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EMERGING ISSUES IN HEALTHCARE SIMULATION

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ABSTRACT

Despite the size and importance of the health care industry, simulation is less prevalent in health care than in other fields such as manufacturing, logistics, and military applications. Yet simulation clearly has the potential to play a role in health care decision-making at many levels. The purpose of this panel is to discuss some of the issues that practioners must be aware of in order to tap the potential of simulation in the health care arena. The panelists have extensive experience in health care and the use of simulation in that environment. They have provided statements outlining several key issues for achieving success in current and future health care simulation projects. These will serve as the starting point for discussion at the conference.

1 DAVID FERRIN

Emerging issues in health care simulation include the following:

- *Assisting our customers in the area of Information Technology (IT).* Healthcare simulation has not gone into emerging technology. It has in other industries. Prioritization of IT resources, both physical and financial, in settings with limited capabilities will greatly benefit our customers and patients.
- *Combining our models of Information Technology with our traditional process models.* This approach is needed for improved, validated end-to-end, business models that capture the value propositions of alternative infrastructures.

Our main challenges as simulation professionals in healthcare are:

- Improving our personal capabilities to make valid, verified models;
- Understanding our customer's business needs;
- Providing our customers with the answers and insights to their business needs. In other words, doing our homework well.

2 TOM OGAZON

Simulation Modeling is an excellent tool to complement other approaches employed by our Industrial Engineering team at the Jackson Health System. Globally, our organization is involved in a variety of performance improvement activities to include case management, performance improvement teams, and benchmarking customer satisfaction and clinical outcome data. The Management Systems Engineering department spearheads the benchmarking of operational business statistics looking for FTE and cost reductions, conducts Departmental Operational Reviews, and during the past year, we have embarked on applying simulation modeling to explore complex departments from an operational perspective.

Our IE team conducts traditional Operational Reviews of departments. In those we flowchart processes, review table of organizations, collect data on relevant indicators, evaluate staffing levels and scheduling, and provide consultative reports providing recommendations to the Executive Staff. These reports combined with the benchmarked operational data provide valuable solutions and recommendations. There are however instances where the financial perspective of the bottom line figures and the operational perspective from our observations and staff input simply do not seem to be describing the same department. A unit manager may state: “We are supposed to be able to do it with 10% less people, but we know that we can barely survive today". There are obviously factors that have not been accounted for. This is where simulation can be of assistance.

Simulation forces us to look at processes on a very detailed level, and if deployed correctly, it can be an excellent tool for both financial and departmental people to reach consensus on resources and other requirements. The validation process can be an excellent tool in assisting all parties to fully understand the complexities of the system. The animation and the statistical validity of the data builds credibility for the project.

We have completed simulation projects in the Radiology Special Procedures area and the Financial Assessment Department. Currently, we are simulating the ORs, and will momentarily start modeling the L&D area and the Peri-Anesthesia Areas. There is also interest in modeling other business offices within the Institution.

There are many challenges for Simulation Modeling in health care.

1. Gaining buy in from the Executive Staff and the Senior Medical Staff that this is of benefit. One needs a success story.
2. Collecting data without adequate information systems is difficult.
3. Modeling of physician resources (especially Attending physicians in a teaching hospital) is challenging, and many times they end up being excluded.
4. Departmental Staff can be fearful of the results, while the Financial Staff may wonder the need for the project if departmental financial indicators already exist.
5. We are modeling people, not machines, in a very dynamic and volatile environment. Sometimes data cannot be collected on all important factors so assumptions are made.

Simulation is an outstanding tool for Health Care. It is an objective way to describe an operational area to compliment other methods. Additionally, its true power lies in the ability to explore “what if" scenarios and make decisions accordingly. It is up to us to prove to Health Care Executives the power of this tool. There is no doubt in my mind that it is critical to employ it in understanding our very complex health care operations.

3 JOSÉ A. SEPÚLVEDA

Rather than “emerging" issues in healthcare simulation, these pages address some recurring issues observed in over twenty years of experience using simulation models to analyze patient flow, resource utilization, and the operation of healthcare facilities. This experience includes modeling an outpatient surgery unit, a very large laundry facility, two large emergency departments, a cancer treatment center (analysis of an existing facility and design criteria for a new building), a cardiology department, a blood bank, a spinal cord injury center, a hospital engineering department, a rural region emergency transportation dispatching center, and an urban transportation courier unit.

In these days of global communications, ubiquitous computers, sophisticated simulation modeling and statistical analysis software, and large capacity and fast processors, the weakest links in the analysis chain are the users' understanding of the process analysis approach, the availability (or lack thereof) of data, and the conflicting objectives posed by the decision makers.

3.1 Process Analysis

Modeling healthcare processes implies a workflow that exists and can be charted, a history that can be analyzed, and process steps that can be measured (money, time, and quality). A process step adds value if the customer recognizes the value and it is done right the first time. Some operational steps may be non-value added, but necessary if required by law, regulation or contract; required for health, safety, environmental or ethical considerations; or required because of physical limitations. In addition, experience tells us that waiting time and process interruptions will occur. Often, wait time is a step in the process. A common goal is to make process interruptions and wait time as few and small as possible. Process Analysis is a tool used to study each step of a process from the operator's point of view, reflecting all the value-added and non-value added steps observed and the interactions between the operators. The idea is to analyze the activities that take place through the flow of a patient during his stay in the system under normal operating conditions. The intent is that all operators that participate in the process become familiar with the tasks performed by others and to document what is done at each step of the process. The goals of the analysis are to improve how things are done, avoid duplications, eliminate non-value added activities, level workload, evaluate different process alternatives, and benchmark (compare methods, functions, and activities) the overall operation against market competitors. Simulation is then a tool used to describe and represent the process as analyzed and to study the effects of changing the process.

Process analysis implies the participation of a representative from each of the different types of operators involved in the process. It also requires the participation of a management representative and of an external observer to ask critical questions, draw the flow diagrams and supervise the work of the team. In our approach, this means forming teams of six to eight individuals who meet weekly (for about six to eight weeks) from one to two hours to perform the process analysis. This is an expensive proposition for any organization, as it involves people with high skills and competence. On the positive side, it is quite common that the interaction and discussions lead very quickly to the detection of easily solvable problems and improve coordination, which, on more than one occasion, have in themselves paid for the whole study at a very early stage. Although expensive, process analysis is a necessary effort to ensure the model reflects SOP in the unit and to help in the validation and verification of the model. Most important, it is often cited as the activity that helps the most with the users' understanding and trusting the model, as we can usually point out in the animation that it reflects the operation as described and performed by the user (not as observed and/or perceived by the modeler).

Typical results of this effort are recommendations for significant changes in the way things are done. This may involve changing the process flow, reducing process times, changing material handling methods, re-assigning functions, bringing in new technologies, updating information processing methods, adding or replacing resources, eliminating existing resources or services, and justifying new resources. Quite often, these proposed changes are alternative scenarios evaluated using the simulation model, thus using simulation for its best application: studying the effects of proposed changes in the system without actually modifying or disturbing the system itself.

3.2 The Data

It has been our experience that data availability in healthcare facilities is often non-existent or excessive. In some (rare) instances, notably emergency departments, the information is electronically stored and it is relatively easy to retrieve from existing databases just about anything that may be needed for a given patient. For example, information is available for the time of arrival, the transportation mode, the initial assessment, vital signs, age, gender, triage evaluation, diagnosis, medications given, disposition, laboratory and radiology results, times of consultation, attending personnel, patient disposition, and -of course- insurance coverage. Unfortunately, more often than not, important information is stored but can not be used directly in modeling. For example, we may have data for a patient's arrival to a preparation room where the patient is dressed, vital signs are taken, blood may be drawn and other procedures may take place to prepare the patient for, say, surgery. We may also have data for the time the patient is sent to surgery; thus we can calculate the time the patient spent in the preparation room. However, this time is in actuality the result of two components, one that reflects value-added activities (the actual tasks and time needed to prepare the patient) and one that reflects the non-value added steps (time elapsed from the moment the patient was ready until then downstream process actually could accommodate him.) For analysis and performance evaluations, it is necessary to disassociate these times. Value added times should be included as distributions and/or parameters of the model, all other times should be a result of the interactions of entities and resources in the simulation model.

Quite often, the available data is abundant but it is stored on a non-electronic form (patient's files). More often, the data does not include crucial elements such as procedure start and ending times. It thus become necessary to take and analyze sample data. It is a common assertion in the literature that data and distributions can be easily estimated by asking an expert for educated estimates. The old adage, garbage in-garbage out, is still very valid. A good sample is better than a thousand experts' opinions. It is our experience that small variations in some distribution parameters, or (worse) a change in the distribution itself, usually leads to significant changes in model results, e.g., may lead to different conclusions.

3.3 Conflicting Objectives

Conflicting objectives for healthcare models occur quite frequently when the opinions of hospital managers clash with those of medical personnel. While some may be interested in the utilization of certain resources, others may give more importance to prompt service. Similarly, recommendations suggesting a relaxation in the criteria to increase the number of patients assigned to a fast-track area may find stiff opposition from physicians who may ultimately be responsible for the decision. On the other hand, we have used simulation to show physicians demanding the construction of a new operating room that the true bottleneck was actually the recovery room. A model correctly designed for a given situation may be unsuitable when used from the wrong perspective. Consider, for example, an outpatient unit with a non-stationary Poisson demand process. Simulating this process as a terminating simulation over several simulated days may yield different recommendations (regarding the number of resources) than performing the analysis as a non-terminating simulation looking for the steady state at the highest observed arrival rate. In one case, you may be interested in average performance throughout the day and may be willing to observe long lines at peak time. In the other, you may be interested on prompt service provided at peak time, trying to avoid people leaving without getting treatment.

3.4 Summary

In summary, helping the clients to understand the process, to participate in the model development, and to ensure that the data is reliable and valid is as important as building an attractive model. It is the simulation practitioner's responsibility to assess the conflicting views and objectives of managers and medical personnel and to build models that address some of these views without completely ignoring the others. Not doing this is equivalent to correctly solving the wrong problem, thus condemning the model to be unused and the model building effort to go to waste.

4 TIMOTHY WARD

Simulation modeling is a greatly underutilized tool in health care. When simulation modeling is used in health care, it is usually applied to problems unrelated to medical practice issues. For example, models may be built to study cars in the parking lot, or the delivery of patient meals. Also, improving the flow of lab tests or radiology procedures through the respective departments without analyzing the clinical appropriateness of the tests/procedures being performed.

I believe it is critical to use simulation modeling in the right context. This tool should not be used to model relatively unimportant processes or processes that do not involve clinical practice decisions. I believe the four points outlined in McKee, et. al. (1999) puts simulation modeling where it belongs. These points are:

1. Forecasting demand,
2. Practice pattern analysis,
3. Facility sizing, and
4. Nurse staffing.

Simulation modeling is a tool that can tell you the resource requirements (items 3 and 4) associated with defined patient volume and provider practices patterns (items 1 and 2). If you assume away the forecasting and practice pattern analysis or you assume away issues of clinical appropriateness, then I believe the resulting analysis will be modeling noise.

The cost savings achieved from many process improvements are disappointing. Introduction of a new process or pharmaceutical that shortens length of stay or otherwise reduces health care resource requirements does not necessarily mean health care costs will be reduced. Capacity (facility and staffing) must be put in balance with the new reality to achieve any significant cost savings. Simulation modeling is the tool best suited to re-balance capacity variables associated with process improvements and, consequently, realize the desired cost savings.

To be successful, a simulation modeling project must have clearly defined objectives first. The project must also be product or service line focused, not hospital department focused. Many times, the process required to build a simulation model is of equal or greater value in improving unit performance than the results of the simulation model. On the other hand, if the process of building or implementing a simulation model is simplified or shortened, some benefits or potential performance improvements may be overlooked.

Completing the simulation modeling work is only the start of the project, not the end. Frequently, the difficulties associated with changing current behavior, political considerations, inertia, etc. makes implementation of simulation model findings difficult or impossible. Participation in the project and *leadership* by top management is essential or the modeling efforts will be of little or no value. Greater attention to "change management" is needed to implement and achieve the performance improvements possible through simulation modeling efforts.

As a management engineer and/or simulation modeler, you must be satisfied seeing a fraction of their work implemented. If possible, spend more time documenting the results of this work. If the results are not implemented immediately, with sufficient documentation, these results may be dusted off and implemented several months or years down the road.

The state-of-the-art for many health care consultants today is benchmarking and expert opinion. This is good. However, if the unit of analysis falls short of the benchmark, what must be done to improve performance? Usually, this question is unanswered and the unit managers are left to their own devices to achieve the desired performance. Simulation modeling can assist these managers to determine the changes necessary to achieve the desired performance. Furthermore, simulation modeling allows experiments to be conducted with several hypothesized solutions, prior to implementation. *Prospective* analysis of the implications of changes in practices or policies is something rarely done in health care today and something that can be directly addressed through simulation modeling.

The prospective payment system has recently been introduced for outpatient procedures. There are very few benchmarks available for these procedures and many consultants are currently working hard trying to develop these measures. Simulation modeling should be the tool of choice in this effort.

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