Cardiac Catheterization Laboratory
IT User Experience and Information Flow

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1. Introduction

This research is for understanding users, their activities, and information flow and its exchange in Cardiac Catheterization (Cath) through observational approach and method. Cardiac Catheterization is a procedure for diagnosis and treatment for heart conditions by inserting catheter into an artery in a leg or arm. Cardiologists, nurses and technicians require professional knowledge and cooperative performance toward each other and with specialized equipment. In general, one attending cardiologist and one cardiologist fellow, one or two circulating nurses, and a technician comprise the Cath team. Attending cardiologist who is responsible for the procedure leads the procedure. A cardiology fellow supports attending cardiologist performing a procedure by role. Technician takes charge of logging procedure data into the IT system for chronological data. Nurse works closely with all the members enacting support as well as with the patient.
Cath Lab Floor Plan

Typically, the work area of the Cath Lab is divided into three spaces: the operating room, control room, and holding rooms (Figure 1). The operating and control room are separated by the window; through this glass window Cath team communicate during the procedure. In control room where a technician stays mostly during the procedure, IT equipment is fully furnished, such as IT system for logging chronological data and imaging system for angiogram and angiography. In operating room the procedure is performed by doctors and a patient is lying on operating table which is specially equipped for taking images of the heart. Storages for supplies are furnished in the room. And scrubbing area for the doctors is in the operating room. Racks for the lead vests can be found inside the control room or in the space connecting the operating and control room. Most of the equipment used in the operating room is movable, such as the operating table, scanners and screens variable may account for problems in the user flow related to the use of space.

Figure 1. Cath Lab Floor Plan
Work Flow

Cath team is required to cooperate in carrying out clinical care in time-dependent work processes according to their roles.

Before the Cath procedure starts in operating room, every patient is evaluated beforehand by a cardiologist who reviews the chart and conducts a brief interview and examination. These activities are performed in the holding room or in the operating room. Meanwhile, the nurses and other staff prepare for the procedure in the operating room prepping supplies and the technician gets ready by entering patient information that needs to go into the chronological data recording system in the control room. And the technician sometimes helps the circulating nurses preparing procedure in the operating room. The cardiologists review the previous case of the patient which is archived in imaging system if necessary. After a patient is moved to the operating table, the cardiology fellow enters into the operating room to get ready. Then, the attending cardiologist scrubs to perform the procedure. During the procedure, the nurse gets supplies from inventory at request of the cardiologists and administers medications to the patient. The technician inputs chronological data from the procedure into the IT reporting system in the control room and displays data to the monitors in the operating room upon request of the cardiologist. After the procedure is done, the attending cardiologist leaves first. After the patient is moved to the recovery room after treatment of the cardiologist fellow, the nurses start cleaning the operating room for the next. The technician in the control room finalizes reporting, prints out the report, and gets signatures from all the team members of the procedure (Figure 2).

![Figure 1. Cath Lab Procedure](image-url)
Research Problem

Cath lab is the origin of producing information, which will be stored, shared, managed, and distributed across the departments of the hospital (Figure 3). Inventory, charge, images from angiogram, hemodynamic data, medication administration, practice procedure, etc. are distributed across the departments in the hospital as the purpose of billing and cost capture, Cardio Vascular Information System (CVIS) as well as finance and accounting, medical record and coding, ACC registry, quality assurance, benchmark, and clinical research.

Figure 3. Information Flow in Cath Data Circulation

2. Literature Review

Redefining Health Care
by Michael Porter and Elizabeth Olmsted Teisberg

In this chapter, the author develops eight strategic and organizational imperatives focused at competing in value:

1. Redefine the business around medical conditions.
   Hospitals are doctor centric, procedure centric or institution centric, not patient centric. The relevant aspect in health care delivery is a medical condition seen over the full cycle of care. In this model, medical conditions (patient centric) represent the basic unit of analysis.

2. Choose the range and types of services provided.
   Facilities and space can grow into areas of true efficiency.
   Strategic focus is not about narrow specialization, but more about the pursuit of excellence in the fields.

3. Organize around medical integrated practice units.
   Traditional health care structure is organized around departments of medical specialties such as internal medicine, cardiology, etc. It can also be organized into shared
functions like operating rooms, imaging, etc. However, it is necessary to shift to an integrated practice unit structure (IPU). IPUs are defined around medical conditions, not particular services, treatments or tests. This makes it possible to offer a multidisciplinary approach to diagnosis, treatment, and disease management.

4. **Create a distinctive strategy in each practice unit.**
   In each IPU, a provider should seek a distinctive focus that differentiates it from other competitors. Within an IPU, individual physicians should develop unique expertise and sub-specializations that deepen the overall competence of the group.

5. **Measure results, experience, methods and patient attributes by practice unit.**
   The most relevant unit for measurement is medical conditions, not broad functions, physician practices, or hospitals as a whole. Information also needs to encompass the full cycle of care for a patient.

6. **Move to single bills and new approaches to pricing.**
   Providers need to issue a single bill for each episode of care and eventually the full care circle. It is the entire episode, not single services that is the meaningful cost for the value delivered.

7. **Market services are based on excellence, uniqueness and results.**
   Providers must communicate their areas of unique excellence at the IPU level. These areas can be their teams and facilities, their strengths, expertise in medical practice.

8. **Grow locally and geographically in areas of strength.**
   Excellent providers in an IPU can grow regionally, nationally and even internationally.

In this chapter, the authors develop outline the role health plans in the value-based competition approach for health care.

Before, health plans failed to control rapidly rising costs and became one of the least trusted in the system. What is required now is a dramatic shift from just being insurance organizations to that of health organization. This chapter outlines a number of these shifts that are needed from the perspective of the health plan providers to change their role in the system -- essentially, a role that shifts them from being that of just a payer to that of a participant.

In the past, the “zero-sum” mentality of cost-shifting meant health care was treated as a commodity. This was a dead end that has failed because health care is not a commodity.

The thrust of the chapter is about shifting the strategic, operational, and operating policies of health plans so that they add value for patients -- a shift from a culture of denial to that of value-based competitive results.
Enabling choice and management of health
Instead of the orientation around “medical necessity” which places doctors and members in an adversarial position with health plans, shift to a focus of improving health. Move from adversaries to partners. Shed the attitude of constraints and overseeing physicians practices and to enabling patients and doctors to obtaining excellent care. Also, move to measure results and recognize providers of excellence

Measure and reward providers based on results
The old mentality built large networks of providers to obtain the bargaining power that would allow them to negotiate down the price. They also focus on micro-managing every aspect of a doctor's care, approving or disproving every element. Rather, move to get patients the best and most efficient providers it drives down costs.

Maximize value of care over the full care cycle
Churn rates are at about 25% within five years, which has forced a very short-term perspective, so everything is about keeping costs down rather than focusing on care. But, the value should be determined over the full cycle of care. This perspective shifts the role of the health plan from costs to care.

Minimize need for administrative transactions and simplified billing
The old mentality is ruled by extensive paperwork relative to referrals, treatments, bills, contracts, etc. and many of these administrative-based transactions do not add any value. The goal should be to reduce the costs required for administrative approvals.

Compete on member health results
Currently the competitive focus is about trying to lower costs and limit growth of premiums. In the future, plans need to compete on results per unit of spending and should look at a measure that considers the overall health of members.

The remainder of the chapter outlines a number of imperatives for health plans if they are to move to value-based competition.

• Provide health information and support to patients and physicians
• Restructure the health plan-provider relationship
• Redefine the health plan-subscriber relationship
Chapter 7
Implications for Suppliers, Consumers, and Employers

New opportunities for suppliers
• Compete on delivering unique value over the full cycle of care
• Demonstrate value based on careful study of long-term results and costs versus alternative therapies
• Ensure that products are used by the right patients
• Ensure that products are embedded in the right care delivery processes
• Build marketing campaigns based on value, information, and customer support
• Offer support services that add value rather than reinforce cost shifting

New responsibilities for consumers
• Participate actively in managing personal health
• Expect relevant information and seek advice
• Make treatment and provider choices based on excellent results and personal values, not convenience or amenities
• Choose a health plan based on value added
• Build a long-term relationship with an excellent health plan
• Act responsibly

New roles for employers
• Set the goal of increasing health value, not minimizing health benefit costs
• Set new expectations for health plans, including self-insured plans
• Provide for health plan continuity for employees, rather than churning
• Enhance provider competition on results
• Support and motivate employees in making good health choices and in managing their own health
• Find ways to expand insurance coverage and advocate reform of the insurance system
• Measure and hold employee benefit staff accountable for the company’s health value

From September to December 2007, field observations were carried out in a major metropolitan research hospital in the United States in order to understand the context of Cath Lab work and activities. Site visits and additional observations were conducted at an additional Cath Lab in a different hospital. Direct field observation is supported by photographic and video documentation of the surroundings. Also, in-situ interviews were conducted. Cath procedure reports and doctors' dictation notes for the cases were analyzed. In total, 3 Cath cases were observed. Direct field observation provided the team with the opportunity of understanding the context of the procedure. It also allowed us to observe the activities of the different actors involved in the process.

Field Notes

Taking notes during observation was a standard practice for the team. They represent a brief record of insights, topics, thoughts, short comments, explanations, remarks, etc. They usually serve as an aid for memory. The notes have to be expanded and transcribed as soon as possible in order to input the most information possible.

Photographic Documentation

Before video documentation, the team was able to collect digital images of the physical environment. That is, the actual space without being in use. This started our understanding of the space and the localization of equipment, materials and supplies. There was also extensive photographic documentation during cath procedures. The still images obtained served the team as reminder of pivotal points during the procedure. These images may be used in the development of storyboards for a particular stage of the process. However, interpretation from the researchers is at a higher probability.
Video documentation of our observations was fundamental in analyzing in depth the social interaction among team members as well as the workflow, a direct result of the nuances of every case. Without video documentation of the cases, understanding the unit of analysis in depth would have been very difficult. The downside of this method is the necessity of having several cameras recording the same unit of analysis from different perspectives. This may prove complicated in a very sensible and confidential environment such as a hospital. Also, the implications of mounting video cameras on the walls or ceiling may be a limitation for some spaces, since there has to be an approval from personnel in charge of physical plant. However, for the case being, mounting the cameras out of the way was the only option. It is not wise to have cameras on tripod in environments with such heavy traffic load, and especially if that may pose a threat in the workflow of the actors.

Although video documentation and analysis is time consuming, it provides rich data for the researchers. It also has the advantage of providing for a lower level of interpretation compared to photographic documentation.

Interview

The interviews conducted were non-structured, interviews, that is, the research team concurred in topics and issues that needed coverage and then the interview flowed in a conversation mode. This allows for building rapport with the interviewee and permits the researcher to learn about issues that were not originally addressed but that may play an important role in practice.
4. Findings

Information Technology Issues

Some technologies, while very advanced, leave gaps in their ability to address everyday practices. The inventory system is not automated or synchronized with the ordering of supplies and requires Cath Lab staff to visually inspect inventory supplies and order manually on a regular basis. Further, historical inventory data is not applied to future orders and also requires Cath Lab staff to make predictions about future inventory needs.

Billing personnel, in addition to their use of computer scheduling and billing systems, prefer to make use of a hand-written log to track the progress of patient procedures, the billing of those procedures, and information about patient location following procedures. The log book has become a useful tool that scheduling and billing personnel have relied upon for years to provide a comprehensive view of all procedures and their status that current IT systems do not feature.

Data entry with automated and manually created can be inconsistent. Since the Cath Lab team still strongly relies on print documents manually created and the part of information is created automatically by IT system at the same time, information generated can be various.

Space Issues

Operating Room

• The configuration of the operating rooms presents some obstacles for the Cath Lab team. The location of a column in each lab often requires staff to walk- around to perform their duties, adding additional steps and time, particularly during long cases.
• The placement of computer screens in the control room often blocks the available view of the technician of the procedure. Two computer screens dominate the view of the technician, while sitting at their location and inhibit the technician’s ability to view the staff performing the procedure.
• Additionally, the placement of screens used by the cardiologists and nurses in the operating room often block their view of control and inhibit visual communication between the rooms.
• The mobility of medical equipment in the operating room is constantly changing the configuration of the operating room. This condition presents difficulties in the development of regular space flow patterns.
Control Room

- Usage of the control room for by others unrelated to the procedure can create distractions for the technician.
- In the majority of cases, control rooms are narrow spaces probably designed with the main users in mind, the technician and a cardiologist. However, since the procedure's information is stored in the IT system located in the control room, different actors make use of this space at the same time. These actors can range from medical students researching information, to physicians consulting other physicians via phone call, to cardiologist transcribing their report.

Communication Issues

- Microphone communication between the operating and control room is compromised at times or prevents clear understanding between the operating and control room. This may be due to unrelated conversations in the control room, or by the sound generated by the medical equipment in the operating room.
- The announcement of medications or medical supplies used during procedures is often an area where communication requires verification between the operating and control rooms.
- Visual contact between operating and control room staff is often compromised by placement of the screens in the operating room.
- The screens, as well as other medical equipment in the operating room are movable, creating difficulties for staff in finding a regular spot during the procedure to communicate with the control room.

5. Future direction. Questions generated

There is a level of communication not addressed in this study that takes place between the Cath Lab staff and the patient. Before the procedure there is often some level of consultation and explanation between the patient (or patient’s family) about the patient’s condition and the recommended procedure to be performed. Further, patients are often awake for Cath Lab procedures and there is verbal communication between the cardiologists and patient. In a few observed cases it was noted that the cardiologists would speak to the patient about the procedure, it’s progress, findings, and at times, request information from the patient about medical history or current levels of discomfort or pain. Research focused on doctor-patient communication taking place before, during and following Cath Lab procedures would provide a more comprehensive understanding.
While doing this study integrated information issue is addressed. The Cath report is automatically generated by IT system including information of team, procedures performed, medications administered, hemodynamic data, etc. On the other hand, the doctor’s opinion and summary for the procedure is still dependent on hand-written notes. The way of creating information impacts on Cath Lab team members’ workflow. For example, a collection of printed documents should be taken care of by someone throughout the journey of information to be managed or distributed. Also, this diverse ways of generating information imply possibilities of carrying out error, mistake, etc. when it is distributed.

6. Discussion (Limits)

The main limitation for this study is logistics. In a very complex and case sensitive environment such as a Cardiac Cath Lab, a great deal of effort goes into planning the observation of every case. Given the nature of the procedure, there is a very short time frame when the patient can be consented. That is usually right before the procedure starts. There is also the need of getting all the actors involved consented. Fortunately, in this study the medical staff was very cooperative in that regard. After the procedure is observed there is also a time delay before the procedure information starts flowing to the different systems in the hospital. The tracking of this information is also complex and somewhat confusing.