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Improving Utilization Management of Laboratory Tests Ordered for Chemotherapy Patients in Johns Hopkins Aramco Healthcare

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Abstract

Background: Laboratory testing is a fundamental diagnostic and prognostic tool to ensure the quality of healthcare, treatment and responses. Our study initial goal was to evaluate the cost of the currently performed laboratory tests for patients who are undergoing chemotherapy treatments in our organization's Oncology Treatment Center. Secondarily to reduce the cost of unnecessary lab tests by 50% in one year period.

Methods: This was a cross-sectional observational study. The intervention strategy involved implementing the British Columbia Cancer Agency (BCCA) guidelines in the patient's EHR, to be followed by oncologists when ordering lab tests for chemotherapy patients. Data were collected for 200 cases with 10 different chemotherapy protocols post-intervention, and a paired t-test was used to compare the cost differences pre and post-intervention.

Results: Data analysis demonstrated a significant cost reduction in unnecessarily performed lab tests (77%, $p<0.01$), when following the BCCA guidelines.

Conclusions: Lean-thinking in clinical practice realized by integrating a standardized laboratory test guided by BCCA guidelines into the EHR in our organization has significantly reduced the financial costs within one year. Thereby enhanced efficient resource utilization and increased awareness for further efforts to expand such practice to be applied to the other treatment protocols.

Keywords: Unnecessary lab tests; BCCA guidelines; Lean thinking; Efficient utilization

Introduction

Laboratory testing is fundamental to ensure quality healthcare. It serves as a tool for diagnosis, prognosis and a guide for treatment decision and response. Laboratory medicine is a high demand activity in clinical care which requires continuous testing utilization by scrutinizing appropriate needs [1]. Numerous studies have estimated 20%-30% overutilization and a substantial increase of unnecessary spending on healthcare institute resources due to unnecessary testing and procedures that did not contribute to improved patient care [2,3]. Understanding the value of laboratory medicine is vital for the optimal use of the patient testing. Commonly, pathologists are champions of lab test utilization assessment, as they observe testing behaviours and trending patterns and can manage testing algorithms by suggesting alternatives [4,5]. However, test selection is a complicated process that is sensitive to the patient and physician, and is influenced by laboratory-related factors as well as hospital strategies [6].

Clinical Decision Support systems (CDSs) have become widely recognized as important tools to ensure patient safety during healthcare decision-making. These Information Technology (IT) systems are widely applied in laboratory medicine to order diagnostic and treatment monitoring tests, as an integral part of the patient Electronic Health Record (EHR), which supports holistic patient centred care [7,8]. Additionally, applying Evidence-Based Medicine (EBM) in the era of EHR is highly promising, provided that it is a user friendly system [9,10]. Research demonstrates a positive economic impact of the CDS-incorporated EHR in improving healthcare efficiency [11].

Our organization follows the British Columbia Cancer Agency (BCCA) guidelines for treating oncology patients who are scheduled for chemotherapy. These guidelines cover the cancer care spectrum from prevention, diagnosis, and treatment to palliative care, and include established cancer management guidelines and protocols for proper care [12]. This quality improvement project is intended to study the efficiency of the utilization management in our Oncology Treatment Center (OTC). Through following BCCA guidelines to reduce laboratory tests volume and reduce unnecessary financial strains on our healthcare system. Definitely, with paying attention to patient factors, importantly, treatment outcomes and patient satisfaction. In addition to provider factors including alignment with organization goals seeking patient safety as well as continuity and sustainability.

The initial goal of this study was to evaluate the cost of the currently performed laboratory tests for patient undergoing chemotherapy treatments, and how they are in agreement with the guidelines used in our OTC. The secondary goal was to reduce the cost of unnecessary lab tests by 50%, in addition to reducing the cost of the total performed lab tests by 40% in a one year period.

Materials and Methods

This is an observational study, a quality improvement initiative. Considering this project as a lean 6-sigma project, we followed the

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DMAIC methodology to accomplish our goals. (DMAIC comprises the steps of: Defining the problem, Measure the baseline, Analyse the current situation, Implement the intervention, and Check/control the improvement).

Defining the problem

Oncology institute setting: Johns Hopkins Aramco Healthcare (JHAH) is a 300-bed tertiary hospital located in the Eastern Province of Saudi Arabia. It offers the medical care for its beneficiaries including employees and their families with full financial coverage. The Oncology Institute in our hospital provides care for hundreds of oncology patients per year, where the treatment is provided in the ambulatory clinic.

Previous practice: Until 2019, the laboratory tests were ordered by oncologists/haematologists through our EHR system (Epic) before the initiation of any chemotherapy cycle treatment (within 7 days). It was noticed that a panel of lab tests is almost ordered for all cancers almost equally, rather than disease-specific tests per the BCCA guidelines, which is the reference for treatment protocols in our Oncology Institute. Obviously, there are unneeded lab tests ordered for different chemotherapy protocols that would not contribute to decision-making or improve patient outcomes in any way for that specific cycle of chemotherapy, with minding patient's chemotherapy reaction and outcomes of course.

Opportunity statement: The oncology institute in our hospital can improve this practice through standardization of oncology clinician utilization of the current BCCA guidelines/recommendations for different chemotherapy protocols; these guidelines are only for patients who are going to receive treatment. This intervention will reduce the cost of extra unneeded lab tests, in addition to the total performed lab tests for oncology patients. Ultimately it improves utilization management with a zero cost action plan.

Measuring the baseline and analysing the current situation

Baseline data were collected, as a pilot, to investigate the status of ordering the lab tests through a cross-sectional retrospective analysis of 20 medical records for oncology patients with 10 different chemotherapy protocols from June to August 2019. The available chemotherapy protocols were ABVD, AC Taxol, Bortezomib, Avastin/Xeloda, Carfilzomib, Gemcitabine cis, RCHOP, TCH, Docetaxel, and PTD.

Firstly, we wanted to evaluate our adherence to the BCCA guidelines in ordering the proper lab tests for each chemotherapy protocol, according to patient health status. Secondly, to compare the number and the cost of lab tests ordered as per current practice versus the same when following the BCCA guidelines. The laboratory tests included CBC, renal panel, hepatic panel, and electrolytes panel. The prices for all lab tests were obtained from financial department.

Quality improvement initiative goals:

1. To calculate the cost of the currently performed laboratory tests for patient undergoing chemotherapy treatments, and how they are in agreement with the BCCA guidelines.
2. To reduce the cost of "extra unnecessary lab tests" by at least 50% and the cost of the "total performed lab tests" by 40% within one-year (from January to December 2020), after implantation of the action plan.
3. To ensure the continuity of such intervention during the second year (during 2021) and onwards to confirm the sustainability, to manage the utilization of oncology resources and reduce the costs on our organization.

Implementation of intervention

The intervention started in September to December 2019; it included an "end user approach" and a "system approach".

The end-user approach included educational sessions for oncologists, nurses, and clinicians to follow the BCCA guidelines in ordering the required lab tests for each treatment protocol, in addition to explaining the benefits of evidence-based guidelines:

1. Reducing the extra unneeded lab tests
2. Reducing waiting time and invasive procedure (during blood collection)
3. Increasing patient satisfaction
4. Decreasing workload on lab staff and lab materials
5. Helping stat orders to be processed faster
6. Implementing an action plan with zero cost
7. Improving utilization management at the Oncology Institute
8. Sufficient use of our resources for cost-effectiveness

The system approach included integrating the BCCA guidelines into the EHR (Epic). Initial consensus on the source of guidelines to be followed was achieved by all oncologists, oncology nurses, and clinicians, then they were made live in Epic to alert the users of the needed lab tests for each specific treatment protocol during order entry (Figure 1). This is not a strict template however, it is implemented in Epic in a way that enables oncologist and oncology clinicians to individualize the chemotherapy related lab tests based on patient condition. The final step was to monitor the changes closely throughout the time of the study onwards and ensuring that the integrated BCCA guidelines were followed as planned.

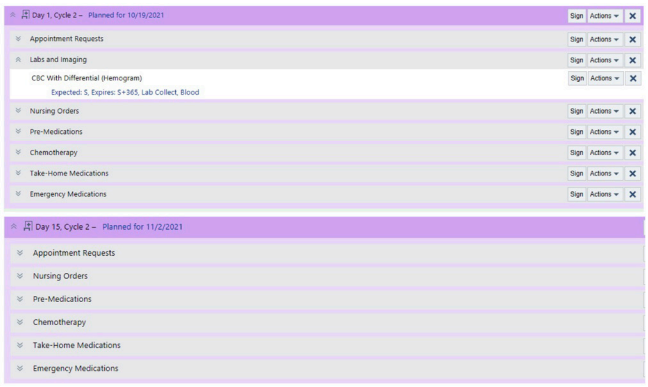

Figure 1: A snap shot from Epic was taken after implementing the BCCG guidelines, from an active treatment plan for a patient receiving ABVD shows that Day 1 Cycle 2 a lab (CBC) test is required while in Day 15 Cycle 2 there is no lab test required.

Checking/Controlling the improvement

Data were collected retrospectively (from January to December 2019) for 200 oncology patient with chemotherapy treatment plans, including the 10 protocols that were included in the baseline, to represent the "pre-intervention" data. Likewise, "post-intervention" data were collected (from January to December 2020), including 200 cancer

patients with matching courses of chemotherapy protocols.

Key Performance Indicators (KPIs)

KPI "Outcome measure" 1: The cost of the extra unnecessarily lab tests, defined as the average cost of the extra unnecessarily performed lab tests after adherence to BCCA guidelines.

KPI "Outcome measure" 2: The cost of the total performed lab tests, defined as the average cost of the actual total performed lab tests.

Data retrieval and analysis

JASP software (version 0.14.1; Amsterdam, the Netherlands) was used for statistical analysis.

Results

Baseline data analysis

The baseline data analysis showed that the Oncology treatment center paid around 104,709 USD for 1085 lab tests performed for 20 patients who received 10 different chemotherapy protocols. However, with a simple calculation for an estimated actual cost would be around 35,085 USD for 409 lab tests when the recommended BCCA guidelines were followed. This in turn demonstrates an estimated financial loss of 69,623 USD, which is about 33.5% higher than the actual cost, as illustrated in Figure 2.

Post-intervention data analysis

KPI 1 (The average cost of unnecessary lab tests): The analysis revealed that approximately 434,867 USD were spent on "extra unnecessary lab tests" for (n=200) cases collected for pre-intervention, calculated by subtracting the needed lab tests per the BCCA guidelines from the overall performed. In comparison to 98,400 USD the cost of similar number of lab tests for comparable cases collected for the post-intervention. This shows a significant cost reduction of "unnecessary lab tests" by 77.4% for 200 cases (paired t-test $p<0.01$) (Figure 3). Although there were still extra lab tests ordered at the clinician's discretion, an amount of 336,467 USD was saved for 200 cases.

KPI 2 (The average cost of the total performed lab tests): Data analysis illustrated that about 739,440 USD spent on total of 6970 lab tests actually performed for the (n=200) patients pre-intervention, comparing with 403,333 USD for 4010 total lab tests performed for the same number of cases post-intervention. That reflects a 45.5% reduction in the total cost of all performed lab tests (including necessary and unnecessary), (paired t-test, $p<0.01$) (Figure 4). The financial saving is around 336,107 USD for 200 cases.

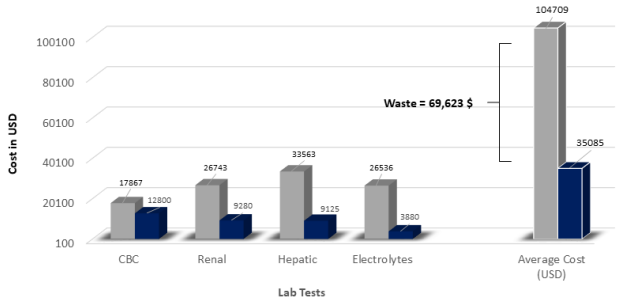

Figure 2: Lab Test Costs for "Actually Performed" vs. "Recommended by Guidelines". **Note: (** **)** Cost for "performed" lab tests without adhering to guidelines, **Note: (** **)**Cost of performed lab tests as per "BCCA guidelines".

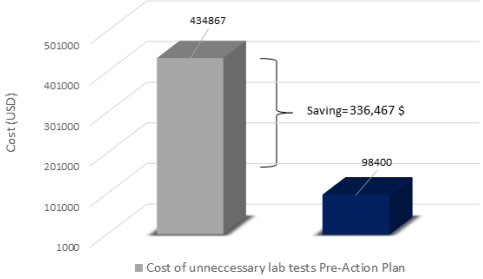

Figure 3: The average cost of unnecessary lab tests post-intervention comparing to pre-intervention, for 200 cases with 10 chemotherapy protocols.
Note: ( ) Cost of Unnecessary lab tests pre-action plan. ( ) Cost of Unnecessary lab tests post-action plan.

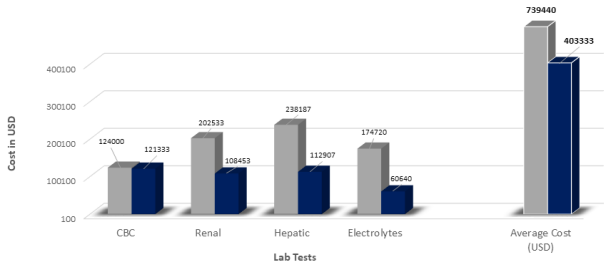

Figure 4: The average cost of the total performed lab tests pre-intervention (without adhering to BCCA guidelines), versus post-intervention (adhering to BCCA guidelines), for 200 cases with 10 chemotherapy protocols.
Note: ( ) Cost for "Total performed" lab tests pre-intervention. ( ) Cost for "Total performed" lab tests post-intervention.

Discussion

Oncology is an important body of content knowledge with increasing complexity in terms of cancer typing, staging, prediction, biomarkers, and therapy decisions. The clinical care of cancer patients undergoing chemotherapy treatment requires baseline blood tests prior to each treatment cycle for proper dosing, as the laboratory results change with disease progression [13]. To date, guidelines embedded within the patient EHR, including required laboratory tests for each step, are essential for proper decision-making. The foremost benefit is patient safety, effective quality of care, and improved healthcare system efficiency and management capability [14,15]. Physician-ordering practices for lab tests have been researched in many studies worldwide; they have been observed to be the main reason for laboratory overload and require management rationalization [16,17].

A literature review indicated that numerous quality improvement initiatives are in place to manage the efficient utilization of laboratory tests for patient care. For instance, the Academy of Medical Royal College in the United Kingdom established a guide to conserve healthcare resources and promote the value of healthcare. This guide or toolkit assists physicians and clinicians in effectively utilizing healthcare resources, resulting in improved quality and quantity of patient care [18]. We intended to apply a similar approach in our organization, where the oncologists tend to order a list of laboratory tests that are available in the hospital laboratory to ensure the eligibility and readiness of the cancer patient to receive their chemotherapy dose.

Medical laboratories experience high-volume activity and consume the largest portion of the cost of healthcare [19]. It has been estimated that more than 6 billion USD, a figure that is expected to grow, is spent on no-value-added tests or procedures [20]. Certainly, utilization measures must be implemented to prevent the catastrophic collapse of healthcare systems [21]. Clinicians face challenges in selecting proper, efficient, and safe laboratory tests for diagnosis or monitoring of a disease, which can result in adverse clinical and financial consequences [22]. A study conducted in Saudi Arabia revealed that the physicians were responsible for 10% of actual over-utilization of lab test orders, and recommended a health informatics system approach [23]. Therefore, to improve patient outcomes in the first place and to efficiently utilize resources, lab tests must be ordered appropriately, guided by evidence-based practices that are built within the EHR. However, the feasibility of integrating clinical bundled guidelines, the quality of evidence on which they are based, clinician perceptions/preferences, and the potential for waste reduction are challenges that need further assessment [24].

Our study revealed a significant cost reduction by 77.4% for the extra unnecessarily performed lab tests ($p<0.01$). In addition to a 45.5% reduction in the cost of the total performed laboratory tests for oncology patients undergoing chemotherapy treatment, when following the BCCA guidelines that are built into our patient's EHR ($p<0.01$). Undoubtedly, patient factors including treatment outcomes were ensured not to be jeopardized during this study, in addition to other factors such as patients inconvenience, discomfort or anxiety. Interestingly, random interviews with patients, during the study period, indicated their satisfaction with the new intervention as lower volume of blood sample to be collected. This should be compared to a controlled clinical trial conducted at Johns Hopkins International of Medicine-Baltimore that found an 8.6% decrease in the number of lab tests per patient in the active arm of their study, while there was a 5.6% increase in the control arm [25].

Although research studies lack a comparative analysis of cost-outcome metrics, the assimilation of Clinical Decision Support Systems (CDS-EHR) is highly promising for waste reduction and utilization control in healthcare resources [26]. Press's usability testing study has showed that a CDS tool implemented in the emergency room allowed an efficient execution of patient care by users [27]. A similar tool was used together with other behavioural intervention strategies in a cost-effective analysis clinical trial conducted by Gong, who succeeded in reducing inappropriate antibiotic prescriptions, and consequently the costs, in addition to enhancing potential clinical benefits for patients [28]. Moreover, reducing the low-value lab tests decreased the phlebotomy-required tools and the collected blood volume, and thus inconvenience, discomfort, and patient anxiety [29] which was successfully confirmed in our study. Furthermore, all the seven oncology physicians (100%) in our organization's Oncology Treatment Center (OTC) admitted that such intervention alerted their behaviour towards ordering the only required lab tests, thus reflected on the cost of lab tests accounted on the OTC, relative to 81% of the physicians included in Horn's study [30].

Our successful intervention strategies with simple performance measures led to a statistically significant reduction in the number and cost of unnecessary lab tests. This had a substantial effect on improving efficiency in healthcare resource utilization in our hospital, taking in consideration that this is aligned with the organizational goals seeking patient safety in first place. Additionally, sustainable improvement has been ensured by data collected in the next year (January to December 2021), which showed similar numbers and percentage of improvement. Indeed, quality improvement can offer an enormous financial return as well as increase awareness of further efforts to expand such practice. Certainly, an extensive impact would be witnessed when implementing similar intervention to other oncology treatment protocols, including

immunotherapy, biological, hormonal, palliative, and radiotherapy.

Conclusion

This quality improvement initiative in our hospital's Oncology treatment center is built on the success of other healthcare organizations and applied lessons learned. Non-adherence to evidence-based guidelines leads to excessive unnecessary utilization of healthcare resources. However, implementing a standardized laboratory tests recommended by BCCA guidelines into the EHR has improved efficiency, thereby reduced financial strains on our organization.

Limitations

Unfortunately, we could not find another facility in the kingdom or GCC that did similar project to compare our data validity with. Moreover, we decided to start our quality improvement project including only the chemotherapy protocol and the laboratory tests related to the chemotherapies available in our organization. However, the plan is to expand this intervention to the other oncology treatment protocols (i.e. immunotherapy, radiotherapy biological, hormonal, and palliative therapy).

Authors' contributions

IAJ and SAG came up with the initiative, collected the required data, participated in oncology staff education, and reviewed the analysis and the manuscript. NAF and JS provided the administrative support including integrating the clinical guidelines into the electronic health record, participated in oncology staff education, and reviewed the analysis and the manuscript. HAS formulated the quality improvement project set up and guidelines, carried the data analysis, interpretation and created the full manuscript writing.

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Availability of Data and Materials

Original raw data are available with corresponding author if requested.

Ethics Approval and Consent to Participate

An approval was granted by the Ethics Committee of Institutional Review Board in our organization (November 30, 2021/IRB # 21-35). Informed consent was waived for this quality improvement initiative.

Statements and Declarations

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