Med ECG

Medical Educational Consulting Group

Michigan Medicine Emergency Department: Space Utilization Solutions

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Our Team

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Agenda

- Problem Statement
- Overview of Solutions for Crowding
- Vertical Treatment Zones
- Analytical Options
- Recommendations
- Next Steps

Problem Statement

What is the optimal resource allocation for vertical treatment zones in the Michigan Medicine ED?

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Solutions for Crowding

Physician in Triage

Skilled personnel at Triage shown to increase efficiency:

- Nurse
- Physician's Assistant
- Attending

Fast Track

Streamlined treatment of non-urgent patients

- Recently, widely adopted
- Typically staffed by senior staff
- Selectively implemented during peak traffic

Vertical Treatment

Waiting rooms for mid-acuity (ESI 3) patients

- Less bed utilization
- Allows for ESI escalation

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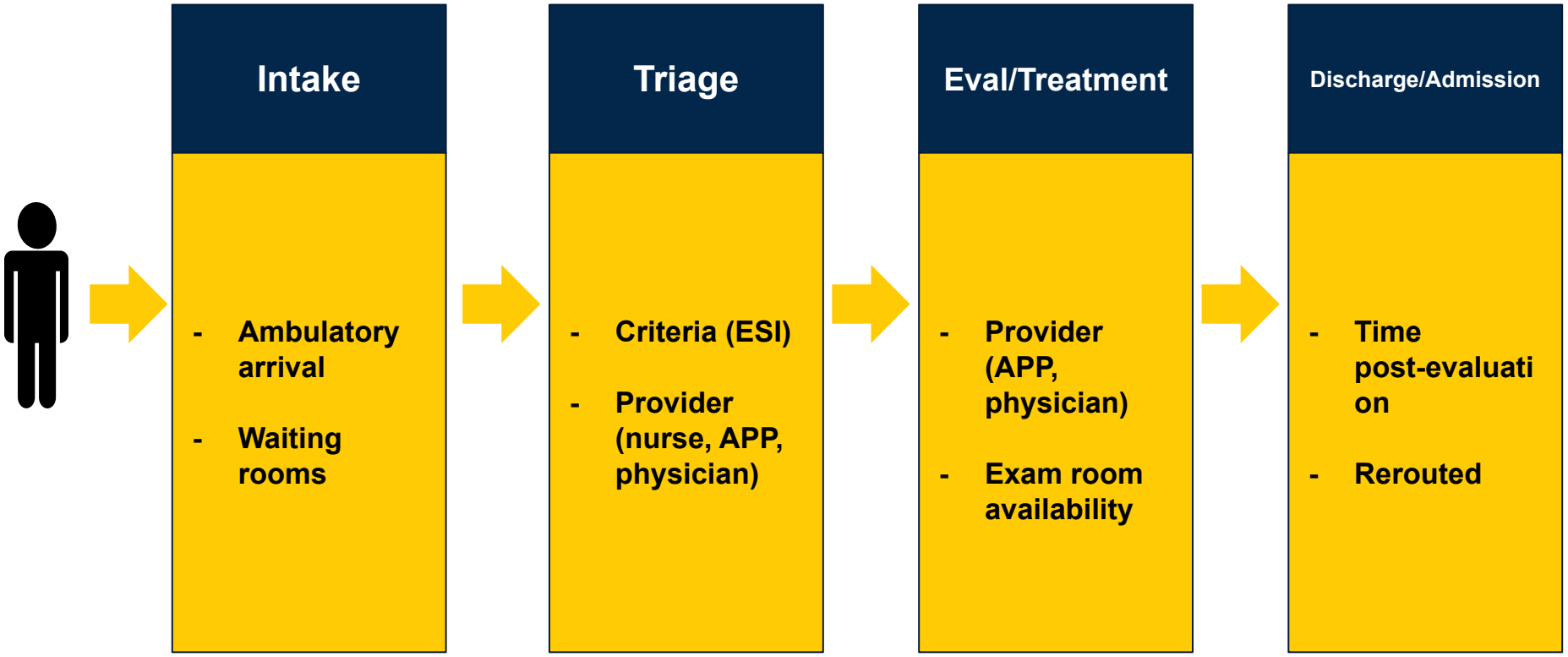
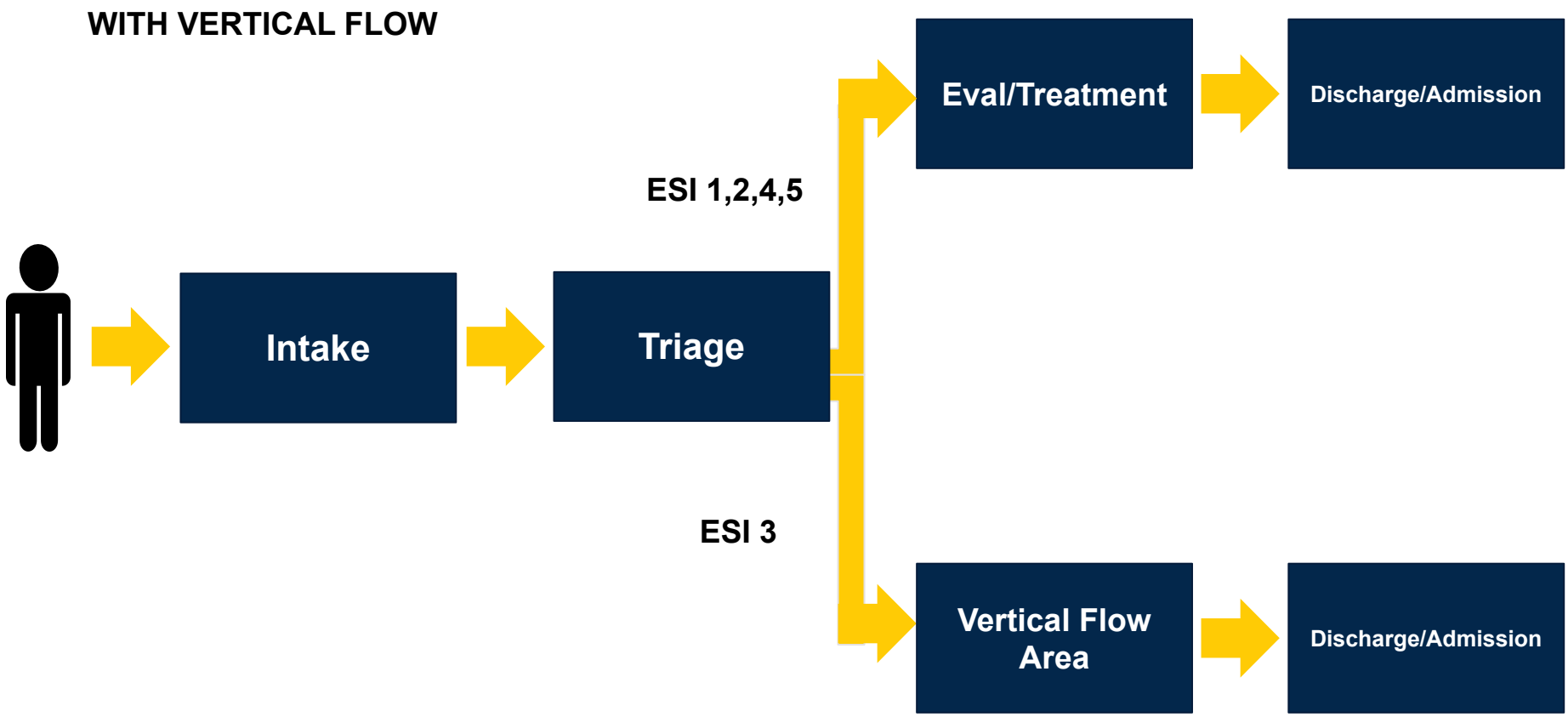
Patient ED journey pathway



Patient ED journey pathway without vertical flow

WITHOUT VERTICAL FLOW

Patient ED journey pathway with vertical flow



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Key Aggregate Metrics

Length of stay	**How long do patients stay in ED?**
Bed utilization rate	**How much of our capacity is being used?**
Left without being seen	**How many patients leave prior to triage? Prior to evaluation/treatment?**
Patient satisfaction	**How satisfied are patients with their ED experience?**
Billing	**How is hospital revenue affected by inefficiencies in ED throughput?**

Patient Flow Modeling Options (Wiler et. al. 2011)

Modeling Type	Description	Ability to Forecast ED Crowding	Ability to Predict Process Improvement Impact
Formula-Based	Past experiences of ED flow used to posit formulas	Poor	N/A
Regression-Based	Statistically predicts dependent variables based on independent variables	Fair	Poor
Time-Series Analysis	Statistically uses recent past performance to predict current and immediate future performance	Fair	Poor
Queuing Theory	Mathematical formulas derived from system principles, utilizes many underlying assumptions	Poor	Good
*Discrete-Event Simulation	Computer-generated model used to sample inputs and generate outputs, *most frequently used in literature	Fair	Good

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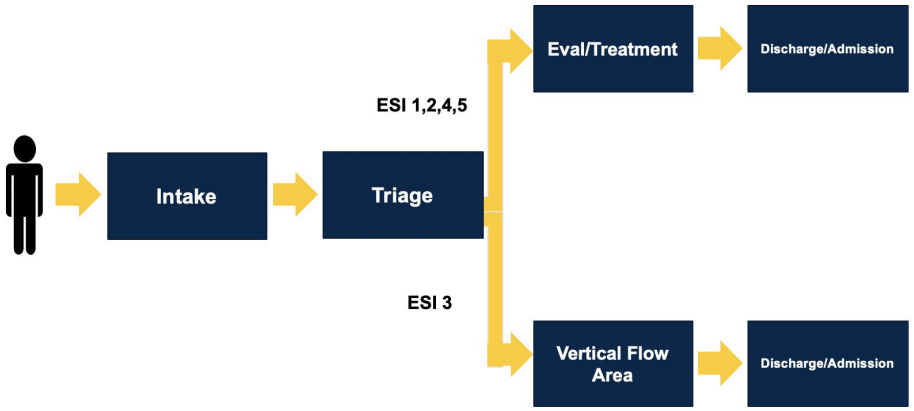
Discrete Event Simulation with SimPy software

<u>Steps of DES:</u> mimic ED journey → tweak → evaluate outcomes

- **1. Establish baseline model that matches current ED throughput**
  - Verify using Michigan ED data
- **2. Run experimental changes**
  - Tweak one point in model
- **3. Evaluate effect on outcomes**
- **4. Establish key recommendations**

***SimPy*: Discrete Event Simulation mimics ED journey**



<u>Benefits</u>

- **Free, customizable, & more control than other options (e.g. Arena, Simul8, etc.)**
- **Commonly used in Healthcare Discrete Event Simulations**
- **Can change any individual step in flow model → assess outcome changes**

Needed Data for SimPy Simulation: Normal & Vertical flow

Time	**Time elapsed between each step of journey (intake to triage, triage to evaluation, evaluation to discharge/admission, Average visit length by ESI, Average time spent with provider by ESI, Length of stay in ED by ESI)**
ESI & Outcomes	**ESI data (How many of each incoming?, Percentage of patients admitted vs. discharged by ESI)**
Dept. Setup	**Beds, Staffing, Triage (How many beds per area?, How many spaces in Vertical Flow area?, Staffing of each area, Staffing changes over day/week)**
Macro-patient data	**How many patients per day? Demographic data, most common concerns for ED by number of cases per month.**

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Next Steps

Data Gather → **Modeling** → **Presentation**

Patient Level Data
- ESI levels
- Timestamps
  - LOS
  - TTP

ED Flow Data
- Vertical treatment zone scheme

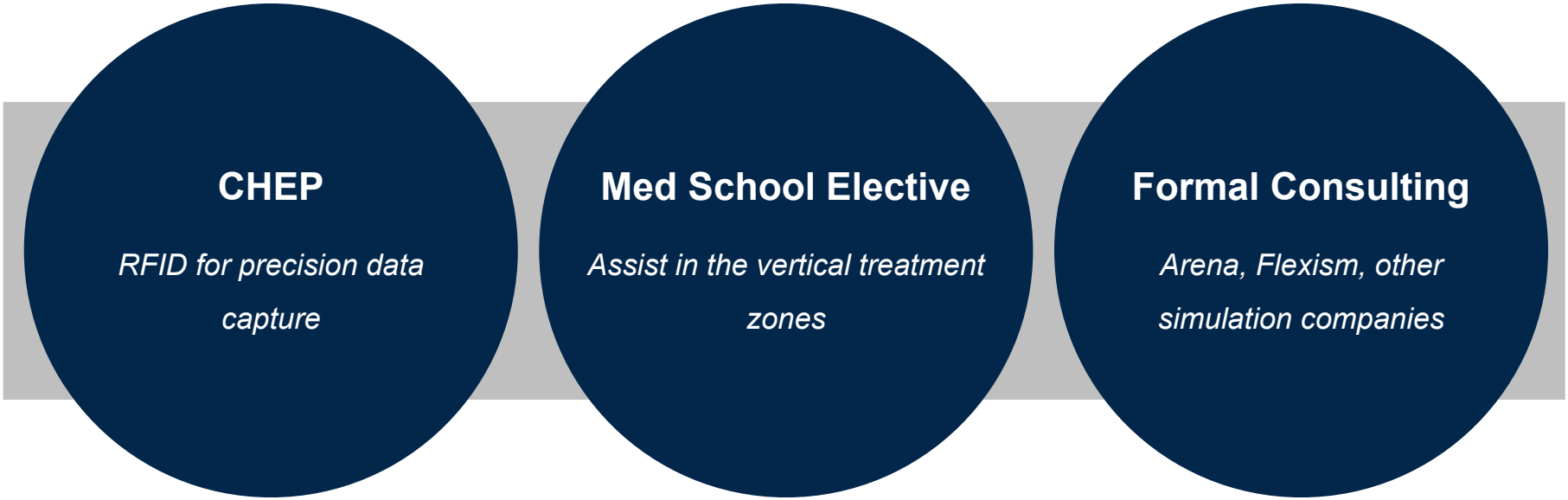
Build
- Ensure proper inputs and outputs
- Incorporate data gathered

Validate
- Compare model outcomes with known outcomes

Provide Final Results
- Optimal size
- Impact on time and money saved

Deeper Dive
- Potential U of M collaborations
- Student Involvement
- Professional modeling and consulting

Next Steps: Deeper Dive



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Appendix

- SimPy Screenshots
- Case Studies
- Vertical Treatment Zone Factors

SimPy Carwash Example Screenshot

```
def setup(env, num_machines, washtime, t_inter):
    """Create a carwash, a number of initial cars and keep creating cars
    approx. every ``t_inter`` minutes."""
    # Create the carwash
    carwash = Carwash(env, num_machines, washtime)

    # Create 4 initial cars
    for i in range(4):
        env.process(car(env, 'Car %d' % i, carwash))

    # Create more cars while the simulation is running
    while True:
        yield env.timeout(random.randint(t_inter - 2, t_inter + 2))
        i += 1
        env.process(car(env, 'Car %d' % i, carwash))


# Setup and start the simulation
print('Carwash')
print('Check out http://youtu.be/fXXmeP9TvBg while simulating ... ;-)')
random.seed(RANDOM_SEED)  # This helps reproducing the results

# Create an environment and start the setup process
env = simpy.Environment()
env.process(setup(env, NUM_MACHINES, WASHTIME, T_INTER))

# Execute!
env.run(until=SIM_TIME)
```

The simulation's output:

```
Carwash
Check out http://youtu.be/fXXmeP9TvBg while simulating ... ;-)
Car 0 arrives at the carwash at 0.00.
Car 1 arrives at the carwash at 0.00.
Car 2 arrives at the carwash at 0.00.
Car 3 arrives at the carwash at 0.00.
Car 0 enters the carwash at 0.00.
Car 1 enters the carwash at 0.00.
Car 4 arrives at the carwash at 5.00.
Carwash removed 97% of Car 0's dirt.
Carwash removed 67% of Car 1's dirt.
Car 0 leaves the carwash at 5.00.
Car 1 leaves the carwash at 5.00.
Car 2 enters the carwash at 5.00.
Car 3 enters the carwash at 5.00.
Car 5 arrives at the carwash at 10.00.
Carwash removed 64% of Car 2's dirt.
Carwash removed 58% of Car 3's dirt.
Car 2 leaves the carwash at 10.00.
Car 3 leaves the carwash at 10.00.
Car 4 enters the carwash at 10.00.
Car 5 enters the carwash at 10.00.
Carwash removed 97% of Car 4's dirt.
Carwash removed 56% of Car 5's dirt.
Car 4 leaves the carwash at 15.00.
Car 5 leaves the carwash at 15.00.
Car 6 arrives at the carwash at 16.00.
Car 6 enters the carwash at 16.00.
```

Case Study: Vertical Flow in a Tertiary Care Center

Vertical split-flow	***The effect of vertical split-flow patient management on emergency department throughput and efficiency*** **American Journal of Emergency Medicine** **Garrett, Berry, Wong, Qin, & Kline, 2018**

Location
Baylor University in Dallas, TX

Hospital Characteristics

- **Tertiary care center**
- **Level 1 trauma center**
- **Academic ED**
- **74 beds**
- **Inpatient ED boarding every day**
- **Cohort characteristics:**

Table 1
Pre- and post-cohort demographics.

	Pre (N = 107,217)	Post (N = 114,833)
Age in years, median (IQR)	41 (26–57)	42 (26–57)
Gender, female (%)	60,438 (56)	65,165 (57)
Pediatric (%)	9157 (8.5)	8423 (7.4)
ESI: 1, 2 (%)	38,552 (35.9)	36,849 (32.1)
Outcome (%)		
Admit	21,303 (19.9)	21,506 (18.7)
LWBS & eloped	3513 (3.3)	4004 (3.5)
Expired	307 (0.29)	307 (0.27)
Discharge	77,429 (72.2)	83,784 (73.0)
Other (transfer, left AMA)	4608 (4.3)	5232 (4.6)

ESI: Emergency Severity Index. LWBS: left without being seen. AMA: against medical advice.

Methods

Pre-intervention period (12 months):
- **ESI 4 and 5's seen in a fast-track area**
- **ESI 1, 2, and 3's seen in main ED**

Intervention: Fast-track area closed (10 beds and small waiting room) and staff reassigned to vertical flow; Triage nurse used CC, pulse ox, and heart rate to assign ESI level

Post-intervention period (12 months):
- **ESI 3, 4, and 5 who could sit were triaged to vertical flow area (VFA)**
- **VFA protected from ED crowding**

Outcomes

- **Despite a higher patient volume in the post-intervention period, total Length of Stay (LOS) decreased by 17 minutes**
- **No increase in staffing or decrease in patient satisfaction**
- **Fewer patients using bed space because they are sitting upright in chairs (vertically)**
- **All exams and treatments performed in a single occupant room**
- **If mis-triaged, patient reassigned to "horizontal" bed**
- **No change in ED boarding**

Case study: Designing Efficient emergency departments: Discrete event simulation (DES) of internal-waiting areas and split flow sorting

Overview	Company
Looks at nine different graded combinations of ESI, Intake Personal, and Split Flow via discrete event simulation to predict incremental increases in efficiency. Easter B, Houshiarian N, Pati D, Wiler JL. Designing efficient emergency departments: Discrete event simulation of internal-waiting areas and split flow sorting. *The American Journal of Emergency Medicine.* 2019;37(12):2186-2193. doi:10.1016/j.ajem.2019.03.017	[logo]

Methods:

- **University of Colorado Hospital ED for DES base data**
  - ➢ urban
  - ➢ tertiary care
  - ➢ primary teaching hospital
  - ➢ 101,000 Patients
- **Metrics Collected:** ED layout, staffing, patient data (age, sex, CC, diagnostics), Tx, LOS, ESI

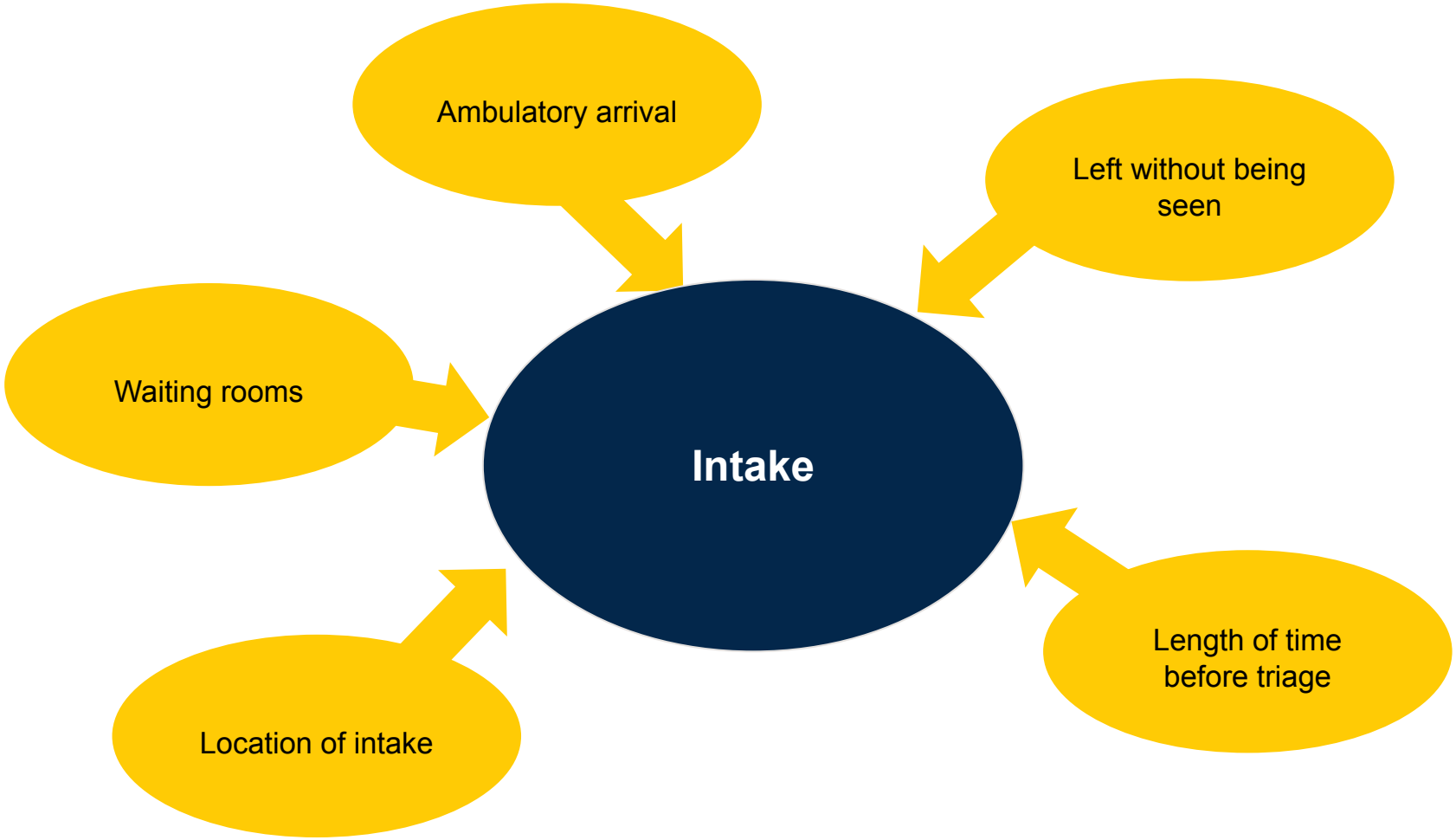
Key decisions and events

1. **Model Development via patient profiles**
2. **ARENA Input Analyzer to create probability distributions**
3. **Process maps created and added to ARENA**
4. **Model validation**
5. **Variable Manipulation and Data output of 3 variables:**
   a. **ESI**
   b. **Intake Personal**
   c. **Split Flow rooms**

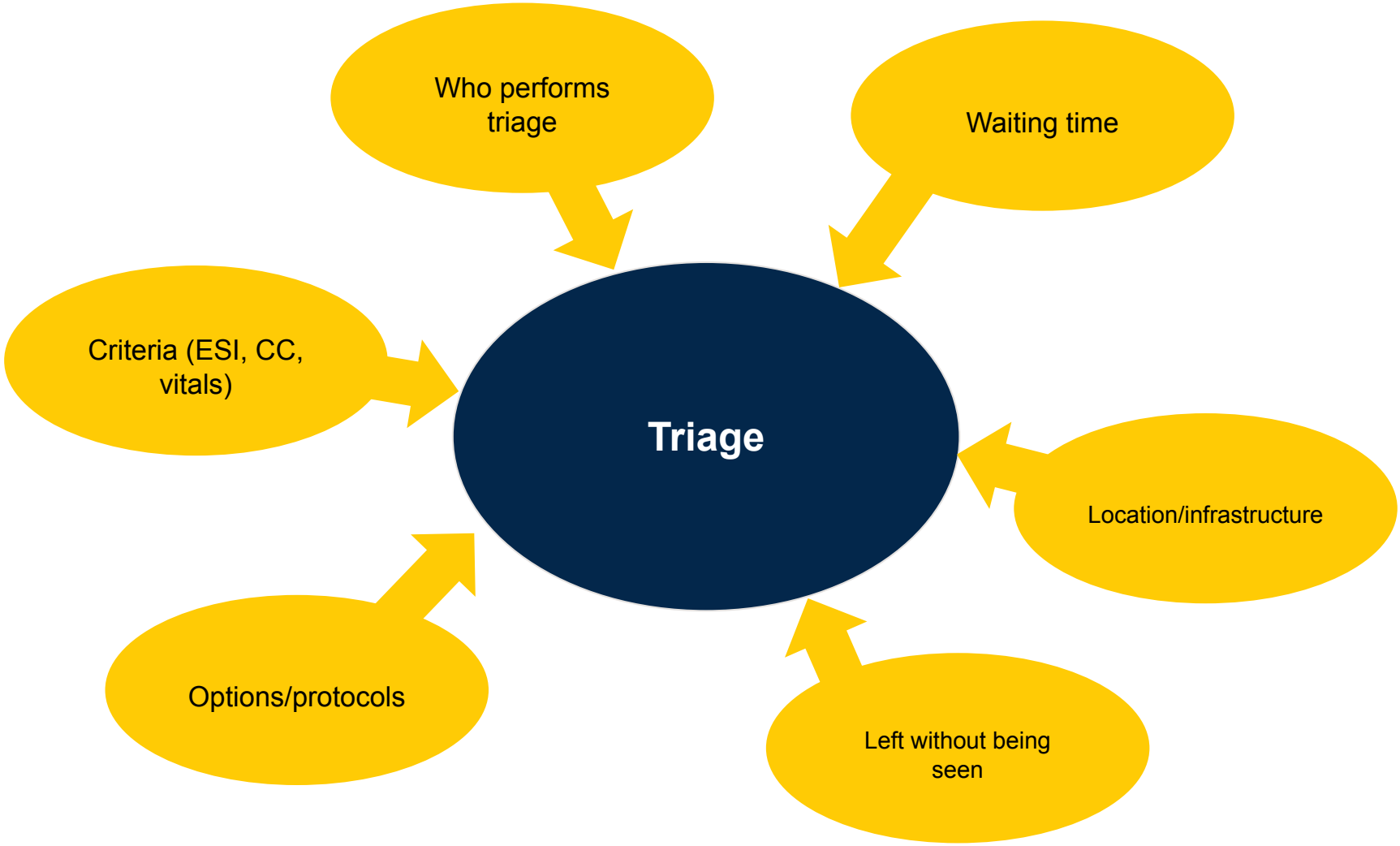
Results

- **Endpoints observed:**
  - Length of Stay
  - Bed Utilization rate over 24hr
  - Door to provider time
  - Left without being seen rate
  - Movements of Patients
- **Lowest Length of stay and highest bed utilization rate seen with flow split by intake attending with two internal-waiting areas (~54 min LOS decrease)**

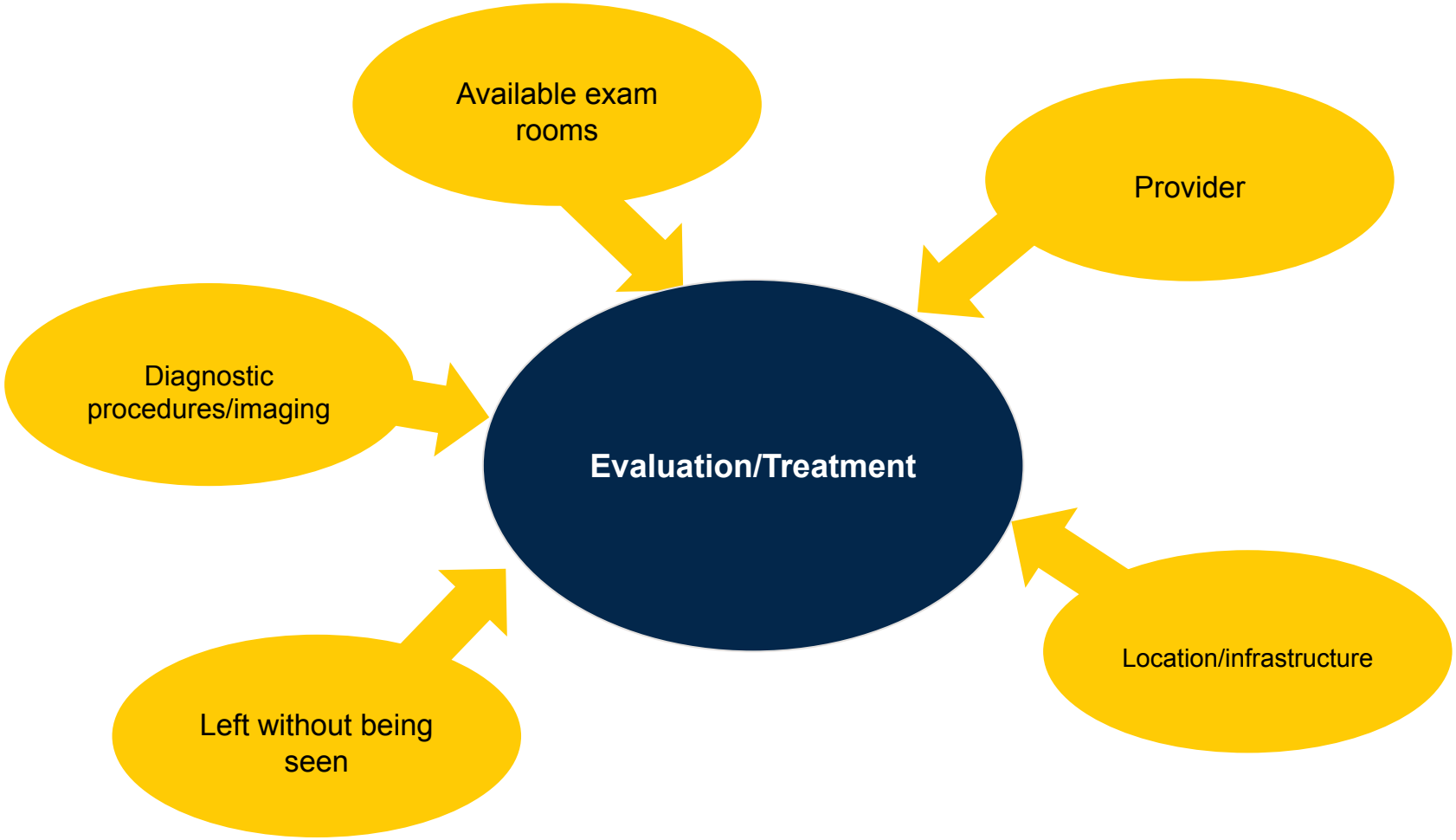
Appendix: Intake Factors



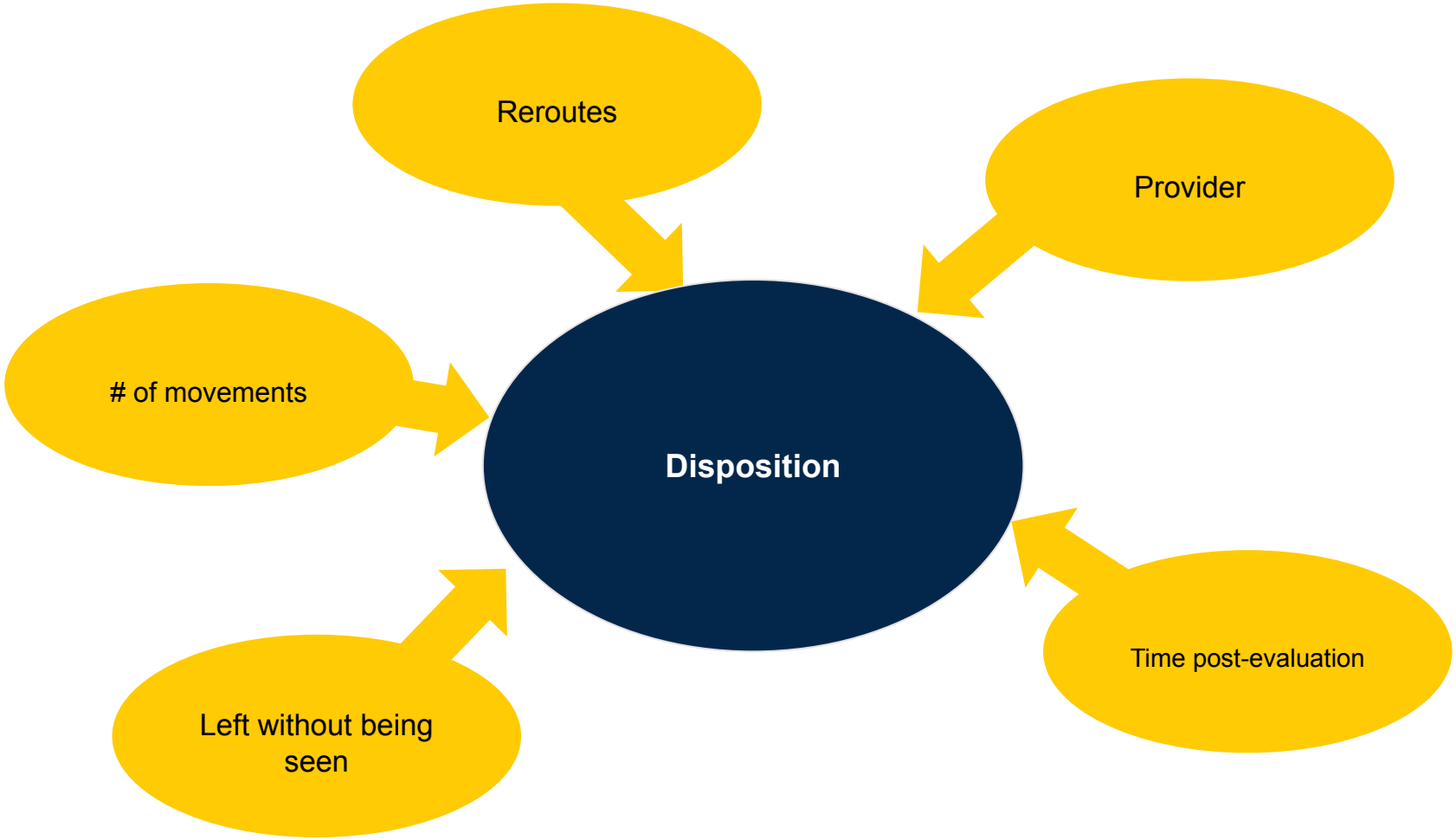
Triage Factors



Evaluation/Treatment Factors



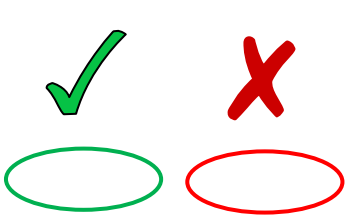
Disposition Factors

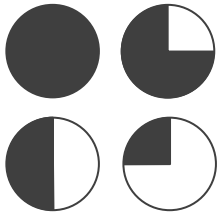


Slide with individual copy and paste items

Comment box for internal communication on slides

Header 1 – 1 line





Impact High Low

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Header 2 – 2 lines

Thought bubble point: more of these images can be found at nounproject.com

"Take home" point box

Two-panel slide with left-side graph and takeaways

Graph header

Insights/Takeaways

Point 1

- **Bullet 1**
- **Bullet 2**
  - Sub-bullet

Point 2

- **Bullet 1**
- **Bullet 2**
  - Sub-bullet

Two-panel slide with notes and right-side graph

Header

Point 1

- **Bullet 1**
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  - Sub-bullet

Point 2

- **Bullet 1**
- **Bullet 2**
  - Sub-bullet

Graph

Process (3 steps) with text explanation

Point 1
- **Bullet 1**
- **Bullet 2**
  - Sub-bullet

Point 2
- **Bullet 1**
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Process (4 steps) with text explanation with dividers

Point 1
- **Bullet 1**
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Table (5 row labels)

Category	Explanation
Label 1	• Details
Label 2	• Details
Label 3	• Details
Label 4	• Details
Label 5	• Details

Table (5 row labels x 2 columns)

Category	Header 1	Header 2
Label 1	• Details	• Details
Label 2	• Details	• Details
Label 3	• Details	• Details
Label 4	• Details	• Details
Label 5	• Details	• Details

Vertical process (3)

Timeline

- Point 1
- Point 2
- Point 3

Timeline

- Point 1
- Point 2
- Point 3

Timeline

- Point 1
- Point 2
- Point 3

Vertical key points (2)

Key point 1	**Key point description**
Key point 2	**Key point description**

Vertical key points (3)

Key point 1	Key point description
Key point 2	Key point description
Key point 3	Key point description

Vertical key points (4)

Key point 1	Key point description
Key point 2	Key point description
Key point 3	Key point description
Key point 4	Key point description

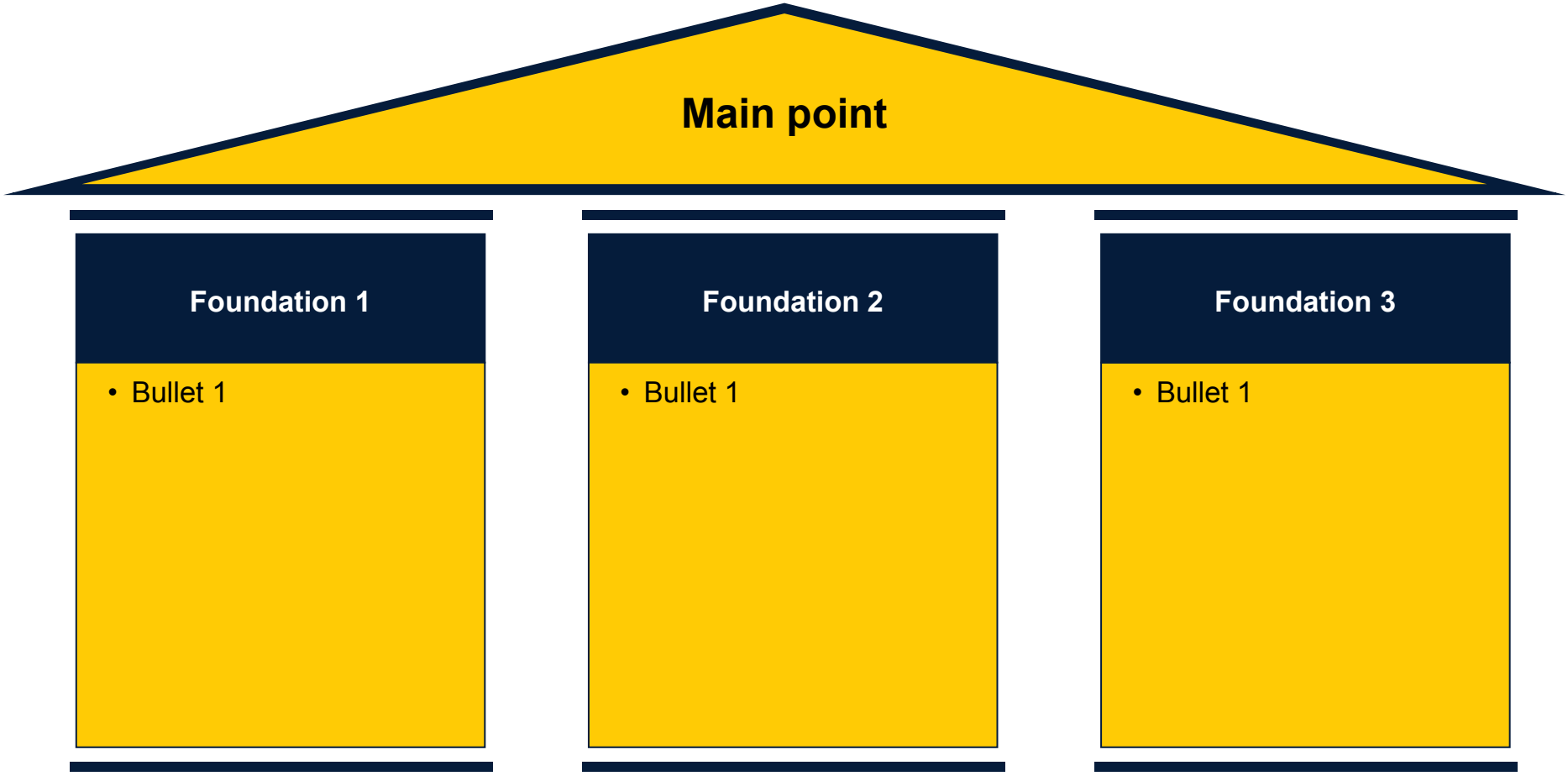
Vertical key points (4)

Key point 1	Key point description
Key point 2	Key point description
Key point 3	Key point description
Key point 4	Key point description

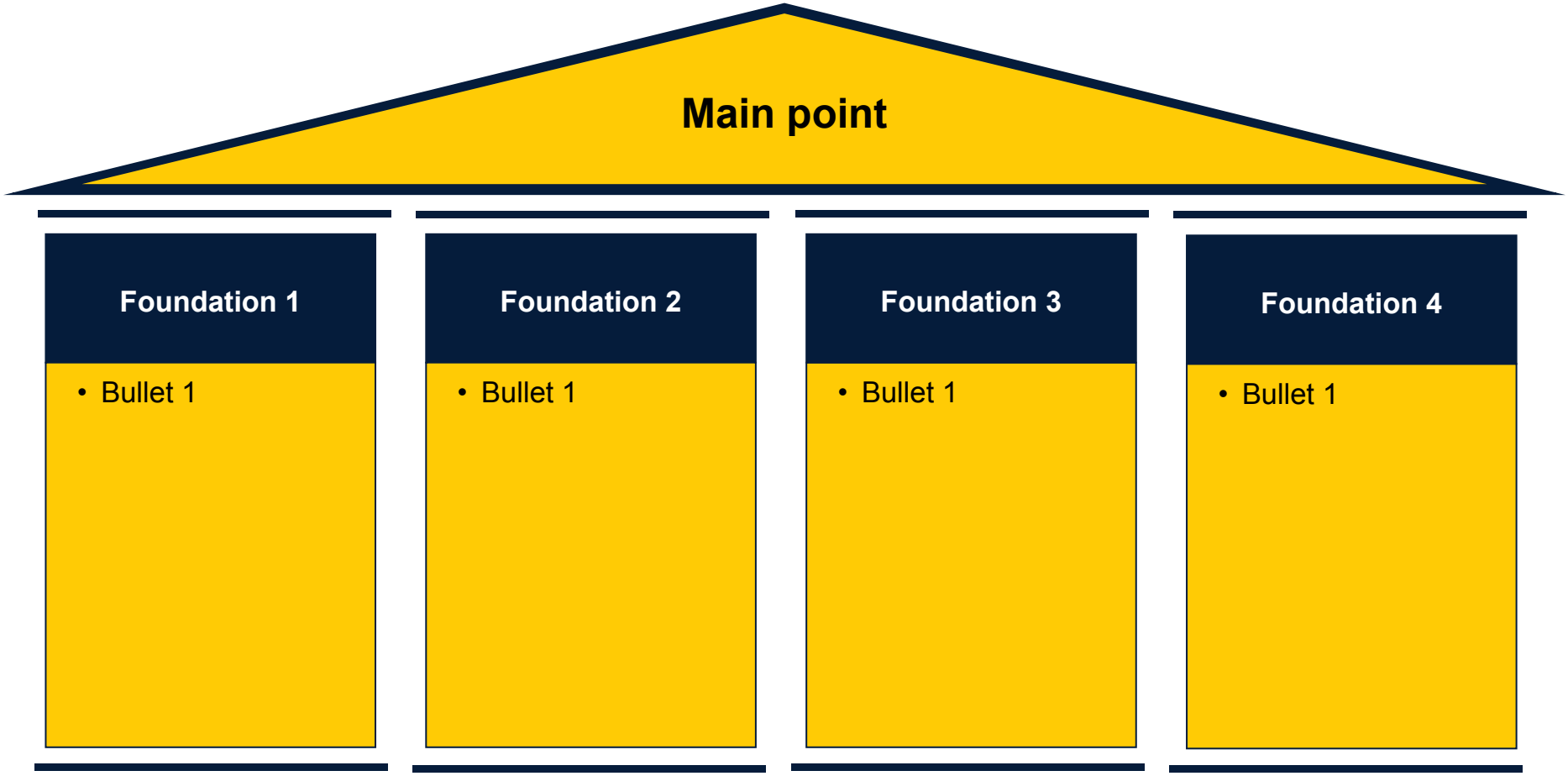
Agenda

- Simple slide formats
- Advanced formats
- Copy and paste-items

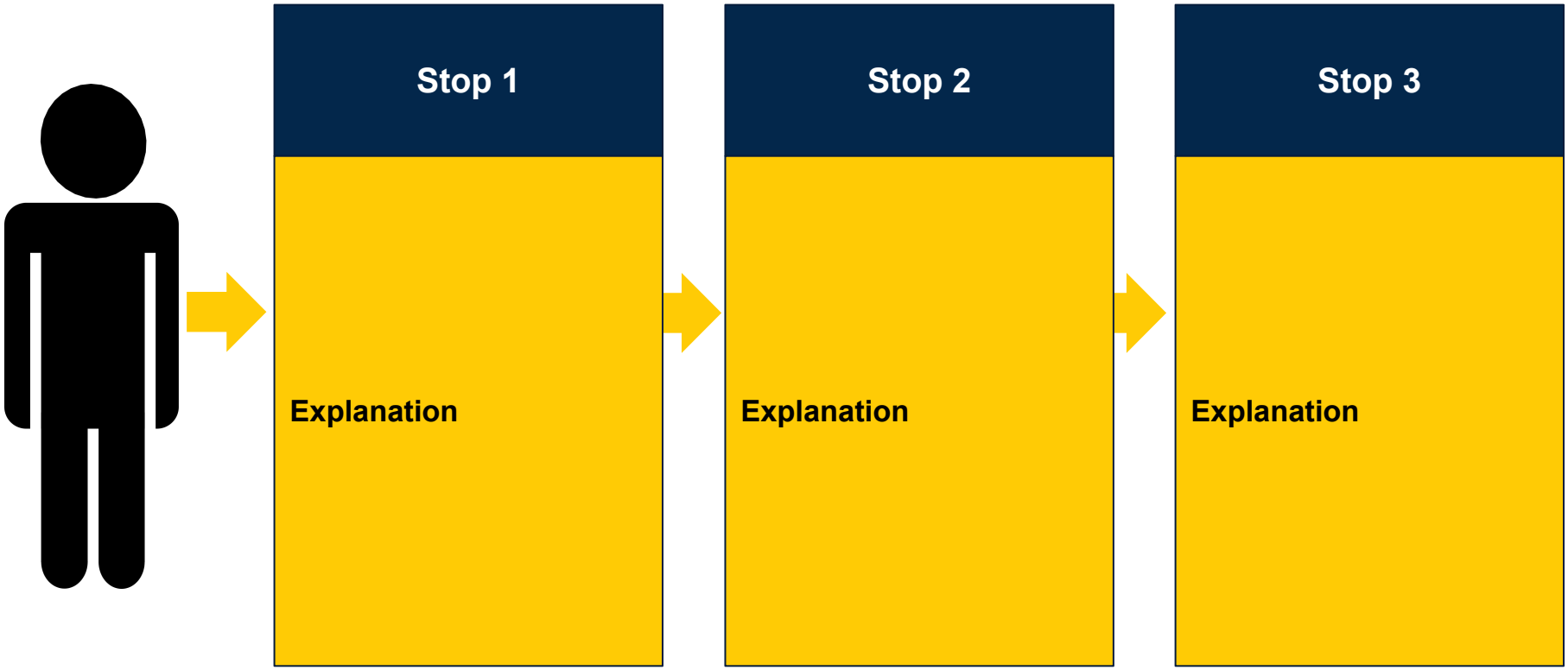
Foundations (3) leading to main point



Foundations (4) leading to main point



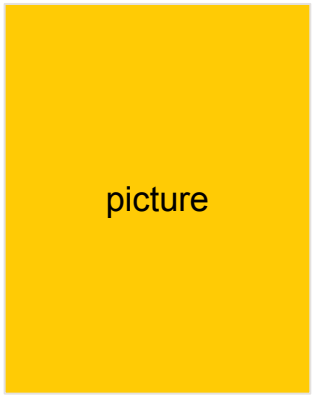
Patient journey pathway



Interesting visual of three main points

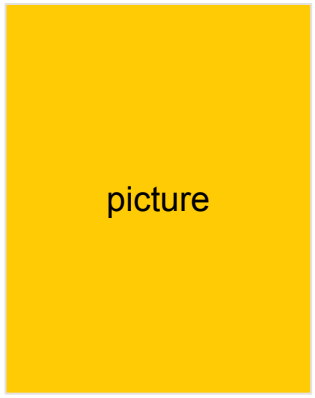
Team page (4)

First Name
Last Name



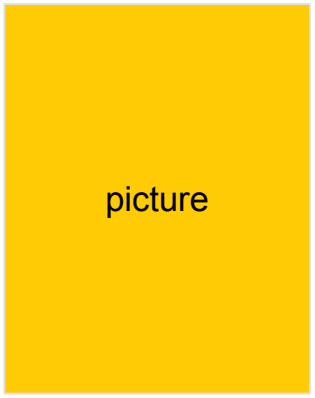
Role
Description

First Name
Last Name



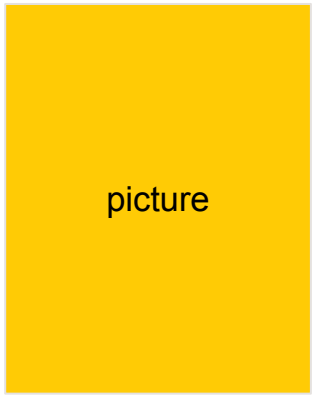
Role
Description

First Name
Last Name



Role
Description

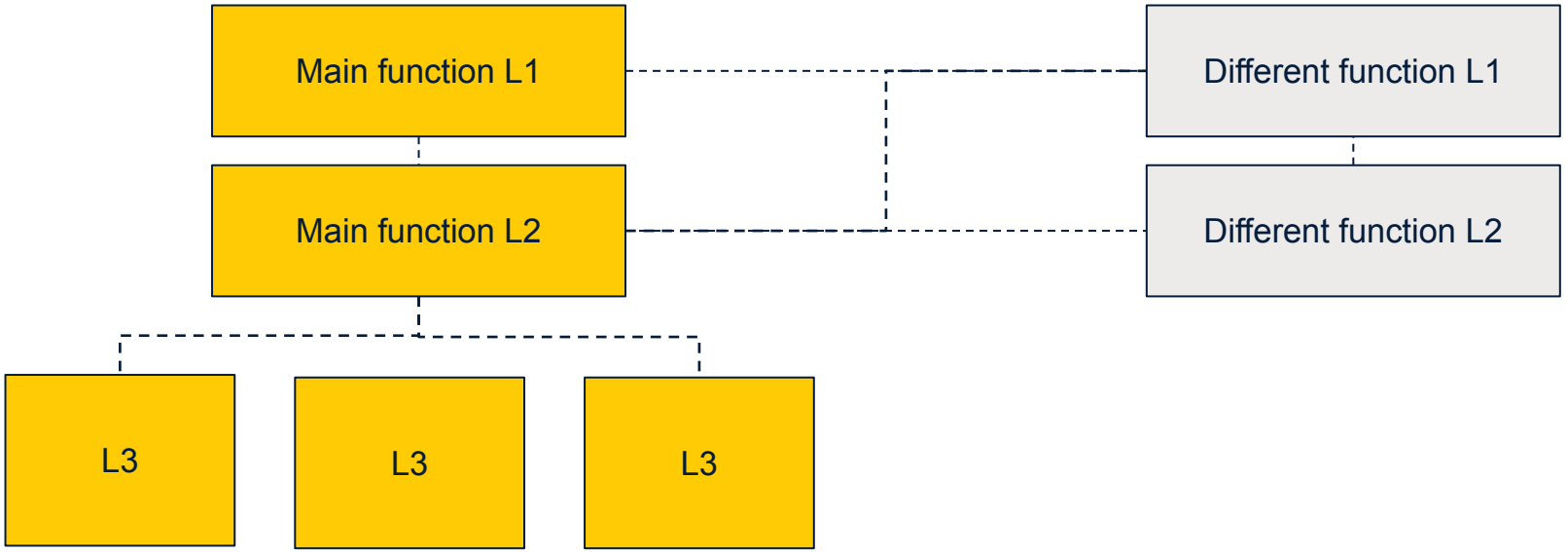
First Name
Last Name



Role
Description

Organization structure

Department/team title

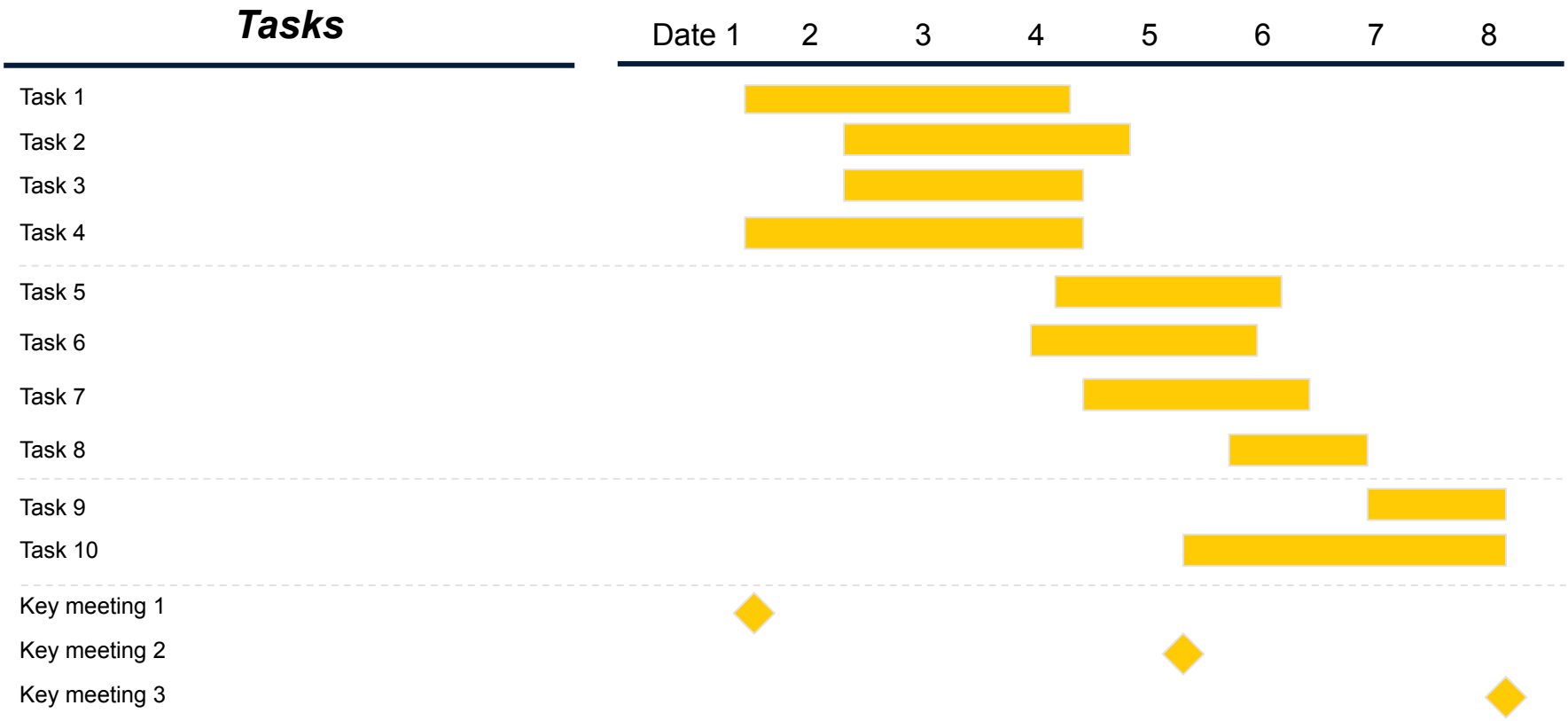


Research paper summary template

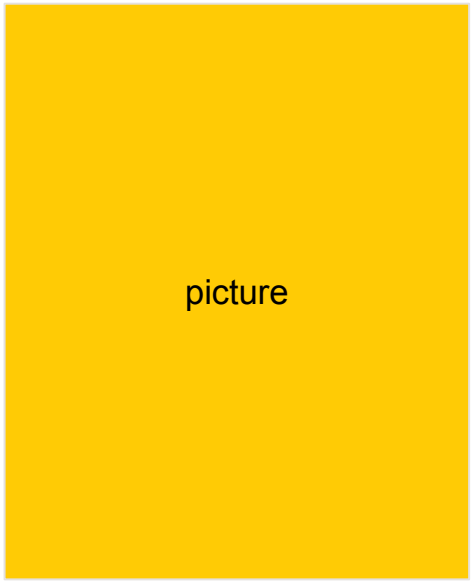
Research paper	*Article title* [Author], [Year]	***Location***
		[logo]

Primary objectives	***Methods***	***Outcomes***
Main goals of paper	**Methods overview (can be in steps)**	**Conclusions and discussion**

Gantt chart timeline



Face page and personal bio



Summary of relevant experience

- Experience 1
- Experience 2
- Experience 3

[Name] is an [year] at the University of Michigan Medical School. In medical school, [Name] has worked on [main projects and experiences]. Prior to starting medical school, [Name] worked at [prior jobs if applicable], where he/she [main tasks and experiences]

Education: [Name] earned a [degree] from [School] in [Year]

A selection of [Name]'s relevant project experience include:

- Detailed experience/role 1
- Detailed experience/role 2