Going beyond audit and feedback: towards behaviour-based interventions to change physician laboratory test ordering behaviour

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Abstract

Studies indicate there are a variety of contributing factors affecting physician test ordering behaviour. Identifying these behaviours allows development of behaviour-based interventions.

Methods **Through a pilot study, the list of contributing factors in laboratory tests ordering, and the most ordered tests, were identified, and given to 50 medical students, interns, residents and paediatricians in questionnaire form. The results showed routine tests and peer or supervisor pressure as the most influential factors affecting physician ordering behaviour. An audit and feedback mechanism was selected as an appropriate intervention to improve physician ordering behaviour. The intervention was carried out at two intervals over a three-month period.**

Findings **There was a large reduction in the number of laboratory tests ordered; from 908 before intervention to 389 and 361 after first and second intervention, respectively. There was a significant relationship between audit and feedback and the meaningful reduction of 7 out of 15 laboratory tests including complete blood count ($p = 0.002$), erythrocyte sedimentation rate ($p = 0.01$), C-reactive protein ($p = 0.01$), venous blood gas ($p = 0.016$), urine analysis ($p = 0.005$), blood culture ($p = 0.045$) and stool examination ($p = 0.001$).**

Conclusion **The audit and feedback intervention, even in short duration, affects physician ordering behaviour. It should be designed in terms of behaviour-based intervention and diagnosis of the contributing factors in physicians' behaviour. Further studies are required to substantiate the effectiveness of such behaviour-based intervention strategies in changing physician behaviour.**

Keywords: audit and feedback, child, diagnostic tests, laboratory medicine, medical students, physicians, teaching rounds, test ordering, test request, utilisation review

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Introduction

There are growing concerns about healthcare costs, with a tenfold increase in most countries in recent years, leading to more and more studies on how to control the related costs and use of healthcare resources.[1,2] An area of particular concern is the ordering of investigations;[3] the number of required tests increased from 6% to 8% from 2004 to 2014.[4,5]

Diagnostic laboratory tests impose more financial difficulties and lead to poor patient satisfaction with services by causing morbidities like polyphlebotomy and hospital-acquired anaemia.[5,6] Despite the unpleasant impact caused by laboratory tests, studies revealed 26.4% and 20.6% of all laboratory tests are over utilised.[7,8] It is both clinically and financially significant to understand physician ordering behaviour in requesting laboratory tests. Recognising over utilised laboratory tests and developing strategies to improve physician ordering behaviour in requesting diagnostic tests in the form of utilisation review programmes and behavioural change are considered priorities in health systems in every country, particularly developing countries.[1,9,10] Previous

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Table 1 Contributing factors in inappropriate laboratory tests

1	Lack of experience[1,6]
2	Fear of litigation[1,22,23]
3	Inadequate educational feedback[24]
4	Unawareness of cost of test[6,24]
5	Pressure from patients (patient actively asks for tests)[1,22,23]
6	Expansion of modern diagnostic technology[25]
7	Routine test ordering (routine clinical practice)[24,26]
8	Rapid test result availability[23]
9	Lack of awareness about rational use of clinical laboratory test[1]
10	Failure to check previous results[6,26]
11	Lack of accessible guidelines[6,22]
12	Insufficient knowledge of physicians in basic science and physiopathology[6]
13	Peer pressure (interns and residents)[5,22]
14	Supervisor pressure or top residents[5,22]
15	Fear of errors of omission of uncertainty[1,24,27]
16	More frequent handover of care between colleagues[5]
17	Inadequate knowledge about the appropriate use of laboratory tests[1]
18	Increased speed of electronic requesting in information system[23]

literature suggested that unnecessary tests might be due to a wide range of reasons, including a poor physician awareness of how to use and interpret laboratory tests,[11,12] lack of clinical guidelines,[6,13] inadequate supervision during bedside rounds,[14] unawareness of test costs[15] and fear of legal issues.[16] Accordingly, strategies to change physician ordering behaviour range from providing feedback,[17] changing laboratory test formats,[18] providing physicians with information about test costs,[19,20] and utilising clinical guidelines.[21] Other studies focused on designing interventions consistent with contributing factors in local settings and alignment of intervention with factors that affect human behaviour (behaviour-based intervention). In order to design a tailored intervention that improves behaviour, it is necessary for all these contributing factors to be considered. In this study, after carrying out a pilot study in a children's ward in a teaching hospital and identifying contributing factors in physician laboratory test ordering, we designed a targeted intervention.

Methods

Study design and setting

This experimental study was conducted at a 510 bed teaching hospital in Kashan, Iran, during 2015.

Table 2 Prioritising unnecessary and MULTs

Tests	MULTs		Unnecessary tests	
	Rating	%	Rating	%
Urinalysis	1	84.8	14	6.6
C.B.C	2	80.4	15	2.2
CRP	3	73.7	12	10.9
ESR	4	71.7	13	10.8
Urine culture	5	65.3	9	21.8
Sodium NA	6	45.5	10	19.6
BUN	7	41.2	7	38.8
Stool examination	8	39.1	6	39.2
Potassium K	9	39	11	17.4
V.B.G	10	36.9	4	52.1
Creatinine	11	36.8	8	32.5
Alkaline phosphates	12	30.5	1	69.5
Blood culture	13	30.4	5	49.8
S.G.P.T	14	30.4	2	60.5
S.G.O.T	15	21.7	3	56.5

Study protocol

To identify contributing factors in test ordering behaviour and select an appropriate and targeted intervention to reduce the number of unnecessary tests, a review of related literature was conducted. Scientific databases including PubMed, Science Direct and Google Scholar were searched using keywords about improving test ordering, modifying test request behaviour, unnecessary requesting of tests, variation in test ordering behaviour, utilisation management in the laboratory, managing demand in laboratories, and contributing factors in unnecessary test ordering. The contributing factors in requesting unnecessary laboratory tests are provided in Table 1.

A multidisciplinary team, together with a research team, of paediatricians, health information management professionals and health service management, collaborated to determine the tests to be considered and design the intervention. The study aimed to implement a targeted intervention on the tests; it was agreed the intervention would be carried out on the most utilised laboratory tests (MULTs) and most costly tests.

A list of the most ordered laboratory tests on the children's ward and their costs was collected using the hospital information system. There were 15 tests considered as the most utilised and expensive for children, including urinalysis, blood urine nitrogen, sodium, potassium, creatinine, S.G.O.T, S.G.P.T, alkaline phosphate, complete blood count, erythrocyte sedimentation rate, C-reactive protein, urine culture, blood culture, stool examination and VBG. Then, the most expensive and MULTs, as well as contributing factors in inappropriate test ordering behaviour, were developed in

Table 3 Factors contributing to inappropriate laboratory test ordering based on physicians' opinions

Causes	n	%	Causes	n	%
Routine test ordering (routine clinical practice)	43	89.1	Insufficient knowledge of physicians (in basic science and physiopathology)	23	45.7
Peer pressure (interns and residents)	31	63	Pressure from patients (patient actively asks for tests)	22	43.5
Supervisor pressure (or top residents)	30	60.9	Lack of experience	19	37
Inadequate knowledge about the appropriate use of laboratory tests	30	60.9	Inadequate educational feedback	19	37
Fear of errors of omission of uncertainty	30	60.9	Failure to check previous results	19	37
Fear of litigation	28	56.5	Rapid test result availability	13	23.9
Lack of awareness about rational use of clinical laboratory test	27	54.3	Expansion of modern diagnostic technology	12	21.7
Unawareness of cost of test	27	54.3	Increased speed of electronic requesting in information system	9	15.2
Lack of accessible guidelines	25	50	More frequent handover of care between colleagues, within or between teams	9	15.2

the form of a questionnaire to collect the views of medical students, interns, residents and paediatricians regarding test ordering behaviour. The questionnaire comprised four sections: i) covered all demographic of samples in the study; ii) participants were asked to prioritise the MULTs; iii) participants were asked to find the most inappropriate tests; iv) participants were to choose contributing factors in laboratory test ordering (Table 2).

The questionnaire was assessed for face validity and given to some paediatricians to check the content validity. The initial questionnaire was given to 30 medical students, interns, residents, and paediatricians who were not initially involved in the study. To determine reliability, Cronbach's alpha coefficient was employed (= 0.87). The final questionnaire was distributed to 50 subjects including paediatricians (6), residents (5), interns (29), and medical students (10) to gather their points of view. Data were analysed using frequency distribution in SPSS 16.0 software.

Determining the type of laboratory tests to perform the intervention

The results obtained from the second and the third sections of the questionnaire were used to determine the unnecessary tests and MULTs. Subsequently, the top 10–15 MULTs were determined and laboratory tests with more than 50% of frequency in both the unnecessary and MULTs sections were selected as must-check ones. Table 2 shows the top 15 selected tests according to physicians' viewpoints.

Contributing factors in test ordering behaviour to select the type of intervention

With the help of descriptive statistics (determining the factors contributing to unnecessary ordering behaviour), the results obtained from the fourth section of the questionnaire indicated that participants would consider routine test ordering as well as peer and supervisor pressure as factors in unnecessary laboratory tests (Table 3).

Based on the results of the pilot study, audit and feedback (A&F) with a small educational meeting was introduced as an appropriate and targeted intervention to change physician behaviour in a given local setting.

Intervention

Feedback is information about an individual's performance provided by outside sources.[28] In this study, tables and charts illustrating the frequency, cost, and test results (normal/abnormal) of 15 laboratory tests were presented and discussed during morning reports meeting. The intervention team consisted of 16 interns and 14 residents in the hospital paediatric ward. Since the training courses for interns in the children's ward last for three months, we organised the intervention into two sections within a 3-month period. Thus, according to Ivers the feedback period in this study was categorised into moderate type – from a month to a year.[29]

Implementing intervention

To implement the intervention, the researcher collected baseline data, including the type and number of laboratory tests ordered during the first 14 days after interns started working on the children's ward. The results were analysed

Tests	Pre-intervention		First intervention		p value	Paired t-test
	Average	Standard deviation	Average	Standard deviation		
ESR	8.70	1.01	4.30	0.63	0.007*	3.4
CRP	8.70	1.01	4.30	0.63	0.007*	3.4
BUN	8.10	0.82	5.20	1.1	0.06	2.06
VBG	62.79	0.82	46.88	0.73	0.06	2.09
UA	9	0.94	4.40	0.77	0.006*	3.5
UC	6.40	0.93	4.30	0.80	0.1	1.7
BC	4.30	0.66	2.50	0.52	0.054	2.2
SE	4.20	0.66	1.50	0.45	0.004*	3.8
AST	1.70	0.30	1.10	0.40	0.26	1.2
ALP	1.70	0.30	1.10	0.40	0.26	1.2
ALT	1.70	0.30	1	0.39	0.17	1.4

Table 4 The effect of A&F on physician test ordering behaviour in the pre-intervention phase and first intervention

Tests	Pre-intervention		Second intervention		p value	Paired t-tests
	Average	Standard deviation	Average	Standard deviation		
CBC	10.20	1.28	5.60	1.02	0.017*	2.9
ESR	8.70	1.01	4.90	0.96	0.033*	2.5
CRP	8.70	1.01	4.90	0.96	0.03*	2.5
BUN	8.10	0.84	5.40	1.04	0.09	1.8
VBG	62.79	0.82	26.67	0.34	0.01*	3.2
UA	9	0.94	4.80	1.05	0.016*	2.9
UC	6.40	0.93	4.70	0.95	0.2	1.1
BC	4.30	0.66	2	0.61	0.043*	2.3
SE	4.20	0.66	1.20	0.44	0.004*	3.8
AST	1.70	0.30	1.50	0.47	0.7	0.34
ALP	1.70	0.30	1.50	0.47	0.7	0.34
ALT	1.70	0.30	1.50	0.47	0.7	0.34

Table 5 The effect of A&F on physician test ordering behaviour in the pre-intervention phase and second intervention

and illustrated (in the form of histograms, bar graphs and tables), showing how frequently the 15 tests were ordered during 14 days. Data were presented to physicians (interns and residents) in two morning report sessions. During small educational meetings the utilisation and medical necessity of ordered tests were discussed by paediatricians. The same process was followed for the next intervention.

Data analysis

We employed descriptive statistics (frequency distributions) to determine the frequency of ordered tests and a paired-t test to find a significant relationship throughout various stages in this study. Similarly, a repeated measure test was applied to determine any significant relationships throughout all stages of the study.

Ethical consideration

All stages of this research were approved by a Research Ethical Committee of Research & Technology Vice Chancellor at KAUMS [Code# IR.KAUMS.REC.2014.42]. Residents' consent was not obtained because of three reasons: i) ordering and interpreting of laboratory tests are among routine residents clinical practice, ii) the importance of appropriate utilisation of laboratory tests was debated at morning reports sessions, iii) Residents should be blind of the type of intervention. All information about the outcome of the investigation was confidential and solely used by the investigating team.

Results

The total number of ordered laboratory tests reduced from 908 before the intervention to 389 after the first intervention and 361 after the second.

After the first feedback session, there were significant decreases in ordering CBC, ESR, CRP, and UA (Table 4), which were maintained after the second feedback session (Table 5). Several other tests showed significant deceases after the second, but not the first, intervention (Tables 4 and 5).

Discussion

Here we show that A&F as a targeted intervention changes physician ordering behaviour in a paediatric ward. Our findings are consistent with previous studies of feedback changing physician test ordering behaviour.[30] Thomas reported that enhanced feedback and brief educational reminder messages reduce laboratory tests ordered by primary care physicians.[31] Similarly, Bunting found that using personal feedback and educational material had positive impacts on community physicians' ordering behaviour.[32] Minerowicz, through weekly feedback reports in the form of graphically illustrating requesting behaviour, reduced the number of tests requested.[3]

To keep an ongoing A&F process, a multidisciplinary team should be formed – a utilisation review committee – to continuously assess laboratory test utilisation in hospitals.

Our results suggest that the number of interventions can affect physician test ordering behaviour. Earlier studies debated that there is a relationship between the duration of A&F and behaviour change.[33] Ivers reviewed 140 papers relating to A&F interventions and concluded that the frequency and duration of A&F has an important impact on its effectiveness.[29] Winkens' study on the impact of routine individual feedback on laboratory tests cost, suggested a reduction in costs of laboratory tests would be amplified if the A&F intervention were continued.[33]

Not all studies support these conclusions. For example Eccles, through the study of impact of feedback on full blood count tests, found that A&F intervention did not affect physician test ordering behaviour; and highlighted the role of frequency of A&F with regular education reminder messages to improve the physician test ordering behaviour.[34] Similarly, Baker evaluated the effectiveness of A&F intervention on physician test ordering behaviour for a 3 month interval in 1 year, and concluded that it was ineffective. Baker believed that A&F of limited duration led to failure.[35]

We believe that our A&F intervention was successful as we designed a behaviour-based intervention approach based on contributing factors identified in our pilot study of clinicians' viewpoints.

The Belgian Health Care Knowledge Center, in a systematic literature review of appropriate use of laboratory tests and improving test ordering behaviour inferred that various interventions, particularly audit and feedback, can improve physician test ordering behaviour as long as they are regular and continuous and designed based on local context conditions.[29] Most studies highlight the importance of focusing on contributing factors and behaviour-based interventions.[36]

Our study was limited in several ways. First, the small number of residents sampled in the study might have biased the results and not given a true representation of the likelihood of residents changing their behaviour. Second, feedback was provided for only 3 months: the provision of feedback over a longer period may have increased the robustness of our findings.

Conclusion

A&F interventions that target identified factors have positive effects on changing physician test ordering behaviour, at least in the short term. The ideal duration and frequency of A&F behaviour-based interventions to ensure its long term effect remains open to debate.

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