AUTOMATION OF VITAL REGISTRATION SYSTEMS IN THE UNITED STATES: A SUMMARY OF SELECTED STATES' ACTIVITIES[1]

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Introduction

The application of computer technology to the administrative and operational activities of vital registration has received major attention in state programs in the United States in recent years. In the past, computerization had focused primarily on the vital and health statistics and research components of state vital registration systems, with registration functions continuing in a manual mode. Some developments in automation had occurred over the years, but most often these efforts were directed to the solution of individual problem areas such as record storage or indexing. Many of these efforts were based on the use of microforms—roll microfilm, cassettes, and microfiche. More recently, automation has been extended to encompass all aspects of vital registration with the goal of developing a completely automated registration system. Several states have come close to realizing this goal, with many of them now directing major resources to implement such systems. Over the next five years, most states will have fully automated significant portions of their registration activities, with several approaching a "paperless" system.

This trend is not limited to the United States. Many countries have experienced increasing demands on the registration system for services and have responded by moving toward automation. Some of the developments described in this article for U.S. states may have application in other countries and may serve to expedite the transition from manual to automated systems, minimize associated problems and reduce costs. Sharing of information and interaction among the international registration community can provide significant benefits to all.

Background

Vital registration in the United States is decentralized (1), with each state having total responsibility for the administration and operation of its system. Each state has its own laws, rules and regulations which govern registration processes and functions. Within the state organizational structure, the vital registration program is located in the state health agency, reflecting the early uses of birth and death records in identifying health problems and assessing the health status of the population. Within this decentralized state system, two national organizations work closely with the states to coordinate and standardize registration activities: the National Center for Health Statistics and the Association for Vital Records and Health Statistics.

The diversity of the various state systems has contributed to differing levels of automation of vital registration activities. The needs and problems associated with meeting demands for registration services are often quite similar among the various states, but the availability of staff, resources and equipment often dictates the extent to which automation can take place. For this article, 10 states[2] were contacted, and they provided information regarding their current status and future plans for the automation of vital registration functions. These 10 states register about 1.5 million birth and death records annually (one million births and one-half million deaths). The

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[2]The states were Colorado, Illinois, Kansas, Massachusetts, Michigan, Minnesota, New York, South Carolina, Utah, and Wisconsin.

various levels of development represented in this group of states reflect fairly well the current status and direction of automation in state vital registration programs in the United States generally.

Automation activities

Specific areas in which states have automated vital registration functions include data entry, record processing, indexing, record retrieval, electronic certificate forms, optical disk storage, data transmission and microfilm systems. At this time, no one state system can be described as "fully automated" and some state registration systems are not automated to any degree. But the direction is clearly towards a paperless system except in those instances where a hard copy is required for the issuance of record copies. The developments currently underway in a number of states are rapidly approaching this goal.

Data entry, storage and retrieval

Several approaches have been taken to resolve the problems associated with entering data from vital record forms. In traditional processing, the certificate forms are completed in the field—at the hospital, clinic or other place of occurrence—and submitted to the state health agency for coding and keypunching. This requires substantial resources in terms of staff, equipment and storage space for these records at the state level. As such resources become more costly to state agencies, alternative methods of getting the data into electronic form have to be considered.

One method currently being employed by several states is to do the coding and data entry at the source. Records are then transmitted electronically over telephone lines, or the data are copied and submitted to the agency on floppy disks. Since in the United States nearly all births occur in hospitals, submitting birth certificate information electronically not only eliminates the workload at the state agency but provides more timely and accurate data. This process employs a microcomputer, generally a personal computer (PC), located at the hospital which contains a software package to display the particular state's certificate form and to perform certain data editing functions. Hospital staff enter the birth information on the displayed form which then undergoes an editing process on the PC. Edit checks include verifying that data fields contain only alpha or numeric data and that codes for selected variables are in the proper range; logical checking on variables such as mother's age, weight of infant, and date of birth; and checking for internal consistency of the data.

This approach eliminates the need for a centralized coding and data entry staff, minimizes the need for interchange of certificates with the hospitals for corrections or incomplete data, and significantly improves the timing and availability of the data for both registration and vital statistics purposes. Estimates from the various states surveyed indicate that data entry requirements are reduced by 40 to 60 percent or more at the state agency level, coding is reduced by 50 percent, and the timeliness and availability of the data are increased by nearly 80 percent. These estimates reflect differences for these types of operational activities following implementation of automation. Costs of the equipment and the software for this type of application range from $2,500 to $4,000 depending on the size of the system. Most states anticipate including death records and fetal death records in the system, with an additional cost of only the software packages for each record type. The latter is estimated at $500 to $900 for each type of record. No additional equipment is required for this upgrade. Similar costs for equipment and software

would be required for each site at which the data are entered or accessed (hospital, clinic, funeral establishment).

A second approach being taken in several states is the use of optical disk systems for record storage, retrieval and printing of copies of records. Certificates completed in the field are forwarded to the central agency for coding, scanning, and indexing for entry into the system. This type of system produces a high quality image that does not suffer from the deterioration that occurs with paper documents or microfilm. A high resolution scanner is used to electronically capture record images, which are stored on optical disks. A computerized indexing system provides for automatic searching of the documents, with the amount of data entry for the index directly related to the number of variables needed for record identification.

The optical disk system provides a permanent storage medium for documents which requires very little physical space, has excellent reproduction quality and, when integrated with a computerized index, offers document retrieval at electronic speed. It also offers the capability to enter statistical data at the time of indexing to allow for the development of vital statistics data along with the processing of routine registration activities. As with microfilm, optical disk provides an exact copy of the original document (and generally of higher quality) and incorporates the full capabilities of the computer to locate, link and process the documents. Major savings in data entry staff, time and resources are also realized. In this way, a fast, cost-effective and efficient processing system can be implemented to meet the registration demands of the public and to provide a capability for preparing relevant vital statistics.

Costs associated with optical disk systems vary widely, depending on the size of the system and the applications to be used. The growing incidence of PC-based optical disk systems makes their use in various applications financially feasible. Including scanning equipment, computer and processors, the cost ranges from $10,000 to $100,000 or more, depending on the size of the application.

Other types of systems are also being developed. Several states have opted for a computerized record storage, processing and retrieval system for the registration program in which the complete certificate data—birth, death, fetal death, marriage, divorce—are keyed and stored on mainframe computer systems. This approach has a significant data entry cost associated with it, particularly if multiple years of data are to be inputted into the system for both registration and statistical purposes. However, it does afford the greatest degree of flexibility in terms of total document processing. Copies of the record can readily be prepared, corrected and mailed; complete indexing parameters are available for record matching and retrieval; updating of data is fully automated; information is readily available to multiple users and for multiple uses; and statistical processing and analysis are readily accommodated.

Indexing of records

A key element in each of the systems described above is the indexing of the stored record/data. In all cases, states with automated systems have a computerized index for record search and retrieval, whether the systems are computer-based, optical disk or microfilm systems. Information contained in the index generally includes name of the individual, date of the event (birth, death), residence of the individual, and place of occurrence of the event. Other variables—sex, race, names of parents—may be included as deemed necessary. In some instances, the index contains sufficient information to immediately print a short form certification of the record for mailing to a client.

Different methods for searching are used by states, including a straight alphabetical search on the surname and/or given name, use of the Russell Soundex code (2), which can be

generated automatically by the computer, New York State Identification and Intelligence System code (3) or other algorithms based on the name of the individual. In conjunction with the alphabetic name or code, the date of the event and place of occurrence are usually all that are needed to locate the record. In an index containing over 5 million records, an average search time is under 5 seconds. Of course, this depends on the size of the computer and the algorithm used but generally the search is very fast. For indexes which contain sufficient data for the preparation of a certification, a certification form can be printed simultaneously.

The savings in time and staff of a computerized index as compared to manual searching using index books or microfilm/microfiche-based indexes are significant. The cost of disk storage has decreased to the point where a computer index on either a mainframe or a microcomputer system is a highly cost-effective and efficient method for record searching and retrieval. The algorithms employed must be carefully considered since they can be dependent upon the naming conventions used. For example, the Russell Soundex code system eliminates all vowels contained in a name in arriving at the search code. This may not be effective for record searches in countries where multiple vowels commonly occur in family names.

Electronic birth record

The major area of current development in many states is the electronic birth certificate. Births account for the largest volume of records, and they require the greatest amount of registration activity, thus representing the single most cost-effective record for automation. The amount of information collected on the birth certificate, the number of copies issued annually, the amount of processing for corrections and updating, and the variety of applications for use of this record far exceed those of all the other types of vital records. Because of these characteristics, states are choosing the electronic birth record as the first to be computerized in the registration system.

There are a number of advantages to computerizing the birth record. First and foremost is the fact that the birth record is completed at the originating source i.e., the hospital. This affords a convenient location to place equipment, provide training, and establish standards for operating the system. In doing so, immediate benefits are realized with significant reductions in transcription errors, incomplete reporting of data, need for followback queries, and lost certificates. Once the data are entered at the hospital, they are immediately available to the hospital for its own use and are in a format ready for printing and for transmission to the state agency. The printed paper copy may take any route necessary; for example, it may be routed through a series of local agencies prior to final storage at the state level. However, since the data are transmitted electronically, there is no delay in the availability of the record at the state agency. Records which become lost can be instantly regenerated either at the hospital or at the state registration office without the need to reenter any of the data.

The security afforded by the electronic system is not readily reproducible in a manual system. Information received only via the electronic system is validated as an official record. Fraudulent paper copies of certificates cannot be added to the system and when attempted can be identified through cross-matching of the paper and electronic documents. Entry of data into the records can be done only by authorized staff through a series of controls on identification and password access to the computer system. Any irregularities in the system related to registration data can be quickly identified as to the terminal used and the staff with authorized access to the computer. All changes to the record are controlled through the computer entry system and can easily be restricted as to what changes can be made and by whom.

The electronic record system also affords a number of processing features which reduce the need for subsequent record corrections or changes. The audit/edit features built into many of the

systems described include spelling checks, data validation, auto-coding of selected variables such as institution and geographic locality, single entry of common data elements such as dates, and automatic calculation of variables such as length of gestation (based on dates of delivery and last menses) or conversions (e.g., pounds and ounces to grams). Each of these features saves significant processing time, reduces the need for subsequent changes to the record, and minimizes many types of errors.

In decentralized registration programs where local registration offices can issue copies of records, the computerized system provides the flexibility for local access to computer-based records. Many of the states with automated systems permit electronic access to the state's central database for the purpose of issuing record copies. Communication networks have been established whereby an authorized local registration office can access the central computer, initiate a search for a record and have the information transmitted and printed on a form in the local office. In some cases, regional offices of the state agency have been established in various locations throughout the state and can issue copies of records utilizing the central state computer system. Decentralized access and retrieval of electronic records for registration purposes represent a growing area of development.

These capabilities reflect the potential that computerized registration systems provide and differ significantly from what optical disk and microfilm oriented systems can provide. The latter systems are found in centralized registration programs where the central state agency has responsibility for issuing record copies. Electronic networking occurs internally, and access is generally restricted to the central agency. However, with the increased use of facsimile equipment, copies from these systems can be transmitted to the local agency for direct issuing of the record. In either case, the benefits of the electronic/automated record are well established.

The transmission of data from the hospital to the central state agency for the electronic birth record takes one of several forms. The data, when entered on the microcomputer at the hospital, may be copied to a diskette and mailed to the state agency. In this case, the diskettes are then uploaded to the agency's mainframe and into the birth registration database. All of the activities described above can then be performed. Generally this is the first option used when initiating remote preparation of the record. A second method is to complete the records at the hospital and prepare a database for subsequent transmission electronically over telephone lines. This approach has been implemented in a number of states primarily from hospitals having a large volume of births. This is the goal of most of the registration programs. Direct on-line access, where individual records are transmitted directly to the agency's central computer, is being considered in some areas as another option but as yet has not been implemented in the states surveyed for this report. Each of these methods allows for electronic access utilizing diskettes, computer tape files or through on-line query to the central agency database by other authorized state and local health agencies. Conditions of access and use by these other agencies are controlled by established rules and regulations or by statute.

Overall, the electronic birth record, where it has been employed in the states, has minimized the need for manual intervention in the processing of the record. There have been significant improvements in the (1) quality of the data as received from the hospital source, (2) timeliness of receipt of the data, (3) efficiency in processing changes and corrections, (4) security and confidentiality since fewer staff are necessary to handle the records, (5) availability of the data for multiple use and users, (6) search and retrieval of documents and (7) physical storage requirements and handling. The added benefit of having immediate data for the preparation of certification forms and the compilation of vital statistics data makes the automated system a realistic goal for most registration programs.

Automated registration activities

Other automated registration activities with regard to the electronic record have been developed in state systems, including transaction processing, billing and accounting features, and direct mailing of both registration materials and information related to maternal and child health. These are labor-intensive activities which readily lend themselves to computer processing. One state's summary of the types of activities which are automated include:

1. *Key entry*

- Edits records (replaces former manual edits)
- Writes letters requesting corrections for errors (replaces manual system)
- Codes entries automatically (replaces manual coding system)
- Allows on-line update for corrections and amendments (replaces manual coding and batch entry)
- Allows entry of indexes for historical records

2. *Correspondence*

- Allows entry of administrative information for all requests for documents (replaces 5-part paper receipt form)
- Allows tracking requests in response to inquiries from the public or from law enforcement

3. *Fee tracking and accounting*

- Accounts for all fees received (replaces paper documents needed for audit purposes; partial replacement for manual deposit requirements)

4. *Issuance of certified copies*

- Allows immediate search and issuance of birth certificates (replaces manual search and photocopy of record)
- Allows legal amendments to birth records (replaces 2-part paper certified copies)

5. *Production of administrative reports*

- Indexes for use by state and local registration offices
- Fiscal reports for budget, deposits, special accounts
- Administrative workload reports for registration section
- Reports on field offices
- Notification of registration of parents

6. *"New" record system*

- Preparation of new accurate certificate following adoption or paternity action (replaces manual correction process)
- Update of database with "new" information (expedites updating of record data base)

- Cross-reference of information, new/old name, for tracking impounded records for the registrant (newly available process)
- Notification of changes to local offices

7. *Access to database*

- Provides network access to local offices (Register of Deeds, Child Support, Income Maintenance)

Each of the above computerized functional registration areas has significantly changed and improved the operation of the state's registration program. The benefits of computerization go beyond those associated solely with the registration functions. Software packages such as word processors, data base management systems and spreadsheets can be incorporated into the microcomputers used for the registration system to further enhance processing and productivity. Examples include correspondence to consumers prepared on a word processor; a series of workload statistics compiled from a spreadsheet; and integration of data from adoption or paternity records with the original birth information contained in a database management system.

Future directions

Generally, some degree of adjustment is needed to adapt an established automated system to another registration program. However, the likelihood of successfully implementing a system given the background, experience and developments that have occurred in state programs would appear to be high. It is clear that there is a need for automation in registration programs as record volumes grow, demands for services increase, and resources and funds decline. In the past, registration activities have not drawn the attention or resources that other programs have. This is changing, and new efforts are often directed at upgrading programs through the use of automation.

Costs to initiate a computerized system for registration vary widely. Many state programs have taken a stepwise approach, automating current registration functions or selected activities and phasing in older records and related functions. This reduces the need for major expenditures for data entry or scanning and indexing of records, computer equipment and software, training and redeployment of staff. For registration programs having low volumes of records, most of the processes described above can be accommodated on microcomputers. These systems contain disk storage capacities in the 100 megabyte range. Coupled with external disk storage devices, desktop microcomputer systems can range to several gigabytes of storage. Memory capacity in these systems run to several megabytes, providing ample processing and speed of operations.

Options which permit gradual movement to an automated registration system that several states have taken include microfilm systems utilizing computer-assisted retrieval (computer index) and optical disk systems. The latter also offers a computerized indexing capability for record search and retrieval. One of the difficulties associated with these systems is in error correction and updating. Changes to microfilm are difficult, usually requiring the creation of a separate record copy and subsequent storage and indexing of the new record. Current optical disk systems are also in this category, where most have "write once, read many" disk. This means separate images must be made for corrected or updated records. Computerized records can be changed instantly and a code inserted indicating the date and nature of the change. The flexibility of the electronic record is clearly superior.

Compared to manual systems, however, both microfilm and optical disk systems offer major advantages. They contain the actual image of the original record, including all signatures and dating stamps and seals that have been placed on the certificate. Computerized record copies do not contain this information in the original form.

Indexing for both types of systems is computerized and provides for rapid retrieval of a particular record. Storage space is also reduced significantly, and multiple copies can be prepared and distributed to local offices as needed. The drawback here again is with corrections and updates to the record. Overall, these systems offer significant improvements in the operation and management of registration activities, with the optical disk providing higher quality imaging than microfilm, particularly for older records. Once the original paper document is reduced to either an electronic image or a copy of the original image, subsequent processing for registration functions is clearly enhanced.

Applications for developing countries

Computerization specifically in the registration area is not widespread in either developed or developing countries. However, many of the applications, computer programs and systems development as described above for U.S. states may be useful elsewhere in programs considering implementation of automated systems for registration. The extent to which these applications have utility for registration systems in developing countries is significant, primarily in those instances where development has been done on microcomputer systems. The capabilities of these systems today rival those of mainframe computer systems of only a few years ago. Computer memory, disk storage and processing speeds are such that only the largest national registration programs may not be efficiently maintained in this environment.

Countries which have considered moving to automated registration have often looked to the mainframe computer as the means to implement the system. This is not a requirement with today's technology. In many situations, microcomputers can do the entire range of functions to be automated including record storage, indexing, updating and correction of records, administrative and fiscal recordkeeping, billing and receipting for services and copies of records issued, and tracking of related transactions. These functions are readily adaptable and have been used in the microcomputer systems in several states.

The main difficulty in implementation of automated systems, given equipment availability, relates more directly to collecting and recording the data on the certificates. Serious problems exist in many countries in getting the event reported at the local level and subsequently transmitting the record to a central processing office. This is a principal concern that must be resolvable prior to committing resources to an automation plan. The optimal situation is one where both of these activities are developed concurrently so the system can be structured to accommodate all of the requirements of the registration process.

Procedures such as the estimation of expected numbers of birth and death records from a particular geographic area can be built into the system. The comparison of the expected number for an area with the reported number of events would automatically note when discrepancies arose. This would then be used for followback to the local area to determine any reporting problems. Such built-in checks serve to quickly identify problems and result in improved registration and service, since ultimately the benefit of having an officially recorded document is for the individual and family.

There is potential for adapting computerized systems developed in one country for use in another—vital registration has common elements, regardless of the area. Birth and death certificates contain similar data items, both demographic and medical; need for record copies is

universal; and processes related to amending or correcting records are also common to the registration system. Hence, where these have been implemented, the transition to, and implementation in other countries is facilitated. Vital (civil) registration provides a unique, if not identical framework internationally for sharing common interests, resolving common problems, and realizing common goals. Certainly the area of computerization represents a common thread relevant to registration programs. The degree to which the benefits of this technology can be achieved requires continuing communication, interaction and interchange among the members of the registration community worldwide.

References

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