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Rationalisation of laboratory tests ordering and consumption at Armed Forces Hospital, Jazan

Manal Ahmed Aldiba,[1] Essa Mohammad Jamali,[2] Ahmed Dighriri,[2] Ahmed Mohammad Abdulhaq,[2] Matrah Rabia Ali,[2] Ali Mohammad Otaif,[2] Bader Yahya Safhi,[2] Ali Al-Fageeh,[2] Ahmed Al-Sharif[2]

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[1]Laboratory, Armed Forces Hospital Jizan, Jizan, Saudi Arabia
[2]Medical Laboratory, Armed Forces Hospital, Jizan, Saudi Arabia

Correspondence to
Dr Manal Ahmed Aldiba; manalaldiba@yahoo.com

ABSTRACT

Laboratory testing is one of the major and important component of medical diagnosis. However, unrationalised laboratory test ordering may lead to misdiagnosis of diseases which would delay treatment of the patients. It would also lead to wasting the laboratory resources that adversely impact the hospital budget. The aim of this project was to rationalise laboratory tests ordering and ensure effective utilisation of resources at Armed Forces Hospital Jizan (AFHJ). This study included two major steps: (1) the development and implementation of quality improvement interventions to reduce the unnecessary and abuse of laboratory testing in the AFHJ and (2) evaluation of the effectiveness of these interventions. In order to determine the possible causes of the problem, fishbone diagram was used to structure a brainstorming session. Pareto analysis was used to prioritise the causes so that the emphasis can be laid on most significant one. After interventions implementation, the data analysed and found that there was significant differences between 2019 and 2021 of total patients percentage and distribution that was revealed by box plot, who had a request of Hemoglobin A1c (HbA1c) (p=0.002), Thyroid Stimulating Hormone (TSH) (p=0.002), Free Thyroine (FT4) (p=0.002), Free Triiodothyronine (FT3) (p=0.001), Follicle-Stimulating Hormone (FSH) (p=0.002), Luteinizing Hormone (LH) (p=0.002) and Prolactin (PRL) (p=0.001). We achieved a 33% reduction in total laboratory tests cost and the total laboratory budget decreased from 6 000 000 SR in 2019 to about 4 000 000 Saudi Riyals (SR) in 2021. A change in laboratory resource consumption requires changes in physicians awareness. A modification of the electronic ordering system applied more restrictions to the ordering physicians. Extending these measures to the entire hospital might lead to significant reduction in the healthcare costs.

INTRODUCTION

Laboratory testing is one of the major and important component of medical diagnosis. However, unrationalised laboratory test ordering may lead to misdiagnosis of diseases, which would delay treatment of the patients. It would also lead to wasting the laboratory resources that adversely impact the hospital budget.[1]

Kobewka *et al* reviewed numerous international studies and concluded that a considerable proportion of the laboratory tests performed were unnecessary and did not contribute to patient care.[2] Introducing effective and sustainable solutions for the optimal use of laboratory testing in clinical practice is a challenge. Our project focused on increasing the awareness about appropriate laboratory testing with an aim to change the mindset of physicians.

Inappropriate and excessive use of laboratory testing has multiple reasons but, some of the major ones include practising defensive medicine by ordering a barrage of tests for all patients to avoid any litigation issues, medical malpractice, lack of knowledge of the value of ordered laboratory tests, and patients pressure for proactive testing.[3–5]

Additionally, 'demand management' may be misunderstood as a reduction in ordering laboratory tests, whereas, on the contrary it simply implies to ordering the appropriate test. It could subsequently lead to an increase or decrease testing depending on the good medical sense and practice of the attending physician.[6]

Problem description

Unnecessary and excessive laboratory test requests for a patient affects patient care. It may lead to delay in correct diagnosis, misdiagnosis and faulty treatment, needless follow-up testing and appointments, prolong hospital admission stay, and unwarranted stress to the patient. Perhaps, out of all these, the most significant is risk to patient safety due to incorrect or delayed diagnosis.[7] Apart from jeopardising the patient's safety, another very relevant consequence of inappropriate laboratory test ordering is the immense financial burden incurred to the hospital budget and ultimately National Health Services.[8]

Armed Forces Hospital Jizan (AFHJ) is a 70-bedded hospital located in the outskirts

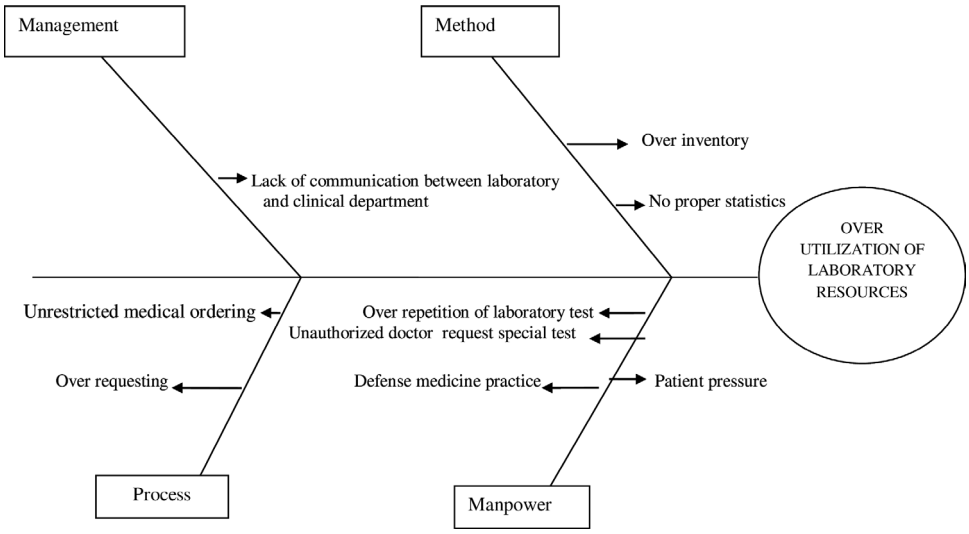

Figure 1 Root cause analysis for over utilisation of laboratory resources.

of Abu Arish. It has a dedicated laboratory service that provides comprehensive services 24/7 for all the patients using the hospital facility. During 2017, 2018 and 2019, the average number of laboratory tests ordered from just 12 different medical specialties in our hospital were 603 155–709 595 and 788 438, respectively. The overall average for these three years was 700 396 laboratory tests.

We collected the annual consumption of ordered laboratory tests and categorised it according to frequency of testing, cost and the requesting department. This facilitated in targeting the tests can be managed and controlled. It was found that the most frequent tests with a high cost were HbA1c, TSH, FT4, FT3, FSH, LH and PRL. Therefore, our project rationale was to study the efficacy of rationalisation of laboratory tests ordering and their consumption as a part of quality improvement (QI) project at AFHJ, Kingdom of Saudi Arabia (KSA).

Aim

The aim of this project was to rationalise laboratory tests ordering and ensure effective utilisation of resources at AFHJ by a 10% reduction in selected pathology tests (HbA1c, TSH, FT4, FT3, PRL, FSH and LH) in the targeted clinics by the end of December 2021.

METHODS

Context

This study included two major steps: (1) the development and implementation of QI interventions to reduce the

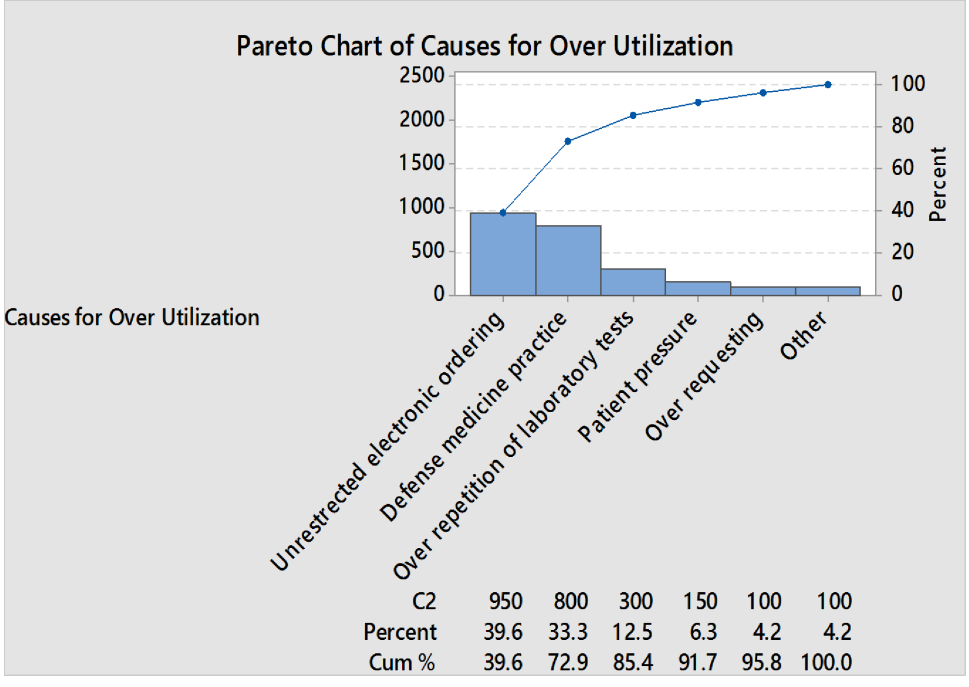

Figure 2 Pareto chart of causes for over utilisation of laboratory tests.

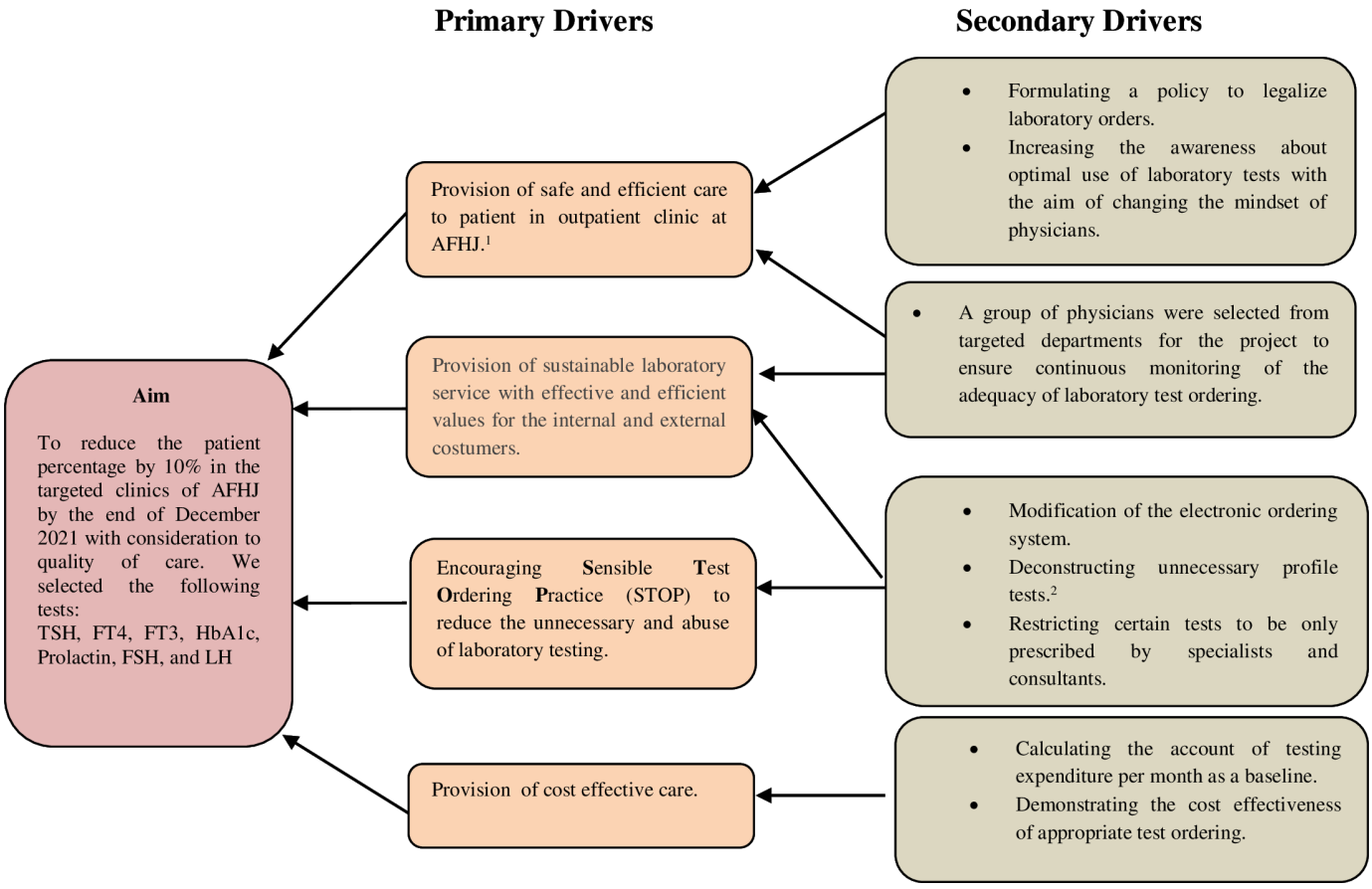

Figure 3 Driver diagram—showing the primary and secondary drivers that led to achievement the aim of the project. [1]AFHJ, Armed Forces Hospital Jizan. [2]Deconstructing profile tests—means separating the individual analytes being tested in a composite profile; like instead of just selecting lipid profile the physician would have to individually select cholesterol, triglycerides, high density lipoprotein, etc.

unnecessary and abuse of laboratory testing in the AFHJ and (2) evaluation of the effectiveness of these interventions. To achieve this aim, a project team was formulated that comprised of a pathologist (team leader), two physicians and five laboratory specialist.

In order to determine the possible causes of the problem, fishbone diagram was used to structure a brainstorming session (figure 1) . Pareto analysis was used to prioritise the causes so that the emphasis can be laid on most significant one (figure 2). It was found that the main reason for the unnecessary laboratory test requests was unrestricted electronic ordering and defensive medical practice.

Interventions

The team constructed a driver diagram to describe its theory for improvement and show how the factors are connected (figure 3) with the help of which the proper interventions could be formulated to solve various issues. The plan-do-study-act (PDSA) cycles were used to develop the interventions. Four cycles of PDSA were conducted in order to reduce the unnecessary laboratory tests ordering. These were carried out with the following themes: PDSA1—standardise laboratory tests ordering, PDSA2—reinforcement, PDSA3—controlling laboratory tests ordering and PDSA4—monitoring and feedback.

Prior to starting the PDSA1, an initial meeting was held by team leader with the hospital medical director and head of the clinical department to discuss the reason behind over utilisation of laboratory tests. On the basis of the recommendations from this meeting, in PDSA1, the project team was given final shape and a policy was established that clearly stated the indications and minimal time for repeating of certain test. In PDSA2 cycle, issues of defensive medical practice and patient pressure for proactive testing were handled. Initially the formulated policy was distributed to all physicians of the hospital through hospital information system (HIS). After this physicians in the project team were assigned by medical director to monitor and ensure implementation of policy in their department. In PDSA3 modification of the electronic ordering system HIS was done. As a result of this modification, the physicians had to write justification for ordering the tests. Some tests were restricted to certain categories of doctors based on their professional classification like vitamin D_3, ANA and anti-dsDNA could only be requested by a consultant. Also if a test was being repeated before the minimal repetition time, an alarm

Table 1 Comparison between mean, minimum and maximum of number of enrolled laboratory tests in 2019, 2021 and 2022 of each test

Test name/year	Mean	Minimum	Maximum
TSH 2019	905	746	1439
TSH 2021	305	220	390
TSH 2022	281	230	390
FT4 2019	775	630	1200
FT4 2021	170	110	280
FT4 2022	128	110	150
FT3 2019	692	530	1005
FT3 2021	75	30	110
FT3 2022	43	30	60
FSH 2019	164	120	185
FSH 2021	52	18	80
FSH 2022	47	18	80
LH 2019	164	120	185
LH 2021	52	18	80
LH 2022	47	18	80
PRL 2019	217	127	281
PRL 2021	47	29	82
PRL 2022	44	29	82
HbA1c 2019	894	550	1124
HbA1c 2021	497	303	670
HbA1c 2022	402	303	465

Table 2 Comparison between mean, SD, 95% CI of patients percentage who had a request of enrolled laboratory tests in 2019, 2021 and 2022

Test name/year	Mean (%)	SD	95% CI (%)
TSH 2019	14	0.04	12 to 18
TSH 2021	4	0.01	3 to 6
TSH 2022	4	0.01	3 to 5
FT4 2019	15	0.05	12 to19
FT4 2021	3	0.01	2 to 3
FT4 2022	3	0.01	2 to 3
FT3 2019	13	0.04	11 to 15
FT3 2021	2	0.06	2 to 3
FT3 2022	2	0.01	2 to 3
FSH 2019	17	0.05	15 to 22
FSH 2021	3	0.01	2 to 4
FSH 2022	3	0.01	3 to 4
LH 2019	16	0.05	14 to 22
LH 2021	3	0.01	2 to 4
LH 2022	3	0.01	2 to 4
PRL 2019	25	0.1	19 to 33
PRL 2021	4	0.01	2 to 5
PRL 2022	3	0.01	2 to 4
HbA1c 2019	14	0.02	13 to16
HbA1c 2021	7	0.02	6 to 8
HbA1c 2022	7	0.02	6 to 8

or notification would pop up in the system. Additionally, the project team members carried out 'deconstruction of profile tests'; meaning thereby if hormonal profile had to be requested the physician would have to individually select the hormone tests in it instead of just clicking on hormonal profile. In PDSA4, the selected tests were monitored to observe if the interventions made in PDSA2 and PDSA3 succeeded in controlling excessive and unnecessary test ordering. The rate of tests ordering was also calculated compared with the total number of patients visiting the hospital. Subsequently, the team leader gave monthly feedback about the laboratory tests ordering to the medical administration through a written report.

Study of the interventions

Formulating a policy for laboratory legalisation led to increase the awareness about optimal use of laboratory testing with the aim of changing the mindset of healthcare workers. Modification of the electronic ordering system by using soft S.T.O.P (Sensible Test Ordering Practice) (justification) instead of hard S.T.O.P (automatically rejecting order with or without direct notification of the ordering physician) to permit ordering of some tests, applied more restriction on the ordering physicians also system giving alarm for minimal repetition time for some tests which mean that if a particular test is requested before the indicated time period, a notification would pop up on the physicians computer screen as a reminder. Deconstructing the unnecessary profile tests to decrease the number of many unnecessary ordered tests. A group of physicians from targeted departments were selected

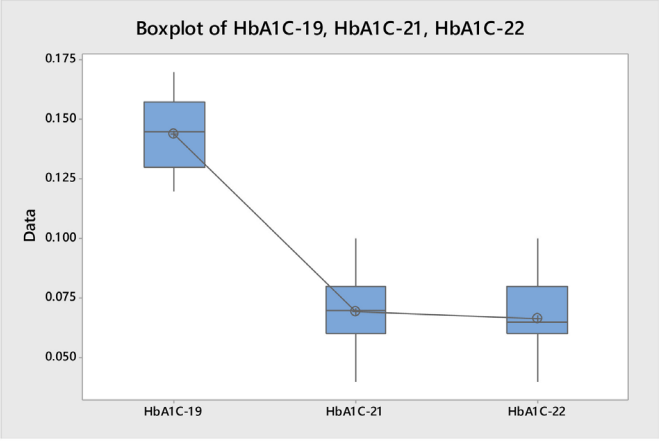

Figure 4 Comparison of distribution of total patients percentage who had a request of HbA1c test from FMC&IM clinic in 2019, 2021 and 2022. FMC, Family Medicine Clinics; HBA1C, Hemoglubin A1c; IM, Internal Medicine.

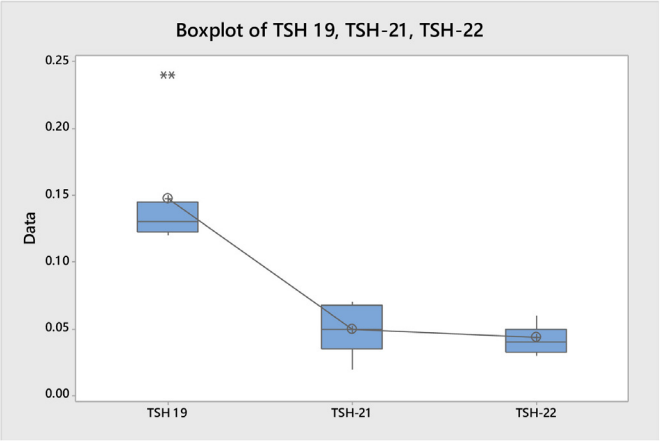

Figure 5 Comparison of distribution of total patients percentage who had a request of TSH test from FMC&IM Clinic in 2019, 2021 and 2022.

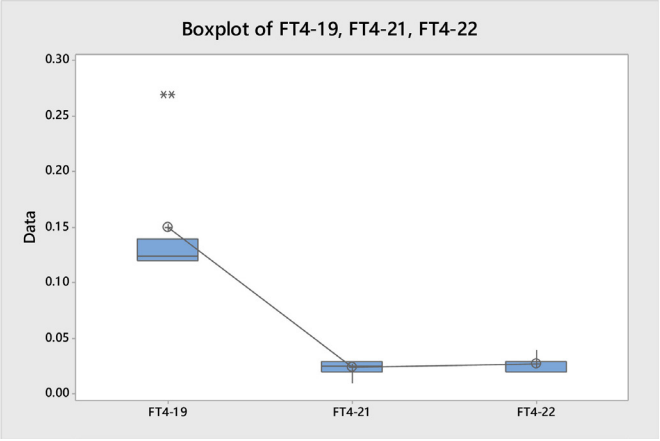

Figure 6 Comparison of distribution of total patients percentage who had a request of FT4 test from FMC&IM Clinic in 2019, 2021 and 2022. FMC, Family Medicine Clinics; IM, Internal Medicine; TSH, Thyroid Stimulating Hormone.

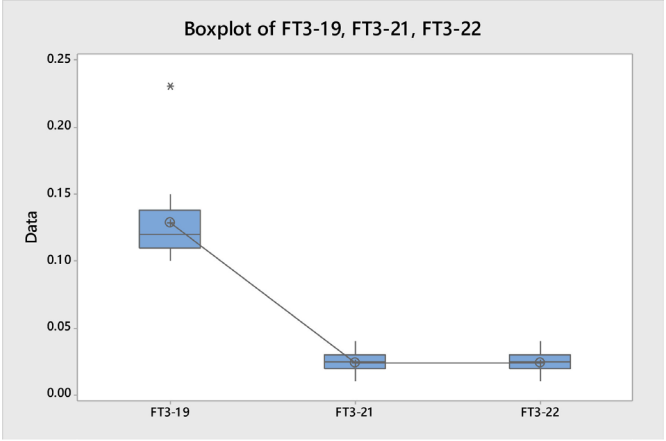

Figure 7 Comparison of distribution of total patients percentage who had a request of FT3 test from FMC&IM clinic in 2019, 2021 and 2022.

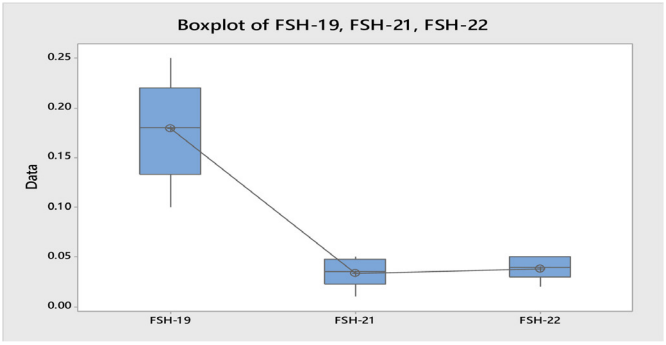

Figure 8 Comparison of distribution of total patients percentage who had a request of FSH test from FMC&IM clinic in 2019, 2021 and 2022.

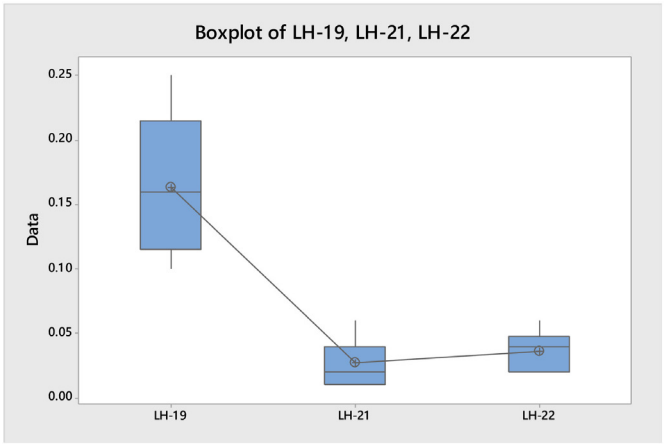

Figure 9 Comparison of distribution of total patients percentage who had a request of LH test from FMC&IM clinic in 2019, 2021 and 2022.

to be involved in the project to ensure continuous monitoring of adequacy of laboratory test ordering.

Measures

The measures to resolve the problem of unnecessary test ordering were adopted for the years 2019, 2021 and 2022. In this the total number of selected tests and the

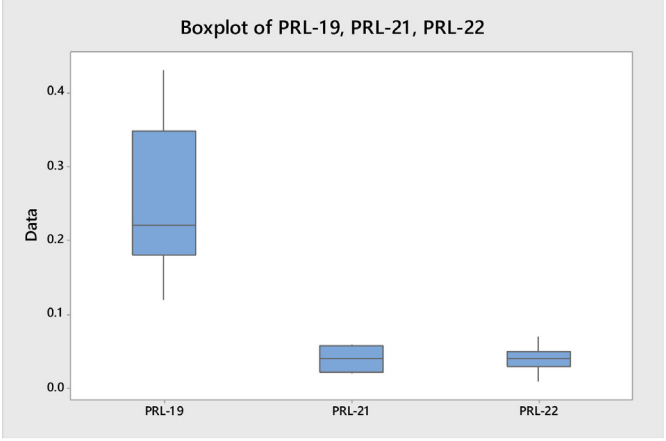

Figure 10 Comparison of distribution of total patients percentage who had a request of PRL test from FMC&IM clinic in 2019, 2021 and 2022.

percentage of patients for whom investigations were ordered was collected retrospectively through HIS. The data of the 3 years were analysed on a month-wise basis using the box plot graphs and comparison tables.

RESULTS

The comparative results (mean, minimum and maximum number) of enrolled laboratory tests in 2019, 2021 and 2022 is shown in table 1. Whereas, the comparison between mean, SD, 95% CI of patients percentage who had a request of enrolled laboratory tests in 2019, 2021 and 2022 is shown in table 2.

After implementation of interventions, the team analysed the data and found that there was a statistically significant difference between 2019 and 2021 of the total patients percentage and distribution as revealed by box plot; HbA1c (p=0.002), TSH (p=0.002), FT4 (p=0.002), FT3 (p=0.001), FSH (p=0.002), LH (p=0.002) and PRL (p=0.001). To ensure the sustainability of such a project the team compared the studied measures between 2021 and 2022 and found that there was no significant differences between 2021 and 2022 of total patients percentage who had a request of HbA1c (p=0.709), TSH (p=0.34), FT4 (p=0.26), FT3 (p=0.82), FSH (p=0.44), LH (p=0.17) and PRL (p=0.88). These are shown in figures 4–10.

DISCUSSION

Summary

The idea of this project started after noting many un-rationalised laboratory orders and increased reagents consumption. After 1 year since we began our project, the most effective tool was formulation of policy and HIS modification which resulted in enhancing the utilisation of laboratory resources and decreasing the level of reagent consumption. The second was to establish effective communication between laboratory and the targeted medical departments to apply the goals of our project and ensure the sustainability of laboratory services.

A study conducted at King Faisal Specialist Hospital and Research Centre, Jeddah focused on inpatient wards and targeted three laboratory tests, that is, complete blood count, renal function test and random blood sugar. They found that about 11% of these tests were repeated, over used and ordered unnecessarily. They recommended two approaches for reducing unnecessary test ordering; one targeting the user and other the investigation ordering system.[9] Our study used these approaches and focused on selected outpatient clinics (internal medicine, family medicine and OB/gynae) and targeted seven different laboratory tests, that is, HbA1C, TSH, FT3, FT4, LH, FSH and PRL. In another similar study where modification was made in ordering system along with physician education was conducted by the emergency department of the Vrije University, Amsterdam Centre and showed a 13% reduction in the total diagnostic costs.[10] Whereas, in our study, we achieved a 33% reduction in total laboratory tests cost and the total laboratory budget decreased from 6 000 000 SR in 2019 to about 4 000 000 SR in 2021. Another interesting and unexpected observation was that there was no reported diagnostic error in spite of reduction in the total laboratory test ordering. In fact, we saw that the request for special tests such as vitamin D and cardiac biomarkers also reduced.

Interpretation

Our interventions led to statistically significant and sustainable reduction in laboratory tests ordering and consumption of reagents. The policy formulation as well as HIS modifications resulted in rationalisation of laboratory test ordering. Engagement of physicians from targeted departments in the project delivered the concept of our aim to their colleagues, which helped to achieve this goal. After implementing the QI interventions, the number of thyroid function tests, HbA1c, FSH, LH and PRL have become more rationalised and convenient. The money saved from the laboratory budget was available to ensure uninterrupted test services and add more tests to the laboratory investigation inventory.

Limitations

Even though all stakeholders were consulted before implementation of the project but no formal written survey was conducted to assess the physicians opinion on unnecessarily ordered tests or about the intervention to reduce them. Also, no survey was conducted post each PDSA cycle to assess improvement or difficult in the physicians work.

The data of test comparison were made between 2019, 2021 and 2022, however, the year 2020 was disregarded, due to the COVID-19 pandemic, which led to the partial cessation of work during that year.

CONCLUSION

A change in laboratory resources consumption requires changes in physicians awareness and behaviour. Knowledge and attitude concept must regularly be targeted in acquiring and sustaining behavioural changes. A modification of the electronic ordering system applied more restriction on the ordering physicians. Significant decrease in laboratory testing are achievable but would require much more effort at better defining unnecessary testing and linking optimal testing strategies with patient outcomes. Introduction of a few simple measures to improve awareness among the physicians led to a significant reduction in the total laboratory budget. Extending these measures to the entire hospital and even entire country might lead to significant reduction in the healthcare costs.

Twitter Ahmed Dighriri @N/A and Matrah Rabia Ali @NA

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Competing interests None declared.

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Patient consent for publication Not applicable.

Ethics approval Project interventions did not affect patient safety and quality of medical care. In other hands did not add any burden to the hospital budget or required any financial support. Ethically approved consent has been requested and obtained from the AFHJ research ethics committee.

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