LEGISLATIVE RESEARCH SERVICES

Alaska State Legislature
Division of Legal and Research Services
State Capitol, Juneau, AK 99801

(907) 465-3991 phone
(907) 465-3908 fax
research@legis.state.ak.us

Research Brief

TO: Representative Chris Tuck
FROM: Katie Spielberger, Legislative Analyst
DATE: April 8, 2015
RE: Licensing Radiologic Technologists
LRS Report 15.348

You asked for information about the practice and licensing of radiology. Specifically, you wished to know which states license radiologic technologists, and what those states typically require for licensing, including education and continuing education requirements. You also wished to know about health risks associated with overexposure to radiation, including any specific incidents regarding harmful effects of overexposure.

Broadly, radiology is the area of medicine concerned with the diagnosis and treatment of diseases and injuries using procedures such as X-rays, magnetic resonance imaging (MRI) scans, computed tomography (CT) scans, nuclear medicine, and ultrasound. Radiologists, the medical doctors who specialize in the field, typically have four to six years of specific post-medical school training in the field.[1] Radiologic technologists are those health care professionals who, under the supervision of physicians, perform diagnostic imaging or administer radiation therapy; in the U.S., the most common education path for radiologic technologists is an associate's degree, according to the Bureau of Labor Statistics.[2] Radiologic technologists may focus on one of many specialized areas of practice—for example, technologists may be radiographers (who use x-ray equipment to produce images), MRI technologists, nuclear machine technologists, sonographers, or radiation therapists (who administer radiation for therapeutic, rather than diagnostic, purposes).

According to the American Society of Radiologic Technologists (ASRT), 39 states regulate radiographers and 35 states regulate radiation therapists. It appears that five states—Alabama, Idaho, Missouri, North Carolina, and South Dakota—and the District of Columbia currently have no regulatory standards pertaining to radiologic technologists. Alaska is among states with minimal regulations.[3]

Based on our review of state licensure information compiled by the ASRT, common requirements for state licensure include successful completion of an exam offered through the American Registry of Radiologic Technologists (ARRT) and/or the state, as well as at least 12 hours of continuing education annually. The ARRT reports that 35 states use their exams for state licensing purposes.[4] In addition to state licensing, many technologists seek certification through the American Registry of Radiologic Technologists (ARRT) by completing a certification and registration exam and reporting continuing education credits every two years.

Precise requirements for licensure vary by state and by practice area—for example, 31 states have specific requirements for radiologic technologists who operate nuclear medicine technology. The ASRT provides detailed information about each state's requirements, including statutory and regulatory citations and links to further state resources, at *http://www.asrt.org/main/standards-regulations/state-legislative-affairs/individual-state-licensure-info*.

---

[1] American College of Radiology, *http://www.acr.org/Quality-Safety/Radiology-Safety/Patient-Resources/About-Radiology*.

[2] U.S. Bureau of Labor Statistics, Occupational Outlook Handbook, Radiologic and MRI Technologists, *http://www.bls.gov/ooh/healthcare/radiologic-technologists.htm*.

[3] ASRT, *http://www.asrt.org/main/standards-regulations/state-legislative-affairs/states-with-licensure-or-certification-laws.* The ASRT also tracks regulatory and legislative developments at *http://www.asrt.org/main/standards-regulations/regulatory-legislative-news*.

[4] American Registry of Radiology Technologies, *https://www.arrt.org/State-Licensing/Licensing-vs-Certification-Registration*.

Alaska Regulations and Legislative History

In Alaska, regulations promulgated in 2009 require operators of medical radiation devices to fulfill a minimum training curriculum and require those responsible for registering the equipment with the state—presumably, the employers of equipment operators—to maintain a record of all training and educational programs the operator attended.[5] As described in 7 AAC 18.230 (attached), the minimum acceptable training curriculum must include the fundamentals of radiation safety, device operation and radiation controls, quality control procedures, and procedures that minimize exposures. In addition, operators of medical fluoroscopic equipment must receive a minimum of 10 hours of instruction in the safe operation of the fluoroscope.[6]

Since 2005, a total of six bills have been introduced in the Alaska Legislature that would require radiologic technologists to be licensed with the State, including the current House Bill 29. Many past bills died in their first committees of referral, with the notable exception of HB 150 in the 24th Legislature (2005-2006), which passed the House.[7] One additional bill, HB 71 in the 25th Legislature (2007-2008), received hearings.

In committee hearings, supporters of these measures primarily cited public health and safety concerns arising from people operating radiologic equipment with insufficient training, particularly the dangers of overexposing patients to potentially carcinogenic radiation.[8] For example, a 2006 state investigation of Bartlett Regional Hospital found the hospital had exposed patients to unnecessary levels of radiation.[9] Clyde Pearce, Chief of Radiological Health, Division of Public Health, Department of Health and Social Services (DHSS), testified in 2007 that the DHSS estimated between 600 and 700 people throughout Alaska were operating radiological equipment without proper training. In response to a 2014 query from our office regarding whether this is still the case, he replied,

> That number is an estimate but since those individuals are not documented anywhere we can't be absolutely certain of the actual number. So the number is as valid now as it was in 2007. The untrained operators work throughout the state. The proportion is higher in rural areas, but the major cities have more offices and small clinics where they hire untrained operators so the overall numbers are not concentrated in any one particular area.[10]

Pushback to the legislation in 2006 and 2007 appears to have come primarily from concerns about potential financial and regulatory burdens on small clinics and their employees. For example, in 2007 testimony, S. Lynn Hornbein, an urgent care physician from Palmer, questioned being able to afford a qualified radiologic technologist and worried that patients would have to visit another facility for radiologic services, thereby increasing the expense of treatment and delaying diagnoses. Sonia Handforth-Kome, the President of the Alaska Primary Care Association (APCA), testified that the APCA did not support the bill as written due to concerns that it would significantly impact the budgets of organizations without guaranteeing patient safety. She further noted the following:

---

[5] Under certain circumstances, registrants may request waivers of certain requirements regarding pre-existing equipment (7 AAC 18.405), but no waivers appear to pertain to requirements regarding employees.

[6] Fluoroscopic equipment passes an X-ray beam through the body to show a continuous X-ray image on a monitor. Its use may result in relatively high radiation doses for patients. More information on benefits and risks associated with the procedure can be found at *http://www.fda.gov/radiation-emittingproducts/radiationemittingproductsandprocedures/medicalimaging/medicalx-rays/ucm115354.htm*.

[7] Other bills introduced that would have required radiologic technologists to be licensed with the State included HB 384 in the 26th Legislature, HB 338 in the 27th Legislature, and HB 323 in the 28th Legislature.

[8] Committee minutes for HB 150 in the 24th Legislature, accessed through *http://www.legis.state.ak.us/basis/get_bill.asp?bill=HB%20150&session=24*, and for HB 71 in the 25th Legislature, accessed through *http://www.legis.state.ak.us/basis/get_bill.asp?bill=HB%20%2071&session=25*.

[9] "State faults hospital for radiation use," Jeannette J. Lee and Matt Volz, *Juneau Empire*, September 20, 2006, accessed at *http://juneauempire.com/stories/092006/sta_20060920021.shtml*.

[10] E-mail communication, July 21, 2014. Mr. Pearce can be reached at 907-334-2107 or through *clyde.pearce@alaska.gov*.

> We have very stringent safety programs in place in Unalaska, [and] I would be more comfortable with a bill that required that we prove . . . our training program when we prove our safety measures and . . . quality measures, than with a bill that simply requires education. I have one certified and two uncertified x-ray techs on staff and there is no discernable quality difference between them. In fact, my two uncertified ones have more experience than our, arguably, safer and better [tech] because they're very stringent about how they follow our safety guidelines; we have to pretty much urge our certified one to follow the safety guidelines.[11]

The only bill to license radiologic technologists for which a fiscal note was created was HB 150 in 2006. The fiscal note estimated annual operating costs of $41,000 for the first year of the program and $35,700 for subsequent years, the bulk of which would fund one half of an Occupational Licensing Examiner position to support the program.[12] Working from the assumption that 400 individuals would seek licensure under the bill, the fiscal note estimated that each licensee would need to pay $294 biennially to cover the costs of the program.[13]

Health Risks from Overexposure to Radiation

Nationally, the use of medical imagining has been increasing, and with this increase has come increased concerns over health risks associated with overexposure to radiation. A 2012 study by researchers at the University of California, San Francisco and the Group Health Research Institute showed that medical imaging is increasing even in those health maintenance organization systems (HMOs) which don't have a financial incentive to conduct them. The study also found significant variation in the doses used by facilities.[14]

A retrospective cohort study of patients examined with CT scans in Great Britain when they were younger than 22 years of age found a positive association between radiation dose from CT scans and the later diagnosis of leukemia and brain tumors. While study authors noted that clinical benefits should outweigh the small risk, "radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising [sic] radiation, should be considered if appropriate."[15]

We attach a 2010 *New York Times* article, "Radiation Offers New Cures, and Ways to Do Harm," which documents several incidents of accidental overexposure to radiation. Based on extensive research,

> The Times found that while this new technology allows doctors to more accurately attack tumors and reduce certain mistakes, its complexity has created new avenues for error — through software flaws, faulty programming, poor safety procedures or inadequate staffing and training. When those errors occur, they can be crippling.

The article also notes that, with no central oversight agency, such accidents are "chronically underreported."

We hope this is helpful. If you have questions or need additional information, please let us know.

---

[11] House Labor and Commerce Committee Minutes, April 27, 2007, accessed through *http://www.legis.state.ak.us/basis/get_bill.asp?bill=HB%20%2071&session=25*.

[12] Fiscal Note 2, CSHB 150(FIN) accessed at *http://www.legis.state.ak.us/PDF/24/F/HB0150-2-2-022706-CED-Y.PDF*.

[13] AS § 08.01.065 requires each licensed profession to cover its own regulatory costs. While costs for training programs for radiological technicians vary, in 2006 testimony on HB 150, Donna Rufsholm of the Alaska Society of Radiology Technology referred to an online program available for $229 that would meet the training standards the bill would have established.

[14] Jason Bardi, "Radiation Exposure From Medical Imagining Has Increased Even at HMOs," June 12, 2012, University of California, San Francisco News, *http://www.ucsf.edu/news/2012/06/12146/radiation-exposure-medical-imaging-has-increased-even-hmos*.

[15] *Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study*, Pearce, Mark S et al. *The Lancet,* Volume 380, Issue 9840, 499 – 505, accessed at *http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2812%2960815-0/abstract*.

The New York Times

HEALTH | THE RADIATION BOOM

Radiation Offers New Cures, and Ways to Do Harm

By WALT BOGDANICH JAN. 23, 2010

As Scott Jerome-Parks lay dying, he clung to this wish: that his fatal radiation overdose — which left him deaf, struggling to see, unable to swallow, burned, with his teeth falling out, with ulcers in his mouth and throat, nauseated, in severe pain and finally unable to breathe — be studied and talked about publicly so that others might not have to live his nightmare.

Sensing death was near, Mr. Jerome-Parks summoned his family for a final Christmas. His friends sent two buckets of sand from the beach where they had played as children so he could touch it, feel it and remember better days.

Mr. Jerome-Parks died several weeks later in 2007. He was 43.

A New York City hospital treating him for tongue cancer had failed to detect a computer error that directed a linear accelerator to blast his brain stem and neck with errant beams of radiation. Not once, but on three consecutive days.

Soon after the accident, at St. Vincent's Hospital in Manhattan, state health officials cautioned hospitals to be extra careful with linear accelerators, machines that generate beams of high-energy radiation.

But on the day of the warning, at the State University of New York Downstate Medical Center in Brooklyn, a 32-year-old breast cancer patient named Alexandra Jn-Charles absorbed the first of 27 days of radiation overdoses, each three times the prescribed amount. A linear accelerator with a missing filter would burn a hole in her chest, leaving a gaping wound so painful that this mother of two young children considered suicide.

Ms. Jn-Charles and Mr. Jerome-Parks died a month apart. Both experienced the wonders and the brutality of radiation. It helped diagnose and treat their disease. It also inflicted unspeakable pain.

Yet while Mr. Jerome-Parks had hoped that others might learn from his misfortune, the details of his case — and Ms. Jn-Charles's — have until now been shielded from public view by the government, doctors and the hospital.

Americans today receive far more medical radiation than ever before. The average lifetime dose of diagnostic radiation has increased sevenfold since 1980, and more than half of all cancer patients receive radiation therapy. Without a doubt, radiation saves countless lives, and serious accidents are rare.

But patients often know little about the harm that can result when safety rules are violated and ever more powerful and technologically complex machines go awry. To better understand those risks, The New York Times examined thousands of pages of public and private records and interviewed physicians, medical physicists, researchers and government regulators.

The Times found that while this new technology allows doctors to more accurately attack tumors and reduce certain mistakes, its complexity has created new avenues for error — through software flaws, faulty programming, poor safety procedures or inadequate staffing and training. When those errors occur, they can be crippling.

"Linear accelerators and treatment planning are enormously more complex than 20 years ago," said Dr. Howard I. Amols, chief of clinical physics at Memorial Sloan-Kettering Cancer Center in New York. But hospitals, he said, are often too trusting of the new computer systems and software, relying on them as if they had been tested over time, when in fact they have not.

Regulators and researchers can only guess how often radiotherapy accidents occur. With no single agency overseeing medical radiation, there is no central clearinghouse of cases. Accidents are chronically underreported, records show, and some states do not require that they be reported at all.

In June, The Times reported that a Philadelphia hospital gave the wrong radiation dose to more than 90 patients with prostate cancer — and then kept quiet about it. In 2005, a Florida hospital disclosed that 77 brain cancer patients had received 50 percent more radiation than prescribed because one of the most powerful — and supposedly precise — linear accelerators had been programmed incorrectly for nearly a year.

Dr. John J. Feldmeier, a radiation oncologist at the University of Toledo and a leading authority on the treatment of

radiation injuries, estimates that 1 in 20 patients will suffer injuries.

Most are normal complications from radiation, not mistakes, Dr. Feldmeier said. But in some cases the line between the two is uncertain and a source of continuing debate.

“My suspicion is that maybe half of the accidents we don’t know about,” said Dr. Fred A. Mettler Jr., who has investigated radiation accidents around the world and has written books on medical radiation.

Identifying radiation injuries can be difficult. Organ damage and radiation-induced cancer might not surface for years or decades, while underdosing is difficult to detect because there is no injury. For these reasons, radiation mishaps seldom result in lawsuits, a barometer of potential problems within an industry.

In 2009, the nation’s largest wound care company treated 3,000 radiation injuries, most of them serious enough to require treatment in hyperbaric oxygen chambers, which use pure, pressurized oxygen to promote healing, said Jeff Nelson, president and chief executive of the company, Diversified Clinical Services.

While the worst accidents can be devastating, most radiation therapy “is very good,” Dr. Mettler said. “And while there are accidents, you wouldn’t want to scare people to death where they don’t get needed radiation therapy.”

Because New York State is a leader in monitoring radiotherapy and collecting data about errors, The Times decided to examine patterns of accidents there and spent months obtaining and analyzing records. Even though many accident details are confidential under state law, the records described 621 mistakes from 2001 to 2008. While most were minor, causing no immediate injury, they nonetheless illuminate underlying problems.

The Times found that on 133 occasions, devices used to shape or modulate radiation beams — contributing factors in the injuries to Mr. Jerome-Parks and Ms. Jn-Charles — were left out, wrongly positioned or otherwise misused.

On 284 occasions, radiation missed all or part of its intended target or treated the wrong body part entirely. In one case, radioactive seeds intended for a man’s cancerous prostate were instead implanted in the base of his penis. Another patient with stomach cancer was treated for prostate cancer. Fifty patients received radiation intended for someone else, including one brain cancer patient who received radiation intended for breast cancer.

New York health officials became so alarmed about mistakes and the underreporting of accidents that they issued a special alert in December 2004, asking hospitals to be more vigilant.

As this warning circulated, Mr. Jerome-Parks was dealing with what he thought was a nagging sinus infection. He would not know until two months later that cancer had been growing at the base of his tongue. It was a surprising diagnosis for a relatively young man who rarely drank and did not smoke.

In time, his doctors and family came to suspect that his cancer was linked to the neighborhood where he had once worked, on the southern tip of Manhattan, in the shadow of the World Trade Center.

Several years before, he had taken a job there as a computer and systems analyst at CIBC World Markets. His starting date: September 2001.

Diagnosis and Treatment

What Mr. Jerome-Parks most remembered about Sept. 11, his friends say, were bodies falling from the sky, smashing into the pavement around him. He was particularly haunted by the memory of a man dressed in a suit and tie, plummeting to his death.

In the days and weeks that followed, Mr. Jerome-Parks donated blood, helped a family search for a missing relative and volunteered at the Red Cross, driving search-and-rescue workers back and forth from what became known as “the pile.” Whether toxic dust from the collapsed towers caused his cancer may never be known, though his doctor would later say he believed there was a link.

Mr. Jerome-Parks approached his illness as any careful consumer would, evaluating the varied treatment options in a medical mecca like New York. Yet in the end, what led him to St. Vincent’s, the primary treatment center for Sept. 11 victims, was a recommendation from an acquaintance at his church, which had become an increasingly important part of his life.

The Church of St. Francis Xavier in Manhattan, known for its social advocacy, reflected how much Mr. Jerome-Parks had changed from his days in Gulfport, Miss., where he was raised in a conservative family, eventually moving to Toronto and then New York, where he met his Canadian-born wife, Carmen, a dancer, singer and aspiring actress.

In turning to St. Vincent’s, Mr. Jerome-Parks selected a hospital that had been courting cancer patients as a way to solidify its shaky financial standing.

Its cancer unit, managed by Aptium Oncology, a unit of one of the world’s leading pharmaceutical companies,

AstraZeneca, was marketing a new linear accelerator as though it had Mr. Jerome-Parks specifically in mind. Its big selling point was so-called smart-beam technology.

"When the C.F.O. of a New York company was diagnosed with a cancerous tumor at the base of his tongue," promotional material for the new accelerator stated, "he also learned that conventional radiation therapy could potentially cure him, but might also cause serious side effects."

The solution, the advertisement said, was a linear accelerator with 120 computer-controlled metal leaves, called a multileaf collimator, which could more precisely shape and modulate the radiation beam. (View an interactive graphic demonstrating how multileaf collimators work, and how problems at St. Vincent's caused a fatal overdose.) This treatment is called Intensity Modulated Radiation Therapy, or I.M.R.T. The unit St. Vincent's had was made by Varian Medical Systems, a leading supplier of radiation equipment.

"The technique is so precise, we can treat areas that would have been considered much too risky before I.M.R.T., too close to important critical structures," Dr. Anthony M. Berson, St. Vincent's chief radiation oncologist, said in a 2001 news release.

The technology addressed a vexing problem in radiation therapy — how to spare healthy cells while killing cancerous ones.

Radiation fights cancer by destroying the genetic material that controls how cells grow and divide. Even under the best of circumstances, though, it carries a risk, much like surgery or chemotherapy.

The most accurate X-ray beams must pass through healthy tissue to penetrate the tumor before exiting the body. Certain body parts and certain people are more sensitive to radiation. According to research by Dr. Eric J. Hall of the Center for Radiological Research at Columbia University, even accurate I.M.R.T. treatments, when compared with less technically advanced linear accelerators, may nearly double the risk of secondary cancer later in life due to radiation leakage.

When therapeutic errors enter the picture, the risk multiplies. An underdose allows the targeted cancer to grow, while an overdose can burn and cause organ damage.

While most radiation burns are mild, comparable to a sunburn, larger doses can damage the cells lining small blood vessels, depriving the skin and soft tissue of nourishment. The result is a wound that resists healing.

"Not only do you lose the blood vessels, but the tissue becomes chronically inflamed, which can lead to scarring," said Robert Warriner III, chief medical officer of Diversified Clinical Services, the wound care company.

After soft-tissue injury, bone death in the head and jaw is the second most common radiation injury that Diversified Clinical treats.

At their worst, radiation injuries can cause organ failure and death.

Dr. Salvatore M. Caruana, then a head and neck surgeon at St. Vincent's, gave Mr. Jerome-Parks another option: surgery.

"I wanted him to have laser resection," Dr. Caruana, now at New York-Presbyterian Columbia University Medical Center, said in an interview.

In the end, Mr. Jerome-Parks chose radiation, with chemotherapy.

His wife would later tell friends that she wondered whether St. Vincent's was the best place for him, given that the world-renowned Memorial Sloan-Kettering was nearby. But she did not protest. His mind was made up, and there was no time to lose. His cancer was advancing, and smart-beam technology promised to stop it.

A Plan Goes Wrong

On a brisk day in March 2005, Mr. Jerome-Parks prepared for his fifth radiation session at St. Vincent's. The first four had been delivered as prescribed. Now Dr. Berson wanted the plan reworked to give more protection to Mr. Jerome-Parks's teeth.

Radiation can damage saliva glands, and if saliva stops flowing, tooth decay and infections become a significant risk. Coupled with bone weakness from radiation, the simple act of extracting a tooth can lead to destruction of the lower jaw and ultimately its removal, doctors say.

Dr. Edward Golembe, who directs a hyperbaric oxygen chamber at Brookdale University Hospital in Brooklyn, said he had treated serious radiation injuries to the jaw and called them "a horrible, horrible thing to see."

Tasked with carrying out Dr. Berson's new plan was Nina Kalach, a medical physicist. In the world of radiotherapy, medical physicists play a vital role in patient safety — checking the calibration of machines, ensuring that the computer delivers the correct dose to the proper location, as well as assuming other safety tasks.

Creating the best treatment plan takes time. "A few years ago, we had computers that would take overnight to actually come up with a good treatment plan," said Dr. David Pearson, a medical physicist who works with Dr. Feldmeier's radiotherapy team at the University of Toledo. Faster computers have shortened that process.

"But we still need to be able to verify that what the computer has actually come up with is accurate," Dr. Pearson said. "The first time it tries to solve the problem, it may not come up with the best solution, so we tell it, O.K., these are the areas that need to be fixed."

A few months before Mr. Jerome-Parks's treatment, New York State health officials reminded hospitals that I.M.R.T. required a "significant time commitment" on the part of their staffs.

"Staffing levels should be evaluated carefully by each registrant," the state warned, "to ensure that coverage is sufficient to prevent the occurrence of treatment errors and misadministrations."

On the morning of March 14, Ms. Kalach revised Mr. Jerome-Parks's treatment plan using Varian software. Then, with the patient waiting in the wings, a problem arose, state records show.

Shortly after 11 a.m., as Ms. Kalach was trying to save her work, the computer began seizing up, displaying an error message. The hospital would later say that similar system crashes "are not uncommon with the Varian software, and these issues have been communicated to Varian on numerous occasions."

An error message asked Ms. Kalach if she wanted to save her changes before the program aborted. She answered yes. At 12:24 p.m., Dr. Berson approved the new plan.

Meanwhile, two therapists were prepping Mr. Jerome-Parks for his procedure, placing a molded mask over his face to immobilize his head.

Then the room was sealed, with only Mr. Jerome-Parks inside.

At 12:57 p.m. — six minutes after yet another computer crash — the first of several radioactive beams was turned on.

The next day, there was a second round of radiation.

A friend from church, Paul Bibbo, stopped by the hospital after the second treatment to see how things were going.

Mr. Bibbo did not like what he saw. Walking into a darkened hospital room, he recalled blurting out: " 'My goodness, look at him.' His head and his whole neck were swollen."

Anne Leonard, another friend, saw it, too, on a later visit. "I was shocked because his head was just so blown up," Ms. Leonard said. "He was in the bed, and he was writhing from side to side and moaning."

At a loss for what to do, Ms. Leonard said, "I just stood at the foot of the bed in the dark and prayed."

In a panic, Ms. Jerome-Parks called Tamara Weir-Bryan, a longtime friend from Toronto with nursing experience. Something was not right, she said. Then, as Ms. Weir-Bryan tells it: "She called me again, in agony, 'Please believe me. His face is so blown up. It's dreadful. There is something wrong.' "

At Ms. Jerome-Parks's suggestion, Ms. Weir-Bryan said she called the hospital, identified herself as a nurse and insisted that someone check on Mr. Jerome-Parks. If anything was done, it was not enough.

The next day, the hospital sent a psychiatrist to speak to Ms. Jerome-Parks, according to the hospital. A couple of hours later, her husband received yet another round of radiation.

Overdosed on Radiation

The Times has pieced together this account of what happened to Mr. Jerome-Parks largely from interviews with doctors who had been consulted on the case, six friends who cared for and comforted him, contemporaneous e-mail messages and Internet postings, and previously sealed government records. His wife declined to be interviewed about the case, as did Ms. Kalach, the medical physicist, and representatives of Aptium, Varian and St. Vincent's.

In a statement, the hospital called the case an "unfortunate event" that "occurred as a result of a unique and unanticipated combination of issues."

On the afternoon of March 16, several hours after Mr. Jerome-Parks received his third treatment under the modified plan, Ms. Kalach decided to see if he

was being radiated correctly.

So at 6:29 p.m., she ran a test to verify that the treatment plan was carried out as prescribed. What she saw was horrifying: the multileaf collimator, which was supposed to focus the beam precisely on his tumor, was wide open.

A little more than a half-hour later, she tried again. Same result.

Finally, at 8:15 p.m., Ms. Kalach ran a third test. It was consistent with the first two. A frightful mistake had been made: the patient's entire neck, from the base of his skull to his larynx, had been exposed.

Early the next afternoon, as Mr. Jerome-Parks and his wife were waiting with friends for his fourth modified treatment, Dr. Berson unexpectedly appeared in the hospital room. There was something he had to tell them. For privacy, he took Mr.

Jerome-Parks and his wife to a lounge on the 16th floor, where he explained that there would be no more radiation.

Mr. Jerome-Parks had been seriously overdosed, they were told, and because of the mistake, his prognosis was dire.

Stunned and distraught, Ms. Jerome-Parks left the hospital and went to their church, a few blocks away. “She didn’t know where else to go,” recalled Ms. Leonard, their friend.

The next day, Ms. Jerome-Parks asked two other friends, Nancy Lorence and Linda Giuliano, a social worker, to sit in on a meeting with Dr. Berson and other hospital officials.

During the meeting, the medical team took responsibility for what happened but could only speculate about the patient’s fate. They knew the short-term effects of acute radiation toxicity: burned skin, nausea, dry mouth, difficulty swallowing, loss of taste, swelling of the tongue, ear pain and hair loss. Beyond that, it was anyone’s guess when the more serious life-threatening symptoms would emerge.

“They were really holding their breath because it was the brain stem and he could end up a paraplegic and on a respirator,” Ms. Giuliano said.

Ms. Lorence added: “I don’t really think they expected Scott to live more than two months or three months.”

The group was told that doctors were already searching for tips on how to manage what promised to be a harrowing journey not only for the patient and his family, but also for the physicians and staff members involved in his care.

The full investigation into why Mr. Jerome-Parks had received seven times his prescribed dose would come later. For now, there was nothing left to say.

As Dr. Berson rose to leave the room, Ms. Lorence noticed that his back was soaked in sweat.

A Warning Goes Unheeded

Rene Jn-Charles remembers where he was and how she looked on that joyful day — his wife, Alexandra, the mother of their two young children, in brown jeans and a brown top, standing in front of him at the corner of Lincoln Place and Utica Avenue in the Crown Heights neighborhood of Brooklyn.

“Babes,” she said. “I have no cancer. I am free.”

Her doctor had called with the good news, she said. A seemingly unbearable weight had been lifted. Now after breast surgery and chemotherapy, she faced only radiation, although 28 days of it.

Ms. Jn-Charles had been treated for an aggressive form of breast cancer at a hospital with a very different patient profile from the one selected by Mr. Jerome-Parks. Unlike St. Vincent’s, on the edge of Greenwich Village, the Downstate Medical Center’s University Hospital of Brooklyn is owned by the state and draws patients from some of Brooklyn’s poorer neighborhoods.

Ms. Jn-Charles’s treatment plan also called for a linear accelerator. But instead of a multileaf collimator, it used a simpler beam-modifying device called a wedge, a metallic block that acts as a filter.

In the four years before Ms. Jn-Charles began treatment, 21 accidents in New York State were linked to beam-modifying devices, including wedges, records show.

On April 19, 2005, the day Ms. Jn-Charles showed up for her first radiation treatment, state health officials were still so worried about what had happened to Mr. Jerome-Parks that they issued an alert, reminding operators of linear accelerators “of the absolute necessity to verify that the radiation field is of the appropriate size and shape prior to the patient’s first treatment.”

In legal papers before she died, Ms. Jn-Charles explained how the radiation therapist had told her not to worry. “It’s not painful — that it’s just like an X-ray,” she said she was told. “There may be a little reaction to the skin. It may break out a little, and that was basically it.”

‘A Big Hole in My Chest’

For a while, all seemed well. Then, toward the end of therapy, Ms. Jn-Charles began to develop a sore on her chest. It seemed to get worse by the day. “I noticed skin breaking out,” she would later say. “It was peeling. It started small but it quickly increased.”

When Ms. Jn-Charles showed up for her 28th and final treatment, the therapist took her to see Dr. Alan Schulsinger, a radiation oncologist. “He just said that they wouldn’t give me any radiation today, and he gave me the ointment and stuff and said go home and come back in a couple of days,” Ms. Jn-Charles said.

A couple of days later, she returned. “More skin was peeling off, and going down into the flesh,” Ms. Jn-Charles said. Once again, she was told to go home and return later.

On June 8, 2005, the hospital called her at home, requesting that she come in because the doctors needed to talk to her. Fourteen days after her last treatment, the hospital decided to look into the possible causes of her injury, hospital records show.

It did not take long. The linear accelerator was missing a vital command — to insert the wedge. Without it, the oncology team had been mistakenly scalding Ms. Jn-Charles with three and a half times the prescribed radiation dose during each session.

At the hospital, doctors gave her the bad news, and later sent a letter to her home. “I am writing to offer our deepest apologies once again for the devastating events that occurred,” Dr. Richard W. Freeman, chief medical officer, said in the June 17 letter. “There is now a risk of injury to your chest wall, including your skin, muscle, bone and a small portion of lung tissue.”

Ms. Jn-Charles had been harmed by a baffling series of missteps, records show.

One therapist mistakenly programmed the computer for “wedge out” rather than “wedge in,” as the plan required. Another therapist failed to catch the error. And the physics staff repeatedly failed to notice it during their weekly checks of treatment records.

Even worse, therapists failed to notice that during treatment, their computer screen clearly showed that the wedge was missing. Only weeks earlier, state health officials had sent a notice, reminding hospitals that therapists “must closely monitor” their computer screens.

“The fact that therapists failed to notice ‘wedge OUT’ on 27 occasions is disturbing,” Dr. Tobias Lickerman, director of the city’s Radioactive Materials Division, wrote in a report on the incident. The hospital declined to discuss the case.

The overdose resulted in a wound that would not heal. Instead, it grew, despite dozens of sessions in a hyperbaric oxygen chamber. Doctors tried surgery. The wound would not close. So they operated a second, a third and a fourth time. In one operation, Ms. Jn-Charles’s chest wall was reconstructed using muscle from her back and skin from her leg.

“I just had a big hole in my chest,” she would say. “You could just see my ribs in there.”

She saw herself falling away. “I can’t even dress myself, pretty much,” she said. “I used to be able to take care of my kids and do stuff for them, and I can’t do these things anymore.”

Her husband remembers one night when the children heard their mother crying. They came running, frightened, pleading: “Tell me, Daddy, what happened to Mommy? Say she’s O.K., she’s O.K.”

For more than a year, Ms. Jn-Charles was repeatedly hospitalized for pain and lived with the odor of her festering wound. Meanwhile, her cancer returned with a vengeance.

Several months after her wound had finally healed, she died.

No Fail-Safe Mechanism

The investigation into what happened to Mr. Jerome-Parks quickly turned to the Varian software that powered the linear accelerator.

The software required that three essential programming instructions be saved in sequence: first, the quantity or dose of radiation in the beam; then a digital image of the treatment area; and finally, instructions that guide the multileaf collimator.

When the computer kept crashing, Ms. Kalach, the medical physicist, did not realize that her instructions for the collimator had not been saved, state records show. She proceeded as though the problem had been fixed.

“We were just stunned that a company could make technology that could administer that amount of radiation — that extreme amount of radiation — without some fail-safe mechanism,” said Ms. Weir-Bryan, Ms. Jerome-Parks’s friend from Toronto. “It’s always something we keep harkening back to: How could this happen? What accountability do these companies have to create something safe?”

Even so, there were still opportunities to catch the mistake.

It was customary — though not mandatory — that the physicist would run a test before the first treatment to make sure that the computer had been programmed correctly. Yet that was not done until after the third overdose.

State officials said they were told that the hospital waited so long to run the test because it was experiencing “a staffing shortage as training was being provided for the medical physicists,” according to a confidential internal state memorandum on the accident.

There was still one final chance to intervene before the overdose. All the therapists had to do was watch the computer screen — it showed that the collimator was open. But they were not watching the screen, and in fact hospital rules included no specific instructions that they do so. Instead, their eyes were fastened on Mr. Jerome-Parks, out of concern that he might vomit

into the mask that stabilized his head. Earlier, he had been given a drug known to produce nausea, to protect his salivary glands.

Government investigators ended up blaming both St. Vincent's, for failing to catch the error, and Varian, for its flawed software.

The hospital said it "acted swiftly and effectively to respond to the event, and worked closely with the equipment manufacturer and the regulatory agencies."

Timothy E. Guertin, Varian's president and chief executive, said in an interview that after the accident, the company warned users to be especially careful when using their equipment, and then distributed new software, with a fail-safe provision, "all over the world."

But the software fix did not arrive in time to help a woman who, several months later, was being radiated for cancer of the larynx. According to F.D.A. records, which did not identify the hospital or the patient, therapists tried to save a file on Varian equipment when "the system's computer screen froze."

The hospital went ahead and radiated the patient, only to discover later that the multileaf collimator had been wide open. The patient received nearly six times her prescribed dose. In this case, the overdose was caught after one treatment and the patient was not injured, according to Mr. Guertin, who declined to identify the hospital.

"The event at the hospital happened before the modification was released," he said.

Mr. Guertin said Varian did 35 million treatments a year, and in 2008 had to file only about 70 reports of potential problems with the Food and Drug Administration.

Accidents and Accountability

Patients who wish to vet New York radiotherapy centers before selecting one cannot do so, because the state will not disclose where or how often medical mistakes occur.

To encourage hospitals to report medical mistakes, the State Legislature — with the support of the hospital industry — agreed in the 1980s to shield the identity of institutions making those mistakes. The law is so strict that even federal officials who regulate certain forms of radiotherapy cannot, under normal circumstances, have access to those names.

Even with this special protection, the strongest in the country, many radiation accidents go unreported in New York City and around the state. After The Times began asking about radiation accidents, the city's Department of Health and Mental Hygiene reminded hospitals in July of their reporting obligation under the law. Studies of radiotherapy accidents, the city pointed out, "appear to be several orders of magnitude higher than what is being reported in New York City, indicating serious underreporting of these events."

The Times collected summaries of radiation accidents that were reported to government regulators, along with some that were not. Those records show that inadequate staffing and training, failing to follow a good quality-assurance plan and software glitches have contributed to mistakes that affected patients of varying ages and ailments.

For example, a 14-year-old girl received double her prescribed dose for 10 treatments because the facility made a faulty calculation and then did not follow its policy to verify the dose. A prostate cancer patient was radiated in the wrong spot on 32 of 38 treatments, while another prostate patient at the same institution received 19 misguided treatments — all because the hospital did not test a piece of equipment after repairs.

In March 2007, at Clifton Springs Hospital and Clinic in upstate New York, a 31-year-old vaginal cancer patient was overradiated by more than 80 percent by an inexperienced radiotherapy team, putting her at risk for a fistula formation between the rectum and vagina. Afterward, she received antibiotics and treatments in a hyperbaric oxygen chamber.

In 2008, at Stony Brook University Medical Center on Long Island, Barbara Valenza-Gorman, 63, received 10 times as much radiation as prescribed in one spot, and one-tenth of her prescribed dose in another. Ms. Valenza-Gorman was too sick to continue her chemotherapy and died of cancer several months later, a family member said. The therapist who made those mistakes was later reprimanded in another case for failing to document treatment properly.

The therapist not only continues to work at the hospital, but has also trained other workers, according to records and hospital employees. A spokeswoman for Stony Brook said privacy laws precluded her from discussing specifics about patient care or employees.

Other therapists have had problems, too.

Montefiore Medical Center in the Bronx fired a therapist, Annette Porter, accusing her of three mistakes, including irradiating the wrong patient, according to a government report on June 1, 2007. Ms. Porter retains her license.

"We know nothing about that person — zero," said John O'Connell, an associate radiologic technology specialist with the State Bureau of Environmental Radiation Protection, the agency that licenses technologists.

Montefiore declined to comment. Ms. Porter, through her lawyer, denied making the three mistakes.

Fines or license revocations are rarely used to enforce safety rules. Over the previous eight years, despite hundreds of mistakes, the state issued just three fines against radiotherapy centers, the largest of which was $8,000.

Stephen M. Gavitt, who directs the state's radiation division, said if mistakes did not involve violations of state law, fines were not proper. The state does require radiotherapy centers to identify the underlying causes of accidents and make appropriate changes to their quality-assurance programs. And state officials said New York had taken a leadership role in requiring that each facility undergo an external audit by a professional not connected to the institution.

Two years ago, the state warned medical physicists attending a national conference that an over-reliance on computer programs might be leading to mistakes, including patient mix-ups. "You have to be ever-vigilant," Mr. O'Connell said.

The state imposed no punishment for the overdoses of Mr. Jerome-Parks or Ms. Jn-Charles. The city levied fines of $1,000 against St. Vincent's and $1,500 against University Hospital of Brooklyn.

Irreparable Damage

Mr. Jerome-Parks needed powerful pain medicine soon after his overdose.

Yet pain was hardly the worst of it. Apart from barely being able to sleep or swallow, he had to endure incessant hiccupping, vomiting, a feeding tube, a 24-hour stream of drugs and supplements. And apart from all that, he had to confront the hard truth about serious radiation injuries: there is no magic bullet, no drug, no surgery that can fix the problem.

"The cells damaged in that area are not reparable," Ms. Jerome-Parks reported to friends in an e-mail message shortly after the accident. National radiation specialists who were consulted could offer no comfort. Hyperbaric oxygen treatments may have helped slightly, but it was hard to tell.

"He got so much radiation — I mean this was, in the order of magnitude, a big mistake," said Dr. Jerome B. Posner, a neurologist at Memorial Sloan-Kettering who consulted on the case at the request of the family. "There are no valid treatments."

Though he had been grievously harmed, Mr. Jerome-Parks bore no bitterness or anger.

"You don't really get to know somebody," said Ms. Leonard, the friend from church, "until you see them go through something like this, and he was just a pillar of strength for all of us."

Mr. Jerome-Parks appreciated the irony of his situation: that someone who earned a living solving computer problems would be struck down by one.

He grew closer to his oncologist, Dr. Berson, who had overseen the team that caused his injury. "He and Dr. Berson had very realistically talked about what was going to happen to him," said his father, James Parks.

Ms. Jerome-Parks, who was providing her husband round-the-clock care, refused to surrender. "Prayer is stronger than radiation," she wrote in the subject line of an e-mail message sent to friends. Prayer groups were formed, and Mass was celebrated in his hospital room on their wedding anniversary.

Yet there was no stopping his inevitable slide toward death.

"Gradually, you began to see things happening," said Ms. Weir-Bryan, the friend from Toronto, who helped care for him. "His eyes started to go, his hearing went, his balance."

Ms. Giuliano, another of the couple's friends, believed that Mr. Jerome-Parks knew prayer would not be enough.

"At some point, he had to turn the corner, and he knew he wasn't going to make it," Ms. Giuliano said. "His hope was, 'My death will not be for nothing.' He didn't say it that way, because that would take too much ego, and Scott didn't have that kind of ego, but I think it would be really important to him to know that he didn't die for nothing."

Eventually the couple was offered a financial settlement, though it was not a moment to celebrate because it came at a price: silence. With neither of them working and expenses mounting, they accepted the offer.

"I cried and cried and cried, like I'd lost Scott in another way," Ms. Jerome-Parks wrote in an e-mail message on April 26, 2006. "Gag order required."

Now, the story of what happened to Mr. Jerome-Parks would have to be told by his doctors and the hospital, neither of which were part of the settlement. The identities of those who settled were not revealed.

"He didn't want to throw the hospital under the bus," Ms. Leonard said, "but he wanted to move forward, to see if his treatment could help someone else."

Dr. Caruana, the physician who had recommended surgery over radiation, added: “He said to let people know about it.”

Friends say the couple sought and received assurances that his story would be told.

Mr. Jerome-Parks’s parents were in Gulfport in February 2007, waiting for their house to be rebuilt after it was destroyed by Hurricane Katrina, when they got the news that their son had died.

Afterward, they received a handwritten note from Dr. Berson, who said in part: “I never got to know any patient as well as I knew Scott, and I never bonded with any patient in the same way. Scott was a gentleman who handled his illness with utmost dignity, and with concern not only for himself but also for those around him.”

He ended by saying: “I commit to you, and as I promised Scott, everything we learned about the error that caused Scott’s injury will be shared across the country, so that nobody else is ever hurt in this way. On a personal level, I will never forget what Scott gave me.”

Dr. Berson no longer treats patients, said Dr. Josh Torgovnick, a neurologist who helped care for Mr. Jerome-Parks after the accident. “It drove him to retire,” he said, referring to the fatal overdose. The hospital disputes that, saying Dr. Berson still sees patients at the hospital.

Dr. Berson did not respond to several messages seeking an interview about the case. Citing privacy concerns, a spokesman for St. Vincent’s, Michael Fagan, said neither the hospital nor Dr. Berson would grant an interview.

In July, Mr. Jerome-Parks’s father stood across from the beach in Gulfport where his son’s friends had scooped up the sand they sent for his final Christmas.

“He taught us how to die,” Mr. Parks said. “He did it gracefully and thoughtfully and took care of everything. Most of us would lose it. He didn’t. He just did everything that he had to do, and then he let himself die.”

Mr. Parks said he had thought about starting a campaign to make medical mistakes public — but he never did. Nothing would ever come of it, he concluded.

Simon Akam, Andrew Lehren, Dan Lieberman, Kristina Rebelo and Rebecca R. Ruiz contributed reporting.

A version of this article appears in print on January 24, 2010, on page A1 of the New York edition with the headline: A Lifesaving Tool Turned Deadly.
