Computerised protocols for laboratory investigation and their effect on use of medical time and resources

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Abstract

Aims: To devise a computerised management system protocol which not only proposes the laboratory investigations to be performed on each patient but also performs related clinical functions.

Methods: The system was designed by senior members of staff. The protocols defined all laboratory investigations including haematology, biochemistry, immunology and cross-matching, and included static and dynamic rules. Patients can be changed to different or additional protocols, as required; likewise proposed tests can be deleted or added. The software is written in MUMPS and runs on a 386 PC running MSM MUMPS under MSDOS.

Results: The number of clinical chemistry tests requested per patient per day fell by 9·5% ($p < 0.01$) for transplant recipients and by 28·8% ($p < 0.01$) for non-transplant recipients. The average time spent by junior medical staff requesting laboratory investigations and enquiring about results fell from 10 minutes per patient per day to 4·1 minutes ($p < 0.001$).

Conclusions: The introduction of this system in no way abrogates clinicians' responsibility for the management of patients, because all proposed investigations must be confirmed or modified by the authorising doctor. The system allows for the audit of requesting patterns and subsequent improvement in protocols by recording any alterations made to the proposed investigations. Significant benefits in terms of better use of house officer time and medical resources were also achieved.

House officers spend a great deal of their working hours performing routine but essential tasks which are secondary to their main function of looking after patients, such as writing request forms and obtaining and assessing results.

Clinicians use protocols to define diagnostic procedures and investigations in the management of patients in different circumstances. Such protocols are often informal, incomplete, and may be unwritten, and are usually drawn up by experienced clinicians but generally implemented by more junior staff. Deviations from protocols occur for several reasons: first the patient's clinical condition may change unexpectedly, requiring emergency investigation. Second, the protocol may be inadequate and may not deal with all aspects of the patient's condition. Changing situations, such as the introduction of new drugs, may render a protocol out of date. Often, however, deviations from protocols are due to inadequate communication by senior medical staff, lack of understanding by junior staff, and a concern that important tests should not be omitted.

Methods

PROTOCOLS

Investigation protocols were designed by senior members of the Liver Unit to be applied to all patients admitted to the Unit. The protocols define all laboratory investigations including haematology, biochemistry, immunology, microbiology and cross-matching, and contain both static rules (such as liver function tests to be performed for a patient for the first 14 days after transplantation) and dynamic rules (so that, for example, liver function tests will be requested on day 15 if the serum bilirubin on day 14 is greater than 50 umol/l). Static rules can be applied to all pathology disciplines, but the automatic application of dynamic rules is currently only possible for clinical chemistry and haematology in this hospital where the laboratory computers are directly linked to the system. Patient management falls broadly into seven basic investigation protocols and patients are allocated, on admission to the Unit, to one (or more) of these. Patients may be changed to different (or additional) protocols as required by their clinical condition.

During the day the results of investigations are received by the system, and at any time, but normally at about 1700 hours, the house officer reviews both the results and the investigations proposed for each patient for the following day. Proposed tests can be deleted and additional tests added. Request labels, designed in conjunction with the laboratories and phlebotomists, are generated automatically. Details printed include the patient's name, registration number, date of birth, diagnosis, ward and investigations required, together with the type of specimen tube to be used and whether the sample represents a biohazard. An additional label for attachment to the specimen tube is also generated. No additional writing or signature is required, because authorisation is conferred and recorded by the house officer's preview and possible amendment of the proposed tests. Audit of the system flows from its internal recording of tests proposed by protocols but deleted by the house

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Table 1   Effect of protocol application on clinical
chemistry investigations

	Before	After	% Change
Transplant recipients (excluding trial test)			
No of patients	32	16	
No of tests	8503	2835	
No of patient days	871	321	
Test per patient day	9·76	8·83	−9·5*
Non-transplant recipients			
No of patients	81	93	
No of tests	6332	4198	
No of patient days	758	706	
Test per patient day	8·35	5·95	−28·8*

* p < 0·01 (t-test)

officer, of tests manually added and of unsoli-
cited results received—that is, requests made
without using the system.

THE COMPUTER SYSTEM

The computer system and the generalised
software in which the investigation protocols
are expressed have been described in detail
elsewhere.[1][2] The software is written in
MUMPS and runs on a 386 PC running MSM
MUMPS under MSDOS linked to laboratory
computer systems and to the hospital PAS.

HOUSE OFFICER TIME

House officers were asked to fill in diaries for
three weeks before and three weeks after
implementation of the system, recording the
number of minutes spent writing request forms
and obtaining results and the times at which
these activities were undertaken.

Results

The investigation management system was
introduced on 1 January, 1991. The junior
house staff changed on 31 January. During the
three months of the evaluation period, 14% of
the patients admitted received liver trans-
plantations, 32% were admitted for investiga-
tion, 7% were admitted with fulminant hepatic
failure and 46% for other reasons. As a
comparison we studied a similar period of time
between October and December 1990 during
which the percentages of patients in each of
these categories were 15%, 35%, 8% and 42%,
respectively. The effects of protocol manage-
ment on levels of haematology investigation
were not evaluated because data for the com-
parative study period could not be obtained
from the laboratory's computer system.

EFFECT OF COMPUTERISED PROTOCOL MANAGEMENT ON PATHOLOGY REQUESTING

In the study period before the system was
introduced there were 32 liver transplant reci-
pients compared with 16 in the period after
implementation. Overall, the numbers of clin-
ical chemistry tests measured for each trans-
plant recipient were similar before and after the
system was introduced. However, coincident
with the introduction of the system a pro-
spective study comparing FK506 with cylo-
sporin was begun. The study generates extra
tests, and removal of these from the analysis
showed a 9·5% reduction in the number of
analyses requested per patient day after intro-
duction of the system (table 1). There was no
significant difference in inpatient stay or out-
come.

In non-transplant recipients there was a 28·8%
reduction in the number of tests requested per
patient per day. There was no significant
change in the duration of inpatient stay and
there were no significant differences in the
clinical diagnoses of the patients in the two
periods of study. The customary increase in
laboratory requesting immediately following
the introduction of new house officers was not
observed.

EFFECT OF COMPUTERISED PROTOCOL MANAGEMENT ON HOUSE OFFICER WORKING PRACTICES

The introduction of the protocol management
system resulted in a significant reduction in the
amount of time spent by house officers in
filling out request forms and label writing
(table 2) and in enquiring about specimens
and results.

Discussion

The preliminary results of this initial trial have
shown that this approach can be of substantial
benefit in reducing the amount of time spent
by house officers on secretarial matters, and
perhaps more importantly this has been asso-
ciated with a reduction in the amount of late
night work. Some saving in medical staff time
could be anticipated from experience in coun-
tries where non rulebased ward ordering sys-
tems provide streamlined requesting facilities
but such systems do not provide dynamic
investigation management which we have
found to relieve junior medical staff of time
consuming collating and listing activities.
Patients are investigated in a logical and
predefined way and investigation protocols
may be readily assessed and modified. There
has been an additional benefit in that the total
number of investigations requested has been
significantly reduced. However, no account is
taken of cost, and although the number of tests
requested has been reduced inappropriate but
cheap analyses might have decreased with
some increase in appropriate but more expen-
sive ones.

Audit is rightly achieving increasing impor-
tance and the Audit Commission has recently
highlighted the need for improvement in the
use of laboratory services.[3] Overuse of labor-

Table 2   Average daily time spent by house officers requesting laboratory tests and
enquiring about specimens and results

	Before	After
Average daily number of patients on unit	13	17
a) Requesting (form filling/label writing) Time spent (minutes):		
Between 8 am and 8 pm	51 (0–122)	27 (0–60)
Between 8 pm and 8 am	38 (0–110)	12 (0–60)
Total time spent (minutes)	89 (10–175)	39 (15–60)
Average time per patient (minutes)	6·8 (0·8–14·0)	2·3 (1·2–3·3)*
b) Specimen/result enquiries		
Total time spent (minutes)	41 (2–89)	30 (10–60)
Average time per patient (minutes)	3·2 (0·2–6·4)	1·8 (0·6–3·3)
Grand total (minutes)	130 (12–236)	69 (40–115)
Grand total per patient (minutes)	10·0 (0·9–18·2)	4·1 (2·4–6·3)*

Values given in parentheses are ranges
* p < 0·001 (Mann-Whitney test)

atory facilities has been attributed to a number of factors, not least the practice of defensive ordering by junior medical staff, possibly to appease senior colleagues,[4] and to allay fears of possible accusations of malpractice. Many strategies have been proposed to improve laboratory use. These include the design of problem orientated request forms,[5] the use of financial rewards for junior staff,[6] comprehensive feedback to senior staff of pathology requesting patterns and costs,[7] chart review with emphasis on its educational role[8][9] and the introduction of clinical guidelines and protocols for investigation.[10][11] Such strategies have not been uniformly successful. Attempts to alter the patterns of requesting must involve the expertise of the more senior staff, but this must directly modify the behaviour of those who are requesting the tests. Exclusion of junior staff from feedback on pathology requesting is unsuccessful.[7] Laboratory costs must be balanced against other measures of patient care. It is important that any intervention designed to modify requesting behaviour must be sustained or frequently reinforced to maintain the desired effect.[6][10] Ongoing participation of junior staff needs to be encouraged and can only be achieved if they perceive that there is an advantage, not only to their patients, but also to themselves.

Implementation of computer assisted protocol management has, by radically altering the interface between the requester and the laboratory, specifically addressed some problems encountered in rationalising the use of laboratory resources. The introduction of locally agreed requesting protocols addresses problems of medical and local pathology audit and has shifted the burden of protocol planning from junior to senior staff and the clerical load to the computer. At no level can the medical staff abrogate their responsibilities because it is their duty to ensure that appropriate tests are requested and the information gained acted on. Thus there is no threat to clinical freedom.

Further studies are in hand to quantify effects of refinements to investigation protocols and to examine changes in pathology testing in terms of volume and cost. The system is currently being extended to include outpatient clinics and drug prescribing.

It is clearly important that the system we have developed should be evaluated in other centres and in other disciplines. Nevertheless, it is felt that this initial trial has validated our approach and has shown that, in an albeit limited context, this approach works effectively, is associated with a reduction in laboratory investigations, reduces the time spent by junior staff on areas peripheral to their main role, and permits audit both within units and between units.

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