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Understanding Patient Flow

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One of the major elements in improving efficiency in the delivery of health care services is patient flow. From a clinical perspective, patient flow represents the progression of a patient's health status. As such, an understanding of patient flow can offer education and insight to health care providers, administrators, and patients about the health care needs associated with medical concerns like disease progression or recovery status. Equally important, an understanding of patient flow is also needed to support a health care facility's operational activities. From an operational perspective, patient flow can be thought of as the movement of patients through a set of locations in a health care facility. Then, effective resource allocation and capacity planning are contingent upon patient flow because patient flow, in the aggregate, is equivalent to the demand for health care services.

Part of the motivation behind the need to understand patient flow has been brought about by a relatively recent change in health care operations. Until the mid 1980s, the major payers of health care services in the United States (namely, the federal government, state governments, and employers) paid health care providers (primarily physicians and hospitals) on a cost reimbursement or negotiated cost reimbursement basis. In this system, there was little incentive to concentrate on efficiency in delivering health care services. Not surprisingly, this situation was accompanied by rapid increases in the cost of health care services.

In the mid-1980s, the federal government adopted a prospective payment system (PPS) and employers decided that they were unwilling to simply accept the rapid inflation in health care costs. Shortly thereafter, health care providers found themselves dealing with fixed payments for their services. This meant that providers could no longer pass their costs on to the payers. In turn, these consequences created a real incentive for health care providers to concentrate upon efficiency in the delivery of health care services. Hence, providers began to pay increased attention toward understanding and managing patient flow at their facilities.

The Health Care Environment

Given the natural complexity of the health care environment, the health care setting greatly influences both the perception and analysis of patient flow. Fortunately, however, the health care environment can be easily characterized based upon the nature of health care services. Traditionally, health care services can be distinguished as either inpatient or outpatient. Inpatient care, such as an appendectomy, is provided when patients are required to remain at a hospital or care facility for the duration of their treatment or illness. With outpatient care, like a physical examination, patients are treated and released the same day.

To place the delivery of health care in its current context, there has been one rather persistent trend associated with the operational side of health care delivery in the United States. The mode of health care delivery has been gradually shifting away from the inpatient setting. Owing to numerous technological advances in diagnostics, medications, and procedures and the evolution of reimbursement plans that limit inpatient hospital stays (e.g., Medicare's PPS and managed care plans), most health care needs can be handled on an outpatient basis. As reported in the latest annual survey of the American Hospital Association's hospital members (Hospital Statistics™, 2000), both the number of hospitals and the number of hospital beds have been steadily declining. In 1998, there were 6,021 hospitals with 1,013,000 beds. This represented a 1.2% decrease in the number of hospitals and a 2.1% decrease in the number of beds from the previous year. The average daily census (i.e., the number of

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inpatients who receive hospital care each day, excluding newborns) has also decreased, but the number of hospital-based outpatient visits have continuously increased and topped 545 million in 1998.

Attributes of Patient Flow

Patient flow can be described by one of two complementary approaches: clinical or operational. Regardless of approach, all patient flows share four common characteristics: (1) an entrance, (2) an exit, (3) a path connecting the entrance to the exit, and (4) the random nature of the health care elements. Obviously, patient flow begins at that point when a patient is first diagnosed with a particular medical condition, or where the patient first enters or is admitted to a health care facility. Likewise, after the medical condition has run its course, or the patient leaves or is discharged from a health care facility are signals of the patient flow's exit. Between these two points is a set of conditions, activities, services, or locations that the patient may encounter. Within these points, the patient requires a variety of health care resources (e.g., beds, examining rooms, physicians, nurses, or medical procedures). This implies that patient flow can be depicted as a network. In fact, the key characteristics of patient flow can be conveniently summarized using basic network features in which nodes represent the health care elements and arcs indicate the flow between the elements. Consequently, for a given health care service, patient flow can be portrayed in a very straightforward fashion because of the flexibility in definition of the network's nodes and arcs.

As examples of patient flow, consider the networks given in Figure 1 (adapted from Thomas, 1968) and Figure 2 (adapted from Bretthauer & Côté, 1998). Figure 1 is an example of an inpatient medical condition and illustrates the possible recovery paths associated with a group of discharged alive coronary patients. In this network, the nodes specify the degree of physical recovery while the arcs point out the possible courses of recovery. In contrast, Figure 2 is an outpatient application of a family practice clinic's patient-care episodes.

These examples are typical of most any network depiction of patient flow. Usually, only a moderate number of nodes and arcs are required to effectively portray a health care service.

The last important characteristic hinted at by the patient flow examples is the inherent random nature of patient flow. The randomness is embodied in two features. First, for a given health care service, not all of the elements in a patient flow network may be applicable to all patients. For example, considering Figure 1, the recovery path for a discharged alive coronary patient could consist solely of the patient progressing from acute care to primary activity before being discharged. Second, the time patients spend at each node and the time patients spend in the overall network also implies a degree of randomness. As an example, following from Figure 2, a likely concern of any patient who has ever visited their family doctor is to wonder how long the visit will take.

Operational Issues and Patient Flow

Once a health care facility has an understanding of its patient flows, these flows can be used to improve the facility's operations. In particular, resource planning, scheduling, and utilization are all affected by patient flows. Quantitative tools, like forecasting and queuing models, can help decision makers assess health care services in light of the patient flows.

Forecasting the demand for health care services impacts almost all aspects of health care operations. Once patient demand is estimated, the facility can then anticipate what resources (e.g., medical staff and equipment) will be required. Similarly, it is not entirely coincidental that the patient flow networks resemble queuing networks. Like any other service industry, health care is subject to capacity and resource limitations and queuing for services will occur. Queuing models, whether developed as analytic approximations or as simulations, can be used to augment the facility's understanding of its operations. Queuing performance measures such as time in the system and traffic intensity have direct correspondence to the patient flow characteristics.

Conclusion

Health care resources have become increasingly scarce and expensive. The administrators of health care facilities are continually faced with the task of balancing the delivery of quality health care with the appropriate allocation of their resources. Many opportunities currently exist to apply the quantitative tools of operations management or management science to support health care decision making. As is the case with any successful application of these tools, an understanding of the underlying

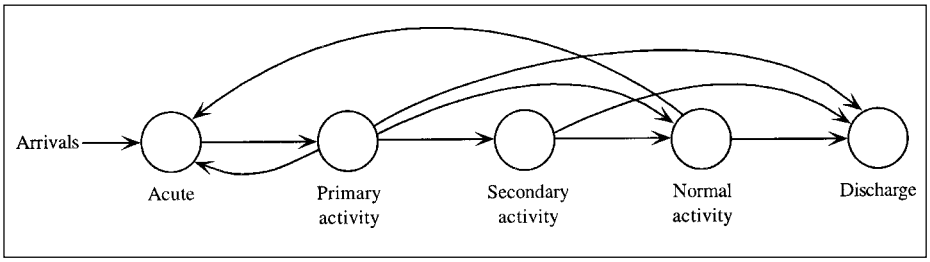

Figure 1: Patient flow for discharged alive coronary patients.

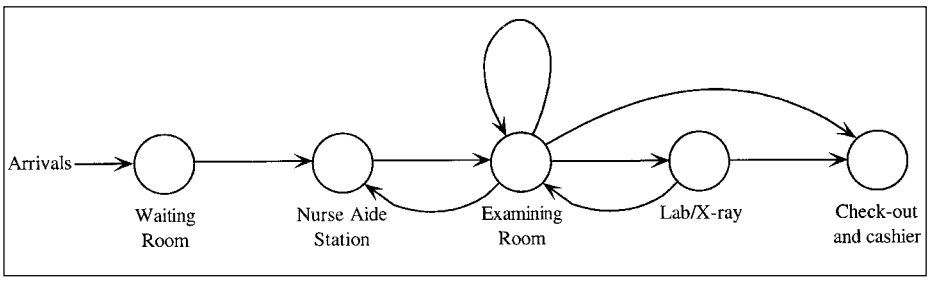

Figure 2: Patient flow for patients at a family practice clinic.

environment is essential and within the health care environment, the concept of patient flow is fundamental.

References

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Board of Directors

President Lee J. Krajewski (University of Notre Dame) chaired the Board of Directors meeting that was held on Saturday, January 15, 2000, in Tucson, Arizona. The following is a report of the actions taken by the Board and matters brought to its attention. The Executive Committee met on Friday, January 14. Its recommendations to the Board are included in the items reported below.

1. The minutes of the November 1999 Board of Directors meeting were approved with one correction for clarification.
2. A policy and procedures statement regarding Home Office retirement compensation was approved.
3. The financial statement for the period ended June 30, 1999, was reviewed and accepted.
4. A revised policy statement regarding year-end allocation of annual return on investments to regions was approved.
5. The financial statement for the period ended December 31, 1999, was reviewed and accepted.
6. The Midwest region's FY 2000-01 budget was reviewed and accepted.
7. The following reports were accepted for review:
   a) Alpha Iota Delta Liaison Committee
   b) Case Studies Committee
   c) Development Committee for Excellence in the Decision Sciences
   d) Doctoral Student Affairs Committee
   e) Executive Committee
   f) Fellows Committee
   g) Home Office
   h) Information Technology Committee
   i) Innovative Education Committee
   j) Investment Advisory Committee
   k) Member Services Committee
   l) Nominating Committee
   m) Programs and Meetings Committee
   n) Publications Committee
   o) Regional Activities Committee
   p) Strategic Planning for International Affairs Committee
   q) Ad hoc Committee on Improving the Annual Meetings
   r) Ad hoc Committee on A Teaching Publication
   s) Ad hoc Committee on Regional Accounting Practices
   t) Regionally-Elected Vice Presidents
   u) *Decision Line* editor
   v) 1999 Doctoral Student Consortium Coordinator
   w) Coordinator of Placement Services
   x) New Faculty Development Consortium Coordinator
   y) Treasurer
   z) 2001 Annual Program Chair
   aa) 1999 Doctoral Dissertation Competition Coordinator
8. Recommended candidates from the Doctoral Student Affairs Committee for Coordinators of the 2001 Doctoral Student Consortium and the 2001 Doctoral Dissertation Competition were accepted.
9. Recommended changes to the Policies and Procedures Manual from the Doctoral Student Affairs Committee were approved with minor modifications.
10. Recommendations from the Investment Advisory Committee were accepted, including actions to be taken regarding the Institute's Money Market Accounts and a Certificate of Deposit maturing on 5/17/00.
11. Recommended candidates from the Programs and Meetings Committee for Coordinator of the 2001 New Faculty Development Consortium were accepted.
12. A procedural policy statement concerning reporting mechanisms, proposed by the Programs and Meetings Committee, was revised and accepted.
13. Approval was given to the Regional Activities Committee's recommendation to hold a Strategic Planning training session during the 2000 Annual Meeting in Orlando to assist the regions in the development of their mission and strategies.
14. The Strategic Planning for International Affairs Committee's recommendation to hold the Institute's 6th International Meeting in Chihuahua, Mexico, July 8-11, 2001, was accepted. A non-member registration fee of $40 for Institute membership for one year was also approved, with the stipulation that the $40 differential fee be returned to the Institute to defray the cost of providing membership benefits for one year to non-Institute members attending the meeting.
15. A recommendation was accepted from the Ad hoc Committee on A Teaching Publication that a new DSI publication be initiated.
16. Recommendations from the 1999-00 Ad hoc Committee on Regional Accounting Practices were approved, in concept, with implementation mechanisms to be further developed by this committee in 2000-01.
17. A recommendation from the 1999 Doctoral Dissertation Competition Coordinator was accepted, regarding year-round publicity for the Competition in *Decision Line.*
18. Recommendations were accepted for Committee Chair appointments and new members of the Case Studies and Innovative Education Committees for 2000-01.
19. The report from the 1999 Annual Meeting Program Chair was reviewed and accepted.
20. The Treasurer's report to accompany the FY 1997-98 audit report for publication in *Decision Line* was reviewed and accepted.
21. The report from the *Decision Sciences* Journal Editor was reviewed and accepted as part of the report from the Publications Committee. ■