NovaSim

LOGIC IN MOTION

Make the most of your resources with our simulation-based decision tools

▶ CHALLENGE
How to move 152 children to a new facility in a single day without sacrificing patient safety or breaking the budget.

▶ OUTCOME
A simulation-based decision support tool helped CHP move coordinators to design and test plans for every eventuality. The move was completed smoothly in less than 7 hours on May 2, 2009.

▶ SUMMARY

The Children's Hospital of Pittsburgh of UPMC (CHP) had a unique and once-in-a-career problem; how to move 152 children the two and a half miles to its new state-of-the-art facility in a single day, without sacrificing patient safety and without breaking the budget. This was not just a simple matter of shuttling ambulances back and forth. While the problem is simple to describe, there were deceptively complex logistical challenges to address, including the coordination of over 250 staff members, 35 ambulances and scores of specialized, shared pieces of medical equipment. Even elevators had to be considered in the final analysis.

CHP is a regional facility catering to the sickest of the sick, which means that a large portion of its patients at any given time are critically ill. Each child involved in the move had unique medical issues and therefore required a particular set of resources during the move. Patient safety hung in the balance, so it was obviously important to get it right on the first try, yet testing strategies on actual patients was out of the question.

What CHP really needed was a way to carefully evaluate various move strategies in advance, but without having to involve the actual patient population. They found the answer in a discrete event simulation tool developed by NovaSim. The final simulation-based decision support tool allowed Children's to design and test plans for such important considerations as the planned move sequence and the optimal number of resources, including staff and ambulances, for move day.

The CHP Pediatric Move Simulation Project was started nearly two years before the move date. CHP staff used the completed model for extensive interactive move scenario analysis for over a year. The simulation model helped CHP move coordinators develop a clear plan for every eventuality, and to develop a strategy for optimally managing move logistics. Thanks to their foresight and careful planning, the move was completed smoothly in less than 7 hours on May 2, 2009.

NOVA SIM
LOGIC IN MOTION

▶ ORGANIZATION

The Children's Hospital of Pittsburgh (chp.edu), part of the University of Pittsburgh Medical Center family, is a world-renowned clinical and research pediatric facility. Recently, US News and World Report rated CHP among the top ten pediatric hospitals in the US. At any given time, CHP's census will include a number of very high acuity patients, including organ transplant, cardiac and oncology patients, as well as babies requiring neonatal intensive care. Through the main facility as well as through various affiliated outpatient locations, CHP manages over 500,000 patient visits annually. As part of their commitment to providing ongoing care of the highest quality, CHP moved to a new state-of-the-art facility in Pittsburgh's Lawrenceville neighborhood on May 2, 2009.

Move coordinators had to juggle load and unload points for more than 35 ambulances.

> What CHP really needed was a way to carefully evaluate various move strategies in advance, but without having to involve the actual patient population. They found the answer in a discrete event simulation tool developed by NovaSim.

▶ CHALLENGE

Moving 152 very ill children in a single mass evacuation is much trickier that it may seem at first glance. Because so many of the children are critically ill, allowing them to queue up in hallways was not an option. The project team set a goal of making sure that no high acuity patient would ever be in transit longer than two hours. Because of limited access points, it wasn't possible to simply throw more resources at the project. There comes a point, for example, where adding further ambulances does not increase the throughput rate of patients moved. After a while, additional resources just get in the way. The simulation model needed to determine where that point was. Then there was the question of human resources. While some low acuity patients can get by with a nurse escort, others needed a full specialized transport team that might consist of a doctor, one or more nurses, a respiratory therapist and a paramedic. Given that a number of patients could be in transit at any time, predicting the exact number of staff needed is a difficult question. Still other patients could only be moved using scarce, very expensive

equipment such as the extreme premature babies in the NICU who needed specialized transport isolettes. Prior to the move, the hospital owned only three transport isolettes and new ones cost several hundred thousand dollars each. For obvious reasons, buying a great deal of additional equipment was not a realistic option. In addition, the hospital was only going to be buying a limited number of new equipment, which meant that, without additional resources of some kind, as soon as beds, cribs and ventilators from the old facility had to be cleaned and delivered to the new hospital in time to keep pace with the arrival of patients. Clearly, there was a lot to keep track of. These issues and more highlighted the need for the simulation model.

▶ SOLUTION

CHP selected NovaSim for this assignment on the basis of NovaSim's deep expertise in process and data analysis as well as discrete event simulation of human service delivery systems. The project was kicked off with a two-day onsite visit, during which the joint CHP-NovaSim project team toured both facilities and met with move coordinators to identify the project objectives, scope, scenarios and overall solution approach.

▶ OBJECTIVES

After an initial onsite visit, the project team arrived at the following list of objectives:

1. Provide an interactive tool that would allow CHP staff to explore the expected outcomes associated with various move planning scenarios.
2. Enable communication among project team members about why certain planning decisions have been made and their expected results (i.e. why was 40 ambulances

2

www.novasim.com ■ 800.538.6394 ■ PO Box 30278 ■ Bellingham, Washington 98228
Make the most of your resources with our simulation-based decision tools

Due to their cost, transport isolettes were a major resource constraint.

the right answer and not 50).
3. Enable staff to answer important questions (please see Questions Answered Section)

SCOPE

The scope of the model started with the preparation of a patient for the move and ended with the installation of the patient in the destination unit. Tasks were modeled at a relatively high level. For example, a task might include preparing a patient for the move. Detailed subtasks involved in preparing the patient for the move, such as time to place a patient on a particular piece of transport equipment, were not explicitly modeled. Patients were grouped by acuity in such a way that they could be treated identically. For example, a typical group might consist of vented NICU patients, while another might consist of ambulatory acute care children.

SCENARIOS

Each move scenario was defined by setting decision variables for each patient group in each of the following areas:
1. Move sequence and timing – which groups get moved when?
2. Load elevator assignment – which patient groups could use which elevators at the old facility?
3. Load point assignment – which hospital exit should be used for each patient group?
4. Transport mode - ambulance, mass transport (i.e. bus), helicopter
5. Unload point assignment – which entrance at the new hospital should be used for each patient group?
6. Unload elevator assignment - which patient groups could use which elevators at the new facility?
7. Mapping of source units to destination units – which patient groups would be taken to which

location at the new facility?
8. Number of scarce resources available by time of day – staff, vehicles and equipment:

With all of the above decision variables set, CHP move coordinators could then run the simulation to evaluate whether their strategies would lead to an acceptable outcome. A scenario's quality was judged by the following criteria:
● The total time required to move all patients is acceptable (less than 12 hours)
● No individual patient has an unacceptable transit time (defined by patient type)
● Resource utilization levels are acceptable (i.e. expected utilization percentage is high enough to minimize cost, but low enough to buffer variation in the process and ensure patient safety)
● Solution is robust across a range of outcomes for uncontrollable factors (i.e. actual census is different than planned, individual move times vary more than expected, etc.)

DATA NEEDED

Because the need to move many patients across town all at once is a rare situation, CHP did not have access to

The model was instrumental in understanding the move's important drivers, how to optimally plan resource numbers and in developing strategies to head off problems before they occurred.

historical data with which to populate the model. Still, the only way to simulate the evacuation of patients from one hospital to the other was to estimate certain process times. The project team was well aware that these times were estimates and used sensitivity analysis to evaluate possible outcomes across the feasible range of input data parameters. The most important data needed related to the time required to move patients of each type through each of the process steps.

▶ RESULTS & REPORTS

In order to best support CHP staff in finding optimal strategies, the Patient Move Simulator produced a number of detailed results for each scenario.

- Summary results by patient group and unit where appropriate:
  - ✔ Wait times at each major stop along the transport path
  - ✔ Overall time from initiation of the move to its completion
  - ✔ Shortest move time among the group
  - ✔ Longest move time among the group

- ✔ Percent of total move time attributable to waiting/delays
- Gantt chart showing when each unit's move is started and completed.
- Detailed log of each simulated patient's route
- Graphs of queue lengths and waiting time distributions
- Intra-day statistics, providing half-hourly snapshots of:
  - ✔ The number of patients waiting at each step along the transport route
  - ✔ Resource utilizations during the period

▶ QUESTIONS ANSWERED & LESSONS LEARNED

The CHP Patient Flow Simulation Tool consisted of an Excel-based user interface that allowed users to make changes to all parameters without requiring any expert knowledge in simulation whatsoever. End users could even add new patient groups, change the starting census, and modify resources, as needed to evaluate a number of 'what-if' questions. The following is just a small sample of the questions that were explored:

- How many elevators do we need? What will their utilization be? Do we have enough capacity to dedicate the use of certain elevators to a certain purpose?
- Which possible route should be moved for each patient group to minimize bottlenecks?
- How many ambulances can we efficiently use?
- How would a dramatic change in patient mix on move day affect the expected outcome?
- What is the best move sequence?

As the result of exploring these questions and evaluating many, many scenarios, the move team learned a number of important, but often non-intuitive lessons. For example, the simulation model made it clear that:

- It would be critical for all patient prep work to be completed prior to the official move start time of 7 am. Moreover, the simulation model served as an excellent communication tool in explaining to staff why the move coordinators had to insist on this measure.
- Using two separate patient movement 'tracks', a strategy developed, fine-tuned and tested with the model, would provide excellent results. This strategy

involved delineating a 'blue' track for acute care patients and a red track for critical care patients. The different tracks use different elevators, hallways, entrances and exits. Early plans called for three tracks, but the model demonstrated that two tracks would be sufficient.

- The order in which patients were moved would have a huge impact on the move's over all efficiency. It was initially suggested that the move should start with the sickest patients. However, because the sickest patients all tended to need the same kinds of limited equipment and resources, it was better to intersperse the critical patient groups with acute groups, which would use a different set of resources. The simulation showed that when a unit with very sick patients is moved at the same time as a unit with less acute patients, it helps to keep resources highly utilized without artificially creating bottlenecks through counter-productive competition for the same resources.
- An early plan to "hot truck", or move needed support equipment such as ventilators along with the patient move, rather than bring in additional temporary equipment, was not likely to work. Careful simulations of the equipment moving process showed that it would be highly unlikely that the equipment could be moved fast enough to keep pace with the needs of the patients. As a result, the team had plenty of advance notice that they would need to develop a solution involving rented equipment, thereby avoiding this potential logistical disaster.

✔ Vehicle utilization during the period

OUTCOMES

Upon completion of model development, CHP staff used the tool extensively for over a year to help create, evaluate and analyze scenarios for the most efficient move process. The model was successfully used to identify significant drivers of success, potentials for bottlenecks and relevant solutions. During the initial scenario period, a 'typical' patient census was used. As move day approached, CHP staff entered the actual patient census to test and fine tune final scenarios.

Jennifer Iagnemma, CHP Move Coordinator, reports that move day, May 2, 2009 could not have gone better. Thanks to a carefully prepared and optimized plan, the CHP team was able to move 152 patients in less than seven hours. She reports that the simulation model very closely modeled the real life move, though she cautions that

The move plan had to include possible air transport, even if it wasn't needed on move day.

the model was best used for understanding how parts of the system work together, rather than for prediction of absolute numbers. This is because a situation with no direct historical basis necessarily required the input of estimated data, such as transportation times. Because transportation time was overestimated in the model input,

the model predicted a correspondingly longer time for the move to complete than occurred in reality.

Still, Jennifer says that the model was instrumental in understanding the move's important drivers, how to optimally plan resource numbers and in developing strategies to head off problems before they occurred.

MEDIA COVERAGE

● Four Part Video Series about Move – *Post-Gazette*
http://www.post-gazette.com/pg/09123/967003-114.stm

● Local News Video (May 2, 2009)
http://kdka.com/video/?id=53721

● Children's Hospital Moves To Lawrenceville Today (5/2/2009)
http://kdka.com/health/Childrens.hospital.move.2.998687.html

● Children's Hospital Staff Practices With Mock Move (2/22/2009)
http://kdka.com/health/Childrens.Hospital.move.2.940507.html

● Children's Hospital Plans for Big Move (1/30/09)
http://kdka.com/health/Childrens.Hospital.move.2.904664.html

FOR MORE INFORMATION:

If your hospital is moving, if you'd like a state-of-the-art tool to model your disaster planning scenarios, or if you need expert consulting for any patient flow issue, we'd be happy to help! Please contact:

Kerrie Paige, PhD
President
NovaSim, LLC
800-538-6394 x600
Kerrie@novasim.com
www.novasim.com

CHP Patient Move Simulation Case Study
©2009, NovaSim, LLC