Using a Computerized Patient Record to Reengineer an Outpatient Clinic

Stephen M. Borowitz, M.D.
University of Virginia Health Sciences Center, Charlottesville, Virginia, 22908

ABSTRACT

By employing process flow analysis and work redesign techniques during the design and implementation of a computerized patient record in the pediatric outpatient clinics at the University of Virginia Health Sciences Center, we have developed a database of clinical observations while simultaneously shortening the time that patients spend waiting in the pediatric clinics and decreasing the number of support staff employed within the clinics.

Like most other large medical institutions, the University of Virginia has a long history of administrative and financial computing systems, however our first entry into the realm of clinical computing didn't begin until five years ago when the institution installed a computerized electronic physician order entry and communication system. The implementation of this system was a very painful process, but the system is now deeply ingrained in the institutional culture [1]. While there were some altruistic motives for developing this system, the biggest single reason for its development was anticipated cost-savings. While the system has resulted in many benefits ranging from faster order processing to a dramatic decline in medication errors, the overall cost savings have been small. This is not a unique experience. As a whole, information technology has generated neither tremendous cost savings nor substantial gains in productivity [2,3]. In those organizations that have realized significant benefits from the adoption of information systems, this success has only been achieved when the system has been designed to serve process requirements, and the organization has focused on the implementation and post-implementation management of the information system to insure its adoption and proper use [4,5].

When we reviewed the development and implementation of our order entry and communication system, we found that in many circumstances the system seemed to create more rather than less work. This was a direct consequence of computerizing old ways of doing business, and as such, actually adding more steps to existing processes [6]. Therefore, before implementing a computerized patient record in the Department of Pediatrics at the University of Virginia we performed a comprehensive assessment of current practices. Management Information Systems graduate students from the McIntire School of Commerce at the University of Virginia reviewed work and information flow in the outpatient clinics.

Rather than being a seamless operation, the delivery of patient care was a composite of three discrete and distinct enterprises: 1) patient registration and its associated documentation; 2) the delivery of care and its associated documentation; and 3) patient billing and its associated documentation. While these three processes related to one another, they often proceeded in parallel as well as opposing directions. Moreover, these three enterprises were managed by three distinct groups of people. The end result of this division of labor was a series of extremely complex and convoluted processes. As an example, ***figure 1*** depicts outpatient billing and registration at the beginning of our assessment. While computers have been incorporated in many places, they have not been used to integrate the process, but rather to dis-integrate it.

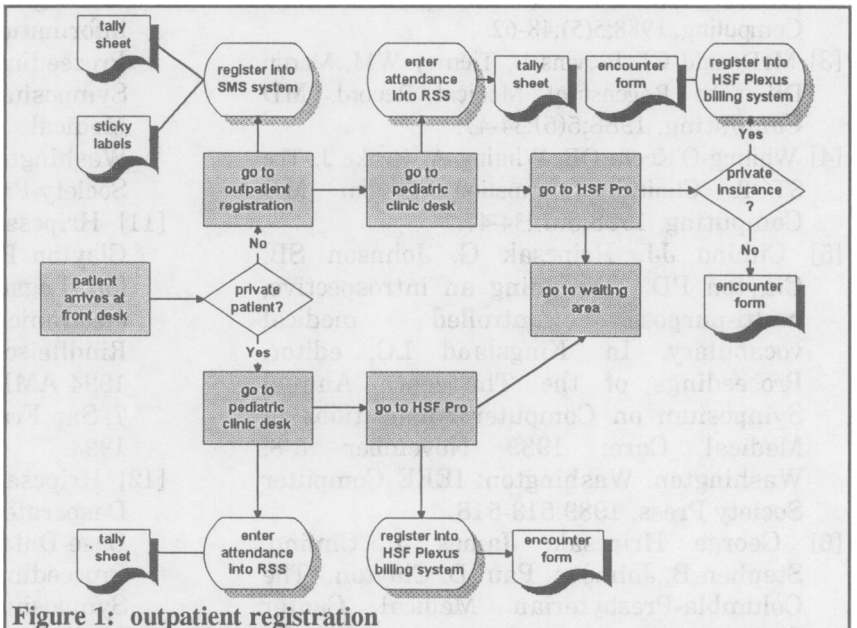

Figure 1: outpatient registration

Ideally, patient care should be an iterative process with needed documentation as well as billing

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and administrative information being an outgrowth of the delivery of care. We have tried to use the Lifetime Clinical Record (LCR) as a means of redesigning work and information flow in our outpatient clinics while simultaneously capturing clinical information.

At its very best, a patient encounter in all outpatient settings should be very simple. The patient arrives, he or she is escorted to an examination room, the physician, already armed with all the information he or she needs, visits with the patient, delivers whatever care is appropriate, and the patient leaves. In the process of delivering care, information should be automatically collected and routed to the appropriate resources, and the needed documentation generated. For such an encounter to occur, there must be complete integration of billing and administrative functions with the actual delivery of care as well as with the documentation processes. We employed process redesign to streamline the outpatient registration process and integrate it into the delivery of patient care (*figure 2*). With the new system, when a patient is registered at the front desk of one of the pediatric clinics, the nursing staff are immediately notified on a status screen that the patient is in the waiting room, as well as the time of the patient's appointment and the time the patient arrived to be seen (*figure 3*). By entering vital signs and growth parameters directly into the clinical database, nursing staff automatically notifies physicians that the patient is in a room and ready to be seen, as well as the time the patient arrived in the room.

PEDIATRIC ATTENDANCE DISPLAY

	MED REC	PATIENT NAME	RESOURCE	APPT	REGS	INRM
1	XXXXXXX	XXXXXX ,XXXXXXX XXXX	PULMONARY DRS	09:30	09:11	09:16
2	XXXXXXX	XXXXXX ,XXXXXXXXX XX	RA GOMEZ	09:30	09:02	09:39
3	XXXXXXX	XXXXXXX ,XXXXX XXX	RA GOMEZ	09:30	08:13	09:47
4	XXXXXXX	XXXXXXXX ,XXXXX	WL CLARKE	09:30	10:12	10:22
5	XXXXXXX	XXXXXX XX ,XXXX XXXX	PW HEYMANN	09:30		
6	XXXXXXX	XXXXXX, XXXXXX XXXX	RA GOMEZ	10:00		
7	XXXXXXX	XXXXXX ,XXXXX XXXX	RA GOMEZ	10:00	09:52	10:10
8	XXXXXXX	XXXXXXX ,XXXX XXXXX	PW HEYMANN	10:00	09:50	
9	XXXXXXX	XXXXXX ,XXXXXXX XXXX	PW HEYMANN	10:00	09:35	
10	XXXXXXX	XXXX ,XXXXXXXX XXXXX	PULMONARY DRS	10:15	09:55	10:28
11	XXXXXXX	XXXX XX ,XXXXXXX XXX	RA GOMEZ	10:30	09:56	10:08
12	XXXXXXX	XXXX ,XXXXXX XXXXX	WL CLARKE	10:30		
13	XXXXXXX	XXXXXXXX ,XXXXXXX XX	PULMONARY DRS	10:30	10:31	10:50
14	XXXXXXX	XXXXX ,XXX X	RA GOMEZ	10:30	10:10	11:19

__ <------ SELECT ITEM, PRESS ENTER TO COMPLETE SELECTION

Figure 3: waiting room status screen

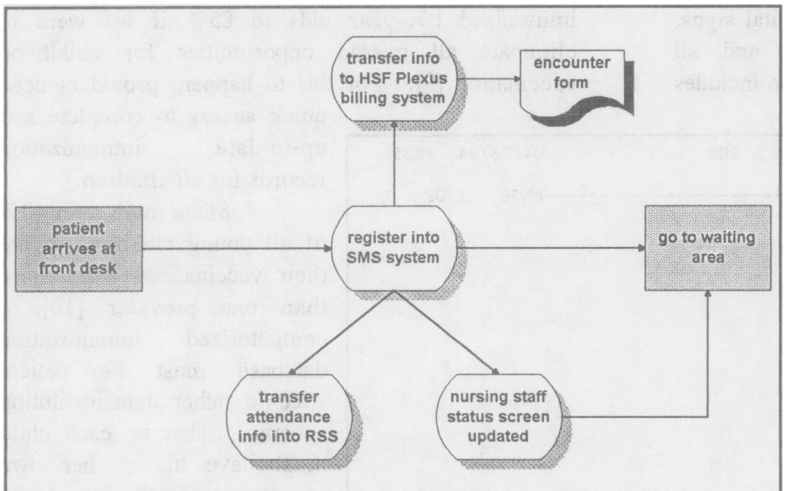

Figure 2: registration after work redesign

This relatively simple process redesign enabled the development of a database of clinical observations that previously were not accessible to providers while simultaneously shortening the time that patients spend waiting in the pediatric clinics. On average, every patient visit has been shortened by fifteen minutes. While most of this time has been shaved from registration and waiting room time, there has also been a decrease in the amount of time patients spend waiting in exam rooms. The end result has been a substantial decrease in the cycle time associated with a patient visit thus allowing more patients to be seen in the same number of examination rooms. Moreover, the information system has improved the efficiency of nursing staff. Before implementation, approximately 60% of nursing time in the outpatient setting was spent performing clerical functions. By streamlining the visit process, we have decreased the amount of paper documentation the nursing staff are required to generate. Patient flow through the clinics has been significantly improved, parents are more satisfied, and we have been able to eliminate one full-time nursing position.

Data retrieval from the LCR is very straight-forward and widely accessible. Terminals are available throughout all inpatient and outpatient units in the medical center, and the system can be easily accessed across the university-wide ethernet as well as remotely by modem. This provides faculty, housestaff, students, and referring physicians ready access to the system from their offices and their homes. The LCR has been integrated into the medical center wide computerized appointment scheduling system, as well as the electronic mail system. Many terminals also have direct access to the health sciences center library's card catalog,

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                    PATIENT VERIFICATION                    04/23/94  1832

      SEX: F  DOB: 11/19/1990  MRN: XXXXXXX
 RACE: W  M/S: S                                          SSN: XXX-XX-XXXX
-------------------------------------------------------------------------------
    DEMOGRAPHIC DATA                 |    ****** LCR PEDS CLINIC MENU ******
ADDRESS:    XXX PEACOCK DRIVE        |     ! 01 VITAL SIGNS GROWTH DATA ENTRY
ADDRESS2:                            |     ! 02 VIEW PEDIATRIC FLOWSHEET
CITY:       CHARLOTTESVILLE          |     ! 03 VIEW FLOWSHEET OPTIONS
STATE:      VA  DISTRICT CODE:   1   |     ! 04 CORRECT PEDIATRIC OBSERVATIONS
ZIP CODE:   XXXXX                    |     ! 05 VIEW CASE HISTORY
PHONE:      XXX-XXX-XXXX             |    ****** LCR IMMUNIZATION MENU ******
COUNTRY:                             |     ! 06 IMMUNIZATION DATA ENTRY
NEAREST RELATIVE                     |     ! 07 VIEW IMMUNIZATION RECORD
LAST NAME:  XXXXXXXX                 |     ! 08 CORRECT IMMUNIZATION DATA
FIRST NAME: XXXXXXXX XXXX            |     ! 09 PRINT IMMUNIZATION RECORD
REL TO PAT:  M                       |
PHONE:       XXX-XXX-XXXX            |     ! 10 VIEW OLPR DOCUMENTS
                                     |                  ENTER SELECTION __
-------------------------------------------------------------------------------
  ! (PF11) SIGNOFF                        (PF17) RECORD PATIENT IN ROOM TIME
  ! (PF14) RETURN TO PT LOCATE MAIN MENU  (PF18) RECORD PATIENT DEPARTURE TIME
                                          (PF16) SEND PATIENT DATA TO LCR
```

Figure 4: LCR retrieval screen

MEDLINE®, and a number of other full-text and bibliographic databases.

To retrieve patient information from LCR, the desired patient is identified by name, hospital number, or social security number and the provider is presented with a short list of retrieval options (***figure 4***). The level of access is regulated by linking menu options to provider identification. All coded information has been entered into a flowsheet which currently includes a history of medical encounters, diagnoses, vital signs, growth data, immunization information, and all laboratory results (***figure 5***). The system also includes

```
   PATIENT RESULTS DISPLAY          SELECT A SET              04/23/94  1835
NAME: XXXXXXXXXXXXXXXXXXX
-------------------------------------------------------------------PAGE   1 OF   2
  ?  1  PED FLOWSHEET
  ?  2    PED VS
  ?  3    PED GROWTH
  ?  4    ADM SET
  ?  5    LAB - PEDIATRICS SET
  ?  6      CBC PROFILE
  ?  7      CHEM DEPT SET
  ?  8        ARTERIAL BLOOD GAS
  ?  9        ELECTROLYTES (WHOLE BLOOD)
  ? 10        ENZYME PROFILE
  ? 11        LIPID PANEL
  ? 12        REABSORBED PHOSPHORUS
  ? 13        URIC ACID CLEAR
  ? 14        UREA NITROGEN CLR
  ? 15        CHEM/IMM/OTHER
-------------------------------------------- KEY IN A NUMBER __ AND PRESS ENTER
  !(PF14) RETURN TO PT MENU        ! PF8 MAX
  !(PF15) DISPLAY OPTIONS          ! PF6 UP
                                   ! PF7 DOWN
                                   ! PF9 MAX
```

Figure 5: LCR flowsheet

a powerful search function that allows clinicians to search for particular data elements rather than forcing them to browse through the entire worksheet.

Transcribed text, including discharge summaries, operative reports, radiology reports and selected consultation reports and outpatient notes, is linked to an encounter history. This affords clinicians the ability to reconstruct a narrative of the patient's record at any workstation.

We have tried to use similar techniques in the development of a regional immunization database for Central Virginia. Nowhere is the failing of the paper patient record more apparent than with childhood immunizations. Childhood immunizations are among the most cost effective of health interventions. It has been estimated that for every dollar spent on childhood immunizations, we save $14 down the line [7]. Despite the fact that virtually all children in this country are completely immunized by the time they enter school at age five, only 50-60% are completely immunized by age two [8]. It is during the first two years that children are at greatest risk for many of the diseases we are trying to prevent with immunizations. Without any changes in patient behavior, we could increase the rate of completely immunized two-year olds to 85% if we were to eliminate all missed opportunities for childhood vaccination [9]. For this to happen, providers need quick access to complete and up-to-date immunization records for all children.

Since more than 40% of all young children receive their vaccinations from more than one provider [10], a computerized immunization database must be patient specific rather than institution specific. That is, each child must have his or her own complete immunization record which includes all immunizations administered regardless of whether those immunizations have been administered at a single geographic site, or many different sites.

Since the immunization database is shared among many providers, each with their own unique information management system, and therefore each with their own unique patient identification system, a master

index has been created which associates all the different patient identifiers with a specific child. This allows providers to query and update the database using the patient identifier associated with their own current information management system.

With our current paper-based system, there are many obstacles to immunizing a child. First, a complete immunization record must be available and accessible, then the record must be reviewed, consent obtained, and finally the immunization administered. Not surprisingly, there is a great deal of paper work associated with this process (*figure 6*). By integrating the immunization database with the registration and billing systems, we have eliminated a number of the potential stumbling blocks for immunizing children, and essentially forced providers to consider immunization at every opportunity. At the same time we have managed to eliminate much of the nursing and clerical paperwork associated with the administration of immunizations (*figure 7*).

The immunization database allows providers at any site quick and easily obtainable immunization records on-line for any child within Central Virginia. By mapping immunization information to a simple one page grid, caregivers can quickly determine a child's immunization history and administer appropriate immunizations to bring that child "up to date". Current immunization recommendations can be retrieved with a keystroke. Data entry screens have been designed to improve workflow so that all necessary information is captured on-line. This results in significantly less paper work and the ability to retrieve information enhanced. As the database evolves, it will provide decision support in the form of actively advising the provider of all vaccinations currently due a patient, identify true versus false contraindications for the administration of immunizations, and provide new information about immunization practices at the point of use. With further development, the system will also be able to assist in the reminder process, identifying children who are due for immunizations, and automatically generating reminder letters.

In summary, a computerized patient record can improve the delivery of health care by providing health care professionals with better and faster access to clinical data of higher quality. There are no longer significant technological barriers to the development and implementation of a computerized patient record, but rather, there are substantial behavioral, administrative, and political barriers. In order for the health care industry to realize substantial cost savings and gains in overall productivity with computerization, we cannot simply computerize our current paper-based medical record. Computerizing existing processes adds more steps to existing work flow, and as such, decreases

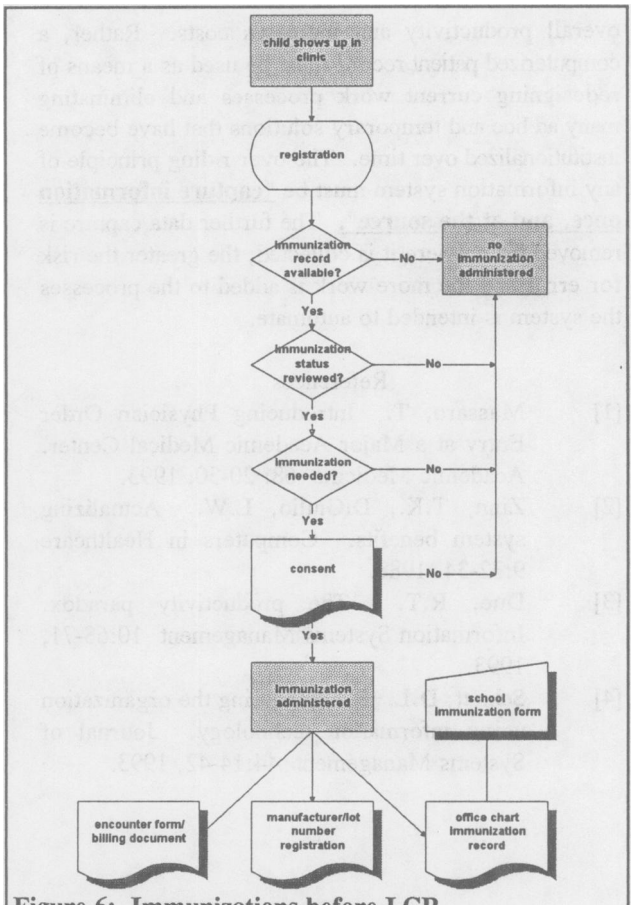

Figure 6: Immunizations before LCR

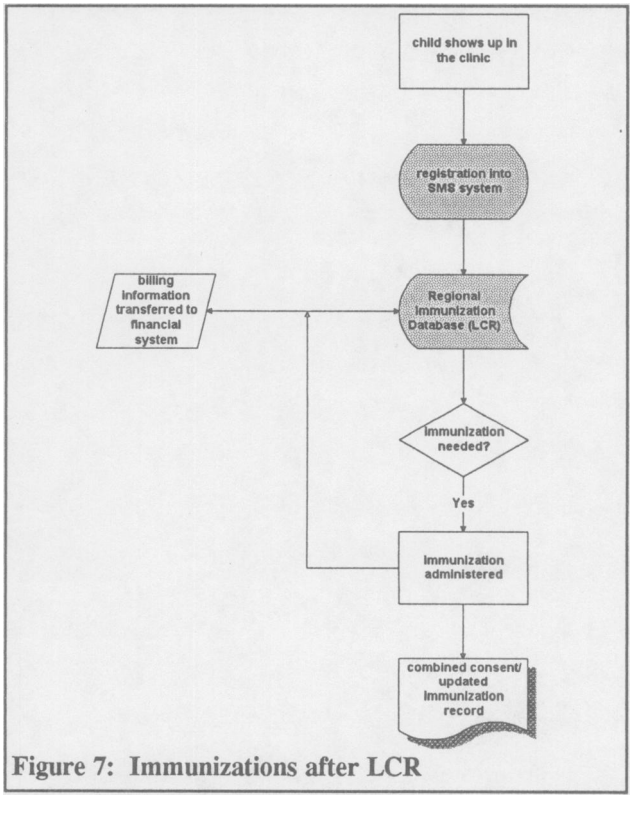

Figure 7: Immunizations after LCR

overall productivity and increases costs. Rather, a computerized patient record must be used as a means of redesigning current work processes and eliminating many ad hoc and temporary solutions that have become institutionalized over time. The over-riding principle of any information system must be **"capture information once, and at the source".** The further data capture is removed from where it is collected, the greater the risk for error and the more work is added to the processes the system is intended to automate.

References

[1] Massaro, T. Introducing Physician Order Entry at a Major Academic Medical Center. Academic Medicine 68: 20-30, 1993.

[2] Zinn, T.K., DiGiulio, L.W. Actualizing system benefits. Computers in Healthcare 9:32-34. 1988.

[3] Due, R.T. The productivity paradox. Information Systems Management 10:68-71, 1993.

[4] Schnitt, D.L. Reengineering the organization using information technology. Journal of Systems Management 44:14-42, 1993.

[5] King, W.R., Raghunathan, T.S. How strategic is information systems planning. Datamation 22:133-140, 1987.

[6] Hammer, M., Champy, J. Reengineering the Corporation. Harper Collins Publishers, Inc., New York, 1993.

[7] White, C.C., Kaplan, J.P., Orenstein, W.A. Benefits, risks, and costs of immunization for measles, mumps, and rubella. Am. J. Public Health 75:735-744, 1985.

[8] Shalala, D.E. Giving pediatric immunizations the priority they deserve. JAMA 269:1844-1845, 1993.

[9] Szilagyi, P.G., Rodewald, L.E., Humiston, S.G. Missed opportunities for childhood vaccination in office practices and the effect on vaccination status. Pediatrics 91:1-7, 1993.

[10] Blumen, L. Proposal for a National Immunization Tracking System. Centers for Disease Control 1993.