Lean and Stochastic Modeling – Two Approaches to Improving Operations in Emergency Departments

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Lean Approach

- The approach similar to that of developing Lean Enablers for SE (Oppenheim, 2011), and Lean Enablers for Managing Engineering Programs (Oehmen, Oppenheim et al, PMI-INCOSE-MIT, 2012)
- Steps:
  1. Formulate the Challenges to Lean operations
  2. Study the wastes and develop Lean Enablers to overcome/mitigate the Challenges and eliminate wastes

Lean Approach- The Challenges in ED

- Highly regulated environment
- Every ED patient must be seen by an MD
- Near-random patient volume cannot be controlled
- Patient flow dependent on other (some inefficient) departments (radiology, lab, hospital pharmacy)
- Union agreement regarding staffing ratios (x RNs per 10 patients)
- Frequent shortage of hospital beds to move critically ill patients to
- Boarders (staying in ED for long time because no hospital beds are available)
- Multiple hand-offs create potential for errors and inefficiencies
- Inconsistent communication and training of staff
- Dynamically competing demands and resources. When the ED is near capacity, staff pulled from non-critical areas creating bottlenecks
- Staff and provider burn-out due to increased volume as a result of the ACA
- ED cost/patient/hour much more expensive than hospital or Urgent Care clinic (because of higher density of equipment and MD/RN resources)

Lean Approach: Wastes in ED

1. **Waiting**
   - Patients wait for triage, for MD disposition, for transportation to/from other departments, for labs and radiology, for MD/RN, for ED bed, for hospital bed, for pharmacy…
   - MD/RN wait for each other
2. **Over-processing** (trivial medical services performed by expensive professionals)
3. **Over-production** (MDs and RNs spending time on computers)
4. **Inventory** (e.g. medical supplies that become obsolete)
5. **Transportation** of patients over long distances
6. **Walking** of staff over long distances
7. **Defects/rework** (repeated tests, paperwork, treatment of ED infections)
8. **Waste of human potential**: burnout of ED staff

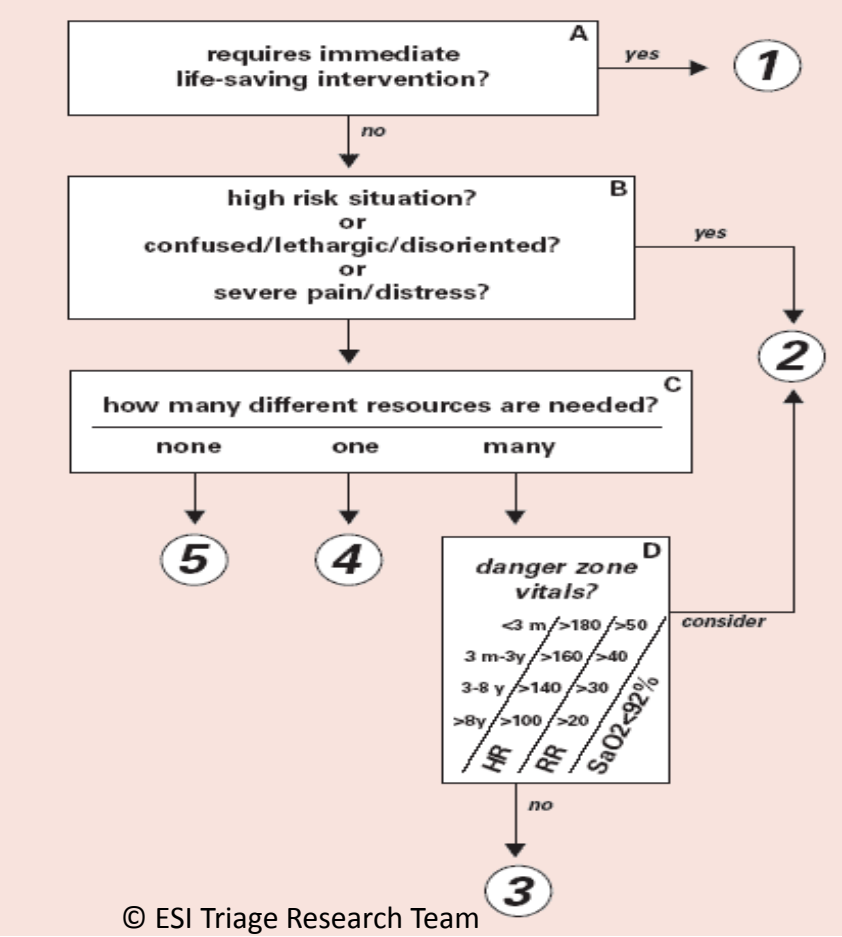
Lean Enablers for ED

1. **Minimize the patient's time in ED**
   - Since the cost/patient/hour is higher in the ED than anywhere else in the system, make every effort to minimize the patient's time in ED without compromising the quality of medical care.
   - As we minimize the time, we effectively increase capacity and revenue.

Lean: Triage by Emergency Severity Index

2. Open the ED capacity

- Improve the patients' flows using Emergency Severity Index (ESI)
- Open Urgent Care 24/7 (dynamic staffing, if needed)



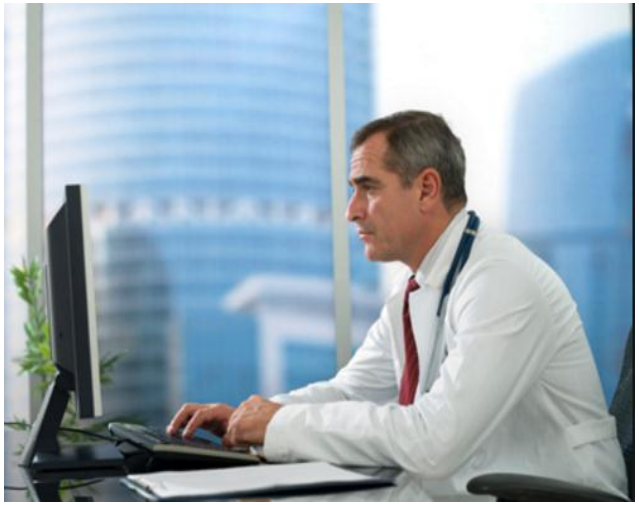
3. ASAP Perform triage by RN+ MD (required by EMTALA law) + admission clerk to separate patients into different flows:

1	- Eliminate hospitalist evaluation and have ED physician make the decision to send the patient to hospital. - If a bed is available in the hospital and the patient is sufficiently stable to move, proceed to do so without delay. - Otherwise, stabilize the patient in ED and then move to hospital as soon as a bed is available
2, 3	Treat in ED, possibly follow up in hospital
4	Move to Urgent Care, if available
5	Give “aspirin” and discharge, or move to Urgent Care

Lean Enablers for ED

4. Hospitalists to review and process admissions remotely

- Eliminate waiting for hours for hospitalists to come to ED
- Hospitalists to review electronic records entered by ED physician from hospital location, except in unclear cases.
- The hospitalists should not batch patient evaluations.
- A hospitalist should initiate the evaluation within, say, 15 min from request.
- The requests should appear on a large visual control board in hospital.



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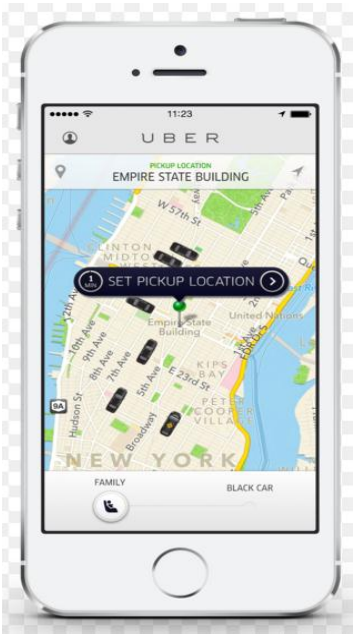
Lean Enablers for ED

5. **Avoid batching of patients in any manner**
6. **Minimize the time of patient waiting for transport**
   - The transport by wheelchair/bed to radiology, discharge, and the hospital should be JIT
   - Make enough transporters available to eliminate waiting
   - Implement an efficient Uber-like electronic system of calling a transporter in real time when needed.



Lean Enablers for ED

7. **Hospital to notify the ED electronically that a room will be available in the next, say, 15 minutes.**

Lean Enablers for ED

8. Streamline discharge process

- Implement early and proactive communication with family to ensure efficient discharge process without waiting
- As soon as medical treatment ends, move the patient to a dedicated discharge lounge or waiting room. Streamline the discharge process.

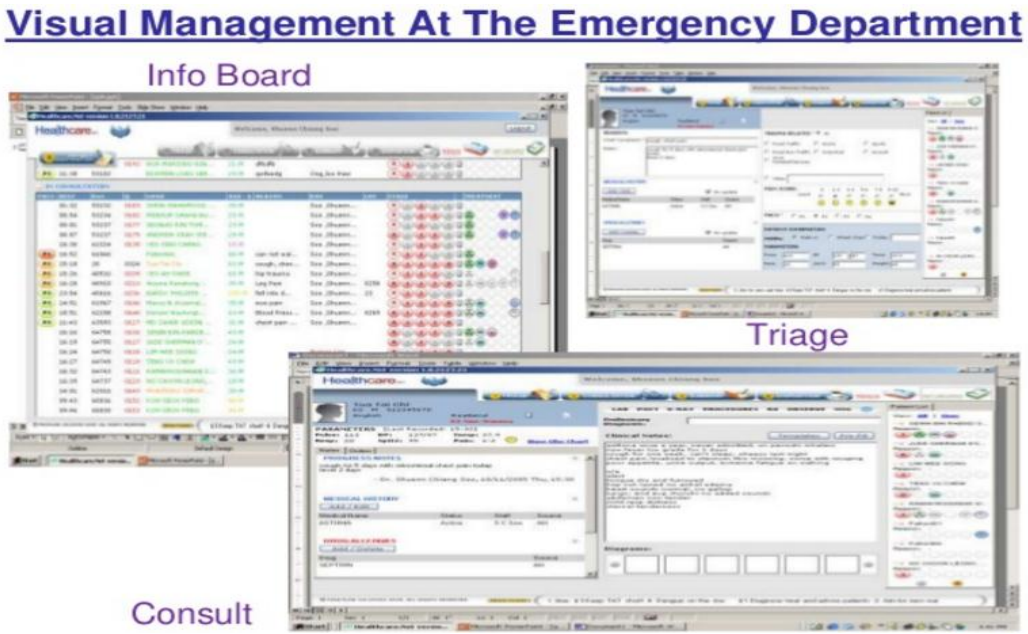
Lean Enablers for ED

9. Prepare contingency plans

Prepare plans for unusual number of patients in the ED, (e.g., reacting to a mass shooting, epidemic, earthquake, etc.)

10. Implement Visual Controls

- Show patient status (arrived, triaged, roomed, diagnosed, waiting for transport, in testing, admitted, waiting for discharge, hospital room ready, etc.)



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Lean Enablers for ED

11. **Perform efficient changeover of ED beds/rooms between patients**
    - Electronic cues for the Environmental Services (EVS) staff to clean the room
    - Start cleaning, say, 5 min after patient leaving
12. **Improve coordination between medical staff**
    - Ideally, the MD, RN and scribe to see the patient at the same time
    - Promote teamwork and information sharing
13. **Minimize unnecessary walking by staff**
    - Architect ED spaces to minimize distances and walking
    - Place supplies nearby
    - Apply 5S
    - Locate ancillary departments (radiology, laboratory, pharmacy) near ED
14. **Avoid unnecessary testing**
    - Apply evidence-based guidelines to ensure appropriate orders for tests
15. **Utilize medical staff properly**
    - Reduce MD/RN time on computer through use of scribes/dictation

Stochastic Modeling Approach

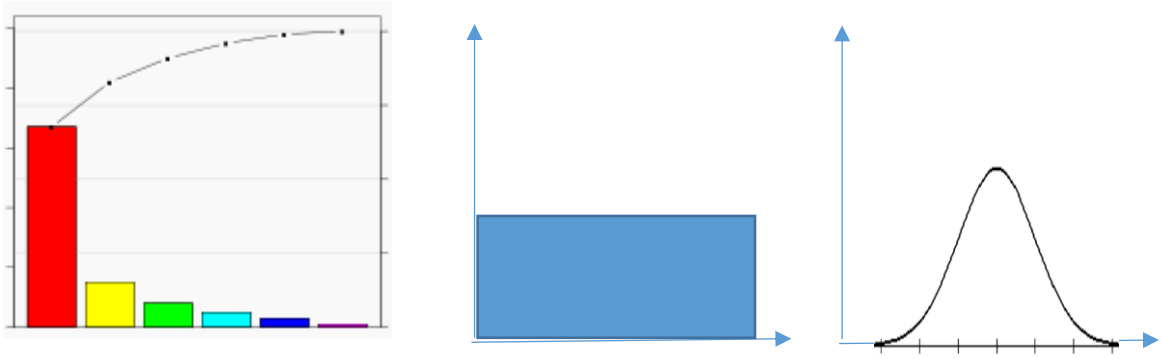
Stochastic Modeling of ED

1. Start with detailed process map

- Show all tasks and possible paths:
  - Arrival by ambulance or walk in
  - Triage, determination of ESI
  - Member registration or new patient enrollment
  - 1st destination: waiting room, ED bed, to hospital, to Urgent Care, to test 1, test 2, etc., to fast treatment, to treatment/stabilization in ED, to discharge
  - 2nd destination (e.g., next test, etc.)
  - 3rd destination (e.g., next test, etc.)
  - Treatment/stabilization in ED
  - Evaluation for hospital admission by a hospitalist
  - Discharge
  - Include distributions of wait times for each task and the task duration as a function of the number of resources (beds, MDs, RNs, transporters, EVS staff, clerks)

Stochastic Modeling of ED

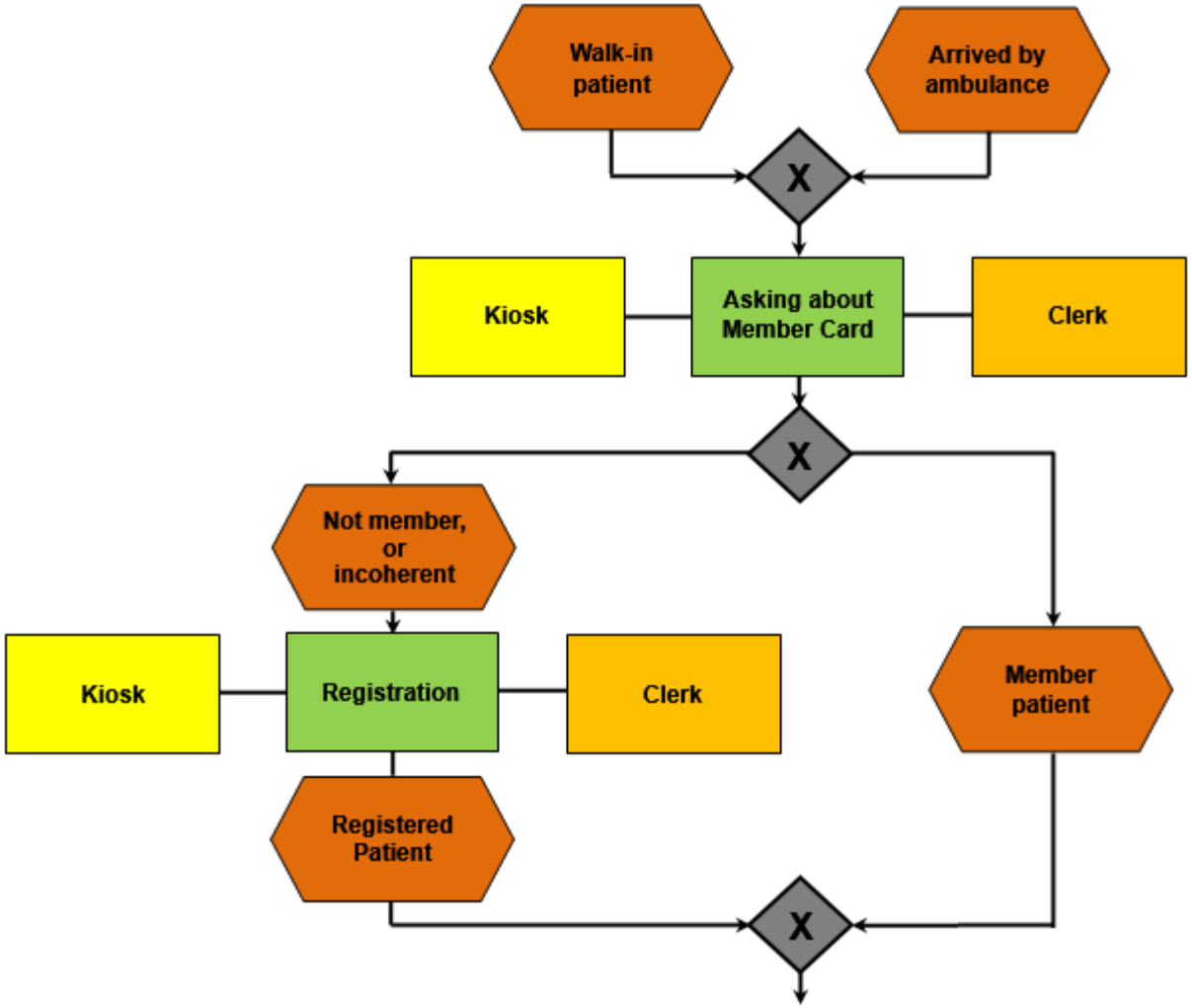
2. Inputs for each task to be collected based on past (say, one year) of ED statistics, by interviews
   - Number of patients broken down by ESI
   - Distribution of time in ED and in tests
   - Number of occurrences of each step
   - Probability of occurrence (or %)
   - Distribution (step?, uniform?, normal? other?)
   - Min value and max value



Stochastic Modeling of ED

3. Assume numbers for the resources used
4. Using random number generators select a random path through the tasks and random durations of all tasks based on the given number of resources
5. Calculate the patient time in ED for the pass
6. Using Monte Carlo repeat 4, 5 for a large number of cases.
7. Repeat (3-5) using different number of resources
8. Plot the number of patients served versus different resources assumed.

Stochastic Modeling of ED
ED process example



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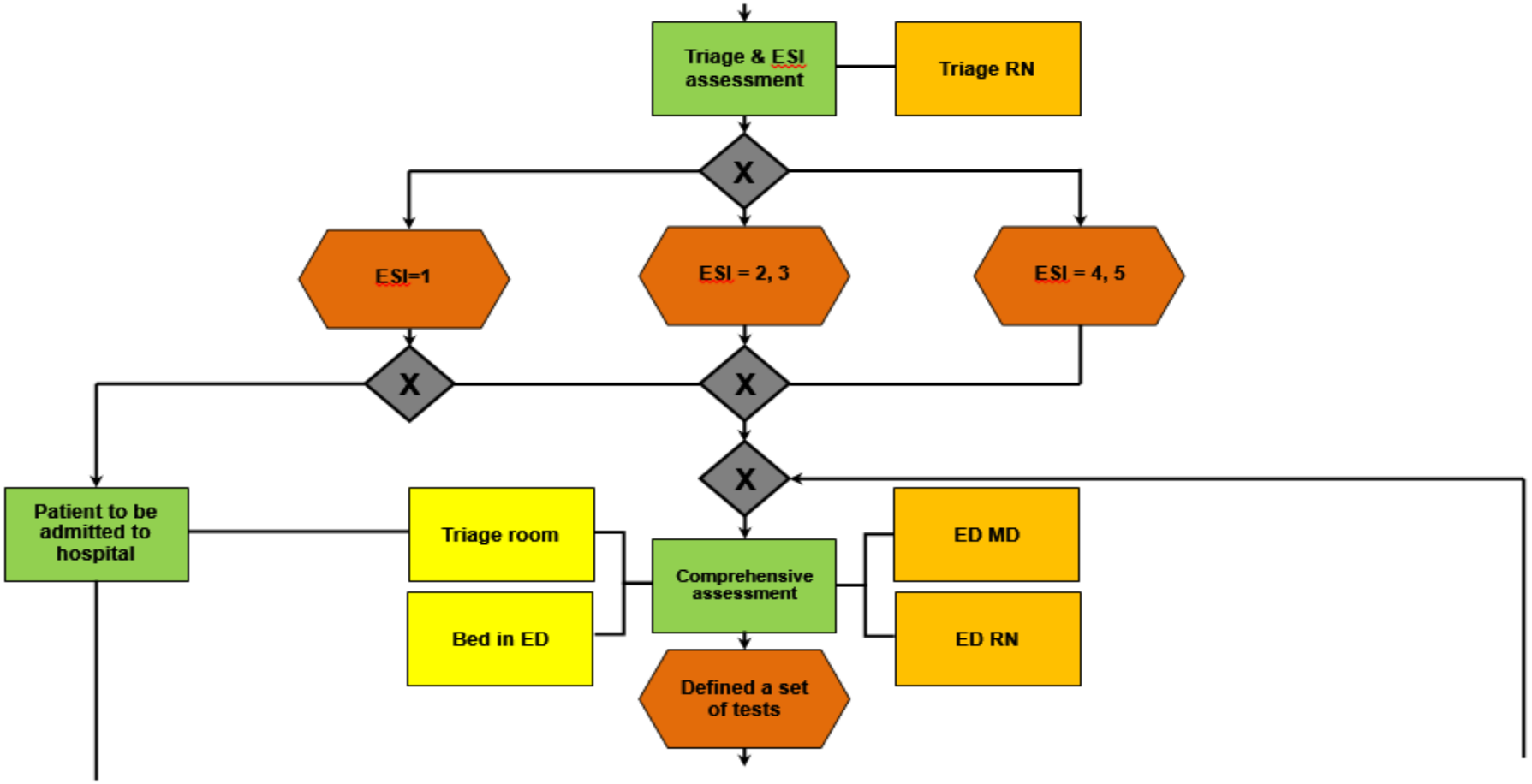

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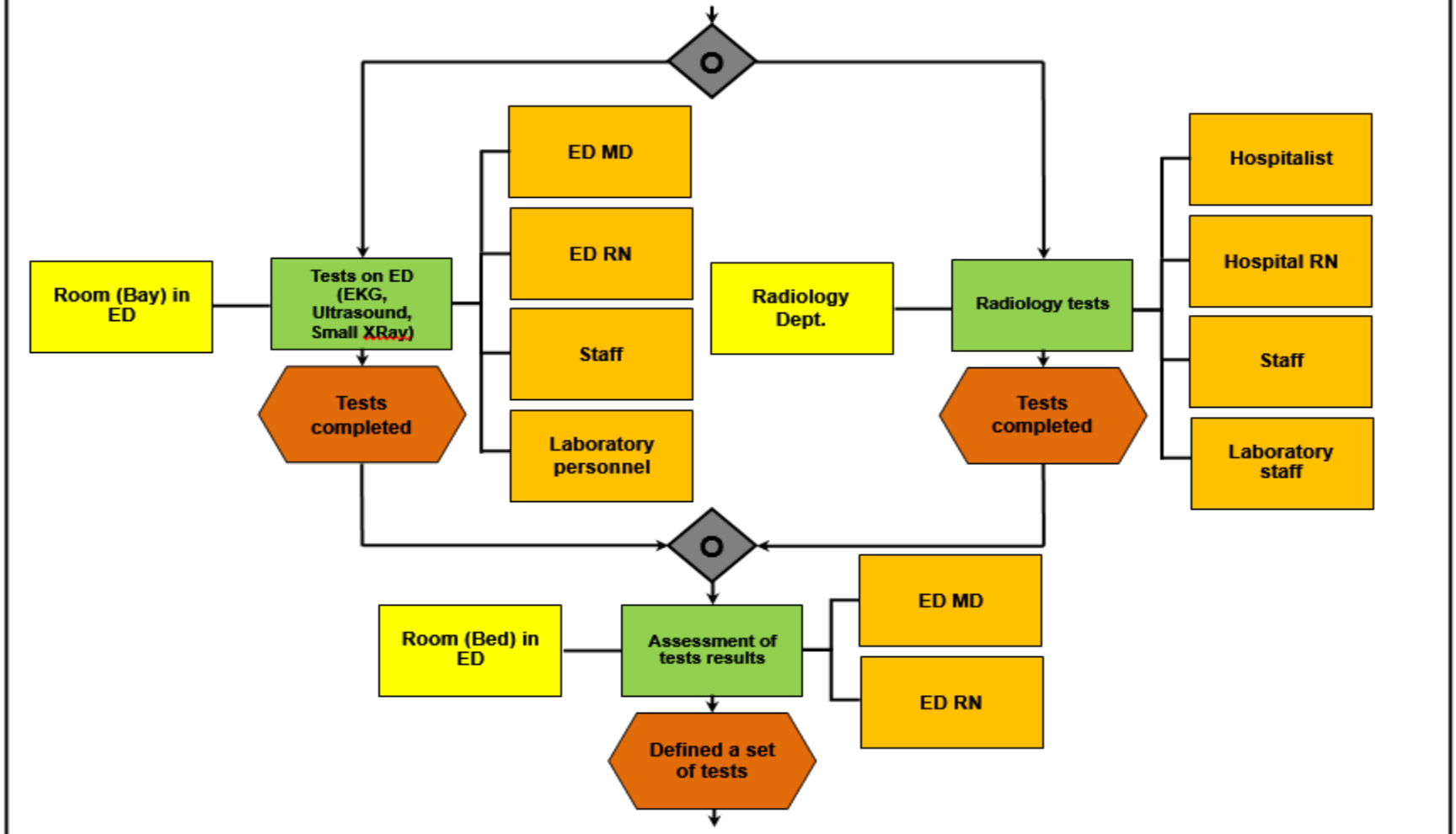

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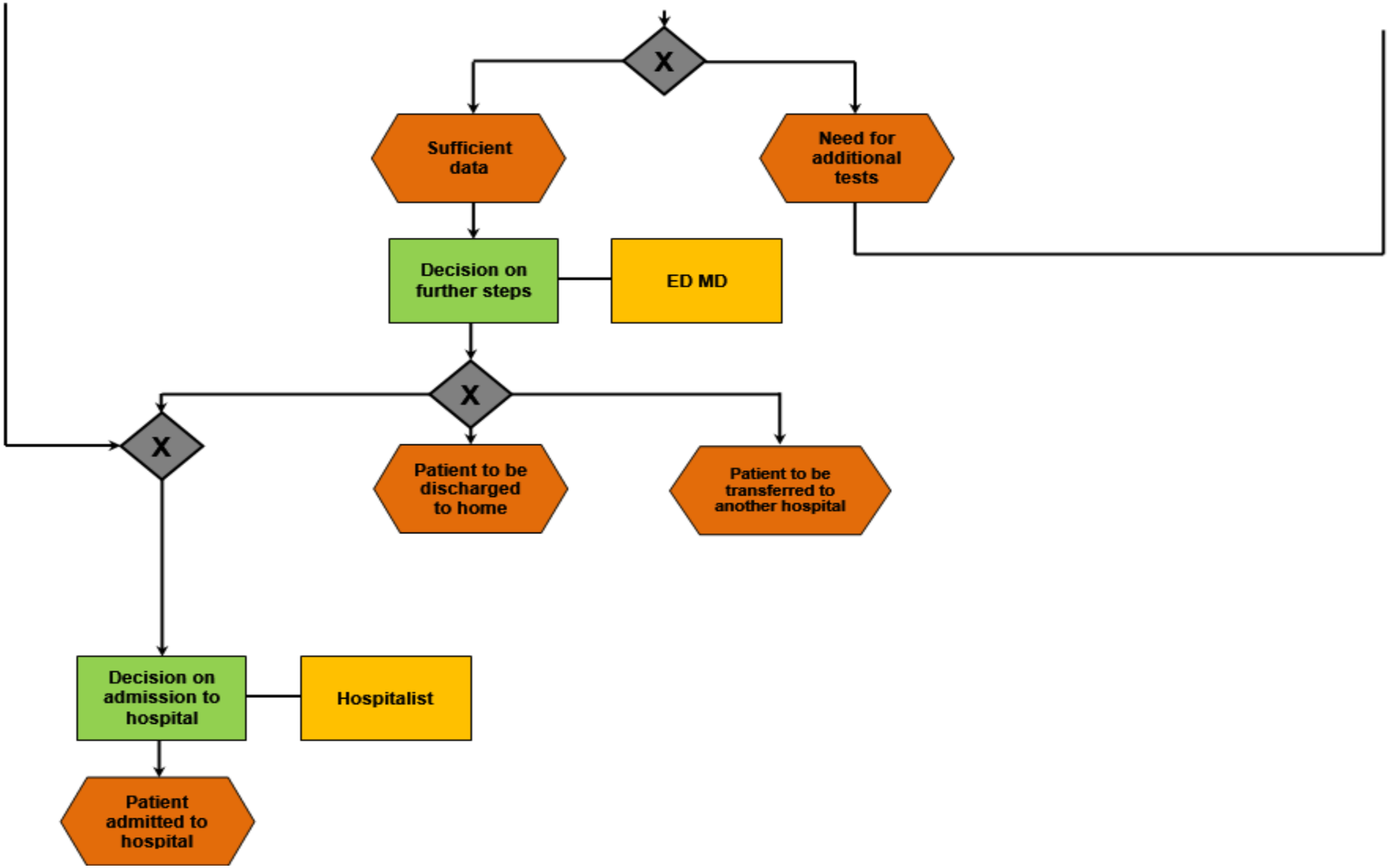

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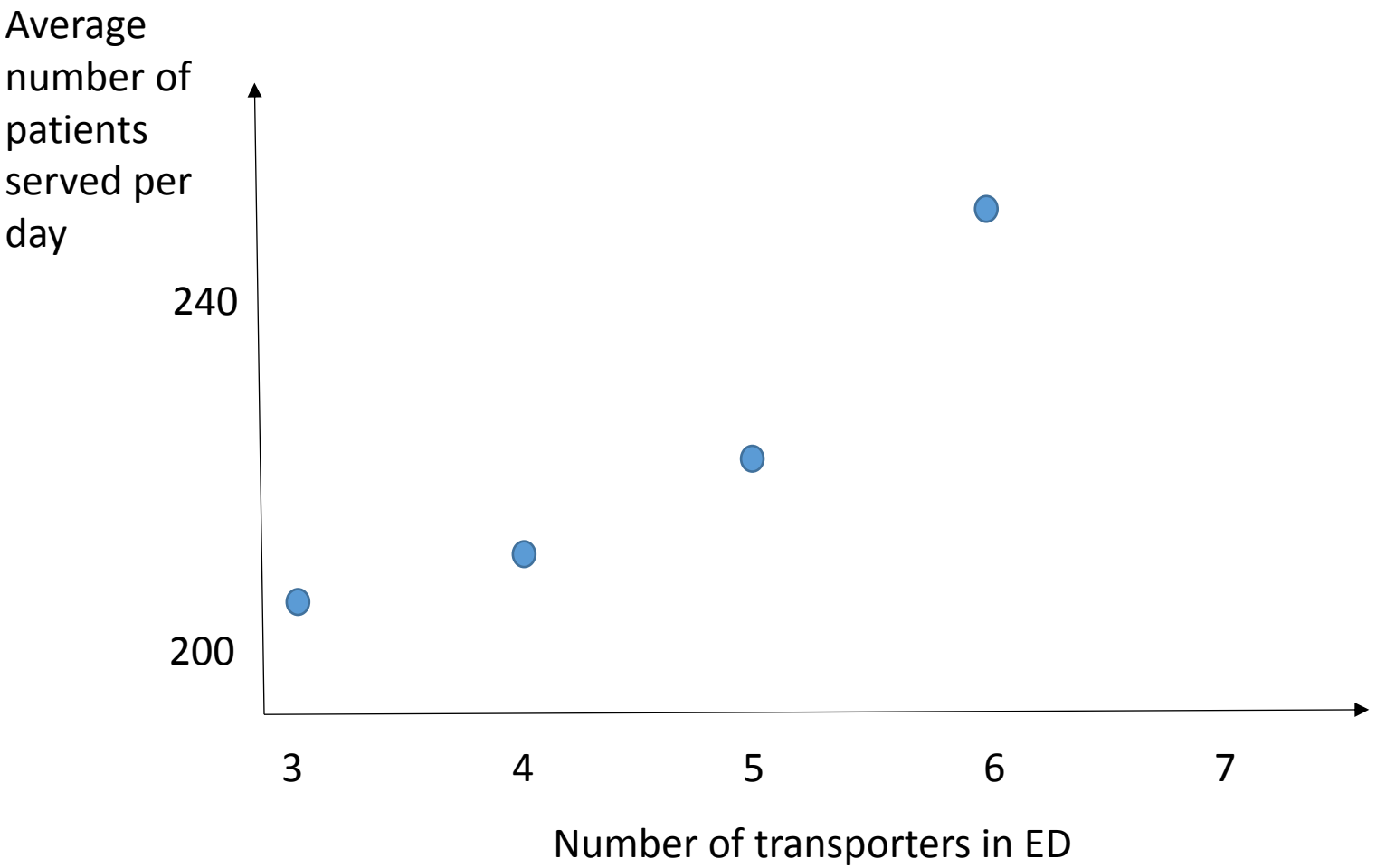

Summary

- Lean is a proven and powerful tool for streamlining ED operations, removing waste, speeding up treatment, and effectively increasing ED capacity and revenue
- Lean routinely improves throughput times by 40-80%

- Stochastic Modeling is a powerful tool for studies of throughput and capacity as functions of the number of resources (beds, MDs, RNs, transporters, EVS staff)