The purpose of this paper is to describe the Nursing Acuity Information System (NAIS™), a microcomputer application which manages patient classification system data entry, processing, and reporting. NAIS™ has been developed from a pencil and paper system used by the nursing administration at Beverly Hospital, an acute care community facility in northeastern Massachusetts. Augmenting a manual patient classification-based staffing system, NAIS™ is of particular interest because of its implications for micro-based data management capacities in nursing departments and the innovative employment of software tools used.

1. Patient Classification As A Management Control System

The primary purpose of the manual patient classification data system has been to quantify nursing unit workload via a point-based classification system (GRASP) for purposes of daily staffing. It has provided nursing administration with an objective data base that can be used to monitor variation in nursing unit workload, in total, and by shift (McPherson, 1982; Meyer, 1978). Staff planning and budget development processes benefit from the system since report formats integrate patient classification data with payroll and budgeted staff information. Patient classification schemes have been described in depth elsewhere (Gionavanni, 1979; Grimaldi & Mitchell, 1982; Meyer, 1978; Vaughn & MacLeod, 1980; Wood, 1982), both for manual and automated systems (Roehrl et al., 1982) and in particular for the GRASP system (GRASP Users Conference Proceedings, 1983). We refer the reader unfamiliar with patient classification who has an interest in the details of its principles and procedures to these sources. The primary objective of the following discussion of the Beverly Hospital paper implementation of GRASP (B.U.G.S., Beverly Utilization of the GRASP System) is to illustrate the feasibility of removing moderate scale paper-based data systems (Shapin, 1982; Keen, 1982) with relatively simple and inexpensive microcomputer systems.

The immediate benefit gained through daily classification of patients is the ability to more effectively manage the allocation of staff on a shift-by-shift basis. The system established for classification focuses upon the use of the point-staff conversion tables and involves information flows that connect the nursing units, the staff scheduling office and nursing administration. The documents associated with the paper system are shown in the flowchart of figure 1.

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The figure shows the staffing system as it existed late last year (1982). What follows is a brief description of that system's operation. Each shift, the points for all patients on each unit are summed on the "Daily Point Collection Form". That data and the patient census for the unit are reported to the Nursing Administration over the hospital's message system. A typical transmission would read: AVER TO NSA 10:30 CENSUS IS 33 AND POINTS ARE 1567. That census and point information is entered into the appropriate column of Form D, the "Daily Shift Staff Report". For each shift, a range of census and a range of nursing acuity points determines the number of nurses required. The point/staff conversions for each unit/census/shift are initially established by...
management engineering studies. For example, census/point/staff conversions at Beverly Hospital translate for the ICU during the evening shift to the following: with more than four but less than eight patients, if the points are between 1055 and 1128, five nurses are needed, and so on.

For each unit/shift there is a permanent staff--nurses who are consistently assigned to that unit for that shift on that day. Typically that number is small, suitable for covering the unit only at low occupancy/acute levels. The difference between the nurses required (as calculated by looking up the information on the point-staff conversion tables) and the number of nurses regularly assigned (today) is the unmet need. At Beverly this need is met by a float pool. Other institutions may use a combination of floats, agency nurses, and transfers.

Reviewing Form "D" from FIGURE 1 in more detail, we see that the numbers in the "Need" column are offset by entries in the "Adjustments" (i.e., floats or transfers) column, thereby reducing the "Variance" to near zero as nursing administrators can consider appropriate. Forms H, J, and K were the management control section of the system. The Classification Management Report was a monthly summary. Form J is used for unit specific audits, and Form K was designed to present graphical trend analyses.

Overall the paper system described above worked quite well. It provided much daily and monthly data to nursing administration in formats which could be effectively utilized. The problem with the paper based system was that data were simply not accessible for administrative analysis except under tremendous time and labor efforts to compile the data. The large volume of paper generated in these efforts was necessary to retain data in formats which could be tabulated on a computer. This "paper mountain" was recreated at monthly intervals in order to access information for managing the nursing staffing function effectively.

With a strong but unwieldy paper based system in place, the decision was made to automate the data management functions to provide more timely reports, more breadth in analyses of staffing patterns and patient acuity, to eliminate the chances for "arithmetic" errors, and to decrease the time burden on nursing managers to use the data.

**NAIS™ Information Flow**

The new components of information flow begin with the system interrupting the paper flow after point "C" (see FIGURE 1 above). Values for the current patient census and acuity based points from each unit are (as before) sent by message to nursing administration. These data are now however, entered into the microcomputer which responds by automatically calculating the required staffing. NAIS™ also has information about "backbone" staffing levels, and from that data it automatically calculates the staffing needs.

A list of possible floats for the appropriate shift is presented using the computer screen (or if desired print-out). The on-duty nursing administrator makes the key decisions regarding which units are to receive additional staffing based on the computed relationships between patient acuity levels, patient census and regular staff available. The computerized system facilitates this process by checking internally for such inconsistencies as one float nurse being assigned to more than one complete shift (fractions of shift assignments are allowed), or to two or more units simultaneously. Values for adjustments and variance are calculated and displayed for review by the system automatically.

When the variance has been reduced to an acceptable level, a hard copy is made of the Daily Shift Staff Report. A copy of the float allocation form is automatically printed as well. Data are then saved and, in aggregate form, are used by the system to generate the Classification Management Report at the end of each month.

With data storage and formatting handled automatically within the system software, several new reports are expected to be developed as the system implementation process proceeds. Currently the NAIS™ based information flow replicates the previous flow with the critical difference being that the data are now primarily "flowing" within the microcomputer rather than via hand calculations from form to form.

**Software Characteristics**

In this software development project we have sought to embody viable software microcomputer software principles as outlined by Peter Keen (1982)

"The aim of (micro-dss) software is to build tools that can help managers and professionals improve their productivity and effectiveness in key activities. Computers have provided this group with many benefits; many activities that were once done by hand can now be done by computer. This includes critical aspects of planning, analysis, forecasting and decision-making. The information managers need can now be made more accessible. Bulky,
standardized reports no longer substitute for a real Management Information System. Decision support through microcomputers helps make information available and accessible."

Using these ideas in NAIS™, we have as far as possible, avoided writing source code in traditional programming languages. Rather we have sought to build management tools with easy to use software "tools" which nurse managers can learn to use in the context of a specific system (NAIS™) and subsequently can use these packages to build other information systems.

Specifically, NAIS™ runs on the Apple II+ microcomputer, and uses VisiCalc™ as a primary "programming environment." VisiCalc™ is an electronic spreadsheet. The program makes the computer screen look like a large columnar pad, with numbered rows and lettered columns. Any cell in the spreadsheet can be defined in terms of other cells. For example, consider the following spreadsheet:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

If we define Cell D3 as B2 + C2, the number 5 will appear in cell D3. Moreover, if we change the value in Cell B2 to 3, the number 6 will appear in cell D3. This is the heart of what is referred to as the "Visicloners" ability to facilitate "What If?" analyses. VisiCalc™ can sum rows, columns, set entire columns equal to some other column times some factor, etc. Facilities for file management, storage, editing, data entry checking, and encoding of formulas to obtain desired values are also available in the VisiCalc™ command set. A disadvantage of using VisiCalc™ is that the applications cannot be supported by completely dedicated software.

Form D and the float selection sheets, and several other displays exist simultaneously on one large VisiCalc spreadsheet. Consequently the user may move from one screen to another, and all the screens can be logically related and interdependent. FIGURE 4 below shows the "entry screen" users encounter as the enter the system.

A Nursing Administrator may first look at the master form and, for a specific unit, observe a need of two. A few keystrokes will bring up the float selection screen. A few more keystrokes will return the master form to the screen, appropriately altered for any changes made in the floats selection screen. Consequently, changes to one screen change all the others, simultaneously, automatically.

The supporting software, therefore, is a sophisticated VisiCalc™ template, complete with a large logic section which evaluates information entered and directs the drawing of data from appropriate subsections and lookup tables. The basic spreadsheet characteristics are fairly clear to users in the float selection form, a bit less obvious in the master form, and completely user transparent in the help screens. More than 51k of memory are used by the entire template. The system currently runs on a standard Apple II+ Apple modified only by the inclusion of a RAM board to increase the available VisiCalc™ memory to contain all the requisite data lists and conditionals.

The management control type reports receive information from the master form in Data Interchange Format (DIF) files. Eventually DIF files will be drawn from the monthly summary "Classification Management Report," a plotting program (e.g., VisiPlot/VisiTrend™) to create graphical presentations of time trend data. Consistent use of the data interchange format in NAIS™ also encourages allows future enhancements wherein data elements may be derived from exterior data bases. For example, it has been proposed that DBMaster™ be used as a Data Base Management System to generate a list of available floats for each shift. Using a series of reformatting programs, DBMaster's file can be reformatted to be read by the NAIS™ templates.

The system is currently in a parallel debugging and implementation test. Results from this testing indicate that the system significantly reduces the time spent on daily staffing, increases the accuracy of staffing calculations, and provides better management reporting of nurse staffing.

Implications

Moderate sized "paper mountains" such as the paper based patient classification system for staffing at Beverly Hospital can effectively automated using relatively inexpensive microcomputer hardware and software. It should be emphasized that the success we have experienced in developing a microcomputer system is in no small measure attributable to the strength of the paper data management system already in place at Beverly. In addition, it should be noted that our system is a limited one, constructed as one module, in the context of overall nursing department automated data management needs. We also attribute our success to this modular approach.

The kind of solution NAIS™ provides for patient classification data management is not without some trade-offs, of course. As McHugh and Schultz (1982) have pointed out among others, the ideal system for acuity-information management might be one which is integrated within the hospital's overall HIS patient data base. These nursing acuity and staffing data are valuable data which as observers have suggested (Grimaldi & Mitcheletti, 1982; McHugh and Shultz, 1982; Wood, 1982) "ought" to be usable throughout the hospital not "only" within the nursing department "locked" into a microcomputer.
Let us briefly examine these trade-offs with micro-based "turnkey" acuity staffing systems. First, for nursing, from a practical implementation, resource availability, and computer literacy (Hardin & Skiba, 1982) point of view, a modular style approach is likely to achieve greater success than developing a "grand system" encompassing and integrating all aspects of staffing and acuity data management prior to implementation. For many departments of nursing today, the need for better (more accessible and interpretable) management control data is quite urgent. In Massachusetts, for example, recent cost-containment legislation capping hospital budgets has greatly increased pressures on nursing management to account for and control, current staffing patterns (Joel, 1983). Thus, many nursing managers are not in position to wait for hospital wide systems to be developed and implemented which includes the data they need today. Secondly, most nursing departments do not have the resources necessary to purchase or develop such a large scale system (or system modification if an HIS is in place) within their own budgets. Without those resources they are involved in the all too familiar battle over development schedules (Dohrenfest, 1982; Nolan, 1977), which seems to regularly occur in hospital data processing departments. In addition, we suspect that for many micro-based acuity systems the concern over "locked-in" data in a "turnkey" system is exaggerated. In NAIS we have taken care to develop standard data formatting within the system so that communication with external databases is facilitated, we suspect that NAIS is not the only such system with this feature.

The aspect of microcomputer decision support type systems such as NAIS which is almost universally absent in "integrated" mainframe systems, is that small systems provide a present tense and productive method to use and learn about software tools (Kernighan & Plauger, 1981) as management tools. Building the capability to understand, use, and ultimately design these tools is a critical need if nursing is to take full advantage of the information revolution currently upon us. Interestingly, in acquiring the capability to use results from a de-centralized micro-based system in hospital-wide decisions some integration of data definitions and structure is already occurring at Beverly Hospital.

As a result of discussions arising out of newly automated reporting formats at Beverly, nursing is now utilizing the hospitals census statistics with the corresponding acuity index in preparing the monthly report, rather than nursing unit (2 p.m.) definitions of patient census. Hospital decisions are necessarily based on the financial information available, the nursing management reporting system is now consistent with the hospitals financial reports. This means that nursing acuity data can be used for the first time in hospital analysis and planning. The available information now provides administration with a means of comparison as changes occur in the acuity, census and paid nursing hours. These data are now potentially usable in answering a series of questions and issues such as: as the hospital plans to expand or change in house patient services, where is the labor force available? The reports can be used to forecast Budget (staffing) changes over time. As specific unit acuity levels and census develop patterns of over or under utilization, NAIS based historical documentation will be invaluable. What are the causes of the changes? Has patient mix changed accidentally or be design? Have staffing control practices affected productivity, motivation, retention of staff or hiring practices?

In conclusion, a micro-based acuity and staffing system such as NAIS can provide valuable management control data for nursing departments as well as raising the visibility and usefulness of nursing data throughout the hospital.

References


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