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Computer-Critiqued Blood Ordering Using the HELP System

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Recently the medical risk of blood transfusions has emphasized the need to improve the safe use of blood products. For the past 2½ years at LDS Hospital we have used the HELP computer system to assist and critique ordering of blood products "on-line" by physicians and nurses. This report details the computer methods used to order blood products and to critique the appropriateness of those orders. Physicians personally enter the orders for more than 45% of the blood products using computer terminals, whereas 7% are from physician standing orders. Nurses enter the remaining orders from written orders (26%), verbal orders (14%), and phone orders (8%). There were 3396 blood orders for 1043 patients generated by 273 physicians during the fourth quarter of 1989. Each order is justified at the time it is entered by selecting from a menu of physician-approved criteria. The criteria are linked to supportive data in the data base, i.e., laboratory results and clinical data. The computer verified that 82% of these orders met criteria. Quality Assurance nurses verified the remaining 18%. Of these 18% only one in eight required manual chart review. After computer and Quality Assurance review, only eight (0.24%) of the orders were found to be true exceptions to established criteria. Physicians and nurses have accepted the computerized critiquing system. Through use of the computer we provide "on-line" critiquing and improve the use of scarce blood product resources.

Introduction

Blood transfusions can be lifesaving therapy for patients with a variety of medical and surgical conditions. Further, blood products are a resource in scarce supply and have a limited shelf life. In recent years several measures have been taken by hospitals and governmental and accrediting agencies to optimize the use of blood products. The National Institutes of Health (NIH) and the Food and Drug Administration (FDA) have developed criteria for blood product use through consensus conferences (*1-3*). They have also publicized these criteria through a variety of publications and bulletins (*4, 5*). The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) (*6-8*) and the medical community have recently emphasized the importance of

scrutinizing blood product use (*9*). The JCAHO guidelines provide a strategy to evaluate the appropriateness of blood therapy use. The JCAHO requires that the medical staff do a quarterly review of blood usage to evaluate the appropriateness of all transfusions, including the use of whole blood and blood components.

Assessing physician behavior using a computerized system was suggested by Miller in 1983 with his critiquing program for anesthesia (*10*). His system required that virtually all the data needed be entered by the anesthesiologist. The system described here requires that only a limited amount of data be entered by the physician or nurse.

Others have applied computers to the blood ordering process (*11-15*). Hoeltge and associates performed an excellent retrospective study where they chose one or two transfusion orders each day and followed them up with the aid of computerized criteria application (*11*). Sielaff and Connelly used a computer to evaluate platelet orders. Their study of 75 orders required the laboratory staff to enter the order and also required the entry of laboratory data (*12*). Spackman and associates used a knowledge-based computer to give advice on 3 I patients requiring fresh frozen plasma, cryoprecipitate, and platelets (*13*). Their system was tested in the laboratory and used by technologists or pathologists to enter some data while acquiring some data from their laboratory system. They noted that there were two problems to be resolved: first, to mimic the knowledge of the blood bank physician and, second, to prevent unnecessary delays in the ordering process. Clark and Wilkes used a computer system to limit crossmatching with a maximum surgical blood ordering schedule (*14*). They found that by implementing their criteria in the hospital's order entry system they saved costs and improved the blood bank workflow. Coffin and colleagues used algorithms to do a retrospective evaluation of the appropriateness of blood orders (*15*). They concluded that algorithms can be developed to fulfill regulatory and accreditation requirements and help to focus on educational programs for blood ordering.

This article describes how the HELP clinical computer system was used to facilitate blood ordering and review of the order for appropriateness. The HELP system presents physicians and nurses with pertinent clinical information to assist them in applying appropriate blood ordering criteria and critiques their performance.

Methods

LDS Hospital is a private, not-for-profit 520 bed tertiary care facility located in Salt Lake City, Utah. It has a staff of 556 active private physicians and has a medical student and housestaff teaching program affiliated with the University of Utah School of Medicine. The hospital is the development site of the HELP system, a comprehensive medical information system (*16-18*). Two unique features of the HELP system were used to carry out this project:

1. A computerized integrated clinical database that is the repository for much of the patient's clinical data.
2. A computerized medical decision-making capability using a knowledge base that is able to interpret data, provide alerts, and critique patient orders.

In the spring of 1986 the hospital was reviewed for accreditation by the JCAHO and found to lack blood usage measures in the following areas: (1) Medical staff did not adequately review blood usage each quarter. (2) The appropriate use of whole blood and blood components was not reviewed each quarter. (3) The ordering practices for blood and blood products were not reviewed. (4) Clinically valid criteria for blood usage were not established. (5) Evidence of conclusions, recommendations, and actions taken and the results of actions taken to optimize blood usage were lacking.

In the spring of 1987 after this unsatisfactory review, the President of the Medical Staff and the directors of the Blood Bank and Quality Assurance approached the Medical Informatics Department to investigate whether computerized assistance with blood ordering was feasible. In 1985 the blood bank had developed an order form requiring only "checking the box" to give the reason for the blood order. Unfortunately the appropriate box was seldom checked. After reviewing alternative methods for improving physician blood ordering practices, the director of the blood bank and medical executive committee recommended development of a computerized blood ordering system.

Criteria for the appropriateness of transfusion of blood products were formulated by our medical staff using primarily criteria found in the literature, but with some local adaptations (*6-9*). For example, Salt Lake City is at 4600 feet elevation, so the criteria for red cell use may be more liberal than those for sea-level locations. Also, the surgeons wanted less stringent hematocrit requirements for anemia for patients over age 35. After local medical experts developed the criteria, they were presented to each medical department. Minor revisions were made and finally the medical executive committee approved the criteria. This same committee also encouraged and approved the use of computerized ordering. After the approval process, an "on-line" computerized order critiquing approach was developed.

Computerized Blood Ordering

Criteria are based on clinical indications and laboratory data. Table 1 is a simplified list of criteria adopted. Figure 1 diagrams the integrated blood ordering computer system. The system uses the HELP Computer System to integrate data entered by seven groups in the hospital: (1) admitting, (2) clinical laboratory, (3) surgical scheduling, (4) physicians who place their blood orders directly, (5) nurses who place the physicians

TABLE 1

LDS Hospital Summary Criterion Required For Transfusion

Red blood cells (RBC)
Hemoglobin <12 g/dl or hematocrit <35% if age >35 years
Hemoglobin < 10 g/dl or hematocrit <30% if age <35 years
Oxygen saturation (SaO2) <95%
Active bleeding
Blood loss >500 ml
Systolic blood pressure <100 mm Hg or heart rate > 100 bpm
Adult respiratory distress syndrome (ARDS)
Fresh frozen plasma
Prothrombin time (PT) > 15 s
Activated prothrombin time (PTT) >55 s
Bleeding time >14 s
Cardiopulmonary bypass
Liver transplant
Systolic blood pressure <100 mm Hg or heart rate > 100 bpm
Adult respiratory distress syndrome (ARDS)
Coagulation factors deficiency (<20%)
Platelets
Platelets count <50,000/μl and surgery
Cardiopulmonary bypass
Liver transplant
Active bleeding and platelets <50,000/μl
Active bleeding and bleeding time >14 s
Adult respiratory distress syndrome (ARDS)
Consumption coagulopathy
Platelets <20,000/μl

orders on nursing divisions and during surgery, (6) Blood Bank personnel who process the orders and prepare the blood products, and (7) Quality Assurance (QA) nurses who review blood orders that do not meet computer-based criteria. QA also prepares summary reports for the medical staff departments and individual physician.

Orders for blood products can be entered into the computer system in the following ways: (1) direct physician entry at a terminal, (2) phone and verbal orders given by a physician to a nurse, (3) written order noted by a physician in the patient's chart, and (4) standing orders for certain types of surgery, for example, open heart surgery. Nurses enter physician's phone, verbal, and written orders into computer terminals. By policy, clerical staff are not authorized to order blood; only nurses and physicians can make such orders. The

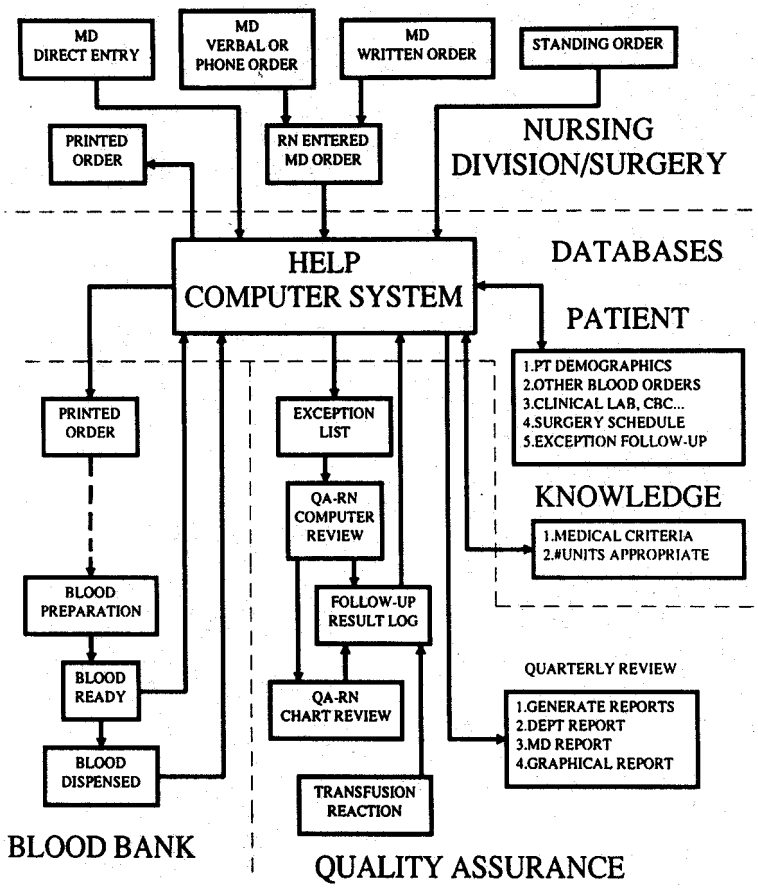

FIG. 1. General block diagram of the blood ordering and critiquing system.

HELP computer system then critiques the orders using data contained within the patient's database and criteria stored in the system's knowledge base.

Once the order is placed and evaluated for meeting criteria, it is printed at the nursing division and in the Blood Bank and stored in the patient's database. After the blood component is prepared and ready, the Blood Bank staff enters the blood unit's ready and dispensed status into the computer. Orders that do not meet the accepted criteria have an override reason entered and are then processed by the Blood Bank and stored in an exception list to be reviewed by the QA department. The QA department (usually once per day) evaluates each of the orders in the exception list to provide information that the computer may not have had to justify the order, i.e., laboratory tests done outside the hospital. Most of the time the freetext override reason provides QA with justification. When objective data do not support the order, the order is then referred to the appropriate physician's medical department quality assurance committee.

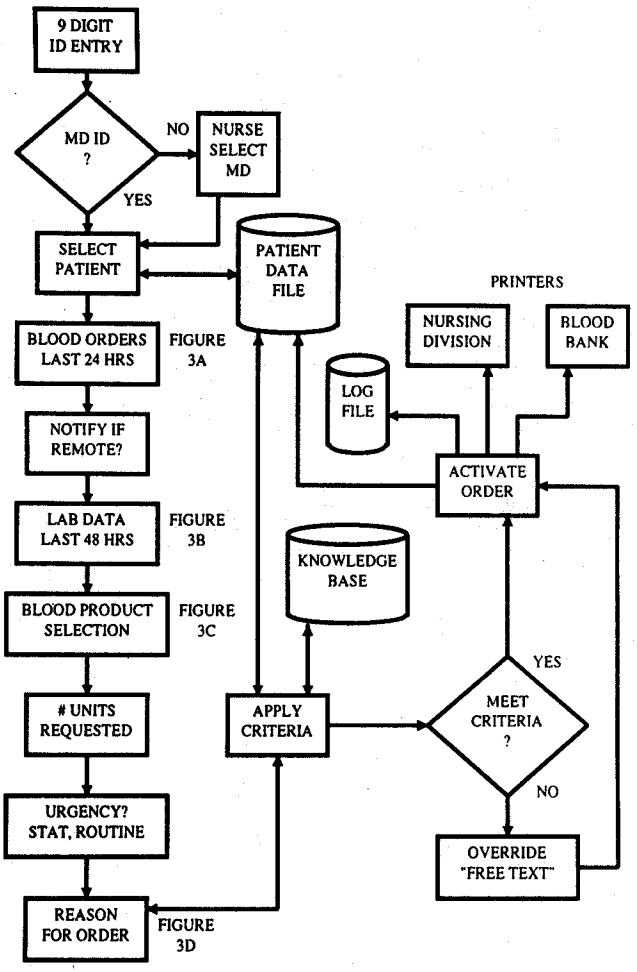

FIG. 2. Flow chart of blood ordering.

Figure 2 is a flow diagram of the ordering process. After selecting the blood ordering option from the main menu on a computer terminal, the physician or nurse must enter his or her personal nine-digit identification (ID) code. The program searches the employee file to determine if the ID I s for an authorized nurse or physician. Should the code correspond to a nurse, the next prompt requires that the ordering physician be identified by typing in his or her last name and selecting from a list of authorized physicians.

If any blood has been ordered for the patient within the last 24 h the orders and their status (dispensed, transfused) are shown (see Fig. 3A). Thus the ordering physician can determine whether the blood has already been ordered, perhaps by another physician.

Because the physician or nurse may not be aware of the latest laboratory data, orders may be placed for a reason that is no longer valid. Therefore the ordering person is also presented with applicable laboratory data for the last 48 h (see Fig. 3B).

Next the nurse or physician selects the exact blood products needed from a menu (Fig. 3C). Once the blood product is selected, the user specifies the number of units required and the order priority (stat, routine, etc.) is specified. At this point, the reason for or criteria that justify the order must be specified (see Fig. 3D). The lists of potential reasons are product specific. Once a reason is specified, the HELP computer system uses the applicable "criteria" resident in the knowledge base (Table 1) to compare the order with the patient's clinical data. When the reason selected by the user is verified and supported by data in the patient's file, the Blood Bank and nursing division are immediately notified of the order via printout. If the order is placed from a remote location (physicians lounge, another nursing division, or from home or office via remote phone access), the

```
PUBLIC, John Q.          NO.  10717783  AGE: 64  SEX: M  ROOM: E716

                          L D S   H O S P I T A L
                             BLOOD BANK REQUEST

                     BLOOD PRODUCTS ORDERED IN LAST 24 HOURS

 1. 25-NOV 16:21  PRODUCT: PLATELETS   DOCTOR: RAINES, XXXX
                  UNITS:     8  TYPE: STAT
                  REASON: CARDIOPULMONARY BYPASS  ACTIVE BLEEDING
                  ** 8 UNITS DISPENSED   0 UNITS REMAINING    0 UNITS READY

 2. 25-NOV 16:20  PRODUCT: FRESH FROZEN PLASMA  DOCTOR: RAINES, XXXX
                  UNITS:     2  TYPE: STAT
                  REASON: BLOOD LOSS  ACTIVE BLEEDING
                  ** 2 UNITS DISPENSED   0 UNITS REMAINING    0 UNITS READY

  ENTER ITEM NUMBERS SEPARATED BY SPACES TO RENEW 24 HOUR BLOOD ORDER OR
  ENTER 'E' TO EXIT PROGRAM OR PRESS <Return> TO CONTINUE ->
```

FIG. 3A. Blood orders made in last 24 h are shown when the order is made.

```
                          L D S   H O S P I T A L
                             BLOOD BANK REQUEST

                MOST RECENT LAB DATA ENTERED OVER A 48 HOUR PERIOD:

                    TEST           VALUE             TIME
                ____________________________________________________

                    HCT               31.2        11/26 04:50
                    HGB               10.0        11/26 04:50
                    PLATELETS      143 K          11/26 04:50
                    PT             12.7           11/25 14:45
                    PTT             38            11/25 14:45
                    ALBUMIN        NA


                ENTER <Return> TO CONTINUE ->
```

FIG. 3B. Laboratory test results within last 48 h shown when the order is made.

physician may request that the Blood Bank personnel telephone the nursing division, since the nurses may not immediately be aware of the printed order. If the criteria are not met, a message is presented to the user stating the acceptable criteria and presents the relevant patient data. If the physician or nurse still wishes to place the order, he or she is then asked to enter a freetext “override” reason to justify the order. Then the order is processed. Orders with “override” reasons are stored as exceptions in the log file.

All the override reasons are logged and followed up by a QA nurse. All orders are stored in the patient file and a special log. The order record consists of 65 possible data elements that provide comprehensive documentation and justification of each blood order request. Eight sources of data from the integrated database are essential to make the blood ordering and critiquing program clinically functional: (1) Blood Bank Module-blood is already on order; (2) Admit-Discharge-Transfer ModuIe-patient age and sex; (3) Clinical Laboratory-hematocrit (Hct) and hemoglobin (Hgb) from the complete blood count (CBC), platelets, prothrombin time (PT), partial thrombin time (PTT), albumin; (4) Surgery Schedule Module-procedures scheduled; (5) Nursing

```
PUBLIC, John Q.      NO.  10717783  AGE: 64  SEX: M  ROOM: E716
ORDERING DOCTOR: JONES, XXXX        ENTERED BY:

                        L D S   H O S P I T A L
                           BLOOD BANK REQUEST

       PRODUCTS                          TESTS

 1- PACKED CELLS                   21- TYPE AND SCREEN
 2- FRESH FROZEN PLASMA            22- HOLD CLOT ONLY
 3- PLATELETS                      23- BLOOD TYPE
 4- LEUKOCYTE POOR CELLS           24- ANTIBODY SCREEING(INDIRECT COOMBS)
 5- WHOLE BLOOD                    25- DIRECT COOMBS
                                   26- COOMBS PACKET (DIRECT & INDIRECT]
 7- WASHED PACKED RBC              27- CORD PACKET
 8- LEUKOCYTE POOR WHOLE BLOOD     28- RH RECHECK
14- OTHER BLOOD PRODUCTS
ENTER ITEMS SEPARATED BY SPACES OR <Return> ->
```

FIG. 3C. Menu of blood products that can be ordered.

```
PUBLIC, John Q.      NO.  10717783  AGE: 64  SEX: M  ROOM: E716
ORDERING DOCTOR: JONES,  XXXX        ENTERED BY:

                        L D S   H O S P I T A L
                           BLOOD BANK REQUEST

REASON FOR REQUEST: PACKED CELLS      4 UNITS

1 - PRE-OP
2 - ACTIVE BLEEDING (BLOOD LOSS)
22- > 500 CC LOSS (BLOOD LOSS)
32- THIRD SPACING (BLOOD LOSS)
3 - ANEMIA
4 - VOLUME REPLACEMENT
7 - HYPOTENSION, TACHYCARDIA, or HYPOXEMIA
8 - TRAUMA
11- BYPASS <CARDIOPULMONARY>
12- DIALYSIS
14- LIVER TRANSPLANT
15- ARDS/ECCO2R

REASON FOR THE REQUEST ->  3 "ANEMIA"
```

FIG. 3D. Menus showing reasons for ordering the blood products.

Module-vital signs-heart rate, blood pressure, fluid loss; (6) bedside monitors in the intensive care unit (ICU)-heart rate, blood pressure, pulse oximeter O_2 saturation; (7) blood gas laboratory-Hgb, O_2 Saturation; and (8) physicians and nurses entry-bleeding status, plus override reasons.

Although this system was designed primarily to assess and improve the proper and appropriate ordering and transfusion of blood products, it also generated billing and blood product utilization statistics. Quarterly QA reports are produced by transfer of the Blood Bank log file on the HELP system to a personal computer database software package that can easily index, sort and summarize the ordering information.

Blood Orders NOT Meeting Computerized Criteria at the Time of Order

Because the computerized blood ordering program was never intended to be a "rationing" system, all blood orders are accepted. However, all blood orders in the exception file, including all those with an override reason,

```
                                LDS HOSPITAL

                            BLOOD BANK EXCEPTION PILE
                                 29-NOV-89 08: 08

1  PATIENT NAME     NO. 20716668  AGE  74  SEX F  E714 28-NOV-07:58
PRODUCT: PACKED CELLS          UNITS:   1   STAT          WRITTEN ORDER
REASON: NO REASON GIVEN
DOCTOR: MILLAR, XXXX        ENTERED BY: BOWEN, SHELLY G
PLATELETS:   91 k   HCT:    35.7   HGB:  11.4    TIME: 28-NOV 03:58
PT:  13.1  PTT:  42   TIME: 28-NOV 00:03
VIT-HR:  118  VIT-SP:  112   TIME: 28-NOV-7:45
SA 02:   86  TIME: 28-NOV 05:10
PROGRAM EXECUTION TIME: 1 MINUTE
EXCEPTION:  UNCLASSIFIED
1 UNIT ISSUED   FIRST ISSUED: 28-NOV 16:30  LAST ISSUED: 28-NOV 16:30
.
.
6  PATIENT NAME     NO. 10725273  AGE  60  SEX M  E847      29-NOV-18:28
PRODUCT: LEUKOCYTE POOR CELLS UNITS:    4   ROUTINE
REASON: ANEMIA
DOCTOR: MAIR, XXXX         ENTERED BY:
OVERRIDE REASON:  HCT = 22 AT MD OFFICE
PROGRAM EXECUTION TIME: 1 MINUTE
EXCEPTION:  UNCLASSIFIED
1 UNIT, ISSUED  FIRST ISSUED: 30-NOV 08:13  LAST ISSUED: 30-NOV 08:13
```

FIG. 4A. Example of blood order exception list at 08:08 on 29 November 1989.

are reviewed by a QA nurse within 24 h of the order. Figure 4A shows an example of two blood orders as they might appear on the printout that the QA nurse reviews. Order 1 shows that a nurse (Shelly G. Bowen) ordered one unit of packed cells at the written request of Dr. Millar and that there was "No Reason" specified for the order. Note that the laboratory and vital sign data for that particular order are explicitly presented for QA review.

Order 6 was placed directly by Dr. Mair, for an anemic patient, and stated the override reason as "Hct = 22 in MD office." Figure 4B shows the QA assessment and data entry of Order 6 exception. The QA nurse entered "12" indicating that the test was done elsewhere, and although the result was not available in the HELP system, the order met criteria. Figure 4B also shows several other options used to classify exception orders. By logging these reasons, we continue to improve the accuracy and quality of the computerized critiquing system.

```
EDIT THIS RECORD (Y/N)
Y
  3... LAB REPORT DELAY
  4... UNSCHEDULED SURGERY
  5... ORDER ENTRY ERROR
  8... NO REASON GIVEN
  9... DETERIORATING PATIENT
 10... EXCEPTION TO CRITERIA
 11... CRITERIA EVALUATION FLAG
 12... LABS ELSEWHERE
 14... COMPUTER ERROR

WHY WAS THIS ORDER AM EXCEPTION?
  YOU MAY ENTER 1 OR 2 REASONS SEPARATED BY A SPACE OR A COMMA ->
12  "LABS DONE ELSEWHERE"
```

FIG. 4B. Example of a Quality Assurance nurse coding of a blood order exception.

RESULTS

General

For the calendar year 1989, there were 18,293 orders for blood and blood tests entered into the system. Of these requests, 13,833 orders were placed for the 49,916 units of blood products. Quality Assurance nurses reviewed 19% or 2627 of these orders. After review by Quality Assurance and the physician peer review, only 62 (0.45%) of the orders were considered to be true exceptions. These exceptions were then reviewed by individual physician departments.

The system has been in routine clinical use for 2½ years. Results for the *fourth quarter* of 1989 showed that there were 3396 orders for 11,838 units of blood. Of these orders 1 154 (34.0%) were from the Department of Surgery. The housestaff placed 1375 (40.5%) of the orders. The number of orders requiring QA review was 619 (18.2%). Of these 619, there were 190 (5.6% of the total) that occurred because "no reason" was specified. Only 8 (0.24%) of the orders were found to be true exceptions or only about one order in every 424 orders placed.

To measure the effect and value of having previous orders and laboratory data presented on the computer terminal at the time of order, the number of times during a 6-month period that the ordering program was exited before completion was measured. For all reasons there were 677 (12.9%) times an order was not completed. There were 137 (2.4%) of the orders that were terminated after previous order information was presented. There were 176 (3.3%) orders terminated after laboratory data alone were presented when there were no previous orders for blood. For the situation where there were previous orders *and* laboratory data, there were 364 (6.9%) when the order was terminated. However, these results must be interpreted with caution. We were only able to detect that the ordering program had been terminated. The reason for termination could have been because the user did not want to make the order *or* because of a system "time out." For example, a nurse or physician may have been interrupted and another user may have "exited" the ordering program. Our best estimate is that about half the findings are real and the other half were due to the above noted reasons.

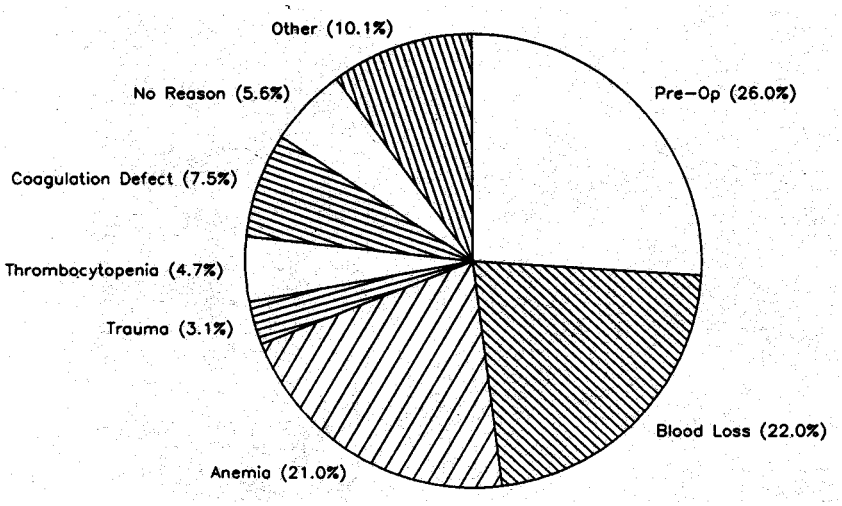

FIG. 5. Blood ordering reason—4th quarter 1989.

For patients for whom blood was ordered for anemia, there has been a continuous and statistically significant ($P < 0.01$) decrease in Hct levels. The average Hct level for the first quarter of 1989 was 28.13 (596 orders for anemia) and by the last quarter of 1989 it was at 27.05 (636 orders for anemia). For the first quarter of 1989 there were 163 (25%) blood orders for anemia made for patients with a Hct greater than 30. For the first quarter of 1990, after the Hct criteria were reduced to 30, the number of anemia orders for Hct greater than 30 was only 49 (7.5%).

Ordering Reasons

Figure 5 summarizes the reasons for ordering of blood products for the *fourth quarter* of 1989. Preoperative order (26%) was the largest single reason, with blood loss (22%) and anemia (21%) following. For the 619 (18.2%) orders that QA nurses had to review because they "fell out," 35% were attributed to deteriorating patient conditions, 3 1% because "no reason" was provided, and 17% because of emergency unscheduled surgery. Knowledge of the reason for the order led us to (1) program more standing orders, (2) improve laboratory reporting procedures and shorten laboratory turnaround times, (3) review the justifying options for completeness and clarity to reduce the amount of manually entered freetext override reasons, (4) make improvements in the timeliness and accuracy of the surgery scheduling process, and (5) refine and expedite the QA review and reclassification process.

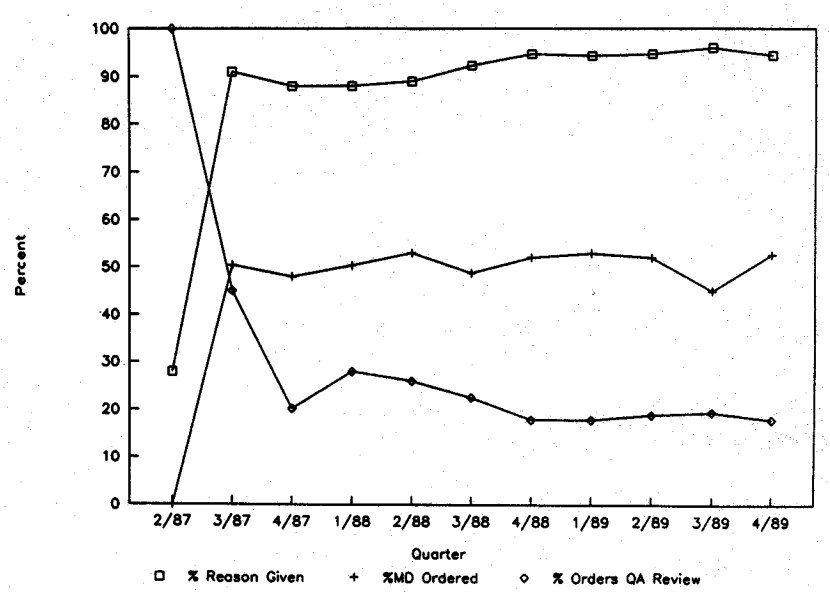

FIG. 6. Computerized blood ordering trends—2½ year experience.

Quality Assurance Review Trends

Figure 6 shows the blood ordering trends over the 2½-year period that the computerized system has been in operation. In the second quarter of 1987, all blood orders were written on paper forms. At that time only 28% of the blood ordered had any reason specified and 100% of the blood orders required QA review. The second quarter after implementation of the computer system (4^{th} quarter 1987), 91% of the blood orders had the reason given and only 18% required QA review (40% of the orders were personally entered by physicians). There has been continued improvement in the rate and accuracy of the blood justification over the 2½ years since the system was implemented.

Physician and departmental quarterly reports lead directly to (1) fewer records requiring physician review, (2) substantially improved documentation justifying blood use, and (3) better physician peer comparisons within medical disciplines.

Mode of Entry

Figure 7 shows that 45.6% of the blood was ordered by physicians at terminals. Standing orders accounted for 7.0% of the orders. Written orders accounted for 25.8%, verbal for 14.0%, and phone for 7.6%. The average time for ordering blood through the computer was 2.2 min. Physicians appreciated the information from laboratory and previous blood orders presented during the blood ordering process. Thus the time required to enter the order is efficient compared with the time spent searching a manual chart for the latest laboratory results and previous blood orders.

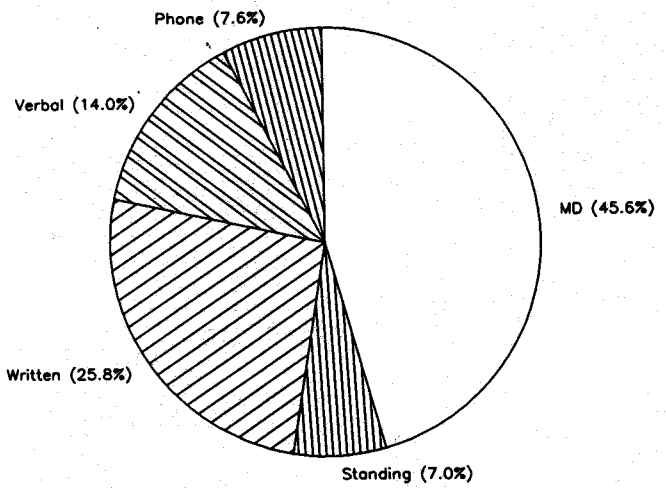

FIG. 7. Blood ordering method-4th quarter 1989.

Comparisons of method of order entry with orders resulting in "exceptions" were revealing. We found in I989 that "written" orders had a 28.4% exception rate, "phone orders" a 21 .2% exception rate, "verbal orders" a 16.0% exception rate. Many of these orders did not have an override reason given because nurses were instructed not to guess at the reason for the order exception. However, when physicians entered the orders, the exception rate was only 13.5% and every order had an overriding exception reason entered.

CONCLUSIONS

Implementation of our computerized ordering system was a team effort of the hospital medical staff and Medical Informatics, Quality Assurance, Clinical Laboratory, Blood Bank, and Nursing Departments. During the implementation of the ordering system we found that the following elements were crucial to our success: (1) The entry system must be fast. Some early (first few weeks} implementations were slow and cumbersome and resulted in widespread corn- plaints from the medical and nursing staff. We were competing with a short handwritten note in the paper chart. (2) The system must be easy for staff physicians to learn and use. There was not a convenient time when we could train busy staff physicians and the housestaff were continuously changing. (3) Because blood product ordering is a physician's responsibility and because nurses must often enter those orders, the total cooperation of the nursing staff was essential. (4) It was crucial to allow physicians to "override" the criteria and not be prevented from completing an order to gain acceptance by the medical staff. Without this allowance, the project would likely have failed. (5) It became clear after only two quarters of using the system, that departmental summary statistics of performance were insufficient to influence physicians. Only when we gave specific and detailed data to each individual physician would they pay any attention. (6) Continuous review of the criteria was necessary. What physicians agreed to by consensus forum was not workable in every circumstance. Some criteria were too loose and others were unrealistically tight. (7) It very

quickly became apparent that a wide variety of patient data was needed to understand and justify ordering practices. (8) Delays in reporting laboratory data by just minutes became crucial. When the project began, it was common practice for the laboratory personnel to enter results into the computer in batches. As a result, laboratory personnel often phoned the nursing division to make them aware of critical laboratory values before verifying and entering the results into the computer. (9) Timely entry of all patient data was crucial to making the blood ordering system function efficiently and effectively. (10) Laboratory results from outside the hospital are not available to the HELP system and continue to be a problem. In the future we may pilot a program to permit users to enter the data into the patient data file when approved outside laboratories are used.

Unique elements of our blood ordering program are the following: (1) There is concurrent review of the order as it is placed by the physician or nurse. It is not a retrospective review system. (2) Physicians personally enter orders 45.6% of the time. Few hospital computer systems now require direct physician order entry. (3) "On-line" feedback of information that justifies the order is presented to the person making the order. If the order does not meet computerized criteria. it can be overridden by keying in the reason. (4) There is prompt (within 24 h) follow-up of orders that were overridden to validate and code the reason for the exception. (5) The method uses the integrated database of the HELP system and requires no keyboard entry of laboratory, vital sign and other data. (6) There is review of every blood order rather than just a sample. Because of our small number of inappropriate orders, a "sampled" approach may be insufficient. (7) The medical staff approved and accepted standardized blood product ordering criteria. (8) The system provides guidance and education and does not ration.

The JCAHO requires that at least quarterly the medical staff perform blood usage review to evaluate the appropriateness of all cases in which patients were administered transfusions of whole blood or blood components. The JCAHO allows for retrospective (collecting the data after discharge) review but prefers concurrent (collected while the care is provided) review. Our computer ordering system provides real time review and allows prompt review of the override reason and summarized usage reports for each medical department and individual physician. The JCAHO allows hospitals to review a sampling of orders if the hospital can provide data to support that their sampling is representative after 6 months of complete data collection. Our system has been operating since July of I987 (21/2 years). After review, the Transfusion Committee has chosen to stay with 100% Computerized critiquing rather than a sampling method.

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