PHARMACY PRACTICE

# Computerized Integration of Pharmacy and Laboratory Data: A Prototype Model

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Computerization of patient-specific data has created the capability of easy access to a large range of information. To optimize the accessibility to any individual patient's health care data, all such information should be recorded in a single computer system or on a network allowing communication between different computer systems. At present, no comprehensive Canadian health care documentation system exists to record data and events in the treatment of individuals as both in-patients and out-patients. Even within individual hospitals, the compilation of all patient specific information in one computer system is rare. Although hospital wide information systems exist, few hospitals have committed the resources for implementation of integrated systems because of the high cost and the lack of optimal functionality in all areas. If a hospital-wide system exists, differences in operating systems may prevent communication between different users. Frequently, departments within an institution, including Pharmacy, independently selected and implemented computer systems that most closely met their immediate needs. This hindered the sharing of information with other health care services within the hospital. However, the ability to obtain and manipulate data from two or more computer systems within a hospital would increase the efficiency of many hospital activities. The use of a bridging personal computer to retrieve and manipulate the data would reduce the time required for processing by the main computer systems. This would provide the benefits of a hospital-wide computer network, without requiring direct communication between the main computers.

This report describes a prototype project to interface two independent departmental computer systems (Pharmacy and Laboratory) to allow for efficient identification and evaluation of potentially inappropriate drug therapy. A unique patient characteristic (an elevated serum creatinine measurement) was utilized to identify those patients potentially requiring non-standard drug therapy regimens, since the presence of impaired renal function is associated with altered dosage regimens, for many drugs[1]. An estimate of the renal function of an individual can be obtained from knowledge of the individual's age, sex, and serum creatinine concentration[2].

A modification of the original Cockcroft-Gault equation allows estimation with S.I. units and without knowing the patient's weight or sex (i.e., Crcl(ml/sec) = {(140-age) x 1.5}/Serum creatinine (in micromoles/liter)). This assessment is based on the assumption that renal excretion of medications is related to the excretion of endogenous creatinine.

An estimate of the individual's creatinine clearance versus a normal individual's clearance gives an indication of the degree of renal impairment and, hence, the degree of alteration of drug dosages as determined by pharmaco-

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kinetic study[1]. Comparison of the patient's drug regimen with the recommended dosage for a given degree of renal function requires integration of three databases (the patient's drug profile, laboratory data, and drug dosing references). A similar algorithm would be applicable for any disease state that affects the dosing requirements of drugs and that can be quantified through an objective measurement of an individual patient characteristic. Similar processes performed on other databases could evaluate other aspects of an individual's drug therapy.

### Model Description

The Pharmacy utilized a standalone computer system (BDM, Saskatoon) which interfaced with other hospital computer systems for admission, discharge, and transfer information. Similarly, laboratory data were maintained on a Vax (HCS, Vancouver) system. Prior to this project, the pharmacists manually retrieved patients' serum creatinine measurements, calculated the estimated creatinine clearance, compared the patients' dosages with the estimated creatinine clearance, and retrieved dosage recommendations from a published source[1]. At initiation of the project, no drug dosing reference for renal impairment was available in an electronic format. A computer based data file containing information on drug dosages in renal impairment was developed using information obtained from primary and tertiary literature sources[1]. Then to facilitate communication between the independent Pharmacy and Laboratory computer systems, procedures were developed to obtain the pertinent information from each system and transfer it to a separate personal computer for manipulation and evaluation of data. The process required a program to facilitate a primary sort of all the laboratory data into a format for transfer and recognition by the personal computer, a secondary program to allow manipulation of the data and comparison with Pharmacy computer and dosing reference information, and a third program for user organization and maintenance.

In detail, the program designed for this compilation was developed in dBase programming language (Aston-Tate dBase, version 4.1) to allow direct processing of the ASCII (American Standard Code for Information Interchange) Laboratory data file. Patients with abnormal serum creatinine concentrations were identified and their drug profile was requested from the Pharmacy computer. A program was developed to convert the Pharmacy computer data to ASCII for processing by the personal computer in dBase language. The drug profiles of the target patients were searched for any drug requiring dosing adjustment in renal failure as indicated from a compiled listing. The patient's serum creatinine measurement, the dosage of all drugs requiring adjustment in renal failure, and the recommended adjustment as described in published references were combined in a single printed or viewed report. (Appendix A).

This report showed recent serum creatinine concentration measurements and calculated estimates of creatinine clearance to allow the pharmacist to appreciate the degree of renal impairment. The current drug dosage for the medications requiring dose reduction were shown to allow the pharmacist to compare them with the corresponding recommended regimen. Previous interactions with prescribers regarding suggestions for alterations in drug regimens dosages were recorded with identification of the pharmacist participating, the recommendation, and the outcome of the recommendation (accepted or rejected).

The program was intended to run automatically in the Laboratory computer, and be transferred to the pharmacy on initiation from the pharmacist. The total time for the pharmacist to transfer all information was approximately 15 minutes. This process could be automated in the future so that the complete report would be printed automatically at a set time each day without any initiation from the Pharmacy or Laboratory. It was estimated that approximately 350 hours were required for initial preparation of the software. Hocking Datapharm Ltd. estimated that approximately 100-200 hours would be required to totally automate the system or to modify it for other laboratory or pharmacy systems. The prototype has not been incorporated into daily functions of the Pharmacy at St. Paul's Hospital because of changes in the organization of pharmacy services.

## DISCUSSION

The need to improve patient care through optimization of drug therapy, while utilizing pharmacy resources efficiently, is a mandate of all Pharmacy Departments. The application of computer technology to identify patients requiring evaluation of their drug therapy based on the screening of all patients for a specific drug or patient characteristic fulfills the requirement for efficient use of pharmacy personnel. By utilizing pharmacists' time and energy to evaluate and resolve problems in drug therapy, rather than screening for potential problems, effi-

ciency is increased. Most pharmacy distribution computer systems can screen all patients for the presence of a particular drug in the therapeutic regimen. However, the use of characteristics, other than age or sex, requires access to a database not commonly found in pharmacy computer systems.

Systems which use a laboratory measurement to identify patients requiring non-standard drug regimens have been developed by others[3-6]. This project could be considered a prototype for other pharmacy applications where decisions are based on information from two or more sources. Potential applications include comparison of antibiotic regimens with microbiological results[7-11], potential for food-drug interactions using dietary information, and drug induced hematologic or electrolyte disturbances. Systems which compile the information from multiple sources and compare treatment with desired goals will allow for the next advancement in computerized health care technology. Benefits in patient outcome and reduced costs could be anticipated. Experience with prototype systems have suggested cost avoidance[3,4,7], but improvement in patient care has yet to be realized.

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**Appendix A: Sample Report**

21-Mar-1991

**CREATININE & PATIENT PROFILE REPORT**

| | | Int | | IV | O | IVO |
|---|---|---|---|---|---|---|
| BROWN, CHARLIE | TLM | Mar 15 | 14 | A | | Gentamicin adj suggested |
| Adm#:123456 | ROT | Mar 17 | 14 | R | | Raniditine stop |
| Age: 60 | MMS | Mar 19 | 25 | A | | Raniditine re-order |
| Sex: M | | | | | | |
| Dr: Timmons | | | | | | |
| Creatinine Values | | | | | | |

| Extraction | Time | Scr | GFR | Extraction | Time | Scr | GFR |
|---|---|---|---|---|---|---|---|
| 21-Mar-91 | 0250 | 64 | 1.88 | 20-Mar-91 | 0750 | 93 | 1.29* |
| 19-Mar-91 | 0555 | 133 | 0.90* | 18-Mar-91 | 0550 | 130 | 0.89* |
| 17-Mar-91 | 0610 | 93 | 1.29* | | | | |
| 16-Mar-91 | 0705 | 85 | 1.41* | | | | |

| Medication Order D/I | GFR>0.8 | 0.2-0.8 | <0.2 | Start | Directions Comments |
|---|---|---|---|---|---|
| CEFAZOLIN 1G | | | | | |
| I | 8 | 12 | 24-48 | 15Mar | D5W 50ML IV Q8L |
| GENTAMICIN INJ 40MG/ML | | | | | |
| I | 8 | 12-18 | 24-48 | 15Mar | 140MG (3.5ML) IV Q8h |
| RANITIDINE INJ 25MG/ML | | | | | |
| D | UNCH | 75 | 50 | 16Mar | 50MG (2ML) IV Q8H |

Reviewed by:

**Legend to Appendix A:**

Int: Initials of pharmacist making an intervention

Iv: Type of intervention (coded in pharmacy)

0: Outcome of intervention, A = accepted, R = rejected

Scr: Serum creatinine value measured in laboratory

GFR: Glomerular filtration rate calculated by program using Scr value,

*indicates values which are outside normal limits.

D/I: The recommended type of regimen change for the listed drug, whether the dose or interval should be adjusted, according to Bennett[1]

GFR>.8, 0.2-0.8, <0.2: Headings representing three levels of glomerular filtration rates. Each drug entry includes the recommendations for each GFR under the appropriate heading.

Start: Date on which the order was started in the pharmacy computer.