Radiotherapeutic Management of Non–Small Cell Lung Cancer in the Minimal Resource Setting

Danielle Rodin, MD,[a] Surbhi Grover, MD, MPH,[b] Melody J. Xu, MD,[c] Timothy P. Hanna, MD, MSc,[c] Robert Olson, MD, MSc,[d] L. John Schreiner, PhD,[e] Anusheel Munshi, MD, DNB, MNAMS,[f] Francoise Mornex, MD, PhD,[g] David Palma, MD, PhD,[h,*] Laurie E. Gaspar, MD, MBA,[i] on behalf of the International Association for the Study of Lung Cancer Advanced Radiation Technology Committee

[a]*Department of Radiation Oncology, University of Toronto, Toronto, ON, Canada*
[b]*Department of Radiation Oncology, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA*
[c]*Division of Cancer Care and Epidemiology, Cancer Research Institute at Queen's University, Kingston, ON, Canada*
[d]*Department of Radiation Oncology, University of British Columbia, Vancouver, BC, Canada*
[e]*Departments of Radiation Oncology and Physics, Queen's University, Kingston, ON, Canada*
[f]*Department of Radiation Oncology, Fortis Memorial Research Institute, Gurgaon, India*
[g]*Département de radiothérapie, Centre hospitalier Lyon Sud, 69310 Pierre-Bénite, France*
[h]*Department of Radiation Oncology, London Health Sciences Centre, London, ON, Canada*
[i]*Department of Radiation Oncology, University of Colorado School of Medicine, Aurora, CO, USA*

Received 9 July 2015; revised 22 September 2015; accepted 30 September 2015

ABSTRACT

Lung cancer is the most common cancer worldwide and the fifth most common cause of death globally. Its incidence continues to increase, especially within low- and middle-income countries (LMICs), which have limited capacity to address the growing need for treatment. The standard of care for lung cancer treatment often involves radiation therapy (RT), which plays an important therapeutic role in curative-intent treatment of early-stage to locally advanced disease, as well as in palliation. The infrastructure, equipment, and human resources required for RT may be limited in LMICs. However, this narrative review discusses the scope of the problem of lung cancer in LMICs, the role of RT technologies in lung cancer treatment, and RT capacity in developing countries. Strategies are presented for maximizing the availability and impact of RT in settings with minimal resource availability, and areas for potential future innovation are identified. Priorities for LMICs involve increasing access to RT equipment and trained health care professionals, ensuring quality of care, providing guidance on priority setting with limited resources, and encouraging innovation to increase the economic efficiency of RT delivery. Several international initiatives are currently under way and represent important first steps toward scaling up RT in LMICs to treat lung cancer.

Keywords: Lung cancer; Non–small cell lung cancer; Global health; Radiotherapy; Low- and middle-income countries; Quality

Introduction: scope of the problem

Since 1985, the global incidence of and mortality related to lung cancer have surpassed those of all other cancers.[1] In 2010, lung cancer (approximately 85% of which is non–small cell lung cancer [NSCLC][2]) was ranked as the fifth most common cause of death globally, ahead of HIV/AIDS (sixth), tuberculosis (10th), and malaria (11th).[3] The projected increases in total incidence of cancer over the next 15 years (to 2030) are expected to be proportionally higher in low- and middle-income countries (LMICs). The relatively recent

*Corresponding author.

Drs. Rodin and Grover contributed equally to this work.

Disclosure: The authors declare no conflict of interest.

Address for correspondence: David Palma, MD, PhD, FRCPC, Department of Radiation Oncology, London Health Sciences Centre, 790 Commissioners Road East, London, ON, Canada N6A 4L6. E-mail: david.palma@lhsc.on.ca

ISSN: 1556-0864

http://dx.doi.org/10.1016/j.jtho.2015.09.008

and increasing spread of tobacco use in LMICs means that the current lung cancer epidemic in these regions has not yet reached its peak, and rates will likely continue to rise for the next few decades.[4,5] Environmental factors, including air pollution,[5] contamination of drinking water with arsenic, and workplace exposure to arsenic in industries such as mining,[6] are also contributing to this transition in the epidemiology of lung cancer.

RT plays a critical role in the treatment of lung cancer, with rates of RT use as high as 70% in some settings.[7] Global variation in the availability and use of RT is substantial, however. This article discusses the role of modern RT in treatment of NSCLC and reviews the availability of RT in developing countries, as well as in geographically underserviced regions of developed countries. Finally, strategies for maximizing the availability and impact of RT in settings with minimal resource availability are presented.

Role of RT in the treatment of NSCLC

RT plays an important role in the treatment of NSCLC throughout the continuum of care, including in radical treatment of early-stage and locally advanced disease and in palliative care. Although surgery has been the mainstay of treatment for early-stage lung cancer, early-stage disease probably represents a minority of cases in LMICs, as it does in high-income countries (HICs).[8] In order of increasing complexity, nonoperative options for curative-intent treatment of stage I NSCLC include conventional radiotherapy (i.e., 2 Gy delivered daily for several weeks), altered fractionation schemes, and stereotactic radiation. Delivery of curative-intent radiotherapy to patients who would otherwise go untreated is associated with improved survival.[9,10]

In patients with locally advanced disease, RT plays an important role as a component of dual-modality therapy alongside chemotherapy and, in very select patients, trimodality therapy, including surgery. RT also plays a key role in the palliation of disease in the thorax, as well as in the treatment of distant metastatic disease in the brain, bone, and other regions. Palliative RT has been found to improve symptoms of chest pain and hemoptysis by 60% to 80% and cough and dyspnea by 50% to 70%,[11] as well as to result in significant improvement in other symptoms of systemic disease. Palliative thoracic RT in doses of 30 Gy in 10 fractions or higher have been associated with improved survival in patients with good performance status,[12] but adequate symptom control can still be achieved with shorter regimens such as 20 Gy in five fractions or 10 Gy in a single fraction.[13]

RT technology

Before the mid-1990s, RT planning relied on two-dimensional imaging, with simple treatment fields designed using radiography or fluoroscopy (Fig. 1A).[14] Square or rectangular fields could be delivered without any modification of the beam, but more complex shaping of the beam required the creation of metal blocks (Fig. 2) that would be placed in the treatment field to attenuate the beam. In that era, patient setup before treatment was based on tattoo marks placed on the skin, with subsequent adjustment of the patient's position on the basis of radiographic images—called *portal images*

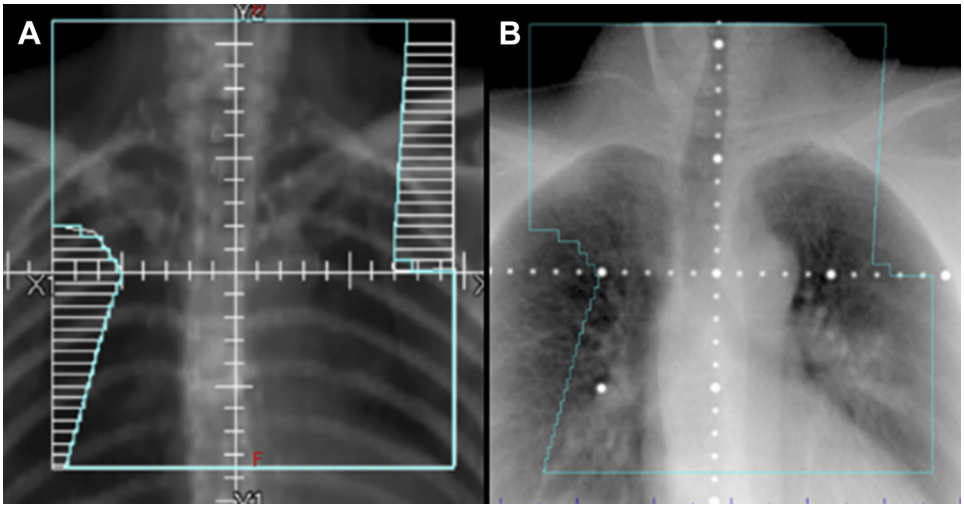

Figure 1. (*A*) An illustration of the concept of two-dimensional treatment planning. The field borders (*blue line*) encompass the upper mediastinum and neck and would be placed using anatomy visible on radiographs or fluoroscopy. The patient would be treated with opposing anterior and posterior beams. (*B*) An electronic portal image showing a patient at the time of treatment, with the field borders (*blue*) superimposed.