Team HOPE

Hospital Optimal Productivity Enterprise

March 26, 2010

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Project Overview

Broad Healthcare Landscape

-Health Care Reform Bill, 2010
-Americans spent $2.3 trillion on health care in 2007
-Hospitals are one of the least efficient sectors

University of Maryland Medical Center (UMMC)

UMMC	UMMC ED
800 beds 1,182 doctors 742 residents	55 beds 20% admission rate 46,000 patients/year

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UMMC Stats

	UMMC ED	Top quartile
Volume (patients / bed / day)	3.6	4.0
Ambulance diversions	408	20
Ambulance diversion (hrs)	4,038	100
Length of stay (hrs)	6	4
LOS Admitted patients (hrs)	10.3	6.7
LOS Treated & released patients (hrs)	9.7	3
Bed ready after request (min)	110.2	70.2

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Residency Model

Medical School

- Four years
- Classes, clinical rotations

Residency

- First year: Internship, general medicine
- Next 2-6 years: Specialty

Attending Physician

- Private practice or hospital

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Research Objectives

Hypothesis

If a simulation modeling the flow of resources within the ED is utilized, then the overall level of efficiency will increase, thus improving patient care

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Literature Review

Resident Education

Study Author	Description of Findings	Impact on Hospital	Simulation Used?
Harvey, 2008	Patients' length of stay reduced when residents on strike	Negative	No
Jeanmonod, 2007	Productivity of inexperienced doctors decreases over the course of a shift	Negative	No
Shayne, 2009	Increased patient density leads to poor time management by residents	Negative	No
Dassinger, 2008	Multitude of 1 to 5 minute actions fragment residents' work processes	Negative	No
Bush, 2007	Increased patient density leads to improved patient care	Positive	No

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Literature Review

Simulation Modeling

Study Author	Description of Findings	Research Hospital?	Emergency Department?	Live Data Collection?
Komashie, 2005	Adding staff/beds leads to reduced waiting times	Unknown	Yes	No
Miller, 2004	Simulations are more fluid than mathematical models	No	Yes	No
Kolb, 2008	Tested five different patient buffer concepts through their simulation	No	Yes	No
Rossetti, 1999	Adding one attending from 10am to 6pm leads to reduced LOS	No	Yes	No

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Studies Comparison

	Research Hospital	Emergency Department	Live Data Collection	Simulation
Bush	Y	N	N	N
Dassinger	Y	Y	Y	N
Harvey	N	Y	N	N
Jeanmonod	N	Y	N	N
Kolb	N	Y	N	Y
Komashie	Unknown	Y	N	Y
Miller	N	Y	N	Y
Rossetti	N	Y	N	Y
Shayne	N	Y	N	N
Team HOPE	**Y**	**Y**	**Y**	**Y**

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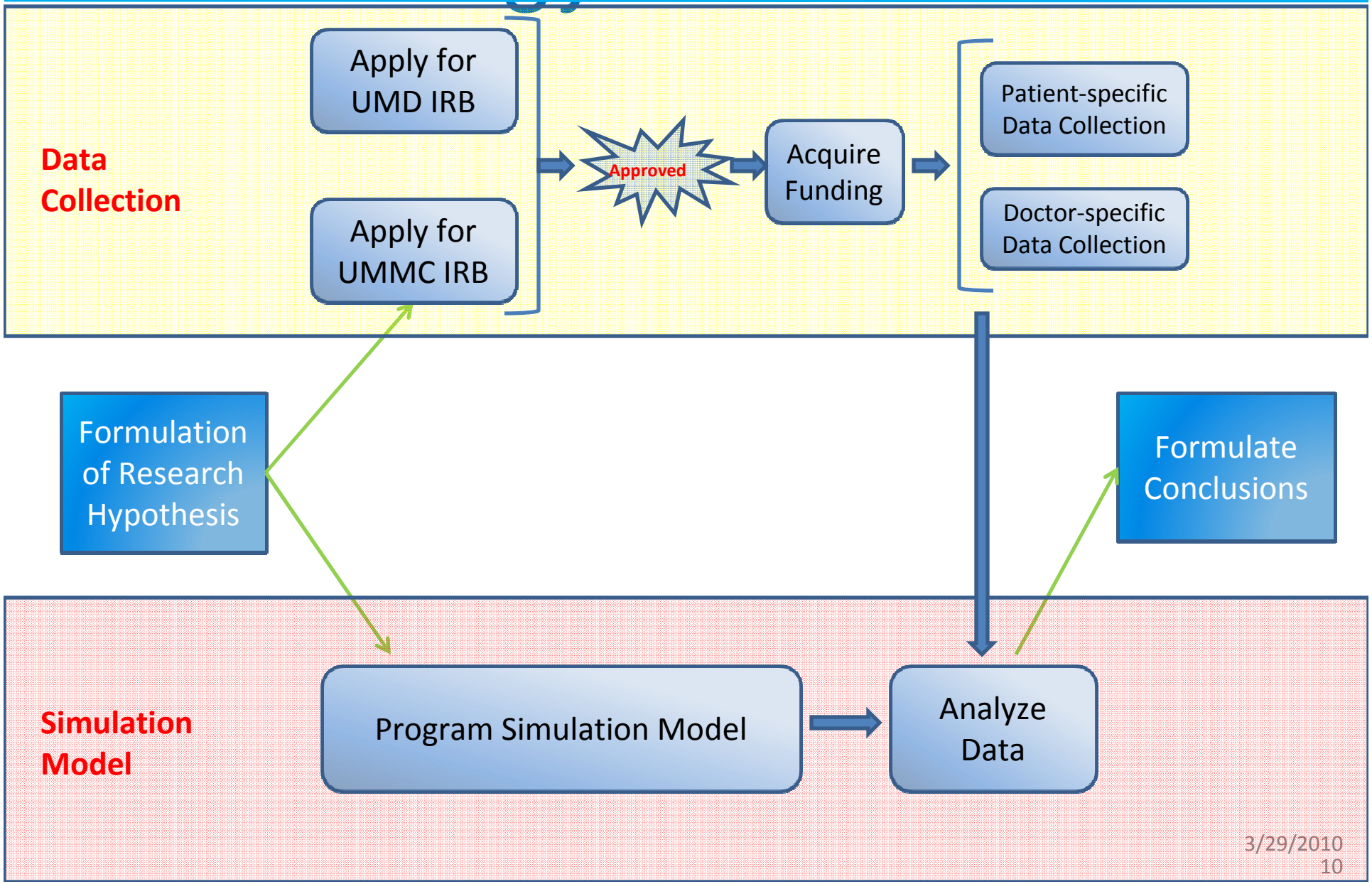
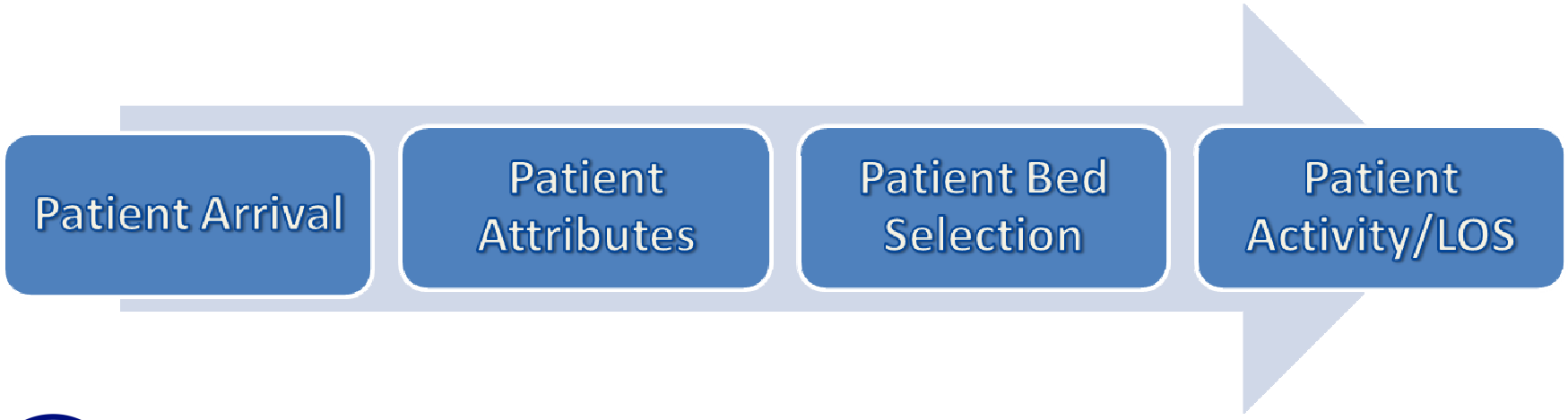
Methodology Overview



Simulation Model

- Several parts to model creation
  - Collect timing, patient and availability data
    - Enables simulation model
  - Validate model



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Collected Data

Timing Data

-Patient visit times
-Computer access times
-Transportation times
-Lab test times

Historical Patient Data

-Arrival time
-Demographic info
-Priority
-Lab tests needed

Availability Data

-Personnel schedules
-Available lab equipment
-Available beds

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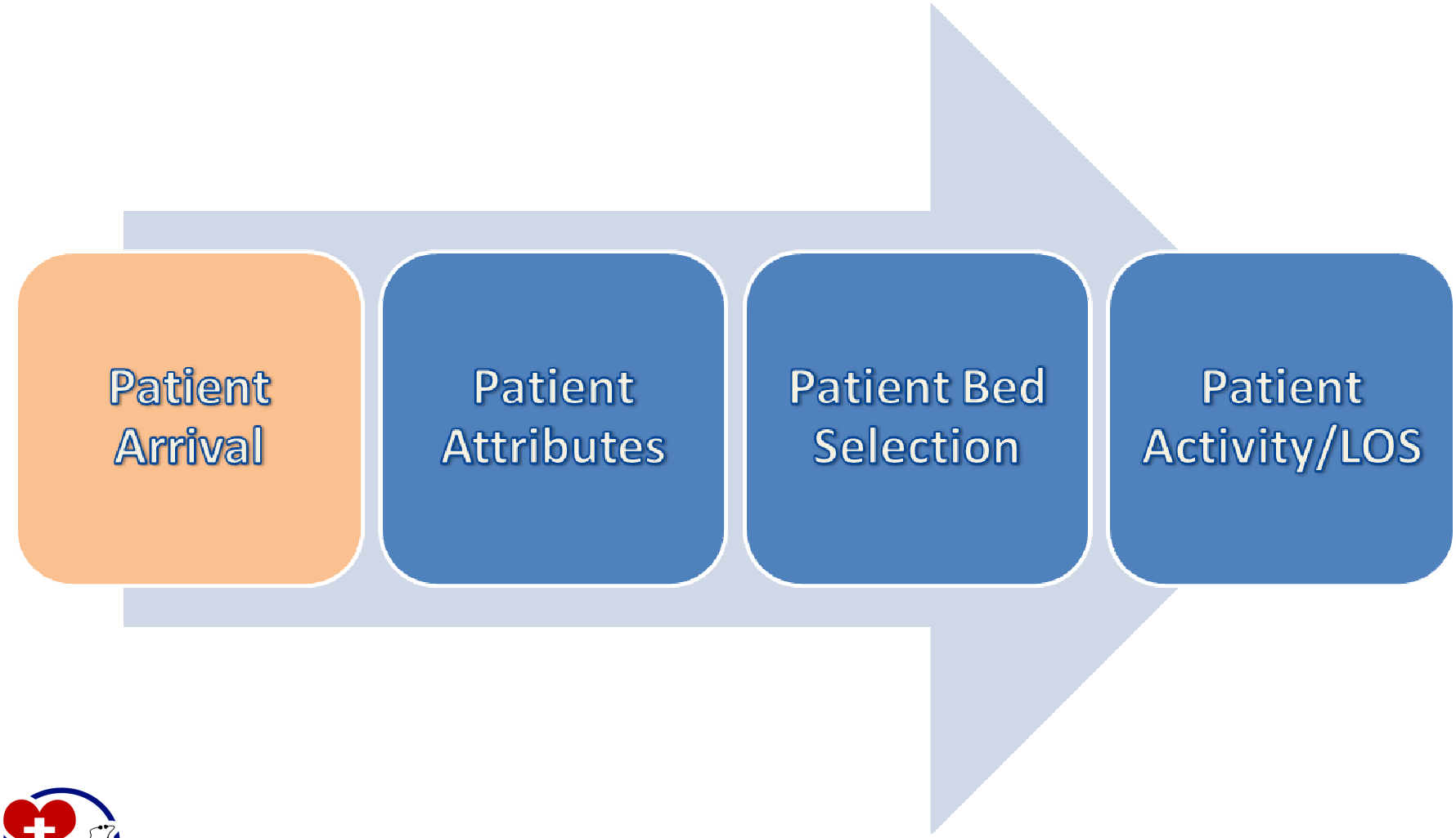
Simulation Process Flow



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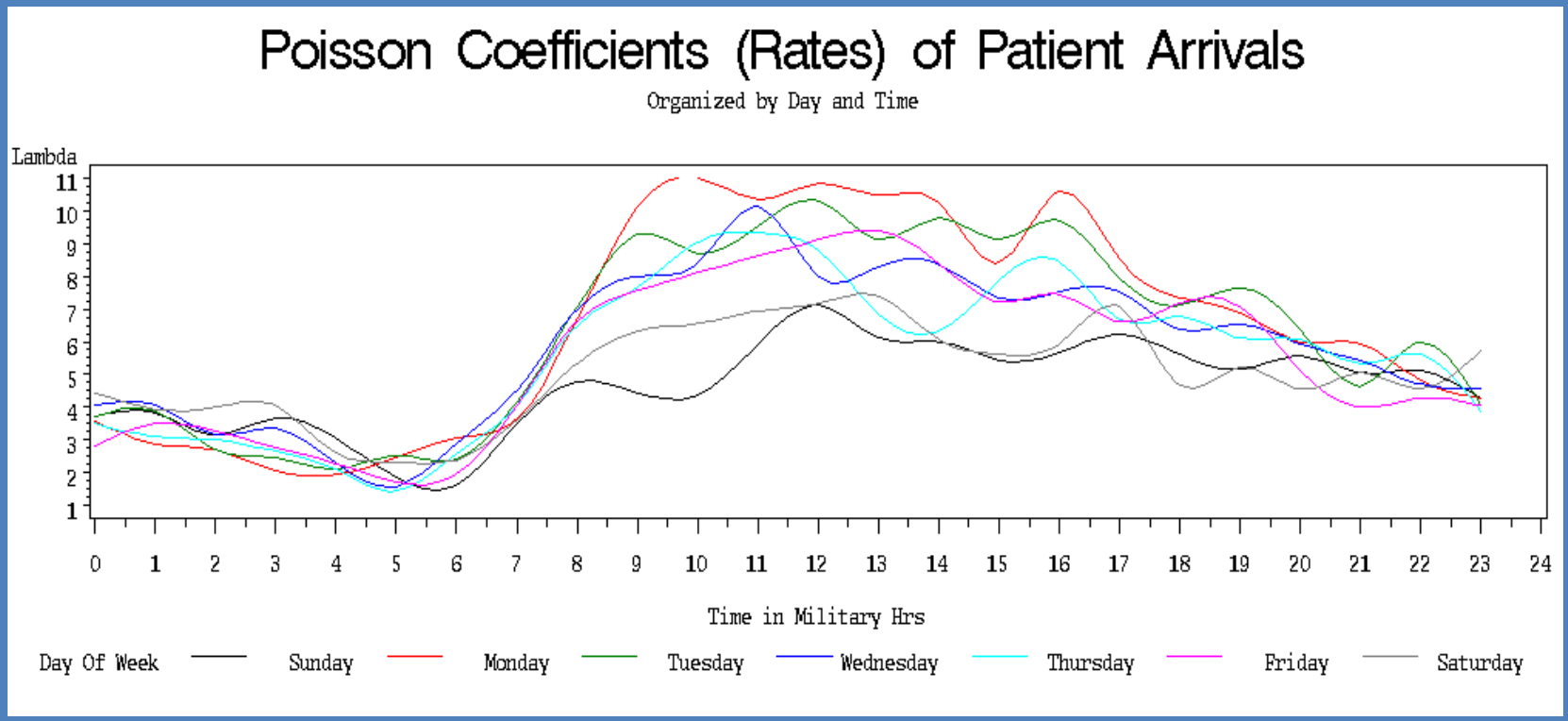
Simulation Process Flow

Useful Statistics Regarding Patient Arrivals Must Be Collected



- **Poisson coefficient represents rate of patient arrivals**
- **Coefficients were calculated for each day of the week by hour**

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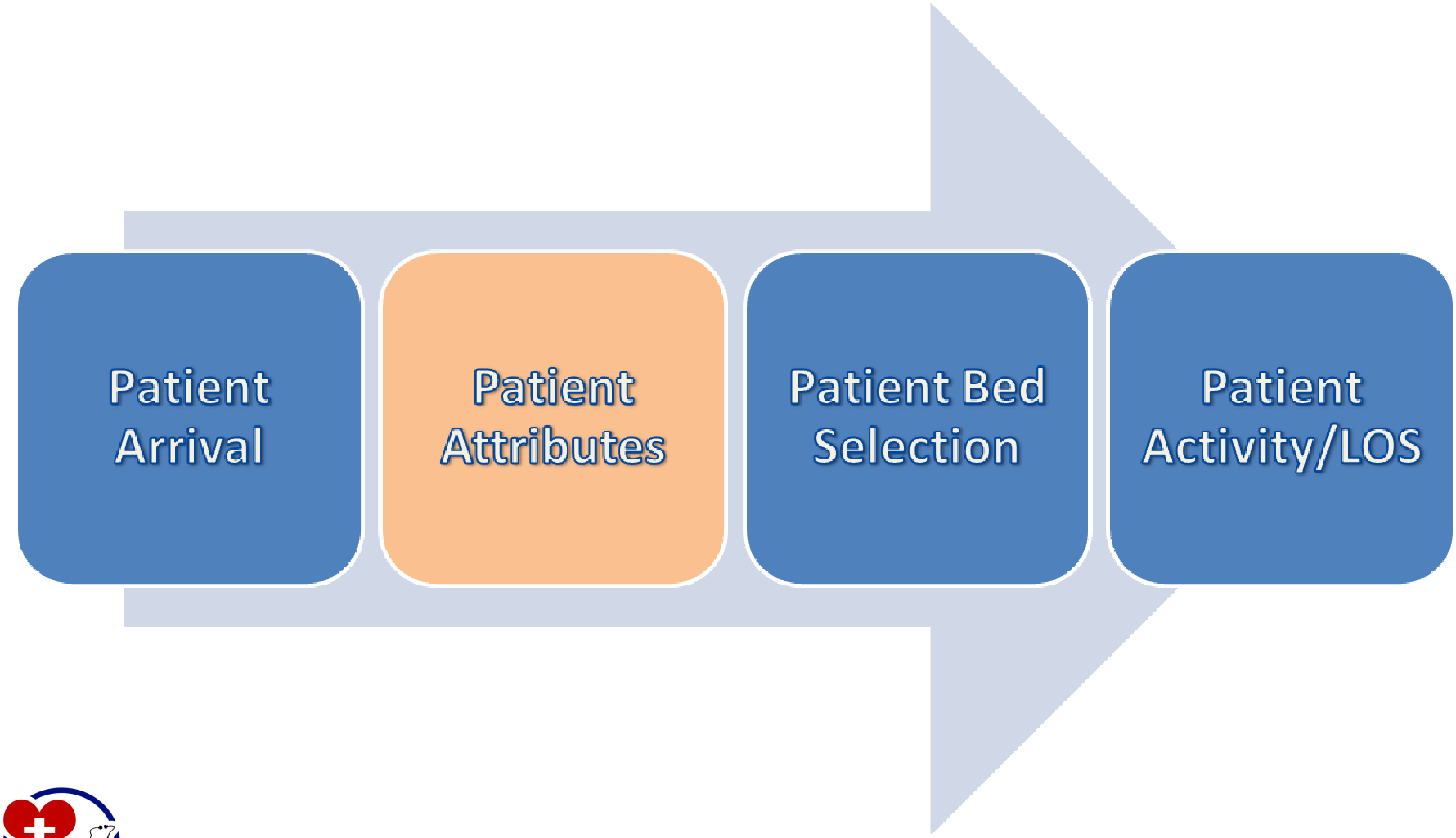
Simulation Process Flow



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Simulation Process Flow

Apply Attributes to Each Patient in Simulation Model

- **Severity Score (1 to 5)**
- **# of Lab Tests Conducted**
- **Triage Time**
- **Probability of Patient Admittance into Inpatient Ward**
- **Probability of Patient Admittance into Ambulatory Zone**

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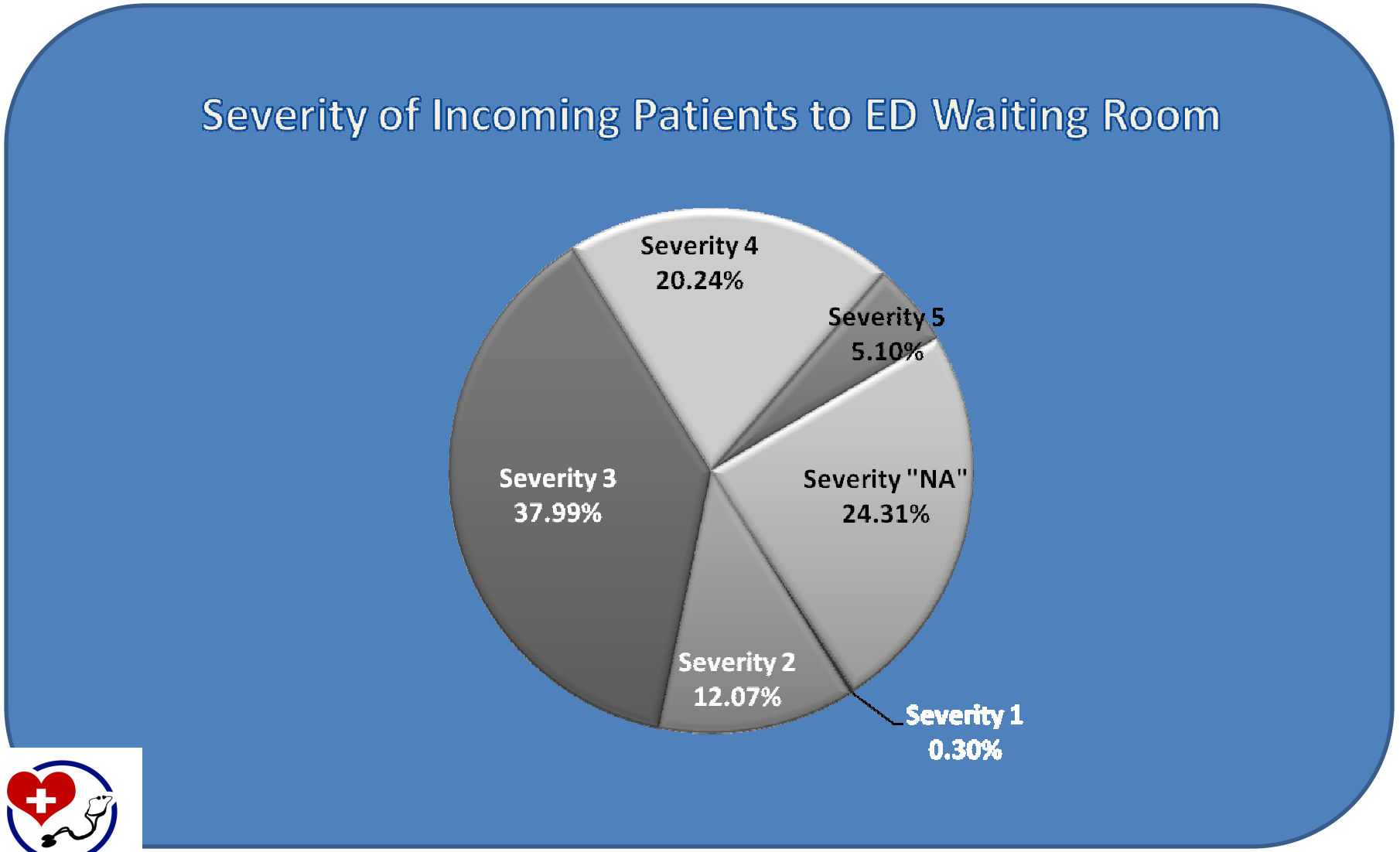
Simulation Process Flow



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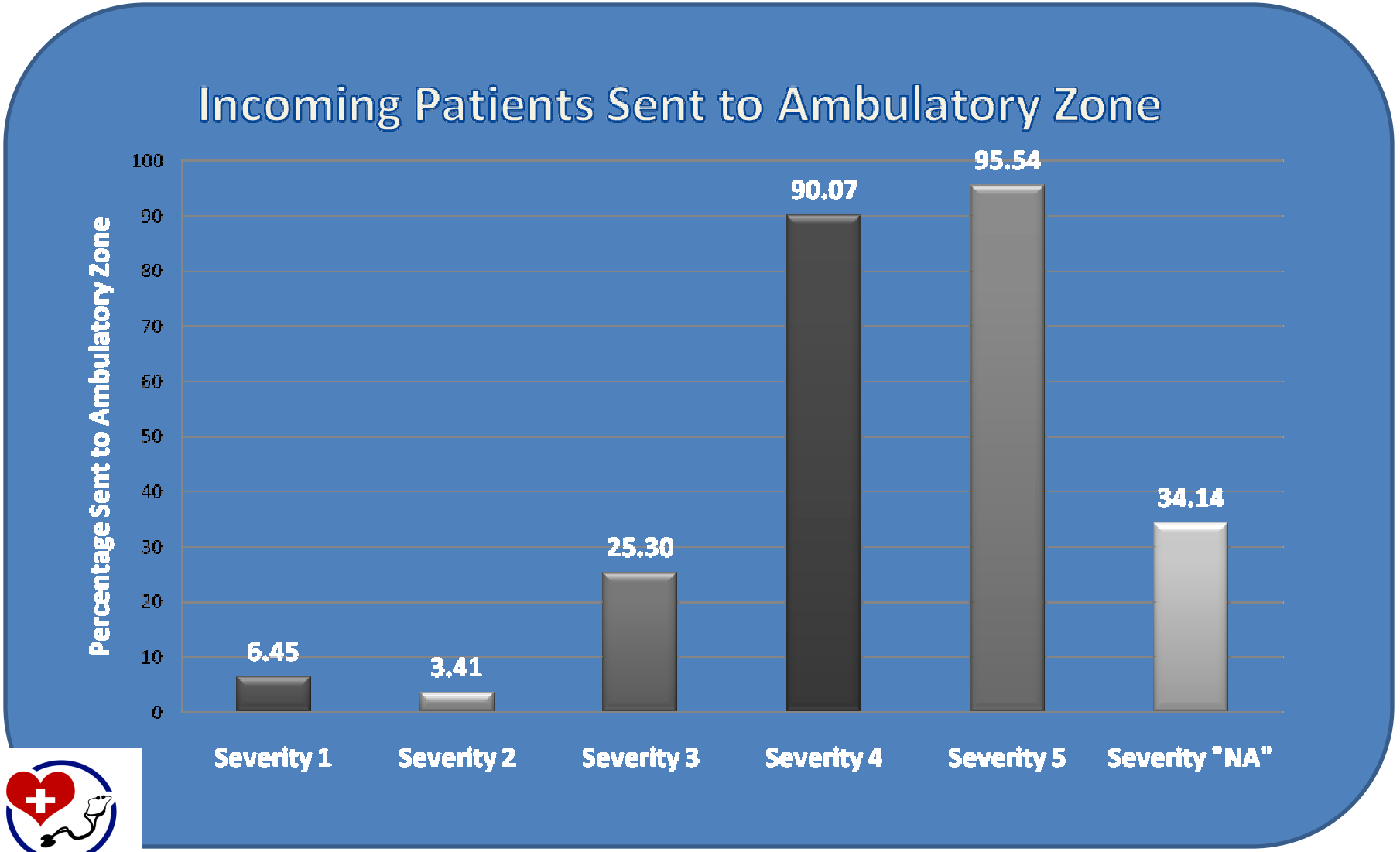
Simulation Process Flow



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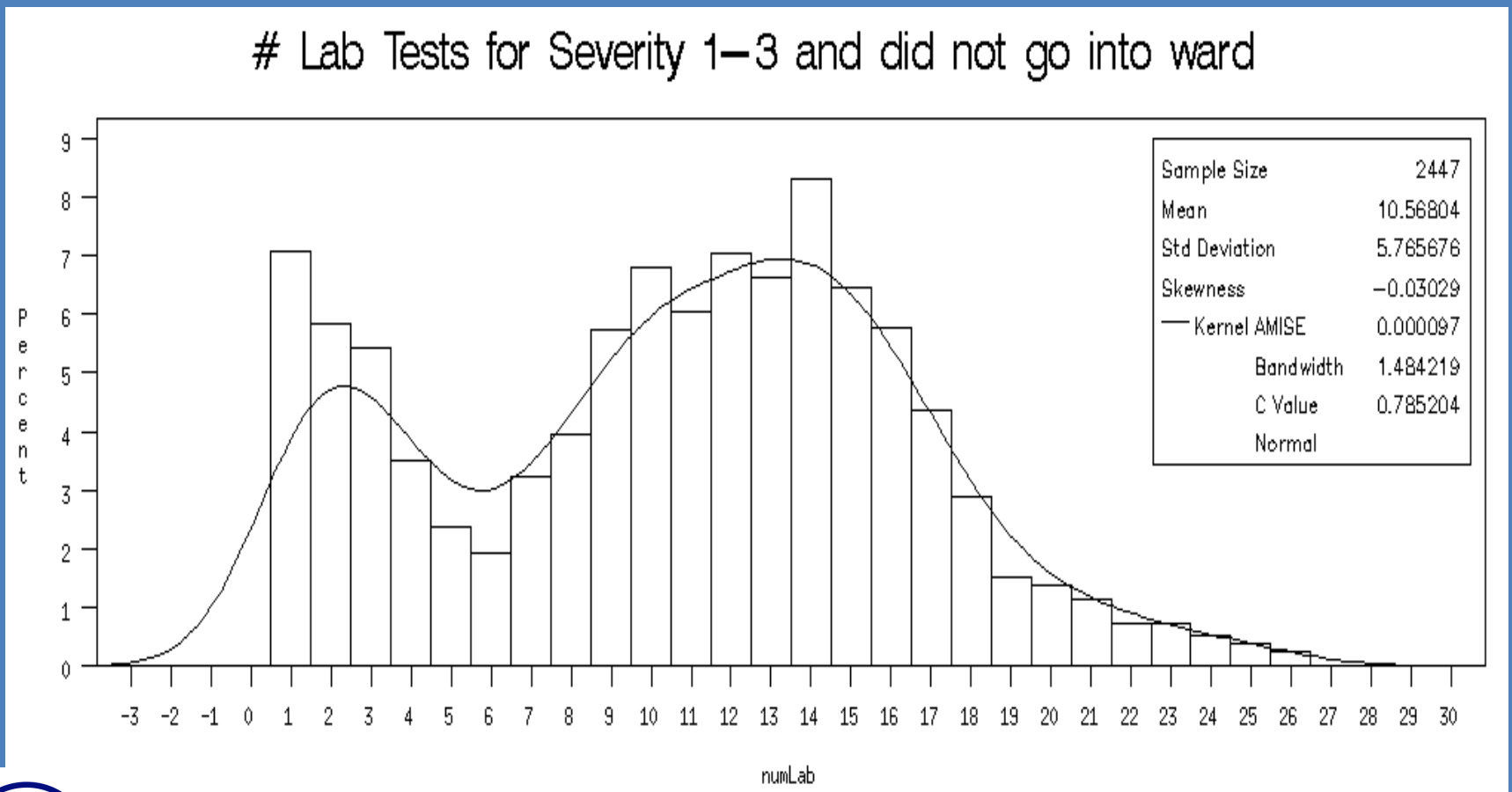
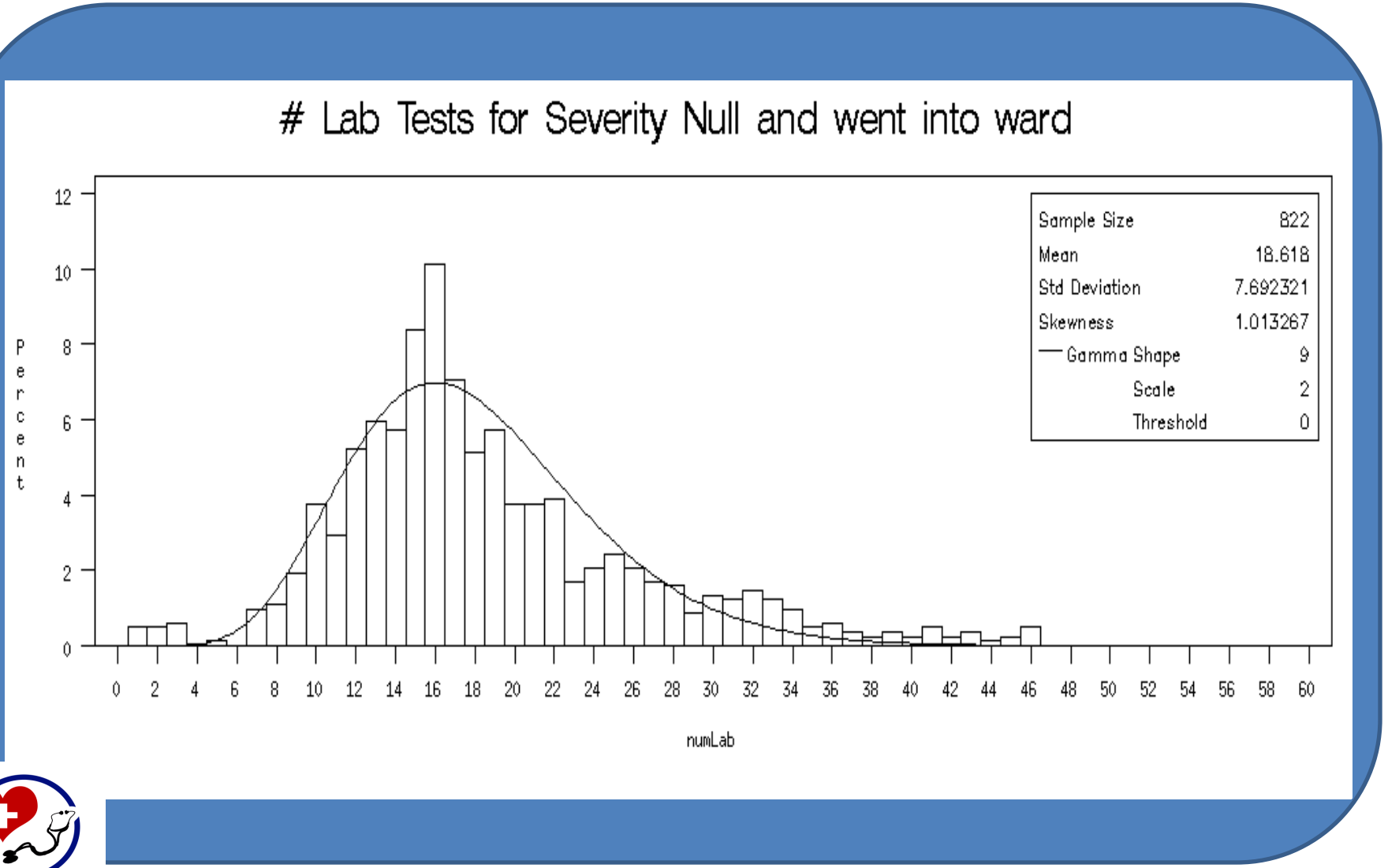
Simulation Process Flow



Simulation Process Flow



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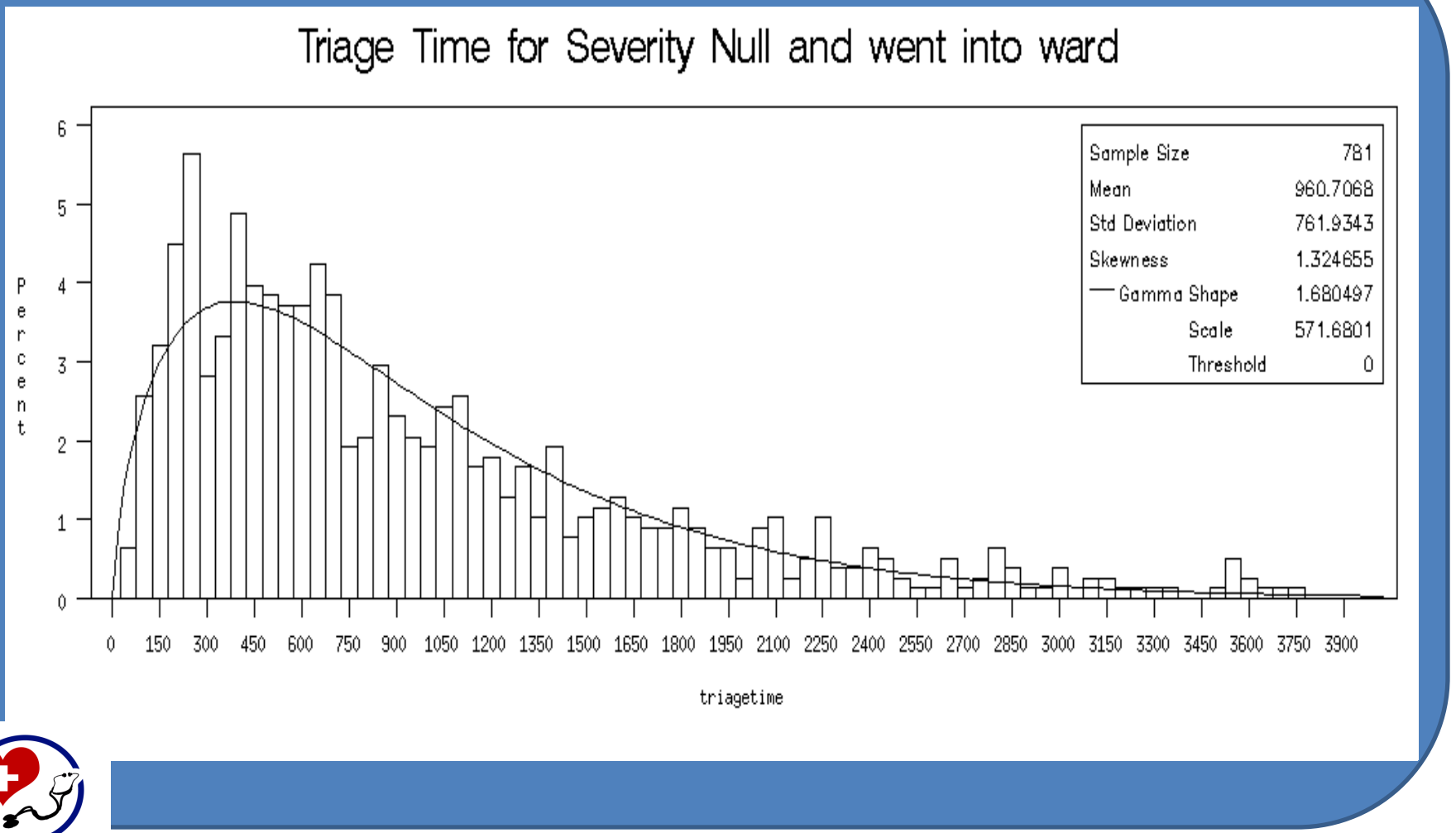
Simulation Process Flow



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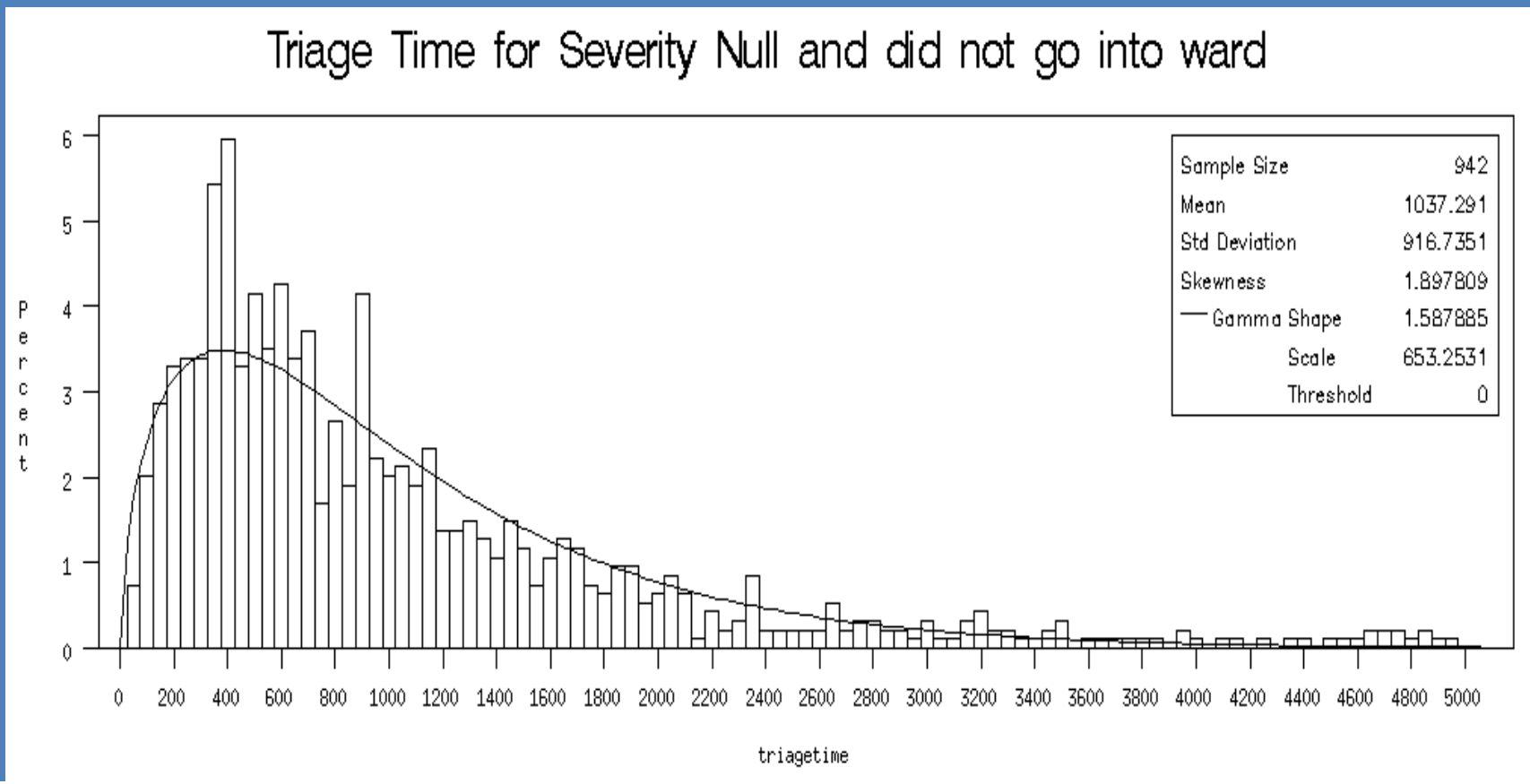
Simulation Process Flow



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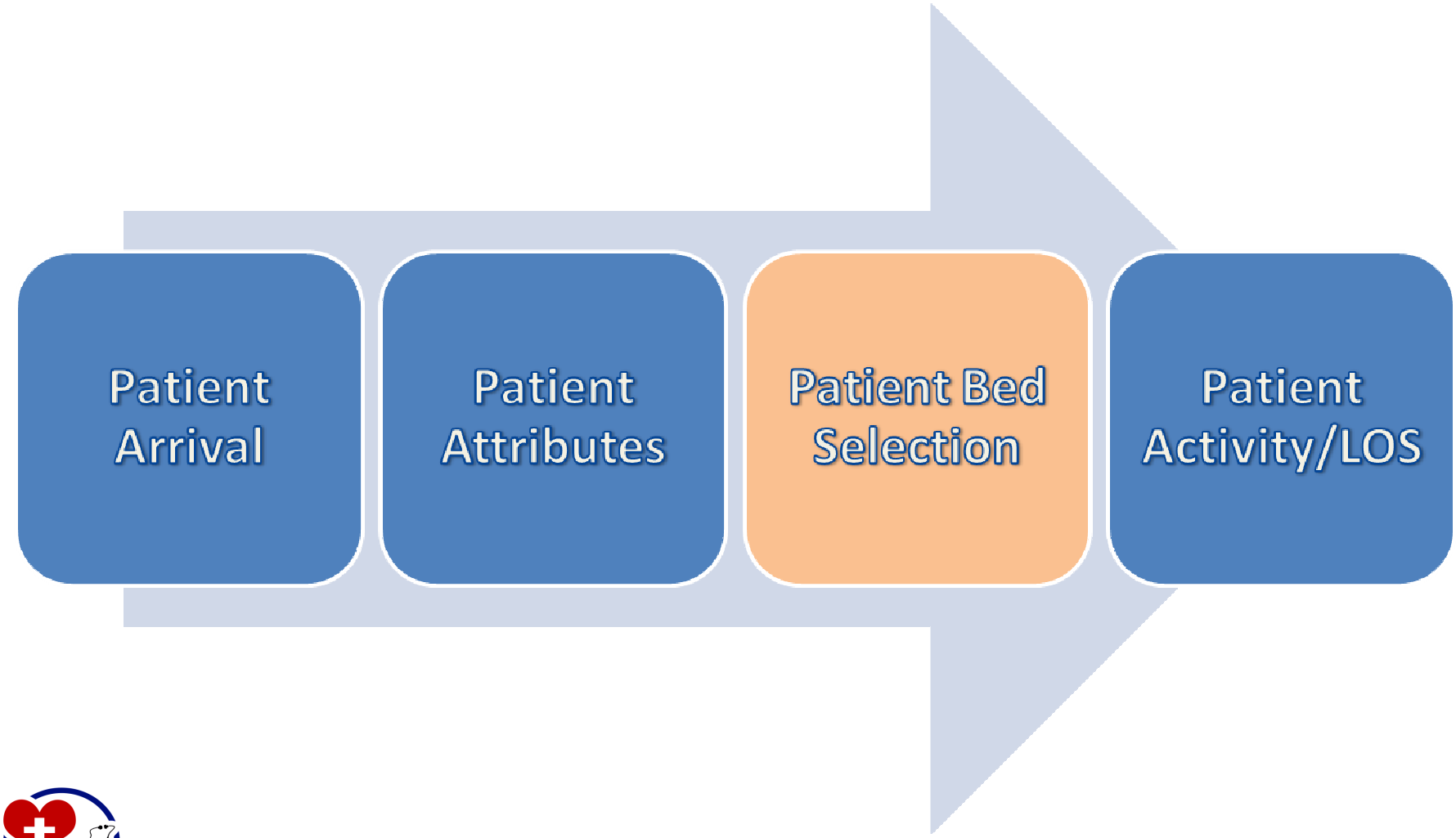
Simulation Process Flow



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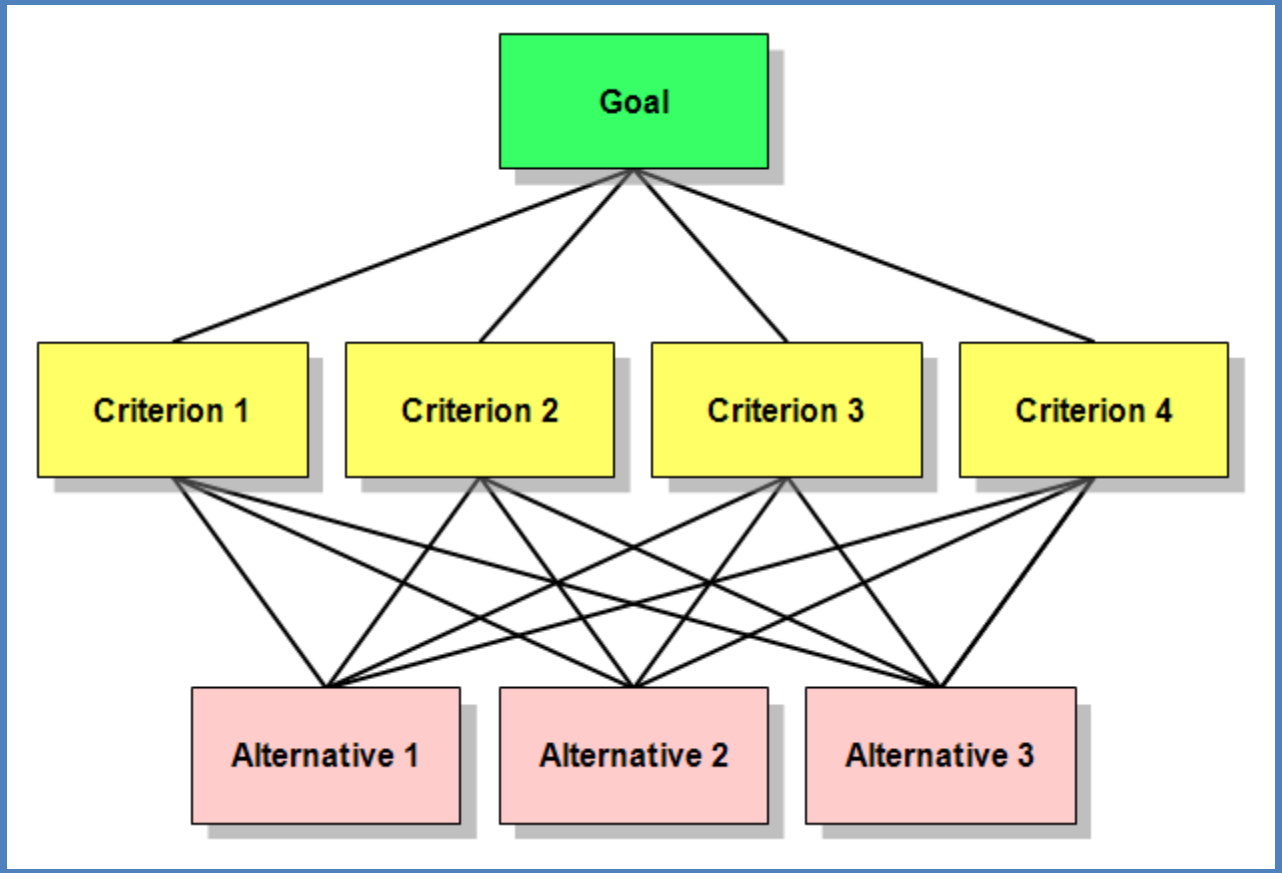
Simulation Process Flow

Analytic Hierarchy Process



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Simulation Process Flow

Analytic Hierarchy Process

- Pairwise Comparison is done for all patients
  - Patient Severity Level
  - # of Times Patient is Passed Over by Triage Nurse
- 16 Classes of Patients are determined
  - Probability of ED Admittance is determined for each class
- No Answer When Called (NAWC) Rate is also taken into account

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Simulation Process Flow

Analytic Hierarchy Process

- **Key initial findings include:**
  - ***Patients with low severity level are often admitted before those with higher severity level***
  - ***The longer patients wait to be admitted, the less likely they are to ever be admitted***

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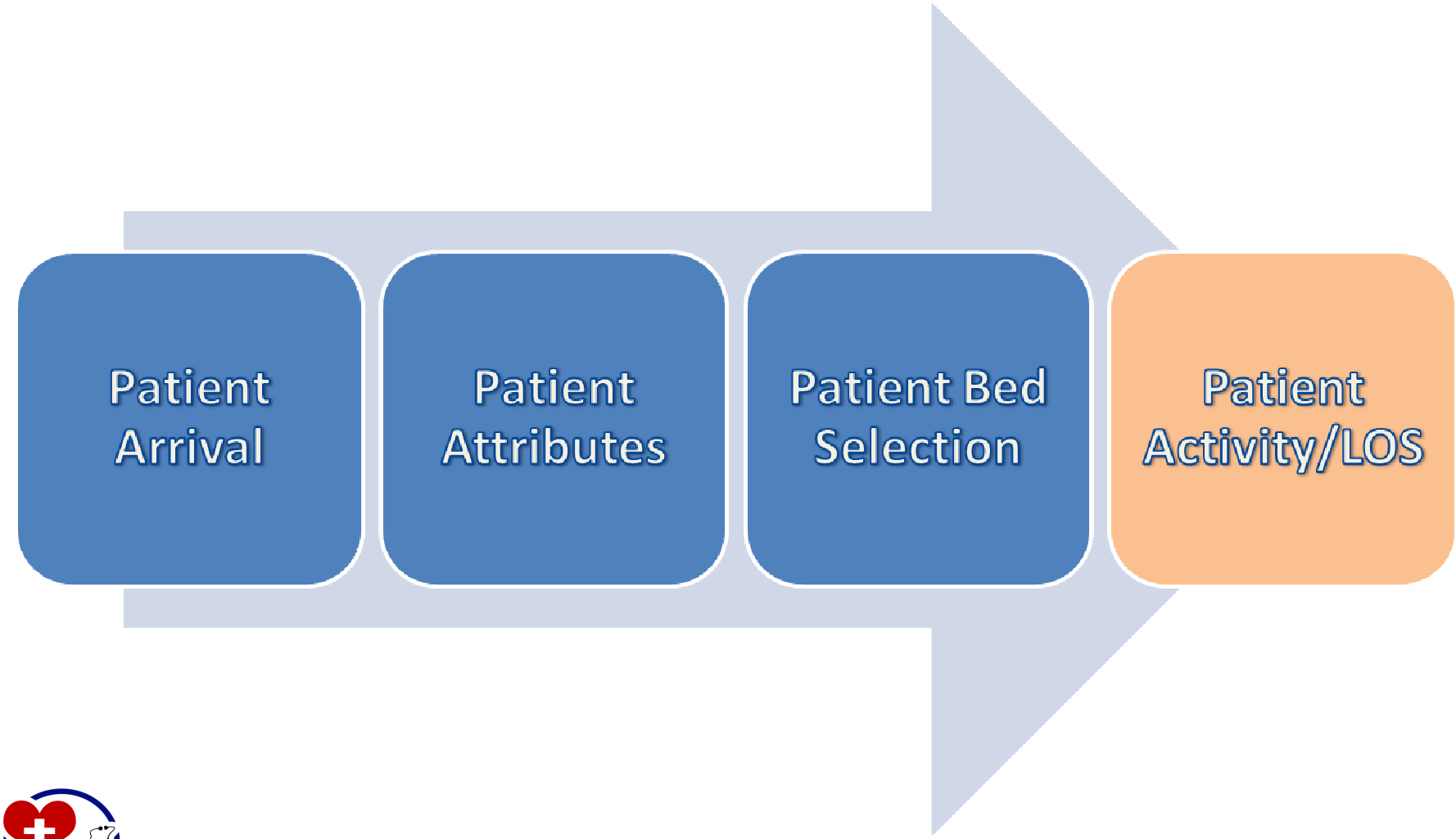
Simulation Process Flow



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Simulation Processes Flow

Parameters Used to Calculate Patient Length of Stay

Basic Parameters *(Historical Data)*

- Patient Severity Level
- # of Lab Tests Conducted
- Whether or not Residents were on duty when patient was admitted

Advanced Parameters *(Live Data)*

- Time spent by doctors during initial patient visit
- Time spent by doctors during typical rounds visit
- Doctor preferences based on severity level, patient condition type, lab tests taken, etc.

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Simulation Processes Flow

Parameters Used to Calculate Patient Length of Stay

- **Created distributions using SAS according to identified parameters**
- **Distributions are used to calculate average Length of Stay (LOS) for patients**

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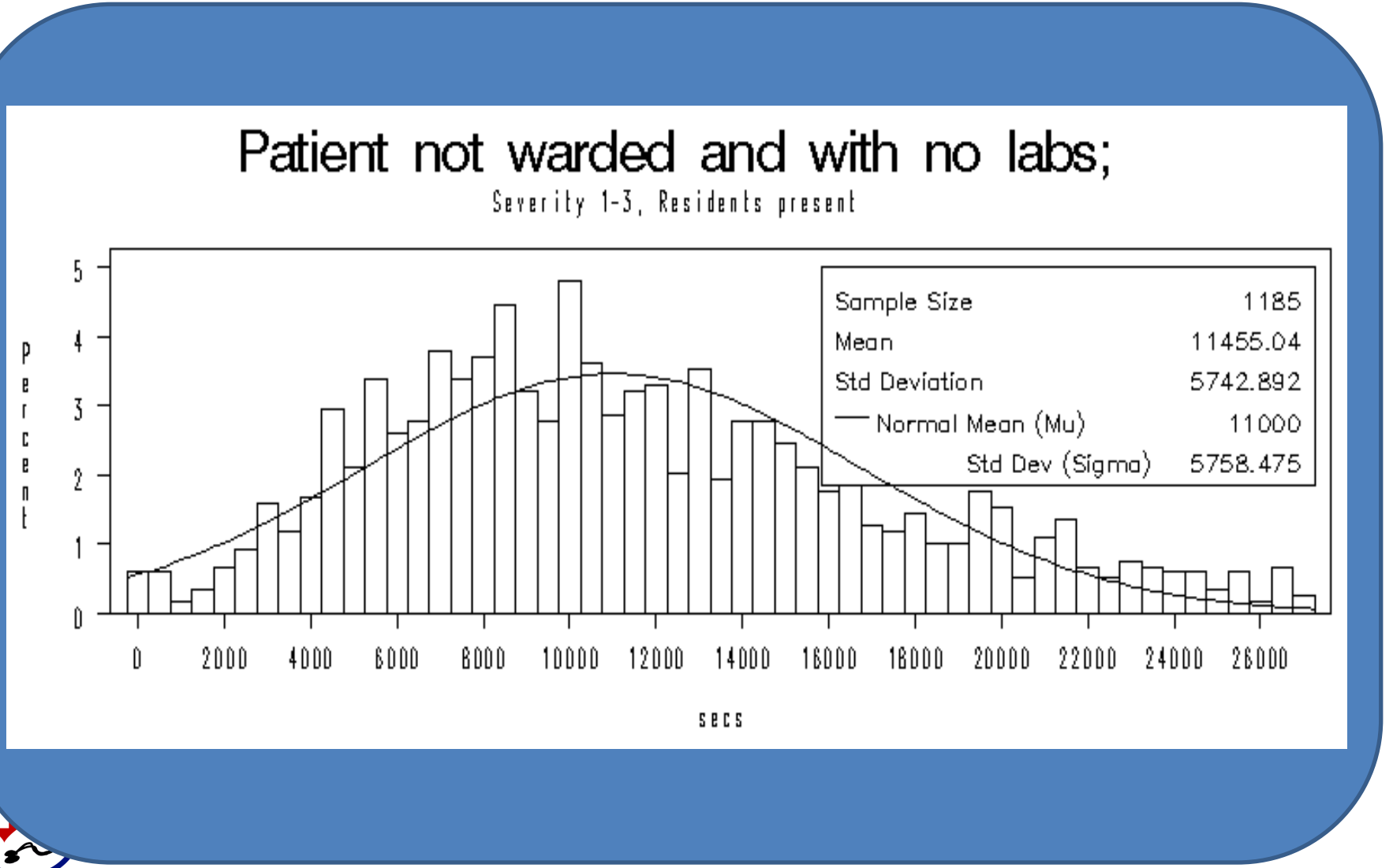
Simulation Processes Flow



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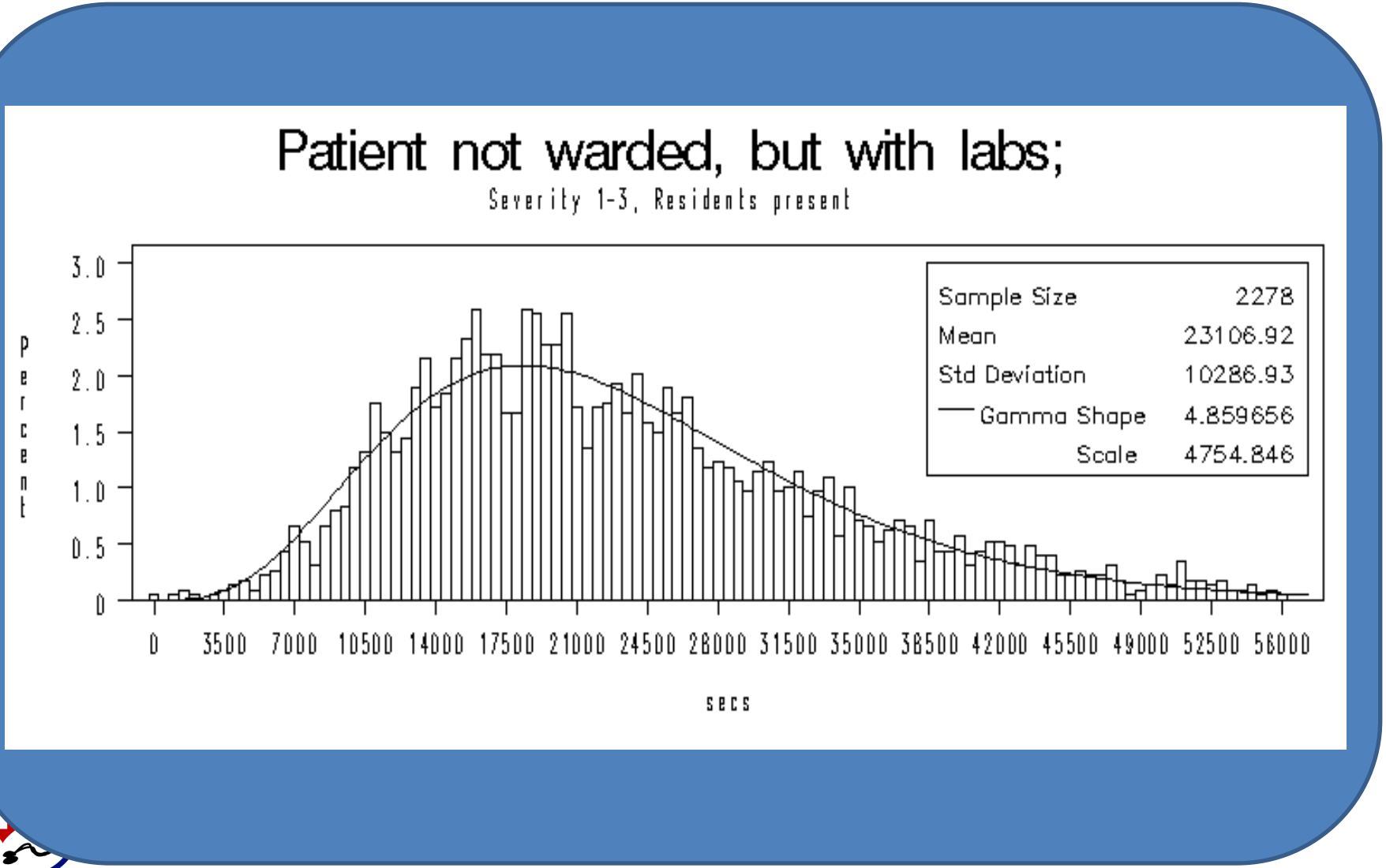
Simulation Processes Flow



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Simulation Processes Flow

Parameters Used to Calculate Patient Length of Stay

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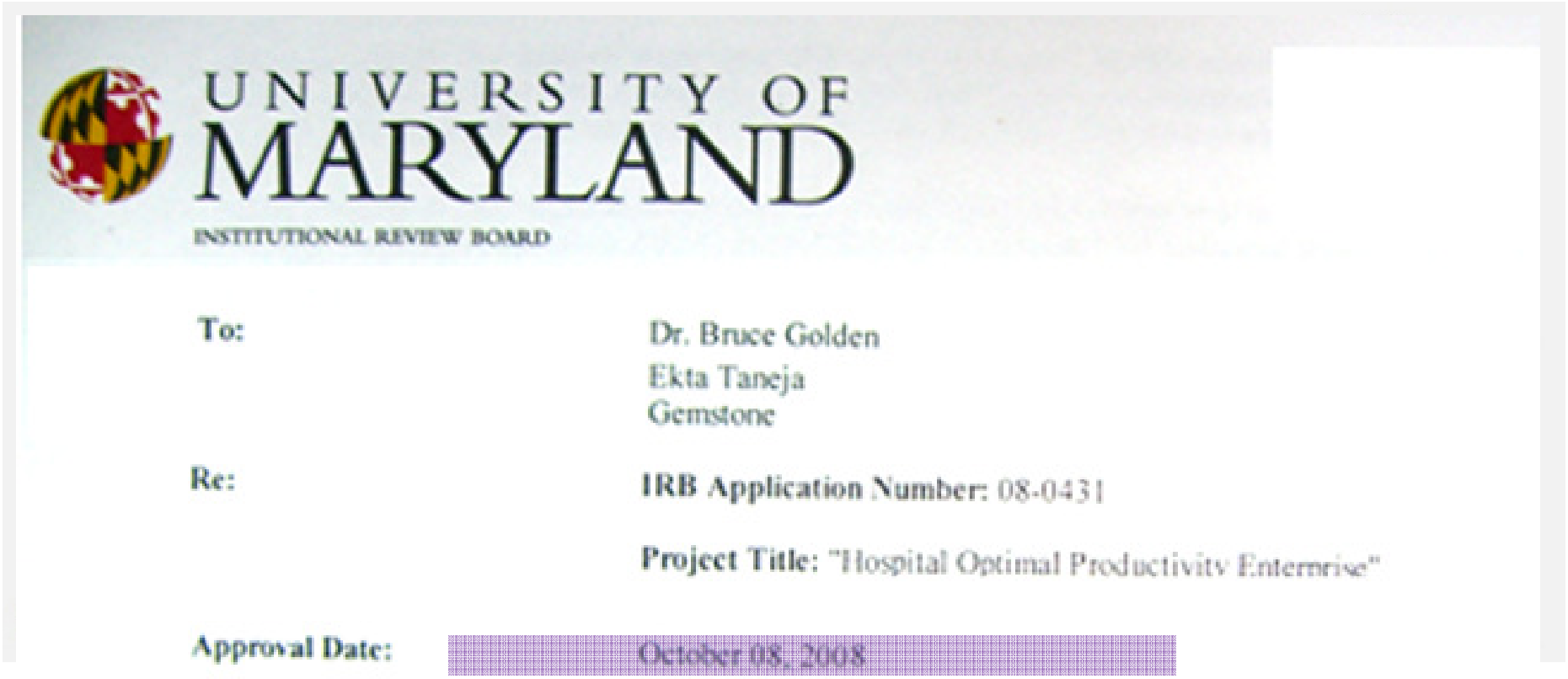
Data Collection

UMD IRB: October 8, 2008



UNIVERSITY OF MARYLAND

INSTITUTIONAL REVIEW BOARD

To: Dr. Bruce Golden
Ekta Taneja
Gemstone

Re: **IRB Application Number:** 08-0431

Project Title: "Hospital Optimal Productivity Enterprise"

Approval Date: October 08, 2008

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Data Collection

UMMC IRB: December 7, 2009

University of Maryland, Baltimore
Institutional Review Board (IRB)
Phone: (410) 706-5037
Fax: (410) 706-4189
Email: hrpo@som.umaryland.edu

New Study Approval Notification

Date: December 7, 2009

To: Jon Mark Hirshon
From: IRB Chair/Vice Chair: Lisa Dixon
RE: HP-00044061
Risk designation: Minimal Risk
Submission Date: 11/3/2009
Original Version #: N/A

Approval for this project is valid from 12/7/2009 to 12/6/2010

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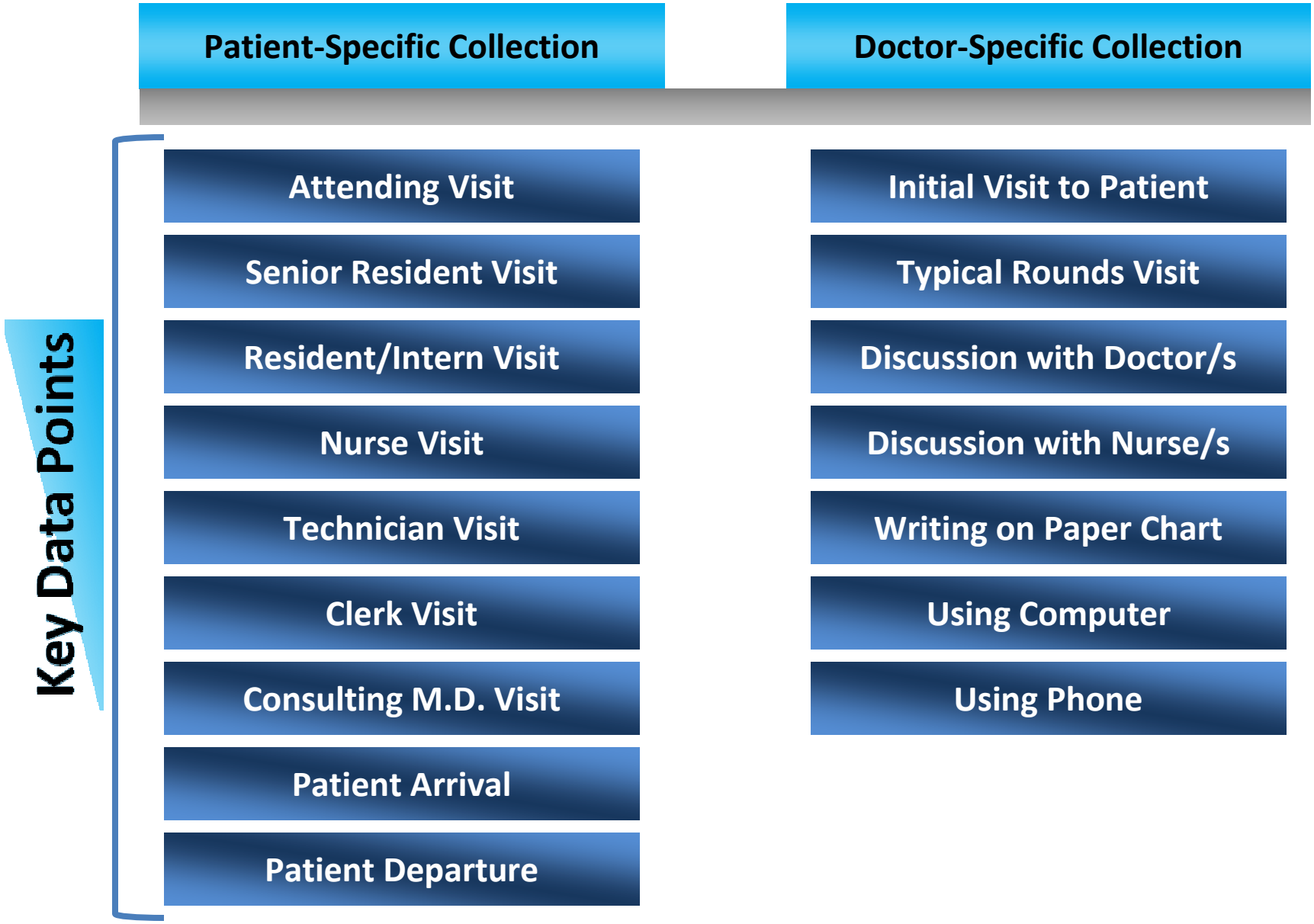
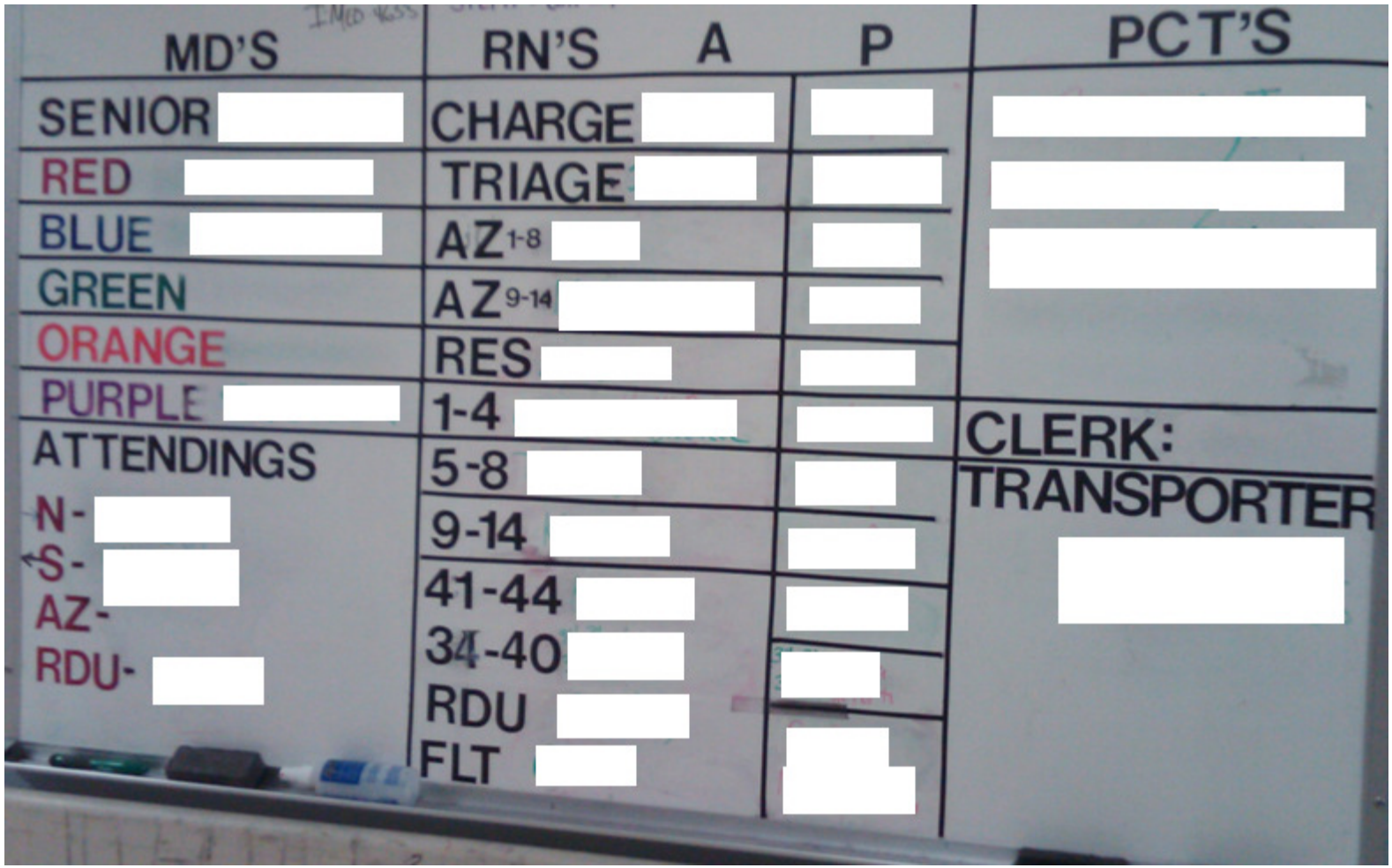
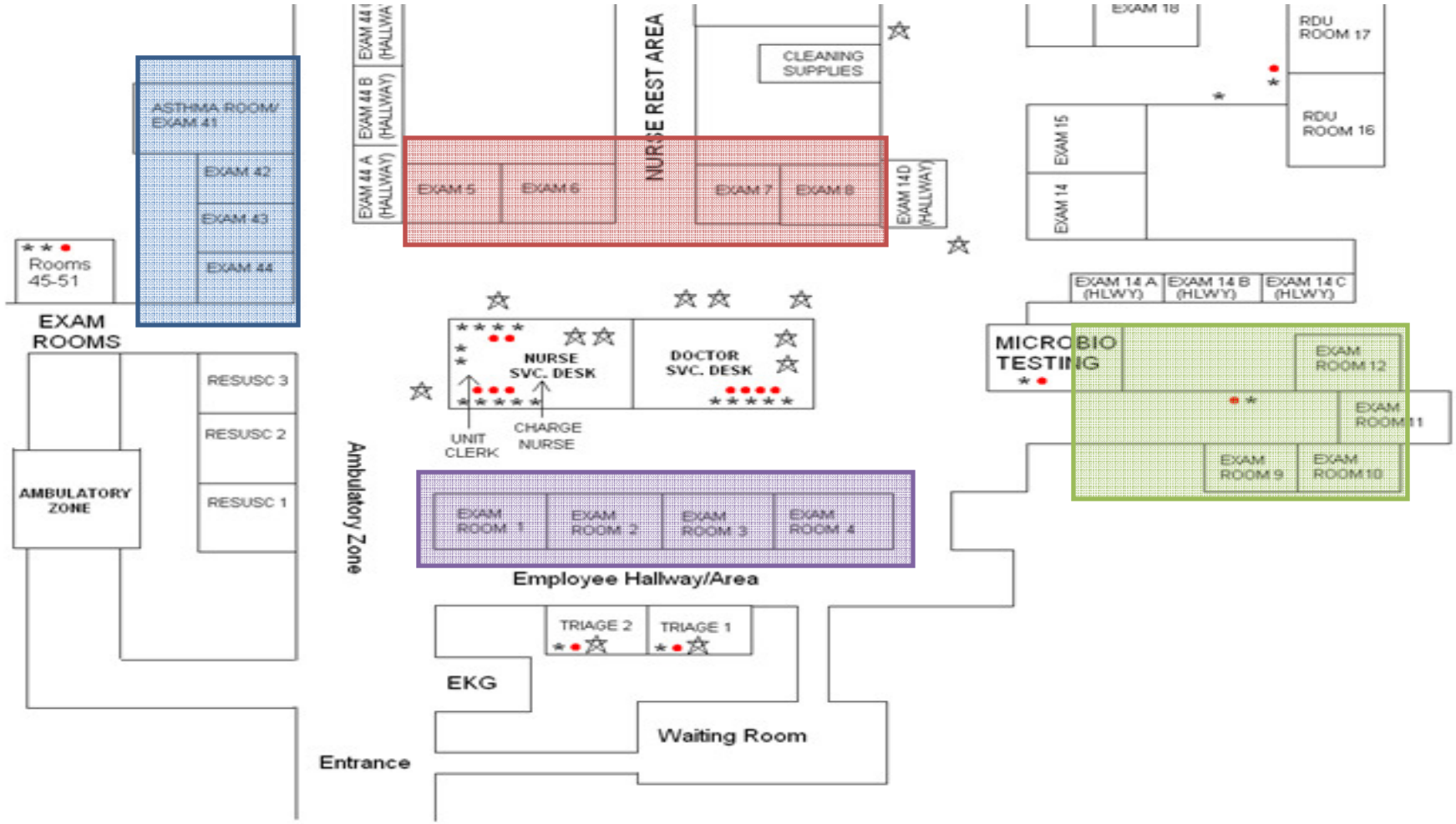
Data Collection



ED Scheduling Board

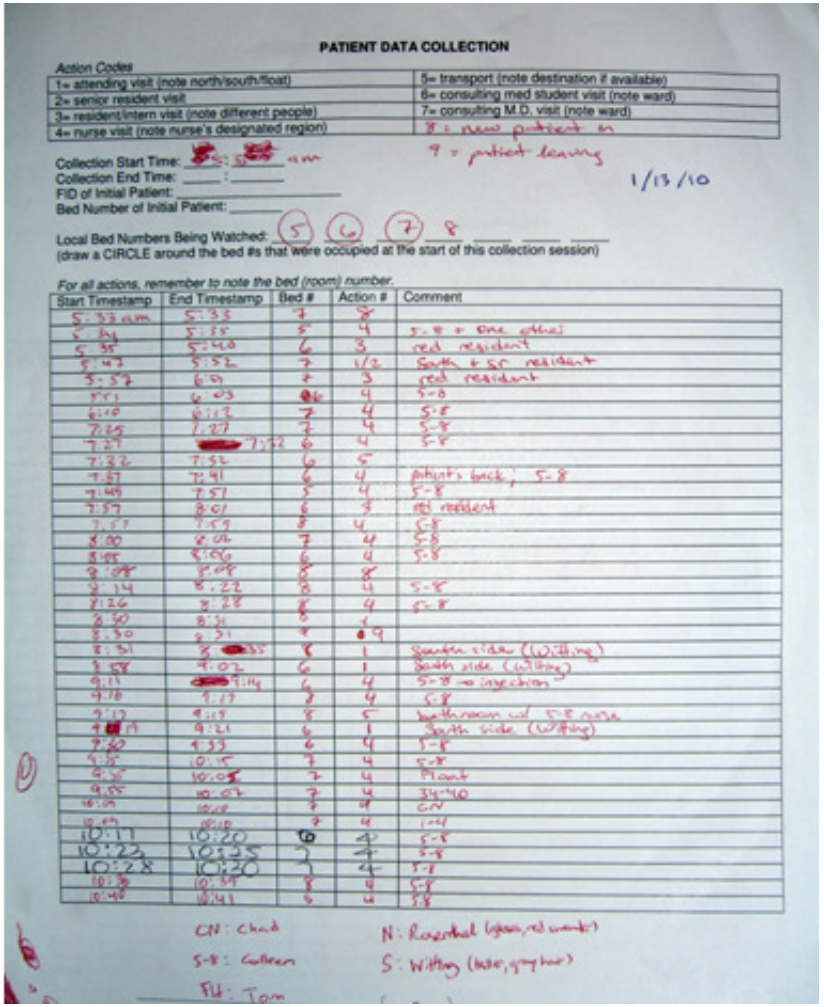


UMMC ED Map



= Collection Area 1 = Collection Area 2 = Collection Area 3 = Collection Area 4

Data Sheets



PATIENT DATA COLLECTION

Action Codes

1= attending visit (note north/south/float)	5= transport (note destination if available)
2= senior resident visit	6= consulting med student visit (note ward)
3= resident/intern visit (note different people)	7= consulting M.D. visit (note ward)
4= nurse visit (note nurse's designated region)	8 = new patient in 9 = patient leaving

Collection Start Time: [redacted] : [redacted] am
Collection End Time: ____ : ____
FID of Initial Patient: ____
Bed Number of Initial Patient: ____

1/13/10

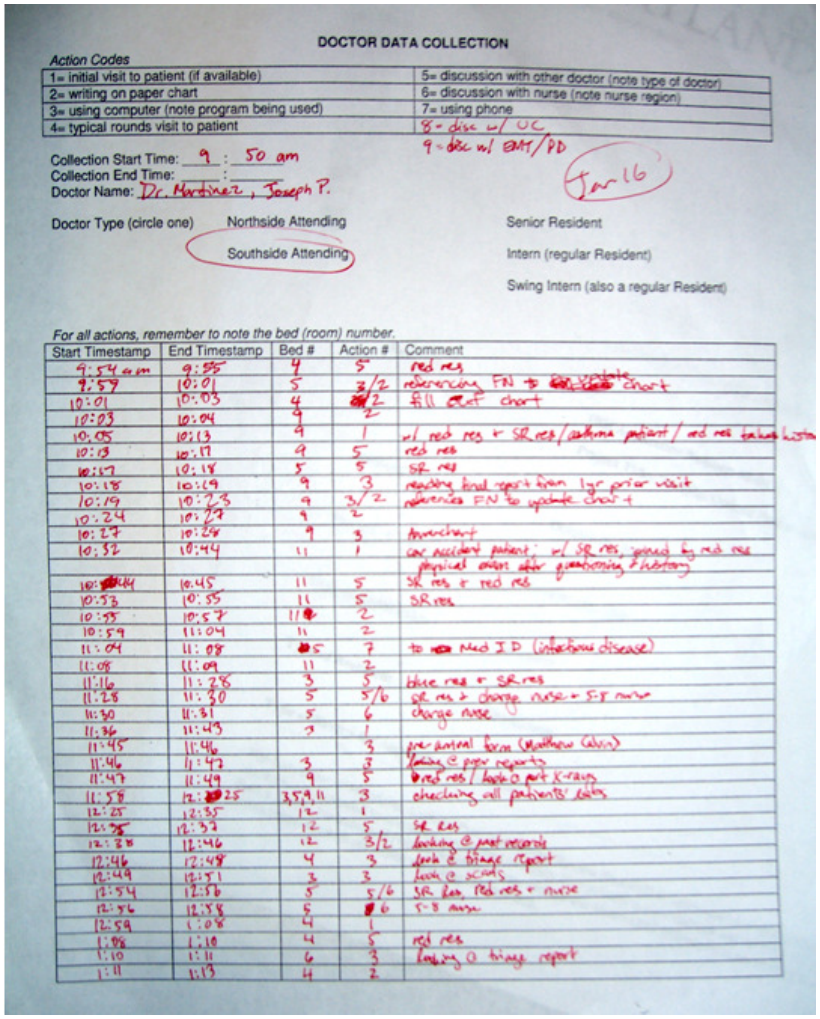
Local Bed Numbers Being Watched: (5) (6) (7) 8 ____ ____ ____
(draw a CIRCLE around the bed #s that were occupied at the start of this collection session)

For all actions, remember to note the bed (room) number.

Start Timestamp	End Timestamp	Bed #	Action #	Comment
5:33 am	5:35	7	8	
5:54	5:55	5	4	5-8 + one other
5:55	5:40	6	3	red resident
5:47	5:52	7	1/2	South + SR resident
5:57	6:01	8	3	red resident
5:51	6:03	6	4	5-8
6:10	6:17	7	4	5-8
7:25	7:27	7	4	5-8
7:27	7:32	6	4	5-8
7:32	7:52	6	5	
7:37	7:41	6	4	patient's back; 5-8
7:49	7:51	5	4	5-8
7:57	8:01	6	3	red resident
7:57	7:59	8	4	5-8
8:00	8:02	7	4	5-8
8:05	8:06	6	4	5-8
8:08	8:09	8	8	
8:14	8:22	6	4	5-8
8:26	8:28	8	4	5-8
8:30	8:31	6	4	
8:30	8:31	4	9	
8:31	8:[redacted]5	5	1	Spanish side (Whitney)
8:58	9:02	6	1	South side (Whitney)
9:11	9:14	6	4	5-8 no injection
9:18	9:19	8	4	5-8
9:19	9:19	8	5	South room w/ 5-8 nurse
9:19	9:21	6	1	South side (Whitney)
9:30	9:33	6	4	5-8
9:35	10:15	7	4	5-8
9:35	10:05	7	4	Mount
9:55	10:07	7	4	34-40
10:09	10:10	7	8	CN
10:09	10:10	7	4	1-4
10:17	10:20	5	4	5-8
10:23	10:25	7	4	5-8
10:28	10:30	7	4	5-8
10:38	10:39	8	4	5-8
10:40	10:41	5	4	5-8

CN: Chad
5-8: Colleen
FH: Tom
N: Rosenthal (glasses, red sweater)
S: Whitney (white, gray hair)

Patient Sheet



DOCTOR DATA COLLECTION

Action Codes

1= initial visit to patient (if available)	5= discussion with other doctor (note type of doctor)
2= writing on paper chart	6= discussion with nurse (note nurse region)
3= using computer (note program being used)	7= using phone
4= typical rounds visit to patient	8= disc w/ UC 9= disc w/ EMT/PD

Collection Start Time: 9 : 50 am
Collection End Time: ____ : ____
Doctor Name: Dr. Martinez, Joseph P.

Jan 16

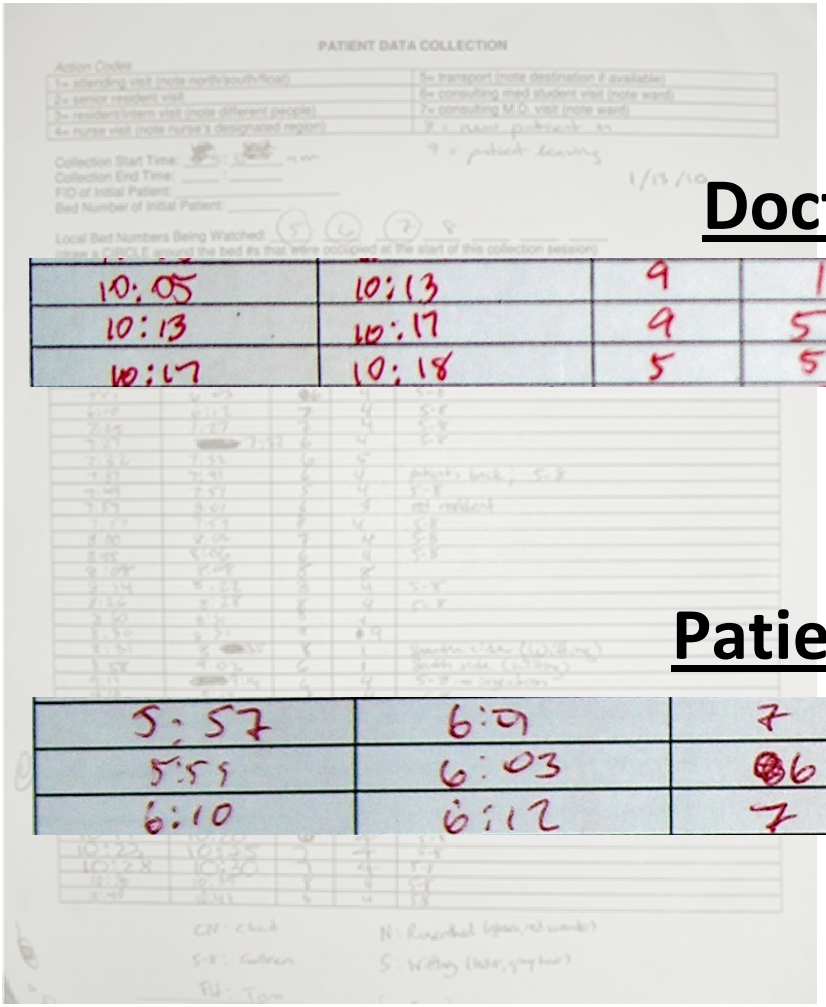
Doctor Type (circle one)
Northside Attending
Southside Attending
Senior Resident
Intern (regular Resident)
Swing Intern (also a regular Resident)

For all actions, remember to note the bed (room) number.

Start Timestamp	End Timestamp	Bed #	Action #	Comment
9:54 am	9:55	4	5	red res
9:59	10:01	5	3/2	referencing FN to [redacted] chart
10:01	10:03	4	[redacted]2	fill out chart
10:03	10:04	4	2	
10:05	10:13	4	1	w/ red res + SR res/asthma patient / red res [redacted]
10:13	10:17	4	5	red res
10:17	10:18	5	5	SR res
10:18	10:19	4	3	reading final report from 1yr prior visit
10:19	10:23	4	3/2	referencing FN to update chart +
10:24	10:27	4	2	
10:27	10:28	4	3	flowchart
10:32	10:44	11	1	car accident patient; w/ SR res, joined by red res physical antics after questioning + history
10:[redacted]44	10:45	11	5	SR res + red res
10:53	10:55	11	5	SR res
10:55	10:57	11[redacted]	2	
10:59	11:04	11	2	
11:04	11:08	[redacted]5	7	to [redacted] Med ID (infectious disease)
11:08	11:09	11	2	
11:16	11:28	3	5	blue res + SR res
11:28	11:30	5	5/6	SR res + charge nurse + 5-8 nurse
11:30	11:31	5	6	charge nurse
11:36	11:43	3	1	
11:45	11:46		3	pre-arrival form (Matthew Calvin)
11:46	11:47	3	3	looking @ paper reports
11:47	11:49	4	5	[redacted] res / back @ pt X-rays
11:58	12:[redacted]25	3,5,9,11	3	checking all patients' labs
12:25	12:35	12	1	
12:[redacted]35	12:37	12	5	SR res
12:38	12:46	12	3/2	looking @ past records
12:46	12:48	4	3	look @ triage report
12:49	12:51	3	3	look @ scans
12:54	12:56	5	5/6	SR res, Red res + nurse
12:56	12:58	5	[redacted]6	5-8 nurse
12:59	1:08	4	1	
1:08	1:10	4	5	red res
1:10	1:11	6	3	looking @ triage report
1:11	1:13	4	2	

Doctor Sheet

Data Sheets

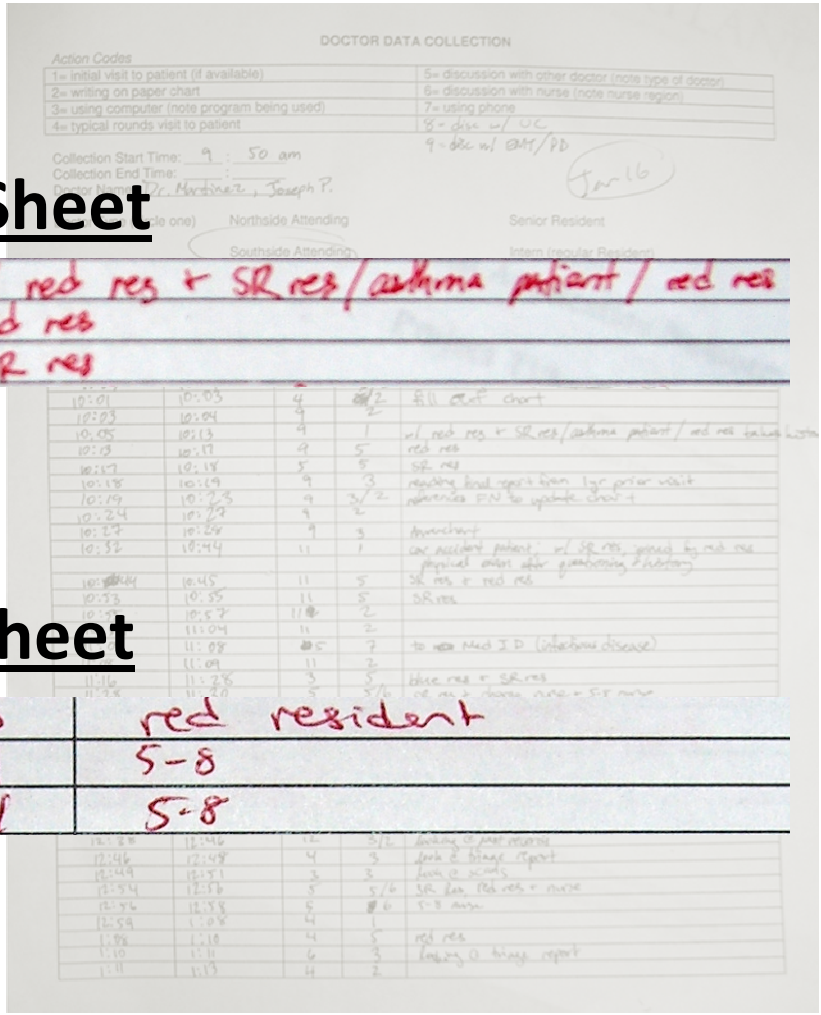


Doctor Sheet

10:05	10:13	9	1	w/ red res + SR res / asthma patient / red res
10:13	10:17	9	5	red res
10:17	10:18	5	5	SR res

Patient Sheet

5:57	6:09	7	3	red resident
5:59	6:03	6	4	5-8
6:10	6:12	7	4	5-8



Patient Sheet

Doctor Sheet

Model Validation

- Metrics in simulation matched closely with their counterparts in the historical data

Metric	Historical Value	Our Value
Patients Per Bed Per Day	2.35	2.37
NAWC Rate	8.02%	8.08%
Time to First Bed	4819s	4909.77s

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Model Validation

- The Kolmogorov-Smirnov test was used to check distributions for the total length of stay, NAWC rate, and time to first bed.

Variable	P-value
Total LOS	<0.001
NAWC Rate	<0.001
Time to First Bed	<0.001

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Experiment Description

- Using simulation model, we tweaked the variable "% of Patients Seen by Residents in ED"
- Tested the effects of this on:
  - Average Time to Discharge Patients
  - Time to First Bed for Patients

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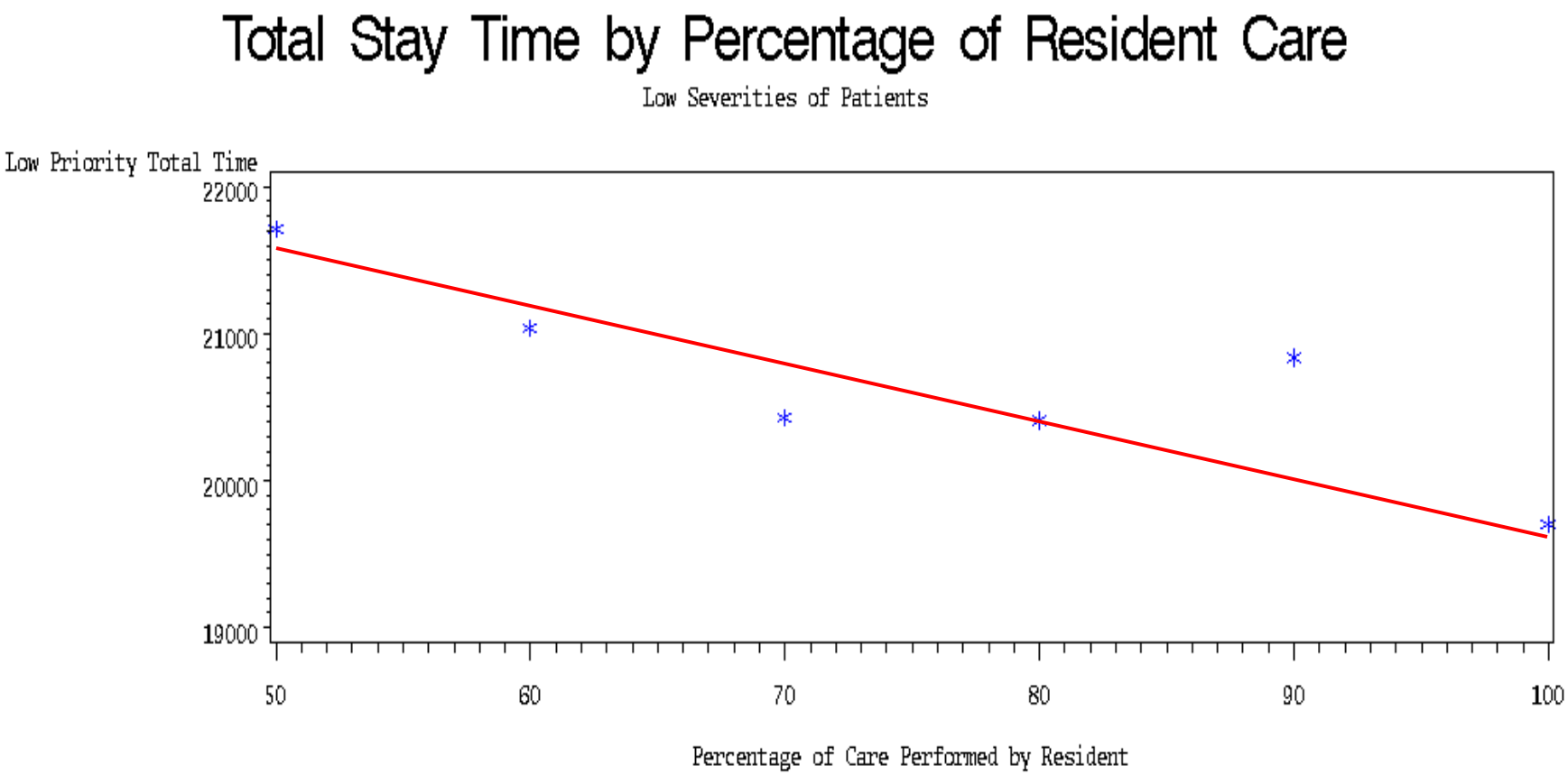
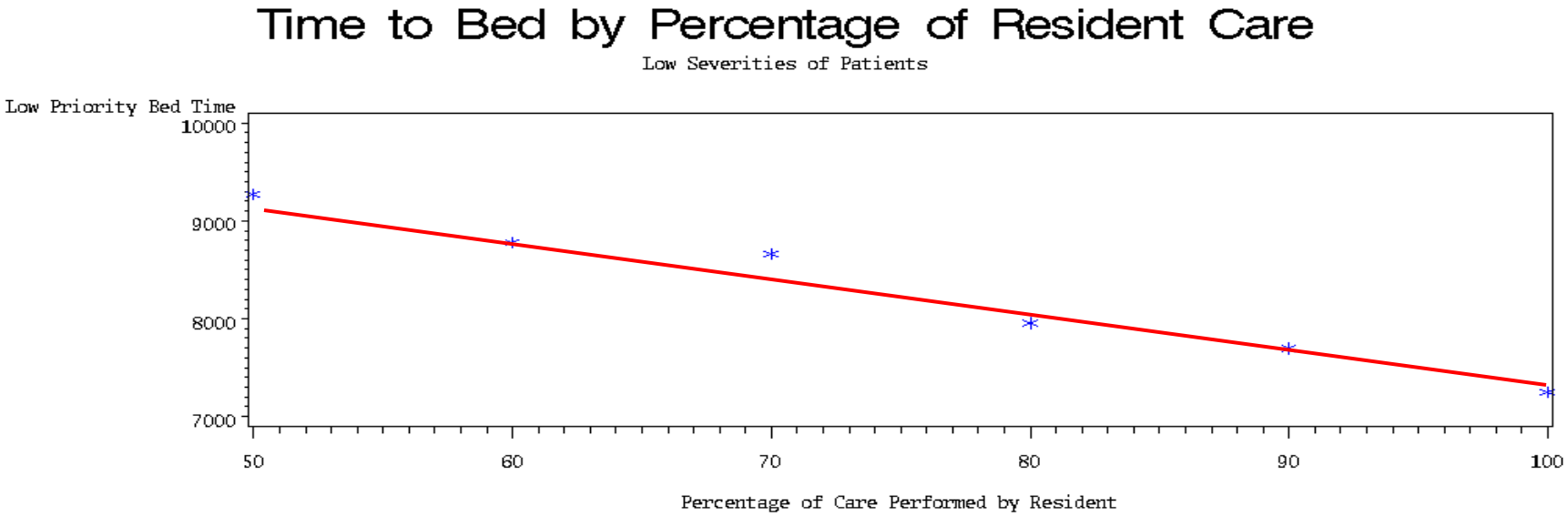
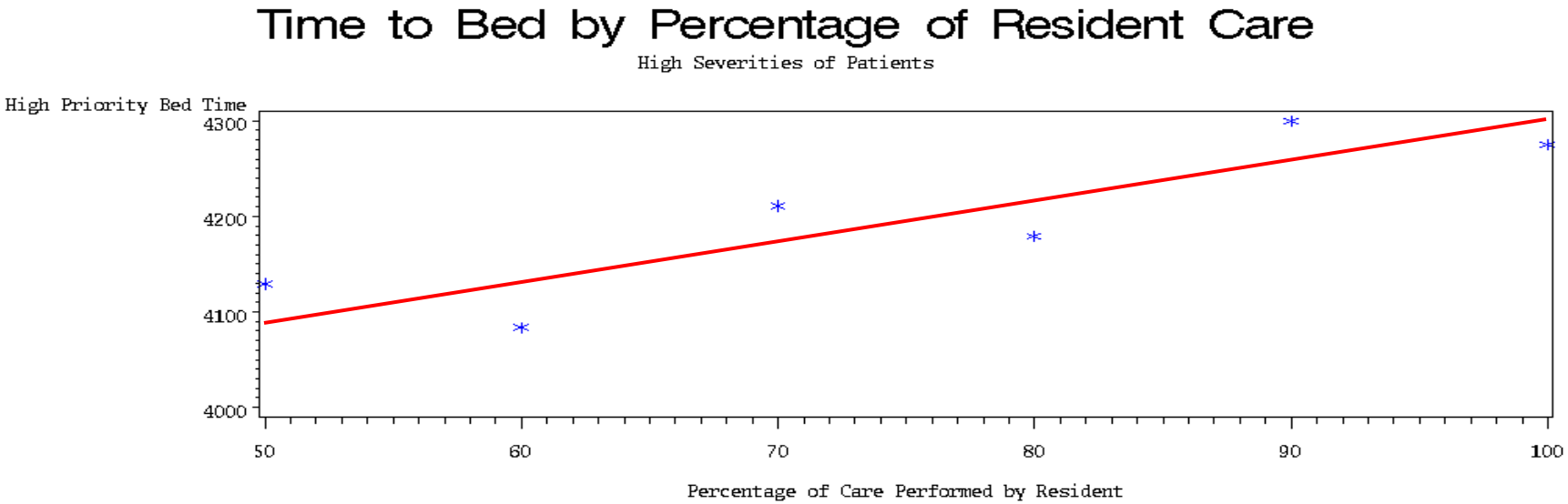
Results


Total Stay Time by Percentage of Resident Care
Low Severities of Patients
Low Priority Total Time
22000
21000
20000
19000
50
60
70
80
90
100
Percentage of Care Performed by Resident

Results


Time to Bed by Percentage of Resident Care
Low Severities of Patients
Low Priority Bed Time
10000
9000
8000
7000
50
60
70
80
90
100
Percentage of Care Performed by Resident


Time to Bed by Percentage of Resident Care
High Severities of Patients
High Priority Bed Time
4300
4200
4100
4000
50
60
70
80
90
100
Percentage of Care Performed by Resident

Conclusions

- Developed a simulation model that is provably similar to actual UMMC ED operations
  - Used quantitative methods to model ED staff's decision making
- From simulation model output, we discovered novel information regarding the effects of residents on ED efficiency

Residents expedite healthcare provided specifically to *Low Priority Patients*

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Acknowledgements

- Dr. Bruce Golden
- Zaida Diaz
- Gemstone Staff
- Jonathan Anderson
- Julie Markowitz
- Esther Yang
- UMD Volunteer Staff
- Peer Advantage Tutors
- Dr. Jon Mark Hirshon
- Mike Harrington
- Gail Brandt
- UMMC ED Staff
- Dr. Carter Price
- Will Herring
- Sean Barnes
- David Anderson

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Questions?

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