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IE 324: SIMULATION

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TERM PROJECT STAGE 2 REPORT

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1. Introduction and Project Definition

The project is about assessing a hospital's emergency department (ED) and offer suggestions to enhance operations, service cost, and service quality. According to head nurse we have talked a lot, patients arrive either by their own means or with an emergency call. They are using triage system to distinguish the patients and the resources accordingly. In order to better understand how the patient arrivals, ED components, and resource availability may all be merged together, we first divided our model into its separate parts. During the model's construction, we made several assumptions that will be discussed later. We have achieved minimum requirements by utilizing 5 ambulances, 8 nurses, 4 observation rooms and 1 treatment room.

2. Assumptions

2.1 For Emergency Call Entrance

- Nurses for each patient are assigned as soon as ambulance arrives to the ED.
- If two patients come with an ambulance and we have only one available CC Room, one is redirected to another hospital with 50% chance.
- A bed is prepared in observation rooms for patients turned their label to yellow from red and it can happen if no clinical test is required or doctor's decision.
- A red patient waits for a doctor two times. First is after s/he has a CC Room, whether s/he needs to go the medical test decided by the doctor, second is after the medical test, to be examined.
- Head nurse told us that doctor examination and treatment for red patients always takes more than five minutes. Therefore, if it lasts less than five minutes we assumed that doctor directs the patient to the surgery, which is not scope of ED.

2.2 For Patients Arrival Entrance

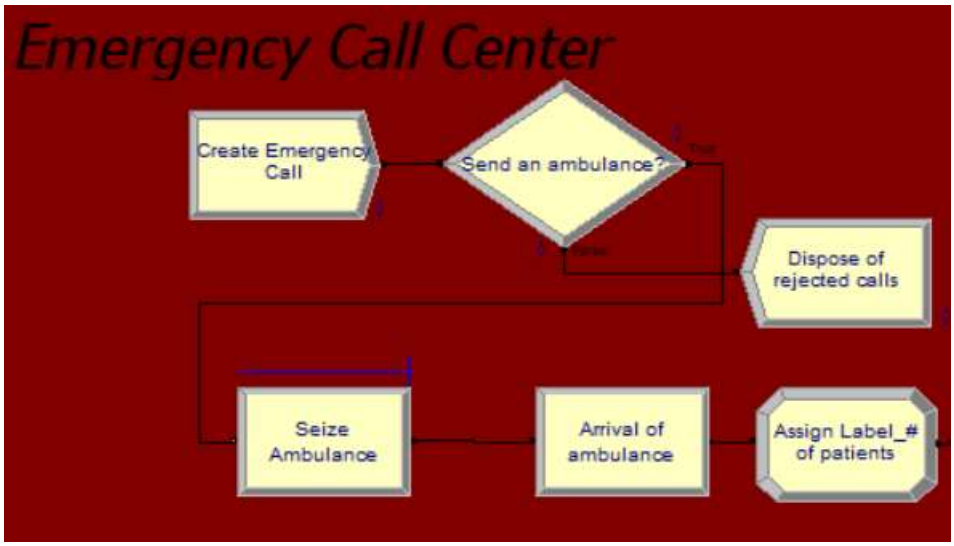
- There are 15 green and 10 yellow chairs in the waiting room, If they are all occupied patient leaves the system. Each waiting patient sits there if it is available.
- In the waiting room, we used a electronical displaying system. By doing that patients that are waiting resources can see if there are available resource in short durations. One of our group members went to the waiting area and calculated the average. It turned out that an average person can see their name on the screen approximately 6.6 seconds.

- After doctor's examination for yellow patients, a CC Room seized for yellow to red patients and joins the red patient streamline after that.

3. Model's Underlying Logic

3.1 Emergency Call Entrance Logic

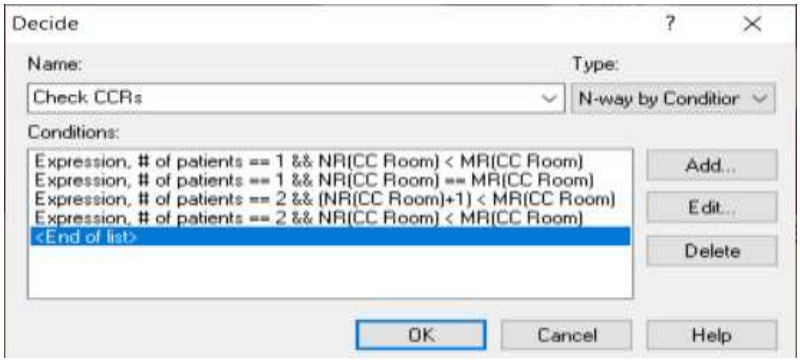
Emergency calls come according to a emergency call schedule and they are accepted if there are available ambulance and CC Room in the ED. Ambulance is immediately sent to the location.



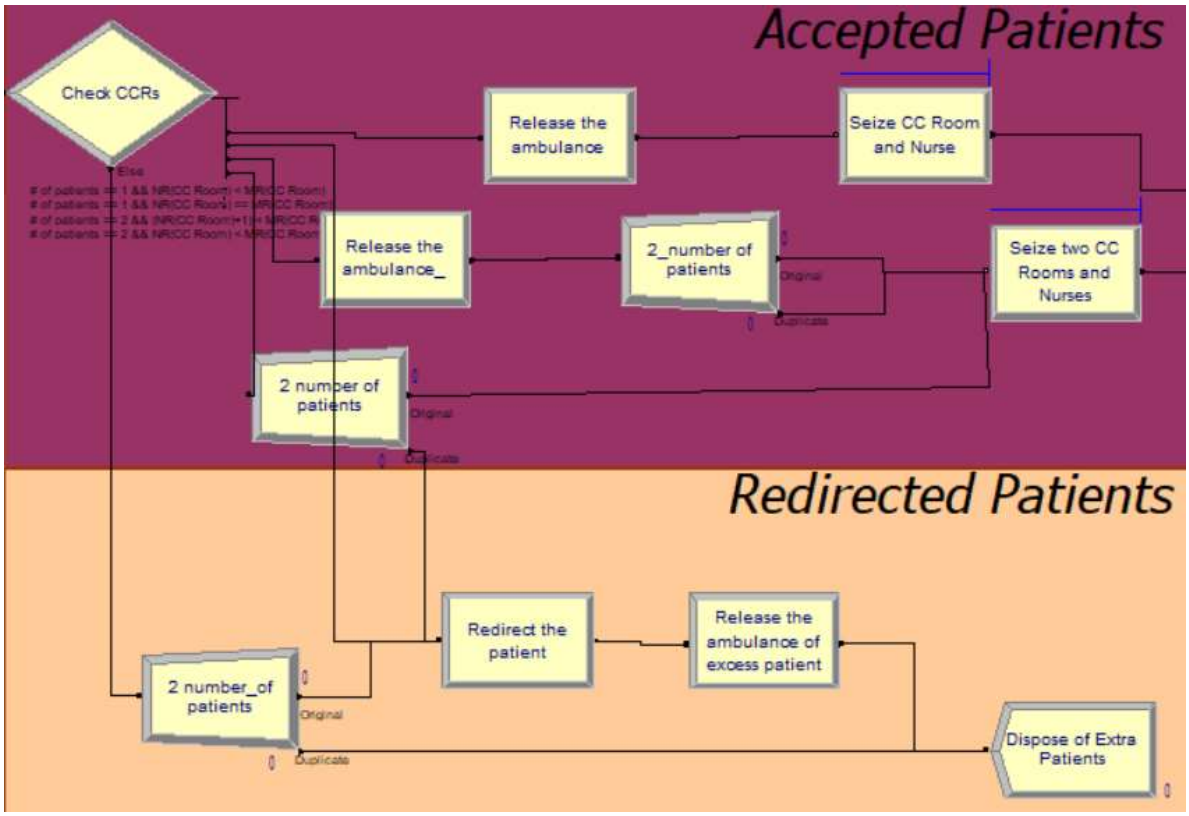
There are five possibilities after the ambulance comes:

1. There is only one patient, and we have an available CC Room for him/her.
2. Again there is only one patient, and we do not have an available CC Room for him/her.
3. There are two patients, and we have available CC Rooms for them.
4. There are two patients, and we have only one CC Room available for one.
5. There are two patients, and we do not have available CC Rooms for them.

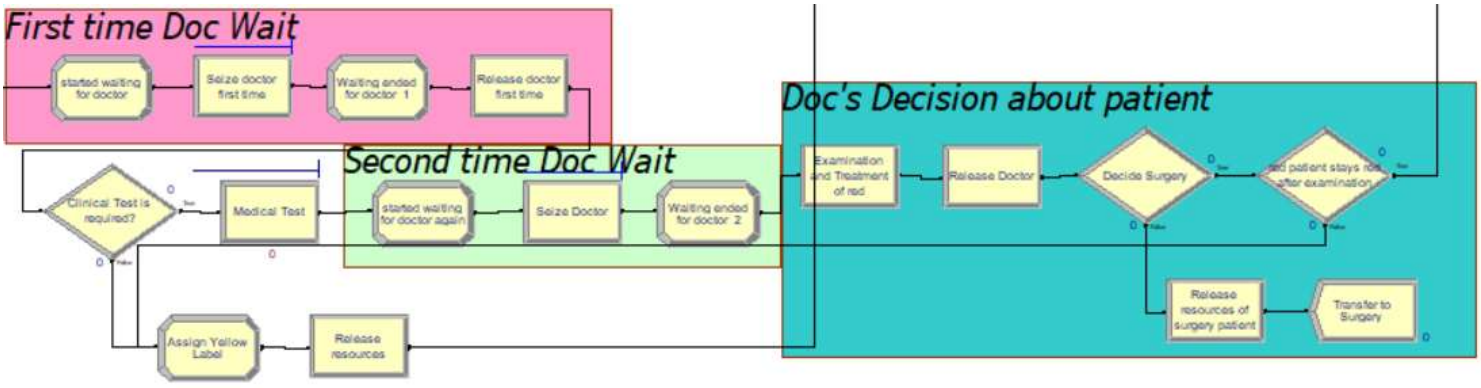
These possibilites are checked within a decide block shown below.



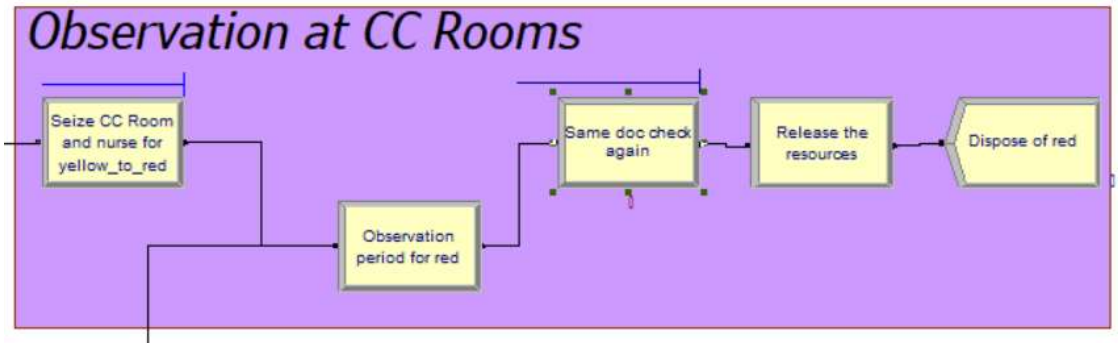
For accepted patients, CC Rooms are seized for each patient. It is shown below. Note that the ambulance of the patients, that one of them is redirected and the other is accepted, is released when the redirection ends. If the number of patients is equal to 2, then it is duplicated by separate block.



After they are settled in the CC Rooms, patients wait for doctor then they go medical tests if necessary. Then, doctor decide the patient will be directed surgery or switch its label to yellow or will be observed at CC Rooms. Complete schema is shown below.



Label switched patients (yellow to red) and red patients will be observed in CC Rooms. They are pretty much the same as what the head nurse told us.



3.2 Patients Entrance Logic

Patients arrive according to a patient's arrival schedule. After they arrive, we assign their reason for referral in the assigned block. There are eight possibilities after the ambulance comes:

1. Arriving patient is green or yellow; hence s/he is looking for a nurse to have a triage test, and there is an available nurse for her/him.
2. Arriving patient came for an injection; hence s/he is looking for a nurse and treatment room for an injection, and there is an available nurse and treatment room for her/him.

If they could not find available resources and have not been in the waiting room before, then:

3. If the patient comes for an injection or green and there are no available resources, s/he is transferred to the waiting room.
4. If the patient is yellow and there are no available resources, s/he is transferred to the waiting room.

If they have a chair in the waiting room and have been waiting for resources, and there are available resources for them:

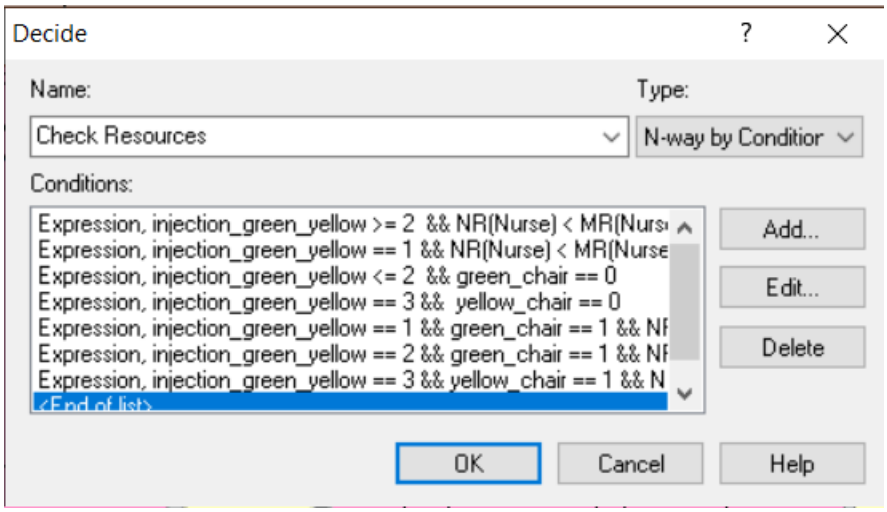
5. If a patient comes for an injection, s/he releases his/her chair and goes to the treatment room to be injected by the nurse.
6. If the patient is green, s/he releases his/her chair and seizes a nurse for a triage test.

7. If the patient is yellow, s/he releases his/her chair and seizes a nurse for a triage test.

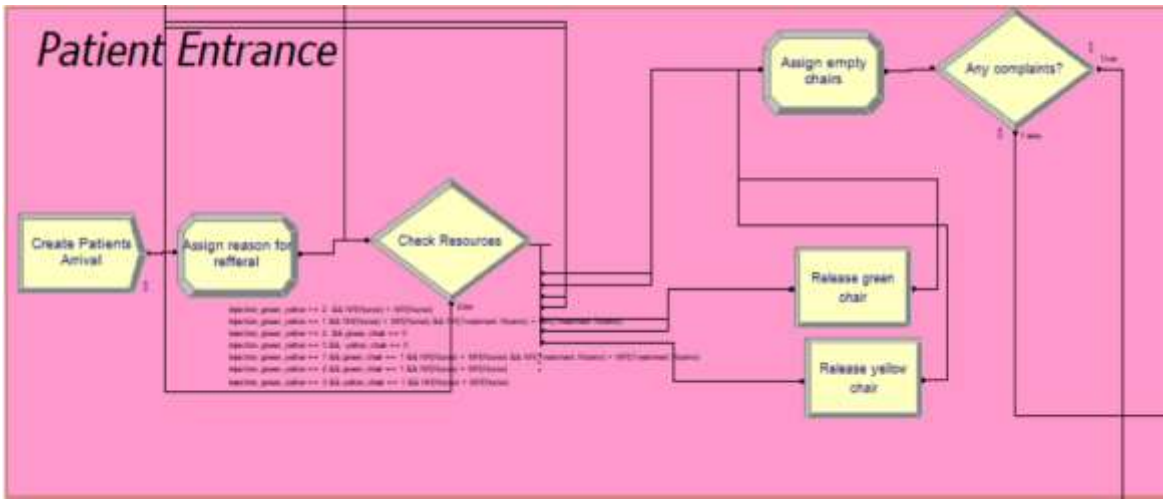
If they are, have a chair in the waiting room and have been waiting for resources, and there are no available resources for them:

8. S/he continues to wait in the waiting room.

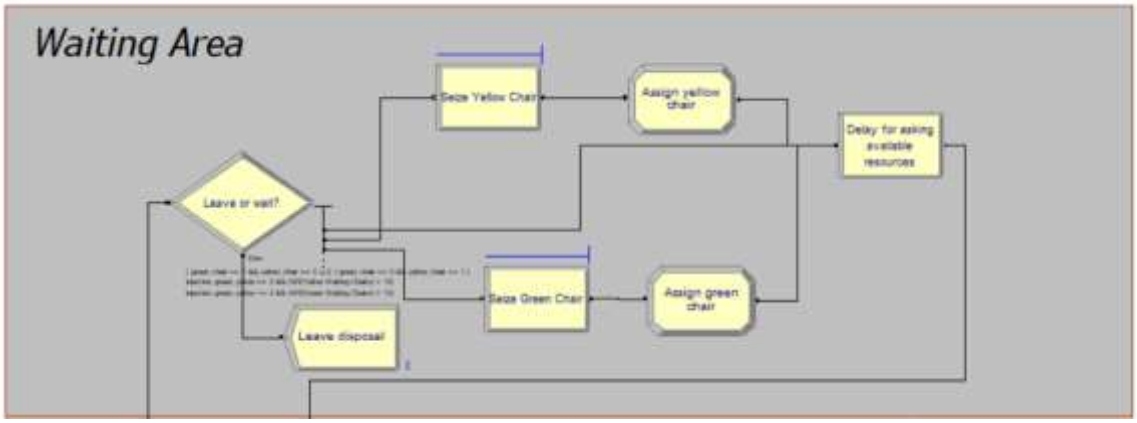
The decide block to check these conditions is shown below.



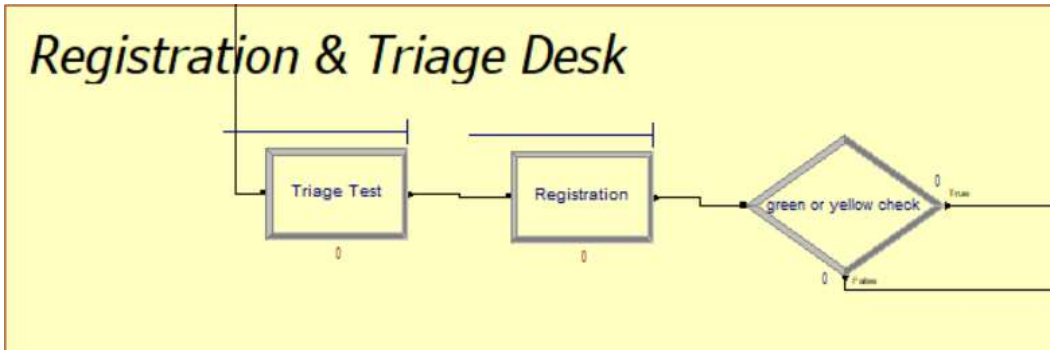
For 1.-2. conditions they are directed to triage test or injection according to their reason for referral. For 3.-4. conditions their headed to waiting room that will be explained in detail after this part. For 5.-6.-7. conditions patients releases their chair and directed to triage test or injection again according to their reason for refferal. For 8. condition patients continues to sit and wait on their chair in the waiting room. Complete schema for patient entrance shown below.



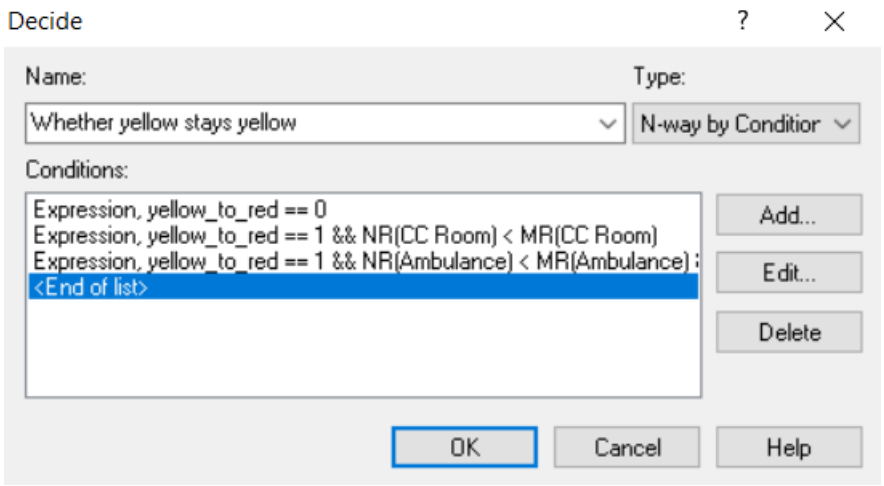
In the waiting room, for the patients who already have chair (8. Condition) need to wait 5 seconds to ask resources again. For the ones came waiting room for the first time checks fifteen green if s/he is green patient or ten yellow chairs if s/he is yellow patient. If there is not available chair, then s/he needs to quit the system, otherwise s/he sits in the corresponding chair and asks resources with a 5 seconds delay due to the electronic displaying system. Waiting room schema is shown below.



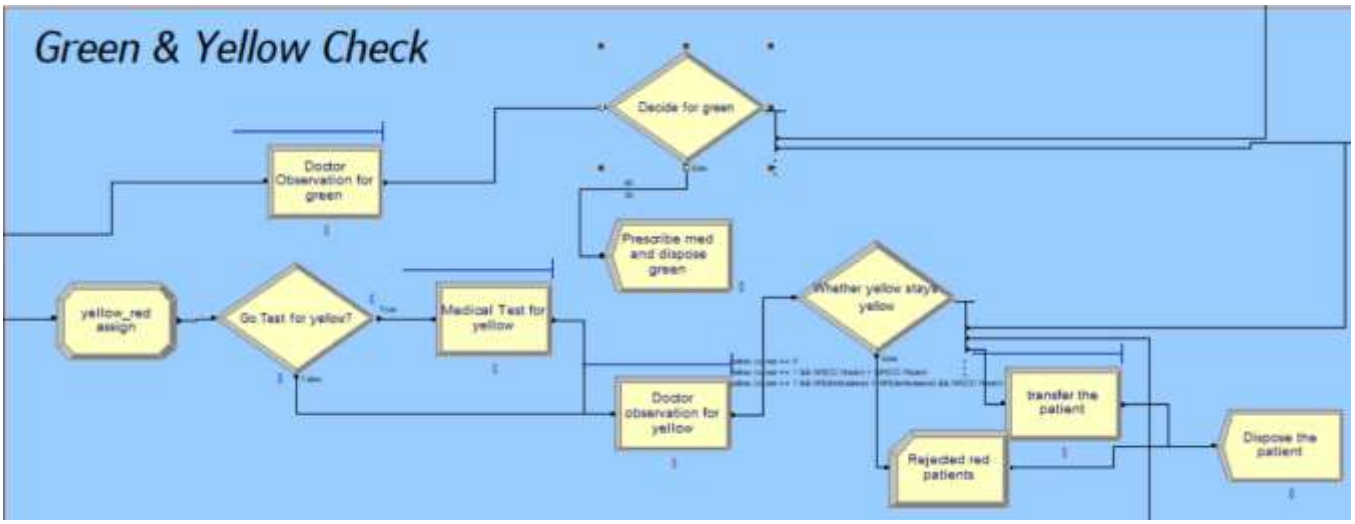
After green and yellow patients directed to triage, a nurse performs the test and registered in the single registration desk. After that they follow corresponding streamline. It is shown below.



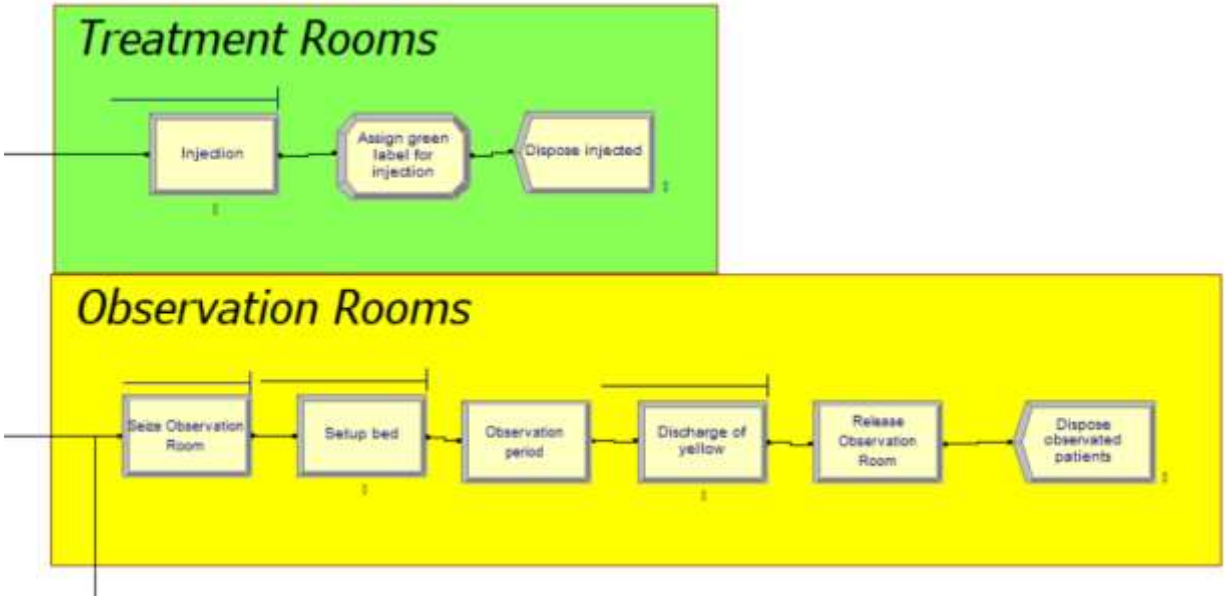
At first, red patients are labeled as yellow. They can turn red after the doctor's observation for yellow. If we have an available CC Room, they join the red patient streamline exactly at the observation for red patients. Otherwise, we check the availability of ambulances. If it is available, we redirect the patient to the other hospital. Else, we reject. The decision block for that and the schema is below.



For green patients, after the doctor's observation, they can go to the treatment rooms for injection, observation rooms, or prescribing medicine and leave.



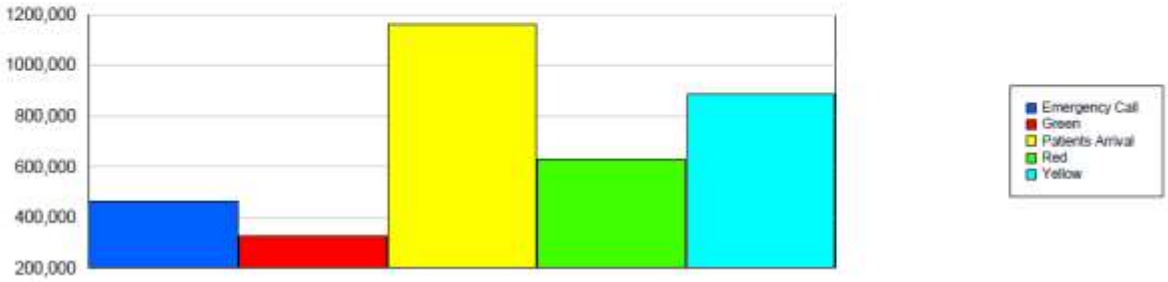
Treatment and observation rooms are shown below. They are pretty much the same as what the head nurse told us.



4. Output Statistics and Minimum Requirements

In 7 days, 324 green, 888 yellow and 630 red patients allowed to emergency department according to our model.

Number In	Value
Emergency Call	461.00
Green	324.00
Patients Arrival	1160.00
Red	630.00
Yellow	888.00



Utilization of our resources as follows.

Usage

Instantaneous Utilization	Average	Half Width	Minimum Value	Maximum Value
Ambulance	0.1120	0,034272640	0.00	1.0000
CC Room	0.1691	0,033443466	0.00	1.0000
Doctor 1	0.1598	0,043190076	0.00	1.0000
Doctor 2	0.1634	0,041564248	0.00	1.0000
Doctor 3	0.1659	0,042248303	0.00	1.0000
Doctor 4	0.1559	0,037315118	0.00	1.0000
Doctor 5	0.1539	0,040466920	0.00	1.0000
Green Waiting Chairs	0.8912	(Insufficient)	0.00	1.0000
Nurse	0.1591	0,023813287	0.00	1.0000
Observation Rooms	0.7324	0,076277251	0.00	1.0000
Registration Desk	0.07977808	0,027852634	0.00	1.0000
Treatment Rooms	0.06038085	0,022457843	0.00	1.0000
Yellow Waiting Chairs	0.00	(Insufficient)	0.00	0.00

Average number busy is shown below.

Number Busy	Average	Half Width	Minimum Value	Maximum Value
Ambulance	0.5601	0,171363202	0.00	5.0000
CC Room	0.6765	0,133773864	0.00	4.0000
Doctor 1	0.1598	0,043190076	0.00	1.0000
Doctor 2	0.1634	0,041564248	0.00	1.0000
Doctor 3	0.1659	0,042248303	0.00	1.0000
Doctor 4	0.1559	0,037315118	0.00	1.0000
Doctor 5	0.1539	0,040466920	0.00	1.0000
Green Waiting Chairs	13.3673	(Insufficient)	0.00	15.0000
Labs	0.1965	0,042173856	0.00	4.0000
Nurse	1.2727	0,190506296	0.00	8.0000
Observation Rooms	2.9297	0,305109004	0.00	4.0000
Registration Desk	0.07977808	0,027852634	0.00	1.0000
Treatment Rooms	0.06038085	0,022457843	0.00	1.0000
Yellow Waiting Chairs	0.00	(Insufficient)	0.00	0.00

Minimum requirements:

- 5.26% of patients left the ED due to crowded waiting area. (<15%)
- The percentage of rejected emergency calls is 6.51%. (<7.5%)
- The maximum time of two waiting spots even if the same patient is 3.99 min. (<10 min)
- The percentage of patients transferred or rejected is 8.7%. (<15%)
- The # of rejected red patients arriving by their own means is 0. (<2)

We have achieved this goals with 5 ambulances, 8 nurses, 4 observation rooms, and 1 treatment rooms. The statistics of requirements shown below.

Counter

Count	Value
Rejected red patients	0.00

Time Persistent

Variable	Average	Half Width	Minimum Value	Maximum Value
waiting ended_1	0.01359043	(Insufficient)	0.00	2.4211
waiting ended_2	0.00552399	(Insufficient)	0.00	1.5727

Output

Output	Value
Percentage of leaved patients due to crowdance	5.2586
Percentage of patients transferred or rejected	8.6983
Percentage of rejected calls	6.5076