A golden rule of radiation therapy is to minimize the radiation dose to normal tissues while maximizing the radiation dose to the target volume. Three-dimensional conformal radiation therapy (3-D CRT) is gaining popularity as a tool to allow radiation oncologists and physicists to follow this golden rule. 3-D CRT allows physicists to use imaging studies to conform the radiation dose distribution as closely as possible to the designated target volume. By limiting the radiation dose to normal tissues, a reduction in the normal tissue complication probability (NTCP) can be obtained. With a reduced likelihood for complications, radiation dose can be escalated resulting in a higher tumor control probability (TCP). One limitation of 3-D CRT which has not been adequately addressed is respiration-induced organ motion. Because the size and shape of the radiation beam does not change during treatment, a tumor that moves with respiration requires an enlarged field size to encompass the tumor throughout the respiratory cycle, leading to irradiation of a larger normal tissue volume with a higher dose. This dose to normal tissue sets the limits on the total dose that can be safely delivered to the tumor.

The goal of this talk is to present an overview of how the current respiration gated radiotherapy (RGRT) is investigated at several institutions. The first peer reviewed paper on RGRT appeared in 1987 by Ohara, et al [1]. They implemented their system at the Tsukuba Proton Research Medical Center, Japan, the first institution which started treating patients with RGRT. The dose-volume histogram (DVH) analysis of well-differentiated metastatic tumors in the liver indicated a substantial reduction in the normal tissue volume irradiated. In the North America, the first technical feasibility of RGRT was reported by Kubo and Hill in 1996 [2]. Since then, several institutions have started RGRT and others are following. To the author's view, a major pivotal moment came at 3D-CRT meeting in St. Louis in 1996, where many prominent radiation oncologists urged the implementation of RGRT. In this talk,

the approaches taken at William Beaumont, Memorial Hospital, University of Pittsburgh Hospital, St. Jude Children's Hospital, University of California Davis Medical Center are summarized. In addition, pioneering work done at Tsukuba and a program at the National Institute of Radiological Sciences, Japan, will be introduced. Each institution offers a different approach to extraction of gating signals from a patient and to gating a CT scanner, if necessary, and a linear accelerator.

Educational Objectives:

1. To review historical development of RGRT.
2. To review different approaches taken by several institutions.

References:

1. K Ohara, et al., "Irradiation synchronized with respiration gate," Int J Radiation Oncology Biol Phys 17, 863-857 (1989).
2. H D Kubo and B C Hill, "Respiration gated radiotherapy treatment: a technical study," Phys Med Biol 41, 83-91 (1996).

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