REVIEW

Pathology tests: is the time for demand management ripe at last?

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With the ever increasing demands for pathology testing within the National Health Service there is a need to manage the demand for these tests. This review discusses strategies for the demand management of requests made by clinicians in the disciplines of biochemistry, haematology, and microbiology. The various approaches that have been used to manage demand will be described, along with specific clinical strategies for demand management.

A recent report of The National Pathology Alliance Benchmarking Review indicated that nearly all laboratories in the UK continue to witness a rise of 5% to 10% each year in requests for laboratory tests.[1] In response to this increase in laboratory tests, hospitals in the National Health Service (NHS) are being urged to rationalise the number of laboratories and to create fewer, more modern laboratories to benefit from economies of scale.[2] Although rationalisation of laboratories is important for efficient management of resources, it is unlikely that the resources in the NHS will ever be able to keep up unless a serious attempt is made to manage demand for pathology tests.

Several studies have shown that between 25% and 40% of all tests sent to the laboratory are unnecessary, yet few laboratories in the UK have managed to reduce these unnecessary tests.[3–5]

Even where such reductions have been achieved, it has been difficult to sustain them. So, what is it that makes it difficult to manage demand? Several reasons have been suggested.[6] These include uncertainty of likely diagnosis (associated with junior and inexperienced doctors); lack of understanding of the basis, sensitivity, and specificity of the tests; and the desire for diagnostic completeness. Furthermore, recommendations of special interest groups, peer and commercial pressure, patient expectation, and more recently, fear of litigation have led to increased demand for laboratory tests. With all these barriers, it is not surprising that although attractive in concept demand management has failed to make appreciable inroads.

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Various strategies have been undertaken to manage demand. A recent systematic analysis has shown that the effects of such strategies are frequently short lived owing to changes in junior clinical staff, lack of interest of senior clinicians, and the redundancy of the guidelines.[6]

Hopeless as it may seem, it may now be possible to manage demand for laboratory tests. Three recent developments in the NHS might now provide important opportunities to introduce, implement, and above all sustain rational laboratory testing.

First, the increasing availability of bidirectional links between the laboratory and clinical areas is enabling clinicians to order tests and receive results using computers. Test ordering databases are currently available that incorporate decision support systems to prompt the clinician about the clinical need and the existence of previous or duplicate tests.[7] The introduction of electronic patient records will further facilitate this process (Sunrise Clinical Manager; iSOFT, Manchester, UK). Second, with the current emphasis on evidence based medicine, there is greater willingness to examine the evidence concerning clinical usefulness for many of the currently performed tests. Finally, greater recognition of the importance of multidisciplinary working and the development of care pathways is bringing about a closer working relationship between clinicians and laboratory staff. In turn, this will probably lead to a greater understanding of the usefulness and limitations of the laboratory tests. A recent survey of clinicians has shown that only a very few consider or are aware of test characteristics such as the sensitivity and specificity of tests.[8]

A major obstacle to successful implementation is "consumer resistance". In the UK, neither the clinician nor the patient directly pays for the laboratory tests. Thus, there is little incentive for clinicians to alter their current patterns for requesting laboratory tests. Marketing strategies have to be developed to "sell" the concept of demand management to clinicians (consumers). This will require paying attention to the product (identifying areas for demand management in consultation with clinicians), placement (bidirectional ward test ordering systems), price (clear cost/benefit analysis), and promotion (use of

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Abbreviations: APTT, activated partial thromboplastin time; A&E, accident and emergency; BCSH, British Committee for Standards in Haematology; CSU, catheter specimen of urine; ESR, erythrocyte sedimentation rate; FBC, full blood count; HSVE, herpes simplex virus encephalitis; NHS, National Health Service; NPT, near patient test; PCR, polymerase chain reaction; VTE, venous thromboembolism

advertising material that appeals to both senior and junior medical colleagues).[9]

In this review, we discuss the role of demand management of requests made by clinicians in the fields of biochemistry, haematology, and microbiology. The various strategies that have been used to manage demand are described in the clinical biochemistry section. The sections on haematology and microbiology pay greater attention to specific clinical strategies for demand management. Although our review does not deal with intralaboratory demand management, we recognise that managing intralaboratory demand by rationalising the number of tests performed on a request is an important element of overall demand management.

Similarly, there are opportunities also available for demand management in the disciplines of histopathology and immunology. The Royal College of Pathologists (UK) is currently looking at several areas of practice where histopathology is of limited or no clinical value. However, these will not be discussed in our review.

CLINICAL BIOCHEMISTRY

The number of unnecessary tests in the clinical biochemistry laboratory is reported to be legion, ranging from 26% to 98% of the total number of laboratory tests.[10 11]

Routine biochemistry

Nearly a third (32%) of requests for biochemistry investigations from accident and emergency (A&E) departments were considered unnecessary, with a negative correlation between the tests requested on each visit and the quality of care.[12] Another study that compared two similar intensive care departments found that one of them performed far fewer investigations without detriment to the patients.[13] In fact, unnecessary testing may result in a significant reduction in blood volume in these critically ill patients.[14] In another study, it was interesting to note that in the assessment of hospitalised psychiatric patients only 4% had important medical conditions uncovered by laboratory testing.[15] Similarly, routine urinalysis on admission to hospital has been reported to be of very small benefit to patient management.[16 17]

Serum electrolytes and blood gases have been shown to be the most frequently "over requested" tests. Indiscriminate yet widespread requests for such "high volume, low cost" tests have a great impact on laboratory resources. Furthermore, such a high frequency of testing has been shown to give rise to the detection of "biochemical abnormalities" in otherwise normal patients. Pursuit of such biochemical abnormalities gives rise to further tests and above all mental anguish to patients.

Similarly, ignorance of the indications for thyroid function tests and misinterpretation of the results may lead to further unnecessary investigations.[18]

Therapeutic drug monitoring, such as monitoring for theophylline and digoxin, has also been shown to suffer from unnecessary and incorrect usage.[19 20]

Near patient tests

Even point of care testing has not been exempt from misuse. For example, near patient testing of patients with diabetes has recently come under scrutiny. A recent study has shown that the NHS incurs huge costs for such tests. Interestingly, the authors observed that unnecessary near patient tests (NPTs) that do not make a positive contribution towards the management of the patient may in fact cause alarm to the patient.[21 22]

Suggestions for reducing unnecessary tests

So what can be done to try and reduce unnecessary laboratory testing in clinical biochemistry? Several different approaches have been tried out with a greater or lesser degree of success.

Reduction of test duplication by improved communication between the clinician and the laboratory—in particular, feedback to clinical staff about test usage and the use of league tables of biochemical laboratory costs and test requests—has been found to be useful in some studies. However, not all researchers have found substantial benefit in feedback techniques, particularly if they are negative.[23–30]

The use of rule based decision support systems for the requesting doctor has been successful in reducing unnecessary thyroid function tests. Greater involvement of the pathologist in deciding whether a test is necessary demonstrated that it is possible to reduce protein electrophoresis testing by 67%.[31 32]

The use of continuing medical education through training programmes has also been reported to reduce the need for unnecessary thyroid function tests. Other education based strategies have resulted in 38% reductions in common biochemical tests.[33–35]

The use of computer ordering request menus has been found to reduce clinician requisitioning. In one report, a computer software system called DECIDE was used to evaluate test performance and suitability. Similar systems report that 4–17% of laboratory tests are unnecessary.[36–40]

> "Greater involvement of the pathologist in deciding whether a test is necessary demonstrated that it is possible to reduce protein electrophoresis testing by 67%"

Careful scrutiny of requests by senior laboratory staff and avoiding test duplication has been reported in one study to reduce laboratory tests by nearly 20%. Verbal justification of tests may be required in some instances.[41 42]

Guidelines for test requesting have been used in various contexts.[43] However, there is no universal agreement about guidelines and to succeed they need to be locally agreed and kept up to date.[44–47] Thorough clinical assessment through medical history and physical examination has been shown to reduce the need for laboratory tests in preoperative patients.[48]

Redesigning of request forms into a problem orientated format may be an effective contribution by the laboratory, although this may be more appropriate to particular tests, such as thyroid function tests or therapeutic drug monitoring. Blank request forms may result in test misuse. In addition, modifying the range of tests offered by the laboratory may also influence clinicians' requesting behaviour.[4]

The use of financial incentives to reduce unnecessary testing has also been attempted but at least one study showed that rewarding clinicians for reducing tests may actually have led to increased testing.[49–52]

There are many other laboratory factors that may reduce test misuse, including the use of near patient testing, a convenient and efficient venepuncture service, and fast turnaround time of laboratory results.[53 54]

HAEMATOLOGY

Strategies for demand management in haematology are generally similar to those described for biochemistry. In this section, we discuss some specific issues pertaining to haematology.

Compared with other pathology disciplines, haematology has a relatively small repertoire.

There are a handful of low cost, high volume investigations including full blood count (FBC), erythrocyte sedimentation rate (ESR), simple coagulation screens (prothrombin time and activated partial thromboplastin time (APTT)), and in transfusion the red cell group and antibody screen, and the crossmatching of blood.

Haematinic assays (vitamin B12, folate, and ferritin) and haemoglobin genotyping using electrophoresis, high performance liquid chromatography, column chromatography, and

isoelectric focusing are more expensive and time consuming tests that are still requested in large numbers, depending on the local population and screening policy.

More specialised investigations include coagulation factor assays, thrombophilia screening, bone marrow morphology, immunology and cytogenetics, red cell enzyme assays, autoimmune serology, and immunoglobulin assays. All these tests tend to be expensive although economies of scale may be possible.

Near patient tests

NPT is useful for out of hours work in A&E departments for FBCs, where it can lead to substantial reductions in the need to send urgent specimens to the laboratory at all times.[55] Near patient coagulation tests have become popular in anticoagulant clinics and A&E departments,[56] where faster turnaround times afforded by NPTs may optimise the management of venous thromboembolism and chest pain.[57] Similarly, but to a lesser extent, haematology and oncology clinics are beginning to appreciate the advantages of NPTs.

Routine haematology

Automated FBCs are one of the most commonly requested of all laboratory tests. High user departments such as A&E departments and intensive care units should be encouraged to develop agreements with the laboratory on the clinical indications for testing and repeat monitoring of blood counts.[58–60]

Similarly, there is good scope for rational guidelines limiting the use of the ESR.

Coagulation

Routine coagulation screens are often requested inappropriately. Too many are done on healthy patients preoperatively, and not enough are requested and acted upon in the bleeding patient.[61 62] Guidelines can help here.[63] The National Institute for Clinical Excellence in the UK is reviewing the guidance and will be publishing its recommendations shortly.

There is a steady rise in the number of patients on oral anticoagulants who require regular monitoring with the prothrombin time. Managing this demand depends on developing an anticoagulant management plan for the patient group, which might be through centralised one stop clinics, community testing in general practitioner surgeries, peripatetic anticoagulant nurses, or patient self testing. In a randomised controlled trial, Poller *et al* compared the use of manual dosing with computer generated dosing.[64] They found that the quality of care was equivalent in both arms of the study and that the patients whose dose was regulated by using the computer were less frequently tested. This was because of improved quality of control in these patients. This is a good example of how a decision support system can lead not only to better patient management but also to fewer test requests.

The management of patients on heparin has been greatly simplified and improved with the widespread introduction of low molecular weight heparins, which have a much more predictable antithrombotic effect, and generally do not require laboratory monitoring. This has had the welcome effect of reducing the number of APTT requests in most laboratories while improving patients' anticoagulation.[65 66]

There has been an exponential rise in the number of D-dimer requests in recent years, with the accumulation of evidence that they have a useful and reliable role as a negative predictor for venous thromboembolism (VTE).[67 68] Although this may lead to increasing demand for pathology testing, it probably reduces demand for more expensive clinical imaging.

Thrombophilia screening is another rapidly expanding area in haematology. There is increasing public awareness of the risks of VTE, especially in association with long haul flights and oral contraceptives. The British Committee for Standards in Haematology (BCSH) has recently published useful guidelines on who should be tested and which tests are appropriate in particular risk groups.[69 70]

Haemoglobinopathy testing

Haemoglobin genotyping is performed both for diagnostic purposes in patients with symptoms suggestive of haemoglobinopathy, and when assessing genetic risk in potential carriers. Screening of neonates, pregnant women, and their partners to detect haemoglobinopathies has been recommended to enable early intervention and counselling. As with any large scale screening programmes, centralised automated laboratory testing may be both cost effective and beneficial in managing demand.

Pre-operative screening in healthy adults of non-white origin for sickle cell trait is widely practised in the UK. A BCSH guideline from 1988 recommends that there is very little evidence to support it, certainly in patients in the ASA 1 (American Association of Anaesthetists score) category having day surgery.[71 72]

Haematinics

Screening for iron deficiency is a useful public health measure in groups such as pregnant women and young children. The most definitive measures of iron status are the plasma ferritin or soluble transferrin receptor assay, although both are relatively expensive tests. Red cell distribution width, available as an automated red cell parameter, and red cell zinc protoporphyrin can be used as cheaper screening tests.[73]

Vitamin B12 and folate values are among the most repeated and inappropriately requested tests (personal experience). It may be necessary to develop guidelines for the appropriate use of these tests.

Bone marrow tests, immunohaematology, and cytogenetics

At the outset managing demand for bone marrow examination appears relatively easy. Haematologists usually perform the sampling and report the findings, and thus can easily assess the appropriateness of the test. Interestingly, however, the National Pathology Alliance Benchmarking review found that, irrespective of the size and type of the hospital, there was a wide variation in the number of bone marrow examinations performed.[1] Thus, it would appear that there is a wide variation in the indications for bone marrow examination even among haematologists!

Trephine biopsy is increasingly carried out in addition to an aspirate, and is indicated when malignancy (either haematological or secondary), fibrosis, or hypoplasia is suspected. Immunophenotyping and cytogenetic studies on bone marrow and peripheral blood are useful mainly in haematological malignancies. These tests are relatively expensive and the development of guidelines may be necessary, especially in the light of clinical trends for more intensive chemotherapeutic interventions, longer periods of bone marrow suppression, and increasing needs for haematological monitoring.

Blood transfusion

Some of the best practice in demand management can be achieved in the discipline of blood transfusion. The technology of compatibility testing has been improved with the advent of rapid and sensitive grouping and antibody screening techniques. This has led to a reduction in the need for blood to be crossmatched for many elective operations. The implementation of maximum blood ordering schedules can be highly effective in managing demand.[74–77]

Major concerns remain about the availability of blood for transfusion and its cost. Donor numbers are sensitive to the increased perception of risk of blood transfusion, as well as potential recipients. The use of cell salvage during orthopaedic surgery and acute normovolemic haemodilution perioperatively reduces the demand for donor blood, and may prove cost effective. Increased demand for autologous donation in certain patient groups also lessens the use of donor blood, but is unlikely to save on costs.[78–80]

More conservative use of blood transfusion can be clinically beneficial as well as cost effective in obstetric, orthopaedic, and cancer patients, and those with chronic anaemia, and can be encouraged with the implementation of audited local guidelines.[81 82]

"The implementation of maximum blood ordering schedules can be highly effective in managing demand"

Similarly, there is evidence that a restrictive strategy for red cell transfusion is as effective as liberal transfusion in critically ill patients.[83]

It is conceivable that the implementation of rule based electronic ordering systems will further facilitate the appropriate usage of blood products.

The use of iron and recombinant erythropoietin in postoperative anaemia instead of transfusion has been shown to be effective, although erythropoietin is expensive.[84] Erythropoietin may also spare the use of blood in patients with myelodysplasia and anaemia associated with cancer chemotherapy.[85 86]

Careful consideration of the threshold platelet count for triggering prophylactic platelet transfusion may conserve platelet usage.[87]

MICROBIOLOGY

Microbiology requests offer the greatest potential for demand management. Review of the literature suggests that some of the greatest gains of demand management have been in the field of microbiology. In this section, we discuss some key areas of practice where demand for tests can be managed successfully.

Urinary tract infection

It is now widely accepted that currently available urine "dipsticks", which detect nitrites and leucocyte esterase, have high negative predictive value (90–95%) and can be used to exclude urinary tract infection in most patients.[88] Similarly, catheter specimens of urine (CSUs) should be tested only in the presence of symptoms. Routine testing of CSUs is wasteful and may lead to unnecessary antibiotic treatment.[89]

Faeces microbiology

The microbiological examination of faeces specimens is highly labour intensive. Rationalising laboratory testing of these specimens can result in substantial savings in laboratory resources. In particular, several recent studies have shown that laboratories need to perform only a very limited range of tests in patients with hospital acquired diarrhoea. Most patients with hospital acquired diarrhoea will require tests for the detection of *Clostridium difficile* toxin only to diagnose *C difficile* associated diarrhoea. Good communications between the medical, nursing, infection control, and laboratory staff is vital for safe and successful implementation of this strategy.[90 91]

Indiscriminate requests for the examination of faeces for ova, cysts, and parasites are a great nuisance to microbiology laboratories.[92] Furthermore, laboratories can rationalise the range of pathogens that they test for routinely. This will depend on the prevalence of the infections in the community or indeed the ability of the tests to detect the pathogens with accuracy. For example, routine examination for enteropathogenic *Escherichia coli* is acknowledged to be unnecessary in the UK because of its extremely low prevalence and the inability of the routine serological tests to detect these organisms accurately.[93]

Blood cultures

Blood cultures are the most important routine specimens tested in microbiology laboratories. Blood cultures collected by junior medical staff are more likely to be contaminated than those taken by trained phlebotomists.[94] Because A&E departments often account for a substantial proportion of blood cultures tested, and most of the contaminants, a rational approach in the A&E department will result in a substantial reduction in both the number of blood cultures and contaminants. Kelly estimates that only 1.6% of all blood cultures taken in the A&E department alter management.[95]

At a recent workshop on the management of community acquired pneumonia, the Association of Medical Microbiologists (UK) concluded that blood cultures are only necessary in patients admitted to intensive care units or those who fail to respond to empirical treatment.[96]

"Kelly estimates that only 1.6% of all blood cultures taken in the A&E department alter management"

Requests for the polymerase chain reaction

The development of diagnostic tests using polymerase chain reaction (PCR) based technology is probably the most important advance in laboratory medicine. PCR based tests have now become available for traditionally "difficult to diagnose" infections, such as herpes simplex virus encephalitis (HSVE), tuberculosis, and chlamydial infections. Because the technology is relatively new, PCR based tests are expensive. Therefore, it is important to make rational use of these tests. For example, recent studies have shown that in immunocompetent patients, PCR tests for HSVE and viral meningitis are highly unlikely to be positive if the cerebrospinal fluid does not have an excess of leucocytes (>4 cells/mm^3) or protein (>600 mg/litre).[97–99]

Take home messages

- There is great need to manage demand for pathology testing so that the most appropriate tests for the clinical management of the patient are requested with minimal wastage of resources
- The availability of information technology and greater acceptability of evidence based medicine will probably be the most important factors in making demand management a reality
- The availability of electronic patient records and laboratory information software, which incorporate decision support systems, will hopefully guide clinicians to request both rational and appropriate tests in the context of individual patients and their clinical features

CONCLUSIONS

In conclusion, several approaches can be harnessed today to make requests for pathology tests more rational and cost effective. The availability of information technology and greater acceptability of evidence based medicine are likely to be the catalysts for making demand management a reality. In practice, clinicians and pathologists need to work closely to review in a critical manner the need for various investigations from the point of view of clinical management, cost effectiveness, and the availability of alternative means of diagnosis. The use of currently available electronic patient records and laboratory information software, which incorporate decision support systems, can guide clinicians to request both rational and appropriate tests in the context of individual patients and their clinical features. Ultimately, demand management is about ordering the most appropriate tests that will facilitate good clinical management of the patient with minimal wastage of resources.

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