Implementing Guidelines In Ambulatory Practice
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ABSTRACT
As we understand the process of ambulatory care better, the need to effectively implement standards of practice becomes more apparent. To facilitate successful use of practice guidelines, we have integrated an artificial intelligence system of Medical Logic Modules into our computerized medical record. A rule shell allows rapid development and prototyping of rules which can be practice reminders, information gathering utilities, or standing orders. A set of utilities allows non-programmer clinicians to develop and maintain the rule set. We will demonstrate these enhancements in the context of the comprehensive patient record.

DESCRIPTION
The pace of ambulatory care continues to increase as more complex health delivery is shifted to the clinic from the traditional inpatient setting. The development and promulgation of complex practice guidelines places further information demands on the clinician and clinic staff. A comprehensive patient care database is but one component of a computer system required to meet the needs of this environment. We describe here our approach to adding artificial intelligence features to an existing computerized medical record.

Background
COSTAR V, originally developed at the Massachusetts General Hospital and now in the public domain [1], has been extensively modified by users to fit specific practice needs. Computerized ambulatory medical records have been in use in our Internal Medicine Clinic since 1983 when we first installed COSTAR on a DEC PDP® 11/34. Expansion to two computers of the Microvax® family with 4.0 gigabytes of computerized patient records has been necessary as acceptance and use of the system has grown. Successful use of COSTAR in Internal Medicine has led to implementation of the software in Medicine Specialty, Cancer Center, Ophthalmology, and Surgery/Transplant clinics. Real-time connections to other campus information systems for capture of laboratory, pathology and radiology information has further added to the utility of COSTAR. These wide area network links are available through a hybrid network architecture across a token ring campus-wide superhighway.

We have made major changes to our installation to facilitate interactive use of computerized medical information [2]. These include adding problem-oriented features, prescription writing facilities, physician display utilities [3], and interactive nursing support [4]. During the past year, we established a system of Medical Logic Modules (MLM) for clinical decision support patterned after the Arden Syntax [5]. This presentation will focus on the development and implementation of the artificial intelligence features that allow a busy practice to effectively employ practice guidelines in daily care.

Rule Shell for Medical Logic Modules
MLMs are discrete rules written in Medical Query Language (MQL®), a high-level development language accessible to non-programmer clinicians. We modified MQL to support an interactive environment, which has given us the tools needed to support this evolution of information management. The ability to customize MQL has been critical for rapid prototyping and development of unique nursing information sets. A specially designed shell allows the clinicians to test and implement these modules quickly without MUMPS programming assistance. Library functions employing features of the Arden syntax permit maintenance of the rule set.

The MLMs are designed and implemented by a clinical practice committee composed of nurses and physicians. They are currently being used for computer-directed history taking, routine order implementation, and practice guideline reminders. A given rule can be triggered by a variety of clinical events linked to any of the codified information in the computerized record. An example is shown in figure 1.

Nursing Encounter Data Capture
Rules cannot function reliably without accurate codified data in the medical record. Before we implement a new rule, the clinicians identify the necessary codified data elements. As each patient is checked-in, the computer prompts the nurse to ask for any missing data elements required for the current rule set. Examples include family history, health maintenance behaviors, and lifestyle choices of the patient. These items are entered into COSTAR during the intake exam by the nurse in the exam room.
**Figure 1: Smoking Medical Logic Module**

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Smoking history on file? Y => Is patient a non-smoker? Y
                             => STOP
                             N => Obtain current smoking history.
                               Document in computer record.
                               N => STOP
                               Y => Is patient currently smoking?
                                    N => STOP
                                    Y => Is patient motivated to quit?
                                         N => Repeat MLM in 12 months
                                         Y => Notify physician of patient’s motivation.
                                             Supply patient with smoking cessation information
```

**Examples of Working Medical Logic Modules**

Our current work has focused on nursing and prevention issues. Future plans call for development of physician-directed rules. The following list gives some examples of currently implemented MLM’s in the internal medicine practice.

- Smoking history taking, patient education, and smoking cessation intervention.
- Screening for orthostatic hypotension.
- Assessing patients' risk for falls.
- Dietary history in hypertension and dietary teaching as indicated.
- History gathering for breast cancer screening and routine mammography as indicated.
- Screening for sleep disorders in hypertensive patients

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**REFERENCES**


**Expanded Costar Data Functions**

Because many guidelines suggest education or counseling for the patient, we designed new COSTAR features for patient education. These include personalized education handouts and computer-generated requests to physicians to initiate education referrals. We expanded the features for documenting and tracking patient education so that a list of patient education goals can be specified and the patient's subsequent progress at meeting these goals can be monitored.

**Exam Room Decision Aids For Physicians**

We redesigned the exam room displays to facilitate physician access to patient data. Particular patient problems trigger the display of problem-specific information and reminders to promote optimal decision making. Reminders of needed procedures are integral to these utilities.

**Prescription Review And Alerting**

Planned implementation of MLM's in our interactive prescription system will produce the ability to alert physicians to prescribing errors and employ pharmacist education while the patient is in clinic.