EDITORIAL

Editorial Process: Submission:12/18/2022 Acceptance:01/22/2023

Operations Management Interventions in Cancer Care Delivery in LMICs: The Way Forward

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Asian Pac J Cancer Prev, **24 (1)**, 1-7

Abstract

Cancer care sector has received significant attention worldwide after an increase in cancer incidence and related mortality every year. There is a large disparity in access to care for cancer patients in view of increasing case number, limited and urban centric cancer care facilities and resource intensive management of cancer along with many other socio-odemographic factors. Cancer care delivery is facing many operational challenges at different steps of care globally and it is more pronounced in LMICs. Research directed towards Operations Management (OM) research can provide solutions to many of the challenges encountered during different steps of cancer care and can help us to manage cancer care delivery landscape with cost cutting and quality improvement. The promising abilities of OM is often overlooked for improving various aspects of cancer care despite the fact that its deployment can create OM surplus where the capitals can be tapped to improve the quality of care for the cancer patients. This paper discusses that fundamentals of OM principles must be implemented for creating resilience and gaining effectiveness and efficiency throughout the cancer care operations.

Keywords: Operations management- cancer care- LMICs- resource utilisation- outcome

Introduction

Many LMICs with weak, under-resourced health systems, are struggling to cope with the rapid rise in non-communicable diseases including cancer but at the same time, infections and malnutrition are still persisting (Shankar et al., 2018). Cancer has emerged as an important public health issue globally and outcomes are more compromising in India and other developing countries in Asia, Africa and Latin America. There is a large disparity in access to care for cancer patients in view of increasing case number, limited and urban centric cancer care facilities and resource intensive management of cancer along with many other sociodemographic factors. A continuous decline in mortality was reported over recent years in view of increased awareness, improvements in early diagnosis and increased availability of evidence-based treatments (Shankar et al., 2015).

Oncologists spend most of their time in diagnosis and treatment of cancer patients and face many operational challenges in cancer care delivery on a daily basis. Although things are changing in LMICs including India, orientation, passion and dedication towards using different approaches to strengthen cancer care is still missing. There is not much effort to ensure how to utilize the best available resources to have a desired outcome.

Resource intense cancer care delivery demands leaders to take charge of their operations. An operation focused delivery with an aim to reduce costs, increased safety, improved clinical outcomes will allow an organization to compete effectively in an aggressive marketplace. These approaches are not quite popular and easily thought of, which can actually play a vital role in cancer care delivery in not only eliminating disparities in care delivery but also rendering an effective, efficient, timely, safe, and patient centric care (Issabakhsh et al., 2021; Saville et al., 2018).

The cost of cancer care is also increasing like any other domain of health care. These increasing costs are making the cancer care delivery less affordable and accessible for the patients and certainly bringing disparities in accessing quality care (Levit et al., 2013).

There are three primary facets of the cancer care delivery challenges in terms of planning, scheduling, and assignment. Cancer treatment planning consists of selection choices. There are many cardinal planning steps in cancer treatment delivery, starting from calculation of number of days for treatment and recovery along with drug doses consumption per day. The planning scopes are defined in terms of patient planning, treatment planning, and oncologist planning (Hadid et al., 2022). Appointment with an oncologist, treatment prescription, number of days of treatment, drugs and patient preparation fall into the scheduling scope. The assignment furnishes the care by assigning the patients to the concerned and requisite

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resources that could be oncologists, nurses, equipment, etc.

The above discussed three scopes were discussed in a study by Turkcan on integrated operations planning and scheduling for chemotherapy (Turkcan et al., 2012), whereas Condotta and Shakhlevich presented a case study for patient's appointment scheduling through multilevel templates (Condotta and Shakhlevich, 2014). Alvardo and Ntaimo and Issabakhsh employed integer programming to model chemotherapy appointment scheduling (Alvardo and Ntaimo, 2018; Issabakhsh et al., 2020). Hooshangi developed a scheduling procedure to improve the patient care services for an oncology unit (Hooshangi-Tabrizi et al., 2020).

The goal of this editorial is to compile the evidence demonstrating OM approaches to address different aspects of cancer care, as it is critical to improve quality of cancer care with the use of updated approaches for better access and outcomes for cancer patients.

Cancer prevention strategies to boost cancer care

It is a well-known fact that more than half of the 11 most common cancers are preventable with different approaches. The risk of developing these cancers can be minimised by health promotion activities, lifestyle changes in terms of quitting tobacco and alcohol, minimizing risk of infections, vaccination against HPV and Hepatitis B (Anand et al., 2008).

Tobacco and Alcohol control

Tobacco is responsible for half of the preventable cancer death globally with major contribution by lung and head and neck cancer (Asthana et al, 2016). Worldwide, tobacco is consumed in various forms like cigarette smoking, cigar, bidi, paan, taibur (in NER, India), gutkha. Thus, tobacco control and smoking cessation strategies are required to reduce the burden of cancer, cardiovascular and respiratory diseases (Vineis et al, 2004). Many policies, rules and regulations are implemented by many LMICs to prohibit or reduce the use of tobacco products but successful implementation and enforcement have been biggest operation challenges.

Alcohol intake increases the risk of head and neck, gastrointestinal, breast and colorectal cancer. In European Prospective Investigation into Cancer and Nutrition Study (EPIC Study) with 350,000 individuals and nearly 70% women participant, 10% and 3% of cancer cases were reported in former and current alcoholic respectively (Schütze et al., 2011). IARC has categorized alcohol as a carcinogen and increases the cancer risk by 2.3 times (Singhavi et al, 2020). There is a need to regulate the alcohol use through various operation management approaches as there is no safe limit of alcohol.

Cancer Vaccination

Some of the cancers like cervical cancer, stomach cancer and hepatocellular carcinoma are caused by infection. Human Papilloma viruses (HPV) infection is associated with cancer of cervix, vagina, vulva, oropharynx, and anal canal in females and cancer of oropharynx, anal canal and penis in males. Hepatitis B and C virus infection is associated with hepatocellular carcinoma, Helicobacter pylori (H. pylori) infection with stomach cancer and Epstein-Barr virus (EBV) infection with nasopharyngeal carcinoma and lymphoma (de Martel et al, 2020). Millions of populations have already vaccinated and vaccine have been reported to be effective in reducing the risk of genital warts, precancerous lesions and invasive cervical cancer.

Lack of awareness regarding HPV vaccination, the importance of the vaccine, and high cost reported as the major barrier to HPV vaccination (Das et al., 2018; Di Giuseppe et al., 2008). Many of the LMICs are considered to be a slightly conservative country where taboo for cervical cancer still persists in view of sexual mode of HPV transmission. Poor HPV vaccine awareness among people, along with uneasy access and high cost of vaccine, vaccine myths make whole operation challenging. Awareness through different channels can be one of the interventions which can help us to achieve the end goals. HPV vaccination is not available to free of cost as part of National Immunisation program in any of the LMICs, so uptake is very poor.

Cancer risks can be reduced by tackling the risk factors and operations management perspectives can be useful to choose the best suited strategies. Hall demonstrated the decision making in choosing the best approach to reduce the number of smokers in the USA (Hall et al., 1992). Another study conducted in 20 countries by Kim was focused on the assessment of cost effectiveness of HPV vaccination programme and about cytology-based screening in three countries (Kim at al., 2013). This study found that vaccination is cost-effective in most countries if available at lower price, but higher price of vaccine made cytology-based screening a cost-effective strategy for cervical cancer care.

There is always a challenge in deciding the best suited strategy to implement health promotion activities, HPV vaccination and tobacco cessation activities at community level in view of limited resources in LMICs. OM approaches in this specific area can help the cancer care professionals to make a better impact at ground level implementation.

Cancer Screening in LMICs

There are many studies on how models have been used to influence screening decisions in different settings, although results have not been validated in day-to-day practice. Zai introduced a screening appointment system, by modelling the IT workflow and staff responsible for communicating reminders to minimise average number of overdue screenings per patient. Simulation technique used in this study predicted that the invitation system would reduce overdue screenings per patient in the long run. They also found that overdue screenings can be reduced by increasing intervals between two screenings and by increasing the numbers of staff involved with the invitation process (Zai et al., 2014).

Organized cancer screening programs do not exist in most LMICs except India, where there is a focused National program and framework for screening of common cancers i.e., Cancer of breast, cervix and oral

cavity. Existing health-service infrastructure, human resources, and meagre health-service investments often preclude the possibility of introducing and sustaining cancer screening programs in in LMICs. Substantial investments in improving health care infrastructure, human resources, and improvisation systems will be required to improve early detection and treatment of cancers in LMICs (Sankaranarayanan, 2014).

Breast cancer screening strategies

The majority of breast cancer screening papers focused on mammogram screening strategies in relation to time and frequency of screening. Familial predisposition and presence of gene mutation need a modified screening schedule. O'Mahony built a simple mathematical model to demonstrate that different risk levels have different optimal screening intervals (O'Mahony et al., 2015). There are risk stratification models using operations management approaches which can guide the breast cancer screening program more effectively by screening the eligible candidate only. OM approaches can help us to decide about the test of choice and age of screening in population and institution-based screening by taking cost, feasibility, approach, uniformity, planning, scheduling, and assigning into an account.

Cervical cancer screening strategies

McLay and colleagues considered three different performance measures (number of cervical cancer deaths, number of life years lost due to cervical cancer and cervical cancer incidence), and optimised separately for each of them (McLay et al., 2010). Pilgrim and Chilcott worked on a model to smoothen the process of time of the smear test, reporting cervical smear to patients receiving results with an aim to reduce the waiting time for the test results (Pilgrim and Chilcott, 2008). There are three different methods of cervical cancer screening with variation in population and institution-based approaches. As there is so much stigma related to cervical cancer screening in LMICs, OM approaches can help to increase screening uptake in low socioeconomic populations at risk.

Colorectal screening strategies

Campbell investigated the effect of screening the general population with colonoscopy in reference to surveillance and high risk (Campbell et al., 2017). Hosking used a combination of discrete event simulation and system dynamics by working both on supply and demand interventions to understand the likely impacts of different interventions to increase the screening uptake (Hosking et al., 2013). Colorectal cancer screening is resource intense and needs technical expertise to get a desired outcome. OM approaches can help us to find the high-risk population, suitable strategy and test of choice for proper utilisation of limited resources in LMICs.

Prostate cancer screening strategies

There are many studies in reference to prostate cancer screening which assess different models in terms of quality-adjusted life years (Bertsimas et al., 2016) and budgetary constraints (Rauner et al., 2010). With an increase in life expectancy and more ageing population in many LMICs, prostate cancer has become important. It is now debatable to adopt prostate cancer screening in view of improved outcome globally and advocating it in LMICs with low resources will not be justified.

Although population-based programs are offering a unique opportunity to get people screened as per the age and risk factors. In spite of the best efforts, most of the LMICs are unable to do cancer screening for the general population with the screening tests which have shown mortality benefit. Most of the LMICs are adopting screening tests based on feasibility and practical approaches in view of operational challenges. Major operations challenges encountered in LMICS are poor organization, lack of coverage, and lack of quality assurance. The challenges in introducing high-quality screening in LMICs have led to evaluation of alternative screening approaches such as visual inspection with acetic acid (VIA) for cervical cancer, clinical breast examination (CBE) for breast cancer and Oral visual examination (OVE) for oral cancer. Apart from screening uptake, improving cancer awareness and access to early diagnosis and treatment in health services is a valuable breast cancer control option in LMICs. Organized lung and colorectal cancer screening programs are in early stages of development in few LMICs (Shankar et al., 2019). To date, there is insufficient evidence to support the introduction of population-based stomach, ovarian, and prostate cancer screening in public health services (Sankaranarayanan, 2014).

Locating screening facilities

Locating screening facilities can be a herculean task in LMIC where facilities are located in urban areas. Haase and Müller fixed a minimum demand at each center in order to ensure quality and also discussed the location of screening centers to maximise the screening uptake. OM approaches improved both the efficiency and coverage of screening in spite of fewer facilities available in the area (Haase and Müller, 2015).

Following up screening tests

Following up the patients after a positive screening test is of utmost significance for timely initiation of diagnostic and treatment procedures. Most of the time, screen positive patients are not routed to the cancer care center on time as there is a lack of continuum of cancer care in LMICs in view of linkages to the tertiary care centre. Two studies suggested the management algorithm after an abnormal mammogram on screening (Chhatwal et al., 2010; Alagoz et al., 2013). These studies also aimed for early identification of high-risk breast cancer cases with a justification in terms of treatment expenses, fear and anxiety and the possible harm by undergoing further diagnostic tests.

There are many OM concerns in continuing cancer screening services, starting from incorporation of these facilities as a component of comprehensive care, patient travelling to respective departments for screening of different cancer types, incorporation of cancer screening under one roof, and process optimization.

Cancer diagnosis and staging

Cancers are diagnosed following abnormal signs and symptoms in an individual, an abnormal screening test result, incidental detection of suspicious lesion. All the individuals who are suspected to have cancer undergo different diagnostic tests to reach a diagnosis or exclude a diagnosis of a particular cancer and then further stage it.

Managing diagnostic resources

This is always an issue in allocation of resources in cancer care where the same facility is required in two different settings. Lee and colleagues formulated a mixed-integer program for the delivery of nuclear medicine services (Lee et al., 2014). Güneş addressed the problem of allocating colonoscopy resources between screening and symptomatic patients by tactical decision making. They developed compartmental models, in which they put patients with similar cancer type and stage requiring similar services in one compartment (Güneş et al., 2015).

Factors like staff-to-room ratio, appointment timing and turnaround time, expertise of doctors and latest diagnostic machines are important operations considerations to have a diagnostic accuracy. One study experimented with changing the staff-to-room ratio, appointment timing and turnaround time and recommended two rooms per endoscopist along with optimal gap between two appointments to decrease the waiting time without lengthening the clinic day. Another study found that overbooking is the most successful strategy by comparing the effect of overbooking versus alternative strategies to reduce missed appointments (Berg et al., 2010; Berg et al., 2013).

Staging accuracy

Stage of the cancer guides the scheme of treatment and plays a vital role in delivering the appropriate treatment as per the stage for a better outcome (Ekaette et al., 2006). We have now moved from the era of basic diagnostic to an era of advanced diagnostic and there is a large disparity in access to advanced diagnostic which makes the cancer staging in LMICs non uniform. Cancer staging along with molecular diagnostics are the backbone to start evidence-based cancer treatment. Different OM approaches can be used to decrease the gap in diagnosis by optimally using the diagnostic facilities.

Cancer treatment

Cancer is primarily treated with surgery, chemotherapy and radiotherapy either alone or in different combinations. Multidisciplinary teams are needed to deliver the cancer treatment and the whole procedure is resource intense.

Treatment decisions

Treatment decisions are taken based on stage of the cancer, patient preference and performance status. Algorithm for making treatment decisions for prostate and kidney cancer was described in two studies (Simon, 2009; Suner et al., 2012). In order to calculate the survival benefit of chemotherapy depending on its hazard ratio and the stage of the disease, researchers developed a mathematical model based on proportional hazards (Utley et al., 2006).

Access to treatment

There is always an issue of locating treatment centers for which various models have been explored to make the cancer treatment more accessible. The p-median method is widely used for locating treatment centers which minimizes the total demand-weighted distance between each patient and the nearest radiotherapy center. Chahed addressed the problem of efficiently supplying chemotherapy drugs to patients in their homes but it is not safe to deliver chemotherapy at home without supervision of health care professionals (Chahed et al., 2009).

Performance of cancer treatment centers

There is an increased need to focus to design appropriate performance measurement for a radiotherapy centre. Baesler and Sepúlveda worked on finding different resources required in a chemotherapy center by using a goal programming simulation-optimisation method. Multiple objectives (waiting time, chair utilisation, closing time, and nurse utilisation) were considered and weighted based on their importance (Baesler and Sepúlveda, 2001).

Surgery scheduling

Surgery remains the primary treatment for the majority of cancers. There is a long waiting list for cancer surgeries in LMICs and that has an adverse effect on the cancer related outcome. Scheduling of surgery can help in proper utilisation of surgical workforce and a greater number of patients can be operated without much wastage of working hours. One study compared schedules of surgical blocks to look for the assignment of different specialities as per the operating room time by using an analytic approach involving queuing theory to see the workload in different wards created by recovered patients from surgery (Vanberkel et al., 2011).

Chemotherapy scheduling and treatment planning

Chemotherapy scheduling is important to minimise the chaos in chemotherapy day care but there are a variety of problems in terms of scheduling of chemotherapy. Hahn-Goldberg et addressed the online scheduling problem by creating a template of appointment times. The optimizations are solved using constraint programming to minimize the total working time on a particular day (Hahn-Goldberg et al., 2014).

An algorithm to shift appointment times is applied to deal with cancellations. Shi recommended focusing on a specific cancer type and developed a model taking the cost of treatment, process of updating factors related to treatment plans and feasible solutions were derived (Shi et al., 2014).

Radiotherapy scheduling and treatment planning

Radiotherapy needs a more robust operations management approach in terms of planning, scheduling and assigning. A study from Amsterdam developed an integer linear program to optimise allocation of pretreatment tasks to doctors in order to minimise the radiotherapy treatment access time for all cancer types (Bikker et al., 2015). Sauré et al., (2012) simulated the generated scheduling procedure to improve the waiting

times.

Lee and Zaider (2008) described low-dose rate brachytherapy planning for prostate cancer, using optimisation and re-optimisation of placement of radioactive seeds during the implantation procedure. Various studies developed a model in which dose plans produced were as good as those generated by oncologists with achieving dose constraints (Obal et al., 2013; Petrovic et al., 2011; Petrovic et al., 2016). A study by Bortfeld (2006) discussed the mathematical, physical, and technological developments relating to Intensity Modulated Radiation Therapy (IMRT). Chan et al., (2014) approached better matching between the planned dose and the dose received by the patient whereas Jalalimanesh et al., (2017) showed that the dose should be varied over time as the tumour changes size.

Accessibility and affordability of novel cancer therapies in LMICs

Although cancer immunotherapy is considered most promising treatment and has taken center stage in mainstream oncology inducing complete and long-lasting tumor regression, only a subset of patients receiving treatment respond and others relapse after an initial response. In spite of the futuristic therapy, it is only accessible to a few patients and limited to bigger cities and hospitals in LMICs in view of very high cost. Basic chemotherapies are free or supported by government schemes in few of the LMICs but costly targeted and immunotherapy are still beyond reach of the general population (Taefehshokr et al., 2022)

The access to cancer care is a challenge that needs to be overcome as cancer patients have to travel a long distance to reach cancer centres in LMICs. As radiation treatment has changed in the last two decades with the advancement in technology, most of the cancer centres in LMICs are still not upgraded with newer machines and newer forms of treatment like IMRT/VMAT/SBRT. There is a wide gap between the requirement and availability due to the exorbitant cost of purchase and maintenance of radiation machines in LMICs and this gap is increasing every year with increasing population and number of cancer patients. There is utmost need to prioritise personalised treatment with modern technique to improve survival and quality of life.

For every cancer specialist, the cost of novel cancer therapy in chemotherapy and radiotherapy is the top challenge and concern, which are getting better with the Government backed insurance schemes to ensure better universal health coverage. There is a problem with the patient navigation, survivorship care planning, and financial counselling, which are key elements of patient-centered care, which remains a critical issue in most of the LMICs, which we overcome with operations management interventions.

In an evolving cancer care landscape, operations management acumen is critical to sustain delivery of quality cancer care. Many factors like size, structure, geographical location, scope of services, staffing, patient population etc directly impact management and operations of cancer programs and practices. At the same time, cancer care providers encounter many shared challenges in terms of coping of staffs with newer technology, recruitment of quality human resources, strategies for building staff resilience and well-being and more with orienting everyone with a 360-degree view of cancer care delivery fundamentals.

Operations management interventions can significantly assist in improving cancer care delivery by helping to ensure that resources are used efficiently and effectively. This can include managing the flow of patients through the healthcare system, coordinating care among different providers, and implementing protocols and guidelines to standardize care. Additionally, operations management can help to improve communication and collaboration among healthcare providers, leading to better coordination and continuity of care for cancer patients. To summarize, operations management can help to improve the efficiency and effectiveness of the delivery of cancer care services by identifying and addressing bottlenecks and inefficiencies in the system; ensuring that the available resources are used effectively and efficiently, including human resources, medical equipment, and other supplies; improve the quality of cancer care delivery by implementing and monitoring quality control measures, such as clinical guidelines and protocols; reduce costs and increase access to cancer care by identifying and implementing cost-effective strategies and technologies; ensure that the cancer care delivery system is responsive to the needs of the community and that it is culturally appropriate and acceptable.

In a nutshell, operations management can help to improve the overall quality, accessibility, and affordability of cancer care delivery in LMICs.

Acknowledgements

None.

Author Contribution Statement

Authors contributed equally in this study.

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