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HOSPITAL PHARMACY AND AUTOMATION

Morton Slavin

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HOSPITAL PHARMACY AND AUTOMATION

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10 January 1963

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Paper to be presented at the 15th Annual Hospital Pharmacy Seminar which is to be held at the University of Texas, Austin, Texas, 22-24 March 1963.

The practice of hospital pharmacy in the last few decades has undergone some rather remarkable changes, and today faces even more radical ones. Those of the past have been brought about largely by mechanization both within the hospital, and outside, in the pharmaceutical manufacturing industry. Those of today and tomorrow will come about as a result of studies conducted by various investigators within the profession, by pressure from designers of drug dispensing systems and machines, and as a result of the increasing application of Automated Data Processing (ADP) to hospitals.

Automation has two integral parts -- one represented by the mechanization, continuous flow processing, and automatic control so typical of modern industry, and the other by Automated Data Processing. ADP itself originally was performed by electric accounting machines (EAM), but the trend now is to replace these with computer-controlled data processing machines or electronic data processing machines (EDP). Perhaps the best way to illustrate the significance of the change from EAM to EDP is to consider the transportation field. The bicycle and the jet aircraft are both machines to move people, but the disparity in their capabilities is so great that it hardly seems worthwhile to compare the two. This is just as true today in the data processing field and can be illustrated by a specific example. An actual hospital payroll activity, which required 12 hours of EAM time to process, was accomplished in just 30 minutes by the use of an electronic computer!

Whenever the word "Automation" is mentioned, seen in print, or its advantages are pointed out, it makes some people feel rather apprehensive. What a good many of these individuals fail to realize is that it has been with us in one form or another for thousands of years. The abacus, a computing machine, arrived on the scene some 3000 years before the birth of Christ, and the wheel itself dates back to antiquity. Automatic control can be traced back to the

beginning of the 17th century when a bright young man was hired to tend the valves of a crude steam engine. In order for this engine to function, two valves had to be opened and closed at appropriate intervals so that steam could be introduced into a cylinder to raise a piston and so that cold water could be fed in to condense the steam and allow the piston to fall. The story is that this young fellow, Humphrey Potter, was hired to take care of this opening and closing of valves. He found this to be a rather monotonous job and, being of an inventive nature, devised a mechanical linkage which performed the function automatically.

Continuous processing is also no "Johnny-come-lately." Enterprising millers of the 18th century combined the mechanization achieved by the use of the windmill or the water wheel with the first crude application of continuous processing. They stationed "loaders" at the top of the mill to feed in grain which was dropped by gravity onto grindstones where it was ground into flour and then moved by mechanical carrying devices to a discharge point where it was bagged. Other men helped to maintain this flow by delivering the grain to the loaders and the filled sacks of flour were then hauled to a convenient storage place. Today's continuous processing is a little more advanced, requiring neither "loaders" nor "baggers" nor helpers--just a man with a strong forefinger--to push the start and stop buttons!

Other developments occurred in the computation field during this same period. A calculating machine was invented by Blaise Pascal in the early 17th century which could add and subtract. This elementary machine could not multiply or divide directly, but could perform these functions by iteration of its basic ones, addition and subtraction. Some thirty years later, in 1671, the famous mathematician, Leibnitz, built a calculating machine that could multiply directly as well as add and subtract, and the principles used in its construction and operation are embodied in the modern desk calculator of today.

The feedback and programmed control principles which developed concurrently with the advances in mechanization and computation have become the keystone of automation, not only in the data processing field but in manufacturing as well. Feedback was first applied by windmill designers who built devices to automatically adjust the speed of the mill by reducing the angle of the vanes when the wind velocity was too high and to turn the vanes or sails into the wind when its direction changed. Thomas Mead invented the centrifugal governor in 1787, using it to automatically regulate the distance between grindstones in a windmill. Its best known application, however, was the one which was made by James Watt who used it to regulate the speed of his steam engine.

Programmed control made its appearance in 1804, when a fully automatic loom was invented by J. M. Jacquard, who used punched cards tied together in a belt to control the weaving pattern of a loom. The next great advance in the field of data processing was sparked by Charles Babbage who, in the 1830's, tried to build an "analytical engine" or calculator which could perform all arithmetic functions and which could have input introduced into it on Jacquard-type punched cards. This device, although unsuccessful, embodied many of the principles used in the design of today's digital computing machines.

The most significant contribution in the field of data processing was made by Herman Hollerith who, in 1889, developed a punched card system to aid in the processing of census records. This concept was subsequently improved and expanded into the punched card accounting systems so widely used today. The accounting machines themselves evolved into automatic calculating machines which were strictly mechanical in nature, then progressed to electromagnetic ones using relays, and eventually to true electronic machines using vacuum tubes. Today, computers utilize solid state electronic devices (transistors, diodes, etc.) and are so fast that some functions can be performed in nanoseconds or billionths of a second.

While hospital pharmacy and automation may appear to be strange bedfellows, in these days of rapid technological advance, automation has had an impact on every conceivable type of industry and profession. Automated instruction has been suggested as an adjunct to the teaching of pharmaceutical subjects, and automated data processing has been applied to the handling of pharmacy business and inventory control data, and to the compilation of drug listings and formularies. These pharmaceutical applications of automation are just the beginning, and many others will inevitably follow. This may dismay some pharmacists, but they must face up to these changes just as they have in the past to so many others which, although they altered the profession, changed it for the better.

The pharmacist, of course, is not the only professional employee of the hospital who must prepare himself to face the initial problems and accept the ultimate benefits of automation. Physicians are still wary about diagnostic machines; nurses are apprehensive about mechanical nurses or automatic patient monitoring consoles; laboratory technicians react unenthusiastically to auto-analysers and, of course, pharmacists are quite concerned about the use of drug dispensing machines. These reactions are to be expected, particularly if people are exposed to quotations such as the following:

"If medical therapy is indicated, with the concurrence of the physician, the computer will write the prescription for Mr. Jones, taking into account such factors as his weight, age, physical deficiencies, drug idiosyncracies, familial characteristics, and other factors. The prescription may be presented by the computer and handed to Mr. Jones, together with a bill for services or, if he wishes, he will insert his personal credit card into the machine, and instructions will be sent to a centralized automated pharmacy which will compound the prescription under sterile conditions, or the preparation itself may be electrically sterilized by ultrasonic or penetrating radiation.

Whether Mr. Jones travels to the pharmacy, or the prescription is delivered to him automatically, the vehicle will be guided and

instructed as to its destination electronically; the source of power being electronic or nuclear, rather than chemical."

Dr. Vladimir Zworykin, one of the foremost electronic engineers of this era, made the above prediction of things to come in the year 2012 in the May 1962 "Proceedings of the Institute of Radio Engineers." All of this may well come to pass in somewhat less than the 50 years Dr. Zworykin predicted since not only are we discussing automation at this seminar, but centralized unit dispensing and dispensing machines as well.

Perhaps a report of what has been accomplished in the medication area by the Patient Data Automation Branch of the Bio-Medical Systems Department of the System Development Corporation (SDC) of Santa Monica, California may serve to illustrate how automation will affect the future of hospital pharmacy. Within the Patient Data Automation Branch of SDC, two groups* were organized. An analysis team was set up to study the hospital system in terms of its data processing requirements, and a development team was organized to simulate hospital operations and determine whether certain selected types of hospital clinical and administrative data could be processed by a computer. It became evident to both groups that the medication data, because of its characteristics, would lend itself admirably to such manipulation. This was subsequently borne out in a computer experiment, based on real patient data, where a program was designed to process physicians' medication orders.

In this simulation, a physician's medication order was punched onto an IBM card, then read into the computer, producing the following outputs either directly or indirectly:

1. Pharmacy Order to Pharmacy (if drug not available from ward stocks or ward stock low and in need of replenishment).

* Composed jointly of Veterans Administration and SDC personnel

2. Pharmacy Card to Ward (to up-date ward drug inventory when drug is supplied by the pharmacy).
3. Medication Card to Ward (to be used in the preparation and administration of medication, for up-dating patient's medication record, creating nurses' medication notes, adjusting ward drug inventory, etc.).
4. Medication Planning Sheet (to be used to aid nurse in planning drug administration schedule).
5. Ward Drug Inventory Record (to check ward drug stocks).
6. Prescription Card to Pharmacy and prescription label (if drug is controlled, investigational, or a special compound).
7. Patient's Medication Record (chronological listing of all medications ordered and administered to an individual patient).
8. Complete Description of PRN's (patient, medication, dose, prn conditions and limitations).
9. Alcoholic and Narcotic Record (time, date, name of patient, name of nurse administering dose, balance on hand).

In this simulated ward experiment, the computer-produced medication card was intended to be delivered to the ward for use by the nurse in preparing the individual dose of medication in the same fashion as is now done routinely with the conventional type of card. By modifying this routine and delivering the computer-produced medication card to the pharmacy, it could easily be adapted to the centralized unit dose dispensing concept. Since the card has printed on it all the necessary data required for the preparation of the dose, the pharmacist could, of course, accomplish this function in the pharmacy.

One of the difficulties presented by the unit dose concept is the greatly increased workload it will place upon the hospital pharmacy staff. This, however, can be coped with by using an automatic dispensing machine in the pharmacy. This machine could be designed to deliver the appropriate single unit dose of medication upon activation by the computer-produced medication

card. Since all the information essential to the preparation of the dose is punched into the card, it could be read by the input device on the dispensing machine. By suitable use of electronic circuitry and mechanical arrangements, the proper drug would be selected, the right number of units counted off, and the medication unit physically attached to the card with a pressure-sensitive adhesive*. (For bulkier units, such as a 30 ml. dose of aluminum hydroxide gel, the card and the medication could be set up in a tray). Most of the medications could be stored in labeled strip packaged reels (tablets, capsules, disposable cartridges), while bulky medications, such as the liquid mentioned, could be put up in prelabeled disposable plastic containers and stored in hoppers in the machine.

This may sound rather fanciful, but the design of such a machine is technically feasible and its cost should not be unreasonable. The machine would only be stocked with those drugs having a high enough usage rate to warrant automatic dispensing. It would be programmed to reject any medication card calling for an unstocked item or one lacking complete information. These would be filled by the pharmacist in the conventional manner. When all medication cards were machine and/or manually processed, they, and the accompanying medications, would be checked by a pharmacist and then delivered to the wards. Depending on the staffing and organization of the hospital pharmacy, either a 24 or 48 hour supply would be furnished to the ward or, of course, any other suitable scheduling could be arranged. After the nurse administered the medication, the card would be reintroduced into the system to accomplish all the functions outlined in the description of the simulated ward experiment.

A small supply of emergency drugs, with accompanying medication cards, would be maintained in the wards to meet any unscheduled need. After the administration of such a drug, the patient's name and the nurse's identification would be added to the card, and it would be reintroduced into the system in the same fashion as a routine medication card.

* See Figure 1, page 10.

The application of automation in the manner outlined would virtually eliminate all medication preparation on the hospital ward or nursing unit and would eliminate the necessity for the manual recording of medication data. In addition, as a by-product of such a system, many of the stock control, accounting and reporting functions required by the wards, pharmacy, and hospital management could be accomplished. Complete control of the dispensing function would be retained in the pharmacy, where it rightfully belongs, and only one dispensing machine would be required to service an entire hospital. Hospital pharmacies, by the use of the dispensing system outlined, could save considerable nursing time, maintain more accurate inventory control, and yet be able to dispense the thousands of individual unit doses required to meet the exigencies of centralized unit dose dispensing.

Now that an attempt has been made to define automation, outline its history, and discuss its possible impact on hospital pharmacy, it must be placed in its proper perspective. Perhaps the following, written by Harold A. Strickland* of the General Electric Corporation may help to accomplish this:

- "1. Automation will rapidly revolutionize the world.
(We do not believe it will)
2. Automation is easy. (We have not found it to be so)
3. We are now able to do anything that people can do.
(This is not true now and we do not expect it will be true in the future)"

Mr. Strickland's refutations to the premises stated above are no doubt quite valid, but equally so are the principles that machines and computers should be used to accomplish those functions that they can best carry out while man should use his native intelligence, his acquired knowledge and skills to maintain, improve, and supervise a system. Whether this be a hospital pharmacy or a vast industrial complex like General Electric is immaterial, since each will benefit by the judicious application of human attributes and the techniques of automation.

* Vice President and General Manager of the Industrial Electronics Division of the General Electric Corporation; "Understanding Automation," Automation, October 1962, pg. 157.

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Defines automation, outlines its
history and discusses its possible
impact on hospital pharmacy. Discusses

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existing applications of Automated
Data Processing (ADP) to pharmacy
business, education, and information
dissemination activities. Reports on
accomplishments in the medication area
by the Patient Data Automation Branch of
the Bio-Medical Systems Department of the
System Development Corporation (SDC) of
Santa Monica, California. Explains how
a computer-produced medication card can be
integrated with the unit dose dispensing
concept and used to actuate a drug
dispensing machine which would deliver
the dose of drug and physically attach it
to the card.

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