

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 implementation 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.

patients with matching courses of chemotherapy protocols.

of 69,623 USD, which is about 33.5% higher than the actual cost, as

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

immunotherapy, biological, hormonal, palliative, and radiotherapy.

Conclusion

is 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.

Acknowledgments

We would like to thank Epic team for their marvellous help in incorporating the BCCG guidelines into Oncology workflow and making it user friendly.

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

26. Ambinder EP (2005) Electronic health records. *J Oncol Prac* 1: 57-63.
27. Press A, McCullagh L, Khan S, Schachter A, Pardo S, et al. (2015) Usability testing of a complex clinical decision support tool in the emergency department: Lessons learned. *JMIR Hum Factors* 2: e14.
28. Gong CL, Zangwill KM, Hay JW, Meeker D, Doctor JN (2019) Behavioral economics interventions to improve outpatient antibiotic prescribing for acute respiratory infections: A cost-effectiveness analysis. *J Gen Intern Med* 34: 846-854.
29. Harb R, Hajdasz D, Landry ML, Sussman LS (2019)