COMPUTER AIDED DRUG USE EVALUATION IN A LARGE OUTPATIENT POPULATION WITH DHCP

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ABSTRACT

Drugs are a critical factor in the treatment of many diseases. The Drug Utilization Evaluation (DUE) Pilot Project Advisory Group was formed to examine DUE efforts in the Veterans Health Administration (VHA) and develop methods to improve the process. The DUE Pilot Test Project is an eleven site trial to test these methods. The VHA's Decentralized Hospital Computer Program (DHCP) contains a tremendous amount of data related to drug usage. Software tools were developed to gather patient and drug specific data from numerous applications within DHCP. These data were organized and evaluated within DHCP and through the use of personal computers to provide patient and drug specific information to health care providers and to monitor changes in drug usage over time. Procedures were developed to improve the function of the DUE questionnaire generator in the Outpatient Pharmacy Application in DHCP. Patient, drug and facility specific information were transmitted to the VHA's Quality Management Institute and Education Center (QMI), using Network Mailman, for analysis and comparison. Preliminary data show a positive effect on monitoring practices and a reduction in the number of elevated drug levels.

INTRODUCTION

The DUE Pilot Project Advisory Group is interdisciplinary, being comprised of individuals from a number of VHA facilities with medical, nursing, quality assurance, pharmacy, laboratory, information management, educational and scientific credentials. Emphasis was placed on the development of local interdisciplinary DUE teams and improving patient outcomes by improving drug utilization. Previously the VHA's DUE efforts consisted predominantly of questionnaire distribution to providers, tabulation and analysis of the results, and/or manual review of patient charts. The time required to perform these manual reviews made it difficult to perform DUE on large samples of the outpatient population.

The Advisory Group decided the best hope for improving the DUE process at medical centers with available resources was to automate the process as much as possible. We believed it might be possible, through the use of the DHCP database, M routines, and PC software to:

Identify possible drug usage problems in patient populations

Provide a better survey tool

Provide timely drug information to providers

Monitor changes in drug usage

Provide peer group information on drug usage

Provide an indicator of drug related patient outcomes

A literature search was conducted. DUE efforts inside and outside the VHA were reviewed. A five site VHA study on drug toxicities conducted in 1989 found 73% of the 153

reported toxicities were caused by the drugs theophylline (31%), phenytoin (25%), digoxin (10%), warfarin (7%).(Figure 1). Protocols and questionnaires were developed for the four drugs. Due to the limited resources available at many of the Pilot Test Sites, each was asked to implement DUEs on theophylline only.

The primary focus of this paper is the M routines developed for the project, the information they provide, and the findings of the DUE Pilot Project.

STUDY HYPOTHESES

The hypotheses proposed by the DUE Advisory Group are as follows. During the DUE Pilot Test Project:

1. The percentage of patients taking theophylline with no blood theophylline result in the past year will decrease.

2. The percentage of patients with most recent theophylline levels greater than 20 micrograms/milliliter (ug/ml) will decrease.

3. The percentage of patients with "potentially toxic" levels of theophylline (greater than 25 ug/ml) in the past year will decrease.

4. The DUE questionnaire results will show improvement in the following areas:

   Documentation of the indication for theophylline

   Appropriate monitoring of theophylline blood level

   Most recent theophylline level within therapeutic range

   Adverse effects

   Knowledge of how to take theophylline

DHCP SOFTWARE

With the exception of the Baseline Generator, all software developed for this project was designed to be generic, in that it allows user selection of the drug and/or laboratory test.

DUE Baseline Generator (BG): This is a set of M routines which search the facility's pharmacy database for patients with active prescriptions for one or more of the drugs theophylline, phenytoin, digoxin, or warfarin. Data are gathered from the pharmacy, laboratory and other DHCP databases on each of these patients. Only theophylline data are loaded into a mail message, in a delimited format designed for download to a PC database. The following data are transmitted from each pilot site to the QMI for inclusion in a combined database.

Unique patient identifier
Generic name of drug
Date of collection
Unique provider identifier
Provider type (Fee, Staff etc.)
Patient age
Patient sex
Quantity and days supply of drug
Most recent theophylline level
Date of most recent level
Highest level (365 days)
Date of highest level
Lowest level (365 days)
Average level (365 days)
Lab test name (theophylline etc.)
Number of lab levels (365 days)
Number of active prescriptions
Estimated creatinine clearance

Note: Unique patient and provider identifiers are numeric codes which prevent identification without access to the local facility's DHCP database.

A report of the total number of patients receiving each of the four drugs and the number not monitored within the recommended time interval is printed locally. At the request of the pilot sites, a listing of all unmonitored patients is printed.

Screen for High Lab Results: This M routine searches the DHCP laboratory data file for a user specified date range, lab test, and results greater than a user specified level. It allows local DUE teams to find all potentially toxic lab results (theophylline levels greater than 25 ug/ml) reported during a selected time period. It facilitates detection of adverse drug events (ADEs) caused by drugs monitored by a laboratory test.

Outpatient Drug Combination Search: This routine searches the DHCP pharmacy database for outpatients receiving a user specified drug or combination of drugs (e.g. theophylline and ciprofloxin). Identification of patients receiving interacting drugs allows the local site to take corrective action, decreasing the potential for adverse drug events. An added benefit of this routine is the ability to identify patients receiving a specific drug or combination of drugs specified in FDA recalls or warnings.

Drug/Lab Appointment List: This routine prints a listing, by clinic, of all patients receiving theophylline with appointments during a specified date range. The report includes the most recent theophylline level or a statement that no level was performed within the past year. This option is intended to inform providers of theophylline levels, or the lack of monitoring, prior to the outpatient visit.

DUE Questionnaire: The Outpatient Pharmacy application of DHCP includes two options, Action and Informational Drug Profiles, which inform providers of the patient's current outpatient prescriptions. One of these profiles is routinely provided during each patient visit. A recent enhancement, the DUE patch, makes it possible to generate a drug specific questionnaire with the profiles. The DUE Advisory Group modified the use of this software to print an improved theophylline questionnaire (see Appendix A). This software also allows for input of questionnaire answers into a DHCP file for automated retrieval and analysis.

DUE Completion Rate Monitor: This routine provides data to assess the success of the DUE questionnaire-driven portion of the project. Providers are instructed to complete the questionnaire when taking action on an existing theophylline prescription (cancellation, dosage change, renewal). This routine examines all patients with outpatient visits during a date range, determines which had actions taken on theophylline prescriptions, and of that number, how many had DUE questionnaires completed and entered into the DUE answer sheet file. A patient specific report is included to provide a tool for improvement.

DUE Answer Sheet Download: This utility downloads entries from the DUE Answer Sheet file to a PC spreadsheet for local analysis and transmission to QMI for aggregate analysis. Questionnaire results, patient, provider and drug information are included.

Drug/Lab Related Admission: This routine facilitates the detection of drug related admissions. All patients discharged within a selected date range are examined. All patients receiving the specified drug when admitted are included in the report with results of a specified laboratory test for a period before and after the admission date.

Patients Receiving Target Drug: This routine searches the pharmacy database and determines the number of patients receiving a specified drug at any time during the selected time period. This number represents the population at risk of an adverse drug event (ADE). By combining this number with the results of other screening reports (Search for High Lab Results, etc.) the risks can be determined.

Inpatient Drug Combination Search: This routine searches for inpatients receiving a drug or combination of drugs, designated by name or VA drug class. All active IV and Unit Dose orders are examined. It is useful in identifying patients for drug education prior to discharge and to find inappropriate drug combinations.

Lab Results on Drug Profile: A modification to the Outpatient Pharmacy Application, was requested as part of the DUE Pilot Project. Released as a patch to Outpatient Pharmacy version 6.0, it allows drug specific laboratory results to be printed on the outpatient Action and Informational Drug Profiles. The most recent theophylline result or a notification that none are available in the past 365 days is printed.

PC SOFTWARE

Analysis of local questionnaire and BG data, at each pilot site, is performed using Excel spreadsheet software. Analysis at QMI utilizes Excel and SAS software. DUE teams at each pilot site were provided with a statistical cookbook and Excel macros to facilitate local analysis.

IMPLEMENTATION

The Advisory Group held its organizational meeting in July, 1992. Advisory Group meetings were held over the ensuing nine months to develop the objectives and methodology of the DUE Pilot Project. Hands-on training in the use of DHCP, M and PC software occurred in April and May, 1993. Teams from each of the eleven pilot sites participated. All sites were asked to begin running the Baseline Generator on July 4th and begin questionnaire data collection by August 1, 1993.

Baseline Findings: Evaluation of the initial, July 4, 1993, BG data transmitted to QMI revealed the following information:

1. Of the 5,364 outpatients receiving theophylline at the eleven pilot sites, 2,188 (40.8%) has no laboratory result for theophylline blood level within the previous 365 days.

2. Of the 3,176 patients with a theophylline level within the past year, 72 (2.3%) had a most recent theophylline level greater than 20 ug/ml (the upper limit of therapeutic range).

3. Of the 3,176 patients with a theophylline level within the past year, 97 had a theophylline level greater than 25 ug/ml during the past year. This indicates a potential "Toxicity Rate" of 3.2%. Calculation of the actual rate of toxicities would require patient derived data.

4. When patients were grouped by age and number of medications, the rate of elevated theophylline levels (most recent theophylline level greater than 20 ug/ml) showed no consistent pattern of association with either age or number of medications used.

5. Considerable variation exists between the 11 pilot sites. The percent of patients with no theophylline level in the past year ranged from 58% to 24.5%. The percent of monitored patient with a most recent theophylline level greater than 20 ug/ml ranged from 7.3% to 0%. The percent of patients with a theophylline level greater than 25 ug/ml in the past year ranged from 7.3% to 0.8%.

Monthly Data Collection: Each Pilot Site was instructed to queue the Baseline Generator option to run on the first Sunday of each month and to forward questionnaire data downloaded from the DUE Answer Sheet file at the end of each month. Data collection was to continue until April, 1994, but may be extended if possible.

PRELIMINARY RESULTS

All eleven sites have run the Baseline Generator each month. The following changes have been observed.

The percentage of patients taking theophylline with no theophylline result in the past year has decreased from 40.8% in July 1993 to 30.5% in January 1994 (Figure 2).

The percentage of patients with most recent theophylline levels greater than 20 ug/ml has decreased from 2.3% in July to 1.9% in January (Figure 3).

The percentage of patients with potentially "toxic" levels of theophylline (greater than 25 ug/ml) has decreased from 3.2% in July to 1.9% in March 1994.

Ten of the eleven sites have implemented the DUE theophylline questionnaire. Complete data were available for August, September, and October. When rates of questionnaire based measures were compared for August and October, the following changes were noted.

The percentage of patients with proper documentation of the indication for theophylline increased from 96.4% to 97.9%.

The percentage of patients with appropriate monitoring of theophylline blood levels decreased from 64.7% to 61.2%.

The percentage with theophylline levels within the therapeutic range decreased from 65.6% to 64.5%.

The percentage of patients with adverse effects of theophylline increased from 4.8% to 7.8%.

The percentage of patients (or care givers) who could state how to take theophylline changed slightly from 93.5% to 93.7%.

CONCLUSION

Preliminary results show improvement in all indicators of theophylline usage derived from Baseline Generator data. The percent unmonitored in the past year and the percent with "potentially toxic" levels (greater than 25 ug/ml) decreased significantly (Both p values were less than 0.0001 based on the chi-square test for statistical significance). Data derived from questionnaire data did not reflect the same improvement. Four of the five questionnaire derived indicators did not show significant change. The remaining indicated an increase in patients with adverse effects or toxicity from 4.7% of outpatients to 7.5%. This unexpected change does not correlate with Baseline Generator data showing a reduction in elevated theophylline levels.

The DUE questionnaire is a valuable tool for increasing provider awareness. It prompted providers to examine theophylline monitoring practices and patient education. This increased awareness may have brought about changes in patient care which reduced the number of unmonitored patients and the occurrence of "potentially toxic" theophylline levels. However the results of the questionnaires may have been affected by the increase in provider awareness. The increase in provider indicated adverse effects or toxicities was the most significant ($p=0.05$). Data derived directly from the DHCP database provides a more reliable indicator of change.

The entire population of outpatients receiving theophylline was included in the study using existing human resources. This was possible because a large portion of the data was gathered and transmitted automatically. Questionnaire data was more difficult to collect at a central database (QMI). More effort was required to enter the questionnaire results into DHCP, download them to a PC and transmit them by modem to QMI.

The software developed to support the DUE Pilot Project could become an important aid in the management of patients receiving problem prone drugs. In outpatients receiving theophylline it facilitates the review of monitoring intervals and measured blood levels. Drug specific questionnaires when automatically printed as part of the drug profile currently in use, may have a positive effect on drug usage. By detecting potentially toxic laboratory test results and inappropriate drug combinations adverse drug events can be identified which might otherwise go unreported. It is possible to quantify some aspects of drug usage, monitor them over time, and compare the results with findings from other facilities.

Further study may determine which portions of the DUE Pilot Project were most beneficial. It may be possible to maintain gains with continued computer assisted monitoring and appropriate feedback to providers.

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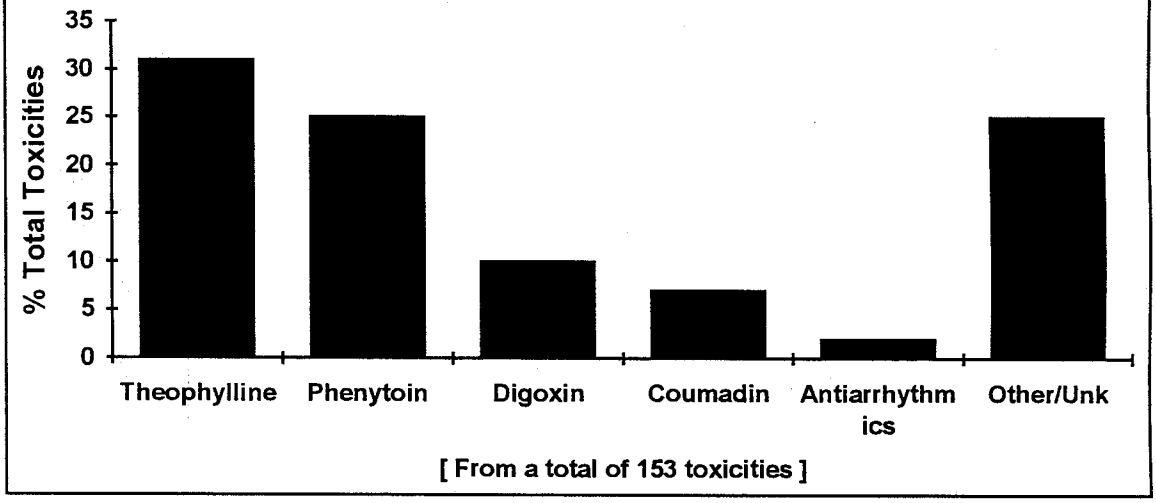
FIGURE 1.
PERCENT OF TOTAL TOXICITIES BY DRUG IN A FIVE SITE VHA STUDY, 1989



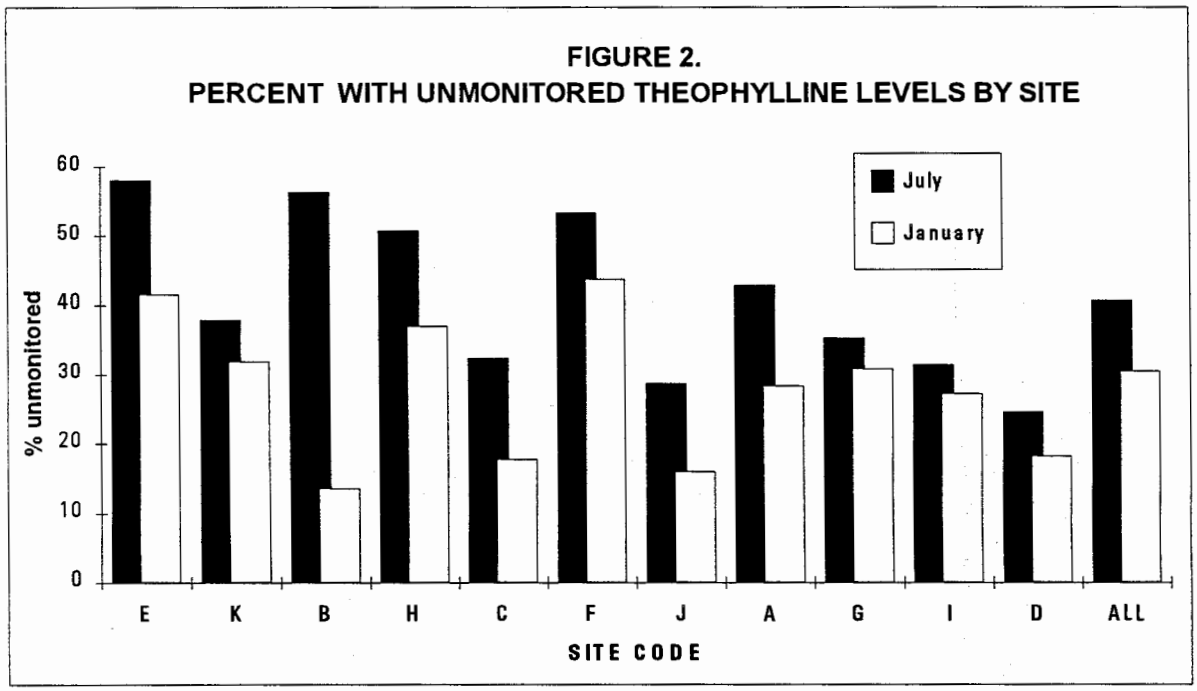


FIGURE 2.
PERCENT WITH UNMONITORED THEOPHYLLINE LEVELS BY SITE
% unmonitored
60
50
40
30
20
10
0
July
January
E
K
B
H
C
F
J
A
G
I
D
ALL
SITE CODE

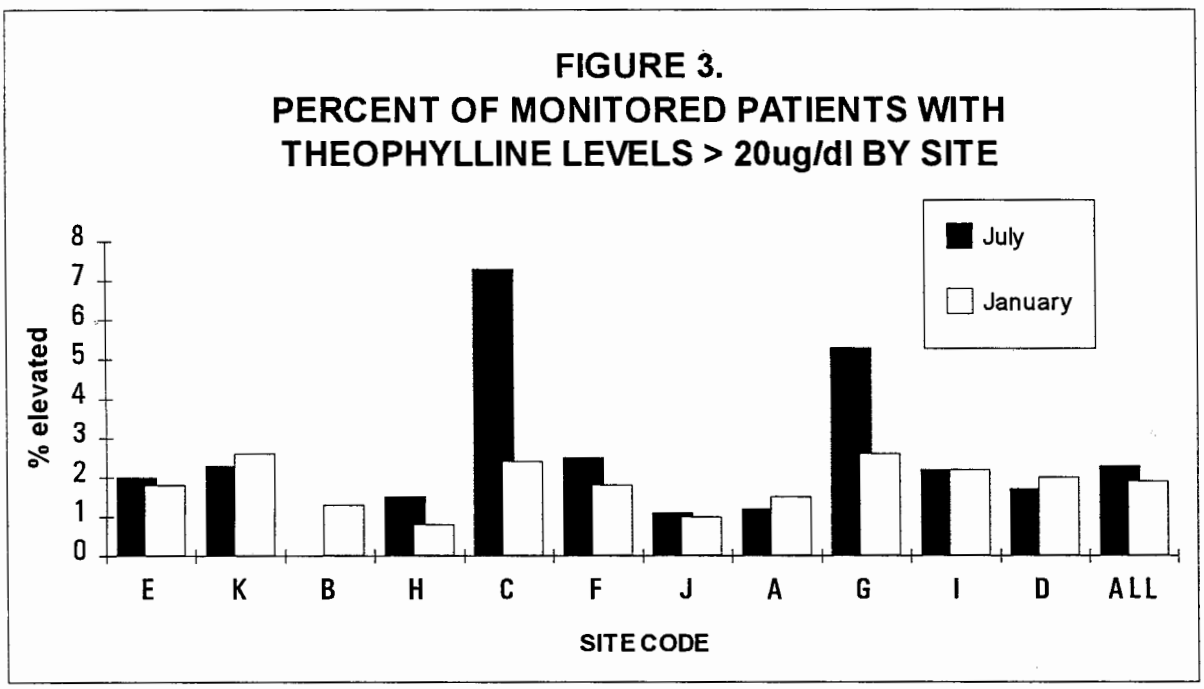


FIGURE 3.
PERCENT OF MONITORED PATIENTS WITH
THEOPHYLLINE LEVELS > 20ug/dl BY SITE
% elevated
8
7
6
5
4
3
2
1
0
July
January
E
K
B
H
C
F
J
A
G
I
D
ALL
SITE CODE

DUE Questionnaire for Theophylline

Drug: _____ Rx #: _____
Provider: _____ Patient: _____
Section: _____ Seq. #: _____

This medical center is evaluating the use of theophylline. **If you are changing, renewing, or canceling theophylline or changing the use of an interacting drug, please fill out this form** by circling the appropriate answers and instruct the patient to take this form to the Outpatient Pharmacy. **Thanks for your help.**

Y = Yes N = No NA = Not ascertained / not available

Y N 1. Is the indication for theophylline documented in the patient chart?

Y N N/A 2. Theophylline dosage is assessed if patient is concurrently receiving **interacting agents**.*
[If patient is known NOT to be on an interacting drug, answer "Y".]

Y N N/A 3a. If patient has recently started taking theophylline or has had a recent change in dose, was theophylline level **monitored** within last month?
OR
3b. If patient is on maintenance therapy, has the level been monitored in the last year?

Y N N/A 4. Is most recent theophylline **level within therapeutic range** (5 - 20 mcg/ml)?

Y N N/A 5. Is the patient experiencing symptoms of **adverse effects** or **toxicity** of theophylline?** **If yes, please document in chart.**

Y N N/A 6. Can the patient (or caregiver) **state how** to take theophylline?

7. **Follow-up action(s)**: (check all that apply)
[ ] Continue current therapy; [ ] Theophylline dose adjusted;
[ ] Discontinue theophylline; [ ] Add another drug;
[ ] Discontinue another drug; [ ] Educate patient or caregiver;
[ ] Referral; [ ] Change monitoring interval;
[ ] Other (list) _____

Signature _____ Date_____

* Ciprofloxacin, cimetidine, allopurinol, erythromycin-type antibiotics & verapamil tend to raise blood levels.
* Smoking, phenytoin, carbamazepine, rifampin & phenobarbital tend to decrease blood levels.

** I.e., nausea, tremors, restlessness, tachyarrhythmias, seizures, nervousness, confusion.

ATTACHMENT A