Unnecessary repeat requesting of tests: an audit in a government hospital immunology laboratory

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REVIEW

Unnecessary repeat requesting of tests: an audit in a government hospital immunology laboratory

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Unnecessary repeat requesting of tests can make up a large proportion of a laboratory's workload. This audit set out to establish the size of this problem and to identify the circumstances under which these repeat requests were made in a government tertiary hospital immunology laboratory. The numbers of tests for immunoglobulin measurement, common autoantibodies, and tumour markers that were repeated over a 12 month period were analysed by interrogating the Delphic laboratory computer system using a management information system for raw data enquiry protocol. Repeat requests within 12 weeks of a previous request made up 16.78% of the total workload. The total cost of the tests was estimated at US$ 132 151. The waste of technician time and reagents as a result of unnecessary repeat testing is excessive. Many of these tests might be eliminated with the use of interventions such as computerised reminders.

The utilisation of laboratory services has increased during the past several decades in many health care jurisdictions around the world.[1–3] Studies have found up to a 17 fold variation in the number of tests that physicians order.[4 5] In our immunology laboratory, the total number of tests performed annually increased by 63% between 1995 and 2003.

The appropriate use of laboratory tests is necessary for optimal patient care. Increased laboratory use is appropriate if it allows accurate diagnoses to be made, ideal treatment to be identified and monitored, accurate prognoses to be established, and patients' hospital stays to be shortened. Physician ordering practices have been analysed extensively,[6–9] and inappropriate test ordering found to be a primary reason for increased laboratory use.[10–16] Over ordering may be the result of inexperience or lack of knowledge about the appropriate use of tests,[17 18] failure to check previous results, test ordering routines that are difficult to change, or fear of errors of omission and litigation. Moreover, patients actively ask for tests and often attach greater value to test results than is justified.[19 20]

> ''The appropriate use of laboratory tests is necessary for optimal patient care.''

Performing unnecessary tests may have adverse effects—for example, unnecessary exposure to toxic treatments or false positive results that may induce fear and anxiety in patients,[21 22] or may result in a cascade of further unnecessary testing.

Laboratory tests cost the health care system large amounts of money,[23–26] and their inappropriate use may be associated with other inefficiencies in health care delivery. Identifying inadequacies in the use of laboratory services may disclose problems in other areas of health care.

As with other areas of physician behaviour,[27 28] improving the use of laboratory tests has been difficult.[29] Repeat testing is one component of laboratory utilisation that could be modified.[30 31] When a previous result is not available or the ordering physician is unaware that the test was performed previously,[32] information technology can present previous test results[33] or give the probability that a test will be abnormal.[34]

One change with great potential to affect physician behaviour is computerised physician order entry.[35–37] Alerts can be issued automatically at the time of test requesting if that test was requested recently. However, the degree to which alerts have affected physician behaviour has been variable.[38]

Many attempts have been made to change test ordering performance and bring it into line with existing guidelines on optimal testing. Results have been mixed but showed that successful strategies require a well balanced combination of interventions.[27 39–42]

Many serum rheumatological tests have become available relatively recently. As a result, some physicians are not fully aware of the indications, sensitivity, specificity, cost, and clinical usefulness of these tests. Several studies[43–46] have suggested that overuse of common serum rheumatological tests—including antinuclear antibody (ANA), rheumatoid factor (RF), and many other autoantibody tests—leads to unnecessary referrals and further laboratory investigations. Failure to use these tests in a knowledgeable and thoughtful manner can result in diagnostic confusion and increased costs.[47]

Tumour markers are widely used in the diagnosis and management of cancer. Tumour

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Abbreviations: ADNA, anti-double stranded DNA antibodies; AENA, anti-extractable nuclear antigen antibodies; AFP, α fetoprotein; AGPC, anti-gastric parietal cell antibodies; AMA, antimitochondrial antibodies; ANA, antineutrophil antibodies; ASM, anti-smooth muscle antibodies; CEA, carcinoembryonic antigen; PSA, prostate specific antigen; RF, rheumatoid factor

Table 1 Test unit costs, repeat intervals, and turnaround times

Test	TAT (days)	Unit cost*	Repeat interval	References for justification of repeat interval
ANA	3	21	4 weeks	44–46
AENA	4	13	4 weeks	44–46
ADNA	6	11	6 weeks to 6 months	6–12 weekly for active 6–12 monthly for inactive[46 50]
RF	3	4	4 weeks	Except in Sjögren's syndrome[44–46 51 52]
AMA	8	9	4 weeks	53–60
ASM	8	9	4 weeks	53–60
AGPC	8	9	4 weeks	61, 62
IgG, IgA, IgM	3	7	4 weeks	63, 64
AFP	3	6.5	12 weeks	65–69
CEA	3	6.5	12 weeks	65, 67, 70–77
CA15.3	3	7.5	12 weeks	67, 70, 78
PSA	4	7.5	12 weeks	65, 67, 79

*In US$.
ADNA, anti-double stranded DNA antibodies; AENA, anti-extractable nuclear antigen antibodies; AFP, α fetoprotein; AGPC, anti-gastric parietal cell antibodies; AMA, anti-mitochondrial antibodies; ANA, antinuclear antibodies; ASM, anti-smooth muscle antibodies; CEA, carcinoembryonic antigen; PSA, prostate specific antigen; RF, rheumatoid factor; TAT, turn around time.

markers have five potential uses in patient care: screening, diagnosis, establishing prognosis, monitoring treatment, and detecting relapse. The value of a marker in a particular malignancy also depends on the effectiveness of the treatment available. Tumour markers have been used to screen for occult cancer but have proved to be valuable only in selected cancers. An extreme increase in a marker often indicates a poor prognosis, and in some malignancies can indicate the need for more aggressive treatment. Tumour markers have their greatest value when used to monitor treatment in patients with widespread cancer. Nearly all markers show some correlation with the clinical course of disease, with marker increases at all stages declining to normal after a curative intervention.

> ''One change with great potential to affect physician behaviour is computerised physician order entry''

Unnecessary repeat requesting of tests can make up a large proportion of a laboratory's workload. This audit set out to establish the size of this problem in a government tertiary hospital immunology laboratory. This setting has not been studied previously and is informative because most immunology tests are slow to change, so that repeat testing within a short time serves no useful clinical purpose. We also tried to identify the circumstances under which these repeat requests were made because this information might suggest what action could be taken to reduce the rate of such requests.

METHODS

Setting

The clinical immunology laboratory, in the department of pathology, Queen Mary Hospital is a tertiary immunology laboratory operating under the Hospital Authority of Hong Kong. Although it primarily serves the Hong Kong West cluster with a population of half a million people, approximately 20% of requests are from other hospital authority hospitals. The study samples included all the laboratory requests received from all sources during a 12 month period from October 2001 to September 2002.

Test selection and definitions

We analysed the use of eight tests commonly requested by rheumatologists, the results of which are unlikely to change greatly over short time periods, namely: IgG, IgA, and IgM values; ANA; antimitochondria antibodies (AMA); anti-gastric parietal cell antibodies (AGPC); anti-smooth muscle antibodies (ASM); anti-double stranded DNA antibodies (ADNA); anti-extractable nuclear antigen antibodies (AENA); and RF. Immunoglobulin concentrations ordered for the diagnosis or monitoring of myeloma were excluded. We also analysed the following tumour marker tests, which may be more variable over time and are useful in disease monitoring: α fetoprotein (AFP), carcinoembryonic antigen (CEA), CA15.3, and prostate specific antigen (PSA). All these tests are either frequently requested, labour intensive, or high cost. AFP ordered for the monitoring of hepatocarcinoma was excluded. We analysed requesting patterns over a 12 month period, identifying tests that were repeated within one day, one week, one month, and three months of a previous request by interrogating the Delphic laboratory computer system using a management information system for raw data enquiry protocol.

A literature review was performed to identify published guidelines for performing each test, and test specific time intervals within which a repeat test was unlikely to show clinical change were developed (table 1). The recommended

Table 2 Requests for common immunological tests over a 12 month period

	Weeks between requests									No. of annual requests
	Same day	<1	>1–2	>2–4	>4–8	>8–12	>12–24	>24–48	Total	
ANA	32	77	54	129	193	161	310	136	1092	6161
AENA	15	58	29	48	73	48	106	63	440	4742
ADNA	14	107	263	644	967	667	1016	151	3829	6150
RF	23	37	28	68	85	67	116	65	489	3843
AMA	1	9	7	20	29	36	101	30	233	1427
ASM	1	12	9	20	32	37	96	37	244	1312
AGPC	1	4	3	0	3	1	2	1	15	501
IgG, IgA, IgM	39	251	271	603	699	339	519	168	2889	7059

ADNA, anti-double stranded DNA antibodies; AENA, anti-extractable nuclear antigen antibodies; AGPC, anti-gastric parietal cell antibodies; AMA, anti-mitochondrial antibodies; ANA, antinuclear antibodies; ASM, anti-smooth muscle antibodies; RF, rheumatoid factor.

Table 3 Percentage of all repeated requests within specified time frame for common immunological tests over a 12 month period

	Same day	1 week	4 weeks	12 weeks	26 weeks	52 weeks	Total*	No. of annual requests
ANA	2.9	10	26.7	59.2	87.6	100	1092 (17.7)	6161
AENA	3.4	16.6	34.1	61.6	85.78	100	440 (9.3)	4742
ADNA	0.4	3.2	26.9	69.5	90.1	100	3829 (62.3)	6150
RF	4.7	12.3	31.9	63.0	86.7	100	489 (12.7)	3843
AMA	0.4	4.3	15.9	43.8	87.1	100	233 (16.3)	1427
ASM	0.4	5.3	17.2	45.5	84.8	100	244 (18.6)	1312
AGPC	0.6	33.3	53.3	80.0	93.3	100	15 (3)	501
IgG, IgA, IgM	1.3	10.0	40.3	76.2	94.2	100	2889 (40.9)	7059

ADNA, anti-double stranded DNA antibodies; AENA, anti-extractable nuclear antigen antibodies; AGPC, anti-gastric parietal cell antibodies; AMA, anti-mitochondrial antibodies; ANA, antinuclear antibodies; ASM, anti-smooth muscle antibodies; RF, rheumatoid factor.
*Percentage of annual requests in parenthesis.

frequencies of checking tumour markers used in our study in different cancers are based on practice guideline sources, including those of the National Academy of Clinical Biochemistry; European Group on Tumour Markers; Standards, Options and Recommendations Project; Scottish Intercollegiate Guideline Network; and American Joint Committee on Cancer. Table 1 also shows the turnaround times for our laboratory.

An unnecessary repeat test was defined as one that followed a preceding test of the same type before the test specific time interval had elapsed, and a redundant test as an early repeat test that might be eliminated with little loss of information.

ANALYSIS

For each test, the registered patient's database records were used to perform a list screen to identify tests that might have been performed earlier than the test specific interval. The patient's records included basic demographic information for each patient, either in the hospital or outpatient setting.

To estimate the proportion of early repeats that was redundant for a given test, the proportion of tests that met the early repeat criteria was determined.

To estimate the potential cost savings if all these redundant tests were eliminated, the number of tests was multiplied by the 2002 costs/test, which were calculated as follows:

$$\text{Cost/test} = \left\{\frac{\text{Staff salaries/year}^*}{\text{Total WLU/year}}\right\} \times \text{WLU/test} + \text{Reagent cost/test}$$

*US$ 0.85/WLU (workload unit).

RESULTS

In total, 9231 requests for immunoglobulin measurement, RF, ANA, AMA, ASM, AGPC, ADNA, and AENA were repeated during the year, making up 29.6% of the total number of these tests performed (table 2). Repeat requests within 12 weeks of a previous request made up 14.6% of the total number of tests. For individual tests, the corresponding proportions were: autoantibody screens, 12.9%; RF, 8.0%; and immunoglobulins, 31.2% (table 3). In total, 19 102 repeat requests were made for tumour markers (table 4). Repeat requests made within 12 weeks of a previous request accounted for 21.2% of the total number of requests for these tests. For individual tumour marker tests, the corresponding proportions were: AFP, 21.4%; CEA, 13.4%; CA15.3, 29.6%; and PSA, 20.5% (table 5).

The total cost of tests repeated within 12 weeks of a previous test was estimated at US$ 132 151.

Shorter time periods were also analysed. Repeat autoantibody tests are not indicated within a four week period,[44–46] yet 5.3% of autoantibody screens and 4.1% of RF tests were repeated within this time. The total cost of tests repeated within four weeks of a previous test was estimated at US$ 29 527. Tests repeated within a two week time period accounted for 3.2% of the total workload for the year.

Possible reasons for repeat testing were sought within the data collected. Because more than 95% of the requests are from Queen Mary Hospital or hospital authority hospitals, tests performed in general practice and then repeated on referral to hospital are minimal. In addition, only 5–10% of unnecessary repeats were because of a change of consultant or location within the hospital. More than 90% of all repeated tests were performed by the same consultant team in the same location. Clearly, hospital consultants and their teams should be the target of any intervention to change this requesting behaviour. Feedback of individual test use data to consultants has been shown to reduce overall request frequency for haematology and clinical chemistry tests.[10 48] Whether this results in an improvement in clinical care has been contested,[49] but with the tests we have analysed there is no doubt that frequent repeats are unnecessary.

DISCUSSION

Pathologists are required to identify areas of potential improvement in laboratory operation, noting tests that are

Table 4 Requests for tumour markers over a 12 month period

	Weeks between requests									No. of annual requests
	Same day	<1	>1–2	>2–4	>4–8	>8–12	>12–24	>24–48	Total	
AFP	66	473	648	1159	1430	1377	3096	1968	10217	24072
CEA (colon cancer)	11	90	85	251	554	727	1590	500	3808	10875
CEA (breast cancer)	6	9	25	58	91	282	654	161	1286	5438
CA15.3	2	27	67	329	457	475	912	290	2559	4582
PSA	9	26	35	150	266	179	400	167	1232	3244

AFP, α fetoprotein; CEA, carcinoembryonic antigen; PSA, prostate specific antigen.

Table 5 Percentage of all repeated requests within specified time frame for tumour markers over a 12 month period

	Same day	1 week	4 weeks	12 weeks	26 weeks	52 weeks	Total*	No. of annual requests
AFP	0.6	5.3	23.0	50.4	80.8	100	10217 (42.4)	24072
CEA (colon cancer)	0.3	2.7	11.5	45.1	86.9	100	3808 (35.0)	10875
CEA (breast cancer)	0.5	1.2	7.6	36.6	87.5	100	1286 (23.6)	5438
CA15.3	0.1	1.1	16.6	53.0	88.7	100	2559 (55.8)	4582
PSA	0.7	2.8	17.9	24.0	86.4	100	1232 (38.0)	3244

AFP, α fetoprotein; CEA, carcinoembryonic antigen; PSA, prostate specific antigen.
*Percentage of annual request in parenthesis.

high volume, expensive, difficult to perform, or of questionable medical benefit. As health carers strive to reduce the cost of an episode of care, the laboratory may, ironically, incur additional costs by providing testing that contributes to earlier diagnosis and better disease management, although any consequent decrease in the length of stay in hospital will of course be cost effective. Laboratory staff must work with physicians and the institution to design processes that reduce cost through decreased use and improved decision making, and by the selection of clinically relevant, cost effective technologies and testing protocols. To evaluate new methods and equipment, laboratory expenses must be refined to include workload recording of individual tests and cost accounting of supplies, equipment, facilities, and reagents.

Guidelines are urgently needed to assist test ordering. Inappropriate tests are costly, generate more inappropriate tests, and affect patient care. Ultimately, it is the pathologist's job to help clinicians to order the right tests, at the right time, in the right order.

Tests that are repeated too early to provide useful information represent only a small proportion of those that are unnecessary or of marginal yield. However, they form a group that is relatively easy to target. In the study of Bates *et al*,[80] 8.6% of a defined group of commonly performed chemistry tests appeared to be redundant.

Table 6 shows some possible reasons for unnecessary repeat testing. Test duplication may occur simply because the requesting clinician is not aware that the test has already been performed. This should not have been a major justification for test repeats in our study, in which all tests had short turnaround times, of three to eight days (table 1). Where no result is immediately available a new test is ordered. Computerised physician ward ordering systems have been implemented in a variety of sites,[35–37] and have been found to improve efficiency of care.[37] Such behaviour might be modified by an interactive generic clinical request system that gives details of tests already ordered, and may also block the re-requesting of selected tests within a specified time frame. Computerised reminders, delivered to the ordering physician at the time a test is ordered, hold great potential for reducing the number of redundant tests.[35] To be most effective, these reminders should be delivered in situations in which there is a high likelihood that they will be followed.

Table 6 Possible reasons for repeat testing

Not aware that the test has already been performed
Poor understanding of half lives of tumour markers
Lack of appreciation of the value of repeated testing of autoantibodies
Overemphasis on surveillance
Inexperience or lack of knowledge about the appropriate use of tests
Failure to check previous results
Test ordering routines that are difficult to change
Fear of errors of omission and litigation
Patients actively ask for tests

Our study was performed in part to prepare for the implementation of alerts about potentially redundant tests in our hospital.

> ''Ultimately, it is the pathologist's job to help clinicians to order the right tests, at the right time, in the right order''

However, even computerised alerts will be ignored if clinicians do not accept the recommendation, so our results also have implications for physician education. Some of the redundant tests probably resulted from a poor understanding of the half lives of tumour markers or a lack of appreciation of the value of repeated testing of autoantibodies. Others may have been caused by an overemphasis on surveillance. All of these issues may be addressed through education, and physicians in clinical laboratories should become more involved in bringing them to medical schools and residency programmes, and to practising physicians.

Tumour markers and autoantibody tests should be readily addressable with computerised reminders at the time of ordering, unless computerised ordering systems are bypassed in obtaining these tests. It may be appropriate to repeat certain tests more frequently in lieu of rejected requests—for example, to guide chemotherapy of multiple myeloma using β2 microglobulin values rather than immunoglobulin and/or paraprotein values.

It is complicated to assess the economic impact of the elimination of tests identified as redundant. Assuming that a system could prevent all such redundant tests from being performed, and assuming no adverse impact on patient care, total costs in our laboratory could be trimmed by about US$ 132 262.5/year. These savings could be used to employ additional staff who could contribute to the performance of income generating activities, such as clinical trials. It is only by reducing laboratory costs and increasing income that resources can be freed for the development of new ''cutting edge'' services.

Our study was performed at only one large university hospital laboratory, so that it may not be possible to generalise to other settings. A randomised trial is required to determine how many of these tests can actually be eliminated. Our projections were based on a small sample of the performed tests that may not have been representative of the entire range of tests. Another limitation is that clinical changes may have occurred that were not documented in the medical record. The tests that were analysed are those that are frequently used and for which published guidelines or recommendations exist. The usefulness of repeating other tests is an area for further investigation. Finally, even for the tests included in our study, more stringent intervals may make sense. Our criteria for defining an early repeat were usually more generous than those published in the literature. For example, most autoantibody tests not used in disease activity monitoring are never justified for repeat when positive, but may be repeated when negative.[50–62] We have

used an interval of four weeks for these tests, whether positive or negative, based on the half life of IgG (23 days).

> ''Combinations of practice guidelines, modifications to the laboratory requisition form, and funding policy changes were associated with significant decreases in the use of several tests''

Interventions to improve laboratory utilisation include feedback, physician education, laboratory requisition form changes, policies concerning laboratory test ordering, and financial incentives.[81] Studies have concluded that educational interventions have mixed effects on laboratory test use.[29 82–84] Significant decreases in test rates were seen when laboratory requisition forms were modified to contain fewer test choices,[85] presented tests in physiologically sensible groups,[86 87] or required ordering physicians to justify the need for the test.[88] Some studies have shown that policies that prohibit particular tests in particular situations[83] or limit the allowable total number of investigations[89] are effective in decreasing use. However, their effect decays with time if the intervention programme is not continued.[90] Combinations of practice guidelines, modifications to the laboratory requisition form, and funding policy changes were associated with significant decreases in the use of several tests. The effects of these interventions were persistent and avoided a large number of tests, resulting in decreased costs.[91]

In our audit, there was no attempt to determine whether the tests were ordered appropriately. Some of the repeated tests may have been requested to confirm a previous abnormal result, but this too is a practice that we would not encourage unless the results truly conflict with the clinical findings. In such cases, the physician should consult the laboratory directly, in response to which senior immunologists should maintain close involvement with the re-testing procedure. Physicians should become familiar with all the validation processes in place for ensuring accuracy of reported test results, and laboratory scientists must be able to provide convincing evidence that the laboratory's results are trustworthy.

A population based assessment is optimal for the accurate measurement of repeat laboratory testing. This allows laboratory use to be studied for everyone within a geographical area, rather than within a particular hospital or health services organisation. A population based analysis allows laboratory use to be followed even when patients transfer between different sectors of the healthcare system, such as from the community to the hospital. Finally, a population based analysis produces unbiased utilisation rates because a true denominator (that is, all the people in a particular area) rather than a ''pseudodenominator'' (all the people who had a laboratory test) is used. This is necessary for a meaningful comparison between repeat laboratory testing and the utilisation of other health services. Generic clinical request systems have the potential to help clinicians screen for inappropriate, ineffective, potentially dangerous, or unnecessary tests.

Take home messages

- We carried out an audit to assess the extent of unnecessary repeat testing and to identify the circumstances under which repeat requests were made in a government tertiary hospital immunology laboratory
- Repeat requests for immunoglobulin measurement, common autoantibodies, and tumour markers within 12 weeks of a previous request made up 16.78% of the total workload, with an estimated cost of US$ 132 151
- This excessive waste of technician time and reagents might be reduced by the use of interventions such as computerised reminders

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