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Evaluating Conventional and Novel Drug Delivery Systems: A comparative study and their Applications in treatment of Lung Cancer in Twin cities of Pakistan

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A B S T R A C T

In Pakistan's twin cities of Rawalpindi and Islamabad, lung cancer, a prevalent and deadly malignancy globally, presents significant treatment challenges. The use of conventional therapies such as radiation and chemotherapy, despite their widespread application, is hindered by their limitations, including non-targeted systemic toxicity, which significantly reduces their overall effectiveness. Novel drug delivery systems, particularly those utilizing nanotechnology, present notable advancements in cancer cell targeting, reduced side effects, and improved patient outcomes. This study assesses the superiority in effectiveness, safety, and cost-effectiveness of Conventional and Novel Drug Delivery System for lung cancer treatment in the Twin Cities of Pakistan. 54.1% of respondents consider Novel Drug Delivery System to have a better balance between safety and efficacy compared to conventional therapies. 58.1% of respondents cited high costs, 70.3% cited limited expertise, and 47.3% cited inadequate healthcare infrastructure as hindrances to wider adoption. 70.3% of respondents emphasized the need for government support in implementing Novel Drug Delivery System technologies. To significantly improve lung cancer treatment outcomes and make cancer care more accessible for patients in the twin cities of Pakistan, it's crucial to implement location-specific approaches, raise awareness, and invest in infrastructure.

Keywords: Lungs Cancer, Nanotechnology, Chemotherapy, Radiation therapy, Novel drug delivery system.

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INTRODUCTION

Background: Lung cancer is a type of cancer that develops in the lungs, mainly in cells that line air passages. It is one of the most common and deadly types of cancer. Lung cancer is broadly classified into two types: non-small cell lung cancer (NSCLC), which accounts for approximately 85% of cases, and small cell lung cancer (SCLC), which is more aggressive but less common. Long-term tobacco smoke exposure is the leading cause of lung cancer, and factors such as environmental exposure, genetic predispositions, and underlying lung disorders can contribute to its development (Rami-Porta et al., 2005).

Epidemiology: In Pakistan, lung cancer was responsible for 5.9% of all new cases, amounting to 10,538 instances, and was the second most prevalent disease in males and the third most common disease overall. Data from KCR 1995-2002 revealed that age-standardized incidence rates (ASIRs) per 100,000 for lung cancer ranged from 21.4 to 25.5 in men and from 2.9 to 4.2 in women, with a 16% increase in men and 31% in women over the eight-year period (Bhurgri et al., 2006).

The 2010-2012 Punjab Cancer Registry reported lower ASIR for lung cancer in men (4.6) and women (1.2) per

100,000 compared with the KCR data, possibly due to regional and lifestyle factors, such as higher tobacco use in the KCR regions. In 2020, 9.6% of all cancer deaths were caused by lung cancer, and the age-standardized mortality rate for both sexes was 6.2 per 100,000.

Role of Conventional and Novel Drug Delivery System in treatment of Lungs Cancer: Advances in cancer therapy and personalized techniques have significantly increased the therapeutic effectiveness of some cancers while reducing major side effects, like those associated with chemotherapy (Zitvogel et al., 2008). Nanotechnology's role in medicine has expanded significantly over the past few decades, encompassing safer diagnostics, superior therapies, and targeted tumor treatment. For treating cancer, Nanoparticle (NP) systems offer superior pharmacokinetics, tumor cell targeting, reduced adverse effects, and drug resistance (Palazzolo et al., 2018).

Significance of study: Conducting a comparison between traditional and Novel drug delivery systems (DDS) is essential for discovering enhanced cancer treatments. Novel DDS with tailored administration, fewer side effects, and higher effectiveness are better choices for treating illnesses like lung cancer. Traditional DDS causes non-specific harm to healthy cells and reduces therapy effectiveness because of systemic toxicity. This study aims to expose disparities in lung cancer care among Pakistan's twin cities and provide recommendations for improvement. In Pakistan, especially in the Twin Cities, there's a lack of comprehensive data on the comparison of conventional and advanced drug delivery methods for treating lung cancer. Most studies have overlooked the local healthcare challenges in this region, such as infrastructure limitations, treatment costs, and public awareness. Effective and feasible treatment options for local communities can be determined through local studies. Our study aims to bridge the knowledge gap by providing region-specific insights.

2.3% of Pakistani patients with lung cancer undergo curative surgery upon diagnosis (Sheikh et al., 2022). For diagnostic purposes, video-assisted thoracoscopic surgery and exploratory thoracotomy are commonly used in complex, incurable conditions (Shamji and Beauchamp, 2021).

Conventional therapies: Chemotherapy can be administered before, during, or after surgery. Each method has a specific purpose. Radical chemotherapy could treat responsive cancer tumors effectively. Radiation and chemotherapy can be more effective when used together because they target rapidly dividing cells, and chemotherapeutic treatments inevitably come with hazardous side effects. Chemotherapy often leads to nausea, vomiting, diarrhea, constipation, hair loss, impaired liver and kidney function, and bone marrow suppression (Skeel and Khleif, 2011). Among 100 chemotherapy patients in Pakistan, 75% experienced nausea and vomiting, 31% had gastrointestinal issues, including diarrhea, 40% complained of abdominal pain, and 14% reported memory impairments (Aslam et al., 2014).

Unlike chemotherapy, radiotherapy specifically focuses on tumors with alpha, beta, gamma, and proton radiation. For various malignancies, such as head and neck, cervical, bladder, prostate, and skin cancers, radiotherapy can be a surgical alternative with notable tumor control success rates (Khan et al., 2022). Radiation therapy's normal tissue toxicity negatively affects patient recovery and quality of life. The limited therapeutic potential of radiation for patients with cancer, despite technological advancements and increased use of chemotherapy, is overshadowed by its low effectiveness and inescapable side effects (Jassem and oncology, 2007).

Nanotechnology: Given the limitations and side effects of current cancer treatments, researchers and physicians are exploring new, more precise treatment approaches. In the last few decades, nanotechnology has significantly advanced medicine, most notably in cancer therapeutics and diagnostics, where it offers advantages such as precise tumor targeting, enhanced pharmacokinetics, fewer side effects, and drug resistance mitigation through nanoparticle-based drug delivery systems (Palazzolo et al., 2018).

The search for precise and less side-effective cancer treatments by scientists and physicians has been spurred on by the adverse effects and limitations of current cancer medicines. In medicine, nanotechnology has increasingly been adopted for cancer therapy, offering improvements in pharmacokinetics, precise targeting, reduced side effects, and resolution of drug resistance (Perrault et al., 2009).

In Pakistan, the introduction of novel drug delivery systems has confronted several healthcare, infrastructure, and socioeconomic challenges. In developing countries, the high costs of advanced drug delivery methods, limited expertise, and insufficient public funding hinder the implementation of novel drug delivery systems. Resource-constrained nations like Pakistan face significant hindrances to the adoption of new treatments (Ather and Sherin, 2014).

MATERIAL AND METHODS

Research Objectives:

1. To evaluate and compare the efficacy of conventional drug delivery system and novel drug delivery system in treatment of lung cancer.
2. Investigate the safety profile and patient tolerance of these systems.
3. Identify challenges (e.g. cost effectiveness) and opportunities for further research and development.

Study design: In Islamabad and Rawalpindi, our cross-sectional study examines and contrasts the application of traditional and advanced drug delivery methods for lung cancer treatment. The investigation utilized a structured questionnaire.

Study population: Participants in the study hailed from various fields in the Twin Cities and had experience with lung cancer treatment or management. Healthcare professionals, medical students, and people with a general

interest or background in lung cancer therapy made up the participants.

Selection of Participants: Participants selected based on:

Inclusion criteria

Healthcare Professionals: Individuals like Physicians, Pharmacists and healthcare professionals actively involved in the treatment or management of lung cancer.

Medical Students: Those studying in relevant field

Residents of Twin Cities: Participants residing in Islamabad or Rawalpindi or nearby areas who regularly visits healthcare centers in twin cities.

Informed Consent: Respondents who willingly provided consent to participate in the study.

Exclusion criteria

Non-Healthcare Professionals: Individuals without relevant professional or academic backgrounds in lung cancer treatment.

Non-Residents: Those not residing in the Twin Cities of Islamabad and Rawalpindi or not

Incomplete Responses: Surveys that were not fully completed or lacked key information.

Sample size: The sample size was sufficient to accurately represent the target population and preserve statistical significance. A total of 150 respondents were surveyed. The T-Test was used to calculate this figure based on the anticipated population of healthcare professionals, medical students, and related individuals in the Twin Cities of Pakistan. The sample size was selected to ensure a 95% confidence interval with a 5% margin of error.

Data analysis: Graphs were generated using Google Forms Software while errors were analyzed using different software. Google Forms Software generated the percentages.

RESULTS AND DISCUSSIONS

Knowledge and Awareness

Source of Knowledge and Awareness of difference between conventional and Novel Drug Delivery Systems

Our research findings show that academic sources (35.1%) and social media (31.1%) were the primary sources of information concerning Conventional and Novel drug delivery methods. Research publications (24.3%) and medical professionals (21.6%) play a minor role, whereas other sources account for only 1.4%. The significance of academic and internet platforms in increasing awareness is increasing.

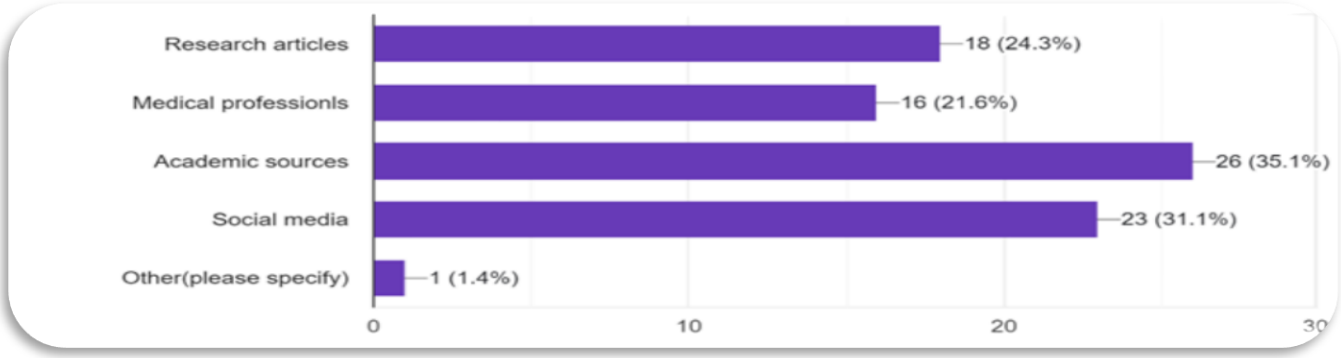

Figure 1: Source of Knowledge and Awareness of difference between conventional and Novel Drug

Figure 2: Balance of Efficacy and Safety in Drug Delivery.

Balance of Efficacy and Safety in Drug Delivery Systems

Our research findings shows 54.1% of respondents felt that novel drug delivery systems provide a better balance of efficacy and safety than Conventional drug delivery system for treating lungs cancer. In comparison, 10.8% prefer conventional systems, 20.3% believe both are equally

balanced, and 14.9% are unsure. This demonstrates a significant desire for creative solutions that strike a better balance between effectiveness and safety.

Cost Effectiveness of Conventional and Novel Drug Delivery Systems

Cost-Effectiveness of Conventional Drug Delivery Systems

Our Research findings suggests that 39.2% consider Conventional drug delivery system for treating lungs cancer to be moderately priced, 24.3% to be cost-effective, and 12.2% to be highly cost-effective, while 17.6% consider them to be costly and 6.8% to be extremely expensive, indicating a range of affordability viewpoints.

Cost-Effectiveness of Novel Drug Delivery Systems

Our Research findings shows 37.8% of people believe that Novel drug delivery system for treating lungs cancer is reasonably priced, whereas 31.1% believe it is costly, whereas, 10.8% of people take it as very expensive. Only 13.5% consider them cost-effective and 6.8% find them extremely cost-effective.

Applications in Twin Cities of Pakistan

Main Challenges in the Application of Novel DDS

According to our research, the main barriers to implementing Novel drug delivery systems in Pakistan's twin cities are insufficient knowledge and expertise (70.3%), high costs (58.1%), and inadequate infrastructure (47.3%). Additionally, 29.7% of respondents identified regulatory constraints as a challenge, highlighting significant barriers to the adoption of Novel drug delivery systems.

Measures to Improve Implementation of Novel DDS

Our Research suggests that government assistance (70.3%), public awareness (59.5%), and training (51.4%) might all help improve novel drug delivery systems in Pakistan's twin cities. Furthermore, 41.9% find benefit in collaborating with international organizations, whereas 1.4% suggest alternative approaches.

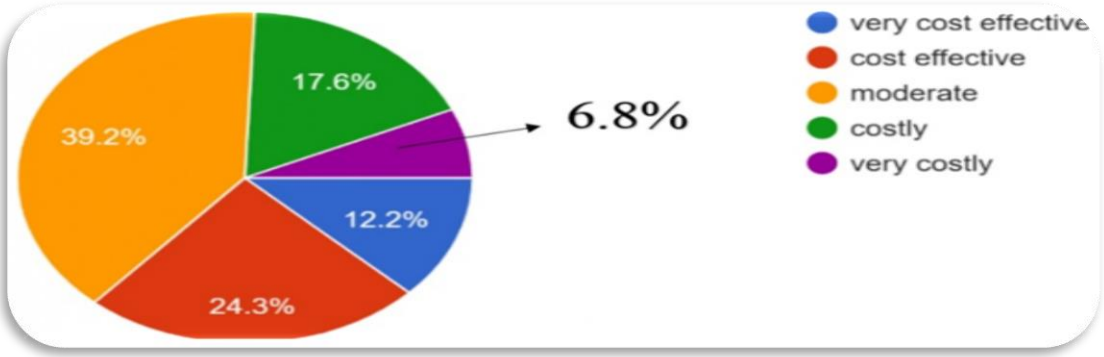

Figure 3: Cost-Effectiveness of Conventional Drug Delivery

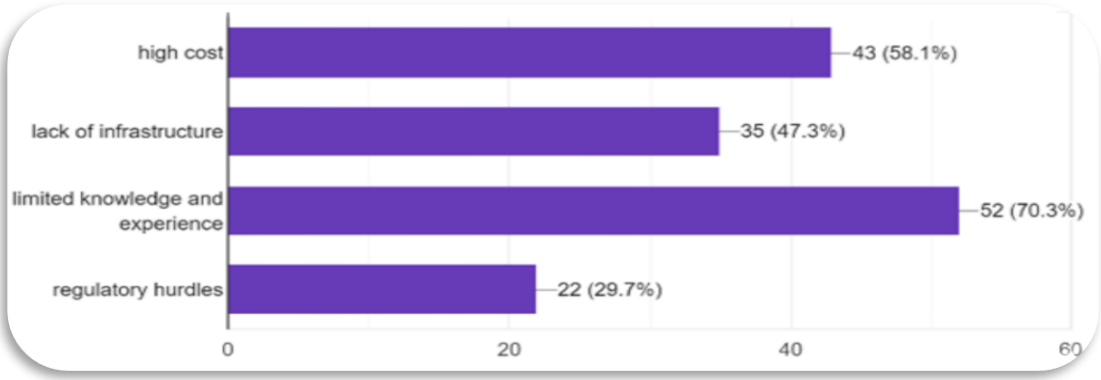

Figure 4: Main Challenges in the Application of Novel

CONCLUSION

The Novel Drug Delivery Systems used in our research offer advantages over conventional methods for treating lung cancer in Islamabad and Rawalpindi. Conventional treatments, chemotherapy, radiotherapy, and surgery are effective, but they carry significant drawbacks, including severe side effects and limited effectiveness. Novel nanotechnology-based systems can achieve higher efficacy, reduced toxicity, and enhanced cancer treatment outcomes. The widespread adoption of promising health technologies is obstructed by challenges like high costs, limited professional awareness, and inadequate infrastructure. Investing in educating healthcare providers and patients about the benefits of advanced therapies is essential to

overcoming barriers to their use. Improved healthcare infrastructure is essential for the successful implementation of advanced drug delivery systems. Subsidies and insurance policies can make innovative treatments more affordable and accessible to the general public. Addressing lung cancer treatment challenges in Pakistan's twin cities will significantly improve patient care, contributing to increased survival rates and enhanced quality of life.

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