

Feedback and reminders for primary care test requests.

The original publication of this article was published in

The Lancet 2006;367(9527):1990-6 and

is available from <http://www.thelancet.com/>

The effect of enhanced feedback and brief educational reminder messages on laboratory test requesting in primary care: A cluster randomised trial (ISRCTN06490422).

Authors:

Ruth E Thomas, PhD

Research Fellow

Health Services Research Unit

University of Aberdeen

Aberdeen, UK.

Bernard Lewis Croal, MD

Consultant/Senior Lecturer

Department of Clinical Biochemistry

NHS Grampian

Aberdeen, UK

Craig Ramsay, PhD

Senior Statistician

Health Services Research Unit

University of Aberdeen

Aberdeen, UK.

Feedback and reminders for primary care test requests.

Martin Eccles, MD

Professor of Clinical Effectiveness and The William Leech Professor of Primary Care Research

Centre for Health Services Research, School of Population and Health Sciences

University of Newcastle upon Tyne

Newcastle upon Tyne, UK

Jeremy Grimshaw, PHD

Director,

Clinical Epidemiology Program,

Ottawa Health Research Institute,

And

Full Professor

Department of Medicine

University of Ottawa

Ottawa, Canada

Corresponding author:

Bernard Lewis Croal

Consultant/Senior Lecturer

Department of Clinical Biochemistry

NHS Grampian

Polwarth Building

Foresterhill

Aberdeen,

UK

Feedback and reminders for primary care test requests.

Email: bernie.croal@nhs.net

Fax: +44 (0) 1224 558841

Tel: +44 (0) 1224 552507

Name of Departments the work should be attributed to:

Health Services Research Unit, University of Aberdeen, Aberdeen

Department of Clinical Biochemistry, NHS Grampian

Word count excluding summary, acknowledgements, references and tables: 3172

Summary word count: 258

Number of tables: 4

Number of figures: 1

Feedback and reminders for primary care test requests.

Summary

Background:

Laboratory services play an important role in screening, diagnosing and managing patients within primary care. Use of laboratory tests is increasing and evidence suggests that overuse is a feature of this increase. Our aim was to assess the effect of two interventions on the number of laboratory tests requested by primary care physicians.

Methods:

The study was a cluster randomised controlled trial using a 2x2 factorial design involving 85 primary care practices, (370 general practitioners) who request all laboratory tests from one regional centre. The interventions were: quarterly feedback of practice requesting rates for nine laboratory tests, enhanced with educational messages; brief educational reminder messages added to the test result reports for nine laboratory tests. The primary outcome was the number of targeted tests requested by primary care practices during the 12 months of the intervention.

Findings:

Practices that received either or both the enhanced feedback and the reminder messages were significantly less likely than the control group to request the targeted tests in total. (Main effects analyses: enhanced feedback, odds ratio 0.87, 95% CI 0.81 to 0.94; reminder messages, odds ratio 0.89, 95% CI 0.83 to 0.93). The effect of the interventions varied across the targeted tests individually, although the general pattern showed a reduction in the number of tests requested for both interventions. Neither intervention was consistently better than the other.

Interpretation:

Feedback and reminders for primary care test requests.

Enhanced feedback of requesting rates and brief educational reminder messages, alone and in combination are effective strategies for reducing test requesting in primary care. Both strategies are feasible within most laboratory settings.

Keywords

Randomised controlled trial, reminder systems, audit and feedback, primary care, laboratory medicine, test requests

Feedback and reminders for primary care test requests.

Introduction

Laboratory services play an important role in screening, diagnosing and managing patients within primary care. Use of laboratory tests has increased substantially in recent years(1, 2) and a survey(3) of United Kingdom (UK) laboratories showed an 83% increase in primary care test requesting between 2000 and 2004.

Potentially there are many reasons for this increase including the development of new useful tests, and the impact of new guidelines and contracts(4, 5). However, previous studies(6-8) provide grounds for thinking that unnecessary test ordering may be a component of this increase.

Unnecessary test requesting is not only a burden on laboratory resources, but may also be detrimental for patients as it can lead to subsequent unnecessary investigation and treatment of healthy individuals following false positive results(9-12). In addition, it is an inappropriate use of the finite resources available for healthcare provision as a whole (1).

The effectiveness of strategies to change health professional practice in general and test requesting in particular is varied(1, 13-18). Previous reviews(10, 13- 15) have suggested that audit and feedback of test ordering rates, educational messages, test request form changes, reminders and computer decision support are all potentially effective methods of changing test ordering behaviour. In a systematic review (13) focussing on studies evaluating methods to improve diagnostic test requesting, including 49 studies with a control group, the majority of interventions evaluated claimed effectiveness, however, conclusions are limited by methodological flaws such as lack of a randomised comparison group (in 41 of the 49 studies). In addition, few of the studies evaluated the effectiveness of these interventions within a primary care setting. In a recent systematic review, which included 85 randomised

Feedback and reminders for primary care test requests.

trials, audit and feedback (19) has been shown to have small to moderate effects on health professional practice, however, the evidence within primary care test requesting is sparse, as only two of the trials evaluated the effect of feedback on laboratory test requesting within primary care. The authors concluded that their review does not provide support for unevaluated use of audit and feedback. Finally, current systematic reviews suggest that “single” intervention strategies may be as effective as multiple complex interventions in changing health professional practice(17, 19).

At the time of planning the current study, we had recently completed a cluster randomised trial of two strategies to reduce requests for lumbar spine and knee x-rays from primary care(20). We found that whilst simple, comparative audit and feedback of request rates had no discernable effects, the provision of educational reminder messages led to a 20% relative reduction in requests. These interventions were considered relatively easy for radiology departments to implement. In view of the limitations in the current evidence we undertook a cluster trial (randomising by practice to minimise contamination across practitioners within practices) using similar interventions to those used in our previous study to determine their effect on laboratory tests requests from primary care.

Feedback and reminders for primary care test requests.

Methods

Setting and Population

The study took place in the north east of Scotland, UK, and involved all 85 primary care practices (approximately 370 general practitioners) in the area covered by NHS Grampian. The clinical laboratories based within Aberdeen Royal Infirmary provided all laboratory services for these primary care practices.

Interventions

Nine laboratory tests were chosen as targets for intervention (Table 1) due to their perceived limited value for some patient subgroups within primary care, their impact on laboratory workload, and to reflect the range of laboratory services. Educational messages describing inappropriate use were developed for each of the targeted tests (Table 2 shows examples of these educational messages).

The tests were chosen and messages developed during a series of meetings with senior clinicians from four laboratory disciplines within NHS Grampian laboratories (Clinical Biochemistry, Haematology, Immunopathology; and Microbiology). The content and format of the educational messages and feedback were reviewed and commented on by primary care physicians and other laboratory clinicians.

In general, the evidence base for the appropriate and inappropriate use of laboratory tests is poor. Therefore the majority of the target tests were chosen and the content of the educational messages were developed using consensus expert opinion. However there is evidence for some of the targeted tests and their associated educational messages, for example: the use of the tumour markers Carcino-Embryonic Antigen (CEA) and Carbohydrate antigen - 125 (CA125) are not appropriate for diagnostic or screening use, and

Feedback and reminders for primary care test requests.

should be reserved for following up known patients with relevant cancers(21). In addition, the tests are not licensed for these diagnostic or screening indications(22). Similarly, Follicle Stimulating Hormone (FSH) has been shown to be of limited value and is potentially confusing when used to assess menopausal status(23).

Enhanced feedback:

The feedback consisted of a six-sided colour booklet presenting graphs of practice level data for each of the nine targeted tests and for each laboratory discipline as a whole. Each graph showed tests requesting rates over the previous three years (number per 10,000 patients per six months) for the practice compared to the regional rates.

The feedback was enhanced with the educational messages (examples shown in Table 2) which were included alongside the graphs for each of the targeted tests. The booklets were posted to each general practitioner within each intervention group practice on four occasions (updated every three months from the start of the intervention period). Examples of the feedback booklet are available from the corresponding author.

Reminder messages:

The brief educational messages (Table 1) were added as reminders to the test result reports sent to the requesting practice. The laboratory information system was programmed to recognise the relevant cues for each of the targeted tests (see Table 1) and automatically add the brief educational reminder messages to the relevant printed and electronic test result reports. The messages were activated every time the cue occurred and were presented at the same time as the test result. The reminders messages were intended to influence future requests for the targeted tests.

Feedback and reminders for primary care test requests.

The interventions were introduced in February 2002 for 12 months.

Study Design

The study design was a cluster randomised controlled trial using a 2 × 2 factorial design(24). All practices (85) were allocated to one of four groups: control, enhanced feedback alone, reminder messages alone or both enhanced feedback and reminder messages, using minimisation(25) based on practice list size (the number of people registered with the practice: 0 to 3000, 3001 to 8000 and over 8000), practice setting (rural or urban) and training status, (training or non training practice). Practice list size was predictive of the number of test requests. Practice setting and training status were chosen as factors that may influence the effect of the interventions. They potentially reflect differing populations, access to health care services, and receptiveness to practice innovation. Allocation was restrained to the enhanced feedback groups for one practice that had taken part in the piloting of the feedback booklet.

A statistician independent of the research team and blinded to the identity of the practices performed the minimization at the end of the pre intervention period.

Data collection

The numbers of each targeted test requested per practice (accurate individual physician level requesting data was not available) were collected for the 12 months before (pre intervention) and the 12 months of the intervention period. The data were downloaded from the NHS Grampian laboratory information system. The laboratory personnel who processed the requests were blinded to intervention group status.

Feedback and reminders for primary care test requests.

Sample size

The sample size was based upon a cluster level analysis adjusted for the test ordering patterns in the 12 months prior to the intervention using analysis of covariance. Data on the number of tests requested per practice in Grampian over two years (1998 to 1999) showed a high correlation between the number of requests per practice per year for Thyroid Stimulating Hormone (TSH) and Follicle Stimulating Hormone (FSH) (> 0.9). Using this information, a study with 90 practices had 80% power at 5% significance to detect a relative reduction of 12% in the number of TSH requests assuming a pre intervention level of 129 requests per 1000 of the population (obtained from the 1999 figures). This sample size was for the main effects only and assumed no interaction between the two interventions. Similar detectable differences were obtained for FSH. We did not have pre trial data for the other targeted tests.

Statistical analysis

A main effects analysis of covariance, adjusting for pre intervention yearly test requests and minimisation factors was performed on the natural logarithm of the number of test requests per year (sum of the targeted tests). The model fitting strategy was to test the minimisation variables (design) followed by the logarithm of the pre intervention test requests (covariate) and lastly two binary variables (intervention) corresponding to the enhanced feedback and reminder messages main effects were included. Any design or covariate variables failing to achieve statistical significance at the 5% level were excluded. The resultant intervention main effects were transformed onto an odds ratio (OR) scale with corresponding 95% confidence intervals. Analyses of each targeted test were performed similarly. Possible intervention interaction effects (i.e., non-additive effect of both interventions) were also investigated by including an interaction term in the above models.

Feedback and reminders for primary care test requests.

Subgroup analysis

It was decided a priori to investigate whether larger effects of the interventions were observed for practices reporting a higher pre intervention level of test requests. The models tested were identical to those used for the primary outcomes except for the addition of an interaction term between pre intervention request level and the intervention group. In addition, to test for a reduction in the spread of test requests, Levene's test for equality of variances was applied between the pre intervention and intervention phases.

The study was reviewed by the Local Research Ethics Committee and Grampian Area Medical Committee, General Practice Sub-Committee.

Role of funding source

The funders of this study, other than the initial peer review process prior to funding, did not have any involvement in study design; in the collection, analysis, and interpretation of data; in the writing of the report or in the decision to submit the paper for publication.

Feedback and reminders for primary care test requests.

Results

It was planned to recruit the ninety practices within NHS Grampian, however, four of these practices merged with others prior to the start of the study. Two practices merged with each other during the pre intervention period. Eighty-five practices were thus allocated to the interventions and included in the trial (Figure 1). No practices refused to take part and every practice contributed data to both 12 month pre intervention and intervention periods (Figure 1). Table 3 shows that the practice characteristics were similar across the intervention groups.

Across the total targeted tests, general practices receiving either the enhanced feedback (OR 0.87, 95% CI 0.81 to 0.94) or the brief educational reminder messages (OR 0.89, 95% CI 0.83 to 0.83) were significantly less likely to request targeted tests (Table 4). There was no evidence of an interaction between interventions (OR 0.98, 95% CI 0.84 to 1.14) so the combined effect was equivalent to a 22% reduction (OR 0.78, 95% CI 0.71 to 0.85) in total targeted test requests.

The effect of the interventions varied across each of the targeted tests individually, although the general pattern showed a reduction in the number of tests requested in the intervention groups (Table 4). Practices that received enhanced feedback reduced test ordering for all nine tests, which reached statistical significance for four tests (AAS, FSH, TSH, B12). Practices receiving the brief educational reminder messages also demonstrated reductions in test requests across eight tests, which reached statistical significance for three tests (CEA, TSH, B12).

For eight of the tests, there was no statistical evidence of an interaction effect (median [IQR] size of interaction OR was 0.99 [0.87, 1.23]). For Ferritin, the interaction effect was significant

Feedback and reminders for primary care test requests.

(OR 0.60, 95% CI 0.42 to 0.87), neither intervention had a significant effect alone, but in combination there was a reduction in test requests (OR 0.58, 95% CI 0.36 to 0.92).

Subgroup analyses exploring the possibility of effect moderation by pre intervention number of test requests provided no evidence that the effect was increased or decreased by the number of pre intervention test requests (enhanced feedback OR 1.05, 95% CI 0.95 to 1.15; reminder messages OR 0.96, 95% CI 0.87 to 1.05). There was no indication that the variability of test requests was changed in the intervention period (Levene's Test, $F=0.032$, $p\text{-value}=0.859$).

Feedback and reminders for primary care test requests.

Discussion

This study evaluated the effect of enhanced feedback and brief educational reminder messages on nine tests requested from primary care for one year. Enhanced feedback alone and brief educational reminder messages alone each achieved moderate(19) reductions of around 10% in the number of requests in total, whilst the effect of the interventions in combination showed larger reductions of >20 % in the total targeted tests requested.

The effects of the interventions varied across the individual targeted tests but showed a general pattern of reduction in requesting which was particularly consistent when both enhanced feedback and brief educational reminder messages were used together. Neither intervention alone appeared consistently better.

Our study was a rigorous design with all allocated practices included in the analysis. It involved all primary care practices in one region of Scotland (a previous study(20) does not give us any reason to suspect that these practices' requesting of investigations differs from other UK regions).

The targeted tests, although only representing a small proportion of test requesting in primary care, when used inappropriately, potentially have important implications for further diagnostic testing and specialist referral. TSH accounted for the majority of the targeted tests requested, and therefore had a major influence on the overall combined result. However, there were statistically significant reductions in requesting across the range of laboratory tests allowing confidence in the generalisability of the results(26). Our results are particularly impressive when considered in the context of the year on year increases in requesting of the targeted tests observed(2, 3) prior to the intervention period.

Feedback and reminders for primary care test requests.

Factorial designs are efficient for evaluating two or more interventions when they act independently of each other(24, 27). Our results, except for ferritin, do not suggest an interaction between the feedback and reminders, that is, the combined effect of the feedback and reminders was additive (the sum of the effect for feedback plus the effect for reminders) rather than synergistic. However, as the study was not powered to detect interactions we cannot be sure that they were not present; to fully investigate whether these interventions act independently a much larger trial would be needed.

Due to mergers of primary care practices the original sample size of 90 was not achieved with subsequent loss of power. However, adjusting for pre intervention minimisation factors increased the power of the study and we were able to identify our pre defined clinically important differences in TSH and FSH requesting.

We measured all requests for each test over the study period and we assume that the effects observed are due to reductions in unnecessary requesting. Ideally, we would have included a measure of the proportion of requests that were unnecessary, however data to determine this were not available. An economic analysis was not conducted as this would require further data on the appropriateness of the tests requested and subsequent effects on patient wellbeing for example health effects, reassurance gained or lost.

Whilst the general pattern across the individual targeted tests is a reduction in requesting our results suggest that the effect of the two interventions alone may vary within and across the individual tests. The reductions observed do not all reach statistical significance possibly reflecting the higher variability, low number and lack of power for some of the tests, for instance, CEA. However, across and within tests of similar volume (e.g. FSH, Ferritin and HPS) effectiveness seems to vary. Our outcome measures (all requests for a targeted test)

Feedback and reminders for primary care test requests.

may be too general to detect changes related specifically to the message for some of the tests. It is also possible that the potential for changes in requesting related to the educational message differs across the individual tests. Requesting a test is a result of complex considerations, motivations and behaviours(28, 29) that may be conflicting(30) and may differ for each of the targeted tests and conditions. The brief educational reminder messages and enhanced feedback may address different considerations and motivations and thus their effectiveness may vary across the individual targeted tests. Further understanding of these motivations and behaviours and how they can be changed is needed to inform and optimise the choice and development of interventions for future trials.

Our study has shown effects that are as large as those in a recent robust study of test requesting using a multifaceted strategy, arguably more complex to deliver and maintain(31). This lends further support to emerging evidence that complex multifaceted interventions may not be superior in effectiveness(17, 19).

Across two similar trials, reminder messages have consistently shown reductions in targeted radiology(20) and total targeted laboratory tests. The reminder messages in both these studies influenced future requests. The advent of computerised order communication systems with interactive real-time interrogation means there will be the opportunity to influence laboratory test requests as they are made. It has been suggested previously (10, 14) that the type of reminder influences their effectiveness and therefore it would be important to investigate the effectiveness of these real time reminders compared to those designed to influence future requests.

The six monthly feedback tested in the radiology requests trial(20) was shown to be ineffective whilst the quarterly feedback enhanced with educational messages tested in this

Feedback and reminders for primary care test requests.

study showed moderate effects for the total tests, generally consistent with those observed for audit and feedback interventions elsewhere(19). It seems that differences in the presentation of feedback, such as enhancement with educational messages or frequency of the feedback and again, the targeted condition may influence the effectiveness of audit and feedback interventions demonstrating the need for further research testing appropriate permutations head-to-head to inform design of effective audit and feedback interventions.

At the time of planning this study, a control group or usual practice group was necessary as there was insufficient evidence of the effectiveness of reminders or audit and feedback on diagnostic behaviour. Current evidence(17) suggests a need for head to head comparisons of interventions, however, taking into account the primary research question and sample size requirements we would still consider incorporating a usual practice group within a study as it gives an estimate of the absolute effect size.

We studied the effects of these interventions over one year. Using a non-experimental design Winkens et al(32) suggest a persistent effect of feedback on test requesting over nine years in routine practice and Tierney et al(33) in their trial of reminders about test charges suggests the effects do not persist after stopping reminders. To inform the use of these interventions in routine practice their longer term effects on test requesting need to be rigorously evaluated. In addition, the consequences of increasing the number of targeted tests needs to be investigated as this may influence the potency and sustainability of the interventions.

In conclusion, we have identified and rigorously evaluated two strategies that seem feasible within most laboratory settings and together appear to be consistently effective across a range of laboratory tests.

Feedback and reminders for primary care test requests.

Acknowledgements

We are grateful to all NHS Grampian general practices and laboratory staff, especially those who gave comments and advice on the interventions. We wish to thank HSRU secretarial staff for compiling the booklets. We would like to acknowledge the contributions of Dr Ron Winkens to the design of the interventions, Professor Phil Hannaford to the design and conduct of the study and Austen Kite to data programming and collection. We would also like to thank Professor Adrian Grant and Dr Richard Herriot for advice and support throughout the project.

Contributorship

Bernard Croal and Jeremy Grimshaw conceived the project. All authors contributed to the design of the study. Ruth Thomas and Bernard Croal were responsible for running the project. Craig Ramsay was responsible for the statistical analyses. All authors interpreted the data and findings. Ruth Thomas wrote the first draft of the manuscript, all authors commented on it and all further revisions. Bernard Croal and Ruth Thomas are guarantors for the paper.

Sources of Funding

The Health Services Research Unit is funded by the Chief Scientist Office of the Scottish Executive Department of Health. Ruth Thomas is funded by the Wellcome Trust (GR063790MA). Bernard Croal was supported by a grant from Grampian Endowments. Jeremy Grimshaw holds a Canada Research Chair in Health Knowledge Transfer and Uptake. The views expressed are those of the authors and not necessarily the funding bodies.

Feedback and reminders for primary care test requests.

Conflicts of interest statement

None of the authors have any conflicts of interest

Feedback and reminders for primary care test requests.

References

1. Winkens R, Dinant GJ. Evidence base of clinical diagnosis: Rational, cost effective use of investigations in clinical practice. *BMJ*. 2002 Mar 30;324(7340):783.
2. Information and Statistics Division. *Laboratory Statistics 1999*. Edinburgh: The National Health Service in Scotland; 2000.
3. Beastall GH. The Impact of the New General Medical Services Contract - national evidence. *Bull Roy College Pathol*. 2004;128:24.
4. Twomey PJ, Wierzbicki AS, Reynolds TM. Chemical pathology and the new contract for GPs. *J Clin Pathol*. 2004 Oct;57(10):1022-4.
5. Smellie WS, Roy DV. Impact of the new General Medical Services contract on the clinical laboratory. *Ann Clin Biochem*. 2005 Jan;42(Pt 1):4-10.
6. van Walraven C, Goel V, Chan B. Effect of population-based interventions on laboratory utilization: a time-series analysis. *JAMA*. 1998 12/16/;280(23):2028-33.
7. Durand-Zaleski I, Rymer JC, Roudot-Thoraval F, Revuz J, Rosa J. Reducing unnecessary laboratory use with new test request form: example of tumour markers. *Lancet*. 1993 Jul 17;342(8864):150-3.
8. Leese B. Is there too much laboratory testing? *CHE Discussion Paper*. 1991(79).
9. O'Reilly DS. Thyroid function tests- time for a reassessment. *BMJ*. 2000 May 13;320(7245):1332-4.
10. Axt-Adam P, van der Wouden JC, van der Does E. Influencing behavior of physicians ordering laboratory tests: a literature study. *Med Care*. 1993 Sep;31(9):784-94.

Feedback and reminders for primary care test requests.

11. Casscells W, Schoenberger A, Graboys TB. Interpretation by physicians of clinical laboratory results. *N Engl J Med*. 1978 Nov 2;299(18):999-1001.
12. Griner PF, Glaser RJ. Sounding boards. Misuse of laboratory tests and diagnostic procedures. *N Engl J Med*. 1982 Nov 18;307(21):1336-9.
13. Solomon DH, Hashimoto H, Daltroy L, Liang MH. Techniques to improve physicians' use of diagnostic tests: a new conceptual framework. *JAMA*. 1998 Dec 16;280(23):2020-7.
14. Buntinx F, Winkens R, Grol R, Knottnerus JA. Influencing diagnostic and preventive performance in ambulatory care by feedback and reminders. A review. *Fam Pract*. 1993 Jun;10(2):219-28.
15. Gama R, Hartland AJ, Holland MR. Changing clinicians' laboratory test requesting behaviour: can the poacher turn gamekeeper? *Clin Lab*. 2001;47(1-2):57-66.
16. NHS Centre for Reviews and Dissemination, University of York. *Effective Health Care; Getting evidence into practice*. London: Royal Society of Medicine Press; 1999 02//. Report No.: 5.
17. Grimshaw JM, Thomas RE, MacLennan G, Fraser C, Ramsay CR, Vale L, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technol Assess*. 2004 Feb;8(6):iii,iv, 1-72.
18. Van der Weijden T, Wensing M, Giffel M, Grol R, Winkens R, Buntinx F, et al. Interventions to improve the use of diagnostic tests [Protocol]. *The Cochrane Database of Systematic Reviews*. 1996 (2). Art no: CD000461. DOI 10.1002/14651858. CD000461.
19. Jamtvedt G, Young JM, Kristofferson DT, Thomson O'Brien MA, Oxman AD. Audit and Feedback: effects on professional practice and health care outcomes. *The Cochrane*

Feedback and reminders for primary care test requests.

Database of Systematic Reviews. 2003 (3). Art no: CD000259. DOI 10.1002/14651858.CD000259.

20. Eccles M, Steen N, Grimshaw J, Thomas L, McNamee P, Soutter J, et al. Effect of audit and feedback, and reminder messages on primary-care radiology referrals: a randomised trial. *Lancet*. 2001 May 5;357(9266):1406-9.
21. Fleisher M, Dnistrian AM, Sturgeon CM, Lamerz R, Wittliff JL. Practice guidelines and recommendations for use of tumor markers in the clinic. In: Diamandis EP, Fritsche H, Schwartz MK, Chan DW, eds. *Tumor markers: physiology, pathobiology, technology and clinical applications*. Chicago: AACCC Press, 2002:33-63.
22. CEA - Advia Centaur assay manual. 111773 Rev. D, 2003-04. The Bayer Corporation, Tarrytown, USA.
23. Burger HG. Diagnostic role of follicle-stimulating hormone (FSH) measurements during the menopausal transition - an analysis of FSH, oestradiol and inhibin. *Eur J Endo* 1994; 130: 38-42.
24. McAlister FA, Straus SE, Sackett DL, Altman DG. Analysis and reporting of factorial trials: a systematic review. *JAMA*. 2003 May 21;289(19):2545-53.
25. Scott NW, McPherson GC, Ramsay CR, Campbell MK. The method of minimization for allocation to clinical trials. a review. *Control Clin Trials*. 2002 Dec;23(6):662-74.
26. Cook TD, Campbell DT. *Quasi Experimentation: Design and analysis issues for field settings*. London: Houghton Mifflin Company; 1979.
27. Montgomery AA, Peters TJ, Little P. Design, analysis and presentation of factorial randomised controlled trials *BioMed Central*. 2003 24 November 2003;3(26).

Feedback and reminders for primary care test requests.

28. van der Weijden T, van Velsen M, Dinant GJ, van Hasselt CM, Grol R. Unexplained complaints in general practice: prevalence, patients' expectations, and professionals' test-ordering behavior. *Med Decis Making*. 2003 May-Jun;23(3):226-31.
29. Sorum PC, Mullet E, Shim J, Bonnin-Scaon S, Chasseigne G, Cogneau J. Avoidance of anticipated regret: the ordering of prostate-specific antigen tests. *Med Decis Making*. 2004 Mar-Apr;24(2):149-59.
30. van der Weijden T, van Bokhoven MA, Dinant GJ, van Hasselt CM, Grol RP. Understanding laboratory testing in diagnostic uncertainty: a qualitative study in general practice. *Br J Gen Pract*. 2002 Dec;52(485):974-80.
31. Verstappen WH, van der Weijden T, Sijbrandij J, Smeele I, Hermsen J, Grimshaw J, et al. Effect of a practice-based strategy on test ordering performance of primary care physicians: a randomized trial. *JAMA*. 2003 May 14;289(18):2407-12.
32. Winkens RA, Pop P, Grol RP, Bugter-Maessen AM, Kester AD, Beusmans GH, et al. Effects of routine individual feedback over nine years on general practitioners' requests for tests. *BMJ*. 1996 Feb 24;312(7029):490.
33. Tierney WM, Miller ME, McDonald CJ. The effect on test ordering of informing physicians of the charges for outpatient diagnostic tests. *N Engl J Med*. 1990 May 24;322(21):1499-504.

Feedback and reminders for primary care test requests.

Table 1 Targeted laboratory tests, brief educational messages and cues for activating addition of messages as reminders to results reports

Targeted Test	Brief educational message	Added to test	Cue to activate reminder
		result report for:	message
Autoantibody screen (AAS)	Autoantibody 'screen' requesting is inappropriate for investigation of non-specific illness. Requests should be test-specific.	AAS	AAS request
Carbohydrate antigen - 125 (CA125)	CA125 should not be used to screen, diagnose or exclude malignancy.	CA-125	CA-125 request
Carcino Embryonic Antigen (CEA)	CEA should not be used to screen, diagnose or exclude malignancy.	CEA	CEA request
Ferritin	Ferritin measurement is generally unnecessary in caucasians with hypochromic microcytic anaemia as the underlying cause is almost always iron deficiency.	Full Blood Count (FBC)	FBC request result with a mean cell volume (MCV) < 80 fl
Follicle stimulating hormone (FSH)	In general, FSH testing is of limited value in assessment of menopausal status in women over 40 years	FSH	FSH request

Feedback and reminders for primary care test requests.

of age.

Helicobacter pylori serum

Helicobacter Pylori serology should not be used to assess HPS

HPS request

(HPS)

the efficacy of antibiotic eradication therapy as antibody levels may remain positive for some time after eradication

Immunoglobulin E (IgE)

General allergen 'screening' is unhelpful. Allergen testing IgE

IgE request

requests should instead be specific as directed by the history.

Thyroid stimulating

Thyroid Function tests are not indicated as a screening TSH

TSH request

hormone (TSH)

procedure in young, clinically euthyroid patients.

Vitamin B12 (B12)

B12 levels are of no value and should therefore not be B12

B12 request

requested in patients undergoing parenteral B12 therapy.

Macrocytosis without anaemia is unlikely to be due to B12 FBC

FBC result with a MCV > 95 fl

deficiency (thus should not be requested). Thyroid or liver function tests may be helpful.

Feedback and reminders for primary care test requests.

Table 2 - Examples of educational messages used in the feedback reports

Carcino-Embryonic Antigen (CEA) has been found to be raised in the serum of some patients with gastrointestinal malignancy, notably colonic cancer. It is therefore a useful marker for use in monitoring treatment and in detecting recurrence. CEA should not however be used to screen, diagnose or exclude malignancy. It can also be found to be raised in many other benign conditions, especially gastrointestinal disorders. False positive and false negative results can therefore lead to unnecessary further investigation or false reassurance.

Carbohydrate antigen - 125 (CA125) has been found to be raised in the serum of some patients with malignancy, notably ovarian cancer. It is therefore a useful marker for use in monitoring treatment and in detecting recurrence. CA-125 should not however be used to screen, diagnose or exclude malignancy. It can also be found to be raised in many other malignancies and benign conditions, notably gastrointestinal disorders. False positive and false negative results can therefore lead to unnecessary further investigation or false reassurance.

Follicle Stimulating Hormone (FSH) is released by the pituitary gland and acts to stimulate sex hormone production and reproductive processes. In general, FSH testing is of limited value in the assessment of menopausal status in women over 40 years of age, and so should not be requested for this purpose. Menopausal/Peri-menopausal status is best confirmed retrospectively based on clinical symptoms, signs and frequency or absence of menstruation. Biochemical measurement adds little to this classification, and may mislead.

Ferritin measurement is generally unnecessary in caucasians with hypochromic microcytic anaemia as the underlying cause is almost always iron deficiency. While a source of potential blood loss should always be sought in cases of suspected iron deficiency, treatment with iron replacement is best monitored by clinical response and periodic haemoglobin measurement rather than resorting to iron studies - including ferritin assessment.

Imunoglobulin E (IgE) Raised total IgE and positive specific IgE tests are found in around 40% of the population but are only clinically relevant in around 20% (high false positive rate). General allergen "screening" is unhelpful. Allergen testing requests should instead be specific as directed by the history. IgE tests are not a substitute for adequate

Feedback and reminders for primary care test requests.

history taking. The significance of any result requires careful consideration in the context of the clinical problem.

Helicobacter Pylori serology (HPS) and breath tests are highly sensitive markers of infection associated with symptomatic peptic ulcer disease. HPS should not be used to screen asymptomatic individuals, even if they have a family history of peptic ulcer disease. HPS should not be used to assess the efficacy of antibiotic eradication therapy as antibody levels may remain positive for some time after eradication. A *Helicobacter pylori* breath test should be instigated if peptic ulcer symptoms persist, so as to confirm/exclude continued infection.

Feedback and reminders for primary care test requests.

Table 3 Characteristics of study practices

Characteristics	Control		Feedback* only		Reminders* only		Both	
	N=20	N=21	N=22	N=22	N=22	N=21	n	%
	n	(%)	n	(%)	N	(%)	n	(%)
Training practice	8	(40%)	10	(45%)	10	(45%)	9	(43%)
Non training practice	12	(60%)	12	(55%)	12	(55%)	12	(57%)
Location of practice								
Rural	10	(50%)	11	(50%)	10	(45%)	10	(48%)
Urban	10	(50%)	11	(50%)	12	(55%)	11	(52%)
Practice list size								
<3000 patients	4	(20%)	7	(32%)	7	(32%)	6	(29%)
3001- 8000 patients	9	(45%)	9	(41%)	8	(36%)	8	(38%)
>8000 patients	7	(35%)	6	(27%)	7	(32%)	7	(33%)

*Feedback = quarterly feedback of practice requesting rates enhanced with educational messages, Reminders = brief educational reminder messages added to test result reports

Feedback and reminders for primary care test requests.

Table 4 Effect of the interventions on total and individual targeted tests

	Pre intervention period		Intervention period		Effect of interventions*	
	Median number [IQR] [†] per 10,000 patients per practice	[IQR] [†] per 10,000 patients per practice	Median number [IQR] [†] per 10,000 patients per practice	[IQR] [†] per 10,000 patients per practice	Odds Ratio (95% CI)	P-value
Targeted tests						
Total						
Control group	1071	[783, 1804]	1226	[726, 2057]		
Feedback [‡] only group	1233	[601, 1954]	1079	[575, 1818]		
Reminders [‡] only group	1329	[688, 1726]	1317	[719, 1590]		
Both group	1166	[492, 1749]	1041	[362, 1515]		
Main effects						
Feedback[‡]					0.87	(0.81, 0.94) <0.001
Reminders[‡]					0.89	(0.83, 0.93) 0.003
Individual						
Autoantibody screen (AAS)						

Feedback and reminders for primary care test requests.

Control group	41	[13, 68]	41	[13, 64]		
Feedback only group	49	[26, 75]	33	[20, 49]		
Reminders only group	38	[25, 77]	36	[18, 63]		
Both group	59	[18, 97]	31	[10, 66]		
Main effects					0.78	(0.67, 0.91) 0.002
Feedback						
Reminders					0.96	(0.82, 1.12) 0.599
Carbohydrate antigen - 125 (CA125)						
Control group	13	[6, 22]	16	[9, 25]		
Feedback only group	8	[3, 22]	11	[3, 19]		
Reminders only group	9	[4, 30]	12	[4, 23]		
Both group	9	[1, 24]	11	[4, 19]		
Main effects					0.94	(0.65, 1.36) 0.726
Feedback						
Reminders					0.89	(0.61, 1.30) 0.537
Carcino Embryonic Antigen (CEA)						

Feedback and reminders for primary care test requests.

Control group	10	[1, 16]	11	[4, 33]		
Feedback only group	10	[3, 16]	9	[2, 15]		
Reminders only group	18	[5, 26]	10	[3, 25]		
Both group	13	[2, 33]	6	[2, 19]		
Main effects					0.76	(0.52, 1.13)
Feedback						0.177
Reminders					0.66	(0.44, 0.98)
Ferritin						
Control group	72	[34, 102]	79	[49, 137]		
Feedback only group	72	[43, 95]	60	[23, 106]		
Reminders only group	86	[48, 115]	85	[45, 132]		
Both group	73	[35, 119]	58	[16, 87]		
Main effects					0.91	(0.71, 1.18)
Feedbacks						0.489
Reminders					1.04	(0.81, 1.34)
Follicle stimulating hormone (FSH)						

Feedback and reminders for primary care test requests.

Control group	79	[41, 121]	77	[27, 122]		
Feedback only group	62	[33, 128]	57	[23, 96]		
Reminders only group	77	[42, 105]	55	[30, 92]		
Both group	81	[43, 132]	49	[30, 85]		
Main effects					0.86	(0.75, 0.98) 0.020
Feedback						
Reminders					0.96	(0.85, 1.09) 0.559
Helicobacter pylori serum (HPS)						
Control group	74	[30, 107]	56	[36, 98]		
Feedback only group	59	[26, 120]	66	[21, 104]		
Reminders only group	70	[38, 99]	76	[38, 98]		
Both group	75	[40, 117]	63	[20, 117]		
Main effects					0.95	(0.74, 1.14) 0.589
Feedback						
Reminders					0.91	(0.76, 1.09) 0.293
Imunoglobulin E (IgE)						

Feedback and reminders for primary care test requests.

Control group	20	[7, 34]	24	[9, 34]		
Feedback only group	28	[11, 44]	23	[10, 36]		
Reminders only group	18	[11, 39]	21	[13, 25]		
Both group	30	[18, 46]	23	[7, 38]		
Main effects					0.92	(0.73, 1.16)
Feedback						0.471
Reminders					0.99	(0.79, 1.24)
Thyroid stimulating hormone (TSH)						
Control group	750	[515, 1329]	795	[552, 1466]		
Feedback only group	829	[476, 1412]	802	[432, 1359]		
Reminders only group	961	[476, 1338]	891	[490, 1250]		
Both group	891	[392, 1277]	800	[287, 1077]		
Main effects					0.90	(0.84, 0.97)
Feedback						0.005
Reminders					0.82	(0.83, 0.95)
Vitamin B12 (B12)						

Feedback and reminders for primary care test requests.

Control group	25	[17, 40]	34	[13, 52]		
Feedback only group	32	[18, 53]	23	[15, 48]		
Reminders only group	37	[21, 49]	29	[15, 45]		
Both group	31	[10, 52]	19	[10, 40]		
Main effects						
Feedback					0.81	(0.66, 0.99) 0.041
Reminders					0.81	(0.66, 0.99) 0.043

*Based upon analysis of covariance adjusting for practice list size and pre intervention request level

† IQR = interquartile range

‡ Feedback = quarterly feedback of practice requesting rates enhanced with educational messages, Reminders = brief educational reminder messages added to test result reports

§ Interaction term was statistically significant (p=0.007), effects reported are for main effects and interaction in model

Feedback and reminders for primary care test requests.

Figure 1 Trial profile - see separate file