AN EVALUATION OF THE MEDICAL DOSIMETRY PROGRAM AT THE UNIVERSITY OF TEXAS MD ANDERSON CANCER CENTER SCHOOL OF HEALTH PROFESSIONS

A Dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Education

by

Mahsa Dehghanpour

December, 2011

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Abstract

An aging population in the U. S. has resulted in an increase in the number of patients treated for cancer and in the incidence of cancer relative to other major diseases (NCI, 2010). Because of the aggressive nature of cancer, many methods of treatment are needed. Radiation therapy is one of the oldest and most common methods for treating cancer patients. Radiation oncology teams, which consist of physicians, medical physicists, and several allied health professionals, such as medical dosimetrists, and radiation therapists, are responsible to design and deliver the proper dose of radiation to the patients. Medical dosimetrists are an integral part of this team, who are responsible for developing radiation treatment plans that deliver the prescribed dose of radiation to the tumor while minimizing the radiation dose to the surrounding healthy tissues.

Inadequate training of health care professionals causes medical errors that can lead to horrifying results, damaging patients’ quality of life, and even death. Educational programs are accountable for the proper training of healthcare professionals. One way to ensure the quality of these programs is through constant evaluation to identify their strengths and weaknesses. Educational programs should make improvement to their quality based on these evaluations.

The purpose of this study was to evaluate the Medical Dosimetry Program at The University of Texas MD Anderson Cancer Center School of Health Professions. This study examined the degree of student satisfaction with the quality of faculty, clinical education, curriculum, and new student orientation as well as the quality of graduates

from the employers' perspective. A review of literature in other health related educational programs was described and summarized to make recommendations for improvement of the program.

Data from the end-of-semester faculty and clinical rotation evaluations in 2007-2008, 2008-2009, and 2009-2010 school years were used to assess the degree of student satisfaction with the quality of the faculty and clinical education. Data collected through the end-of-school program evaluations, during these three school years, were used to evaluate the degree of satisfaction with the curriculum and the new student orientation session. Employer satisfaction with the quality of the graduates was determined through the data collected from employer surveys of 2004-2009 graduates.

This study shows that students are satisfied with the quality of their faculty in regard to content knowledge, instructional skills, and professionalism. Students are also satisfied with the quality of their clinical education. However, the satisfaction with the availability of resources and effectiveness of instruction is higher than the satisfaction with consistency in instruction and fairness in grading. A review of end-of-year program evaluation data shows that students are satisfied with their overall experience in the medical dosimetry program. The data show that students are more satisfied with the quality of the medical dosimetry curriculum than the helpfulness of the new student orientation session. Furthermore, a review of employer surveys indicates a satisfaction with the quality of program's graduates in both areas of professionalism and technical skills.

The results of this study made the school administrators aware of strengths and weaknesses of the medical dosimetry program. The author made recommendations to the

medical dosimetry program officials on how to make improvements in order to increase student satisfaction with different aspects of the program. Furthermore, the author made recommendations to improve the evaluation procedures used at the School of Health Professions. Modifying some of the evaluation instruments will result in a more profound understanding of the strengths and weaknesses of the program's components and ways to improve them.

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Chapter I

Introduction

The purpose of this study is to evaluate the Medical Dosimetry Program at The University of Texas MD Anderson Cancer Center School of Health Professions. Medical dosimetry is an allied health profession, and an important component of America's healthcare system. Medical dosimetry professionals, in collaboration with the other healthcare team members, greatly impact the success of treatment for cancer patients.

The results of this study will be used to advise the medical dosimetry program administrators at MD Anderson Cancer Center on how to make modifications or changes to the program in order to improve its quality. The quality of the program has a direct impact on the excellence of the program's graduates, which is essential for optimal patient care.

This chapter discusses America's healthcare system, the role of allied health professionals, and more specifically medical dosimetrists in this system. The rationale behind educating these professionals to a high level of competency, and the accountability of educational programs for student learning outcomes will be explained.

America's Healthcare System

The healthcare system is responsible for the prevention, treatment and management of a variety of illnesses for people in all ages. According to the Bureau of Labor Statistics (2010), in the rapidly evolving healthcare system in the U.S., technological advances and clinical developments increase longevity and improve quality of life. Furthermore, advances in information technology have improved the quality of patient care and the efficiency of healthcare workers.

The healthcare system consists of hospitals, physician offices, nursing and residential care facilities, dentist offices, home healthcare services, health practitioner offices, and ambulatory healthcare services. About 595,800 establishments make up the American healthcare system, of which 76% are physician, dentist, or other health practitioner offices. Hospitals make up 1% of all healthcare establishments, but they employ 35% of all workers. The healthcare system in the U.S. provided 14.3 million jobs in 2008 and will produce 3.2 million new jobs between 2008 and 2018. This is being driven by the growing elderly population, who demand healthcare services, and the need to replace healthcare workers who retire or leave the industry. Furthermore, advances in medical technology have enabled earlier diagnoses and improved patient care and longevity. This results in extensive treatment and care, which demand more healthcare professionals. It is estimated that the compensation for healthcare workers will increase 22% through 2018, compared with 11% for other industries combined (Bureau of Labor Statistics, 2010).

According to an article published in the American Hospital Association (2003), the U.S. Census Bureau anticipates that 25 million people will be added to the population between 2010 and 2020. In addition, the population is aging, and the number of non-working senior citizens will be increased. Furthermore, with advances in technology, people are living longer. Therefore, they need chronic care, which means healthcare expenses over longer periods of time. At the same time, new technology and new medications are more expensive and not affordable for all Americans. This means an increase in healthcare needs, and meeting those needs will be a challenge. According to Heffler et al. (2003), it is anticipated that by 2014, the total money spent on healthcare

will comprise 18.7 percent of the gross domestic product, from 15.3 percent in 2003. As stated on the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO) website in 2010, employers will respond to the increasing cost of healthcare by making workers pay more for their own healthcare costs, which they can do by imposing greater deductibles and co-pays.

The other problem is the lack of adequate qualified healthcare workers to satisfy the demand. According to the summary of report published in the Institute of Medicine of the National Academies (2009), the American Society of Clinical Oncology anticipated that by 2020 there will be an 81% growth in the number of people living or surviving cancer, but only a 14% growth in the number of oncology physicians. Additionally, there will be a shortage of primary doctors, physician assistants, nurses, allied health professionals, public health workers, social workers, and cancer registrars. That means that patients with cancer will not have access to healthcare professionals for early detection, treatment, and follow up. The limited access of uninsured patients to effective healthcare services results in illnesses that could have been prevented, suffering, and even death.

Americans' concerns about their healthcare system. Although the American healthcare system is strong in regard to advanced technology and research-oriented healthcare management, there are a number of concerns by the public. One of the concerns is inconsistency in the care received from different healthcare providers. The method of care is influenced by the financial status of the patients and whether or not they are insured, as well as resources available to the healthcare providers (American Hospital Association, 2003).

Many people feel that physicians do not take the time to listen to them. Doctors and nurses feel that the healthcare system is focused on profit and that paperwork consumes a huge portion of their time, which could be dedicated to patient care. Healthcare costs are too high for both patients and employers, who often provide insurance for their employees. The public is anxious about medical mistakes and is frustrated about how much their treatment options depend on how much insurance coverage they can afford. Patients are concerned about the high cost of medications, which often means they cannot afford needed drugs. The other huge concern is the lack of insurance, or not having insurance coverage for specific needs. These concerns call for a change in the U. S. healthcare system (American Hospital Association, 2003).

According to a report from the Institute of Medicine of the National Academies (2009), 20% of adults who are under 65 years of age and 10% of children are uninsured, totaling 45.7 million people as of 2007. The numbers vary across the nation. In 2007, uninsured rates were as low as 6% in Massachusetts and as high as 28% in Texas.

According to the Kaiser Family Foundation (2004), most uninsured Americans are low-wage workers, those who work in small businesses and blue-collar jobs. The lack of health insurance adversely affects the health and financial status of families, causing delays in seeking needed care, which leads to more chronic illnesses and higher costs.

In its 2009 report, the Institute of Medicine recommended that:

> The President work with Congress and other public and private sector leaders on an urgent basis to achieve health insurance coverage for everyone and, in order to make that coverage sustainable, to reduce the costs of healthcare and the rate of increase in healthcare spending. (p. 5)

2010 healthcare reform. As addressed by President Obama in his town hall meeting in Green Bay in June 2009, a significant problem for the government is the increasing cost of Medicare and Medicaid, which represents the single biggest contributor to the federal deficit. He noted, "We have the most expensive healthcare system in the world. We spend almost 50 percent more per person on healthcare than the next most expensive nation" (The White House, 2009).

The President said that we need to change incentives that equate expensive care with higher-quality care, and profits that don't improve the quality of patient care. He also noted that we have to provide American people who cannot afford health insurance with more affordable options. President Obama talked about an option called Health Insurance Exchange. This option would allow Americans to study different insurance plans, compare and contrast their advantages, and select the one that is suitable for them. If none of them were affordable, the government would provide assistance with healthcare coverage. This would mean competition for the private insurance companies, which would make them bring their prices down. In addition, public and private insurance companies would not be allowed to deny coverage for a person with pre-existing conditions, and should offer them a basic benefits package (The White House, 2009).

President Obama signed into law, on March 23, 2010 and March 30, 2010, the final package of health insurance reforms, which will allow all Americans to have access to healthcare for the first time in U. S. history. Under this law, 32 million uninsured Americans will be insured by 2019 (Kittredge & Miller, 2010). According to the Congressional Budget Office, the estimated cost of this plan is $940 billion over 10 years,

and when it is fully executed in 2014, 95% of eligible Americans would have coverage compared with 83% in 2010 (CBS, 2010).

Beginning in 2010, this plan bans insurance companies from denying healthcare coverage for children who have pre-existing health problems. Beginning in 2014, the plan would also prohibit insurance companies from denying adults based on pre-existing conditions, and from charging higher premiums for women. This plan prohibits insurers from imposing lifetime dollar limits on coverage, and allows parents to keep their children on their insurance plan up to age 26. Effective in 2014, this plan would require most employers to provide insurance for their employees and most people to obtain healthcare coverage, or pay a fine. Finally, by 2019, the plan would expand healthcare coverage to 32 million Americans by creating health insurance exchanges and subsidizing coverage for people with low incomes, who cannot afford it (The Washington Post, 2010).

Effective in 2018, this plan would impose an increased Medicare payroll tax on investment income and wages for couples who make greater than $250,000 annually, and individuals who make greater than $200,000 a year (CBS, 2010).

As stated on AFL-CIO website (2010), “the plan closes the Medicare Part D prescription “donut hole”, lowers the federal deficit, and invests in training for primary care doctors, nurses and public health professionals to reverse the shortage of primary healthcare workers” (p. 2). According to the White House Blog in May 4, 2010 about healthcare,

> The recovery act provides $1 billion for prevention and wellness to improve America’s health and help to reduce healthcare costs; $1.1 billion for research to

> give doctors tools to make the best treatment decisions for their patients by providing objective information on the relative benefits of treatments; and $500 million for health workforce to help train the next generation of doctors and nurses. (p. 1)

This means that about 32 million previously uninsured patients will have access to healthcare services. Therefore, more healthcare professionals will be needed to meet the demand of these patients. Educational programs are responsible for producing more healthcare professionals and are accountable for the quality of their graduates to assure the public that patient safety is paramount.

Allied Health Professionals

Hospitals employ a wide variety of healthcare professionals, among them allied health professionals such as respiratory therapists, physical therapists, radiation therapists and medical dosimetrists. Nurses and doctors are not considered allied health professionals. According to the U. S. Bureau of Labor Statistics (2010), allied health workers comprise more than 60% of the healthcare workforce in the U.S. As defined by the Association of Schools of Allied Health Professionals (ASAHP), allied health professionals assist in health services relating to the diagnosis, assessment, and prevention of illnesses. Allied health professionals also provide other services like nutrition consultation, rehabilitation assistance, and management. A report about supply and demand of allied health professionals on the Northeast Ohio Nursing Initiative (NEONI) website in 2006 states:

> Allied health professionals are healthcare practitioners with formal education and clinical training, who are credentialed through certification, registration or

> licensure. They collaborate with physicians and other members of the healthcare team to deliver high quality patient care services for the identification, prevention and treatment of diseases, disabilities and disorders. (p.1)

Hospitals are faced with two problems. One is that there is an immediate need for healthcare workers including nurses and allied health professionals; the other is that due to the growing demand for healthcare workers, there will be a shortage of healthcare professionals in the long term. The Bureau of Labor Statistics (2010) anticipated that there will be a 28.8% growth in health care employment by 2010 and 5.3 million healthcare workers are needed to fill these positions. The supply of allied health professionals is not meeting the demand, due to reduced enrollment in allied health educational programs and an inadequate number of graduates to satisfy current and future demand (High School Graduate, 2010).

Cancer, the Second Cause of Death in America

Cancer is uncontrolled proliferation of cells that are able to metastasize and attack other tissues and organs through the blood or lymphatic systems (National Cancer Institute, 2009). According to the Surveillance, Epidemiology and End Results (SEER) Cancer Statistics Review 1975-2007 published on the NCI website, there were an estimated 1,444,920 cancer cases in the U.S. in 2007, for all primary cancer sites. The 5-year relative survival rate between 1950 and 1954 was 35%, and between 1999 and 2006 was 69.1%. This improvement may be due to the technological advances in detection, diagnosis and treatment of cancer.

Based on this report, the five-year relative cancer survival by race and sex from 1999 to 2006 from 17 SEER geographical areas was 66.8% for white men, 67.0% for white women, 60.6% for black men, and 54.9% for black women. On January 1, 2007, in the United States there were about 11,713,736 people, who had a history of cancer, of which 5,353,054 were men and 6,360,682 were women.

The same report indicates that from 2003 to 2007, the median age at diagnosis for cancer of all sites was 66 years of age. Derived from cases diagnosed in 2003-2007 from 17 SEER geographic areas, the incidence rate was 538.9 per 100,000 men and 408.0 per 100,000 women.

According to the Cancer Trends Progress Report 2009-2010 update, for all cancers combined, there is an increase in the length of survival, and a decrease in the mortality rate. However, the mortality rates for cancer of the pancreas, esophagus, thyroid, and liver are rising. Incidence rates of some cancers such as pediatric cancers, melanoma, leukemia, and women's lung cancer are rising. Based on the 2009 statistics of the American Cancer Society (ACS) about 1,479,350 new cancer cases will be diagnosed in 2009. However, this estimation excludes noninvasive cancers of all sites except the urinary bladder, and excludes basal and squamous cell carcinomas of the skin. As a result, there will be about 562,340 cancer- related deaths in the U.S., which is exceeded only by the deaths caused by heart disease. In the U.S., approximately 1 in every 4 deaths is cancer-related.

There has been a growth in the cost of cancer treatment, corresponding to total healthcare expenditures. Diagnosis of cancer at late stages, which rarely leads to survival, is associated with the specific site, and may be attributed to the lack of health insurance,

income, and education, or related to age, gender, and ethnicity. Furthermore, the cost of cancer treatment is a burden on families and society. In 2006, the cost of cancer-related healthcare was approximately $104.1 billion in the United States. It is estimated that this expenditure increases at a faster rate than overall medical costs. This is due to the aging population, which results in an increase in the number of patients treated for cancer and an increase in cancer incidence relative to other illnesses (NCI, 2010).

National Institutes of Health (2009), estimated that the overall costs of cancer in 2008 is $228.1 billion, of which $93.2 billion is spent on total healthcare costs, $18.8 billion spent on the loss in productivity due to disease, and $116.1 billion spent on the loss in productivity due to premature death.

As stated, the incident of cancer, cancer survival rate, and the cost of the cancer care are rising. Therefore, people need healthcare coverage in order to afford safe and reliable care and educational programs should train quality healthcare workers to satisfy the demand of healthcare system.

Cancer Treatment

The three most common methods of cancer treatment are chemotherapy, surgery and radiation therapy. According to National Cancer Institute (n.d.), there are other types of cancer treatment including: (1) angiogenesis inhibitors therapy, (2) biological therapy, (3) bone marrow transplantation and peripheral blood stem cell transplantation, (4) gene therapy, (5) hyperthermia, (6) laser treatment, (7) photodynamic therapy, and (8) targeted cancer therapy. However, half of the people with cancer are treated with radiation therapy. This can be used alone or in combination with other methods of cancer treatment.

In radiation therapy, high energy ionizing radiation such as electrons, photons, and protons are aimed toward the target. They cause destruction of the cancerous cells by damaging their DNA and their ability to proliferate. As stated by NCI (2010), the purpose of radiation therapy is the complete destruction or shrinkage of a tumor to improve the symptoms of disease or to ease the surgical removal of the tumor. In all cases, a treatment plan is required with the purpose of delivering prescribed radiation dose to the tumor while sparing healthy tissues around it. The delivery of radiation may be conducted internally or externally.

Internal radiation treatment is called brachytherapy, in which radioactive sources in the form of seeds, needles, or tubes are placed inside of a tumor for a certain period of time to destroy the cancerous cells. Brachytherapy can be performed as a primary mode of radiation treatment or as a supplement to external radiation therapy.

In external radiation therapy, radiation generators such as linear accelerators, synchrotrons, and cyclotrons are used to produce the desired type and energy of ionizing radiation. This radiation is then aimed toward the target. Linear accelerators produce high energy electrons and X-rays. Synchrotrons and cyclotrons can produce high energy protons. Another type of external beam radiation is called teletherapy in which a radioactive source, commonly reactor-produced Co-60, is used as a source of radiation located in the head of the machine. The high energy gamma rays emitted from this machine can be directed toward the target to destroy cancerous cells.

Radiation Oncology Team

Radiation oncology team members plan and deliver radiation treatment. A radiation oncology team consists of radiation oncologists, medical doctors who

specialize in cancer treatment using radiation; medical physicists, who establish and supervise the radiation treatment process; medical dosimetrists, allied health professionals trained for constructing the radiation treatment plans and assisting physicists; radiation therapists, allied health professionals trained to deliver the radiation toward the target through the use of high technology equipment as described in the treatment plan; and other professionals such as nurses, nutritionists, and social workers. All the members of a radiation oncology team should have appropriate training, strong communication and problem-solving skills, and professional conduct in order to work collaboratively toward patient treatment.

Radiation oncologists are physicians who are specialized in treating cancer through the use of ionizing radiation such as high energy photons, electrons, gamma rays, and protons. The American Board of Radiology (ABR) issues certification to physicians who successfully completed an approved period of education and training, as well as a computer-based and an oral examination. ABR certification indicates a level of excellence in the profession for radiation oncologists. This certification is valid for ten years. Throughout the ten years, these professionals are expected to continue learning and improving, and to take maintenance of certification exam anytime within the last three years of the cycle and pay a registration fee annually (ABR, 2011).

Medical physicists are professionals who have a MS or PhD in medical physics or related fields as well as a clinical training in medical physics. These professionals are specialized in three areas: (1) clinical services, (2) research, and (3) education. Medical physicists, who are involved in clinical services as members of radiation oncology team, provide consultations with physicians in areas of diagnosis and treatment. In radiation

oncology departments, they conduct and oversee planning of radiation treatments for both external radiation treatment and brachytherapy. One of their critical tasks is the accurate measurement of the radiation output from radiation sources. They are also involved in examination of equipment performance, quality control of treatment and diagnostic systems, radiation safety management, and design of radiation installations. Medical physicists serve as resources to provide clinical and scientific advice to the other members of radiation oncology team to resolve the various problems that occur frequently in radiation oncology field (AAPM, 2011).

The American Association of Physicists in Medicine (AAPM) is the professional organization for medical physicists. The American Board of Radiology (ABR) and American Board of Medical Physics (ABMP) certify medical physicists (AAPM, 2011). Based on the agreement between ABR and ABMP in 2001, ABMP discontinued certification of medical physicists in radiation therapy physics and diagnostic imaging physics but offers ongoing programs for the maintenance of certification in these two subfields (ABMP, 2011).

Treatment planning is a very important step to determine the scheme of radiation treatment delivery. This phase is performed by medical dosimetrists. Medical dosimetrists are professionals who have appropriate level of education and training to develop treatment plans that deliver a prescribed dose of radiation to the target while minimizing the radiation dose to the healthy tissues. The American Association of Medical Dosimetrists (AAMD) is the professional organization of medical dosimetrists and the Medical Dosimetrist Certification Board (MDCB) establishes certification standards for medical dosimetrists. The MDCB certification is valid for five years. In

order to maintain certification, a certified medical dosimetrist should register annually and provide the MDCB with the documentation of obtaining fifty MDCB approved continuing education credits every five years **(**MDCB, 2010).

Radiation therapists are allied health professionals who deliver prescribed doses of radiation according to the treatment plan to a patient through the use of high technology equipment such as linear accelerators. These professionals are highly trained in the use of various computer systems and equipment, and educated in radiation safety, anatomy, physics, clinical radiation oncology, and patient care. Their jobs require high interaction with the patients throughout the treatment as well as professional interactions with the other members of radiation oncology team. American Society of Radiologic Technologists (ASRT) is their professional organization and the American Registry of Radiologic Technologists® (ARRT) provides certification for the radiation therapists (ASRT, 2011). An ARRT certified radiation therapist is one who has completed educational preparation, complies with ethical standards, and has passed a certification exam. In order to keep this certification valid, radiation therapists should renew their registration annually. All registered radiation therapists are required to obtain 24 continuing education credits acceptable by ARRT every two years or pass an examination in another discipline recognized by ARRT to maintain their certification (ARRT, 2011).

The History of Radiation Treatment

Radiation treatment is not a recent break through. It has been performed since the discovery of X-rays and radioactivity. One 19th century event that has played a major role in the advancement of medicine is the discovery of radioactivity. As described by Blaufox (1996), Klaproth discovered uranium in 1789 while he was investigating

pitchblende in Germany, nearly 100 years before Becquerel conducted his experiments with it, which in turn led to the discovery of radioactivity. Bucholz discovered the chemical reaction induced by sunlight on sulfate and nitrate solutions in 1805, and Burnett used uranium salts in developing photographs in 1857. The knowledge acquired from all of this research paved the way for Becquerel's discovery of radioactivity in 1896.

Roentgen discovered X-rays following the work of earlier scientists and his discovery influenced the work of Becquerel. The discovery of radioactivity by Becquerel sparked an interest for further investigation by Marie and Pierre Curie that led to the discovery of radium and polonium. Further experiments with radium by scientists in many parts of the world resulted in an increase understanding of the possible applications of radium in medicine and its biological effects on living tissues. Soon after that, scientists realized the potential hazards of radiation which could cause skin erythema, hair loss, and even death.

The discovery of X-rays. William Crookes was born in London, England on June 17, 1832. Among his many discoveries and inventions, he developed a vacuum tube and used it to study physical phenomena. Crooke's tube was evacuated, but still contained low-pressure residual air. He applied high voltage in the range of a few kilovolts to 100 kilovolts across the electrodes and observed a greenish glow at the end of the tube. At that time, atoms were considered as the smallest particles, and electrons were unknown. Several investigations were performed to study the cause of the greenish glow (Wikipedia, Crookes tube, 2010).

Later, it was noted that the high voltage applied across the tube accelerates the naturally existing charged ions in the tube. These charged ions interact with the molecules of gas inside the tube, removing electrons from them and creating more positive ions. Positive ions are attracted toward the negative electrode, which is called the cathode, knocking electrons off its surface. These electrons are repelled by the cathode and accelerated toward the positive electrode, the anode. Many of these electrons pass through the electrode and strike the wall at the end of the tube. They excite the orbital electrons into a higher energy state. When electrons fall back to their original energy level, they emit light causing the greenish glow on the wall of the tube (Wikipedia, Crookes tube, 2010).

It was the invention of Crookes tube that triggered the curiosity of Roentgen and motivated him to study this apparatus. On November 8, 1895, Wilhelm Roentgen was working with a Crookes tube covered with black cardboard. He noticed a glow on a nearby fluorescent screen that was far away from the Crookes tube. Previously, scientists had observed a greenish glow on one end of the tube, but not outside of it. His previous knowledge about the florescent effect and Crookes tube helped him to conclude that unknown invisible rays from the tube could pass through the Crookes tube and cardboard and induce florescence on the screen. He named them X-rays (Roentgen, 1896).

As described by Linton (1995), Roentgen then conducted several experiments to test the properties of this new ray. In November 1895, he put his hands in the beam path and looked at the fluorescent screen. He saw a projection of the bones of his hands. A few days later, Roentgen made a photographic image of his wife’s hand using the new rays. The image of bones showed on the photographic plate, which he showed others as

evidence. Roentgen gave his first lecture about the X-rays in January of 1896, which aroused a great deal of interest in audience. In 1901, Roentgen received the first Nobel Prize in physics for his discovery (Nobelprize.org, 2010).

Early applications of X-rays. In March 1896, a person who had been shot used a "Roentgen photograph" as evidence in a Montreal courtroom to prove the presence of a bullet that had not been detected by surgery. Soon, hospitals started using X-ray equipment for diagnostic purposes (Linton, 1995).

In 1896, Walter Bradford Cannon, an American physiologist, used a fluorescent screen to observe the passage of barium sulfate through an animal's digestive system. Subsequently, physicians all over the world started using this miraculous radiation on humans, to detect foreign objects such as bullets inside the body or to examine bone fractures. By 1970, almost every American had experienced being exposed to X-rays for medical purposes (Medical Discoveries, 2010).

The discovery of X-rays inspired a great deal of enthusiasm in the medical community. This miraculous ray had the potential to advance the field of medicine to a much higher level. Scientists all around the world started studying this new ray and conducted many experiments with Crookes tube. This resulted in designing a more effective tube to produce X-rays, which enabled physicians to investigate other applications of this ray (Linton, 1995).

As physicians experimented more with this newly discovered radiation, they realized that the passage of X-rays through the body could cause biological changes. It could shrink the mass of a tumor, dry up sores, cause hair loss, and produce many other alterations. This was when scientists started thinking about other applications of X-rays,

such as cancer treatment and hair removal treatment (Linton, 1995). Mould (2007) relates that Leopold Freund in Vienna was the first to use X-rays for treatment, a year after their discovery. He applied X-rays to treat a 36cm long hairy nevus on a 5-year-old girl on November 24, 1896.

Potential hazards of X-rays. However, it was soon after the more extensive application of X-rays that scientists realized that this miraculous radiation could also cause skin inflammation, blood abnormalities, cancer, and even death (Linton, 1995). In March 1896, Thomas Edison reported eye soreness following experimentation with X-rays. In April of the same year, radiation burns to hands were reported in the *British Medical Journal*, and in February 1897, 23 cases of X-ray injuries prior to January 1897 were reported in the *Bulletin of the Johns Hopkins Hospital* (Mould, 2007). These observations raised questions about the safety of the X-ray, and initiated the study of radiation's effects on living organisms and radiation safety and protection.

The discovery of radioactivity by Becquerel. Antoine-Henry Becquerel was born in Paris, France on December 15, 1852. He was born into a scientifically-oriented family, in a house located in the Natural History Museum where his father and grandfather worked and consecutively held the position as the professor of Physics. Both were well-known scientists, who had greatly contributed to their fields and were honored by scientific societies (Blaufox, 1996).

Henri Becquerel entered the Polytechnique in 1873. Then he attended the Corps des Ponts et Chaussees, where he studied engineering for three years. He accepted a position as Demonstrator at the Polytechnique in 1875. Twenty years later, he was appointed as Professor at the Polytechnique and became a Professor of Applied Physics

in the Department of Natural History at the Paris Museum. He was interested in studying the composition of matter and the reaction of matter with magnetic and optical properties. It is easy to see that he acquired these interests from the work of his father and grandfather (Blaufox, 1996).

Being the son of a scientist, who studied minerals and compounds, gave Becquerel the opportunity to inherit not only the interest and the knowledge, but also a supply of fluorescent and phosphorescent substances. Therefore, after he learned about the X-ray, he had resources to start his own investigations (Access Excellence@ the National Health Museum, 2010).

Initially he believed that uranium absorbs the sun's energy, which is then emitted as X- rays. Becquerel exposed potassium uranyl sulfate to direct sunlight for several hours, and then placed it on a photographic plate wrapped in black paper. Based on his previous expertise, he expected the salt to emit X-rays induced by sunlight, which would expose the photographic plate, and darken the area underneath it. When he developed the photographic plate, he observed a shadow underneath the uranium crystals, duplicating the image of the crystal (Access Excellence@ the national health museum, Radioactivity: Historical Figures, 2010). The image of the crystals on the photographic plate was precisely what he expected to see. On February 24, 1896, he announced that the uranium crystals emitted radiation that exposed the photographic plate (Blaufox, 1996). Becquerel concluded that the phosphorescent substance he was investigating emits radiation, which penetrates through black paper.

Becquerel decided to repeat his experiment on February 26th and 27th. However, due to cloudy weather on those days, further investigation was not possible. Becquerel

returned the prepared apparatus, uranium salt on the photographic plate wrapped in black paper, back to the drawer in darkness. On the first of March, he decided to do another experiment, developing the photographic plate that had been lying in darkness in the drawer, expecting to see a very weak image of the uranium crystals. Surprisingly, he observed a clear image of the uranium salt. This was in contrast with what he expected to see (Access Excellence@ the national health museum, Radioactivity: Historical Figures, 2010).

He decided to set up another experiment, placing salt crystals unexposed to sunlight on the photographic plate, to confirm the previous accidental observation. Repeated experiments showed that uranium itself was the source of a form of radiant energy that could expose photographic plates even without light excitation (Blaufox, 1996). On March 2, 1896, he presented his findings to the Academy of Science. He published his findings 10 days later in a paper entitled, “On Visible Radiations Emitted by Phosphorescent Bodies” (Peh, 1996).

He also found out that there are certain commonalities between X-rays and the radiation emitted by uranium. However, unlike X-rays, radiation emitted by uranium can be deflected by a magnetic field. He concluded that the radiation emitted by uranium consists of charged particles. For his discovery of radioactivity, Becquerel was awarded the 1903 Nobel Prize for physics. (Access Excellence@ the national health museum, Radioactivity: Historical Figures, 2010).

When Becquerel reported his discovery, it did not arouse very much attention among scientists. Roentgen’s discovery with the potential application of X-rays in medicine was still the focus of attention of many researchers. Becquerel performed

further investigations and made more observations, but he soon left this field (Froman, 1996).

Discovery of radium. Becquerel's work directly influenced the work of Marie Curie. She acknowledged in her thesis that she began her research by studying the phosphorescence of uranium, discovered by Becquerel (Blaufox, 1996). She uncovered many phenomena including the discovery of radium and polonium. Marie isolated one decigram of almost pure radium chloride, and determined radium's atomic weight as 225. She presented the findings of this work in her doctoral thesis on June 25, 1903. Marie's doctoral committee reported that the discovery she made through her doctoral thesis was the greatest scientific contribution ever made in a doctoral research study. Half of the Nobel Prize in Physics was awarded to Marie and Pierre Curie in 1903, for their joint research into the radiation phenomena discovered by Becquerel. Henri Becquerel was awarded the other half for his discovery of radioactivity (Froman, 1996).

At that time, Pierre and Marie did not know about the potential hazards of radiation. Pierre often carried a sample of radium in his pocket to show his friends, and Marie enjoyed placing a small amount of radium by her bed, because it shone in the darkness. Marie and Pierre were constantly suffering from fatigue and other detrimental effects of radiation to their general health (Froman, 1996).

Early applications of radium for treatment. Henri Becquerel had left a radium source inside his jacket pocket unintentionally soon after its discovery. He observed a burn on his skin as a result of this accident. Ernest Besnier, who was a dermatologist at St-Louis Hospital in Paris, diagnosed Becquerel's radium burn, and was the first doctor who had the idea of using radium for treatment of lupus. Later, in October 1900, two

German scientists, Friedrich Walkoff and Friedrich Giesel, performed self-exposure experiments with radium to study the biological effects of radium, which resulted in skin burns (Mould, 2007).

In June 1901, Pierre Currie had performed an experiment to test the biological effects of radium, just like Becquerel's accidental experiment. He intentionally placed a sample of radium salt, wrapped in a thin cover, on his arm for ten hours. Then he studied the wound every day, and after 52 days, a permanent grey scar remained. In 1903, Pierre presented the possibility of using radium for the treatment of cancer before the crowded auditorium at Royal Institution in London (Froman, 1996).

According to Mould (2007), Henri Danlos at St-Louis Hospital in Paris, was the first physician to whom Pierre Curie loaned a sample of radium. Danlos performed the first successful radium treatment on a case of lupus, by placing the radium directly on the lesion. The results were published in 1901. Prior to this successful treatment, two attempts had been made to use radium for treatment, one by Hermann Strebel in Germany and one by Francis Williams in the U.S., but both were unsuccessful due to the very low strength of their radium samples.

In 1903, in St. Petersburg, Goldberg and Efim Semenovich claimed the first cure of a basal cell carcinoma of the face in Russia. In his February 1904 paper, Dr. Francis Williams stated that he had treated 50 patients with pure radium bromide for acne, psoriasis, lupus vulgaris, lupus erythematosus, eczema, keloid, rodent ulcer, epidermoid carcinoma, and breast cancer cases (Mould, 2007).

All these early experiments paved the way for new techniques that increased the effectiveness of radium treatment for deep seated tumors such as treatment using

intratumoral applicators. Today, brachytherapy, which is a treatment using radioactive sources implanted inside a tumor, is one of the most common forms of cancer treatment, used all over the world to treat cancer in all areas of the body.

Further use of X-rays for treatment. The early reactions of cancer to radiation gave hope that radiation therapy is the ultimate cure for cancer but disappointments started when tumors recurred and normal tissue complications began to appear. Physicians used the dose necessary to cause skin redness, as a limit to estimate the appropriate duration of radiation treatment. Soon, it was noted that accurate dosimetry was critical in management of cancer treatment. In 1920, X-ray machines were designed with the capability to produce as high as 200-250 kilovoltage X-rays. These machines could treat deeper tumors without increased skin reactions. In 1937, machines with the capability of producing higher energy X-rays such as supervoltage, betatrons, linear accelerators and teletherapy machines were introduced. Soon after, treatment planning computers, which advanced treatment planning techniques and delivery, were developed (Bentel, 1996). Today, radiation therapy is one of the most common techniques for treatment of cancer.

The Medical Dosimetry Profession

As stated earlier, a radiation oncology team is responsible for designing, administering, and evaluating radiation treatment for the cancer patient. This team consists of radiation oncologists, medical physicists, medical dosimetrists, radiation therapists, nurses and other support service providers. These individuals work closely to provide the highest quality of cancer management and patient care.

Radiation oncologists are responsible for the entire radiation treatment process and medical physicists are involved with the physics aspect of quality assurance and provide guidance and supervision to the other team members (Khan, 2010). Medical dosimetrists must have an understanding of many subjects, including clinical radiation oncology, anatomy, radiation biology, radiation physics, radiation therapy techniques and equipment, quality assurance, radiation safety, and mathematics and use professional judgment and critical thinking skills to construct a radiation treatment plan for the patient. They use sophisticated treatment planning software, computed tomography images of patients, and the information from the radiation oncologist, to construct a radiation plan for cancer treatment. The goal of this plan is to deliver the prescribed radiation dose to the tumor in an effort to destroy it and minimize the radiation dose to the surrounding healthy tissues, to avoid serious radiation-induced health problems. Medical dosimetrists also assist physicists in quality assurance checks and brachytherapy source preparation, and are involved in the documentation of patient treatment.

The Medical Dosimetrist Certification Board (MDCB) is the recognized agency responsible for certifying medical dosimetrists. This is accomplished by designing and administrating the certification exam and processing continuing education credits. A certified medical dosimetrist is an individual who successfully passed the MDCB examination. To maintain MDCB certification, the certified medical dosimetrist is required to obtain 50 continuing education credits every five years to demonstrate awareness of changes and advances in the profession (MDCB, 2010).

The American Association of Medical Dosimetrists is the international society of medical dosimetrists, which has the mission of promoting and supporting the medical

dosimetry profession (AAMD, 2010). A definition of qualified medical dosimetrists was approved by the AAMD board of directors in August 2007, which recognizes the qualified medical dosimetrists as those individuals certified by the Medical Dosimetrist Certification Board, who also hold a minimum of a baccalaureate degree (AAMD, 2010). Although it is strongly recommended, currently, a degree or certification from MDCB is not required for practicing medical dosimetry.

There is a shortage of radiation oncology team members including medical dosimetrists. This shortage should be addressed by educational programs by producing greater numbers of quality professionals. As described by Kresl and Drummond (2004) in the *International Journal of Radiation Oncology*:

> The field of radiation oncology has evolved into an exceptionally technologically driven and multi-disciplinary discipline over the last two decades. This specialty of medicine is one that requires not only the command of highly complex modalities but also the assembly of a competent and expertly skilled team of medical professionals. Although the profession has grown tremendously in the past years, the workforce has not been able to meet the demands of the practice. A significant shortage of radiation therapists, dosimetrists, and oncology nurses exists in the United States today and will almost certainly increase in severity over the next several years. A similar crisis has been seen in several other countries most notably Canada and Australia and has contributed to prolonged delays in cancer treatment for many patients. (p. 8)

Medical Dosimetry Professional Development

Historically, there were no distinct professionals exclusively designated to perform treatment planning and radiation dosimetry. According to Khan (1998):

> Historically dosimetrists were classified as physics personnel with a Bachelor of Science degree in the physical sciences. They assisted physicists in routine clinical work such as treatment planning, exposure time calculations, dosimetry, and quality assurance. They could be called a physicist assistant, analogous to physician assistant. (p. 9)

In the late 1960's and early 1970's, medical physicists became too involved in radiation measurement and technology development to perform routine calculations and design dose distribution maps for individual patients. Thus, they hired math or physics college graduates to serve as their assistants in this capacity. At smaller centers, medical physicists trained radiation therapists to perform routine beam-on-time calculations. As more calculations and dose maps became necessary for each patient, some radiation therapists began to perform these tasks, rather than the radiation therapy itself. As knowledge and technology developed, a unique mix of expertise became necessary to perform the increasingly complex calculations and treatment designs. The dosimetrist became a distinct and integral component of the radiation oncology team. Today, medical dosimetrists are essential members of the radiation oncology team who in collaboration with it, provide care for cancer patients (M. J. Chapman, personal communication, November, 2004).

According to the American College of Radiology (1995), one dosimetrist is desired for every 300 patients treated annually (as cited in Khan, 2010). The 2002

radiation oncology workforce study, by the American Society for Therapeutic Radiology and Oncology (ASTRO), indicates that the total number of medical dosimetrists in practice in private, academic, and other settings was 2,882. According to this study, 702 additional medical dosimetrists (24.4% more) are needed. A staffing survey conducted by ASTRO in 2011 estimated a 4.9% unfilled full time equivalent positions in medical dosimetry. Although this is less that in 2004 (8%), but according to this workforce study, there has been a fluctuation in the percent unfilled full time positions in medical dosimetry from 2004 to 2011 and there has been a need for these professionals. The shortage of radiation oncology staff impacts the quality of patient care, the capacity to handle the patient load, and the hours worked by existing staff. Because there is a nationwide shortage of medical dosimetrists, and due to the many advances in treatment planning, career outlook for medical dosimetrists is excellent.

Advanced technology and the complexity of radiation treatments call for more time to create a treatment plan and perform related tasks. The first generation of medical dosimetrists is currently reaching the retirement age. There are only a small number of educational programs in the United States that produce medical dosimetrists. Although some hospitals train radiation therapists on the job to work as medical dosimetrists, these individuals have a difficult time passing the MDCB examination since they lack focused classroom instruction. It is clear that these few educational programs cannot provide the needed workforce for a field that is growing and already suffering a severe shortage of personnel. In addition, new programs develop very slowly due to a lack of funding and a shortage of available program personnel.

The Consequences of Inadequate Training of Healthcare Professionals

Inadequate training causes medical errors that can lead to horrifying results, damaging the patient's quality of life and even resulting in death. In a recent article in New York Times, Walt Bogdanich (2010) revealed a number of medical errors in radiation oncology in a New York City hospital. In one accident, this hospital treated a 43-year-old patient for tongue cancer. The radiation oncology team did not catch a computer error, which aimed the wrong beam of radiation at his brain stem and neck for three consecutive days. This radiation overdose left him deaf, unable to swallow, struggling to see, and nauseated. It also caused ulcers in his mouth and throat, teeth loss, and severe pain. He was finally unable to breathe and died. In another accident, a 32-year-old mother of two young children received the wrong beam of radiation, which left a hole in her chest, and eventually killed her. These are just two instances of many mistakes that were revealed. There are, however, many radiation errors that will never be detected, because they are hard to identify. According to Jeff Nelson, President and Chief Executive of the nation's largest wound care company, 3000 patients were treated for radiation injuries in 2009.

In a letter to the editor of New York Times, AAMD President, Theresa Kwiatkowski (2010), stated that "an integral part of safe and effective patient care is the assurance that all persons who perform medical imaging examinations or plan and deliver radiation therapy treatments, meet a minimum education and credentialing standard" (p. 1). She also believes that although we are human and humans make mistakes, those who have proper training and credentials can better avoid medical errors.

CARE Bill. The American Society of Radiologic Technologists (ASRT) began a campaign in 1997 to protect patients from being overly exposed to radiation and support reducing healthcare expenses. Since 1999, ASRT has introduced House and Senate bills that require minimum educational and certification standards for healthcare radiation workers in all states. The CARE Bill, which stands for consistency, accuracy, responsibility, and excellence in medical imaging and radiation therapy, would ensure that there is an equal quality of care for patients who undergo any type of radiologic procedures, just as there is for those who receive mammograms under the Mammography Quality Standards Act (ASRT, n. d).

CARE Bill would regulate minimum education and credential standards for allied health professionals and might impact the curriculum of some allied health programs. It would also result in an increase in the number of educational programs, because on-the-job-trained (OJT) workers without any formal education would no longer be qualified. This bill emphasizes the importance of educational programs in training high-quality allied health professionals in radiation fields. Those who obtain the proper training and are certified by their professional society would be considered qualified to perform patient care.

Educational programs are accountable for the proper training of these individuals. One way to ensure the quality of an educational program is by an accurate program evaluation that addresses the strengths and weaknesses of every aspect of the program. This will inform program administrators of the areas needing improvement.

Accredited Medical Dosimetry Programs

The only agency recognized by the United States Department of Education to accredit radiologic technology educational programs, including medical dosimetry programs, is the Joint Review Committee on Education in Radiologic Technology (JRCERT, 2011).

According to JRCERT (2011), there are 16 accredited medical dosimetry programs in the U.S. These programs are: (1) Bellevue College in Washington State with a capacity of 9 students, (2) Georgia Health Sciences University with a capacity of 6 students, (3) Pitt Community College in North Carolina with a capacity of 4 students, (4) Roswell Park Cancer Institute in New York with a capacity of 6 students, (5) Southern Illinois University Carbondale with a capacity of 39 students, (6) the Cleveland Clinic Foundation in Ohio with a capacity of 3 students, (7) the University of Texas MD Anderson Cancer Center with a capacity of 36 students, (8) Thomas Jefferson University in Philadelphia with a capacity of 8 students, (9) University of Arkansas for Medical Sciences with a capacity of 6 students, (10) University of Cincinnati, Raymond Walters College with a capacity of 3 students, (11) University of Maryland Medical Center with a capacity of 2 students, (12) University of North Carolina Hospital in Chapel Hill with a capacity of 2 students, (13) University of Oklahoma Health Sciences Center with a capacity of 8 students, (14) University of Wisconsin-LaCrosse with a capacity of 12 students, (15) UT Health Science Center in San Antonio with a capacity of 6 students, and (16) Indiana University School of Medicine with a capacity of 16 students.

The Medical Dosimetry Program at the University of Texas MD Anderson Cancer Center

The University of Texas MD Anderson Cancer Center is one of the largest medical dosimetry programs in the U.S. This program is sponsored by MD Anderson's School of Health Professions and is supported by the Division of Radiation Oncology. This program prepares students for all aspects of a career in the medical dosimetry field. Students gain technical knowledge and professional skills in treatment planning, dose calculation, quality assurance, and other related subjects through rigorous didactic education as well as a state-of-the-art clinical training under the supervision of qualified medical dosimetrists, physicists, and radiation oncologists (School of Health Professions Student Catalog, 2011).

The medical dosimetry program at MD Anderson Cancer Center started as a certificate program in 1991. This program was in high demand since its inception. Over the last three years, the program has had about 100 applicants per year competing for 14-16 available positions. Many of the applicants reapplied for as many as three years to gain a position in the program. The program has demonstrated a high job placement rate since its inception. Graduates from this program are preferred by employers across the state, the nation, and internationally.

This program carefully selects applicants among eligible radiation therapists and individuals with science backgrounds. This one-year intensive program consists of classroom and clinical education. Certified medical dosimetrists, board-certified radiation oncologists, medical physicists, radiobiologists, resident physicians, and registered nurses teach in the various courses that are scheduled for two days a week.

Students are also encouraged to attend many of the seminars and in-services offered by the Division of Radiation Oncology at MD Anderson Cancer Center. The clinical education components of the program, which are scheduled three days a week, include experience at MD Anderson Cancer Center or other clinical affiliates. Clinical rotations are administered during one year of academic instruction. The clinical training for the medical dosimetry students include two and three dimensional external beam treatment planning, Intensity Modulated Radiation Therapy (IMRT), daily and weekly quality assurance checks, machine quality assurances, brachytherapy planning, and other dosimetry related tasks.

The University of Texas MD Anderson Cancer Center, School of Health Professions is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools (SACS) to award baccalaureate degrees. The medical dosimetry program is also accredited by the Joint Review Committee on Education in Radiologic Technology (JRCERT) to offer baccalaureate degree in medical dosimetry.

The Purpose of This Study

As stated before, the quality of allied health professionals, including medical dosimetrists is a key component in the successful treatment of cancer patients. Inadequate training of radiation workers results in radiation injuries and medical errors. The CARE bill requires allied health professionals to obtain formal education and proper clinical training and to earn appropriate credentials. Due to the current shortage in allied health professionals and the future ban of on-the-job training without a formal education, it will be necessary to establish more educational programs and increase the number of students

in current programs. These training programs will also be supported under the President Obama's healthcare reform.

Since the medical dosimetry program at MD Anderson Cancer Center is one of the few accredited programs in the nation, and is responsible for training a significant number of medical dosimetrists, there is a need to evaluate its effectiveness and research ways to enhance its performance. This study will evaluate different aspects of the medical dosimetry program at MD Anderson Cancer Center, which involves examining the quality of program's faculty, clinical education, curriculum, school orientation, and program's graduates.

Faculty. Medical dosimetry program at the University of Texas MD Anderson Cancer Center is a face-to-face program, requiring students to attend the classroom and clinic. Students attend clinic 3 days a week and school 2 days a week where they interact with program faculty and staff. The quality of work by the faculty impacts the quality of students' education. Through this study, the degree to which students are satisfied with the quality of the faculty will be assessed, using the data from faculty evaluations.

Clinical education. Students learn an extensive body of knowledge in a variety of subjects in the classroom in order to acquire the foundation needed to learn and perform clinical duties. This includes radiation safety, cross-sectional anatomy, medical dosimetry physics, brachytherapy dosimetry, radiation biology, and clinical radiation oncology. Simultaneously, students start their clinical education to apply their didactic knowledge in clinical settings where they observe real-world applications of their learning in the everyday work of medical dosimetrists. Clinical training is a critical component of a student's education, which combines scientific knowledge with technology to apply

toward patient treatment. This requires a great deal of critical thinking and problem solving, because every tumor is different in shape, size, and location. The medical dosimetrist should have the knowledge and creativity to construct and tailor radiation treatment for every patient to satisfy the goal of treatment planning. Clinical instructors, quality of training instructions, and available resources are important factors in creating a quality clinical education. This study will assess the degree of student satisfaction with their clinical education using the analysis of clinical education evaluations completed by students at the end of each semester. The results of this study will inform program administrators of the areas of improvement.

Program curriculum. The curriculum of the medical dosimetry program at MD Anderson Cancer Center follows the AAMD curriculum guidelines as published in the *Medical Dosimetry Journal* (1998, Vol. 23, No. 4, pp 311-332). This is reflected in the JRCERT curriculum grid for accredited medical dosimetry programs. Although the program covers all the subjects required by these organizations, the program administrators can modify the emphasis of certain subjects within the curriculum. To ensure that the curriculum satisfies the needs of students in this rapidly evolving field, this study will ascertain the degree of student satisfaction with the program curriculum. The results can be used to make improvements to the curriculum and its content. This study will use medical dosimetry program evaluation data to assess the degree of student satisfaction with the curriculum.

School orientation. Students' learning environment is an important component of their education. A healthy learning environment reduces stress, helps to build trust among students and their instructors, promotes collaboration and team work, and creates a

respectful and friendly environment for students' educational success. Student services are important in improving student learning environment. These services provide additional resources, programs, and support to assist students with academic success, personal goals, and professional development. Another strategy to reduce pressure among students and introduce them to some components of their learning environment is providing them with information and expectations before the start of the school. This orientation session leads in students' better understanding of school's expectations.

The School of Health Professions provides an orientation session for all admitted students at the beginning of each school year. This orientation session begins with the School of Health Professions' Dean welcoming students to their professional education. Then students learn from variety of lecturers about the available resources such as Sakai course management system; student affairs office; recreation center; health insurance; clinical and academic expectations; patient care philosophy including MDACC codes of ethics and confidentiality policy; available student services such as financial aid, registrar's office, and ombuds office; safety in a laboratory environment; and crime prevention. The quality of this orientation session is important in helping students understand their learning environment, policies and expectations. The quality of this orientation is evaluated every year through program evaluations completed by students just before graduation. This study will use these data to identify the perspective of students on helpfulness of their school orientation.

Employers' satisfaction with the quality of the program's graduates. One year of intensive training in this program produces entry-level medical dosimetrists. One way to evaluate the quality of the program is to seek employers' perspectives on the

program's graduates as entry-level employees. This study will use employer survey data to find the degree to which the program is successful in training high-quality entry-level medical dosimetrists.

Research Questions

To summarize the intent of the dissertation study, research questions have been designed as follows.

1. How has the review of the literature regarding the evaluations of health-related educational programs informed the intended program evaluation of the medical dosimetry program?
2. To what extent are students satisfied with the quality of the faculty?
3. To what extent are students satisfied with the quality of the clinical education?
4. To what extent are students satisfied with the quality of the curriculum?
5. To what extent do students view their school orientation helpful?
6. To what extent are employers satisfied with the quality of the program's graduates as entry-level medical dosimetrists?

Chapter II

Review of Related Literature

Published research on medical dosimetry education does not exist because of the shortage of medical dosimetry programs in the U.S. This retrospective quantitative study would be one of the first multi-dimensional program evaluations in the field of medical dosimetry. Various program evaluation studies have been conducted in other health-related professions. A review of these studies will be used to elucidate different aspects of health-related educational programs, in order to guide the proposed study. The areas of health-related professions that will be reviewed to provide insights into this program evaluation are: (1) medicine, (2) dentistry, (3) nursing, and (4) allied health sciences.

Medicine

Competent graduates of healthcare programs possess proficiency in the content, knowledge, and clinical skills, as well as professional conduct needed to practice in the healthcare field. Patients receiving any type of medical care expect healthcare professionals to have the finest knowledge and skills, as well as professional values, to ensure an optimal outcome for treatment. It is the responsibility of educational programs to allow only those students who meet the competency requirements to graduate. It is critical for educational programs not only to teach content knowledge and practical skills, but also to promote professionalism.

Epstein and Hundert (2002) described professional competence as “the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values and reflection in daily practice for the benefit of the individual and

community being served" (as cited in Halpern 2003, p. 1). The question that arises for educators is how to effectively teach professionalism to students.

According to Spencer (2004), one of the educational experiences that influence students' behavior and professional conduct is their learning environment. A school's curriculum, subjects of study, teaching methods, assessment methods, and the quality of instructors as role models will affect the professional values passed on to the student. Teachers must demonstrate professionalism in their relationship with their students, such that appropriate behaviors are reflected in their actions. This is consistent with Hatem's (2003) argument that role modeling is the most effective method of teaching professionalism (as cited in Halpern, 2003).

Parents raise their children the way they have been raised, which directly influence the behavior and values of the children. Similarly, teachers teach their students the way they have been taught (McKegney, 1989, as cited in Spencer, 2004). Professional values are passed on to the students from their teachers, which they will subsequently utilize when holding teaching positions. Therefore, educators promote professional growth when they hold on to high standards and serve as role models for their students.

Educational programs must also evaluate their students' professional growth. This will illustrate the effectiveness of their teaching strategies with respect to professionalism. Methods for evaluating professionalism, however, are controversial. There is a great deal of literature that supports the concept of students' professional evaluation by several members of the healthcare team, because each member would have his or her own unique perspective on students' professional conduct. These evaluations are essential to identify areas of deficiency to provide feedback and counseling to the

students regarding changes for improvement. Students, who are not willing to improve, should not be allowed to graduate from medical schools because their behaviors will directly affect the quality of patient care (Halpern, 2003).

Another element of competency in medicine is clinical skills. Clinical training is a critical component of healthcare education, which enables students to gain the practical knowledge and skills necessary to provide care for patients. The quality of clinical training is affected by the quality of clinical instructors and the resources available.

Irby (1995) conducted a study regarding clinical teaching effectiveness in medical schools. He identified four elements for excellent clinical instructors. These characteristics include serving as a positive role model, providing effective supervision and mentoring, using a various energetic approach to teaching, and being a student supporter (as cited in Henzi, Davis, Jasinevicius, & Hendricson., 2006). Instructors are essential components of clinical education and so it is necessary for educational programs to evaluate the quality of their clinical instructors to ensure that they have appropriate qualifications and characteristics for their role.

A multi-dimensional assessment of clinical education is essential for educators to gain insight into areas of strength and weakness and possible areas of improvement. In a qualitative study by Lempp and Seale (2004) in a medical school in the U.K., it was noted that a majority of students were dissatisfied with teaching methods in their clinical education. Most described disorganized teaching by clinical instructors and indicated that many unexpected changes occurred in the teaching schedules, which resulted in wasting their time. They also noted that some teachers demonstrated no passion for teaching and

lacked teaching skills, which adversely influenced students' motivation and their attendance at clinical training.

It is noted from this study that educational program directors should consider these issues when scheduling clinical training and selecting appropriate clinical instructors. They should select those professionals who are passionate about teaching, knowledgeable about the profession, and have proper teaching skills. Program directors should consider the fact that many of the clinical instructors have had no formal training in effective teaching strategies. Therefore, providing learning opportunities for clinical instructors can improve their teaching skills. Ineffective clinical instructors adversely affect student motivation and attendance in the clinic, which directly impact the program's effectiveness, student retention rate, licensure examination pass rate, and graduates' quality.

Additionally, a lack of an efficient clinical training causes stress and anxiety among students. A study conducted by Vitaliano, Russo, Carr, and Heerwagen (1984), explored the ways in which medical school pressures are related to stress and anxiety, which are major causes of cognitive dysfunction. They determined that among many stress-causing factors are insufficient time for personal activities, competition, long hours, and pressure to master the subject matter. This is consistent with Chew-Graham and Rogers' (2003) recommendation that support and mentoring outside of the learning environment are appropriate strategies to deal with professional stress among medical students (as cited in Holm, Tyssen, Stordal, & Haver, 2010).

Consequently, another point for program directors to consider is students' personal time when scheduling their classes. Providing support services and a

collaborative learning environment will also reduce the stress and pressures among students and improve their learning outcomes.

Another stress reduction strategy is for medical students to participate in self-development groups. In meetings for such groups, discussions include students' personal life, self-esteem, positive resources, and communication (Holm et al., 2010). These groups can be conducted by faculty or student support services available in the universities. The quality of the support services directly influences the level of stress among students. Support services include counseling, tutoring, financial aid, recreation opportunities, job assistance, and many other services. It is necessary for the educational programs to evaluate the quality of their support services, since it has a direct impact on students' learning environment, stress level, and cognitive function.

From the above discussion, it is noted that the quality of faculty and instructors is an important factor in shaping students' professional conduct and technical skills. Faculty and instructors need to be the learning facilitators and the student supporters, who provide counseling, mentoring, and advising in the academic and non-academic aspects of students' lives. From the review of literature in medicine, it is concluded that assessment of the quality of faculty, clinical training, and student services are important aspects in a multi-dimensional program evaluation of medical schools.

Dentistry

Completing dental school requires intensive clinical and didactic education, like many other health-related programs, which leaves very limited time for students' personal time outside of school. Administrators and decision makers should plan their educational programs considering a balance between students' personal life and their

professional life. This balance will minimize the students stress level and improve their cognitive function. In a study conducted by Stewart, Vries, Singer, Degen, and Wener (2006) in a Canadian dental school, it was noted that students experienced a range of stress-related effects during their training. They found that student anxiety increases and their self-esteem decreases throughout their training. As noted by Stajkovic and Luthans (1998), “a strong belief in one’s ability to perform the actions needed to produce a desired result is essential to competence across diverse activities” (as cited in Stewart et al., 2006, p. 980). For this reason, it is very important that faculty establish a friendly relationship with their students, listen to their personal issues, and provide counseling. This will minimize student stress levels, which in turn will lead to better student learning outcomes.

Another strategy to reduce pressure among students is providing them with information and expectations before the start of the program. It is suggested by Bradley et al. (1989) and Hechter (1996) that providing detailed information to dental students at the initial orientation session results in better understanding of program expectations. Accordingly, students can manage their personal lives to suit the program’s requirements. This improves their learning environment and students’ quality of life throughout the program (as cited in Stewart et al., 2006).

Improving the learning environment with the help of faculty and decision-makers is supported by several studies. A study of the learning environment of North American dental schools was conducted in 18 schools from the responses of 619 students. Freshman dental students felt their programs lacked a positive learning environment, resulting in

high stress level, whereas junior dental students believed that there was a lack of faculty support, encouragement and flexibility (Henzi et al., 2005).

The study performed by Cardall, Rowan, and Bay (2008) re-emphasized the importance of faculty support in student education. This study demonstrated that dental students view poor student-faculty relations as the most important element contributing to a poor academic climate and lack of motivation among students.

If schools do not encourage faculty to be supportive of students, some faculty may behave negatively toward them, perceiving and treating students as inferior. In a study performed by Koerber et al. (2005), Dr. Darryl D. Pendleton, the Associate Dean for Student and Diversity Affairs, indicated that many dental students do not establish a relationship between behavior in dental school as a student and after graduation as a dentist. He believes that "students view dental school as a hazing process that will ultimately lead to joining the dental fraternity of graduated dentists" (p. 216). He concluded that this may be due to the behavior of some faculty who put students down, giving them the impression that they are subordinates. He believes that faculty and staff should teach ethical behavior through their actions and work in class, so that students establish a connection between professionalism as a student and as a practicing dentist. This study reinforced the importance of faculty as professional role models for students.

Another strategy to improve the learning environment and reduce pressure on students is listening to their comments and seeking their input in program improvement. As described by Bradley et al. (1989) and Hechter (1996), efforts should be made by faculty and decision-makers to foster a supportive peer environment and give students a sense of empowerment. This is achievable by considering students' comments and input

in decision-making. This will give students a sense of worth, reduce feelings of hopelessness and stress, and improve students' effectiveness, wellness, and perceptions of their learning environment (as cited in Stewart et al., 2006).

Like all health-related educational programs, an important part of dental education is the clinical experience. There are many factors that affect the quality of clinical education. Henzi, Davis, Jasinevicius, and Hendricson (2006) conducted a study to evaluate North American dental students' perceptions of their clinical education. This study assessed the perceptions of 655 dental students in 21 dental schools in North America. Students identified four negative elements in their clinical experiences: inadequate numbers of faculty and poor availability; inconsistency and insensitivity in feedback received from faculty; deficiency in support resources leading to excessive amounts of non-educational work and clinic inefficiency; and ethically questionable strategies being required to meet procedural necessities. As observed from this study, some of the most important elements of an effective clinical education are the quality of clinical instructors, availability of resources, and professional values, which are consistent with those of medical education. All these elements need to be considered when evaluating the clinical education of students.

A study performed by Myers (1977) reported that effective clinical instructors take their teaching duties seriously, demonstrate professional behavior, and are technically proficient (as cited in Henzi et al., 2006). Many other studies have been conducted in dental schools to identify the factors involved in clinical teaching effectiveness. These studies drew the same conclusions as Irby's studies in medical schools. According to these studies, some of the characteristics of effective clinical

instructors in dental schools are interest and concern in teaching students, providing appropriate feedback and response to students, inspiring students, relating didactic information to clinical application, explaining difficult subjects in a simple manner, and treating students in a facilitative manner (Henzi et al., 2006).

Another important point for clinical instructors is to consider how to establish their expectations in accordance with the competence of students. According to Chambers, Geissberger, and Leknius (2004), some of the expert level clinical instructors are seen by students as poor evaluators. The reason is that these professionals expect "expert" level performance from them. Students feel that an unrealistic level of expectations, results in unfair grading (as cited in Henzi et al., 2006).

Curriculum plays a huge role in students' understanding of the profession. A longitudinal study by Kieser, Dall Alba, and Livingstone (2009) has shown how students' understanding of the dental profession changes with their academic progression from the first year to the second year based on the focus of the curriculum in these two years. This study was in addition to the previous empirical studies that demonstrated how an understanding of professional discipline is dependent on the context of study. This will give an important role to the careful design of the curriculum by program administrators.

Effective teaching is necessary to best implement a curriculum. According to Jahangiri, Mucciolo, Choi, and Spielman (2008) the extent to which teaching strategies accomplish the intended purpose is called teaching effectiveness. Thus the evaluation of teaching effectiveness is another important component of educational programs. Their review of literature has shown that empirical data support the use of three strategies to evaluate teaching: student evaluation, peer evaluation, and self-evaluation. Using all three

approaches is described as triangulation in education literature and is suggested as the best evaluation approach. However, it is recommended that peer evaluation should not be used for formal performance evaluation and promotion decisions and should be used only to improve teaching effectiveness because they can be biased and unreliable. They are helpful if they are conducted along with other types of evaluations (Jahangiri et al., 2008).

Jahangiri et al. (2008) conducted a study to assess teaching effectiveness in U. S. dental schools. This study has shown that the majorities of programs utilize student evaluation (81%) and peer review (78%), but only 31% use self-evaluation and only 19% utilize the triangulation method.

The review of literature in dental schools has shown that dental programs need to evaluate their curriculum, clinical education, quality of instructors, and quality of learning environment on a continuous basis for formative and summative purposes. The results of these evaluations will be used to develop and improve individuals and services, and determine program effectiveness.

Based on this review of literature in dental schools, it is concluded that when evaluating instructors, factors such as the use of effective teaching strategies, supportiveness, professionalism, fairness in grading, and realistic expectations should be considered. When evaluating the learning environment, the participation of students in decision-making, quality of their personal life, and quality of student services should be assessed. When evaluating clinical education, the quality of clinical instructors, availability of resources, opportunities for professional growth, consistency in instruction and feedback, and ethical values should be considered.

Nursing

According to the American Association of Colleges of Nursing (AACN), 215 accelerated baccalaureate and 57 accelerated master's programs were available in the U.S. in 2008. Teaching these students can be a challenge for some faculty (as cited in Rico, Beal, & Davies, 2010). Faculty should be aware of the best teaching practices in order to overcome the challenges they face in teaching health-related professionals.

Rico et al. (2010) identified six themes as the best faculty practices in nursing schools: (1) recognize the value of adult learners, (2) communicate enthusiasm for the career, (3) challenge and inspire, (4) practice the career and share the experiences, (5) be supportive, and (6) use variety of teaching styles. The study showed, in nursing schools, like medical and dental schools, faculty supportiveness, professionalism, quality, and teaching skills are important factors to achieve students' success. Effective clinical instructors motivate students and encourage their understanding of the profession, which improve program effectiveness.

The retention rate of an educational program is one indication of its effectiveness. A student attrition model by Bean (1980) and Bean and Metzner (1985) identified the barriers to academic progression as poor academic performance, inappropriate study habits, lack of academic commitment, unsuitability to the program, family responsibilities, financial status, social support, and long work hours. According to Megginson (2007), another important factor in student retention is previous negative academic experience (as cited in Robertson, Canary, Orr, Herberg, & Rutledge, 2010). All of these factors will negatively affect student motivation, which may result in their academic failure.

Furthermore, Jeffreys (2004) studied a population of RN-to-BSN nursing students. Jeffreys found that factors such as student's background, study skills, class attendance, class schedule, study time, faculty support, counseling, professional events, level of student interaction with the program, peer interaction, mentoring, enrichment programs, environmental factors such as financial and family support, course grades, and affective factors such as self-efficacy could affect student success and retention (as cited in Robertson et al., 2010).

These findings are consistent with the result of the qualitative study performed by Rogers in 2009. He studied factors that led to the success of an associate degree nursing program at a state university in West Virginia. This study identified three factors in student success, including student-related, collaboration-related, and curriculum-related factors.

Student-related factors that were rated important to student success by both faculty and students in Rogers' study include motivation, academic skills, health care experience, life management skills, prioritization, and organization. Faculty and students also commented on factors like stress management, multi-tasking, and personal well-being as important elements in student success.

Rogers' study also showed that students who communicated and collaborated effectively with their peers and faculty, and used support systems like family were more successful. Moreover, the structure of the program and curriculum is important to student success. Students commented that innovative teaching methods instead of a lecture-focused classroom environment, carefully constructed course assessments, and NCLEX-RN workshops were helpful in their success.

A study conducted by Judkins, Arris, and Keener (2005) demonstrated that “high hardiness may be a contributor toward success in the workplace” (p. 319). Hardiness generally refers to personal characteristics that enable a person to hold up under stressful conditions (Kobasa, 1979, as cited in Judkins et al., 2005). According to Turnipseed (1999), hardiness consists of three factors: (1) dedication to work, (2) personal control over events, and (3) a belief that change is a chance for development, not a threat (as cited in Judkins et al., 2005).

Judkins et al. (2005) has also found that nursing students demonstrated increased hardiness from the beginning to the end of the program. This was prominent in their acceptance of change, level of commitment demonstrated by lifelong learning and leadership, and aspirations for autonomy and self-control. According to this study, including hardiness development opportunities into nursing programs can improve these characteristics in students.

Judkins (2001) reported that nurse managers with a higher level of hardiness demonstrated better problem solving skills and lower stress levels (as cited in Judkins et al., 2005). Hardiness is an element of professionalism, which based on these studies, is important to be included in professional growth opportunities.

Another indication of program effectiveness is the student pass rate in professional licensure or registration examinations. Sewell, Culpa-Bondal, and Colvin (2008) examined the processes by which nursing student pass rates on the licensure examination have been improved. These processes included implementing a preparatory course for the licensure exam; implementing a progression policy, which requires students to pass an exit examination with a minimum score in order to graduate; and

improving course content to ensure coverage of identified curriculum gaps. In this process, the faculty learned to consider a variety of learning styles when teaching, and to evaluate, recognize weaknesses, and modify current strategies when needed for optimal student learning outcome.

From the literature review in nursing, it is noted that the best learning outcomes result when faculty establish a professional relationships with their students, use a variety of innovative teaching strategies to accommodate all types of learning styles, and support students by mentoring, advising, and counseling on a continuous basis. Research in nursing has also recommended students to communicate with their faculty and peers, expand their professional network, and meet their physiological needs for their most excellent well-being. The above studies in nursing have also shown that an effective nursing program is one that teaches professionalism to students, prepares them for the licensure examinations by administering mock exams, improves their critical thinking skills, promotes their self-management skills, and continues to improve the curriculum.

Allied Health Sciences

Allied health professionals make up about 50-60 percent of the healthcare workforce. Allied health professions include a variety of diagnostic, therapeutic and preventive disciplines but their education and practices have some common purpose and mutual concerns with the healthcare delivery system (National Commission on Allied Health, 1999). For this reason, it would be suitable to study the various factors that impact the success of educational programs in allied health sciences and identify aspects that are applicable to medical dosimetry programs. Educational programs in allied health

sciences are responsible for providing students with the content knowledge, clinical applications, and non-technical skills related to that specific profession.

Queeney and Smutz (1990) argued that learning the knowledge exclusively, does not equate with competence (as cited in Martin, 1993). This was supported by Nowlen (1988), who described the term competence as "the knowledge, skills, and attitude characteristics necessary for a professional to be able to perform according to established standards and requirements in a contextually appropriate work environment" (as cited in Martin, 1993, p. 10). It was also stated by Lane (2010), that competence in healthcare disciplines includes relevant non-technical skills. These skills impact the overall success of students in school and in the clinic.

Non-technical skills consist of a variety of abilities and qualities, including empathy for patients, critical thinking, teamwork, the ability to work in stressful environment, multi-tasking, self-awareness, emotional control, and many others. As stated by Phelan et al. (1993) and cited by Lane (2010), "when a medical school graduates a student, it implies that the individual has the cognitive knowledge, the clinical skills and the non-cognitive qualities necessary to function as a competent physician"(p. 130). This statement, which can be generalized to other health-related educational programs, makes programs accountable for the quality of their graduates.

Martin (1993) studied medical technology programs to identify some of the most important attitude characteristics, among health professionals in that discipline. He determined that the most valuable characteristic among them is ethical attribute. Ethical attributes include many elements such as integrity, confidentiality, responsibility, and accountability. The second most valuable characteristic that he identified was

communication skills. There are other valuable characteristics identified for medicine, nursing, and other allied health professions such as compassion, teamwork, respect, patient and professional support, and being concerned, balanced and tolerant. Based on this study, it is important that educators make every effort to teach these values to their students and ensure that they acquire a sufficient level of professionalism before they graduate. Furthermore, these characteristics need to be evaluated when assessing the quality of a program's graduates.

In a study to identify variables that predict successful respiratory care education programs, Ari (2005) found that "among all program resources components, the financial resources to student ratio and personnel to student ratio had statistically significant relationships with the mean WRRTE score of respiratory therapy programs"(p. 62). One can argue that financial resources have a direct relationship to the quality of the educators and resources available, which in turn impact the quality of student learning.

The other factor for educators to consider is the generations they intend to teach. According to Collins (2000) today, the majority of students in colleges and universities are generation X. An individual, who was born between 1961 and 1981, is considered a member of generation X. These students have learning styles and personalities different from preceding generations. For example, they learn better through the use of technology (Hays, 1997 as cited in Collins, 2000) than in a lecture-centered classroom environment (Collins & Tilson, 1999, as cited in Collins, 2000).

A study conducted by Collins (2000) examined generation X students' perspective on the characteristics of an effective teacher, course structure, and student learning styles in allied health programs. The author administered a survey to 52 allied

health students, enrolled in 5 health profession university programs. The majority of students indicated a need for exam review sessions, and study guides. They identified characteristics of effective teachers as nurturing, challenging, establishing avenues for extra credit, considering students' capability and learning styles, and promoting critical thinking through group activities. They also preferred teachers who were not easy graders and did not overlook rudeness from students.

The review of literature in allied health professions emphasized the importance of technical and non-technical skills in graduates of allied health programs. Different aspects of these skills should be evaluated by programs to determine program effectiveness. Educators should also be aware of the generational differences of the students they teach and use appropriate teaching strategies to meet their learning styles and characteristics.

Conclusion

From the above literature reviews, it is revealed that all health-related educational programs are accountable for ensuring that their graduates possess an appropriate level of professional conduct as well as content knowledge and clinical skills. It is important for educational programs to consider many elements when designing and implementing their curriculum. Program faculty should provide a suitable learning environment for students, where there is a balance between schoolwork and personal life. Educators should be aware of the new generation of students and their educational demands and consider their learning styles and characteristics. Program officials should select knowledgeable clinical instructors, who are passionate about teaching and possess an understanding of appropriate teaching techniques for different learning styles. Most clinical professionals

are trained to perform clinical duties but have had no formal education in teaching skills. Thus, it is important that program administrators provide teaching opportunities for these professionals to educate them in the skills they need to teach students. This is achievable by holding teaching workshops, making in-class observations, and reviewing students' feedback.

Instructors have a huge responsibility in shaping students' professional values. The best way to achieve this is by serving as appropriate role models for students. They should also be student advocates and support students through mentoring, counseling, advising, and listening to their personal problems. All of these strategies will reduce the stress level and pressure among students, which in turn will improve motivation, cognitive function, and student learning outcomes.

The educational program officials should evaluate the quality of the curriculum, faculty, student professionalism, clinical training, clinical faculty, and student support services in order to gain insights into ways to continuously improve their programs. They should also seek the opinions of employers about the program's graduates in many areas of technical and non-technical skills for formative and summative assessment.

Program Evaluation of the Medical Dosimetry Program at MD Anderson Cancer Center

Programs should establish on-going evaluation strategies in order to assess the quality of their programs in many aspects that have a direct effect on student learning outcomes. It is noted from the review of literature that the quality of faculty, clinical education, curriculum, and student services has a direct effect on student learning outcomes and program effectiveness. The purpose of this study is to evaluate the quality

of the Medical Dosimetry Program at The University of Texas MD Anderson Cancer Center, School of Health Professions in many aspects. This study will inform program decision-makers on areas needing modifications for achieving optimal results and determining the degree to which the program has met its goals and objectives.

The first part of this study, will involve a review of the relevant literature to identify and recommend the components of a health-related program evaluation. It will also inform the Medical Dosimetry Program's officials of the essential components that have a direct effect on student learning outcomes, which also can be considered in this program. In addition, the quality of faculty using the end-of-semester faculty evaluation data collected in 2007-2008, 2008-2009, and 2009, 2010 school years will be assessed.

This study will also assess the quality of the clinical education using the archival clinical rotation evaluations data collected in 2007-2008, 2008-2009, and 2009-2010 school years. End-of-school program evaluations collected in these three school years will be used to evaluate the degree of student satisfaction with the curriculum and initial school's orientation.

The dissertation study will also evaluate the quality of program graduates as entry- level medical dosimetrists using employer surveys conducted in regard to the 2004-2009 graduates. The review of literature has indicated that the competence of a healthcare professional is not only mastery of technical skills, but also demonstrating professionalism and other non-technical skills. Therefore, the quality of graduates will be evaluated in regard to their technical and non-technical skills.

Research questions. To summarize the intent of this study, the following research questions have been designed.

1. How has the review of the literature regarding the evaluations of health-related educational programs informed the intended program evaluation of the medical dosimetry program?
2. To what extent are students satisfied with the quality of the faculty?
3. To what extent are students satisfied with the quality of the clinical education?
4. To what extent are students satisfied with the quality of the curriculum?
5. To what extent do students view their school orientation helpful?
6. To what extent are employers satisfied with the quality of the program's graduates as entry-level medical dosimetrists?

Chapter III

Method

As described in Chapter Two, program evaluation is an important component of an educational program. It provides valuable information to the extent in which a program achieves its goals and objectives and identifies the areas that need improvement. The purpose of this study is to evaluate the Medical Dosimetry Program at the University of Texas MD Anderson Cancer Center (UTMDACC) School of Health Professions in regard to the quality of faculty, clinical education, curriculum, school orientation, as well as the quality of graduates as entry-level medical dosimetrists. A literature review of program evaluations of other health-related programs was conducted as part of this program evaluation to provide insight into this study. This research will make recommendations to the medical dosimetry program at UTMDACC based on the literature review and analysis of data collected in the past as part of the on-going evaluation of the program. The results, discussions, and recommendations related to the first research question are presented in Chapter Four. The results and discussions related to the other research questions are presented in Chapter Five.

Study Population

The population used in this study is medical dosimetry students who were enrolled in the program at UTMDACC during 2007-2008, 2008-2009, and 2009-2010 academic years as well as those employers who hired the 2004-2009 program graduates as entry-level medical dosimetrists.

Sample of Study

All students at UTMDACC are asked to take part in all evaluations conducted by the School of Health Professions. For this reason, all medical dosimetry students participate in faculty and clinical education evaluations at the end of each semester and program evaluations (exit evaluations) at the end of each academic year with the exception of those who are absent during these sessions.

The medical dosimetry program at UTMDACC had 16 students in 2007-2008 school year, 16 in 2008-2009 school year, and 15 in 2009-2010 school year. The sample of this study is the entire population of students from the academic years 2007-2008, 2008-2009, and 2009-2010. In addition, the sample of this study in regard to the quality of graduates is the employers who hired 2004-2009 program graduates as entry-level medical dosimetrists and chose to participate in employer survey for evaluation of these graduates (N=35).

Data Collection and Instrumentation

A literature review of program evaluation in other health-related programs was conducted to learn different aspects of program evaluation, identify the components that are important when conducting a multi-dimensional program evaluation of a health-related program, and to ascertain important elements of health-related programs, which were used to make recommendations to this program for improvement.

All students in the School of Health Professions at UTMDACC are asked to participate in programmatic evaluations. In order to get consent from students, all admitted students in the School of Health Professions are required to complete the Assessment Agreement form and submit it by the conclusion of the orientation session on

the first day of school (see Appendix A). By signing this agreement, students agree to participate in course, faculty, and program evaluations; consent to the program for contacting their future employers; and complete alumni surveys (School of Health Professions Student Catalog, Policy 18.0, n.d.).

The Office of Institutional Effectiveness at the UTMDACC conducts faculty and course evaluations for all eight programs of the School of Health Professions at the end of each semester. In addition to these regular end-of-semester evaluations, this office conducts a program evaluation survey for graduating students at the end of each school year for all these eight programs. A report generated from these evaluations is communicated to each program director to be used for program improvement.

To respond to the first research question, which is how the review of health-related educational programs informed the intended program evaluation, the data from the literature review presented in chapter two was analyzed to identify any research-based modifications that need to be made to this program.

To respond to the second question, which is to assess the extent to which students are satisfied with the quality of the program faculty, this investigation used the faculty evaluation archival data collected as part of the on-going evaluation process of this program (see Appendix B). These archival data include the fall, spring, and summer faculty evaluations for the academic years of 2007-2008, 2008-2009, and 2009-2010.

To respond to the Research Question Three, which is to assess the quality of clinical education, this study used the clinical rotation evaluation data collected at the end of each semester during 2007-2008 and 2008-2009 school years, and at the end of each rotation during the 2009-2010 school year (see Appendix F).

To respond to the Research Questions Four and Five, which assess the quality of the curriculum and school orientation, respectively, this study used the archival data from the program evaluations conducted in summer of 2008, 2009, and 2010 (see Appendix G). The responses to the question 1a of the program evaluation survey which reads, “In your program, indicate your overall satisfaction with quality of the curriculum” were analyzed to indicate the degree of satisfaction with the quality of the curriculum. Responses to the question number 9a of the program evaluation survey which reads “How helpful were the following student related services and programs: new student orientation” were used to determine the satisfaction of students with their initial school orientation.

To respond to the Research Question Six, which is to assess the quality of the program graduates from the perspective of employers, the employer survey data collected in 2004 and 2007 were examined (see Appendix I). Employer data has been collected in 2007 regarding the quality of 2004-2006 graduates and in 2009 regarding the quality of 2007-2009 graduates.

Procedures. Before the end of each semester, the program director or the educational coordinator of medical dosimetry program requests the Office of Institutional Effectiveness to conduct the course and faculty evaluations for that semester. If the semester is the last semester for the students, this request includes a program evaluation as well (see Appendix G). This request is scheduled through an on-line request form. The date for the end-of-semester evaluation is set on a day in which students are present in the classroom as part of their regular schedule. When the evaluation date is set, the information is communicated to all medical dosimetry students asking them to be present

in the classroom to complete the evaluations. The Office of Institutional Effectiveness is responsible for preparing all the survey questionnaires, proctoring the evaluation session, collecting all the surveys, examining the data, and typing student handwritten comments. No member of the faculty is allowed to stay in the classroom while the students are completing the evaluations. A report generated from faculty, course, and program evaluations is sent to the director of the medical dosimetry program, usually a few days after the evaluation session.

Medical dosimetry students complete the clinical rotation evaluation forms at the same time they are completing the faculty, course, and program evaluations. However, at the end of the evaluation session, clinical evaluation forms are collected and returned to the medical dosimetry program's office. The program's administrative assistant, who has been previously trained for completing this process, input the data into an excel spreadsheet and type all the comments in order to generate a report for the program director.

The medical dosimetry program encourages students to keep their contact information up to date upon graduation. The program conducts an employer survey every three years. To begin the process, the educational coordinator sends an email to the graduates of the past three years and asks them to provide the program office with the contact information of their supervisor in their first position as a medical dosimetrist. Subsequently, the educational coordinator on behalf of the program director, sends an electronic letter (see Appendix H) along with the employer evaluation form (see Appendix I) to the supervisors of the program graduates. This letter explains that employers' participation in the evaluation of program's graduates helps to improve the

quality of the program and future graduates. This letter also requests the electronic return of the completed survey to the program's educational coordinator or administrative assistant. Upon collection of these surveys, the data were put on a excel spreadsheet and comments were typed to generate a report for the program director. This report includes the number and percentage of respondents who are strongly agree, agree, neutral, disagree, or strongly disagree with each item as well as the employers' comments.

The program director reviews all reports in order to identify any issues that need to be addressed. The program director communicates the result of evaluations with the medical dosimetry faculty so that they recognize their areas of improvement. The program director also presents a summary of findings to the medical dosimetry advisory committee to address any issues and determine an action plan. However, a rigorous analysis of data has not been conducted to acquire a deep understanding of the overall perception of students about different components of the program.

Limitation. As stated before, a report from faculty surveys at the end of each semester, program evaluations at the end of each school year, clinical rotation evaluations at the end of each semester or rotation, and employer surveys every three years are generated and communicated to the program director. Each report indicates the percentage and number of respondents, who would strongly agree, agree, be neutral, disagree, or strongly disagree with each one of the question items. For this reason, the information on how each participant responded to each question is not available. Therefore, this study is unable to determine the internal validity of the instruments and explore the constructs using factor analysis. The study uses cognitive interviewing to determine constructs for each research questions as needed.

Cognitive interview. This study used cognitive interviewing to translate the question items on the faculty survey, clinical rotation evaluation, and employer survey into valid and measurable constructs. Cognitive interviewing is a method to determine if the survey questions are producing the information that the researcher is seeking. The researcher may ask how the answer to each question was constructed, how the respondent interpreted the meaning of each question, and if the respondent encountered any difficulty in answering the questions (Beatty & Willis, 2007).

Research Question One. Since program evaluation research of medical dosimetry programs is not available, a literature review of program evaluations concerning medical schools, dental schools, nursing schools, and other allied health sciences was conducted and presented in chapter two. To answer the first research question, a descriptive analysis of this literature review was used to make recommendations to the medical dosimetry program at UTMDACC. Response to the Research Question One, which includes the results and discussions of this literature review, is presented in Chapter Four.

Research Question Two. The literature review performed as part of this study identified some of the characteristics of an effective faculty as: (1) demonstrating professionalism in their relationships with their students, (2) being student supporters, (3) establishing a friendly relationship with students, (4) giving students a sense of empowerment, (5) recognizing the value of adult learners, (6) communicating enthusiasm for the profession, (7) challenging and inspiring students, (8) sharing their career experiences with students, (9) using a variety of teaching styles, (10) providing innovative teaching methods instead of a lecture-focused classroom environment, (11)

constructing a careful course assessment, (12) considering a variety of learning styles, (13) improving student critical thinking skills, (14) nurturing and demanding, (15) establishing avenues for extra credit, (16) considering students' capability and learning styles, and (17) promoting critical thinking through group activities. These items can be grouped into three general categories of content knowledge, instructional skills, and professionalism. Therefore, this study utilized data from faculty evaluations to assess the satisfaction of students with the quality of faculty in three categories: (1) content knowledge, (2) instructional skills, and (3) professionalism. The study used the faculty evaluation data collected in 2007-2008, 2008-2009, and 2009-2010 school years to determine the degree of satisfaction with the quality of the faculty.

Faculty evaluation instrument. The faculty evaluation survey is a 5-point Likert scale questionnaire which consists of nine questions. These questions are intended to measure the quality of faculty in the areas of: (1) effective responses to students' questions, (2) providing problem solving skills opportunities, (3) timely feedback, (4) knowledge, (5) providing opportunities for class interaction, (6) accessibility, (7) presentation organization, (8) professional interaction with students, and (9) effectiveness.

Cognitive interview for faculty evaluation. Six faculty members from the School of Health Professions at MD Anderson Cancer Center and two from the University of Houston College of Education were asked to participate in this cognitive interview. A form was made to explain the purpose and the process of identifying the question items that are associated with measuring the three constructs: content knowledge, instructional skills, and professionalism. This form was emailed to these eight faculty members (see

Appendix C). Seven faculty members, six from the MD Anderson Cancer Center and one from the University of Houston, participated and returned their responses.

The analysis of these cognitive interviews identified the questions that can be clustered together to measure each construct (see Table 3.1). This analysis showed that the majority of respondents identified question items 1 and 4 as measuring the content knowledge; question items 2, 5, 7 and 9 as measuring instructional skills; and question items 3, 6, and 8 as measuring professionalism.

Question items related to each construct were used to calculate the degree to which students are satisfied with the quality of the medical dosimetry program faculty. The mean values of these three constructs were calculated for each academic year for the past three years. This not only represents the degree of satisfaction with the program faculty in each school year, but also represents a pattern of change from the 2007-2008 school year to the 2009-2010 school year. A standard deviation was calculated to represent the dispersion of data. The results are presented in Chapter 5.

Table 3.1.

Identification of Survey Items That Load on Constructs Regarding Faculty's Quality

	Content Knowledge		Instructional Skills		Professionalism		N/A	
Question Item	*n*	*p*	*n*	*p*	*n*	*p*	*n*	*p*
1	5	0.71	2	0.29	0	0	0	0
2	0	0	7	1	0	0	0	0
3	0	0	2	0.29	4	0.57	1	0.14
4	7	1	0	0	0	0	0	0
5	0	0	7	1	0	0	0	0
6	0	0	0	0	7	1	0	0
7	0	0	7	1	0	0	0	0
8	0	0	0	0	7	1	0	0
9	0	0	6	0.86	1	0.14	0	0

Note. n is the total number of responses for each construct and p is the percentage of response.

Research Question Three. Data from the end-of-semester clinical rotation evaluations collected in 2007-2008, 2008-2009, and 2009-2010 were used to assess the degree of satisfaction with the clinical education. The review of literature showed that the factors negatively affects clinical education include: (1) inadequate numbers of faculty and their poor availability, (2) inconsistency and insensitivity in feedback received from faculty, (3) deficiency in support resources leading to excessive amount of non-educational work, and (4) ethically questionable strategies being required to meet procedural necessities (Henzi et al., 2006). This study broke down different components of the clinical education into four categories to include some of the factors identified by Henzi and his colleagues. These four categories include: (1) availability of resources, (2) effectiveness of instruction, (3) consistency in instruction, and (4) fairness in grading. Cognitive interviewing was conducted to determine questions that can be clustered together to measure each one of these constructs.

Clinical rotation evaluation instrument. The clinical rotation evaluation instrument is a 5-point Likert scale questionnaire which consists of sixteen questions. These questions are intended to measure the clinical rotation in the areas of: (1) clarity of clinical objectives, (2) clinical rotation orientation quality, (3) rotation schedule suitability, (4) written instructions availability, (5) technical instruction consistency, (6) department personnel supportiveness, (7) encouragement to attend departmental in-services, (8) clinical instructors availability for additional instruction, (9) students' opportunity to gain a broad experience, (10) correspondence between the level of supervision with the level of competency, (11) opportunity to advance with student own pace, (12) encouragement of confidence development, (13) learn different points of view,

(14) treatment planning computers access, (15) patient cases for practice access, and (16) fairness in grading. There is a space available for students' comments.

Cognitive interview for clinical rotation evaluation. Participants of the cognitive interview in regard to the clinical rotation evaluation were eight faculty members and educators from the School of Health Professions at MD Anderson Cancer Center and one faculty member from University of Houston College of Education. A form was made to explain the purpose and the process of identifying the items on the clinical rotation evaluation instrument that are associated with measuring each one of the four constructs: (1) availability of resources, (2) effectiveness of instruction, (3) consistency in instruction, (4) and fairness of grading. This form was provided to these individuals (see Appendix J), which were completed and returned within a week.

The analysis of these cognitive interviews identified the questions that can be clustered together to measure each construct (see Table 3.3). This analysis showed that the majority of respondents identified question items 4, 6, 7, 8, 14, and 15 as measuring the availability of resources; question item 5 as measuring consistency in instruction; question item 16 as measuring fairness in grading, and question items 1, 2, 3, 9, 10, 11, 12, and 13 as measuring effectiveness of instruction.

Question items related to each construct were used to calculate the degree to which students are satisfied with the quality of each construct. The mean values of these four constructs were calculated for each academic year for the past three years. This not only represents the degree of satisfaction with the clinical education in each school year, but also represents a pattern of change from the 2007-2008 school year to the 2009-2010

school year. A standard deviation for each construct was calculated to represent the dispersion of data. The results are presented in Chapter 5.

Table 3.2.

Identification of Survey Items That Load on Constructs Regarding Clinical Education

	Availability of Resources		Consistency in Instruction		Fairness in Grading		Effectiveness of Instruction		N/A	
Question Item	*n*	*p*	*n*	*p*	*n*	*p*	*n*	*p*	*n*	*p*
1	0	0	2	.22	2	.22	4	.44	1	.11
2	0	0	1	.11	0	0	8	.89	0	0
3	1	.11	0	0	0	0	8	.89	0	0
4	8	.89	1	.11	0	0	0	0	0	0
5	0	0	9	1	0	0	0	0	0	0
6	6	.66	0	0	0	0	2	.22	1	.11
7	4	.44	0	0	0	0	2	.22	3	.33
8	7	.78	0	0	0	0	2	.22	0	0
9	1	.11	0	0	0	0	8	.89	0	0
10	2	.22	1	.11	1	.11	3	.33	2	.22
11	0	0	0	0	1	.11	5	.56	3	.33
12	0	0	0	0	0	0	5	.56	4	.44
13	0	0	1	.11	0	0	5	.56	3	.33
14	7	.78	0	0	0	0	0	0	2	.22
15	7	.78	0	0	0	0	0	0	2	.22
16	0	0	0	0	9	1	0	0	0	0

Note. n is the total number of responses for each construct and p is the percentage of responses.

Research Question Four. Quality of the curriculum is one of the key components that affect the quality of a program. Responses to the question number 1a from the end-of-year program evaluations collected in 2008, 2009, and 2010 were used to assess the degree of satisfaction with the quality of the curriculum. This question reads: "In your program, indicate your overall satisfaction with quality of the curriculum."

Research Question Five. The literature review indicated that providing the program's information and expectations at the initial orientation is one of the stress relieving factors (Bradley et. al., 1989; Hechter, 1996 as cited in Stewart et al., 2006). Also, appropriate counseling, mentoring, professional events, and enrichment programs can improve students' success (Jeffreys, 2004 as cited in Robertson et al., 2010).

School of Health Professions provides an orientation session on the first day of school every fall semester for new students. During the orientation session, a variety of information and student services are presented to students, which include: (1) patient care philosophy at UTMDACC, (2) student handbook, (3) Sakai course management system, (4) registrar's office, (5) financial aid office, (6) auxiliary enterprise, (7) student affairs office, (8) ombuds office, (10) safety in a laboratory environment, and (11) UT police crime prevention.

Research question number five is intended to measure the helpfulness of this school orientation for new students. Responses to the question number 9a from the end-of-year program evaluations collected in 2008, 2009, and 2010 are used to assess the degree of satisfaction with the helpfulness of the school orientation. This question reads: "How helpful were the following student related services and programs: new student orientation".

Program evaluation instrument. The program evaluation instrument is a 5-point Likert scale questionnaire which consists of 20 questions. Some of these questions have sub-sections. Questions 1-12 are school and program specific questions. Questions 13-20 are student related demographic questions.

Question one is intended to measure the overall satisfaction with the quality of the (a) curriculum, (b) teaching, (c) advising, and (d) decision-making development. Question two is intended to assess the students' overall satisfaction with the quality of (a) faculty, (b) school administration, and (c) staff. The third question is intended to measure the extent of students' satisfaction with support they received from (a) faculty, (b) school administration, and (c) staff. Question number four asks the student overall satisfaction with (a) safety procedures and (b) quality control in clinical rotations. Question number five and six are intended to determine from students' perception if the education they received prepared them for the certification examination and entrance to the workforce, respectively. Question number seven asks students how strongly they advise others to attend School of Health Professions. Question number eight is intended to assess the degree of satisfaction with (a) classroom adequacy, (b) classroom AV equipment, (c) classroom housekeeping, (d) classroom maintenance, (e) quality of laboratory equipment, and (f) quality of lab safety. Question number nine is intended to determine the helpfulness of (a) the new student orientation and (b) school catalog. Question number ten is intended to evaluate the degree of satisfaction with the MD Andersen Research Library services. Question number eleven asks students to rate student support services including: (a) career development seminars, (b) sale items in student affairs office, (c) social events on campus, (d) student affairs office staff, and (e) student affairs resource

information. Question number twelve is intended to determine if students were aware of the school government representatives and their activities as well as the degree of satisfaction with these areas. Question numbers thirteen to twenty are seeking students' demographic information. There is a space at the end of the evaluation instrument for students' comments.

Research Question Six. The data collected from the employer surveys to evaluate the quality of 2004-2009 graduates were used to evaluate the quality of the program's graduates. According to the literature review, the quality of a health-related program's graduate is determined based on the quality of the graduate's technical skills and professionalism. Therefore, this study aimed to assess the quality of the program's graduates in regard to their technical skills and professionalism. This study used cognitive interviewing to determine the questions on the employer survey that can be grouped together to measure each one of these constructs.

Employer survey instrument. The employer evaluation instrument is a 5-point Likert scale questionnaire, which consists of fifteen questions. These questions are intended to evaluate the quality of the program's graduates in the areas of (1) consistency in quality of work, (2) accuracy in charting, (3) confidence in performing tasks, (4) competency in performing manual and computer dose calculations, (5) time efficiency, (6) participation in or supervision of simulations, (7) performing complicated treatment plans, (8) adapting to changes, (9) communication skills, (10) teamwork, (11) responsibility, (12) performing well under pressure, (13) following safety precautions, (14) critical thinking and problem solving skills, and (15) participating in professional

growth and development activities. There is a space available for employers' additional comments.

Cognitive interview for employer survey. Participants of the cognitive interview in regard to the employer survey were eight faculty members and educators from the School of Health Professions at MD Anderson Cancer Center and one faculty member from University of Houston College of Education. A form to explain the purpose and the process of identifying the question items that are associated with measuring each one of the two constructs, technical skills and professionalism, was made and provided to these individuals. They returned their responses after a week (see Appendix K).

The analysis of these cognitive interviews identified the items on the employer survey that can be clustered together to measure each construct (see Table 3.3). This analysis showed that the majority of respondents identified question items 1, 2, 3, 4, 6, 7, and 14, as measuring the technical skills and question item 5, 8, 9, 10, 11, 12, 13, and 15, as measuring professionalism.

Question items related to each construct were used to calculate the degree to which employers are satisfied with the quality of the program graduates. The mean values of these two constructs were calculated for 2004-2006 and 2007-2009 graduates. This represents the degree of satisfaction with the program graduates in each three school years, as well as a pattern of change from the 2004-2006 to the 2007-2009. A standard deviation was calculated to represent the dispersion of data.

Table 3.3.

Identification of Survey Items That Load on Constructs Regarding Graduates' Quality

	Technical Skills		Professionalism		N/A	
Question Item	*n*	*p*	*n*	*p*	*n*	*p*
1	5	.56	4	.44	0	0
2	9	1	0	0	0	0
3	5	.56	4	.44	0	0
4	9	1	0	0	0	0
5	0	0	9	1	0	0
6	9	1	0	0	0	0
7	9	1	0	0	0	0
8	0	0	9	1	0	0
9	0	0	9	1	0	0
10	0	0	9	1	0	0
11	0	0	9	1	0	0
12	2	.22	7	.78	0	0
13	0	0	8	.89	1	.11
14	6	.67	2	.22	1	.11
15	0	0	9	1	0	0

Note. n is the total number of responses for each construct and p is the percentage of responses.

Summary

Based on this study, the author makes recommendations for program improvement of the medical dosimetry program at UTMDACC using the insights from the literature review, and analysis of various data collected as part of the on-going evaluation of different components of this program. The author also informs the program administrators about the extent to which the students are satisfied with the quality of the faculty, clinical education, curriculum, and school orientation. Additionally, the quality of the program's graduates from the perspective of employers is discussed.

Chapter IV

Results and Discussion of Literature Review

This chapter addresses the first research question: How has the review of the literature regarding the evaluations of health-related educational programs informed the intended program evaluation of the medical dosimetry program. This study makes recommendations to the program administrators for making improvements to the program in various areas.

Analysis of Literature Review

Professionalism

Besides competency in technical skills, another important factor in regard to the quality of a healthcare program's graduates is professionalism (Queeney & Smutz, 1990 as cited in Martin, 1993; Nowlen, 1998 as cited in Martin, 1993; Lane, 2010). An analysis of the literature indicates that role modeling is the most effective method of teaching professionalism to students (Hatem 2003 as cited in Halpern 2003; Spencer 2004; Koerber et al, 2005). For this reason, a program's faculty, educators, and clinical instructors should make every effort to demonstrate professionalism at all times so that the appropriate professional values are transferred to the students. This study made three recommendations in order to improve students' professional conduct.

Recommendations. The first recommendation is for the School of Health Professions' administrators to provide educational opportunities for their faculty and instructors regarding professionalism in order to make them aware of the effect of their professional conduct on students; to train the faculty in improving their professional values; and to define appropriate behaviors expected of them.

Since the medical dosimetry program utilizes clinical medical dosimetrists who are employees of the Radiation Oncology Department as clinical instructors and mentors for the students, the School of Health Professions cannot require them to attend professional development seminars. Therefore, the second recommendation is for the medical dosimetry program director to conduct a lecture during the dosimetry staff meeting before the start of each school year to highlight the key aspects of professional conduct expected of clinical instructors. This will reinforce the values of professionalism when interacting with students and remind them of the professional values expected of them. Alternatively, this lecture can be delivered as a separate seminar for clinical medical dosimetrists. These seminars can be conducted several times a year so that each clinical instructor or mentor has the opportunity to attend. It is recommended that the directors of the medical dosimetry program and the medical dosimetry department discuss the possibility of awarding continuing education credit to attendees, which will count towards their Professional Development Model and their merit.

The third recommendation made by this study is to evaluate both faculty and students in terms of behaviors identified by Martin (1993) as some of the most important attributes among health professionals. These attributes include honesty, confidentiality, accountability, responsibility, integrity, truthfulness, effective communication skills, compassion, teamwork, respect, patient and professional support, and being concerned, balanced, and tolerant. These attributes should be practiced by faculty and instructors, as well as students. Both faculty and student evaluation forms need to be reviewed in order to ensure the inclusion of these components. These evaluations are important to both faculty and students. In the medical dosimetry program, evaluation of clinical conduct

and performance of each student comprises 25% of their clinical grade, so inclusion of the above components will reinforce the behaviors that are expected of them. According to the medical dosimetry program's policy, if a student fails a clinical evaluation, he/she will be given a written warning; if the student fails the second evaluation, he/she will be put on probation; and the third failure results in dismissal from the program. Throughout the program, students will be advised on how to improve different aspects of their professional conduct based on their behaviors and their mentors' recommendations. These advising sessions should be continued in the medical dosimetry program. The advising faculty should review each student's clinical evaluation and meet with the clinical mentors in order to receive accurate feedback regarding students' professional conduct. This will help provide more comprehensive advice to the student.

Quality of Clinical Faculty

As noted by Irby (2005), instructors are essential components of clinical education, so it is necessary to evaluate the quality of clinical instructors. The review of literature showed the characteristics of effective and ineffective clinical instructors (see Table 4.1).

Recommendations. This study made two recommendations in regard to improving the quality of clinical faculty that includes the program director to: (1) conduct a meeting at the beginning of each school year to reiterate the qualities expected of effective clinical instructors and (2) review the clinical instructor evaluation form to ensure the inclusion of these components.

Table 4.1.

Summary of the Characteristics of Effective and Ineffective Clinical Instructors From Different Studies

Study	Effective	Ineffective
Irby (1995) as cited in Henzi et al. (2006)	Positive role model Effective supervision and mentoring Energetic approach to teaching Student supporter	
Lempp & Seale (2004)		Disorganized teaching Unexpected changes in teaching schedule No passion for teaching Lack of teaching skills
Myers (1977) as cited in Henzi et al. (2006)	Take teaching duties seriously Demonstrate professional behavior Technically proficient	
Henzi et al. (2006)	Interest and concern in teaching Provide appropriate feedback and response Inspire students Relate didactic information to clinical application Explain difficult subjects in a simple manner Treat in a proactive manner	
Chambers et al.(2004) as cited in Henzi et al. (2006)	Establish expectations in accordance with the students' competence	

Clinical Education

A study conducted by Henzi et al., (2006) also showed that the factors negatively affecting clinical education are: (1) inadequate numbers of faculty and their poor availability, (2) inconsistency and insensitivity in feedback received from faculty, (3) deficiency in support resources leading to excessive amounts of non-educational work, and (4) ethically questionable strategies required to meet procedural necessities.

Recommendations. This study suggests that the clinical rotation evaluation form be reviewed to assure these four components are included. Those components that are not included need to be incorporated into the evaluation form. The study suggests that the program director be aware of these factors and implement policies for timely feedback to students from clinical faculty and faculty's availability. The program director should provide students with an alternate option when the assigned clinical instructor is not available. The study encourages the program director to investigate any ethically questionable behaviors being performed either by students or clinical faculty. Unethical behaviors should be prevented and eliminated by the program director. It is recommended that the program director ask each student during the end of the semester advising sessions if they feel there are any unethical behaviors expected of them or performed in the clinic or school. Asking the students in a private setting will foster communication about these issues.

Stress

Many of the students in healthcare programs experience stress during their program, which is a major cause of cognitive dysfunction (Vitaliano et al., 1984). The

review of literature showed many stress-causing factors in health-related programs that may also apply to a medical dosimetry program (see Table 4.2).

Many of the stress-causing factors have already been addressed in the medical dosimetry program, including providing students with the class schedule that fits their needs, continuous and regular counseling and mentoring sessions, ample opportunities for student- teacher interaction inside and outside of the classroom, providing the program's information and expectations at the initial orientation, and giving students a sense of empowerment by asking their opinions on improving the program during the regular advising sessions and by the inclusion of a student representative in advisory and curriculum committee meetings. However, some stress-causing factors exist in the program, including (1) insufficient time for personal activities, (2) competition, (3) long hours, (4) pressure to master the subject, (5) lack of appropriate study skills, and (6) insufficient study time.

Table 4.2.

Summary of the Stress Causing and Relieving Factors Indicated in Different Studies

Study	Stress causing	Stress relieving
Vitaliano et. al. (1984)	Insufficient time for personal activities	
	Competition	
	Long hours	
	Pressure to master the subject	
Chew-Graham and Rogers (2003) as cited in Holm et al. (2010)		Support and mentoring outside of learning environment
Holm et al. (2010)		Participation in self-development meetings
Bradley et. al. (1989) and Hechter (1996) as cited in Stewart et al. (2006)		Providing the program's information and expectations at the initial orientation
		Foster a supportive peer environment
		Give students a sense of empowerment
Cardall et al. (2008)	Poor student-faculty relations	
Jeffreys (2004) as cited in Robertson et al. (2010)		Appropriate study skills and study time
		Proper class schedule and attendance
		Proper level of faculty support
		Appropriate counseling, mentoring, professional events, and enrichment programs
		Proper level of student interaction with the program and peer interaction

Recommendations. This study suggests eliminating the one-year program in medical dosimetry, which includes 58 semester credit hours, and spreading out the curriculum over two years. This will minimize the amount of pressure on students and will provide them with a better quality of personal life and more time to absorb new information. Another recommendation is to incorporate new learning strategies into the curriculum. This will teach students not only the content knowledge but also the best strategies for students to learn subject materials.

Competition can be a negative factor that pressures students for higher grades which does not necessarily mean the mastery of information. Competition can be changed into a positive experience by fostering a supportive peer environment in which students are encouraged to assist each other and share their knowledge in order to improve the understanding and knowledge of the class. This study recommends that the program director sets a goal at the beginning of school year for the class. The goal can be set such that 100% of students make at least 85% on the comprehensive exam given at the end of school year. If the class achieves its goal, all students will be awarded a free or discounted trip to the annual medical dosimetry meeting, which is held in June, only two months before their graduation. This strategy will encourage group work and students' interaction inside and outside of school in order to enhance every student's mastery of the material. The comprehensive exam will then be used to measure the class's knowledge and to assess whether the class has reached its goal.

Evaluation of Teaching Effectiveness

The empirical data from a review of literature supports the use of triangulation for evaluating teaching effectiveness. This refers to student evaluation in conjunction with

peer evaluation and self-evaluation (Jahangiri et al., 2008). In the medical dosimetry program at UTMDACC, students evaluate teaching effectiveness of all clinical instructors and program faculty. However no peer evaluation or self-evaluation is being conducted.

Recommendations. This study suggests the addition of both peer evaluation and self-evaluation for didactic faculty and clinical instructors. This will provide a more complete understanding of teaching effectiveness to the faculty and instructors and identify areas for self improvement. Studies suggested that peer evaluations and self-evaluations should not be considered for formal performance evaluation and promotion decisions, since they may be biased and unreliable. However, they are valuable if conducted in conjunction with student evaluations, to counter any bias (Jahangiri et al, 2008). The advantage of having triangulation evaluation is to ensure consistency between the evaluations from students and peers, and to look for any areas that need improvement. Self-evaluation provides awareness of the characteristics that clinical instructors and faculty need to teach effectively.

Quality of Faculty

Rico et al. (2010) identified six themes of the best faculty practices in which faculty: (1) recognize the value of adult learners, (2) communicate enthusiasm for the career, (3) challenge and inspire students, (4) practice the career and share the experiences, (5) be supportive, and (6) use a variety of teaching styles. The other factor that educators should consider is the generational characteristics of the students they teach. According to Collins (2000), the majority of students currently in colleges and universities are Generation X. His study has shown that the majority of students in allied

health programs would like to have exam reviews and study guides. These students identified effective teachers as being nurturing, demanding, challenging, establishing avenues for extra credit, considering students' capability and learning styles, and promoting critical thinking through group activities. They also prefer teachers that are not easy graders and do not overlook rudeness from students. Furthermore, Generation X students learn better through the use of technology (Hays, 1997 as cited in Collins, 2000).

Recommendations. This study recommends that medical dosimetry program faculty increase the use of technology in the classroom. The program can use the Sakai Course Management System and Camtasia which are available resources at the School of Health Professions. All the teaching materials including exam reviews and study guides, as well as course materials such as syllabi, clinical assessment forms, and clinical rotation schedules can be uploaded into Sakai. Thus, resources are available to students at all times and they have access to electronic format of materials. Many students like studying the electronic material rather than the traditional paper format. Students have the opportunity to ask their questions and share their knowledge and experiences using the discussion board in Sakai. Quizzes and exams can be conducted using Sakai which makes it easier for faculty to grade and record exams especially with a large class of students. The Camtasia system can be used in order to record and save lectures along with the speaker's voice for future use by students. If a student misses a class or needs to review a lecture, the faculty will allow the use of the recorded lecture by that student. The program can start offering hybrid and on-line courses whenever appropriate. This saves students time and allows students to study the material at their convenience. The links to the lectures recorded by Camtasia can be uploaded to Sakai to be viewed by students in the

on-line courses. The program can investigate effective ways to track students' clinical hours using technology rather than the typical paper format. In the typical paper format, students ask their clinical instructors to record their time-in and time-out with a signature in order for attendance to be officially acceptable by school officials. This format is inconvenient for students and clinical instructors as well as the clinical preceptor, who spend a lot of time recording students' time and manually calculating the total clinical time per clinical rotation.

This study also suggests that faculty attend educational classes and seminars on teaching skills to learn the variety of teaching styles to match student learning styles and use critical thinking strategies when teaching. This will be implemented in Spring 2011 as part of the school's SACS Quality Enhancement Plan (QEP). Faculty will be required to attend seminars and workshops in order to learn ways to incorporate critical thinking strategies into their lesson plans. Table 4.3. summarizes the recommendations put forth in this study based on the review of the literature.

Table 4.3.

Summary of Recommendations Based on the Review of Literature

Recommended Action	Recommended Modification
Provide educational opportunities for all faculty and clinical instructors.	Discuss professional conduct expected of faculty and instructors.
Conduct regular meetings with clinical instructors.	Discuss the characteristics of an effective clinical instructor and the expectations of them.
Review faculty evaluation form.	Add the following items to the questionnaire: The faculty demonstrates effective communication skills with students. The faculty maintains student and patient confidentiality. The faculty supports students' education at all times. The faculty exhibits integrity and truthfulness at all times.
Review clinical instructor evaluation form.	Add the following items to the questionnaire: The clinical instructor is technically proficient. The clinical instructor explains difficult concepts in a simple manner. The clinical instructor serves as a positive role model for students.
Review student clinical conduct evaluation form.	Add the following items to the questionnaire: The student demonstrates integrity and honesty in all performed activities. The student maintains and protects patients' confidential information. The student is an effective member in all teamwork activities. The student exhibits concern and accountability for the well being of patients.

Table 4.3. (continued)

Recommended Action	Recommended Modification
Review clinical rotation evaluation form.	Add the following item to the questionnaire: In order to fulfill my clinical requirements, I am required to utilize ethical strategies.
Provide opportunities for students to discuss their concerns with the program director.	Investigate if there are any ethically questionable strategies required of students in completing their requirements.
Offer alternative options if assigned clinical instructors are not available.	Program director should discuss the issue with clinical supervisors to find an alternative clinical instructor for students if needed.
Reduce stress and pressure on students and improve the quality of their personal life.	Switch to the two year program and integrate learning strategies into the curriculum by teaching students how to learn.
Establish an incentive plan.	Encourage group work instead of competition by introducing an incentive plan for students based on group success.
Develop a plan to more effectively evaluate faculty.	Include both peer evaluation and self-evaluation for faculty and clinical instructors to learn about their areas of improvement.
Increase the use of technology in the classroom.	Use Sakai Management System, Camtasia System, and electronic tracking of student clinical hours.

Discussion

Based on the review of literature, this study has made recommendations to the school's administrators. This includes: (1) providing educational opportunities for all faculty and clinical instructors in regard to professionalism, (2) scheduling regular meetings with clinical instructors and discussing the expectations of them, (3) reviewing the faculty, clinical instructor, and student clinical evaluation forms, (4) reviewing the clinical rotation evaluation form, (5) providing opportunities for students to talk in a private setting with the program director in regard to any ethically questionable strategies, (6) offering an alternative option if assigned clinical instructors are not available, (7) reducing stressful pressure on students and improving their quality of personal life by switching to a two-year program and integrating learning strategies into the curriculum in order to teach students how to learn, (8) establishing an incentive plan to encourage group work instead of individual competition that can lead to student stress, (9) developing a plan to include both peer evaluation and self-evaluation for faculty and clinical instructors, and (10) increasing the use of technology in the classroom.

An examination of the faculty evaluation form shows that the current evaluation form includes nine items. Three items relate to professionalism: (1) in the classroom, the faculty member provided feedback on tests and assignments in a timely manner; (2) was accessible to students; and (3) demonstrated and interacted with the students in a professional manner (see Appendix B). In order to include some of the most important attributes among health professionals identified by Martin (1993), including honesty, confidentiality, accountability, responsibility, integrity, truthfulness, effective communication skills, compassion, teamwork, respect, patient and professional support,

and being concerned, balanced, and tolerant, a definition of professional conduct can be added to the evaluation form or additional questions can be added to the faculty evaluation form to include evaluating faculty in terms of confidentiality, integrity, communication skills, and supportiveness. The recommended questions are as follows:

(1) The faculty demonstrates effective communication skills with students.

(2) The faculty maintains student and patient confidentiality.

(3) The faculty support students' education at all times.

(4) The faculty exhibits integrity and truthfulness.

A review of the students' clinical evaluation form (see Appendix F), has shown that students are evaluated on clinical conduct by the following measures: (1) maintains a respectful and professional attitude towards patients and division personnel, (2) demonstrates good personal hygiene and dress habits as appropriate to a clinical setting, (3) willingly accepts advice and constructive criticism from division personnel, (4) asks questions to clarify duties, techniques, and information when indicated, (5) refrains from discussing activities or events inappropriate to a clinical setting, (6) reports for duty in a timely manner, keeping clinical instructors informed about absences, and (7) displays appropriate independence and industry in performing clinical tasks. There are no questions to assess students on the values of: (1) integrity, (2) maintaining patient confidentiality, (3) teamwork, and (4) accountability and being concerned for patients' well-being. It is recommended to add four more questions to the student's clinical conduct evaluation, as follows:

(1) Demonstrates integrity and honesty in all performed activities.

(2) Maintains and protects patients' confidential information.

(3) Is an effective member in all teamwork activities.

(4) Exhibits concern and accountability for the well-being of patients.

A review of the clinical instructor evaluation form has shown that most of the characteristics of effective clinical instructors presented in Table 4.1 are included in the clinical faculty evaluation form (see Appendix D). However, this study recommends including additional questions to the form in order to assess clinical instructors' technical skills, instructional skill, and being a positive role model. The recommended questions are as follows:

(1) The clinical instructor is technically proficient.

(2) The clinical instructor explains difficult concepts in a simple manner.

(3) The clinical instructor serves as a positive role model.

Other than evaluating clinical instructors on the above values, an annual discussion of expectations of clinical faculty with the program director would reiterate the values of experienced clinical instructors and promote demonstration of these values to new clinical instructors. This would be an effective strategy, especially in the situation in which every year a body of inexperienced instructors is added to the pool of clinical instructors.

A study conducted by Henzi et al. (2006) has also shown that the factors negatively affecting clinical education are: (1) inadequate numbers of faculty and their poor availability, (2) inconsistency and insensitivity in feedback received from faculty, (3) deficiency in support resources causing too much leg work, and (4) ethically questionable strategies required to meet procedural necessities. A close review of the clinical rotation evaluation form has shown that all the above components except number

4 are included in the evaluation form (see Appendix E). This study recommends the addition of a question to the clinical rotation evaluation form which reads: “In order to fulfill my clinical requirements, I am required to utilize ethical strategies.” This may determine if any ethically questionable strategies are performed by students to meet the requirements.

Chapter V

Results and Discussion of Program Evaluation

In this chapter, the results of the Research Questions Two to Six will be presented and discussed. These questions are as follows:

2. To what extent are students satisfied with the quality of the faculty?
3. To what extent are students satisfied with the quality of the clinical education?
4. To what extent are students satisfied with the quality of the curriculum?
5. To what extent do students view their school orientation helpful?
6. To what extent are employers satisfied with the quality of the program's graduates as entry-level medical dosimetrists?

Faculty Evaluations Analysis

The results of the analysis of faculty evaluations for the school years of 2007-2008, 2008-2009, and 2009-2010 are presented in Table 5.1. The mean scores for the content knowledge, instructional skills, and professionalism for the program's faculty during the three school years are greater than 4.55 out of 5.0, which are favorable. For all three years, professionalism earned the highest score, indicating that students are highly satisfied with the quality of the faculty's professional conduct. Content knowledge and instructional skills earned approximately equal values in each school year. The mean scores for all three constructs of content knowledge, instructional skills, and professionalism are highest in 2008-2009 and lowest in 2009-2010 (see Table 5.1).

Table 5.1.

The Mean Scores and Standard Deviations of Three Constructs Related to the Faculty Evaluations

		Content Knowledge		Instructional Skills		Professionalism	
Group	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*
2007-2008	215	4.72	0.69	4.73	0.66	4.81	0.52
2008-2009	288	4.78	0.47	4.80	0.41	4.83	0.41
2009-2010	261	4.57	0.61	4.55	0.59	4.64	0.55

Note. n=the total number of responses for the faculty evaluations for all the courses in fall, spring, and summer semesters in each school year.

Comparison of three constructs in three years. The analysis of data for the three school years has shown that faculty's content knowledge, instructional skills, and professionalism have improved from the 2007-2008 school year to the 2008-2009 school year. However, these three constructs, have undergone a slight decline from 2008-2009 to 2009-2010 even below their values in 2007-2008. It should be noted that regardless of the decline, the mean scores for all three constructs in 2009-2010 are still above 4.55 out of 5.0 and satisfactory.

Summary of comments. There is a section for student comments on the faculty evaluation form. Although there are many positive comments for the faculty members, only the student suggestions described in this study are to be used for faculty improvement (see Table 5.2).

Table 5.2.

Summary of Suggestions about Program's Faculty by Students

School Year	Student Suggestions
2007-2008	Provide more exam reviews.
	Use microphone because it is hard to hear in the back.
	Use other approaches to answer a student's question.
2008-2009	Provide reviews for long lectures.
	Some of the tests should be longer (more questions on the test).
	It is intimidating to call out students.
	Provide more time for students to answer the questions asked in the class.
2009-2010	Too much to do for a faculty member.
	Be more accessible to incoming students especially concerning their transcripts.
	Be responsive to students.
	Speak slower.
	Review materials before presenting.
	Do not read from the slides and maintain eye contact.

Clinical Education Evaluations Analysis

The overall mean score for the clinical rotation evaluations conducted in 2007-2008 is 4.40 out of 5.0 which is favorable. This value has declined to 4.11 out of 5.0 in 2008-2009, which is 7% less than that in 2007-2008. The overall mean score for the clinical rotation evaluations conducted in 2009-2010 is 4.43 out of 5.0, which shows an improvement to the level of student satisfaction in 2007-2008 school year.

Data show that the student satisfaction with different components of their clinical education varies. The results of the analysis of clinical rotation evaluations for the school years 2007-2008, 2008-2009, and 2009-2010 are presented in Table 5.3. The mean score of 4.39 for availability of resources and 4.48 for effectiveness of instruction in 2007-2008, shows student satisfaction with these two components of their clinical education. However, during the same school year, students were less satisfied with the two components of consistency in instruction and fairness in grading represented by mean scores of 4.09 and 4.19, respectively.

In 2008-2009, the satisfaction with all four components of the clinical education has slightly declined in comparison with those in 2007-2008. However, the pattern of student satisfaction remained the same; students were more satisfied with the availability of resources and effectiveness of instruction and less satisfied with consistency in instruction and fairness of grading. In 2009-2010, the satisfaction with all components of the clinical education increased to a level equal or greater than that in 2007-2008. The pattern of student satisfaction in 2009-2010 has also remained the same as the previous two years.

It is noted that although the degree of satisfaction has changed from year to year, the pattern of student satisfaction with all four components of their clinical education remained consistent in all three school years. The satisfaction with the availability of resources and effectiveness of instruction are almost the same and higher than the satisfaction with consistency in instruction and fairness in grading. This shows that during these three years, the least satisfying components of the clinical education were consistency in instruction and fairness in grading, while the most satisfying components of the clinical education were availability of resources and effectiveness of instruction. This informs clinical faculty to focus on providing consistent clinical instructions to students and follow standard grading guidelines. Student constructive suggestions concerning clinical education in all three school years are presented in Table 5.4.

Table 5.3.

The Mean Scores and Standard Deviations Related to the Overall Clinical Rotation Evaluation and its Four Constructs

	2007-2008			2008-2009			2009-2010		
Group	*M*	*n*	*SD*	*M*	*n*	*SD*	*M*	*n*	*SD*
Overall Satisfaction	4.40	680	0.91	4.11	731	1.10	4.43	1034	0.76
Availability of resources	4.39	257	1.02	4.19	274	1.05	4.48	388	0.72
Effectiveness of instruction	4.48	339	0.78	4.16	365	1.04	4.46	516	0.71
Consistency in Instruction	4.09	43	1.16	3.59	46	1.31	4.14	65	0.94
Fairness in Grading	4.19	42	1.05	3.83	46	1.40	4.23	65	1.00

Note. n=the number of responses for each construct per year.

Table 5.4.

Summary of Suggestions about Clinical Education by Students

School Year	Student Suggestions
2007-2008	Handouts were not always provided in the clinic.
	Clinical instructions vary from instructor to instructor.
	A once a month individual meeting with students to go over their clinical performance evaluation would be beneficial.
	Evaluation of student clinical performance in the first two weeks of program is not fair and valid.
	Instructors have different methods of planning, which is not consistent with mentors.
	Clinical instructions/demonstrations are too general.
	When a computer is not available in the main dosimetry room, the student has to go to another room and work independently which minimizes his/her chance to ask questions.
	Clinical instructors/mentors should not grade student clinical performance if they did not spend time working with that student.
	Grading is subjective and instruction is very inconsistent.
	Unsure of how our clinical grades were generated.
	Unavailability of a MOSAIQ case for a competency or lack of timely feedback on a practice competency makes it hard for students to achieve their goals in a timely manner.

Table 5.4. (continued)

School Year	Student Suggestions
2008-2009	There are not enough computers in some services.
	It is difficult to know what the best coverage is when clinical instructors have different opinions on things.
	Mentor and clinical instructors should be assigned less clinical work to be more available to answer student questions.
	I do not agree with the way my clinical performance evaluation was graded.
	There is inconsistency in instruction and lack of teamwork among instructors.
	We need to be able to create an electronic portfolio in PDF format.
	Teaching must be consistent.
	Grading guideline is inconsistent with what is written in the handout.
	Some rotations are far better than others.
	Some mentors don’t come to students to check on them when they practice.
	Sometimes, mentors are too busy to answer questions and we have to wait for a long time.
	Mentors need to communicate with each other and agree on one thing to provide consistent instruction.
2009-2010	Time spent in Proton center is limited.
	More time in satellite is needed to observe and perform special procedures.
	Clinical schedule was not followed in this rotation so I fell behind.
	Additional practice cases are helpful for faster students.
	Dosimetry staff is overloaded with patients and mentors were unable to grade practice plans and competencies in a timely manner.

Analysis of Program Evaluation Survey

The overall mean scores for the program evaluation surveys given to graduating students in 2008, 2009, and 2010 as well as the mean scores of the student satisfaction with the curriculum and with new student orientation are presented in Table 5.5.

The data shows that students were satisfied with the overall quality of the program in 2007-2008 indicated by an overall mean score of 4.62 out of 5.0. However, this satisfaction has declined in 2008-2009 and 2009-2010 indicated by overall mean scores of 4.27 and 4.14, respectively. Only two components of the program evaluation survey were assessed in this study, satisfaction with the quality of curriculum and new student orientation.

Satisfaction with the quality of the curriculum. The data show that in 2007-2008, students were satisfied with the quality of the curriculum indicated by the mean score of 4.85 out of 5.0. This satisfaction has slightly declined in 2008-2009 and 2009-2010 school years indicated by the mean scores of 4.79 and 4.67, respectively. However, mean scores indicate a high level of student satisfaction with the quality of the program's curriculum in all three years.

Satisfaction with the helpfulness of the new student orientation. In 2007-2008, students were satisfied with the helpfulness of their orientation session indicated by the mean score of 4.54 out of 5.0. The student satisfaction with the new student orientation session has declined from 2007-2008 to 2008-2009 and stayed consistent in the following year indicated by the mean score of 4.0 out of 5.0. The data show that in all three school years, students were more satisfied with the quality of the curriculum than the helpfulness

of the new student orientation session. A summary of suggestions by students written on the program evaluation surveys is presented in Table 5.6.

Table 5.5.

The Mean Scores and Standard Deviations Related to the Program Evaluation Survey and the Two Components of Curriculum and the New Student Orientation

	Overall Satisfaction			Curriculum			New Student Orientation		
Group	*M*	*n*	*SD*	*M*	*n*	*SD*	*M*	*n*	*SD*
2007-2008	4.62	455	0.67	4.85	13	0.36	4.54	13	0.63
2008-2009	4.27	495	0.93	4.79	14	0.56	4.00	14	0.75
2009-2010	4.14	540	0.82	4.67	15	0.47	4.00	15	0.82

Note. n=the total number of responses to the questions on the program evaluation survey or to each construct in each school year.

Table 5.6.

Summary of Suggestions on the Program Evaluation Surveys

School Year	Student Suggestions
2007-2008	Clinical education needs to be improved.
	Many of the computers in our classroom were unusable due to the expired Pinnacle licenses.
2008-2009	Gender and ethnicity should be taken off the evaluations because some programs only have one or two people from different ethnic groups.
	For trainee poster competition, the judges should come from all educational disciplines not just one.
2009-2010	Job market is bad right now.
	Program should shift to provide skills employers ask for such as exposure to all treatment planning software and much more focus on IMRT.
	We cannot be certified without having a work experience.
	School needs to go more electronic with notes.
	Provide PDF format of the lecture handouts before class.
	Registrar's office quality of service to students should be improved.
	More IMRT practice is needed.

Employer Surveys Analysis

The employer surveys were conducted in 2007 for graduates of 2004-2006 and in 2009 for graduates of 2007-2009. The overall mean scores as well as the mean scores for the two categories of technical skills and professionalism for the employer surveys conducted in these two years are presented in Table 5.7. The overall mean scores for the employer satisfaction in 2007 and 2009 are 4.28 and 4.54 out of 5.0, respectively. This indicates an overall satisfaction with the quality of the program graduates from the perspective of employers. The data also show that the overall satisfaction with the quality of the program graduates has increased from 2007 to 2009. The employer surveys sent to the employers were intended to measure the quality of the program's graduates in two major areas: technical skills and professionalism. The data show that the overall satisfaction of employers with the quality of the program graduates with regard to professionalism is greater than their satisfaction with regard to graduates' technical skills. All comments from employers were complimentary so, there were no suggestions to be used for program improvement.

Table 5.7.

The Mean Scores and Standard Deviations Related to the Employer Survey and the Two Constructs: Technical Skills and Professionalism

	Overall Satisfaction			Technical Skills			Professionalism		
Group	*M*	*n*	*SD*	*M*	*n*	*SD*	*M*	*n*	*SD*
2004-2006	4.28	269	0.74	4.20	125	0.68	4.35	144	0.78
2007-2009	4.54	247	0.60	4.42	116	0.59	4.64	131	0.59

Note. n=the number of all responses for the questions on employer surveys related to each category

Discussion

Quality of the Medical Dosimetry Program's Faculty

A review of faculty evaluations in the 2007-2008, 2008-2009, and 2009-2010 school years has shown satisfaction with the quality of faculty in the three constructs of content knowledge, instructional skills, and professionalism indicated by a minimum mean score of 4.55 out of 5.0. In all three years, the satisfaction with the content knowledge and instructional skills are almost the same and lower than the satisfaction with the faculty professionalism. Furthermore, the satisfaction has undergone a slight decline from 2008-2009 to 2009-2010 in all three constructs of content knowledge, instructional skills, and professionalism. This might be due to the significant changes in the program's faculty in 2009-2010 school year. Nevertheless, new program faculty members in their new roles have done a satisfactory job, having attained a mean score of above 4.55 out of 5.0 in all categories.

The questions that were used to measure the satisfaction with content knowledge are: (a) the faculty member responded effectively to student questions, and (b) the faculty member was knowledgeable about subject matter. Furthermore, students suggested through their comments on faculty evaluations that faculty needs to spend more time on preparing their materials, be more accessible to the new students, be more responsive, and use other approaches to answer students' questions.

This study recommends instructors to be more accessible to students' questions and provide different ways of explaining a solution to students' problems. Students have different learning styles and considering all types of learning styles when teaching provides more opportunities for understanding of the material by different types of students.

The questions that were used to measure instructional skills were: (a) the faculty member provided opportunities for application of problem-solving skills, (b) the faculty member provided opportunities for class interaction, (c) the faculty member was organized in class presentations, and (d) the faculty member was an effective teacher. One of the student suggestions was for faculty to provide more time for students to answer questions asked in the class. This study recommends instructors to provide more critical thinking and problem-solving opportunities in the classroom, which would help students apply their didactic knowledge in the clinic and in everyday life as a medical dosimetrist. The School of Health Professions at MD Anderson Cancer Center is accredited by the Southern Association of Colleges and Schools (SACS). One of the SACS requirements is to develop a Quality Enhancement Plan (QEP) to improve students' education. The theme of the School of Health Profession's QEP is improving critical thinking skills among the students. Faculty members are provided with ample developmental opportunities to learn how to incorporate critical thinking strategies into their lesson plans and instructions. This study also recommends to the program's faculty to take the full advantage of these faculty development sessions and update their lesson plans accordingly in order to improve their instructional skills which lead to better student learning outcome.

The questions that are used to measure professionalism were: (a) the faculty member provided feedback on tests and assignments in a timely manner, (b) the faculty member was accessible to students, and (c) the faculty member demonstrated and interacted with the student in a professional manner. This study recommends instructors

to continue practicing professionalism in the classroom and in their interaction with students.

It is very crucial that the results of all of the evaluations be shared with the faculty members in order to make them aware of their areas for improvement. This study also recommends that students be asked to write suggestions when needed in order to inform faculty members of any areas that need improvement. Providing faculty development seminars for faculty members is always a good strategy for improving their teaching skills, content knowledge, and professionalism.

Quality of the Medical Dosimetry Program's Clinical Education

The overall mean scores of the clinical education evaluation for the 2007-2008, 2008-2009, and 2009-2010 school years are 4.40, 4.11, and 4.43 out of 5.0, respectively. This indicates a good level of student satisfaction with their quality of clinical education. A further analysis of data shows that the pattern of student satisfaction with all four components of their clinical education during these three school years is consistent. The satisfaction with the availability of resources and effectiveness of instruction are higher than the satisfaction with consistency in instruction and fairness in grading. This informs the program's faculty to pay more attention to the quality of these areas of clinical education.

In the medical dosimetry program at MD Anderson, there are more than forty clinical medical dosimetrists. In each clinical rotation, there are usually four students with two assigned mentors. Mentors are responsible for formal demonstration of treatment planning construction for the assigned disease site, formal review of students' practice cases, selection of patient cases for students' competency, and grading students'

competency. Furthermore, during the clinical rotation, each student is assigned to a medical dosimetrist for duration of one to two weeks. This medical dosimetrist serves as the clinical instructor and works closely with the student by providing supervision, more instruction, and answering their questions. In this manner, students learn a variety of technical skills and perspectives from different medical dosimetrists. The issue with this setting arises when students learn different techniques from different clinical instructors, which do not completely agree with each other. This may result in student confusion and frustration. All the competencies are graded by the assigned mentors. Therefore, if a student utilizes a technique learned from their clinical instructor, which disagrees with their mentor's opinion, the student may consequently receive a lower grade.

A recommendation from this study is to continue with the clinical experience with some modifications. Clinical work with several dosimetrists and different professionals provide a broad knowledge to students. However, there should be a written standard guideline for both clinical instruction and grading, which all mentors and clinical instructors are required to follow. Although the detail and methods to attain the goal of treatment planning can be different, following a standard guideline in teaching students will ensure consistency in instruction and feedback, as well as fairness in grading. This recommendation is supported by students written comments on clinical rotation evaluations in 2007-2008 and 2008-2009 school years. Students' comments include: (1) handouts were not always provided in the clinic; (2) clinical instructions varied from instructor to instructor; (3) instructors have different methods of planning, which are not consistent with mentors; (4) clinical instructors and mentors should not grade student clinical performance if they did not spend time working with that student; (5) grading is

subjective and instruction is very inconsistent; (6) it is difficult to know what the best tumor coverage is when clinical instructors have different opinion on things; (7) there is inconsistency in instruction and lack of teamwork among instructors; (8) teaching must be consistent; (9) mentors need to communicate with each other to provide consistent instruction; (10) I am unsure of how our clinical grades were generated; (11) I disagree with the way my clinical performance evaluation was graded; and (12) grading guideline is inconsistent with what is written in the handout.

It should be noted that students' comments on 2007-2008 clinical rotation evaluations regarding a once a month individual meetings with students to go over their clinical performance, not evaluating the clinical performance in the first two weeks of first clinical rotation, unavailability of computers in the main dosimetry room, and unavailability of MOSAIQ cases have already been addressed and resolved. Currently, the first student clinical education evaluation is after four weeks of clinical rotation when they gain enough experience to be evaluated; there are periodic meetings with students to review their clinical progress; treatment planning software is installed in all the computers in the main dosimetry rooms, and students have three days after the completion of their competency to complete the MOSAIQ component of their competency.

Although assigned mentors and clinical instructors have a lighter patient workload, sometimes students feel they do not receive the attention they deserve due to the workload of their mentors. Although clinical instructors should never sacrifice patient care, they could direct students' questions to another available colleague if possible and follow-up with the student as soon as they are finished with their clinical duty. Further,

clinical supervisors should assign an alternate instructor for students to confer with when the formal mentors and instructors are busy with their clinical duties. This would benefit students by reducing their wait time for getting their questions answered.

The 2009-2010 students' comments show that students would like to spend more time in the Proton Center and Satellite rotations. This concern will be solved when the program switches to the two-year program. Other students' comments were addressed by the program's officials. The comments include: (1) availability of additional practice cases beyond the usual six for faster students, (2) mentors following their schedule for conducting demonstrations, and (3) lowering clinical load of dosimetry staff to ensure grading competencies in a timely manner.

Quality of the Medical Dosimetry Program's Curriculum and New Student Orientation

An analysis of data from program evaluation surveys shows that students were satisfied with their overall educational experience in the medical dosimetry program. This is indicated by an overall mean score of 4.62 in 2008, 4.27 in 2009, and 4.14 in 2010. This study examined only two elements of the program evaluation survey, satisfaction with the curriculum and quality of the new student orientation. The data show that students are more satisfied with the quality of the program's curriculum than the benefit of their orientation session in these three years. Moreover, the satisfaction with the quality of the curriculum and the helpfulness of the orientation session declined from 2008 to 2010. A review of student comments was conducted to recommend factors that might affect the degree of satisfaction with the program and these two components.

Student comments from the program evaluation surveys given to graduating students in 2008 indicated a need to review clinical education for improvement and to keep the classroom computers' treatment planning licenses valid. These issues have been resolved by the program officials. A review of comments from the program evaluation surveys given to graduating students in 2010 disclosed that students are concerned about the lack of job opportunities. They suggested that the program should include teaching other treatment planning software and more IMRT trainings to the curriculum to make students more marketable. Students' other concern was that if they could not find a job in medical dosimetry after graduation, they could not become certified. This is because MDCB requires that graduates of one-year programs in medical dosimetry have a minimum of six months work experience in order to become eligible to take the MDCB examination. However, graduates of a two-year program in medical dosimetry do not need to have a six months work experience in order to be eligible to take the MDCB examination. This study supports the conversion of the one-year program in medical dosimetry to a two-year program. The two-year program in medical dosimetry not only provides more educational opportunities for students, but also makes students eligible to take the MDCB examination upon graduation. In view of the fact that many employers only recruit certified medical dosimetrists, the two-year program's graduates will have a much better chance of finding a job. Furthermore, because they would have a more extensive education, they would be more prepared to successfully pass the MDCB certification examination.

Review of students' comments from 2010 graduating students, also notified program's officials that students would like to be provided with electronic versions of

their class handouts. This would be beneficial because students could study the material before class and have easy access to it at any time. The program in medical dosimetry started using Sakai course management system in fall 2010 and made available to students the PDF version of some of their class handouts to meet students' request. The author recommends a more extensive use of the Sakai course management system for the curriculum. Reading assignments and problem-solving opportunities for students could also be included in this course management system.

The author recommends modification of the program evaluation survey in order to gain better understanding of students' needs. This will help faculty and administrators to make improvements to the quality of the program and to improve student learning outcomes. Including only one item on the program evaluation survey to measure the quality of the curriculum or the helpfulness of the new student orientation only provides a general understanding of the extent of students' satisfaction. It will not provide a broad and deep understanding of the strengths and weaknesses of these areas in order to find a solution for improvement. Adding open-ended questions to the instrument to seek a more in-depth understanding of students' needs is certainly beneficial for program assessment and improvement.

Students are also concerned about the quality of services they received from the registrar's office. Although the program has no control over the quality of these services, the author suggests that the program's officials assist students by improving communications between the registrar's office and incoming students. All the incoming students at the School of Health Professions meet the registrar's office representatives during the new student orientation session. This study recommends to the program to set

up another meeting before the orientation session for the students to meet the registrar's office representatives in a smaller setting. The students will have the opportunity to discuss their challenges and ask their questions for clarification. This meeting will also give insights to the registrar's office representatives for improvement of their services to students.

In seeking students' honest opinions about the program, it is very important that they feel confident that evaluations are conducted anonymously. This reduces students' fear of possible consequences for giving negative opinions about the program. This was indicated by a comment from one of the graduating students in 2009. She/he mentioned that gender and ethnicity should be taken off the evaluation form because some of the programs only have one student in a particular category. Although demographic information would give valuable information to the researchers, School of Health Professions already has the demographic information of all the students through the application process for admission. Therefore, there is no need to collect this data while conducting the program evaluation for graduating students. The author recommends to the school administrators to remove from the program evaluation instrument the demographic information that could identify students.

Quality of the Medical Dosimetry Program's Graduates

Employer survey data were collected in 2007 from the employers who hired 2004-2006 graduates and in 2009 from the employers who hired 2007-2009 graduates. These data show that employers were satisfied with the quality of the program's graduates indicated by an overall mean score of 4.28 and 4.54 out of 5.0, respectively. The data show that employers were more satisfied with the quality of the graduates'

professionalism than their technical skills. Furthermore, data show that the employers' satisfaction increased in both areas of professionalism and technical skills from 2007 to 2009. The reasons for the employers' satisfaction and the improvement in the quality of graduates are attributed to many factors. The program continuously seeks feedback about the quality of the clinical education and makes improvements based on this feedback.

Two major program improvements made to the clinical education, which affected 2004-2006 graduates, include: (1) requiring students to formally present their competencies in the staff meeting or in their dosimetry service rotation to improve their communication skills, and (2) formal assignment of mentors and clinical instructors to students during the clinical rotation to better train students.

Improvements made to the clinical education that affected 2007-2009 graduates include: (1) adding MOSAIQ (electronic record and verify system) requirement to the clinical competencies to familiarize students with this important aspect of medical dosimetry; (2) requiring students to submit a formal practice plan to their mentors for grading and feedback to better prepare them for their competency exam; (3) creating a database of archival patient cases for each disease site to eliminate student wait time for finding practice and competency cases; (4) requiring students to perform other dosimetry-related tasks besides treatment planning to expand their clinical experience; (5) constructing standardized questions to ask students during their presentations in order to ensure understanding and fair grading of their presentation; (6) imposing a time limit for completing competencies to improve students' efficiency; (7) imposing a time limit for the mentors to grade students' competency to reduce students' wait time; and (8) adding

proton treatment planning training to the clinical education, to expand their technical knowledge and marketability.

It is imperative that the program continue to improve the quality of the clinical education to meet new advances in technology and the demands of employers. Although the employer survey questionnaire used in this program provides valuable information about the quality of the program's graduates, improving the survey questionnaire could expand the program official's understanding of the quality of the graduates and their education. The author recommends, adding two open ended questions to the survey that include: (1) In your opinion, what are some of the strengths of the program's graduate you hired; and (2) In your opinion, what are some of the weaknesses of the program's graduate and how would you suggest the program to improve these areas for the future students? These two questions would give additional information to the program's administrators and help them in their decision-making process for program improvement. Common weaknesses among the program's graduates show areas that need improvement and common strengths among the program's graduates indicate the areas that work well.

Chapter VI

Conclusion and Implications

The purpose of the Research Question One was to describe how the review of the literature regarding the evaluation of health-related educational programs has informed the intended program evaluation of the medical dosimetry program. The intent of the Research Questions Two to Six was to evaluate the medical dosimetry program in regard to the quality of the faculty, clinical education, curriculum, school orientation, and program's graduates as entry-level medical dosimetrists. This chapter will present the conclusion and implications of the study and will recommend the next step in evaluating this program.

Conclusion

Insights to the Program

The first research question addressed in this study focuses on a review of literature related to heath profession programs in order to make recommendations to administrators of the Medical Dosimetry program at the School of Health Professions at MD Anderson Cancer Center. The recommendations derived from this inquiry include: (1) providing educational opportunities for all faculty and clinical instructors in regard to professionalism; (2) scheduling regular meetings with clinical instructors and discussing the expectations of them; (3) reviewing the faculty, clinical instructor, and student clinical evaluation forms; (4) reviewing the clinical rotation evaluation form; (5) providing opportunities for students to talk in a private setting with the program director regarding any ethically questionable strategies; (6) offering alternative options if assigned clinical instructors are not available; (7) reducing stressful pressure on students and improving their quality of personal life by switching to the two-year program and

integrating learning strategies into the curriculum by teaching students how to learn; (8) establishing an incentive plan to encourage group work and substituting that for competition, which can lead to stress; (9) developing a plan to include both peer evaluation and self-evaluation for faculty and clinical instructors; and (10) increasing the use of technology in the classroom.

Currently, the Program implements many routine practices that were identified as worthwhile in the literature review. They include, but not limited to, seeking regular feedback from students with regard to the quality of the program through end-of-semester evaluations, conducting end-of-semester meetings with each individual student, providing a well-rounded clinical education for students, and using technology in the classroom. However, there is always room for improvement and the program administrators should consider the recommendations put forth in this study, which were derived from the review of literature, and begin to modify existing instructional and assessment procedures. This would benefit instructors of the program as well as students.

Quality of the Faculty

The second research question addressed in this investigation was a review of faculty evaluations from the 2007-2008 to 2009-2010 school years, indicating that students are satisfied with the quality of faculty. This assessment is supported by a mean value of at least 4.55 out of 5.0 in all constructs measured. However, the satisfaction decreased slightly from 2008-2009 to 2009-2010. The decline in satisfaction with the faculty from 2008-2009 to 2009-2010 may be attributed to the major transition in the program's personnel. Both faculty were appointed new responsibilities and were required to teach a variety of subjects, some for the first time. As indicated by the comments from

2009-2010, faculty needs to spend more time on preparing their materials, be more accessible to the new students, and be more responsive. These outcomes emphasize the importance of maintaining adequate human resources for students at all times. Since the start of the new two-year program in fall 2010, the number of students has doubled and eleven new courses have been offered. Consequently, it was imperative for the Program to add at least one new faculty member to maintain the quality of the program and student satisfaction with their education.

The faculty assessment affirms that students are very satisfied with the quality of the program's faculty. However, the faculty should continue seeking self improvement in regard to their content knowledge, instructional skills and professionalism by attending continuing education opportunities. Faculty should include more critical thinking and problem-solving opportunities for their students in the classroom and laboratory. Many classes in professionalism, instructional skills, and critical thinking strategies are offered free of charge by MD Anderson Cancer Center for the faculty and staff. Faculty should commit to attend these classes throughout the year in order to improve their instructional skills, lesson plans, and professionalism. Faculty also should keep up-to-date their content knowledge of medical dosimetry and related technical areas. This can be accomplished through attending annual professional meetings conducted by the American Association of Medical Dosimetrists (AAMD). At these meetings, the latest advancements in the field of medical dosimetry and radiation oncology are presented. The School of Health Professions' administrators should continue to provide funds for faculty travel to these annual meetings. Faculty must also continue to attend numerous in-services in the department of radiation oncology offered by physicians, physicists,

medical dosimetrists, and radiation therapists for updates on the latest advancements and techniques being used in MD Anderson Cancer Center.

Quality of the Clinical Education

This study shows that students are satisfied with the overall quality of their clinical education. However, the satisfaction with the availability of resources and effectiveness of instruction are almost the same and higher than the satisfaction with consistency in instruction and fairness in grading. In order to enhance their experience and to address their needs, the author makes recommendations for improving clinical education to both faculty and administrators. These recommendations include: (1) provide students with written treatment planning instructions for all assigned disease sites in every rotation; (2) require clinical instructors and mentors to follow the written instructions when teaching and answering students' questions to eliminate students confusion; (3) provide students and mentors with a detailed clinical competency grading guidelines, and require mentors to follow these guidelines to ensure fairness in grading; and (4) assign an alternate mentor for each dosimetry service to take over if the assigned mentors are not available to answer questions or grade competencies in a timely manner.

Quality of the Curriculum

This study shows that students are satisfied with the quality of the medical dosimetry curriculum. However, the author recommends the elimination of the one-year program in medical dosimetry and replacing it with the two-year program. The two-year program in medical dosimetry provides more educational opportunities for students as well as makes them eligible to take the MDCB examination after graduation. Attaining

MDCB certification will increase graduates' chance of finding employment after graduation.

Another recommendation is for the faculty to provide students with an electronic version of their learning material. This will provide easy access to the learning material as well as a better study format for the students who prefer studying the electronic version of material.

The author also recommends to program administrators to review some of the evaluation instruments to make them more informative. One of the instruments that should be reviewed for improvement is the program evaluation survey. Having only one item on the program evaluation survey to measure the quality of the curriculum only provides a general understanding of the extent of students' satisfaction and gives no information on the components of the curriculum that need improvement. Including additional questions to ask about the strengths and weaknesses of the curriculum and suggestions for improvement would give valuable information to the faculty and administrators.

Helpfulness of the New Student Orientation

This study shows that medical dosimetry students are satisfied with the helpfulness of the new student orientation session with some consideration. Unfortunately, the program evaluation instrument does not provide information about the strengths and weaknesses of the school orientation. The author recommends including additional questions about the quality of the orientation session on the program evaluation survey to ask the strengths and weaknesses of the orientation session and suggestions for improvement.

Quality of the Program's Graduates

This study shows that employers who hired the program's graduates as entry-level medical dosimetrists are very satisfied with their quality of technical work and professionalism. The program should continue updating the clinical education to meet advances in technology and treatment planning. The program should continue seeking feedback from students, graduates, and employers about the quality of the clinical education and to keep the clinical education curriculum up to date.

None of the collected surveys from the employers includes constructive comments. This study also suggests to the program administrators to modify the clinical education evaluation instrument by including questions about the graduate's weaknesses and strengths. These questions would give the program administrators greater understanding of the areas that need improvement.

Implications

A medical dosimetrist is a member of a radiation oncology team who is responsible for constructing radiation treatment plans. Their contribution to the team significantly improves the quality of patient care. These professionals should have acquired appropriate education along with the clinical training in order to be technically and professionally competent. Nothing is justifiable in sacrificing the quality of medical dosimetry graduates. Today's economic crises may have caused many schools across the U.S. to accept more students with no additional resources in order to be financially stable. This strategy cannot be recommended in health-related programs because the preparation of graduates has a direct effect on patient care.

Faculty should be encouraged to attend professional development opportunities in order to improve their technical knowledge, instructional skills, and professionalism, as well as how to incorporate critical thinking and problem-solving strategies into their lesson plans. They should teach the future medical dosimetrists how to think critically and how to be problem-solvers. This is because medical dosimetrists should be creative and possess critical thinking skills necessary to construct and tailor appropriate radiation treatment for each patient. Tumors are different in their shape, size, and location and there is no recipe for making treatment plans for each case. Administrators should continue providing funds for the betterment of faculty, which directly affects improving student learning outcomes.

The medical dosimetry program at UTMDACC started a two-year program in medical dosimetry in fall 2011. This strategy has allowed the school to increase the number of students. More courses were added to the two-year program's curriculum which requires additional resources for development and delivery of them. It is essential for the school administrators to provide and maintain the appropriate number of faculty members and educators for the medical dosimetry program in order to proportionally distribute the teaching load and maintain a degree of satisfaction with the quality of faculty. This is consistent with the finding of Ari (2005) which indicated that the personnel to student ratio had a statistically significant relationship with the success of respiratory therapy students on their board exam. This success is an indication of the quality of education that program's graduates received.

One implication of this study is for the program to switch to the two-year program completely and eliminate the one-year program in medical dosimetry. In the two-year

program, students will gain more knowledge in a less stressful learning environment, be eligible to take the MDCB examination upon graduation, be well prepared to pass their MDCB examination, and be more marketable because of their extensive training and clinical skills and due to the fact that they have the opportunity to be certified by MDCB upon graduation.

This study showed that students are satisfied with the major components of the program. One of the areas of improvement was the helpfulness of the new student orientation session conducted by school for all incoming students. Therefore, faculty and school administrators should work together to make this one-day orientation session a better experience for students. Currently, there is no certain information about the strengths and weaknesses of the orientation session. The first step toward improving the orientation session is to modify the program evaluation instrument used to evaluate the helpfulness of the orientation session. This would give valuable information on the strengths and weaknesses and how to improve this experience for future students. Program directors could also seek students' feedback about their orientation session during their individual end-of-semester counseling with them. The School of Health Professions should continue evaluating this orientation session and makes improvement to its quality using the feedback from students.

Other areas of improvement were consistency of the instruction students received from their clinical mentors and instructors as well as the process used to grade their clinical competency. This inconsistency is due to the fact that they work with several dosimetrists, who have different ways of performing a task. In order to keep the instruction consistent and make the grading process fair, there should be a standard

clinical guideline for each competency case. This guideline should specify in detail what is expected of students, how each step should be conducted, and how each step is graded. All of the dosimetrists who work with students in the clinic should be instructed to follow this standard guideline. One implication of this study is for the program's officials to work closely with the clinical dosimetrists to develop these standard guidelines for each disease site to ensure consistency in the instruction for all students regardless of their assigned mentors. This would eliminate students' confusion and frustration and improve their learning experience.

Another implication of this study is for faculty and administrators to review evaluation instruments that are used in this program. These include: (1) faculty evaluation, (2) students' clinical evaluation, (3) clinical rotation evaluation, (4) program evaluation, and (5) employer evaluation. Including additional questions and additional space for comments would give an extensive amount of information to the faculty and administrators that can be used for improvement.

Future Research

The medical dosimetry program started a two-year program in fall 2010 and made major changes to the curriculum. This study recommends additional research about the quality of the newly launched two-year program in medical dosimetry after graduating the first cohort of students in 2012. This would provide valuable information on the areas that need improvement especially newly-developed courses.

Future research could compare the satisfaction of program's graduates in the one-year and two-year program, as well as the satisfaction of employers who hired the one-year program's graduates versus those who hired the two-year program's graduates.

Future research could also use the data from the modified version of evaluation instruments, which would provide more information on different aspects of the program. This would be beneficial especially in the areas that were not clear when the existing evaluation surveys were used.

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APPENDIX A

ASSESSMENT AGREEMENT FORM

Assessment Agreement

School of Health Professions

The School of Health Professions is required, as part of our accreditation process, to ask for and receive student assessment information. This process helps us in the evaluation of our programs and if deficiencies are noted to make the necessary corrective action(s) to improve the outcome(s).

Students are asked to complete various course, instructor and program evaluations during the academic year. After completion of the program, each student is asked to release his/her scores on the national certification exam(s) and consent to the program contacting his/her employer for information on the adequacy of the student's preparation to meet his/her job requirements. Finally, as an alumnus of The School of Health Professions you will be asked to complete and return alumni surveys which will be sent to you periodically. By signing below you agree to participate in these assessments.

I, the undersigned, agree to participate in course, faculty and program evaluations. I will release to the program my score on the national certification exam(s). I consent to the program contacting my future employer(s) and will complete alumni surveys.

_____ _____

Signature **Date**

APPENDIX B

FACULTY EVALUATION FORM

4306112490

THE UNIVERSITY OF TEXAS
MD ANDERSON
CANCER CENTER

F

FOR IR USE

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SCHOOL OF HEALTH PROFESSIONS

PROGRAM: _____
SEMESTER: _____
COURSE: _____

FACULTY EVALUATION

Shade Circles Like This--> ●
Not Like This--> ⊗ ✓

FACULTY MEMBER: _____
This student is enrolled in the _____ **Program.**

In the CLASSROOM the faculty:

	STRONGLY AGREE	AGREE	UNDECIDED	DISAGREE	STRONGLY DISAGREE	NOT APPLICABLE
1. Responded effectively to student questions.	O	O	O	O	O	O
2. Provided opportunities for application of problem solving skiills.	O	O	O	O	O	O
3. Provided feedback on tests and assignments in a timely manner.	O	O	O	O	O	O
4. Was knowledgeable about subject matter.	O	O	O	O	O	O
5 Provided opportunities for class interaction.	O	O	O	O	O	O
6. Was accessible to students.	O	O	O	O	O	O
7. Was organized in class presentations.	O	O	O	O	O	O
8. Interacted with me in a professional manner.	O	O	O	O	O	O
9. Was an effective teacher.	O	O	O	O	O	O

COMMENTS [PLEASE PRINT CLEARLY]

_____
_____
_____
_____
_____
_____
_____

Thank you for your help! Please give to the proctor, or mail to Institutional Research, Box 1420.

APPENDIX C

COGNITIVE INTERVIEW FORM FOR

FACULTY EVALUATION INSTRUMENT

Dear Colleague,

The Faculty Evaluation Survey used at School of Health Professions at UT M. D. Anderson Cancer Center includes nine items given to students. In order to refine the instrument, I would like to group the statements below into three categories: (1) Faculty Content Knowledge, (2) Faculty Instructional Skills, and (3) Faculty Professionalism. Would you take a few minutes of your time to categorize the nine survey statements?

Please read each statement and identify the category into which it best fits with a health profession's course. Write the number associated with each statement in the one of the three boxes below. If none of the three categories apply, place the number into the non-applicable (N/A) box.

---

1. In the classroom the faculty member responded effectively to student questions.
2. In the classroom the faculty member provided opportunities for application of problem solving skills.
3. In the classroom the faculty member provided feedback on test and assignments in a timely manner.
4. In the classroom the faculty member was knowledgeable about subject matter.
5. In the classroom the faculty member provided opportunities for class interaction.
6. In the classroom the faculty member was accessible to students.
7. In the classroom the faculty member was organized in class presentations.
8. In the classroom the faculty member demonstrated and interacted with me in a professional manner.
9. The faculty member was an effective teacher.

Content Knowledge	Instructional Skills	Professionalism	N/A

If you have classified one of the statements as non-applicable (N/A), how would you label its function in a professional program? Please explain.

Please email your response back to me: mdehghan@mdanderson.org and thank you for assisting me to refine this instrument.

Mahsa Dehghanpour, MS., CMD
Assistant Professor, Program Director
UT M. D. Anderson Cancer Center
School of Health Professions
Medical Dosimetry Program

APPENDIX D

CLINICAL INSTRUCTOR EVALUATION FORM

University of Texas M.D. Anderson School of Health Professions
Program in Medical Dosimetry

Clinical Instructor Evaluation Form

Instructor: _____

Rotation: _____ Date: _____

Please indicate a score from 5 to 1 for each question where the numerical score indicates:
5 Exceptional 4 above Average 3 Average 2 Needs Improvement 1 Not Satisfactory

The Clinical Instructor:

	5	4	3	2	1
1. Shows enthusiasm for teaching.					
Comments:					
2. Refrains from discussing activities or events inappropriate to a clinical setting.					
Comments:					
3. Assigns student duties well balanced and covering typical dosimetric duties.					
Comments:					
4. Clearly explains procedures the student is expected to perform.					
Comments:					
5. Answers questions regarding plans, procedures, and calculations.					
Comments:					
6. Provides adequate assistance in preparing to perform clinical competencies.					
Comments:					
7. Offers advice and constructive criticism in a professional manner in line with student's level.					
Comments:					
8. Encourages the student to act and think independently					
Comments:					
9. Adequately reviews student work in a timely manner.					
Comments:					
10. Treats student fairly and with respect.					
Comments:					

Additional comments:

APPENDIX E

CLINICAL ROTATION EVALUATION FORM

The University of Texas M. D. Anderson Cancer Center
School of Health Professions
Medical Dosimetry Program

CLINICAL ROTATION/ LABORATORY EVALUATION

Rotation: _____

5 Strongly Agree	4 Agree	3 Neutral	2 Disagree	1 Strongly Disagree					
1. The objectives for my clinical rotation were clearly stated.				5	4	3	2	1	na
2. Orientation to my clinical rotation was thorough and helpful.				5	4	3	2	1	na
3. My scheduled rotations were meaningful.				5	4	3	2	1	na
4. I was given hand outs for procedures, computer instructions, calculations, record and verify, etc.				5	4	3	2	1	na
5. Technical instruction by the clinical instructors and other department personnel was consistent.				5	4	3	2	1	na
6. Relative to helping me individually, the department personnel as a whole were very helpful.				5	4	3	2	1	na
7. I was encouraged to attend and participate in departmental in-services.				5	4	3	2	1	na
8. During difficult times a clinical instructor or faculty member was available for additional instruction.				5	4	3	2	1	na
9. My clinical education has given me a broad range of experiences.				5	4	3	2	1	na
10. The level of supervision corresponded well with my level of competency.				5	4	3	2	1	na
11. The department personnel and faculty allowed me the freedom to develop my skills at my own pace.				5	4	3	2	1	na
12. The clinical instructors, department personnel and faculty encouraged my development of confidence in the clinical setting.				5	4	3	2	1	na
13. The clinical instructors, department personnel and faculty encouraged different points of view.				5	4	3	2	1	na
14. I was given adequate access to treatment planning computers.				5	4	3	2	1	na
15. I was given adequate access to patient cases or practice cases.				5	4	3	2	1	na
16. The clinical evaluation system was fair.				5	4	3	2	1	na

Comments:

APPENDIX F

STUDENT CLINICAL EVALUATION FORM

University of Texas M.D. Anderson
School of Health Professions
Program in Medical Dosimetry

Clinical Rotation Evaluation Form

Rotation: Dates:

Student:

Instructor: Instructor:

The student performed the required competency plan presentation: ☐**Yes** ☐**No**

Please indicate a score from 5 to 1 for each question where the numerical score indicates:

5 – Exceptional *4 – Above Average* *3 – Average* *2 – Needs Improvement* *1 – Not Satisfactory*

An average score of less than 3.0 indicates failure, and the student is placed on probation.

I. Clinical Conduct
The student:

	5	4	3	2	1
1. Maintains a respectful, professional attitude towards patients and division personnel.					
2. Demonstrates good personal hygiene and dress habits as appropriate to a clinical setting.					
3. Willingly accepts advice and constructive criticism from division personnel.					
4. Asks questions to clarify duties, techniques, and information when indicated.					
5. Refrains from discussing activities or events inappropriate to a clinical setting.					
6. Reports for duty in a timely manner, keeping clinical instructor informed about absences.					
7. Displays appropriate independence and industry in performing clinical tasks.					
Clinical Score Total x 1 =					

II. Dosimetry Skills (Appropriate to educational level)
The student:

	5	4	3	2	1
1. Performs calculations and checks in a timely and accurate manner.					
2. Demonstrates the ability to chart treatment based on the prescription and plan.					
3. Exhibits knowledge of anatomy, tumor dose, dose tolerance, and typical field arrangement.					
4. After practice, is able to independently produce plans as required for the competency.					
5. Shows the ability to organize and prioritize duties to efficiently complete requirements.					
6. Makes an effort to observe all activities performed by the dosimetrists on the service.					
7. Shows an understanding of basic medical physics concepts and principles					
Skills Score Total x 2 =					
Clinical + Skills Score Total =					

(A score below 63 = Failure)

Comments:

APPENDIX G

PROGRAM EVALUATION SURVEY INSTRUMENT

THE UNIVERSITY OF TEXAS
MD ANDERSON
CANCER CENTER

SCHOOL OF HEALTH PROFESSIONS

PROGRAM EVALUATION SURVEY

This survey is designed to assess your perceptions of the School of Health Professions' educational programs, student services and student programs. Please answer all the questions. If you wish to comment on any questions or qualify your answers, please use the space in the margins or comment in the designated "comments" area. Your comments will be incorporated into the findings. For confidentiality, DO NOT PLACE YOUR NAME ON THE SURVEY. Thank you for your help!

SCHOOL CURRICULUM

1. In your program, indicate your overall satisfaction with:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Quality of the curriculum.					
b. Quality of the teaching.					
c. Quality of student advising.					
d. Development of decision-making skills.					

2. For your program, indicate your overall satisfaction with the <u>quality</u> of:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Faculty.					
b. School Administration.					
c. Staff.					

3. How satisfied are you with the <u>support</u> you have received from your program's:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Faculty.					
b. School Administration.					
c. Staff.					

4. For clinical rotations, indicate you overall satisfaction with:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Following safety procedures.					
b. Demonstration of quality control.					

SATISFACTION WITH PROGRAM/SCHOOL

5. How satisfied are you that the education you received prepared you for your certification exam?

VERY SATISFIED	SATISFIED	NEUTRAL	VERY UNSATISFIED	UNSATISFIED

6. How satisfied are you that the education you received prepared you to enter the workforce?

VERY SATISFIED	SATISFIED	NEUTRAL	UNSATISFIED	VERY UNSATISFIED

7. Would you advise others to obtain their education at M. D. Anderson's School of Health Professions?

STRONGLY ADVISE	ADVISE	NEUTRAL	DISCOURAGE	STRONGLY DISCOURAGE

STUDENT SERVICES AND PROGRAMS

8. Indicate your satisfaction with YOUR SCHOOL'S SERVICES OR PROGRAMS offered below:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Classrooms:					
1. Adequacy.					
2. AV equipment.					
3. Housekeeping.					
4. Maintenance.					
b. Student laboratory facilities:					
1. Quality of Equipment.					
2. Safety.					

9. How helpful were the following student related services and programs:

	VERY HELPFUL	HELPFUL	NEITHER HELPFUL NOR UNHELPFUL	UNHELPFUL	VERY UNHELPFUL
a. New Student Orientation.					
b. School Catalogs.					

STUDENT SERVICES AND PROGRAMS

10. Indicate your satisfaction with the M. D. Anderson Research Medical Library's services and programs:

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
a. Ease of access to online resources					
b. Computer hardware and software					
c. Customer service					
d. Library classes					
e. Print materials needed for study					
f. Study environment					

11. How would you rate the following student support services?

a. Career Development Seminars
b. Sale Items in Student Affairs Office
c. Social Events on campus
d. Student Affairs Office Staff
e. Student Affairs Resource Information

12. Concerning your school student government organization:

	VERY AWARE	AWARE	NEITHER AWARE NOR UNAWARE	UNAWARE	VERY UNAWARE
a. Were you aware of your school government representatives?					
b. How aware were you of school government sponsored activities?					

	VERY SATISFIED	SATISFIED	NEITHER SATISFIED NOR DISSATISFIED	DISSATISFIED	VERY DISSATISFIED
c. How satisfied were you with your school's student government?					

STUDENT INFORMATION

13. Which SHP program did you attend?

1 CLINICAL LABORATORY MEDICINE
2 CYTOGENETIC TECHNOLOGY
3 CYTOTECHNOLOGY
4 DIAGNOSTIC IMAGING
5 HISTOTECHNOLOGY
6 MEDICAL DOSIMETRY
7 MOLECULAR GENETIC TECHNOLOGY
8 RADIATION THERAPY

14. What was your educational objective?

1 BACHELOR'S DEGREE
2 CERTIFICATE

STUDENT INFORMATION

15. What are your goals after leaving School of Health Professions? *(SELECT ALL THAT APPLY)*

1 CONTINUE YOUR EDUCATION
2 FULL TIME EMPLOYMENT
3 PART TIME EMPLOYMENT
4 MILITARY SERVICE
5 OTHER: *(SPECIFY)* _____

16. What is your gender?

1 MALE
2 FEMALE

17. What is your citizenship status?

1 U.S. CITIZEN
2 INTERNATIONAL → *CONTINUE TO QUESTION 20*

18. What is your ethnicity?

☐ NON-RESIDENT ALIEN
☐ RACE AND ETHNICITY UNKNOWN
☐ HISPANICS OF ANY RACE

FOR NON-HISPANICS ONLY:

☐ AMERICAN INDIAN OR ALASKAN NATIVE
☐ ASIAN
☐ BLACK OR AFRICAN AMERICAN
☐ NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER
☐ WHITE
☐ TWO OR MORE RACES

19. What is your marital status?

1 SINGLE, NEVER MARRIED
2 SEPARATED
3 DIVORCED
4 WIDOWED
5 MARRIED

20. What year were you born?

YEAR: 19 _____.

COMMENTS

Thank you for your help! Please Return to: Dr. Marilyn Greer, Institutional Research, Unit 1420

APPENDIX H

EMPLOYER SURVEY LETTER

Dear Colleague:

I am asking for your assistance in the evaluation of the University of Texas M. D. Anderson Cancer Center School of Health Sciences Program in Medical Dosimetry. This evaluation was developed to assess how well our graduates are prepared for entry-level employment when hired. Your thoughts, opinions and ideas are important to us. We want to continue to improve our programs to better serve the community and students.

The survey rating will represent your appraisal of one or more of our former students and should take less than 10 minutes to complete. All results will be held in strictest confidence and will not be used in any way other than to help properly evaluate M. D. Anderson's role in educating competent practitioners. I am sending this evaluation to employers of our students to evaluate their performance at the place of employment. Your participation in this evaluation will be greatly appreciated, in that we are always trying to re-evaluate our program to determine how to change for the better.

Thank you for participating in this important survey. I appreciate your time and the continued support of the Medical Dosimetry Program. Please e-mail your completed survey to mdehghan@mdanderson.org.

Gratefully,

Melissa Jane Chapman, MEd, CMD
Assistant Professor, School of Health Sciences
Program Director-Medical Dosimetry

APPENDIX I

EMPLOYER SURVEY

The University of Texas M.D. Anderson
School of Health Professions
Medical Dosimetry Program
Employer Survey

Instructions:
For each item listed circle the term that best reflects your opinion of the graduate you have hired.

Graduate Name:

	Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1	na
1. Demonstrates a consistently high quality of work.						
2. Maintains accuracy in charting.						
3. Is confident in his/her ability to perform all assigned tasks.						
4. Is competent at manual and computer calculations.						
5. Uses time efficiently.						
6. Supervises/participates in simulations/virtual sim knowledgeably.						
7. Successfully performs complicated treatment plans						
8. Adapts to changes in your department.						
9. Communicates clearly with colleagues.						
10. Cooperates in teamwork.						
11. Is willing to accept responsibility.						
12. Performs well under pressure.						
13. Follows standard departmental safety precautions.						
14. Demonstrates critical thinking and problem solving skills.						
15. Participates in activities demonstrating professional growth and development.						

Comments: Please use the other side of this survey if necessary.

Signature **Date**

Position Title

APPENDIX J

COGNITIVE INTERVIEW FORM FOR

CLINICAL ROTATION EVALUATION INSTRUMENT

Dear Colleague,

I would like to ask you to assist me to refine the Clinical Rotation Evaluation Survey used at The University of Texas MD Anderson Cancer Center School of Health Professions Medical Dosimetry Program. This should only take 10 to 15 minutes of your time.

The intent of the Clinical Rotation Evaluation Survey is to evaluate the quality of the clinical education at the Medical Dosimetry Program. In order to refine the instrument, please place each item into one of four categories: (1) Availability of Resources, (2) Consistency in Instruction, (3) Fairness in Grading, and (4) Effectiveness of Instruction.

Please read each statement and identify the category into which it best fits. Write the number associated with each statement in one of the four boxes below. If none of the three categories apply, place the number into the non-applicable (N/A) box.

1. The objectives for my clinical rotation were clearly stated.
2. Orientation to my clinical rotation was thorough and helpful.
3. My scheduled rotations were meaningful.
4. I was given handouts for procedures, computer instructions, calculations, and record and verify, etc.
5. Technical instruction by the clinical instructors and other department personnel was consistent.
6. Relative to helping me individually, the department personnel as a whole were very helpful.
7. I was encouraged to attend and participate in departmental in-services.
8. During difficult times a clinical instructor or faculty member was available for additional instruction.
9. My clinical education has given me a broad range of experiences.
10. The level of supervision corresponded well with my level of competency.
11. The department personnel and faculty allowed me the freedom to develop my skills at my own pace.
12. The clinical instructors, department personnel and faculty encouraged my development of confidence in the clinical setting.
13. The clinical instructors, department personnel and faculty encouraged different points of view.
14. I was given adequate access to treatment planning computers.
15. I was given adequate access to patient cases or practice cases.
16. The clinical evaluation system was fair.

Availability of Resources	Consistency in Instruction	Fairness in Grading	Effectiveness of Instruction	N/A

Please email your response back to me at mdehghan@mdanderson.org or place it at my box at YB.5816. Thank you for your participation.

Mahsa Dehghanpour., MS., CMD
Assistant Professor, Program Director
The University of Texas MD Anderson Cancer Center
School of Health Professions
Medical Dosimetry Program
(713) 563-3489

APPENDIX K

COGNITIVE INTERVIEW FORM FOR

EMPLOYER SURVEY

Dear Colleague,

I would like to ask you to assist me to refine the Employer Survey used at The University of Texas MD Anderson Cancer Center School of Health Professions Medical Dosimetry Program. This should only take 10 to 15 minutes of your time.

The intent of the employer survey is to evaluate the quality of the medical dosimetry graduates as entry-level medical dosimetrists. In order to refine the instrument, please place each item into one of two categories: (1) Technical Skills, or (2) Professionalism.

Please read each statement and identify the category into which it best fits. Write the number associated with each statement in one of the two boxes below. If none of the two categories apply, place the number into the non-applicable (N/A) box.

The program's graduate:

1. Demonstrates a consistently high quality of work.
2. Maintains accuracy in charting.
3. Is confident in his/her ability to perform all assigned tasks.
4. Is competent at manual and computer calculations.
5. Uses time efficiently.
6. Supervises/participates in simulations/virtual simulations knowledgeably.
7. Successfully performs complicated treatment plans.
8. Adapts to changes in your department.
9. Communicates clearly with colleagues.
10. Cooperates in teamwork.
11. Is willing to accept responsibility.
12. Performs well under pressure.
13. Follows standard departmental safety precautions.
14. Demonstrates critical thinking and problem solving skills.
15. Participates in activities demonstrating professional growth and development.

Technical Skills	Professionalism	N/A

Please email your response back to me at mdehghan@mdanderson.org or place it at my box at YB.5816. Thank you for your participation.

Mahsa Dehghanpour., MS., CMD
Assistant Professor, Program Director
The University of Texas MD Anderson Cancer Center
School of Health Professions
Medical Dosimetry Program
(713) 563-3489