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THE USE OF SIMULATION TO EVALUATE HOSPITAL OPERATIONS BETWEEN THE EMERGENCY DEPARTMENT AND A MEDICAL TELEMETRY UNIT

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ABSTRACT

This paper presents a simulation model of the operations in the Emergency Department (ED) and Medical Telemetry (Med Tele) Units at Rush North Shore Medical Center. The model allows management to see the operations of both units as well as how the processes of each unit impact the other. Due to the large amount of variability that can take place within these units, Rush North Shore Medical Center along with Cap Gemini Ernst & Young sought the use of simulation to help evaluate their operations and provide insight into possible areas for improvement. Rockwell Automation created a model which depicts the current operations and evaluates possible alternatives to reduce the length of stay in the ED and improve operations. Using simulation, the hospital was able to select two to three key changes, rather than creating more stress with ten or more changes, to get the same result.

1 BACKGROUND INFORMATION

Rush North Shore Medical Center brings university-level care to the communities it serves. Through its affiliation with Rush-Presbyterian-St. Luke's Medical Center in 1987, Rush North Shore serves as a teaching hospital by providing a full complement of residency programs. The 268-bed facility includes a staff of nearly 600 physicians, many of whom hold faculty positions at Rush-Presbyterian-St. Luke's.

In order to serve the growing needs of the community, Rush North Shore provides a full range of inpatient and outpatient medical and surgical services including cardiology and cardiovascular surgery, cancer care, orthopedics, psychiatry, geriatric medicine, and women's health services including obstetrics, gynecology and an on-site fertility program. Recognized as one of the top 50 hospitals in the nation for its cardiology and heart surgery programs, the medical center offers a comprehensive range of cardiac care, including open heart surgery. Additional services available on campus include a state-of-the-art Breast Imaging Center, a complete CT/MRI center and an inpatient hospice unit. The Emergency Department operates as a Level II Trauma Center.

2 CLIENT ISSUES

The overall time patients spend in Rush North Shore's Emergency Department is longer than management would like it to be. In order to create a valid simulation model, Rockwell consultants met with key personnel at Rush North Shore Medical Center and identified the length of stay in the ED and the coordination efforts between the ED and the Medical Telemetry Units as important business issues.

A patient having a longer than necessary length of stay in the Emergency Department can lead to the over utilization of emergency department resources and patient dissatisfaction. Rush North Shore chose to evaluate the factors contributing to a patient's length of stay in the Emergency Department. Due to a significant number of admitted patients being admitted to the Medical Telemetry Unit, Rush North Shore thought it necessary to have a model, which

encompasses both areas and demonstrates how the two areas are interdependent.

3 DEFINE GOALS

The initial goals for Rush North Shore Medical Center were as follows:

- Visualize the interaction between the Emergency Department and the Medical Telemetry Unit.
- Determine the bottlenecks and quantify them
- Reduce the overall time a patient is in the Emergency Department.
- Reduce the time a patient is in the ED after it has been decided that the patient is to be admitted to the hospital ("boarders").
- Determine the impact of Medical Telemetry patient discharge/transfer procedures on the overall system.
- Identify bottlenecks associated with communications between bed control, the Emergency Department and the Medical Telemetry Unit.

By creating the simulation model using Arena and supplementing the statistics with animation, all of the above goals were accomplished.

4 PROJECT DESCRIPTION

A simulation model was created which depicted the current operations within the Emergency Department and Medical Telemetry Units. Once the model was validated, Rockwell consultants along with key Rush North Shore Medical Center and CGE&Y personnel constructed various other models to test the suggestions previously submitted by Rush North Shore staff to solve the issue of reducing the length of stay within the Emergency Department. A few of the suggestions that were made by emergency department staff were: the addition of a dedicated triage nurse, reducing the time between when a bed is clean and available on Med Tele and the time it is known to be available and increase the number of Med Tele beds.

The project consisted of an initial two-day site interview, which included interviews with the Emergency Department and Medical Telemetry Unit staff members, housekeeping, bed control, registration as well as the director of Patient Care Operations.

Rockwell created a base-line model of the Emergency Department process and the Medical Telemetry Unit using Arena software (Kelton et al. 2002), with the goal of evaluating the patient time in the emergency department, measuring patient throughput, evaluating resource utilization, and determining queue sizes. The model was also designed to show the impact of each unit on the throughput of the other.

5 MODEL LOGIC EMERGENCY DEPARTMENT – PATIENT ARRIVAL TO PATIENT LEAVING THE ED

The following section describes the basic process logic for a simulation model of the Emergency Department (ED).

5.1 Patient Arrival

This process will start with a patient arriving at the Emergency Department via ambulance, car or direct-admit. A direct-admit is considered to be a patient that is coming from a physician's office, a nursing home or another hospital. A direct admit patient will go through the Emergency Department when the Medical Telemetry Unit does not have a bed available for a patient. At this time, the patients arriving via other means to the ED will not be shown in the model. The process for each of these arrivals is different until the time a patient is taken to a room in the Emergency Department.

The patients arriving via car are first seen at the information desk by either the registrar or a volunteer. A call is placed into the ED to notify a nurse of an arrival. Once a nurse has come to the information desk, the patient is triaged and the type of patient is categorized as a 1, 2, 3, 4, 5, or 6. The registrar or volunteer can also send a patient directly back into the ED if they have determined the patient to be in need of immediate care. If the patient is not sent directly to a treatment room, and has been triaged by the nurse the patient goes to registration. Once registration is complete in the registration area, the patient then returns to the waiting room and waits to be taken to a treatment area. A nurse or a Patient Care Technician (PCT) takes the patient to a treatment area.

If a patient arrives via ambulance, the nurse may determine that the patient is not in need of immediate emergency care, but is directed to a treatment area. The nurse or paramedic takes the registration information to the registrar. The registrar must then enter the information into the registration system. If the patient has been accompanied to the ED by a family member, the family member meets with registration to provide the necessary information.

Once a patient is in the room, a pre-assessment process takes place. At this time, the patient is given initial instructions by either a PCT or nurse. The patient is then seen by a nurse within the ED for the initial assessment. If a test is needed, an order is created and entered into the system. The entry of the order into the system is done either by the ED Secretary, a nurse, or a PCT.

Once an order for a test is entered into the system, the patient is administered the test. If the test is X-Ray, the test can be performed in the ED or outside the ED. If the patient is having a lab test, and the time of day is between 7 AM and 3 PM, a lab technician is sent to the ED. If the lab test is needed outside of this timeframe, a nurse or PCT

from the ED performs the collection of specimens needed for the lab tests. Once the specimens are gathered, a period of time elapses before the results are ready for review.

If the nurse did not initially order tests, the next step is for a doctor examination. If at the time of the doctor examination, it is determined that tests are needed, the same logic described above is executed.

It is then determined whether the patient will be admitted or discharged from the ED. If the patient is admitted, they will then go through the admissions process. If it is determined that the patient will be transferred to another facility, the patient will be processed through the transfer procedure. If it is determined that the patient will be discharged, they are sent through the discharge procedures which are administered by a Nurse. See Figure 1 below.

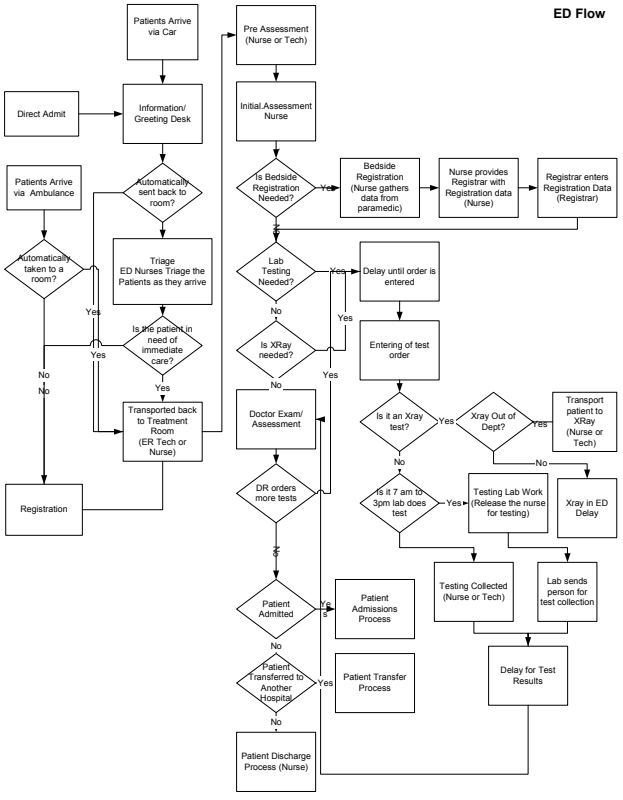

Figure 1: Emergency Department Process Flow

5.2 Admissions from the ED Process

Once it is determined that a patient is to be admitted into the hospital, the following logic flow is executed. The ED Doctor contacts the attending physician. The condition of the patient is discussed. If it is determined that the patient can be admitted, a call to the bed control is made to request a bed. If it is on the daytime shift 7:00 AM-7:30 PM, the call is placed to Bed Control. If the admit is to take place outside of these hours, the house supervisor is contacted for a bed assignment.

However, if during the course of the physician conversation, it is determined that additional tests need to be performed before the patient can be admitted, the ED doctor orders the additional tests. The orders are then entered into the system and the patient follows through the previously stated testing logic within the ED. Once the results of these tests are available, the ED doctor reviews the tests and consults with the attending physician. At which time, the previous logic is executed to determine whether the patient is admitted or more tests are ordered before admission to the hospital. See Figure 2 below.

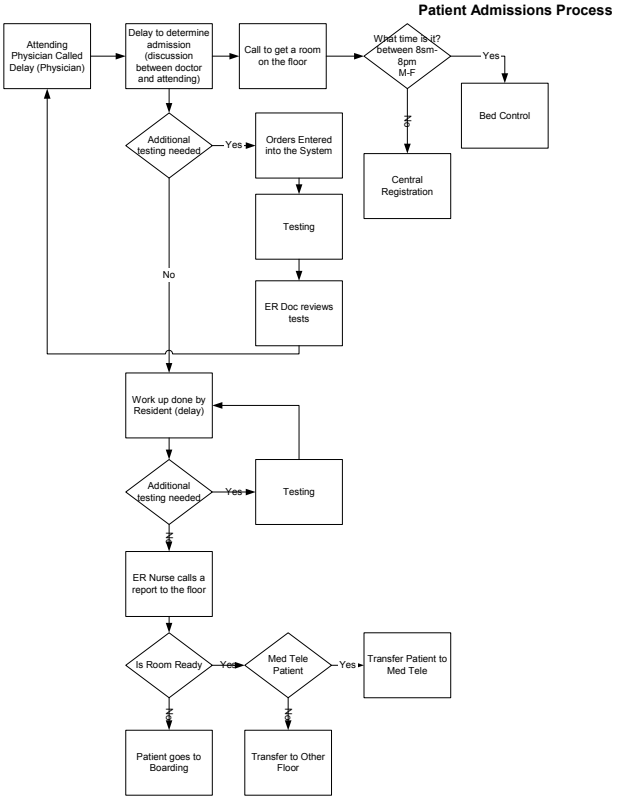

Figure 2: Admissions from the Emergency Department Process Flow

If the initial discussion between the ED doctor and the attending physician determines that additional tests do not need to be performed, the work-up is done by the resident or attending floor physician. The resident or attending floor physician can determine if additional tests are needed and the previously mentioned testing logic is executed. However, if the resident or attending floor physician determines that no additional tests need to be performed, the nurse calls the floor to report the status of the patient. A bed is then called for. Once the bed is ready, the patient is transferred to the appropriate unit.

6 SIMULATION MODEL LOGIC – MEDICAL TELEMETRY UNIT

When the patient arrives to the Medical Telemetry Unit, there is a probability that they will receive a complete assessment. This assessment is performed by the Nurse and Patient Care Assistant (PCA). This assessment consists of several steps. Once the initial assessment with the nurse and PCA is complete, the PCA stays in the room and applies a monitor, checks the vital signs, weighs the patient and performs additional assessments. The Nurse then performs a complete assessment of the patient. Upon completing the assessment, the nurse completes the checklist and may call for tests or contact a doctor to discuss the necessary orders needed for the patient. Once the orders are created, they are either called in or entered in the system by the Unit Secretary or Nurse. Once a patient is in the room, the patient is continually monitored by the nursing and PCA staff. During the time the patient is on the Med Telemetry Unit, the patient can be transported out of the unit to have testing. The patient always returns to the Medical Telemetry Unit after tests are performed. See Figure 3.

Once it is determined that the patient is to be transferred, the appropriate transfer operations take place to get the patient to the next unit. If it is determined that the patient is to be discharged, the Nurse performs a discharge process with the patient and may escort the patient out of the Unit. Once the room is empty, it is considered to be empty and dirty. Housekeeping is notified that the room needs to be cleaned. Once housekeeping has cleaned the room, the room is considered to be empty and clean. The availability of the room must be communicated with either Bed Control or the House Supervisor.

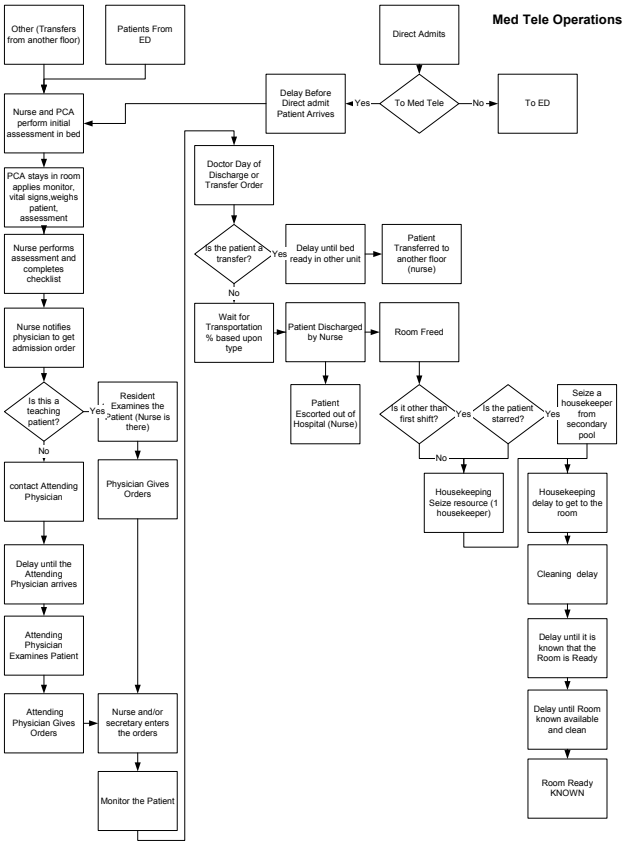

Figure 3: Med Telemetry Unit Process Flow

7 MODEL INPUTS – EMERGENCY DEPARTMENT

A simulation model is only as good as the data placed into it. Because of this, it was imperative that data input into the model was representative of the actual system. Input data was verified and validated by Rush North Shore Medical Center, Cap Gemini Ernst & Young and Rockwell Automation. The data was from either the data gathering process or from internal hospital systems. The following sections describe the needed data.

The following is a preliminary list of data items used as input to the model. These data items were necessary to achieve a valid sample of data points for each of the processes within the Emergency Department.

Arrival Times By Hour:

- Arrival times by car
- Arrival times by ambulance
- Arrival times by direct admits.

Probabilities:

- Probability Ambulance Patient Goes Directly to Room
- Consultant Needed
- Consultant Decide if Tests Needed
- Patient Admitted?
- Is an ED Resource Needed for Transport (If Yes, How many people 1 or 2)?
- Is Nurse or PCT Needed to Transport Patient to Med Tele
- Walkout after Registration
- Decide if Walkout After Initial Exam
- Nurse orders tests before doctor sees the patient
- Is Patient Admitted to Med Tele
- Nurse Escorts Patient to the ED location after registration?
- Is Person sent directly to a room from the Information desk
- Determine if additional test are needed after discussion with floor attending
- Does ER Doctor order tests
- Patient Type (Probability for Patient Type 1, Type 2, Type 3, Type 4, Type 5 and Type 6).

Durations needed for each of the following:

- Nurse Exam Delay
- Delay until Consultant Exam
- Delay for Discharge Process
- Return from Floor Delay
- Delay for Triage Process
- Delay at Registration Office
- Return from Floor Delay Med Tele
- Delay for time until the discharge process starts from the time that the last medical procedure is performed with the patient.
- Gather Registration Info by Nurse
- Delay for nurse to order tests
- Delay for order entry
- Delay for greeting time
- Call to Nurse from greeting
- Delay to determine admission discussion 1st call
- Delay for discussion with bed control
- Delay to discuss additional tests
- Delay for doctor exam
- Delay until consultant returns to ED
- Delay for consultant and ER doc discussion
- Delay for discussion with floor nurse
- Delay for Cleaning of Room in ED
- Delay for Cleaning of Room in ED nonmedtele admit
- Delay for Cleaning of Room in ED medtele admit
- Non MedTele Bed Control Delay
- Non Med Tele Delay for Bed to Be Ready Bed Control
- Direct care durations by hour
- Indirect care ratios and durations.

Probabilities Needed for ER Testing:

- Decide Type of Test (Lab, Xray, CAT, labandxray, labandcat, xrayandcat, allthree)
- Is the nurse utilized for only XRay Test
- Is the nurse utilized for CAT.

Durations needed for each of the following testing activities:

- Delay for XRay Test to department
- Delay for CAT Test
- Delay for Lab Test Results
- Delay for XRay Test done at between 7 am and 11 pm for radiologist to read
- Delay for Lab Test
- Delay for XRay Test done at between 11 pm and 7 am.

8 MODEL INPUTS – MEDICAL TELEMETRY UNIT

The following is a preliminary list of data items to be collected during the data gathering process. These data items will be captured for each patient who is treated in the Medical Telemetry Unit.

Arrival Times By Hour:

- Arrivals from ED
- Arrivals from other floors (transfers)
- Arrivals from direct admits.

Probabilities Needed for each of the following:

- Probability of Having One Test while on the Med Tele unit
- Probability of having a second test while on the Med Tele unit
- Probability of having a second test while on the Med Tele Unit
- Probability of transferring patient to another floor or facility
- Probability of having an initial assessment

Durations needed for each of the following:

- MedTeleNurse for discharge process and escorting patient out of hospital
- Housekeeping to get to the room
- Housekeeping to clean the room
- MedTeleNurse for discharge process and transfer patient out of hospital
- MedTeleNurse for discharge process and transfer to another floor
- Delay for Initial Assessment
- Delay for PCA assessment
- Delay until Nurse and PCA arrive into the room for initial assessment
- Delay until Nurse performs assessment
- Delay for Nurse Assessment and Completion of Checklist
- Delay for Nurse to Notify Attending of needed orders
- Delay until nurse checks on patient
- Delay for Nurse Checking on Patient
- Delay for length of Stay
- Delay some time to see if patient is back in room so they can be discharged
- Delay until 1st testing time
- Delay for testing process
- Delay until bed on other floor available
- Delay until transfer to other facility
- Delay until ready for discharge
- Delay until bed known to be clean and available
- Delay until ready for transfer patient
- Delay until ready for direct admit patient
- Direct care durations by hour
- Indirect care ratios and durations.

Due to the inability to gather a large enough data sample over the course of a week's time, Rush North Shore opted to gather as much actual data as possible and rely on internal systems to supplement the data that was gathered.

For each of the processes, the person performing the process was also noted to ensure proper depiction of the resource utilization.

In the Emergency Department portion of the model, the resources that were modeled included the emergency department staff, the emergency department treatment locations, the registrar and the volunteer at the information desk. For the Medical Telemetry Unit portion of the model, the Medical Telemetry Nurses, Patient Care Assistants (PCAs) and the patient rooms were modeled.

9 MODEL OUTPUTS

In order to assess the effectiveness of a system scenario, certain performance measures for each system must be collected and analyzed. These outputs provided Rush North Shore Medical Center the information to decide upon a possible areas for improvement to reduce the length of stay in the ED as well improvement throughput throughout the hospital. Following is a list of outputs that the model will provide:

1. Patient Time in Emergency Department.
2. Medical Telemetry Unit patients time in the Emergency Department.
3. Time intervals of the patient throughout the process (i.e., length of time until the patient is placed into a bed, length of time until a patient is seen by the ER physician, etc.).
4. Patient Queueing Time at each process.
5. Number of patients in Queue at each process.
6. Number of patients through the Emergency Department.
7. Utilization of Medical Telemetry resources (Nurses and PCAs).
8. Utilization of Emergency Department resources (Nurses, ER Physician, Registrar).

These outputs listed above were the primary outputs evaluated by Rush North Shore Medical Center.

10 SCENARIOS

In order to properly evaluate the current situation in the Emergency Department and Medical Telemetry Units at Rush North Shore Medical Center as well as determine the proper future course of action, the following scenarios were created:

1. Current system flow
2. Change staff levels to see if additional staff would reduce the length of stay
3. Reduce the time for bed notification from the Medical Telemetry Unit to the Emergency Department
4. Increase the number of Medical Telemetry Beds
5. Decrease the number of patients being admitted to the Medical Telemetry Unit
6. Add a dedicated Triage Nurse
7. Decrease the length of stay on the Medical Telemetry Unit.

11 MODEL VALIDATION

In order to validate the model, Rockwell Consultants worked with Ruby Blasak, Directory of Patient Care Operations and Decision Support with Rush North Shore Medical Center. Ruby's function within the project was instrumental. She was responsible for ensuring the accuracy of all data gathered as well as providing insight into the operations as they actually took place within the facility.

Rockwell Automation along with Mary Hayduk (Cap Gemini Ernst & Young (CGE&Y)) designed a data collection form that was used by the data collection staff. The data collection staff consisted of employees from Rush North Shore as well as personnel from CGE&Y who were placed at pivotal places within the ED and the Med Tele Units. Once the data was gathered, Ruby ensured the data was complete and consistent. Once all of the data was gathered, Ruby was able to provide the needed probabilities and time durations which were used to populate the model.

Once the model was populated with all of the actual data gathered, the model then proceeded into validation and acceptance of the model. Rockwell Automation along with CGE&Y and members of Rush North Shore Medical Center evaluated the model and the scenarios.

12 CONCLUSION

The simulation model enabled Rush North Shore Medical Center to test new processes, as well as investments in staff before deciding to implement any of the proposed solutions. This methodology helped to avoid unnecessary costs, and allowed Rush North Shore Medical Center to focus on making only the changes that would provide the needed benefit – reducing the length of stay within the Emergency Department and improving operations between the ED and the Medical Telemetry Units.

The Arena model demonstrated that there are several problems in the emergency department, but also revealed that the main problem was process related, not resource dependent. Rockwell consultants determined:

- Rush North Shore Medical Center could avoid costs of adding a dedicated triage nurse. As the dedicated nurse would create a bottleneck that currently does not exist and increase overall costs of the ED.
- Rush North Shore could improve their overall process if the amount of patients being admitted to the Medical Telemetry Unit was to be decreased or the number of Med Tele beds were to be increased.

Management now has a tool that can be used to test possible solutions. Through the process of building the Arena model, Rush North Shore gained greater detailed knowledge of its Emergency Department and Medical Telemetry Unit operations and procedures. Management now knows most of the problems stem from the process itself. However, the size of the Medical Telemetry Unit does have a bearing on the operations within the Emergency Department. Overall, Rockwell helped Rush North Shore identify many areas to focus on improving. Ruby E. Blasak, Director of Patient care Operation and Decision Support was the driving force behind the project. These findings have significantly directed the change process for Rush North Shore.

REFERENCES

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AUTHOR BIOGRAPHIES

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