May be used when a base is located in a residential suburb of a large city. During daytime hours of the workweek, much of the population shifts into the city with very few calls received in the suburbs. Instead, the calls increase within the city where the population is located. This strategy has the ambulance following the natural migration of the population.
  - Has all the benefits of retrospective redeployment strategy.
  - This strategy is a precursor to SSM.
  - Must be careful not to use this strategy to compensate for poor initial staffing.
  - Crews sometime feel "homeless" during redeployment.



# Deployment Strategies continued

- No bases, System Status Management
  - Most sophisticated, prospective system to date.
  - Based upon historical call data, ambulances are repositioned on an hourly basis.
  - Strategy assumes that call volume and call location follows a pattern that is repeatable, and predictable.
  - Redeployment or "Posting" plans are developed manually and then incorporated into CAD system.
  - Posting plans also include plans for number of available ambulances, as well as hourly and daily fluctuations in call volume and call location.
  - Employees report to work at a central base, pick up their ambulances, and move to their first posting location.
  - Best to stagger shift starting times.
  - Reduces response times.
  - Excessive redeployments make for unhappy crews.
  - Wear on vehicles by redeployments may be offset by repositioning ambulances closer to calls and thereby minimizing emergency response distance.

# Deployment Strategies continued

- No bases, Dynamic Redeployment
  - Does not currently exist.
  - Similar to SSM, but redeployment plans are not developed manually, but rather by computer “on the fly.”
  - Will likely involve neural network technology operating within CAD system.
  - Predicts where calls are most likely to be during the next hour and redeploys available ambulances to those areas.
  - Redeployment is **PROSPECTIVE**.
  - Sends an ambulance to where the NEXT call is likely to be, not where the last call was.



# Deployment Strategies continued

- Non-transport (Medic) units
  - Cost-effective mechanism for reducing response times to low call volume areas.
  - May use suburban-type vehicles that are cheaper to operate.
  - May use standard ambulances which allows for transport using first responders as drivers.
  - Using standard ambulances also reduces “specialization” of fleet, reduces maintenance cost, and provides improved operations efficiency.
  - May use a hybrid vehicle that is smaller and more economical to operate than traditional ambulances, but can also transport.
  - Must not be used to compensate for poorly located ambulance bases and/or poor staffing plans.
  - Some contracts do not permit medic units to “stop the paramedic clock.”
  - Limited utility now that more and more calls are now considered response-time sensitive (MI, CVA, trauma).

# Deployment Strategies continued

- Which Strategy is Best?
  - Depends on the situation.
  - Some are clearly antiquated.
  - Others are not feasible.
  - Must consider the will of the employees.



# Computer Models for Deployment

- Descriptive

  "Describes" how your system can be expected to perform based upon the design you have chosen.
- Prescriptive

  "Prescribes" how you should design your system, given your response time goals, historical call data, and other constraints you provide.

# Computer Models for Deployment continued

- Descriptive
  - Queuing
  - Hypercube Queuing Model
    - Based on equations
    - Doesn't require extensive data sets and programming time as does simulation.
    - Calculates a variety of statistics.
    - Doesn't allow for call prioritization
    - Doesn't permit dispatching of multiple units to the same call
    - All units assumed to have identical service times
    - Doesn't permit prime-time units

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| County-wide Statistics |
| Mean response time |
| Workload imbalances |
| Percent interdistrict responses |
| Response District Statistics |
| Mean response time |
| Percent interdistrict response |
| Emergency Vehicle Statistics |
| Mean response time |
| Workload imbalance |
| Percent interdistrict response |



# Computer Models for Deployment continued

- Descriptive models continued
  - Simulation
    - Much more sophisticated than mathematical models.
    - Able to capture the dynamic operations of an EMS system.
    - Can calculate many parameters of a functioning EMS system.
    - May be possible to incorporate redeployment plans into simulation.
    - Very sophisticated modeling technique that can provide very detailed information.
    - Requires substantial data.
    - Requires extensive programming.
    - Very detailed and accurate, but also very expensive.
    - Best technique for evaluating system design changes **BEFORE** implementing those changes.

# Computer Models for Deployment continued

- Prescriptive
  - Queuing
  - P-median
    - Seeks to minimize average, system-wide response time, given a pre-specified number of bases.
    - Location of bases are “weighted” by demand at each node (“protecting people”).
    - Low demand areas may be under-served in order to reduce system-wide response time average.
    - Assumes staffing levels are sufficient such that no calls will enter a queue.
  - Location Set Covering
    - Determines the minimum number of facilities and their locations such that each demand node has at least one facility within a pre-specified response time.
    - Ignores variation in demand (“protecting places”).



# Computer Models for Deployment continued

- Prescriptive Models continued
  - Maximal Covering Location
    - Determines the location of bases such that the maximum number of calls will be within a pre-specified response time limit.
    - Must pre-specify the number of bases and the response time limit.
    - Constrains number of facilities and incorporates variation in call demand as in p-median model, and retains response-time limit of location set covering model.
  - Additional Coverage and Backup
    - Similar to maximal covering location model.
    - Also maximizes the number of demand nodes that are covered by more than one base location within the response time limit.
    - Addresses issue of availability.

# Using Computer Models for Deployment

- Define base locations using a prescriptive model.
- Redraw response districts.
- Develop staffing plans using queuing theory.
- Develop redeployment plans.
- Evaluate decisions using a descriptive model.



# Presenting Results

- Reduction in average emergency response time is not an intuitive selling point
- Better to use “lives saved”
- Larsen, et al found that survival from cardiac arrest (with VF as presenting rhythm) increased 2.1% for every one minute reduction in response time to ALS (assumed Fired Dept. first responders are AED equipped and CPR trained)
- Cardiac arrests are estimated to account for 4% of total call volume
- It is estimated that VF is the presenting rhythm in 43% of all cardiac arrests.
- Using this information, it is possible to calculate the additional lives saved from improvements in the EMS system. This makes a much more powerful point when presenting to county commissioners.

# Presenting Results continued

- Example
  - 1.5 minute reduction in average emergency response time due to improvements in system design
  - Annual EMS Call Volume = 100,000
  - Annual cardiac arrests = (100,000*.04) = 4000
  - Percentage of cardiac arrests presenting in VF = 4000 * 0.43 = 1720
  - Additional lives saved = 1720 * (0.021*1.5)= 54