HT-ATTENDING: CRITIQUING THE PHARMACOLOGIC MANAGEMENT OF ESSENTIAL HYPERTENSION

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Abstract

HT-ATTENDING is a computer system being developed to critique a physician's approach to the pharmacologic management of essential hypertension. The concept of having a computer critique a physician's plan of management (Medical Plan-Analysis) has already been implemented in ATTENDING, a system whose domain is anesthesia management. HT-ATTENDING extends this approach to a new medical domain. HT-ATTENDING'S goal is 1) to assist a physician in formulating his approach to the hypertensive patient, 2) to help him avoid inadvertent management errors, 3) to introduce him to relevant new agents and modalities, and 4) to mention topical issues concerning hypertension management, all in the context of daily patient care.

1. Introduction

HT-ATTENDING, a computer system designed using Artificial Intelligence techniques, is being developed to critique a physician's approach to the pharmacologic management of essential hypertension.

To use HT-ATTENDING, a physician first inputs the following information about a hypertensive patient whose blood pressure he is attempting to control:

1. a modest amount of underlying medical information, including:
   a. age,
   b. sex,
   c. the patient's blood pressure,
   d. other medical problems such as asthma, renal failure, etc.,
   e. other medications the patient is taking,
2. the patient's current antihypertensive medications,
3. a proposed modification in antihypertensive medications.

The HT-ATTENDING system then produces a prose analysis which critiques the proposed antihypertensive regimen. In so doing, it discusses any advantages or disadvantages of the regimen, and of alternative approaches which might be either reasonable or preferred.

2. Medical Plan-Analysis (MPA)

The concept of designing a computer system to critique a physician's plan of management (Medical Plan-Analysis) has already been implemented in ATTENDING [1], a system whose domain is anesthesia management. HT-ATTENDING extends this approach to a new medical domain.

The traditional approach to computer-assisted medical decision-making has been to have the computer simulate a physician's decision-making process. When applied to areas of medical management, this traditional approach has the clinical effect of trying to tell a physician how best to manage his patient, i.e. how to practice medicine.

In contrast, the paradigm of Medical Plan-Analysis (MPA) allows a physician to specify the management approach he is contemplating, and lets the computer tailor its advice around this proposed approach. Thus MPA is designed 1) to accommodate the inherent variation in medical practice, 2) to recognize that the physician must take the primary medical and legal responsibility for his patient's management, and 3) to cast the computer in the role of an ally rather than a potential competitor.

HT-ATTENDING extends MPA to the outpatient management of a common, chronic medical problem. This domain offers several advantages, including high visibility to the medical community as a whole. It is hoped that the management of hypertension will prove to be a problem of manageable size that will lead to a practical system in a reasonable time-frame. In addition, the system may serve as a model for similar systems in other areas of chronic medical care.

3. Hypertension and Medical Plan-Analysis

The pharmacologic management of essential hypertension [2, 3, 6] is in many ways an ideal domain for Medical Plan-Analysis.

1. It is a management problem which a physician frequently encounters.
2. There is a wide (perhaps bewildering) array of treatment modalities, including diuretics, beta blockers, vasodilators, and central alpha
agonists. New modalities such as angiotensin-converting enzyme inhibitors and calcium channel blockers are either here or on the horizon. In addition, new drugs are being introduced in each category. For instance, there are now six beta blockers available in the United States.

It is difficult for a physician to keep current with all these varied agents and know how best to tailor them to a particular patient's problems. A system like HT-ATTENDING could help him do this, in the context of daily patient care.

3. There are clear-cut risks and benefits of certain agents in certain patients. For instance, there are well-known management errors, such as giving a beta blocker to a patient with asthma, or giving a potassium-sparing diuretic to a patient with renal insufficiency. There are also potential benefits such as giving a cardioselective beta blocker to a patient with peripheral vascular disease or diabetes. HT-ATTENDING can give a physician feedback: bringing potential benefits to his attention, and helping him avoid inadvertent errors.

4. New management issues are periodically raised in the literature which the practicing physician may not always know about: for instance, the potential advantage in mild hypertension of starting diuretics at a low dose (e.g. hydrochlorothiazide 25 mg) [4], or questions as to the best approach to potassium therapy [5]. HT-ATTENDING can mention these issues in passing, and go into more detail if requested.

4. Examples

The following examples illustrate how the current developmental version of HT-ATTENDING critiques hypertension management. Each example first briefly describes a patient, together with a proposed change of antihypertensive medications. HT-ATTENDING's current critique of the proposed change is then shown.

1. A 63 year old woman with a history of congestive heart failure, whose blood pressure is 160/100.

   current regimen: hydrochlorothiazide 100 mg bid
   proposed regimen: hydrochlorothiazide 100 mg bid, propranolol 40 mg bid

   IN THE UNITED STATES, DIURETICS ARE RECOMMENDED BY MOST AUTHORITIES AS INITIAL OR STEP ONE THERAPY. A THIAZIDE DIURETIC OR SIMILAR ACTING AGENT IS THE DRUG OF CHOICE IN MOST PATIENTS. HOWEVER, IF A PATIENT HAS SIGNIFICANT RENAL INSUFFICIENCY (GLOMERULAR FILTRATION RATE LESS THAN 50 ML PER MINUTE), THEN A LOOP DIURETIC LIKE Furosemide WOULD GENERALLY BE CONSIDERED MOST APPROPRIATE.

   IF YOU DO USE A THIAZIDE DIURETIC, CHLORTHALIDONE OR METOLAZONE ARE ALTERNATIVE AGENTS WORTH CONSIDERING SINCE THEY ARE LONG-ACTING AND CAN BE GIVEN ONCE A DAY.

   A BETA BLOCKER WOULD BE OUR PREFERRED STEP TWO DRUG FOR THIS PATIENT. NADOLOL AND ATENOLOL GIVE A MORE PREDICTABLE BLOOD LEVEL AND HAVE A LONGER DURATION OF ACTION THAN OTHER BETA BLOCKERS. BOTH OF THESE DRUGS CAN BE USED ONCE A DAY. THE DOSE OF BOTH OF THESE AGENTS, HOWEVER, MUST BE REDUCED FOR A PATIENT WITH RENAL INSUFFICIENCY.

   GUANETHIDINE SHOULD BE RESERVED FOR PATIENTS WHO HAVE NOT RESPONDED TO OTHER AGENTS SINCE IT IS OFTEN POORLY TOLERATED AND DIFFICULT TO ADMINISTER. THUS FOR THIS PATIENT WE WOULD SUGGEST USING A STEP THREE DRUG SUCH AS A VASODILATOR OR POSSIBLY CAPTOPRIL BEFORE USING A STEP FOUR DRUG LIKE GUANETHIDINE. IF TREATMENT WITH GUANETHIDINE IS BEGUN, WE SUGGEST THAT ALL OTHER TREATMENTS EXCEPT DIURETICS BE STOPPED. IF YOU DO USE GUANETHIDINE, WE WOULD SUGGEST STARTING TREATMENT WITH A LOWER DOSE THAN YOU PROPOSE. WE RECOMMEND THAT GUANETHIDINE BE GIVEN ONCE A DAY, STARTING WITH A DOSE OF 10 MG AND INCREASED SLOWLY.
UNTIL THE DESIRED THERAPEUTIC EFFECT IS ACHIEVED OR INTOLERABLE TOXICITY OCCURS.

3. An otherwise healthy 45 year old male with mild hypertension.

current regimen: none
proposed regimen: prazosin 2 mg bid

PRAZOSIN HAS BEEN USED BY SOME AS SOLE THERAPY, BUT IS NOT AS EFFECTIVE AS A DIURETIC OR A BETA BLOCKER FOR THIS PURPOSE. IN THE UNITED STATES, DIURETICS ARE RECOMMENDED BY MOST AUTHORITIES AS INITIAL OR STEP ONE THERAPY. THE STARTING DOSE YOU PROPOSE IS HIGHER THAN WE WOULD SUGGEST. WE USUALLY RECOMMEND A STARTING DOSE OF 1 MG BID AND A MAXIMUM DOSE OF 10 MG BID. THE DOSE MAY BE INCREASED EVERY 2 - 3 DAYS. WHILE THE SIDE EFFECTS OF PRAZOSIN ARE GENERALLY MILD, THE CLINICIAN MUST BE CAREFUL TO AVOID THE 'FIRST DOSE PHENOMENON' OF SYNOCOPE OR PRE-SYNCOPE COMMONLY SEEN WITH THIS AGENT WHEN THE INITIAL DOSE IS TOO LARGE. THE FIRST DOSE OF THE DRUG SHOULD BE GIVEN AT NIGHT AND THE PATIENT CAUTIONED AGAINST TOO RAPID CHANGE TO THE UPRIGHT POSTURE. THIS PROBLEM IS RARELY SEEN AFTER THE INITIAL DOSE, ALTHOUGH IT HAS BEEN NOTED WHEN THE DOSE IS INCREASED.

5. System Design Considerations

One of the design problems which HT-ATTENDING must confront is the variation in approach which different groups have advocated for the management of hypertension. Three such approaches are discussed in [2, 3, 6]. Figure 1 outlines one approach, which is more fully described in [2].

These approaches differ in the recommended sequences in which different drugs are added in attempting to control of a patient's blood pressure. For instance, there is variation in the initial drug used, although in the United States a diuretic is usually considered the initial drug of choice. Next, some experts recommend a central alpha agonist, while others recommend a beta blocker, and so on.

Despite these differences, there are a number of strong threads of commonality that underlie all the approaches:

1. There is a recognition that clear-cut risks and benefits exist with certain drugs in certain patients.
2. There is an ordering of the different drugs (i.e. step 1 drugs, step 2 drugs, etc.) based on the nature and severity of their side-effects. The relative position of most drugs in this hierarchy is reasonably well agreed upon, although here again there is some variation.
3. There is an acknowledgement that certain combinations make little sense, such as using two different beta blockers or two different central alpha agonists at the same time.

All approaches to the management of hypertension reflect this underlying commonality. The variation in approach reflects a slightly different assessment of the risk tradeoffs involved. In other words, different relative weightings are given to the potential side effects of the various agents. In the face of this variation, HT-ATTENDING must preserve its flexibility. In particular:

1. It must know about the underlying "common threads" discussed above. This knowledge must be organized flexibly enough that the system can respond appropriately to any plan (good, marginal, or poor).
   a. It must be able to bring any specific risks and benefits to the physician's attention.
   b. It must recognize when, say, a step 4 drug is used where a step 2 or 3 drug might be more appropriate.
   c. It must comment appropriately when illogical combinations are proposed.

2. It must be able to accommodate variant approaches which are reasonable.

3. At the same time, the system is designed to state its "own" preferences when appropriate. These preferences [2], outlined in Figure 1,

Figure 1: An Outline of HT-ATTENDING's "Preferred" Approach to Hypertension Management
reflect those of the hypertension clinic where
the system is being developed. When these
preferences are included in the system's
critique, however, they are usually expressed
as alternatives for consideration, in a
low-key rather than a hard-sell fashion.

The development of a system which adapts its
dvice to an arbitrary plan, as outlined above,
has interesting computer science design
implications. In particular, the system must have
its knowledge organized in a more flexible, more
manipulable form than would be required were it
merely designed to advocate a single management
approach.

6. Simple, Practical System Augmentations

The heart of HT-ATTENDING is that part of the
system which analyzes the physician's plan and
produces an appropriate prose critique. An
attempt is made to keep this critique concise, to
the point, and pertinent.

At the same time, however, the physician might
like to know more details concerning certain
agents, modalities, or issues mentioned in the
critique. It is very easy to augment the basic
system to allow this. After the critique, the
physician is given the option of requesting:

1. on-line abstracts of a modest number of
   selected references,
2. short discussions (taken from [2]) of
   selected issues mentioned in the critique.

It is hoped that these computationally-simple
augmentations may significantly enhance the
practical utility of the system.

7. Summary

HT-ATTENDING can be thought of as an
"interactive paper" which tailors its content to a
proposed approach to hypertension management. A
physician could presumably get similar information
by reading several articles on the subject. A
system like HT-ATTENDING has the advantage that
the pertinent information is brought to the
physician's attention in a selective, focused
fashion, organized around his proposed approach to
a particular patient.

It is hoped that HT-ATTENDING may help
demonstrate the utility of Medical Plan-Analysis
as a modality for computer advice, and thereby
serve as a model for similar systems in other
areas of medical management.

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