# A Computerized Reminder for Prophylaxis of Deep Vein Thrombosis in Surgical Patients

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## ABSTRACT

OBJECTIVE: To measure the effect of a computerized reminder system on the rate of deep vein thrombosis (DVT) prophylaxis in surgical patients.
DESIGN: A prospective trial to measure change in compliance compared to historic controls.
MEASUREMENTS: LDS Hospital surgeons developed local consensus as to which procedures should have DVT prophylaxis. The historic rate of prophylaxis for these procedures was measured through a database search of patient records. A computerized reminder system was then implemented which utilized an expert knowledge base and a time drive mechanism to flag surgical cases for DVT prophylaxis. For eligible patients, a DVT reminder appeared on the operating room schedule; surgical staff used this as a guide to apply prophylaxis. During the 3 month trial the rate of DVT prophylaxis was remeasured and compared to the pre-intervention rate.
RESULTS: The pre-intervention rate of DVT prophylaxis over a 3 month period was 85.2% (785 of 921 eligible cases). For the 3 months following the introduction of the computerized reminder, compliance with DVT prophylaxis increased to 99.3% (1084 of 1092 eligible cases). The difference between the historic controls and the study subjects was highly significant ($p < 0.001$)
CONCLUSION: A computerized reminder is an effective method of increasing the rate of DVT prophylaxis in surgical patients.
KEY WORDS: deep vein thrombosis, pulmonary embolism, prophylaxis, care guidelines, clinical information systems, quality improvement

## INTRODUCTION

Venous thrombosis is the abnormal presence of blood clots in the veins. Deep vein thrombosis (DVT) may be asymptomatic or may present as local problems in the lower limbs, such as varicose veins, skin ulcers and chronic pain. More serious complications arise if the clot breaks free from the leg and travels through the heart to the lungs, causing a pulmonary embolism (PE). Unfortunately, in many cases the initial presentation of a PE is sudden death. Pulmonary embolism causes the death of 100,000 patients each year in the United States. Fatal PE may be the most common preventable cause of hospital death and may occur in up to 1% of general surgery patients and 3% of orthopedic patient who do not receive prophylaxis [1,2].

The prophylactic use of anticoagulants or compression stockings reduces the relative risk of DVT and PE by up to 80 per cent. However, prophylaxis is grossly underutilized by surgeons, with reported rates in the literature varying from 50 to 85%. There are 3 reasons why eligible patients may not receive prophylaxis. The first is an issue of lack of knowledge; some doctors may not be aware of the advantages conferred by prophylaxis and so do not order preventative measures. A second possibility a breakdown in the process of care where prophylaxis is ordered but not given. The last reason why prophylaxis may be missed is McDonald's observation that all physicians occasionally forget [3]. Even the best trained clinicians have a measurable rate of omitting to do things that they know they should do.

The medical literature acknowledges the problems with shortcomings in the administration of DVT prophylaxis, yet few papers address the problem of increasing its use. Attempted methods include local consensus conferences, frequent reinforcement to junior house staff, manual reminder systems, mandatory education and feedback to surgeons. A review of the literature through a Medline

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search of the Index Medicus failed to find any studies which utilize computer generated reminders to increase DVT prophylaxis.

## BACKGROUND

LDS Hospital in Salt Lake City, Utah is a tertiary care teaching hospital licensed for 520 beds. For over 20 years, LDSH has had a clinical computing system known by the acronym of HELP (Health Evaluation through Logical Processing) [4]. The HELP system has successfully integrated information management and clinical medicine, including several applications of alerts and reminders. These programs have been of use in preventing adverse drug effects and administering preoperative antibiotics. The authors of these projects have been able to show changes in process outcomes, clinical outcomes and substantial cost savings [5-8].

The HELP system has data-drive capacity, where the user remains passive and is prompted by the system whenever a set of criteria is met. The components of the HELP data-drive system include the clinical data, an expert system to monitor the database, and a knowledge base with rules of logic that trigger the reminder. The advantage of the data-drive technique is that consistent reminders are generated automatically, satisfying Leape's criteria of standardization and reduced reliance on memory as keys to avoid error in medicine [9].

## METHODS

The project design was a prospective study of change in compliance compared to historic controls. The null hypothesis stated that a computerized reminder for DVT prophylaxis had no effect on prophylaxis rate. Subjects were all surgical patients who underwent a procedure that met locally defined criteria for DVT prophylaxis.

Consensus as to which procedures should have DVT prophylaxis was developed by LDSH surgeons based on recommendations from the American College of Chest Physicians (ACCP) [1]. The surgeons decided that total joint replacement procedures would receive anticoagulation, while the other procedures would receive compression stockings. The historic rate of DVT prophylaxis at LDSH was established through a database search of patient records for a 3 month period. Of 921 cases which were defined by the surgeons as needing prophylaxis, 785 had received anticoagulation or compression stockings, yielding a rate of 85.2%.

The HELP system has its own hierarchical coding system known as PTXT (Pointer-To-Text). The surgery schedule uses these codes for pre-operative coding of procedures. An expert knowledge base containing PTXT codes for the procedures in the study was coupled to a time driver. Three times a day (at 07:00, 11:00 and 15:00) the time driver searched the integrated clinical database for PTXT codes of surgical procedures for which DVT prophylaxis was indicated. When a PTXT code in the clinical database matched that of the expert knowledge base, a reminder consisting of the letters 'DVT' printed on the operating room (OR) schedule adjacent to the patient's name. Surgery schedules were printed by various units each morning for that day's cases with the DVT reminder in place.

All surgical staff were orientated to a change in work pattern. When the DVT reminder appeared on the OR schedule, the admitting nurses ensured that the designated patient received an anti-coagulant (for total joint replacement surgeries) or else was wearing TED hose prior to going to the OR. The personnel who assembled the case carts used the DVT reminder as a guide to include compression stockings on the carts. The OR nurses, who were responsible for placing the compression stockings on the patient, had the DVT reminder on the schedule, plus TED hose on the patient, plus the compression stockings on the case cart as prompts to ensure that the patient received prophylaxis.

Data was gathered for 3 months (November 1997 to January 1998) and stored in an Excel spreadsheet. Analysis for statistical significance was done with Pearson's chi-square method.

## RESULTS

During the 3 months of the trial, 1092 cases met the criteria for DVT prophylaxis. Of these, 1084 received anticoagulation or compression stockings, for a rate of 99.3%. Compared to the pre-intervention rate of 85.2%, the difference was highly statistically significant ($p < 0.001$) (Table 1).

Of the 54 surgeons in the study; 47 had no cases that missed prophylaxis, 6 surgeons missed one case each, and one surgeon missed prophylaxis in 2 cases. For the 8 missed cases, prophylaxis was contraindicated in 2 - an elderly patient on chronic coumadin with a high International Normalized Ratio (INR), and a critically injured coagulopathic trauma patient with leg fractures who died on the table.

Inappropriate labeling of patients occurred 89 times (7.8% of all cases). On 13 occasions, although the procedure was included in the study, no DVT reminder was present, a result of clerical error where the wrong PTXT code was assigned to the case. On 76 occasions, patients received the DVT reminder when it was not indicated. This was due to 'sharing' of PTXT procedure codes, a practice which has developed over the years to simplify the process of case cart preparation. For example, umbilical hernias were not part of the study, yet were inaccurately assigned the same PTXT code as epigastric hernias which were in the study. Although they are different procedures, they utilize the same surgical instruments and thus have identical case carts. The problem of shared codes can be corrected by having the surgical staff assign the correct codes to each procedure.

## DISCUSSION

This study demonstrated that computerized reminders can significantly increase the rate of pre-operative DVT prophylaxis. The result is consistent with work done previously at LDS Hospital where computerized reminders increased the rate of prophylactic antibiotics in surgical patients[5-8].

This study has several limitations. There were different sources of data for the study group, which was gathered on a daily basis from the OR schedule and in-patient charts, and the historic control group, which was gathered from a patient database. Another limitation is that the study measured process outcomes, not clinical outcomes. In their paper on designing studies of computer-bases alerts and reminders, Rind et al. address the problem of process versus clinical outcomes and conclude that the clinical value of measuring process outcomes can be determined if there are adequate data on the procedure or behavior that the reminder addresses [10]. In the case of the present study, hundreds of papers over the past 2 decades affirm the effectiveness of prophylaxis in reducing DVT and PE [1,2]. The purpose of this study was not to demonstrate a relationship between prophylaxis and thromboembolism, but rather to increase appropriate use of prophylaxis. Although the study would be strengthened if it showed a decrease in thromboembolic disease, it may be safely inferred that an increase in the rate of prophylaxis will lead to this end.

Finally, this study had an increase in the rate of prophylaxis during the 3 months of the trial, but it is unknown if the effect will be sustained after the study is concluded. Ideally, results should be remeasured in another year to confirm that the rate remains high. Another option would be to discontinue the reminder to see if the rate drops, and then reinstitute the reminder to see if the rate increases again. Such an approach, although sound in scientific principle, can generate frustration among caregivers who prefer consistency of practice over investigative methodology. With the combination of a consensus among the surgeons, a change in work patterns among surgical personnel, heightened awareness of the need for DVT prophylaxis and a consistent computerized reminder, the rate of prophylaxis should remain high.

## CONCLUSION

A computerized reminder, which reflects a local consensus by the surgeons and results in a change in work patterns among surgical personnel, is an effective method of increasing the rate of DVT prophylaxis in surgical patients.

Table 1. All cases for 1996 and 1997, grouped by surgical division, showing number of cases, rate of DVT prophylaxis, chi square and p value.

| Division | 1996 cases | 1996 proph | percent | 1997 cases | 1997 proph | percent | chi square | p value |
|---|---|---|---|---|---|---|---|---|
| general surgery | 480 | 414 | 86.3% | 612 | 611 | 99.8% | 86 | <.001 |
| orthopedic surgery | 193 | 170 | 88.1% | 235 | 231 | 98.3% | 19 | <.001 |
| gynecological surgery | 201 | 154 | 76.6% | 210 | 207 | 98.6% | 46 | <.001 |
| urological surgery | 47 | 47 | 100% | 35 | 35 | 100.0 % | 0 | NS |
| | | | | | | | | |
| total all divisions | 921 | 785 | 85.2% | 1092 | 1084 | 99.3% | 148 | <.001 |

References


1. Clagett GP, Anderson FA, Heit J, Levine MN. Prevention of thromboembolism. Chest 1995;108:313S-334S.
2. Elliott CG. Pulmonary embolism. Curr Pulmonology 1995;16:51-85.
3. McDonald CJ. Protocol-based computer reminders, the quality of care, and the non-perfectability of man. New Engl J Med 1976;295:1351-5.
4. Kuperman GJ, Gardner RM, Pryor TA. HELP: a dynamic hospital information system. New York; Springer-Verlag 1991. Orthner HF, ed. Computers and Medicine.
5. Pestotnik SL, Classes DC, Evan RS, et al. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. Ann Int Med 1996;124:884-90.
6. Classen DC, Evans RS, Pestotonik, SL, et al. The timing of prophylactic administration of antibiotics and the risk of surgical wound infection. New Engl J Med 1992;326:281-86.
7. Classen DC, Pestotnik SL, Evans SE, et al. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. JAMA 1997;277:301-06.
8. Evans RS, Pestotnik SL, Classen DC, et al. A computer-assisted management program for antibiotics and other infective agents. N Engl J Med 1998;338:232-8.
9. Leape LL. Error in medicine. JAMA 1994;272:1851-7
10. Rind DM, Davis R, Safran C. Designing studies of computer-based alerts and reminders. MD Comput 1995;12:122-6.