



***The effects of providing pre-test ordering
cost information on laboratory test costs in
an Internal Medicine ward of a tertiary care
hospital***

by

DR. S. ELLEMDIN

Student no. 95280376

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DECLARATION

I hereby declare that this dissertation presented to the University of Pretoria for Masters of Science in Clinical Epidemiology degree is my own work and has not been presented previously to any other tertiary institution for any degree

AUTHORSHIP

First Author: Dr. S. Ellemdin

Second Author: Prof. P. Rheeder

Third Author: Dr. P. Soma

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TABLE OF CONTENTS

LIST OF TABLES	page 4
ABSTRACT	page 5

CHAPTER 1

1. INTRODUCTION	page 7
2. LITERATURE REVIEW	page 7

CHAPTER 2

1. AIM OF THE STUDY	page 17
2. STUDY QUESTION	page 17
3. HYPOTHESIS	page 17
4. STUDY DESIGN	page 17
5. SETTING	page 18
6. AUDIT AND INTERVENTION	page 18
7. MEASUREMENT and STATISTICAL ANALYSIS	page 19
8. ETHICAL ASPECTS	page 20

CHAPTER 3

1. RESULTS	page 23
2. DISCUSSION	page 27
3. LIMITATIONS OF THE STUDY	page 28
4. CONCLUSIONS	page 29

CHAPTER 4

1. REFERENCES	page 30
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CHAPTER 5

1. ADDENDUM 1	page 37
2. ADDENDUM 2	page 38
3. ADDENDUM 3	page 39



LIST OF TABLES

Table 1 - Variables affecting test ordering tendencies – page 13

Table 2 - Patient demographics – page 23

Table 3 - Hospitalisation and cost data - page 24

Table 4 - ANOVA results – page 26



ABSTRACT

Objectives:

The aim of the study was to ascertain the efficacy of an intervention - where laboratory test costs were provided to clinicians as a pocket-sized brochure - to reduce the laboratory test costs over a 4 month period.

Design:

This was a non randomised intervention study where the intervention group was compared to a similar and concurrent control group regarding the difference in laboratory test costs over a specified period in a specific year. The costs incurred were also computed for the same 2 groups over an identical time period and seasonal period in the preceding year, referred to as the control period.

Setting and Subjects:

The study was conducted in the Internal Medicine Wards at the Steve Biko Academic Hospital. The intervention period was during the winter months of May to August 2008 and the pre-intervention period was in the same months of the preceding year.

Outcome measures:

In the two (2007 and 2008) 4 month periods, for each patient admitted, the number of days in hospital and the laboratory tests ordered were computed. For the Intervention and control groups, pre and post intervention cost and days in hospital were estimated. The differences in logcosts per day were compared over time using ANOVA with group (1-2), time (1-2) and group*time as factors.

Results:

The mean cost per patient admitted in the intervention group decreased from R 2864.09 to R 2097.47 as a result of the intervention – a 27 % reduction in cost. The mean cost per day in the intervention group as a whole also decreased from R 442.90 to R 284.14 due to the intervention – a 36% reduction in cost. By contrast, in the control group, all costs increased in the control group from the pre-intervention to intervention periods – mean cost per admission in this group increased from R 1859.87 to R 2429.25 – an increase of 23%. The mean cost per day admitted in this group also increased from R 363.54 to R 371.92 – an increase of 2.2%.

Conclusion:

A heightened awareness of the cost of a laboratory test be it prospectively or retrospectively is a cost-effective and sustainable method of making doctors order tests rationally and appropriately.

Keywords: laboratory test cost information, cost reduction strategies, tertiary care hospital



CHAPTER 1

- 1. INTRODUCTION**
- 2. LITERATURE REVIEW**



1. INTRODUCTION

Laboratory tests are often requested without clear indication of potential benefit or cost implications (1 - 6). Previous studies have shown that various interventions can reduce the number of tests ordered and thereby reduce the hospitalization-associated costs (7 - 11).

The department of Internal Medicine conducted a survey in 2007 to assess the level of ignorance of the cost of diagnostic tests among registrars (20 out of 22 in current employment at the time) in different years of study in the department of Internal Medicine. This survey resulted from the fact that the laboratory budget was grossly overspent for the year 2006. The result of the survey was purely as part of an internal audit and not intended for publication of any kind. This survey demonstrated an 84% failure rate confirming the primary assumption that physicians estimates of the costs, as were the case in many other studies, were off by 45 to 75% (12 - 16). In a recent Medline and Cochrane review, it was emphasized that doctors have a limited knowledge and understanding of diagnostic costs and more focus is required in educating them in this regard as well making these costs accessible to them. (16)

2. LITERATURE OVERVIEW

Most of the diagnostic and therapeutic services are ordered by physicians on behalf of patients – traditionally under fee-for-service conditions such as the South African public sector these physicians are not needed to make cost-containment a major factor in his decision process (20 - 22). In



fact there is ample evidence of an over-utilisation of such services and it remains unclear who should pay for unnecessary medical services – the patient, the doctor, the hospital or the state coffer (23 - 30). It has been proposed that the physician should share this financial responsibility for over-utilisation of services that he has ordered or provided.

Factors contributing to excessive use of laboratory tests in teaching hospital according to literature review may be divided arbitrarily according to institutional, physician, laboratory and patient factors (31 - 35):

1. Institutional

- a) High proportion of tertiary care patients
- b) Multiplicity of physicians involved in the care of individual patients
- c) Application of test 'routines' in high intensity care areas (e.g. medical ICU)
- d) Peer pressure (e.g. teacher – student – registrar)
- e) Desire for new knowledge
- f) Isolation of clinical pathologist from clinician

2. Physician

- g) Inadequate knowledge of test characteristics
- h) 'Blanket' testing (e.g. simultaneous ordering of secondary diagnostic tests in addition to primary screening tests)
- i) Erroneous inferences from test results leading to additional tests
- j) Diagnostic 'overkill' (e.g. use of 2 or more confirmatory tests when one will suffice)
- k) Medico legal considerations



3. Laboratory

- l) Logistical conveniences (e.g. comprehensive laboratory test requisition team)**
- m) Laboratory inefficiencies**

4. Patient

- n) Need for reassurance**
- o) Patient expectations**

Potential systems to allocate responsibility for over-utilisation of medical services include (36 - 38):

- a) Auditing of patient's records after discharge from the hospital for unnecessary medical services relevant to the clinical problems and diagnoses**
- b) Auditing of physician's prescribing and ordering of service patterns relevant to the patients clinical problems and diagnoses**
- c) Physicians having a thorough knowledge of all medical services – not only the indications, contra-indications, specificities, sensitivities, predictive values, likelihood ratios but also the cost of every service – all this information must be available quickly and with minimal effort laboratories offering services have a 24-hour help line managed by suitably qualified personnel to offer advice on available tests that may influence a clinicians decision in a diagnostic work-up**
- d) Doctors in training obtain a second medical opinion on a case preferably from a consultant physician during a diagnostic work-up**



- e) Laboratories sending monthly feedback of laboratory usage and cost data to clinicians on a monthly basis with a view to this information influencing the way they make decisions**
- f) Providing meaningful incentives for physicians motivating them toward cost-saving – by contrast, one can introduce appropriate penalties against physicians who continue over-utilisation of services despite several warnings**

Compounding the over-utilisation of medical services, from a medico-legal perspective physicians are under no legal obligation to see that services utilised are economically justified – traditional tort law (i.e. medical malpractice) judges the physician on the medical correctness of the treatment rendered, not on its financial soundness (38,39). Thus, a doctor who, in disregard of the financial implications to the patient or funder, provides or orders unnecessary services has no liability unless these services cause physical harm to the patient (40).

It is impossible to estimate the potential savings of placing physicians at risk for the cost of unnecessary services. Nor is it possible to estimate whether the savings would offset the administrative costs of an auditing programme. It is appropriate to consider this proposal as an alternative to arbitrary cost ceilings in the public health service, since this alternative leaves responsibility for determining the level of medical care output in the hands of the physician and his peers. No sooner do physicians accept financial responsibility, the profession is guarded against external regulation.



According to a literature review on improved laboratory usage, several cost-containment strategies have been tried (41 - 47):

- a) Rationing of test – Many studies have shown a drastic reduction in the number of tests after being rationed but this was not sustained in the long term and laboratories have found it unreasonable not to perform tests which clinicians say are indicated**
- b) Form design – The actual request form designed to guide physicians in selecting appropriate investigations has been shown to both increase and reduce the number of tests in comparison to a blank form**
- c) Resource management – There is a view that giving doctors, nurses and other managers budgets and financial targets will result increased efficiency but this view has shown a few times to be over-optimistic.**
- d) Financial unbundling – in a ‘fee for item’ system it has been shown than charging for individual tests has been more cost effective than having panels of investigations covered by one fee.**
- e) Education relating to test requesting – a thorough knowledge of each diagnostic test esp. the sensitivity, specificity, predictive values, likelihood ratios and the like has been shown to short term benefit only**
- f) Education about costs – there appears to be a serious limitation of test costs even in countries where health care has a strong and visible financial component. Methods used include distribution of cost containment newsletters, charges of common tests and**



manuals stressing the cost of tests. So far most strategies have only shown a modest effect in reducing the ordering of unnecessary tests

- g) Decision support systems, protocols and decision analysis trees in diagnostic work-up – these have been to actually work-up but they require great technical support, medical supervision to keep the protocols up-to-date and a willingness on the part of doctors to use the outputs from these system**
- h) Personal incentives – most incentives whether they be cash or kind were shown to be unsuccessful**
- i) Feedback – all 3 forms of feedback (information on test requesting and utilisation, information on the cost of investigations and ranking of physicians according to the tests ordered or the costs) have been shown to be substantial value in reduction of ordering of unnecessary tests**
- j) Review of patient notes – Weekly or monthly audit of junior staff’s clinical notes by senior staff with a view to commentate and analyse the investigations requested has been shown to dramatically reduce the ordering of unnecessary tests albeit in a non-sustained manner**



We propose that factors affecting the use of specific tests be arbitrarily divided into modifiable ones or non-modifiable ones as depicting in table 1

TABLE 1 - Variables affecting test ordering tendencies among physicians

(52)

<u>Non-modifiable factors</u>	<u>Modifiable factors</u>
<p>1. <u>Geographic location</u></p> <ul style="list-style-type: none"> E.g. BMD done by urban physicians compared to rural, different countries with different tests, urban and tertiary settings order more tests 	<p>1. <u>Experience/knowledge</u></p> <ul style="list-style-type: none"> E.g. clinically-driven or guideline based, experience inversely proportional to number of tests
<p>2. <u>Practice setting</u></p> <ul style="list-style-type: none"> E.g. Solo practice do more tests than group practice, tertiary vs secondary vs primary settings differences 	<p>2. <u>Belief system</u></p> <ul style="list-style-type: none"> E.g. routine examination coupled with testing, different deductions from clinical trials, traditional beliefs in certain tests, testing to increase case finding
<p>3. <u>Age and sex</u></p> <ul style="list-style-type: none"> E.g. females and older physicians do mores tests and ECG as well as refer more, female and younger physicians adhere to guidelines 	<p>3. <u>Fear of malpractice/lawsuit</u></p> <ul style="list-style-type: none"> E. g. testing to prevent malpractice esp. due to missing CA and ischemic heart disease
<p>4. <u>Specialisation</u></p> <ul style="list-style-type: none"> E.g. EBM –driven diagnostic testing, sub-specialists test extensively within their field, GP’s often test blindly 	<p>4. <u>Financial incentives</u></p> <ul style="list-style-type: none"> E.g. reimbursement led to increased testing
	<p>5. <u>Awareness of cost testing</u></p> <ul style="list-style-type: none"> E.g. awareness of cost reduce ordering of tests,
	<p>6. <u>Feedback/education</u></p> <ul style="list-style-type: none"> E.g. different forms of feedback and education mostly reduced test ordering
	<p>7. <u>Physician factors</u></p> <ul style="list-style-type: none"> e.g. clinical guidelines, algorithms, monthly audits, etc. all reduced test ordering



This study has addressed several of the modifiable factors –

- **Experience/knowledge – providing cost information to clinicians is likely to prompt them to review and hopefully research the appropriateness of the test and to justify its use despite the cost**
- **Belief system – this study is likely to prompt clinicians to question and possibly revise clinical guidelines especially those that involve a standard battery of tests for a specific clinical scenario or condition**
- **Fear of malpractice/lawsuit – clinicians tend to over-investigate in the fear of missing for example a myocardial infarction, pulmonary embolism or occult cancer – this study should prompt them to sharpen their clinical skills, ask for a 2nd opinion or arrange an appropriate follow-up to reduce the possibility of ‘under-diagnosis’**
- **Financial incentives – it is perhaps worthwhile to consider some form of reward or even remuneration to those clinicians who are cautious ‘spenders’**
- **Awareness of cost testing – this is the obvious difference that has been observed in this study**
- **Feedback/education – perhaps this final factor is crucial in that besides adjusting algorithms and clinical guidelines to include a cost-containment strategy, we strongly feel that regular audits and feedback information be readily available with regard to laboratory cost expenditure of different departments, specific units within each department and possibly even of costs incurred by specific individual clinicians – this may initially appear to be a**



punitive measure at the outset but with time and with the realisation of cost saving is likely to be met in a more favourable light by clinicians

Whilst a global strategy of cost containment which will apply to all groups for all times is a happy thought, a more realistic approach is to consider why different groups of doctors order investigations. It appears that older and more experienced practitioners order less tests than their junior colleagues since the latter places a great reliance on tests (48,49). Thus far education programmes to present the most up-to-date views on laboratory tests including their costs and feedback strategies informing them regularly on ordering patterns appear to hold promise for the future (50,51,52,53,). This study hopes to explore these specific cost-containment strategies in the context of hospitalized patients in a teaching hospital in a South African urban setting.

Because physicians are often unaware of the costs of diagnostic tests, we hypothesized that they would order fewer tests if, when they ordered tests, they were reminded of the exact cost of each test ordered (17,18,19). We intended to find that physicians ordered fewer diagnostic tests after having been given this information during the test-ordering process.



CHAPTER 2

- 1. AIM OF THE STUDY**
- 2. STUDY QUESTION**
- 3. HYPOTHESIS**
- 4. STUDY DESIGN**
- 5. SETTING**
- 6. AUDIT AND INTERVENTION**
- 7. MEASUREMENT AND STATISTICAL ANALYSIS**
- 8. ETHICAL ASPECTS**



CHAPTER 2

1. AIM OF THE STUDY

The aim of the study was to ascertain the efficacy of an intervention - where laboratory test costs were provided to clinicians as a pocket-sized brochure - to reduce the laboratory test costs over a 4 month period compared to a control group as well as to a control period in the preceding year.

2. STUDY QUESTION

Does the knowledge of the laboratory test cost influence the clinician's decision to order the test? This was tested as an intervention in a group of patients within a specified time and compared against a control group of patients within the same specified time period as well a control period over a similar specified time period but in the preceding year

3. HYPOTHESIS

We hypothesised that providing clinicians with the cost of the tests they were in the process of ordering, would question the need and appropriateness of the test without compromising patient care, and in so doing result in a dramatic reduction in laboratory test expenditure.

4. STUDY DESIGN

This was a non randomised intervention study where the intervention group was compared to a similar and concurrent control group regarding the difference in laboratory test costs over a specified period in a specific year. The costs incurred were also computed for the same 2



groups over an identical time and seasonal period in the preceding year, referred to as the control period.

5. SETTING and TIME PERIODS

The study was conducted in the Internal Medicine Ward at the Steve Biko Academic Hospital, an urban teaching hospital in the Gauteng Province of South Africa

The intervention period was during the winter months of May to August 2008 and the pre-intervention period was in the same months of the preceding year. This was a convenient period in both years because the participating doctors were identical in the intervention and the control groups respectively from the control period to the intervention period.

6. AUDIT AND INTERVENTION

Intervention.

Physicians in the intervention group were supplied with an A5 Z flyer providing information on all laboratory costs typically ordered by the department of Internal Medicine. These physicians were asked to write in the cost of every test ordered on the laboratory test request form specially labelled in the intervention group but not in the control group. A weekly audit of all these labelled request forms over the entire intervention period ensured that there was 100% compliance by the physicians in the intervention group in entering the cost of the tests.

Control.

Physicians in another Internal Medicine unit were not aware of this information and continued to order tests as they normally would do. Care



was taken that doctors do not change units or exchange information in the intervention period. More specifically, both groups worked independently during the specified period and the control group physicians were completely blinded to the intervention in progress.

The physicians working in both groups were matched in terms of experience – specifically with regard to level of study and number of years after qualification. In each group there were 2 interns, 1 registrar in the 2nd year of study and 1 registrar in the 3rd year of study, giving a total of 4 physicians per group.

Because the study had been planned in advance it had been possible to allow the same physicians to work in the same units in the year preceding the intervention and over the same time period, viz. May to August. Hence it became possible to compute the cost of laboratory tests in both groups in the pre-intervention period (referred to as the control period) as well as during the intervention period

7. MEASUREMENT AND STATISTICAL ANALYSIS

In the two (2007 and 2008) 4 month periods, for each patient admitted, the number of days in hospital and the laboratory tests ordered were computed from the ward register and the National Health Laboratory Service (NHLS) computer workstation respectively.

The cost of the blood tests were obtained from a price list from the NHLS 2007 brochure. The same price list was used for the pre-intervention (2007)



period and the intervention (2008) period. No adjustment in price was necessary as the NHLS price list changes every 3 years.

Further estimates included:

For the Intervention group - pre and post intervention cost and days in hospital

For the Control group - pre and post intervention cost and days in hospital

The cost difference between the two periods will be compared between the two groups.

The groups were compared using t-tests for transformed data and Mann Whitney tests if skewed. As anticipated the cost data were skewed and were normalised by logarithmic transformation (requiring the use of geometric means in the descriptive analysis). The differences in logcosts per day were compared over time using ANOVA (analysis of variance) with group (1-2), time (1-2) and group*time as factors.

To provide a clearer interpretation of the differences in geometric means over time between the groups we calculated the 95% CI for the ratio of geometric means of period 1 versus period 2 for the 2 groups

8. ETHICAL ASPECTS

This study was approved by the Ethics Committee of the Faculty of Human Health Sciences of the University of Pretoria and the School of Public Health (included in the addendum as addendum 1)

Informed Consent :



Consent was obtained from the superintendent of the hospital for accessing all laboratory information anonymously using the laboratory network (included in addendum as addendum 2)

There was no need for written or verbal consent from the patients since all laboratory tests were accessed on the laboratory network and ascribed a monetary value for the duration of the hospitalisation.

No results were printed in any format or disclosed to any person including the patients.

Doctors participating in the intervention group were fully informed as to the nature of the study by means of the participant information leaflet (included in the addendum as addendum 3)

All the information obtained in this study was regarded as strictly confidential in the collection of data phase as well as the reporting of results phase.



CHAPTER 3

- 1. RESULTS**
- 2. DISCUSSION**
- 3. LIMITATIONS OF THE STUDY**
- 4. CONCLUSIONS**

1. RESULTS

Table 2 – PATIENT DEMOGRAPHICS

	INTERVENTION	CONTROL	p
PRE-INTERVENTION (2007)	N= 260	N=203	
Mean AGE in years (SD)	51.31	51.12	0.91
GENDER Male : Female (%)	148 (57%):112 (43%)	90 (44%):113 (56%)	0.09
INTERVENTION (2008)	N=217	N=217	
Mean AGE	52.43	50.67	0.19
GENDER Male:Female (%)	105 (48%):112 (52%)	96 (49%):121 (51%)	0.75

According to table 1 the baseline demographics, especially the gender and age, were similar in the 2 groups, both in the pre-intervention period as well as the intervention period, with no statistical differences – hence the 4 groups were comparable with one another, both in the pre-intervention and intervention periods.

The obvious difference in number of patients between the 2 groups in the pre-intervention period cannot be explained since these were obtained retrospectively in the intervention year. Possible reasons include registrar preference to admitting patients for work-up as inpatients rather than outpatients and registrar inability to down-refer secondary care patients. The clinical profile of the patients in each of the 4 groups were not expected to be dissimilar because all patients in the aforementioned periods were selected without exception.



For each patient admitted in each group, every single blood test requested was assigned a price and a total was computed for each patient and for the group as a whole. Using the number of patients in each group and the number of days in hospital respectively, we derived a mean cost incurred per patient and a mean cost per day in hospital as shown in table 2.

Table 3 – Hospitalisation and cost data (means are geometric means – Gmeans- as log transformations normalised the distributions)

	INTERVENTION GROUP	CONTROL GROUP	P value
PRE-INTERVENTION (2007)			
Median number of days in hospital (min-max)	7 (1-47) n=260	6 (1-34) n=203	0.18 (MW)
Mean number of days in hospital (SD)	6.46 (5.80 – 7.21)	5.76 (5.08 – 6.55)	–
GMean cost per day in hospital (Rands)	442.90 (403.33 – 486.36) n=260	363.54 (322.98 – 409.19) n=203	0.09 (TT)
GMean cost per admission (Rands)	2864.09 (2630.50 – 3118.40) (1859.87 (1626.45 – 2126.86)	0.001(TT)
INTERVENTION (2008)			
Median number of days in hospital (min-max)	7 (1 –46) n=217	7 (1 – 160) n=217	0.81 (MW)
Mean number of days in hospital (SD)	6.54 (5.83 – 7.43)	6.53 (5.77 – 7.39)	
GMean cost per day in hospital (Rands)	284.14 (250.94 – 321.73)	371.92 (327.49 – 422.36)	0.008 (TT)_
GMean cost per admission (Rands)	2097.47 (1855.79 – 2370.69)	2429.25 (2105.60 – 2802.65)	0.003 (TT)



According to table 2, the mean cost per patient admitted in the intervention group decreased from R 2864.09 to R 2097.47 as a result of the intervention – a 27 % reduction in cost. The mean cost per day in the intervention group as a whole also decreased from R 442.90 to R 284.14 due to the intervention – a 36% reduction in cost.

By contrast, in the control group, all costs increased in the control group from the pre-intervention to intervention periods – mean cost per admission in this group increased from R 1859.87 to R 2429.25 – an increase of 23%. The mean cost per day admitted in this group also increased from R 363.54 to R 371.92 – an increase of 2.2%.

In summary, the intervention appears to have resulted in a dramatic reduction in costs in the group as a whole as well in the cost per admission in this group. By contrast the control group incurred no major change in costs from the pre - intervention to the intervention periods.

The baseline costs in the 2 groups appear to be significantly different – the cost per day in hospital R 442.90 versus R 363.54 with $p = 0.09$ – as well as the mean cost per admission – R 2864.09 versus R 1859.87 with $p = 0.001$ – the higher costs being incurred in the intervention group at baseline . This difference is largely attributed to the intervention group admitting a significantly larger number of patients – 260 compared to 203 – over the specified period as well as the patients in the intervention group spending an extra night in hospital.- 6.46 compared with 5.76 with $p = 0.05$

Table 4 - ANOVA results

	F	p
Model	10.23	0.000
Group	0.38	0.540
Time	12.92	0.003
Group*time	15.87	0.001

The results clearly show that there is an interaction between group and time ($p=0.001$), indicating the effectiveness of the intervention within the intervention group in cost reduction from time/period 1 to time/period 2

The intervention and control groups were further compared with respect to the ratios of their geometric means (Gmeans) of daily costs at the 2 time periods, i.e. period 2 relative to period 1, using a logscale.

For the 2 groups the 95% CI were –

Control : $0.86 < \text{time2.time1} < 1.22$

Intervention $0.55 < \text{time2.time1} < 0.75$

Thus, with 95% confidence we can say that for the control group the costs during time/period 2 (intervention period) can be as low as 86% that of time/period 1 (pre-intervention period) and as high as 122% that for time/period 1.

While for the intervention group the costs during time/period 2 (intervention period) can be as low as 55% that of time/period 1 (pre-intervention period) and as high as 75% that for time/period 1.

The 2 intervals do not overlap, indicating a significant difference, and the interval for the intervention group shows a significant reduction in cost.



2. DISCUSSION

We hypothesised that providing clinicians with the cost of the tests they were in the process of ordering, would question the need and appropriateness of the test without compromising patient care, and in so doing result in a dramatic reduction in laboratory test expenditure.

In this study, providing price information was associated with a significant change in physician test-ordering behaviour. Having no change or increase in laboratory test costs between the control period in 2007 and the intervention period in 2008, the test costs dropped by 27 to 36 % in the intervention group compared to the control group.

This study has re-iterated a few important measures in cost reduction strategies, two of which need emphasis - doctors have a limited knowledge and understanding of diagnostic costs and more focus is required in educating them in this regard as well making these costs accessible to them. (16). Because physicians are often unaware of the costs of diagnostic tests, one hypothesized that they would order fewer tests if, when they ordered tests, they were reminded of the exact cost of each test ordered (17,18,19). We found that physicians ordered fewer diagnostic tests after having been given this information during the test-ordering process.

It is an unfortunate that this study did not measure any outcome data between the groups, viz., mortality, morbidity, length of hospital stay, ICU admission and patient satisfaction. It would have been interesting to see what impact the cost reductions may have had on these outcome measures, especially if patient outcomes were similar between the groups.



3. LIMITATIONS OF THE STUDY

- **No clinical data – one of the shortcomings of the study was that the clinical data pertinent or relevant to each patient was not obtained. In reality, this was impossible to obtain, because the name and cost of each test was obtained from the NHLS computer workstation where clinical details were absent. It is possible that certain clinical parameters like admission diagnosis, critically ill or comatose patients may warrant more extensive work-up necessitating more blood testing. However, it is unlikely that these parameters differ between the groups since every single patient within the specified were enrolled into the study.**
- **No morbidity or mortality data – in as much as the driving point of the study was to reduce laboratory costs, we hope these strategies did not increase morbidity, e.g. ICU admission or deteriorating kidney function or increase mortality, e.g. death due to unrecognised hyperkalemia or unrecognised hypoglycemia**
- **No explanation for the baseline differences in the pre-intervention period – because the pre-intervention data was collected retrospectively and because only laboratory tests were obtained, it was deemed impossible**
- **Radiological tests not included – it is possible that in certain individuals certain radiological tests could have led to increased costs in hospital e.g. the use of the CT or MRI scanner**



4. CONCLUSIONS

Clinicians have a responsibility to ensure that all tests requested on behalf of the patients in their care are appropriate.

Laboratory and radiological testing costs represent a significant proportion of the expenditure of most health care providers, the state teaching hospitals being no exception. While the costs of individual tests may be relatively fixed, a computer order entry system provides an opportunity for controlling these costs. The literature supports the use of such a system, in the context of appropriate education, funding and policy setting (48). Unfortunately, in the State teaching hospital, these systems are rare and not sustainable, hence the need for an immediate, practical and sustainable system of curbing the escalating laboratory costs.

We conclude that merely displaying the charges for diagnostic tests on the laboratory request forms may significantly reduce both the number and cost of tests ordered, whether it be for in patients or out patients (48). As a final comment to cost reduction, providing feedback to doctors regarding cost, be it individual test cost or overall costs, and feedback regarding usage, be it in overall usage, or usage specific to a patient or to a test, in essence, a heightened awareness of the cost of a test, be it prospectively or retrospectively, is the only cost-effective and sustainable method of making doctors order tests rationally and appropriately.

- 4.



CHAPTER 4

• REFERENCES

- 1. Angell M. Cost containment and the physician. JAMA. 1995 Sep 6; 254(9):1203-1207.**
- 2. Bailey RM, Tiemey TM Jr. Costs, service differences, and prices in private clinical laboratories. Milbank Mem Fund Q Health Soc. 2004 52(3):265-289.**
- 3. Bareford D, Hayling A. Inappropriate use of laboratory services: long term combined approach to modify request patterns. BMJ. 2000 Dec 8, 301(6764):1305-1307.**
- 4. Bartlett RC. Control of cost and medical relevance in clinical microbiology. Am J Clin Pathol. 2005 Oct, 64(4):518-524.**
- 5. Bartlett RC. Making optimum use of the microbiology laboratory. III. Aids of antimicrobial therapy. JAMA. 2002 Apr 2; 247(13):1868-1871.**
- 6. Bartlett RC. Cost containment in microbiology. Clin Lab Med. 2005 Dec, 5(4):761-791.**
- 7. Bartlett RC. Trends in quality management. Arch Pathol Lab Med. 2000 Nov; 114(11):1126-1130.**
- 8. Becker BL. The impact of DRGs after year 1: first steps toward greater lab efficiency. Part 1. MLO Med Lab Obs. 2004 Dec; 16(12):32-38.**
- 9. Bellin LE, Kavalier F, Weitzner M, Feldman L, Hamlin R. Hospital cost and use control via New York City health department. Health Serv Rep.**



10. **Benson ES. Initiatives toward effective decision making and laboratory use. Hum Pathology. 2000 Sep; 11(5):440-448.**
11. **Brown PA, Dorsey DB, Kaufmann W, Derman H. Will consolidated clinical laboratories supplant individual hospital laboratories? Hum Pathol. 2003 Sep;4(3):437-448.**
12. **Castañeda-Méndez K. Proficiency testing from a total quality management perspective. Clin Chem. 2002 May; 38(5):615-618.**
13. **Collins JA. Clinical judgment versus the laboratory. N Engl J Med. 2002 Apr 22; 306(16):987-988.**
14. **Conn RB. Clinical laboratories. Profit center, production industry or patient-care resource? N Engl J Med. 1998 Feb 23; 298(8):422-427.**
15. **Cunningham RE, Jarvis WD, Barnes HW. Cost control in the hospital lab. Dimens Health Serv. 2004 Mar; 51(3):30-32.**
16. **Michael Allan G, Lexchin J. Physician awareness of diagnostic and nondrug therapeutic costs : A systematic review. Int J of Technology Assessment in Health Care, 2008, 24: 2 : 158-165**
17. **Dick HM. Costing of pathology services in the United Kingdom National Health Service. H Clin Pathol. 1991 Sep;44(9):705-709.**
18. **Edberg SC, Trepeta R.W. Rapid and economical identification and antimicrobial susceptibility test methodology for urinary tract pathogens. J Clin Microbiol. 2003 Dec;18(6):1287-1291.**
19. **Eisenberg JM, Rosoff AJ. Physician responsibility for the cost of unnecessary medical services. N Engl J Med. 1998 Jul 13;299(2):76-80.**



20. Finkelstein SN. An approach to studying the cost behavior of changing utilization of a hospital laboratory. *Hum Pathol.* 1980 Sep;11(5):435-439.
21. Fuchs VR. A more effective, efficient and equitable system. *West J Med.* 1976 Jul;125(1):3-5
22. Gallwas G. The technological explosion: its impact on laboratory and hospital costs. *Pathologist/1980 Feb;34(2):86-91.*
23. Gama R, Nightingale PG, Broughton PM, Peters M, Ratcliffe JG, Bradby GV, Berg J. Modifying the request behaviour of clinicians. *J Clin. Pathol.* 2002 Mar;45(3):248-249.
24. Getzen TE. Forecasting the economic future of medical care and, forecasting for your department. *Clin Lab Manage Rev.* 1993(5):277-285 Sep-Oct.
25. Ginzberg E. Sounding Boards. Cost containment – imaginary and real. *N Engl J Med.* 2003 May 19;308(20):1220-1224.
26. Ginzberg E. The destabilization of health care. *N Eng J Med.* 2006 Sep 18;315(12):757-761.
27. Ginzberg E. Health care reform – where are we and where should we be going? *N Engl J Med.* 1992 Oct 29; 327(18):1310-1312.
28. Goddeeris JH, Bronken TP. Benefit – cost analysis of screening. A comparison of tests for gonorrhoea. *Med Care.* 2005 Nov; 23(11):1242-1255.
29. Griner PF. Use of laboratory tests in a teaching hospital: long term trends reductions in use and relative costs. *Ann Intern Med.* 1999 Feb;90(2):243-148.



30. Griner PF, Liptzin B. Use of the laboratory in a teaching hospital. Implications for patient care, education, and hospital costs. *Ann Intern Med.* 1999 Feb;90(2):243-248.
31. Hardwick DF. Clinical laboratory management: a critical evaluation. *Pediatr Pathol.* 2000;10(1-2):297-301
32. Hughes RA, Gertman PM, Anderson JJ, Friedman NL, Rosen MR, Ward AC, Kreger BE. The Ancillary Services Review Program in Massachusetts. Experience of the 1982 pilot project. *JAMA.* 2004 Oct 5;292(13):1717-1732.
33. Lee A, McLean S. The laboratory report: a problem in communication between clinician and microbiologist? *Med J Aust.* 2(26-27):858-860.
34. Lundberg GD. Pathology. *JAMA.* 2000 Mar 30;283(13):1381-1383.
35. McGregor M. Technology and the allocation of resources. *N Engl J Med* *N Engl J Med.* 1999 Jan 12;340(2):118-120.
36. Mechanic D. Approaches to controlling the costs of medical care short-range and long range alternatives. *N Engl J Med.* 1998 Feb 2;338(5):249-254.
37. Murphy J, Henry JB. Effective utilization of clinical laboratories. *Hum Pathol.* 1978 Nov;9(6):625-633.
38. Nathanson M. DRGs demand closer cooperation between lab chief M.D.s and CEO. *Mod Healthc.* 2003 Sep;32(9):104-106.
39. Overholt EL. The use of the laboratory: dollars and sense. *Wis Med J.* 2001 May;88(5):38-4—1.



40. **Paris M. Cost and quality control of laboratory services: the New York City medical centralized laboratory proposal Med Care. 2006 Sep;14(9):777-793.**
41. **Peterson SE, Rodin AE. Prudent laboratory usage, cost containment, and high quality medical care: are they compatible? Hum Pathol. 1997 Feb; 18(2):105-108.**
42. **Rodin AE. The pathologist and attending staff: working together for cost effective laboratory use. Pathologist. 2001 Mar; 35(3):149-152.**
43. **Schramm CJ. Can we solve the hospital-cost problem in our democracy? N Engl J Med. 2004 Sep 13; 311(11):729-732.**
44. **Schwartz WB. The inevitable failure of current cost-containment strategies. Why they can provide only temporary relief. JAMA. 2007 Jan 9; 257(2):220-224.**
45. **Steiner JW, Root JM, White DC. Laboratory cost and utilization containment. Clin Lab Manage Rev. 2001 5(5):372-4-376, 378-84. Sept-Oct.**
46. **Thomas RG. Cost effectiveness: clinical laboratories. Ohio State Med J. 2000 May; 75(5):283-285.**
47. **Tiermey 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):1499-1504.**
48. **Winkelman JW. Quantitative analysis of cost-savings strategies in the clinical laboratory. Clin Lab Med. 1995 Dec; 5(4):635-651.**



49. **Wong ET. Cost-effective use of laboratory tests: a joint responsibility of clinicians and laboratorians. Clin Lab Med. 1995 Dec; 5(4):665-672.**
50. **Wong ET, McCarron MM, Shaw ST Jr. Ordering of laboratory tests in a teaching hospital. Can it be improved? JAMA. 1993 Jun 10; 249(22):3076-3080.**
51. **Young DW. Improving laboratory usage: a review. Postgrad Med J. 1998 Apr; 64(750):283-289.**
52. **Sood R, Sood A, Gosh AK. Non evidence-based variables affecting physician's test-ordering tendencies: a systematic review. The journal of Medicine. May 2007, 65 (5): 167-177**



CHAPTER 4

- **ADDENDUM 1 – Ethical approval certificates**
- **ADDENDUM 2 – Participation information leaflet**
- **ADDENDUM 3 – Laboratory cost brochure**



Addendum 1 – Ethics approval certificate



Addendum 2

**PARTICIPANT'S INFORMATION LEAFLET & INFORMED
CONSENT FOR PARTICIPATION IN LABORATORY TEST COST STUDY**

Researcher's name : Dr. S. Ellemdin
Student Number : 95280376
Protocol no. S 25/2008
Department of Internal Medicine - University of Pretoria

Dear Registrar

***TITLE OF MY STUDY– The effect of pre-test ordering cost information on
laboratory test costs in an Internal Medicine ward of a tertiary care hospital***

I am a 4th MSC (Clinical Epidemiology) in the Department of Internal Medicine and School of Public Health , University of Pretoria. You are invited to volunteer to participate in a research project on Laboratory test costs in hospitalized patients at Pretoria Academic Hospital

This letter gives information to help you to decide if you want to take part in this study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to assess whether the knowledge of laboratory test costs influences your clinical decision to request these tests.

The study will be performed using the cost of laboratory investigations in hospitalised patients in the department of internal medicine during a prescribed period. The intervention period is proposed to be 4 months during 2008 – from May 2008 to August 2008

As the admitting doctor in the intervention group, you will be expected to consult with a laboratory price brochure which will be supplied to you in pocket-sized format before or whilst requesting any laboratory test. You will then enter the price of each test on the laboratory request form for all patients admitted to hospital during this period. You may not disclose any of this information to any other doctors working in the other admitting units during this period.

The costs of all the tests are as per the 2008 National Health Laboratory Price list and is included in the addendum

The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences has granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. You will also not be identified as a participant in any publication that comes from this study.

We sincerely appreciate your help.

Yours truly
S. Ellemdin



Addendum 3 - LABORATORY TEST COST BROCHURE

Tariff Code	Tariff Description	Unit Price In rands/cents
2661	U and E	130.04
2960	Creatinine	29.71
3020	Glucose Random(Fasting)	29.71
2780	LFT Bilirubin (Total)	39.19
2786	LFT Bilirubin (Direct)	29.71
2700	LFT Albumin	39.41
3295	LFT(ALP)	42.60
3040	LFT(GGT)	44.30
2685	LFT(ALT)	44.30
2755	LFT(AST)	44.30
2799	CRP	67.95
4605	TSH	160.92
4610	FT4	143.56
2242	FBC	86.27
2000	FBC(Differential Count)	49.73
2245	FBC(Platelets)	18.42
2015	ESR	24.60
2825	Calcium	29.71
2826	Ionised Calcium	55.38
3320	Phosphate	29.71
3210	Magnesium	29.71
3465	Uric Acid	31.10
2855	Lipogram(Cholesterol)	43.77
3440	Lipogram(Triglycerides)	65.18
2865	Lipogram(HDL Cholesterol)	56.66
3344	NT-Pro BNP	386.17
3443	Troponin I	164.22



3241	Myoglobin	101.81
2935	CKMB	101.81
2730	Amylase	42.60
3160	Lipase	42.60
2671	Toxic Screen(Paracetamol)	88.71
3359	Toxic Screen(Salicylate)	88.71
3431	Toxic Screen(TCA)	88.71
2762	Toxic Screen □ Benzodiazepine(urine)	88.71
2705	Ethanol	101.81
3692	Beta □ HCG	82.11
3091	IgE	102.03
2620	Vit B12	102.03
2580	Ferritin	102.03
3105	s □ Fe	55.38
3430	Transferrin	96.06
2615	s □ Folic Acid	102.03
2402	D □ dimer	225.89
2445	PT/INR	49.31
2460	PTT	48.03
4061	HbA1c	116.94
3772	u □ Micro □ albumin(24 hr urine)	67.95
3772+3640	u □ Micro □ albumin(alb/creat ratio)	97.66
3860	Daily u □ protein	25.56
3640+2960	Creatinine Clearance	59.52
2110	Malaria	46.01
5055	Coombs	29.93
5100	Blood Group	29.61
3337	Procalcitonin	377.76
3050	Haptoglobin	77.53
2974	Digoxin	102.03