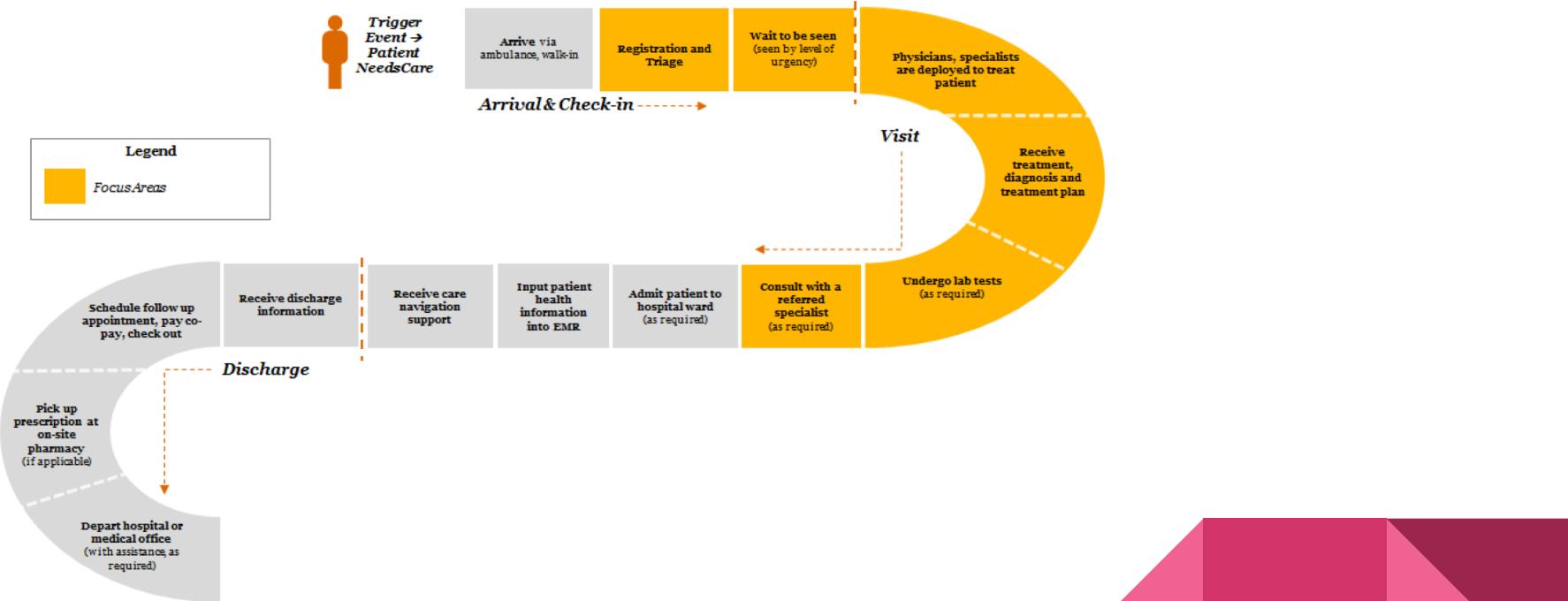


A Proposal to Improve ER Efficiency, Effectiveness, and Accessibility

Presented by: Victor Agbafe, Rahul Chowdhury, Sherilyn Shiycin Wang,
and Shweta Chopra

Of the entire patient journey through ER, the workforce optimization to maintain excessive patient wait time and overuse of the ER are the most serious concerns for a provider



Hope Hospital currently relies on Emergency Management System (EMS) - a queue management software to manage queues and perform triaging functions



Hope Hospital

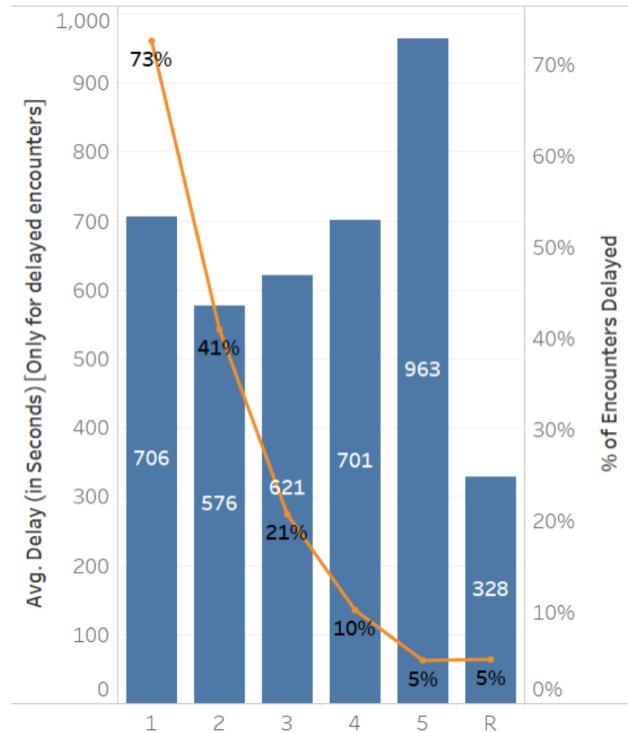
- Tertiary Level Cancer Hospital
- Offers free treatment for all patient
- Funded through philanthropic contributions from the community
- Located in the Middle East

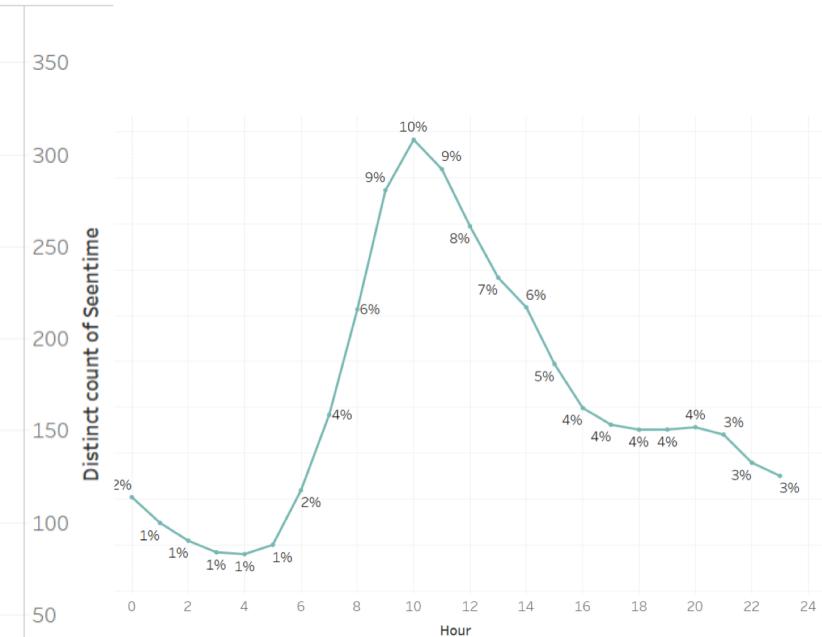
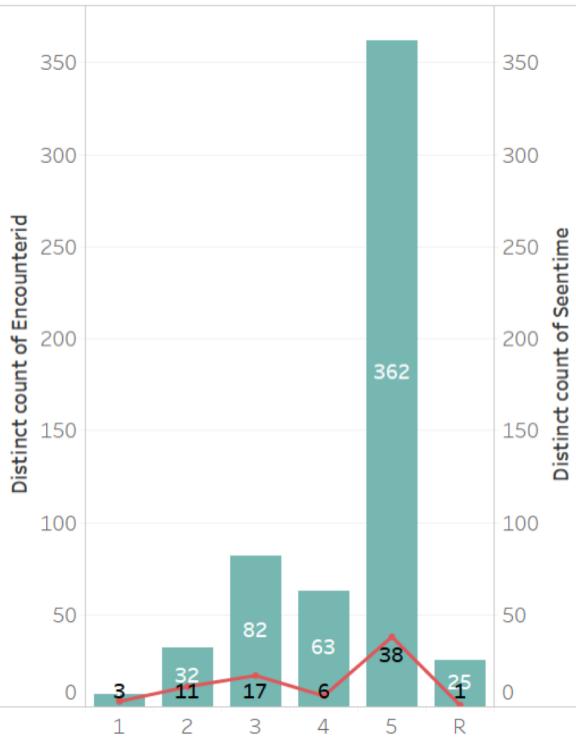
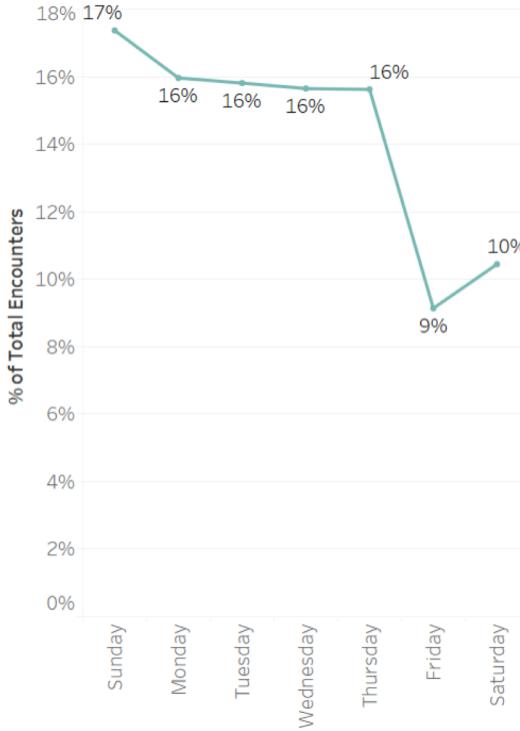


Emergency Room

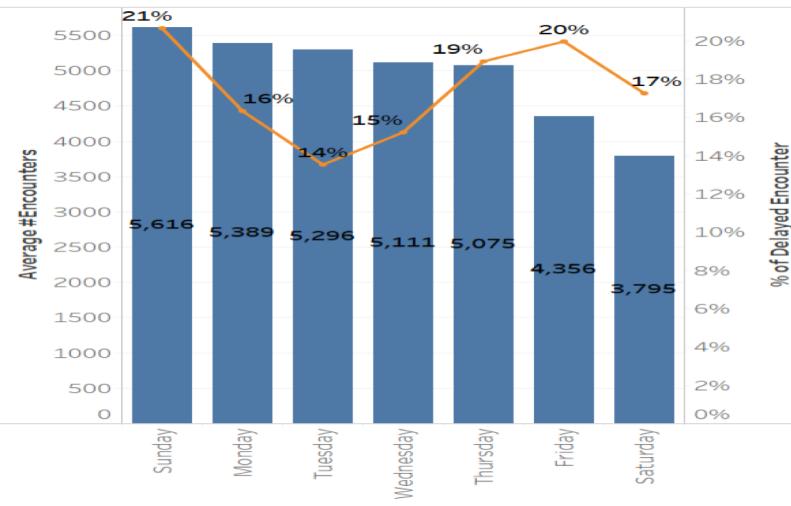
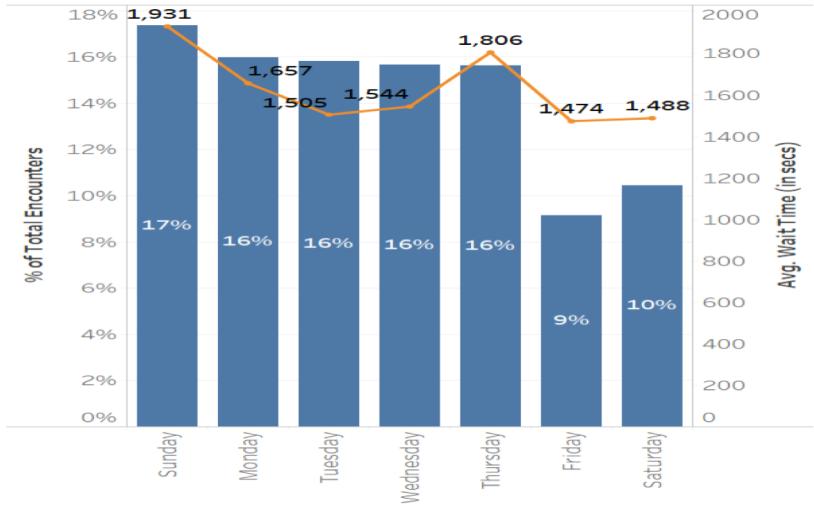


The wait time target for each triage category are not met in most of the severe cases and has an average of ~12 mins for the most critical patients





Similar proportion of delays and wait times on weekends even for a decrease in # encounters indicate there is room for improvement in planning shift allocation



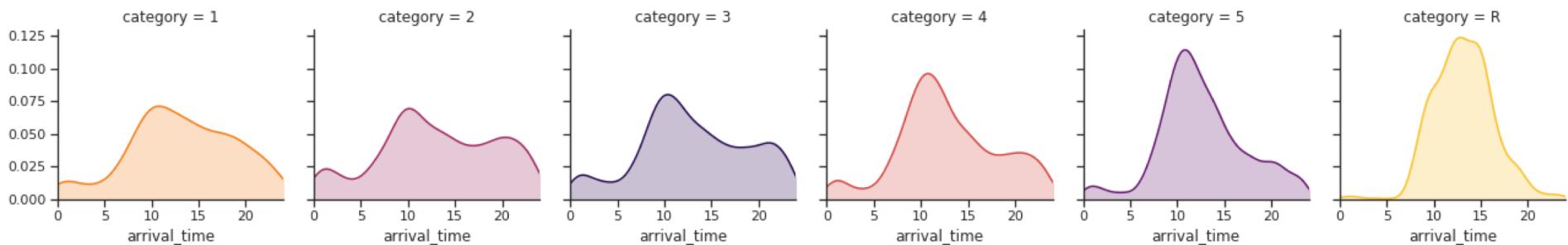
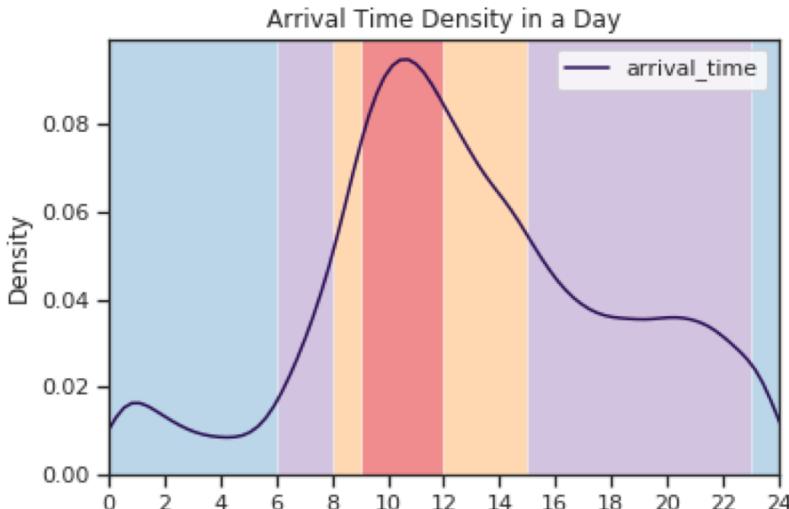
Of the entire patient journey through ER, the workforce optimization to maintain excessive patient wait time and overuse of the ER are the most serious concerns for a provider

- There is a backlog of more traumatic patients in the Emergency room and an excess of people who don't need emergency services.
- Due to the free costs of the emergency room and the ability to simply walk in, patients are incentivized to overuse emergency room services.
- There is a need to more efficiently segment, prioritize, and treat patients in a timely manner based on need.

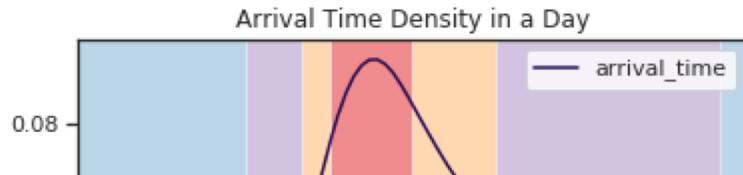
Excessive number of 3,4 and 5 category encounters simply tend to overcrowd the ER and hint at a potential moral hazard issue

Month	Triage Category					
	1	2	R	3	4	5
Jan	65	417	124	683	456	1,018
Feb	41	386	147	600	438	946
Mar	69	472	149	709	559	1,060
Apr	37	208	7	307	196	475
May	63	529		758	459	1,027
Jun	50	547	70	682	354	865
Jul	68	544	235	762	420	868
Aug	59	544	123	720	336	912
Sep	58	456	153	709	331	975
Oct	48	489	119	766	445	1,084
Nov	54	482	145	697	424	1,074
Dec	59	532	191	758	517	1,205

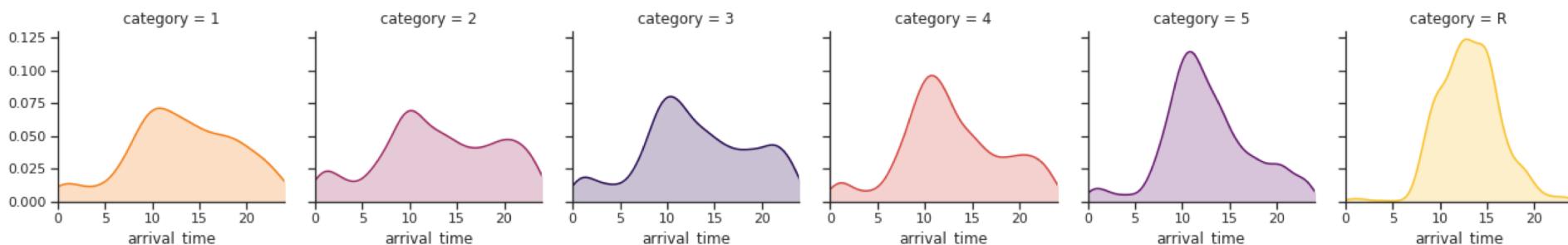
Discriminating a Day into Peak, Non-Peak, Medium, Extremely Low periods



Discriminating a Day into Peak, Non-Peak, Medium, Extremely Low periods



Name	Period	Percentage	Average Number of Visits
Peak	9-12	0.27613536294	8.29084041549
Non-Peak	8-9, 12-15	0.26861869418	6.04886685552
Medium	6-8, 15-23	0.35583092213	3.20509915014
Extremely Low	0-6, 23-24	0.09941502076	1.27923917442



Estimating Lab Time by Maximum Likelihood with TensorFlow

encounter id	room number	encounter time	call time	seen time	completed time	lab
406	1	4/17/18 8:36 AM	4/17/18 8:43 AM	4/17/18 8:57 AM	4/17/18 12:52 PM	CBC, Blood Chemistry

$$\overline{completed_time(i) - seen_time(i)} = \sum_{l \in lab(i)} t_l + r_{room(i)} + \epsilon_{mean}$$

$$\text{Var}(completed_time(i) - seen_time(i)) = \sum_{l \in lab(i)} \sigma_l + \delta_{room(i)} + \epsilon_{std}$$

$$Xt = y_{mean}$$

$$X\sigma = y_{var}$$

Estimating Lab Time by Maximum Likelihood with TensorFlow

$$Xt = y_{mean}$$

$$X\sigma = y_{var}$$

Test	Mean	Variance
Urine Analysis	0.62131184	0.3841998
Urine Culture	-0.52856034	1.3210369
Bleeding Profile	-1.5207993	0.82174927
CBC	-1.3526688	0.1
Blood Chemistry	-1.3425401	0.1
Room 1	1.3596053	1.8585489
Other Labs	-0.3192535	1.0111718
...

Policy Approach

Queing

Step 1

Primary Care integration to have a social service staff that address patients social needs

Step 2

Direct Initial 911 calls through a team of primary care physicians who may choose to see the patients themselves

**Moral
Harzard**

Policy 1

Sliding Scale yearly hospital reimbursement. Based on level 4 and 5 ER visit that also incorporates ACO type savings.

Behavioral Focus

Loss Aversion as patients would want to keep reimbursement at the same initial level

Triaging

Step 1

Physically segment the ER based on one's triage number, double wait times for triage four and five, notify nurses a minute before triage time ends

Behavioral Focus

This would be to address the cognitive limits that people face in helping nurses admit patients more efficiently.

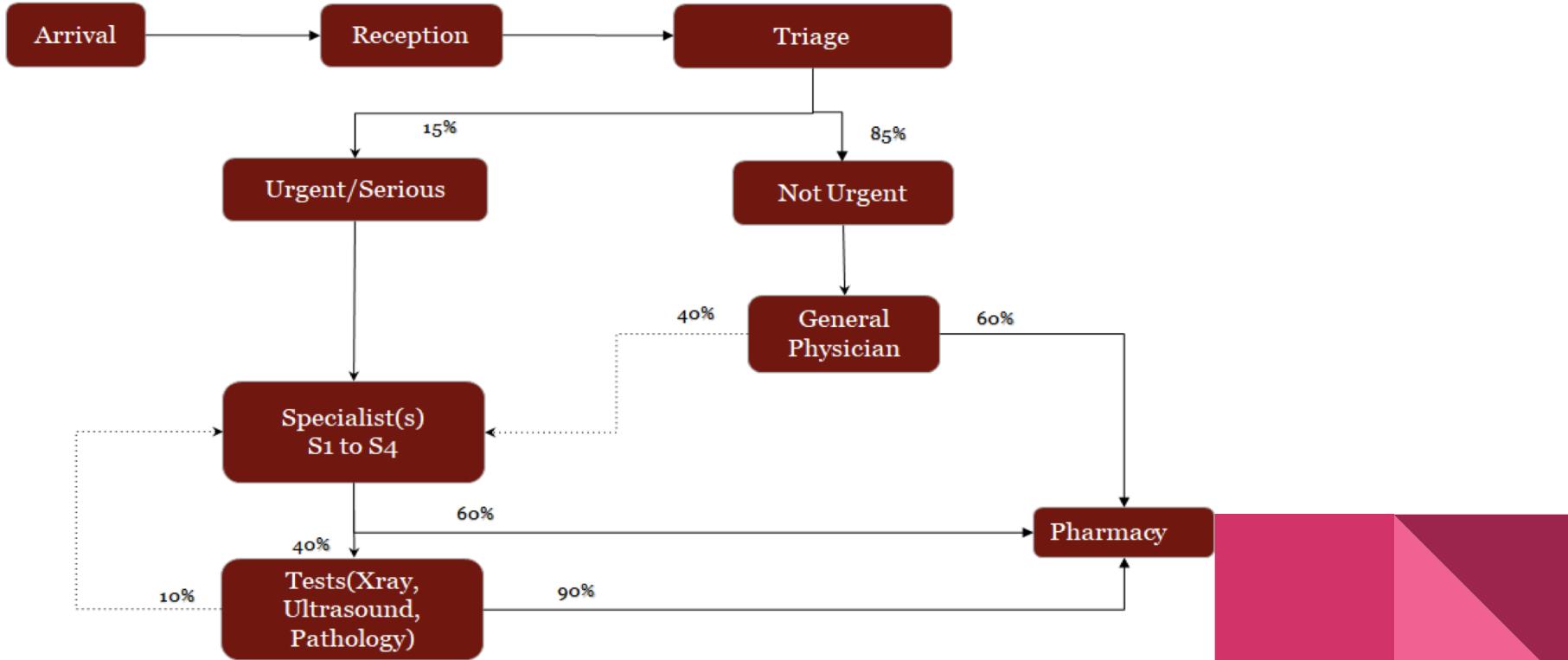
Simulation Demo

Patient Flow Model

Service Parameters		Capacity Parameters	
General Physician	Mean (Minutes) 10 15 15	Variability (%) 15 15 20	Triage Room 1 1 5
Specialist 1	15 15 25	15 15 20	G. Physician Room 1 1 3
Specialist 2	15 15 25	15 15 20	XRay Room 1 1 5
Specialist 3	15 15 25	15 15 20	Specialist 1 Room 1 1 3
Specialist 4	15 15 25	15 15 20	USound Room 1 1 5
			Specialist 2 Room 1 1 3
			Pathology Lab 1 1 5
			Specialist 3 Room 1 1 3
			Pharmacy 1 5 5
			Specialist 4 Room 1 1 3
Speciality Distribution		Arrival Parameters (Patients/Hour)	
Specialist 1	25	Specialist 2	25
Specialist 3	25	Specialist 4	25
Resource Count			
Nurses	1 10 15	Technicians	1 5 10
		Serious (%) 15	



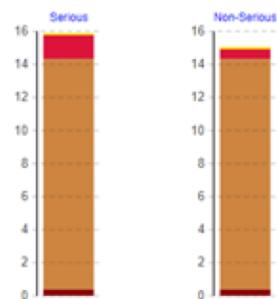
Process Flow in an ER



Summary Stat from Simulation

Summary Statistics

Mean Wait Time Distribution



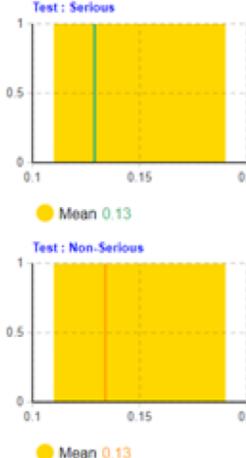
Reception



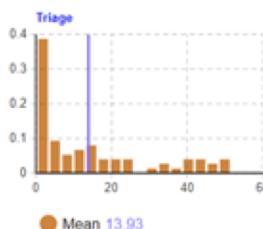
Physician : Serious



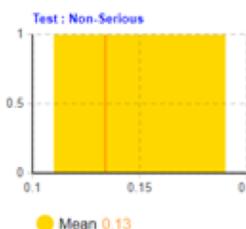
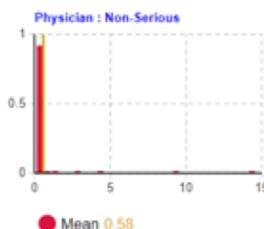
Back To Process Flow



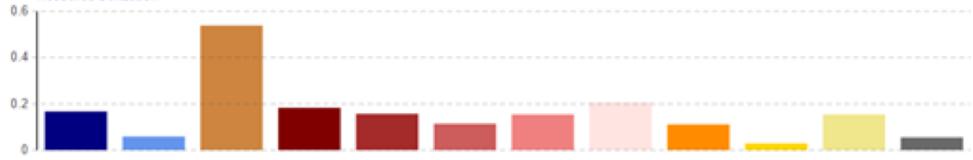
Triage



Physician : Non-Serious



Resource Utilization



Pharmacy



Mean 0

Workforce Management Tool

Hope Hospital ER Utilization Metric Calculations									
Data Range: 1/1/2018 - 12/31/2018									
Month	Operating Cases	Operating Minutes	Total Available Minutes ⁵	Actual Minutes	Operating Utilization (%) ⁶	7:30 1st Case On-Time Starts ⁷	Operating Cases out of Primetime	Total Cases	Total Cost
Jan-18	488	44,293	84,000	49,217	53%	52%	64	552	\$ 1,067,898
Feb-18	451	42,311	80,070	46,134	53%	60%	54	505	\$ 986,930
Mar-18	523	46,019	88,080	50,331	52%	67%	56	579	\$ 1,144,489
Apr-18	544	48,040	87,930	52,282	55%	71%	71	615	\$ 1,190,444
May-18	464	40,758	84,000	45,197	49%	77%	60	524	\$ 1,015,378
Jun-18	479	43,562	88,080	47,888	49%	60%	54	533	\$ 1,048,203
Jul-18	498	47,721	87,930	52,780	54%	67%	71	569	\$ 1,089,781
Aug-18	518	45,820	83,640	50,071	55%	64%	70	588	\$ 1,133,547
Sep-18	506	47,071	88,420	51,234	53%	72%	64	570	\$ 1,107,288
Oct-18	442	40,137	87,930	44,871	46%	60%	53	495	\$ 967,235
Nov-18	441	38,923	79,710	42,240	49%	57%	50	491	\$ 965,047
Dec-18	512	45,153	88,440	50,153	51%	72%	69	581	\$ 1,120,418

* The figures displayed in the above example are not representative of our data set

Thank you!

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Victor Agbafe
Shweta Chopra

