

Peter Almond, PhD

Interview Navigation Materials

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Interview Information:

One session: 4 June 2004

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Interviewer: James S. Olsen, PhD [also present, Lesley Brunet, MA, CA]

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Interview Subject Snapshot:

Name: Peter Almond, PhD

Interviewed: 2004

Primary appt:

Research: Radiation physics

Admin: Head of Section of Radiation Physics

Other:

Interview link:

About the Interview Subject

Nuclear physicist Peter Almond, PhD (retired) was on the faculty of MD Anderson from 1965 to 1985. He served as head of the radiation physics section and directed the cyclotron unit.

This interview was conducted by James S. Olsen, PhD in order to collect background information on radiation therapy for his book, "Making Cancer History." Dr. Almond discusses technical details of radiation and radiation therapy and discusses the evolution of this treatment method at MD Anderson under Dr. Gilbert Fletcher.

Major Topics Covered:

The history of radiation therapy; how radiation therapy works; instruments for delivery of therapy; how therapy has an impact on tumors and patients

The evolution of radiation therapy at MD Anderson

View of Gilbert Fletcher; Fletcher's attitudes to aggressive treatment; his impact on standards of care nationally

Debates between MD Anderson surgeons and radiation therapists regarding treatment

Long term consequences of radiation therapy on patients

Cost effectiveness of radiation treatments

About transcription and the transcript

This interview had been transcribed according to oral history best practices to preserve the conversational quality of spoken language (rather than editing it to written standards).

The Archives may have redacted portions of the transcript and audio file in compliance with HIPAA and/or interview subject requests.

Peter Almond, PhD

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Chapter 01: *Radiation Therapy: A Brief History and Basic Principles*

Overview; Definitions, Explanations, Translations; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; Patients, Treatment, Survivors;

Chapter 02: *Cobalt-60 and the Evolution of Radiation Therapy at MD Anderson*

Devices, Drugs, Procedures; Overview; Definitions, Explanations, Translations; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; Patients, Treatment, Survivors;

Chapter 03: *The Race to Build a Cobalt-60 System and Why it Was Key to MD Anderson's Reputation*

Overview; Definitions, Explanations, Translations; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; The MD Anderson Brand, Reputation; Patients, Treatment, Survivors;

Chapter 04: *Gilbert Fletcher's Impact on Radiation Therapy*

Building the Institution; Portraits; Overview; Definitions, Explanations, Translations; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; The MD Anderson Brand, Reputation; Patients, Treatment, Survivors; MD Anderson Impact;

Chapter 05: *Developing Radiation for 'the Oxygen Effect' in Tumors*

Overview; Portraits; Definitions, Explanations, Translations; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The

History of Health Care, Patient Care; Technology and R&D; The MD Anderson Brand, Reputation; Patients, Treatment, Survivors; MD Anderson Impact; Industry Partnerships;

Chapter 06: Assessing Aggressive Radiation Treatment, Cost Effectiveness and Proton Therapy

Overview; Definitions, Explanations, Translations; Multi-disciplinary Approaches; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; The MD Anderson Brand, Reputation; MD Anderson Culture; Patients, Treatment, Survivors; Industry Partnerships;

Chapter 07: Surgery vs. Radiation Therapy; Long-Term Complications with Radiation Therapy

Overview; Definitions, Explanations, Translations; Multi-disciplinary Approaches; MD Anderson History; Understanding Cancer, the History of Science, Cancer Research; The History of Health Care, Patient Care; Technology and R&D; MD Anderson Culture; Patients, Treatment, Survivors;

Peter Almond, Ph.D.

INTERVIEWER: James S. Olson, Ph.D., and Lesley W. Brunet, MA, CA

DATE: June 4, 2004

PLACE: Research Medical Library Conference Room, University of Texas M. D. Anderson Cancer Center, Houston, Texas

Chapter 01

Radiation Therapy: A Brief History and Basic Principles

A: Overview;

Codes

A: Overview;

A: Definitions, Explanations, Translations;

B: MD Anderson History; B: MD Anderson Snapshot;

D: Understanding Cancer, the History of Science, Cancer Research;

D: The History of Health Care, Patient Care;

D: Technology and R&D;

C: Patients; C: Patients, Treatment, Survivors;

[Tape 1 of 2, Side A]

James S. Olson, Ph.D.

One of the first things, I'm interested in the evolution of some of just the equipment. We start off with sort of the external beam equipment, and I guess also for my own knowledge, what the difference between a linear accelerator is and a Cyclotron, an x-ray machine, what the advantages or disadvantages of protons and neutrons, electrons, those technical kinds of questions. So we'll start off with sort of the evolution of external beam.

Peter Almond, Ph.D.

As you know, x-rays were discovered by accident, but shortly after that, people started making x-ray tubes, which have electrons start the one side and go across and hit a target and produce the x-ray.

James S. Olson, Ph.D.

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Is this a cathode?

Peter Almond, Ph.D.

Yes, but within the X-ray tube, you have to apply a high voltage across the tube to accelerate the electrons to hit the target and then produce the X-rays. With development, you can get the voltage across the tube up to about two hundred, three hundred thousand volts, and the higher the voltage, the faster the electrons go and the higher the X-rays that come out. Now, the reason you want high-energy X-rays is that the higher the energy, the more they penetrate into the body. In the early days when it was very low voltage on the tubes, the X-rays produced essentially would go into the body and would penetrate, but they would very rapidly lose their intensity. So you couldn't put much radiation dose deep in the body. All of it would be at the surface.

James S. Olson, Ph.D.

Therefore there would be more damage at surface tissues?

Peter Almond, Ph.D.

Of course, if the tumor was there, that's where you want to put the radiation energy, but you had to go through the surface and then the surface got a higher energy.

In those days, radiation therapy was limited by the skin dose, and people got arethemas [?] and skin reactions very, very severe in those days of radiation therapy. It was all limited by the skin reactions, I mean how much dose you could put it at because the radiation went through. But clearly so, if you could get more radiation going deeper and deeper, then you could spare the skin. But up to about two hundred, three hundred thousand electron volts was about on a regular basis what you could do with regular X-rays tubes.

Now, there were some special tubes made that went up higher. One or two were built, but they were just too difficult and large and cumbersome. But for the normal sort of X-rays used in treatment, two hundred and fifty to three hundred thousand electron volts were used. But even at that energy, you would get about 50 percent of the dose at about six or seven centimeters in. So you can see 100 percent on the surface and only 50 percent at six or seven centimeters. You were, again, really limited by how much dose the skin would tolerate.

Now, you could try using the radiation coming in from different directions to meet in the middle. You can do that, but even if you lost 50 percent by six or seven centimeters into the body, people are thicker than that, and so even using beams coming from different directions, it's a problem. So one really wanted to go in higher energy to get more penetration, but the X-ray machines for doing that just really cannot be built, at least not successfully and not on a regular basis. So that sort of took us up to about World War II when those machines were . . . and shortly thereafter with those kinds of energy.

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It was people like [physicist Leonard G.] Grimmett and others who thought, Now if we could find a radioactive material that had a gamma ray which was the same as the x-rays but a much higher energy, maybe that can be used. Grimmett, before the war, had in England built a number of external treatment machines using radium, but radium had a lot of disadvantages. One, is it's very expensive. Two, you had to get a lot of it to put into a unit to use for external beam, and they were never successful. They were extremely dangerous in many ways, too much radium around, and that didn't seem to work.

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Chapter 02

Cobalt-60 and the Evolution of Radiation Therapy at MD Anderson

B: Devices, Drugs, Procedures;

Codes

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Peter Almond, Ph.D.

But cobalt 60 seemed to be promising, because it had a high-energy gamma ray coming out of it. The average energy was over a million volts, so that's a big advantage. The other thing that happens when you go to the higher energies, when you deposit energy with a radiation beam in the patient, the X-rays interact, set in motion the electrons, and it's the electrons that deposit the energy. Now, if your X-rays are low energy, the electrons coming off are fairly low energy and they don't go any distance. If you're up in higher energy, you set electrons in motion with quite a lot of energy, which go in a forward direction and deposit their energy downstream. By the time you get to cobalt 60 energies, it takes about half a centimeter or so for the radiation dose to meet its maximum in the body. So the skin dose now is maybe 50 percent of what the maximum dose is, which is a half a centimeter. Then the dose, let's say, ten centimeters could be 50 percent, 60 [percent].

So you do two things. You put the radiation dose deeper into the body, and at the same time, you spare the skin. Radiation reactions with cobalt 60 are much less than with the old x-ray machines. Old x-ray machines in that range, a hundred to two hundred KEV were called ortho-voltage, and you'll see that term. It's ortho-voltage therapy and ortho-voltage machines. We had a whole suite here of ortho-voltage machines when I first came. As I say, it was the skin dose that limited the treatment. Cobalt 60 immediately sort of said, "Well, skin dose is going to be far less," which it was clinically. It was still there, but it was far less, and you're putting the radiation much deeper.

The second thing is with the cobalt 60, you could get enough of it in terms of its activity to put in the machine so the output was high enough and so that you could do this. Radium just didn't put out. You know, you didn't get enough radium to really have the treatments over a short-enough

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time. Cobalt 60, you could get enough cobalt into the unit. Treatment times were a reasonable length. Because you had enough radiation, you could move the patient about eighty centimeters to a hundred centimeters from the source, so you had a nice little distance between the source and the patients. There are various reasons you want to do that, but about a meter is about the optimum from the source, and you could get to that with cobalt 60. So cobalt 60 looked like having a lot of advantages, and Grimmett and others in the development of the cobalt 60 immediately allowed you to do a lot of things you couldn't do.

If that was true, if you went from, say, 250,000 electron volts to one million electron volts, it could up now to ten, twenty million electron volts, really start, because now the skin dose really gets very, very low. The maximum dose is about several centimeters into the body. By the time the 50 percent dose is sixteen centimeters into the body, you can really start to put a lot of radiation dose into deep-seeded tumors, and you're not limited by any skin reaction whatsoever. Difficulty is getting the twenty million electrons for your x-ray machine.

One of the first sort of possibilities for that was a device called the Betatrons, in which magnetic induction is used. It's somewhat like a transformer. You have electrons going around in a circular motion inside a tube, which has got a vacuum in it. It looks like a great big doughnut and was, in fact, called the doughnut. It was about so wide [gestures]. If you changed the magnetic field while these electrons were going around, you can induce them to a going energy, and you're changing the field and their energies increase and the radius of their motion stays the same. If you time things just right, you can get them going around many, many times picking up energy every time they go around, and you can get out to energies of twenty million and maybe even more.

A fellow by the name of [_____] Vitereau [?] in Switzerland had this idea many years before the war. Dr. [_____] Kurston [?], University of Illinois, during the war sort of developed these. I think they had implications for sort of X-raying big pieces of equipment, clearly had some sort of military applications here. At the University of Illinois, they realized that they could generate these electrons, they could strike a target, form the X-rays, and these X-rays were very high-energy X-rays. They suddenly realized that if you can make those X-rays, there's obviously a medical application here.

In fact, they had a graduate student on the program who had a brain tumor, and they got a local radiologist to treat him with these X-rays, so that's how that got started. So people realized there was an application here, and right after the war a number of companies, in particular Allis Chalmers in this country and another company in Europe, decided, well, maybe this was an application to be used in treatment of cancer. So betratrons were built for that purpose. We got one here.

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In fact, when Grimmett came in '49 and '50, he was already talking to the people about getting a Betatron, and they were already making plans for that. It didn't come until the new hospital was ready, but it came about that time. We had an old Allis Chalmers 22MEV Betatron, and it's great advantage was you could put more dose deeper. There was no skin reaction, so you could treat deep-seated tumors. This was why [Gilbert H.] Fletcher used it primarily for external treatment of cervix cancers. He developed a box technique, one fueled from the front, one from the back, one each from either side, and cross-fired them. The trouble with the Betatron was it was fairly low output. The treatments took longer than one would like.

James S. Olson, Ph.D.

In terms of the time it took?

Peter Almond, Ph.D.

Yes. The output was around, on a good day, perhaps sixty rads a minute. Today we'll run machines at four hundred rads a minute. But back then, your expectations were not as high, so you could get it. It was very noisy, because it had a frequency that produced a lot of noise. It was a big, big machine. It was not particularly easy to use; limited motion with the machine, but there was some. Anyhow, clearly, 20 MEV X-rays were a great advantage. So Anderson had the cobalt and they had the 20 MEV, those two machines.

The drawbacks of the Betatron were that they were big machines, they did have low output, and if you wanted to use the electrons directly, and people were beginning to think about, well, we use electrons to produce X-rays, what'll happen if we just use the electrons themselves? It's very, very difficult to get the electrons out of a Betatron. Can be done, and we had one machine here called the Siemens Betatron, which did it, but it was not particularly easy. We tried to get rid of the old Allis Chalmers Betatron, but you've got electrons which are charged with an electrical charge going around in a magnetic field, and the magnet field makes them go around in a circular motion, and that magnetic field is there. Now, if you want to get them out going straight, it's very difficult unless you've got time, somehow or other, to make the electrons think the magnetic field isn't there and come on out. But they would never come out straight. They would always be curved, and it was just a mess. Betatron inherently has the problem, low output, you can't get the electrons out, fairly big machine.

At the same time, you can accelerate electrons in a straight line if you get them in an appropriate electromagnetic field. What happened during the war, of course, when radar got developed, they became very interested in producing very strong sources of electromagnetic radiation, which is what radar is, I guess. So two devices were developed, the Magnetron and the Klystron. Magnetron generally is European and came out of England, and the Klystron out of the United States, but these were two devices which produced enough power in the electromagnetic radiation to have good radar installations. People knew that if you could take that electromagnetic radiation, put it into a linear structure, which is designed with a series of cavities

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along it, if you did that just right, you could introduce electrons at one end along with the electromagnetic radiation. The electrons would ride the electric and then they'd get radiation down to the other end, picking up energy as they went down these little cavities, and come out with high energies at the other end. Because it was linear, they were called linear accelerators.

So you put in electromagnetic radiation at one end, along with electrons, and you run them down these cavities, and they were circular cavities put end to end all the way down. You can either use Magnetrons or Klystrons. People started to build some linear accelerators. When you first do something, you find out all the problems with it. But certainly you can do this, and now the electrons are going straight. So you can either take the electrons out and they'll still go straight until you bend them with a magnet, or they can hit a target and produce X-rays.

James S. Olson, Ph.D.

What's our timing, linear accelerators now, date-wise?

Peter Almond, Ph.D.

This happened right after World War II. I mean, linear accelerators and Betatrons have about the same period of birth, if you like. Certainly, for medical practices, we're still talking in the 1940s, 1950s, I mean, the history of it.

Now, Betatrons are relatively simple machines. There wasn't much to them, they're just big, and if you could build them, you could build them and get good X-rays. Linear accelerators are complicated machines. There are a lot of systems, electromagnetic radiation. You've got to produce the electrons. You've got to keep a high vacuum there. They've got to be kept at the right temperatures, just multiple systems in linear accelerators. To get all of these working right just together took a long time to develop, and so the early linear accelerators for medical purposes although they worked, were not too reliable or successful.

James S. Olson, Ph.D.

Dr. [Luis] Delclos told me that even when we used them here they still broke down a lot.

Peter Almond, Ph.D.

He might have thought so. [laughs] It's very important in medical applications that you know what your up time is and what kind of percentage of running time you had. You get anything below 90 percent, and you're in trouble, and we would keep ours running. But certainly, they would break down. You don't want them to break down at the critical time, so high reliability. Linear accelerators are difficult to get a very high . . . Until you've really worked out all the . . . So it took a lot longer.

We did not even go out for . . . You know, we got the first Betatron here in '54, the next one in

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'60. It was ten years later, we started in '69 or '68, thinking about getting linear accelerators. So it took us ten years or more before even we thought about linear accelerators, and we wrote a request for a proposal for a linear accelerator in about '69, and the bids came in and Raytheon [Corporation] got the bid. They worked with the French company to build this device. The French had built one or two. This was the machine that the accelerating part was in a room this long [gestures], with two stationary sections, and it went through the wall into a big rotating gantry. You may have been treated on that machine, but I think you were probably treated on a next-generation machine, ultimately.

James S. Olson, Ph.D.

What I remember now is 1970 when the Tenth Congress was here, and we really wanted to get that installed by then.

Peter Almond, Ph.D.

Yes, that's right, we did. We put that in, and these machines could go up to, if you wanted, thirty-five million electron volts. We ran ours, again, at about twenty-million electron volts, but it enabled us to get not only high-energy X-rays out, which Fletcher wanted, but it enabled us to get electrons out. The nice thing about electrons is they do just treat the surface. But because you could change the energy of the electrons, we could treat tumors right on the surface or a centimeter deep or two-centimeters deep or three-centimeters deep, we could vary. With electrons, there's no dose beyond where you deposit their energy for the treatment. They just stop. X-rays keep going right through the body. So with X-rays, you end up giving a total dose to the patient very low, but nevertheless much more tissue gets irradiated with X-rays.

As you know, some people wonder whether that then causes later on second tumors. That's been looked at extensively here, and I'm not sure there's much evidence for it. Marilyn Stovall is the person that is the expert in this institution now about second tumors due to levels of radiation, and she's looked at it. I haven't talked to her recently about the results.

But the electrons go to the surface tumors for chest walls, for example, after mastectomies where you may have a centimeter of tissue. You've got lung underneath it. Lung, of course, is extremely sensitive to radiation. You overdose it, you get necrosis and fibrosis and whatever, fibrosis of the lung. So you would like the radiation to treat the chest wall, but not go into the lung. Electrons allow you to do that. When we got the electron beam, Norah [D.] Tapley was still alive, and Fletcher. We developed the techniques for treating the chest wall with electrons and sparing the lung underneath, and electrons allowed you to do that. We did a lot of those treatments, I can tell you, and set up a whole ten weeks' worth. It also allowed you, even the super clav and the internal mammary with the electrons, because we could just put the dose where we wanted it, we put the electrons. For things like on your hand and stuff like that, it's ideal, because you could just go down whatever length you wanted the electrons in, and it would

spare the other side of the body, whatever part you're talking about.

So anyhow, linear accelerators sort of came along. They were slower in developing because they're much more complex than them, but they have a much greater potential. They have higher output. You can get a much larger radiation field with them than with the Betatrons. The Betatrons are also limited to how big the field, this dimension, and you've got some parts of the body you want big fields. So I would say during the seventies when there were a lot of Betatrons around and there were still some Betatron companies selling Betatrons, the linear accelerator companies started to really refine the design and reliability of the linear accelerators. In particular, Varian [?], which is an American company, built a slow-energy linear accelerator. Accelerating structure was about a foot long, and it accelerated up to four million volts and became a replacement, really, for cobalt 60. The 4 and 6 MEV linear accelerators eventually have become so reliable, much greater sort of capabilities that cobalt 60 no longer is being used in the United States. One or two places around the world in sort of developing countries use cobalt 60 because it is cheaper.

The trouble with cobalt 60 is every five years you've got to change the source out, and that's expensive. Cobalt 60 decays at a half-life of five years, up until five years. After you've used it for about five years, the output gets so low that treatments get too long and the replacement sources cost a lot of money. Secondly, you've got to have a licensed person come in and do it without creating a radiation problem. So cobalt 60 after, sort of forty years of use, finally sort of replaced linear accelerators. It's linear accelerators are safer and might have some other things about them which make them superior to cobalt 60, it's just [?].

But Varian, they first came out with the 4 MEV linear accelerator, which was very successful, just X-rays, didn't use electrons, but the high output, and that became a very useful machine. They also started to produce some higher energy machines, out, too, and eventually had one that went to thirty-five, but that was really too big and didn't have [?]. But as the linear accelerators came along, Betatrons slowly disappeared, and by the late 1980s, I suspect, all the Betatron companies were out of business. There was nothing wrong with their radiation, the machines just weren't competitive with the linear accelerators, and so they disappeared.

But the linear accelerators do produce the same kind of radiation. They do produce electrons more efficiently, do produce X-rays, outputs. You can have almost any output you like, so I'd say we ran it about 400 rads per minutes for X-rays. You could go higher, but then there's a little danger to have it too high, and so treatments are short. Then it allows you to do all the modern things that are done with linear accelerators now, because you can put collimators on them that are multi-leaf in shape and fields just to the shape. They're no longer rectangle fields. You know, they've got these fingers that shape the field, and so if you want any shape field, and then that shape can move during the treatment since it's computer controlled.

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So you can sort of change the shape, you can rotate these linear accelerators around the patient while the treatment's going on while the shape of the field is changing, and at the same time, you can change the intensity of the radiation coming on, so that what you do now is then it's called Intensity Modulated Radiotherapy, IMRT. You simply rotate the beam around while doing it. You really sort of focus all the radiation onto the tumor, not in terms only of position, but the shape of the tumor. You can do that, and if it's close to critical structures, you can shape the radiation so that it misses the critical structures and put the radiation right where you want it.

When you consider where we were sort of when linear accelerators and all of this started to where we are today, it really is amazing. Computers have obviously made this all possible.

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Chapter 03

The Race to Build a Cobalt-60 System and Why it Was Key to MD Anderson's Reputation

B: Overview;

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A: Overview;

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B: The MD Anderson Brand, Reputation;

C: Patients; C: Patients, Treatment, Survivors;

[Tape 1 of 2, Side B]

James S. Olson, Ph.D.

The next generation of biological therapies, they hope, will do the same somehow? Not radiotherapy, but chemotherapy, just sort of deliver these drugs systemically anywhere that you can somehow get them to the tumor itself, that same kind of notion?

Peter Almond, Ph.D.

Yes. But the interesting thing is now with radiation therapy if you've got a tumor that's sort of close or wrapping around the spinal cord, there was no way in the past to treat that because if you go through the spinal cord. It's fairly sensitive. You're limited by a dose. Otherwise you're going to cause paralysis. But now you can sort of get the radiation to sort of just wrap around the spinal cord and spare it. It's quite amazing what they can do.

Because these are high-energy X-rays that are being used, the skin dose is low, there's no problem with high-skin doses and radiation burns of the skins. There might be a little reddening, I suppose, but generally even that's gone today. Things have changed a lot. So that's why we went through the Betatron and into the linear accelerators. The Betatrons came along first. They were easier to build, and it wasn't sure right at the beginning whether Betatrons or linear accelerators were the way to go. Most people started at the Betatrons and went over to linear accelerators. The cobalt 60, again, just got replaced by very efficient and reliable linear accelerators, and when you turn a linear accelerator off, it's off. But when you've got a cobalt unit [laughs]—

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James S. Olson, Ph.D.

Oh, it's never off.

Peter Almond, Ph.D.

It's always emitting and you've got to have the right kind of shielding and protection and all kinds of things. Regulatory people don't like those types of things, so they've almost disappeared completely. There are a few around, not in this country, I don't think.

James S. Olson, Ph.D.

Why did that cobalt 60 bring such sort of fame to Fletcher?

Peter Almond, Ph.D.

First of all, they were amongst the first people to first have the idea and then produce a working machine. As you know, the big competition was whether we were first or whether Harold Jones and the people in Canada were first in doing it. In fact, it was simultaneous. I don't think there was any doubt that Harold Jones had this idea. I knew Harold very well, and he developed Betatrons also. He was a visionary and he saw the use of both of these and he saw cobalt 60 and designed units. The Canadians were producing more cobalt 60s than we were, so he had that advantage. That's where we got slowed up, but Grimmett and Fletcher both, I think, saw that cobalt 60 was an ideal isotope to put into a treatment machine, and there wasn't anything else at that time.

This is really before Betatrons. The idea was there but they hadn't really been developed. Linear accelerators were just slow at getting along. And Grimmett, if you read his paper that he published here, his idea was he saw this as a low-cost device that could be put anywhere and be available to anybody throughout the world. This was something that there wasn't a lot of technology involved once it was built, but it was simple to run, simple to operate, inexpensive in many ways, and so he saw this as sort of opening up radiation oncology to a lot of people.

James S. Olson, Ph.D.

Did it?

Peter Almond, Ph.D.

Oh, yes, it did. I mean it really did. So the race was on to build one, and Grimmett's design was a very, very good design. It's just that we couldn't get the cobalt 60 for it soon enough because of politics between Canada and the United States and other things and it wasn't there. But certainly, Grimmett published the first design for the cobalt unit before anybody else and just didn't get it loaded with cobalt soon enough. But it was built here, went into operation here, and was in use here, and proved the concept. It was then mainly the Canadians, Atomic Energy of Canada, Limited.

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As you know, we had an arrangement with G.E. [General Electric] to build the first unit here, and G.E. then went into an arrangement with the Canadians to sort of build units. That didn't last very long and G.E. got out of business and then the Canadians really took over. A company called Atomic Energy of Canada, Limited, which was a tran company, eventually, was the one that ended up building them.

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Chapter 04

Gilbert Fletcher's Impact on Radiation Therapy

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B: MD Anderson Impact; C: MD Anderson Impact;

Peter Almond, Ph.D.

Then the next generation of the cobalt unit was the cobalt unit F, and people used to say the F stood for Fletcher. Whether it did or not, I don't know, but that's the next generation of it, which rotated around the patient, which was all the way around the patient, which allowed you to . . . Stups were easier and you could do rotational treatments and things like that. Fletcher had a lot to do with that unit, and it was un use here for a long time. But it really made fairly inexpensive treatment machines available for anyone.

Certainly, what happened was then they built hundreds of these units and they went in all over the place. Treatments were far superior to the ortho-voltage machines, because there was no skin reaction, very little skin reaction. So it opened up radiation oncology in lots of lots of places, and eventually, of course, where it's gone to is into developing countries. You go to a lot of Central America, South America, India, places like that, who could afford a cobalt unit or two where they couldn't afford anything else. So that made that available. Certainly, it was known that part of the development was done here. I think, in terms of the treatment with cobalt units, certainly Fletcher sort of developed a lot of those and got known for that.

James S. Olson, Ph.D.

Do those regimens sort of spread with the machine?

Peter Almond, Ph.D.

Yes. You used to be able to tell an Anderson trained radiation oncologist by how they treated patients, because it was the way Fletcher would treat. And there would be the people from Stanford [University] and there was the Stanford treatments. And Stanford never went with

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cobalt units. They always stuck with linear accelerators. They had one form of treatment. And there was the Memorial treatment. Very much the approach to treatment became—

James S. Olson, Ph.D.

What was the Memorial treatment?

Peter Almond, Ph.D.

Oh, I don't know. It was certainly probably different fractionations, different dose levels, and that type of thing that got developed.

But certainly, I think the development of the cobalt 60 was Fletcher's. But at the same time, because by the time we got the cobalt here was when this building opened, the original building, of course, was opened. They moved the cobalt unit in shortly thereafter, and the Betatron, and so Fletcher was doing both at the same time.

James S. Olson, Ph.D.

This is in '54?

Peter Almond, Ph.D.

This is in the late fifties. They started in '54. I think he sort of developed both treatments, and in many ways his treatment with the high-energy X-rays got him a lot of notoriety, because not many people had that energy and he was really advocating it. When we got the first linear accelerator, his instructions to me were produce the beam from that Betatron on the new linear accelerator. That's essentially when he said. He said, "I've got this beam out of the Betatron. I want the same beam out of the linear accelerator. Make sure I get it." So that's what we had to do. We had to work with the manufacturer, and we matched the betans for it. That's what he wanted.

Again, then, in the seventies, it became a fairly well publicized sort of controversy between Anderson and a lot of other places, because Fletcher was saying you've got to have at least twenty-million electron volt X-rays, and there were a lot of people using ten to fifteen MEV, and he just said that's not high enough. He got into some pretty good arguments with manufacturers and other people about what was the right energy to use. That's disappeared today because of this intensity modulated radiation therapy. You can do those with six MEV X-rays. You don't need the high-energy X-rays anymore. So we've sort of passed through the cobalt era into the linear accelerators and Betatrons and then the very high-energies. That era has just about disappeared because of the techniques that have made them obsolete, how you can use lower-energy machines to do, and there are certain advantages of using lower-energy X-rays.

When you produce very high-energies, about fifteen MEV X-rays, and the old Betatron and the linear accelerators were about that energy, you produced neutrons, and they're not particularly

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nice to have around. They take a lot of shielding and also some danger for patients to get whole-body neutron doses, so we've always worried about that here.

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Chapter 05

Developing Radiation to Address the "Oxygen Effect" in Tumors

B: Overview;

Codes

C: Portraits;

A: Overview;

A: Definitions, Explanations, Translations;

B: MD Anderson History; B: MD Anderson Snapshot;

D: Understanding Cancer, the History of Science, Cancer Research;

D: The History of Health Care, Patient Care;

D: Technology and R&D;

B: The MD Anderson Brand, Reputation;

C: Patients; C: Patients, Treatment, Survivors;

B: MD Anderson Impact; C: MD Anderson Impact;

B: Industry Partnerships;

Peter Almond, Ph.D.

Now, you wanted to know about neutrons and Cyclotrons.

James S. Olson, Ph.D.

Yes.

Peter Almond, Ph.D.

This goes back to Hermann's suit and hyperbolic oxygen. I'm trying to think of the timescale for this. Anyhow, certainly in maybe the fifties, but probably the sixties, it was known that cells that were anoxic, that is they were not in an oxygen atmosphere, were about three times more radio resistant than cells that were in oxygen or had oxygen supplied to them. You could say that the other way. If you have oxygen there, the cells are more sensitive to radiation. Low oxygen, they're resistant to radiation. It's well known and was documented during that period that in the center of solid tumors where the blood vessels have been pushed out, the cells right in the middle will die due to lack of oxygen. There's a necrotic center to tumors. They're just unviable.

But right around the edge of that anoxic, necrotic center, if you have one, there are cells, which are starved from oxygen, but they're still viable. You try and treat those with radiation. You may kill all of the tumor cells on the outside, which have a good oxygen supply, but you may not kill the cells right in the center that have no oxygen. It's called the oxygen effect, and there's a factor of about three round of radiation. So people started to think, "How can we get over the oxygen thing?" That's why they put them in the hyperbolic oxygen chamber, pumped them up,

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hoped the oxygen would get through and diffuse a little. There were reasons to think that it could work, but there a lot of reasons to think that it shouldn't work, but it was tried and it didn't work. But a number of people found that, in fact, if you were radiated with neutrons rather than electrons or X-rays, the cells and the oxygen effect disappeared. So the killing mechanism was a little different. With neutrons, instead of it being a factor of three, it's a factor of 1.3. So it's a slight difference, but not nearly as much of a difference. So the argument went if we could use neutrons, we could kill all of the cancer cells and maybe we could improve cure rates.

It was tried in the 1940s out in California by a man by the name of [_____] Stone. It was tried in England in Hammersmith Hospital. One of the difficulties is that neutrons are very damaging to tissue, and especially if there is any kind of fat content there, because they interact with the protons in the fat and you get a lot of solid fibrosis with neutrons, a lot of normal tissue damage, that you don't want. An initial trial out in [University of California at] Berkeley had sort of come to a screeching halt because the complications are too high, there's just too much fibrosis in normal tissues. But they were using low-energy neutrons, and one thought that maybe one should try that and see. This was in the late 1960s.

Then Texas A&M built a great big Cyclotron in the late 1960s, and we approached Texas A&M and said would they be interested in a joint project. If we could take a beam line off of their Cyclotron, very high energies, and make neutrons with it, we would get high-energy neutrons, much higher than the people at Berkeley had had, and we would like to see whether we could try neutron therapy. So we had a joint agreement with Texas A&M to develop the program out there, built one. One research area there we turned into a treatment area, and they sort of bused the patients up twice a week. It turns out with neutrons, the fractionation, how many times you give treatments, is not as critical as it is with X-rays. So you could go twice a week without sort of giving out.

James S. Olson, Ph.D.

Instead of every day?

Peter Almond, Ph.D.

Instead of every day. Eventually what we did, we mixed the neutrons with X-rays, which seemed to work very well. Anyhow, that trial, that program, seemed to work. We could certainly get rid of the tumors. The long-term event complications seemed to be less, and so it was decided we can't continue to take patients up there and staff up there and run these two limousines. There was the day the wheel came off the limousine. We were driving along and the wheel took off down the road. Never knew what was going to happen, that was a fairly . . .

James S. Olson, Ph.D.

Who was in the limousine when that happened, which one of you?

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Peter Almond, Ph.D.

I wasn't there. Dave Fossiard [?] . I forget who was the physicist at that time. It wasn't my day on.

Lesley W. Brunet, MA, CA

Was it a bus or a limousine that you went on?

Peter Almond, Ph.D.

Limousine.

James S. Olson, Ph.D.

With the patients.

Lesley W. Brunet, MA, CA

The patients went up on a limousine.

Peter Almond, Ph.D.

Yes, and so did the staff.

James S. Olson, Ph.D.

So did the physicists.

Peter Almond, Ph.D.

Physicists and radiography, we would cram into this limousine. We'd have a driver drive up. We eventually ended up with an apartment or two at A&M, and so several people stayed up there.

Anyhow, that pilot project seemed to work, so we decided we would see whether we would get a Cyclotron here at Anderson and went to NCI [National Cancer Institute] and got funding for one.

A Cyclotron, instead of accelerating electrons, which all the other devices do, accelerates charged particles. We ended up accelerating deuterons, which is a proton and a neutron together.

It's the nucleus of a deuteron, take the electron off, because if deuterium at high energies hits a beryllium target, it will produce neutrons, and these are fairly high-energy neutrons, gives a nice sort of distribution like the distribution out of a linear accelerator for high-energy X-rays. So it was probably better than cobalt 60 in terms of the distribution and depth of penetration.

We went to the Cyclotron corporation in Berkeley that had built one or two sort of Cyclotrons, and they were willing to build us a Cyclotron to be housed in a hospital. Memorial had a Cyclotron up in New York for production of isotopes, but not for . . . The only other hospital

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based Cyclotron was at Hammersmith Hospital in England where they were doing neutron therapy. They claimed a lot of success.

James S. Olson, Ph.D.

There's so much hoopla about it when it happens, and then it seems to die off, to me.

Peter Almond, Ph.D.

Well, it did, and the problem. We eventually got the Cyclotron, we got it operational, we put it in the basement here, and treated a lot of patients with it. What we found out, I think, in the long run was what the initial study had found out, although we could cure patients, the long-term complications were just too high.

James S. Olson, Ph.D.

Because of the tissue damage?

Peter Almond, Ph.D.

Tissue damage, it just, just was not acceptable. As I say, we tried a regimen of part neutrons and part X-rays, which seemed to help. Some people continued a little longer than we did, and there may have been one or two sites that might have been useful and could have been treated by neutrons, but you really couldn't justify the expense. It's a fairly expensive process. The machine was expensive, keeping it operational was expensive, produces a lot of unwanted radioactivity, so health success-wise.

Anyhow, it was a project that needed to be tried. We did the pilot study. It seemed to work and got the Cyclotron here and then treated a lot of patients on it. But as those were followed out, [?] just disproved. I think also what's happened, the other technologies and the other forms of radiation therapy have really sort of improved and improved so that you can get the dose to the tumors that you want. In some cases, with intensity-modulated radiation therapy, you can go up to doses half as high again as you used to be able to go. That's a significant increase, and hopefully the tumor.

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Chapter 06

Assessing Aggressive Radiation Treatment, Cost Effectiveness and Proton Therapy

B: Overview;

Codes

C: Portraits;

A: Overview;

A: Definitions, Explanations, Translations;

B: MD Anderson History; B: MD Anderson Snapshot;

D: Understanding Cancer, the History of Science, Cancer Research;

D: The History of Health Care, Patient Care;

D: Technology and R&D;

B: The MD Anderson Brand, Reputation;

C: Patients; C: Patients, Treatment, Survivors;

B: MD Anderson Impact; C: MD Anderson Impact;

B: Industry Partnerships;

Peter Almond, Ph.D.

Now, the big arguments that you always get are: are you sure you're doing any good?

James S. Olson, Ph.D.

The bottom line question, is it?

Peter Almond, Ph.D.

No one's ever shown that you've improved survival rates and all of that, and I always sort of say to those people, "All right. You know, your question is whether we should pour all this money into all these fancy new treatments and whether it's worth it and whether we're going to improve survival rates, if you are unfortunate enough to ever need the services of a radiation oncologist, I'll give you a choice. Do you want to be treated how they were treating forty years ago or how they're treating today?" And then the argument's over, you see. Things are better and, in fact, survival rates are better. It's very hard, but it's the incremental, the small ones. But what's better is the complication rates are much, much lower, treatments are much more safer and much more precise, much better given. It's just better over all, so it's not.

Hopefully, as you follow these down through . . .

James S. Olson, Ph.D.

That, to me, seems sort of true of surgery, of chemotherapy, that some of the major gains have

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been in sort of preserving the survival rate with less damage.

Peter Almond, Ph.D.

That's right. That's a good deal. As I see it, for cancer treatment, it's there. As I said, Fletcher was known for being really aggressive and that he was going to be aggressive with cancer. He was willing, and, of course, it was the patient that paid the price. He was willing to say, "I'm going to be aggressive." I think he told the patients, "We're going to be aggressive. There's going to be a certain probability that you will have some complications." But he always felt that tradeoff was worth it.

If you had that attitude, could get pretty good cancer control, then you can slowly make sure the complications get less, and you're much better off. You start off sort of not accepting the complications, I don't think you ever sort of move forward, because you don't have the complications. Very often, you sort of hear people sort of say . . . They get treated for cancer with radiation if they're with a radiation oncologist that is not aggressive, so they make sure the patient doesn't get a complication. There used to be a lot of private radiation oncology, and I think it's less and less. What happened is the patient would get treatment, wouldn't get any complications, wouldn't get any skin reaction. They got treated and maybe felt better for a little while, and then the cancer would come back. That was always, "Well, that's just the nature of cancer," or that's an act of God or something.

Take the same patient, had they gone to an aggressive radiation oncologist where the patient gets some complications and the skin reactions, the patient will come out and say, "Well, I got burned up by that radiation oncologist," and it's all the radiation oncologist's fault, even though they may be cured of their cancer. So you have those sort of two extremes. Fletcher pushed the envelope in aggressive treatment even though he had the complications.

James S. Olson, Ph.D.

Didn't I just hear a story in the news about a survey of oncologists who don't give enough of the dose because they want to reduce the side effects?

Peter Almond, Ph.D.

That's always the idea. It's been around for a long time, and it's still as popular for chemotherapy as it is for radiation oncology.

James S. Olson, Ph.D.

Right.

Peter Almond, Ph.D.

Certainly, if you get out into the small sort of community of radiation oncologists, and if you get in then, of course, the trouble is medical liability and lawsuits are the problem. We've always

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been very fortunate here because, I think, the documentation and radiation and then quality control and assurance have always been very, very careful. So I think for small independent people it's difficult to do.

Anyhow, it looks to me now as though this question of the oxygen effect with neutrons has gone away. Some people would try to alter that ratio with sensitizers, chemical sensitizers were tried, chemical protectors were tried, hyperbolic oxygen was tried, and then suits, tourniquet technique, anoxic treatments were tried. So all them, but eventually, I suppose, it will eventually come down to some molecular treatment of radiation or other. I'm not involved with it. I think there is some interaction between some people who work on the molecular level and radiation to see whether those can converge a little bit, which they probably will at some point. \$\$

James S. Olson, Ph.D.

What about all the hoopla about proton therapy? I think I just heard an ad from Loma Linda University the other day.

Peter Almond, Ph.D.

Proton therapy takes advantage only of the physical distribution of the radiation. There's no sort of trying to manipulate the radiobiology of the tumor cells or anything of that. Protons, again, are charged particles. They tend to go into the body, and at the end of their range create a lot of ionization so the dose suddenly goes up. So they go in, and the dose increases at the end and then stops, so the protons have stopped.

If you can send in a number of protons with different energies, where you will go and radiation will give off their energy and stop, and you can sort of build up so they go in and sort of you could cover the tumor with dose, because you've chosen the energies to go in and some to stop at the front of the tumor, some at the end of the tumor. Used to think there was some biological advantage to protons, but there are not. But they are, and you can very precisely now choose these energies. You can again choose the dose to go very precisely around the tumor. No dose behind, no dose to the side, you tend to get very high doses just to the tumor.

In fact, Loma Linda was one of the first. They were not the first. The Russians have been doing it for a long time and the Swedish have tried it. But on a sort of poor scale sort of thing and on their own, Loma Linda did this. They sort of went out and got their funding built their device. Then Mass[achusetts] General, Hermann Suit [?], one of his great contributions was he always thought protons should be tried at Mass General. Then, of course, M. D. Anderson decided to get in it.

I will have to say this, that I'm not sure what the clinical results are today. Loma Linda should

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have results. They've been treating long enough. Certainly for things like prostate and things, I think they should do very well. Mass General has treated some eye tumors, because you could send them into the front of the eye and deposit the dose right on the retina and nothing else. They do that.

The trouble with protons are the machines that accelerate the protons are very, very expensive. Protons are difficult to bend, so they come out of the machine in a straight line, but to use them you've got to bend them onto the patient and then move then around. So the devices to do that become very big because they take very high magnetic fields to do that, and so the gantries that move around the patients are huge. You need to go over to our proton facility sometime and see them. It's a very big engineering project to do that.

Lesley W. Brunet, MA, CA

Let's stop [while I put in a new tape].

[Tape 2 of 2, Side A]

James S. Olson, Ph.D.

Say that again for the record.

Peter Almond, Ph.D.

Of course. It seems to me that in cancer therapy, nothing's a sure thing when you go into it. I think, one, is cancer is a complex disease, and it's always very difficult to know whether that the theories that you put forth to treat it whether they're right or not.

James S. Olson, Ph.D.

Among you physicists then are there sort of inside jokes about this, that it may go the same way the Cyclotron did?

Peter Almond, Ph.D.

Well, no, but there are camps. Obviously there are camps. There are people who will say protons are the way to go because we can now really put very high doses where we want to put them, very low dose elsewhere in the body, and so this is the way to go, and less expensive if we can set it up so we treat a lot of patients and average the cost out. It may not be as expensive as we think it is. There are others who say the modern techniques now with the computer controlled linear accelerators and intensity modulated radiation therapy [?] calumniators and the devices called tomotherapy, which is another device which uses low-energy X-rays, there are people that say with X-rays and with these modern approaches, we can almost approach the same kind of thing that protons. So there are people that are in all these different camps. The cost of the protons is very expensive. But if it does prove out and there can be one or two national

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centers for some sites, maybe it's worth it. Again, I think it just has to be tried. I don't think it needs to be tried everywhere. Loma Linda's a good place, and I've known that group for many, many years. I think they're doing a good job. But you wouldn't want to go to a much smaller place. You don't want to put it in. You've got to go to the M. D. Andersons and the Mass General and say, "Let's see what we can get with proton therapy."

I will say this, for example, on the neutrons, which was an expensive program, took a lot of time to do, but we learned as much about conventional radiation therapy from that project as we did about almost anything else. So we learned a lot, which helped what we're doing today. We learned some radiation biology, we learned some physics, we learned things about fractionation and other stuff, which are still important today. So the modern programs start, neutron therapy did them okay. The knowledge that we got out of it has certainly been very helpful today, and that will come out of the proton project. Whether it's really successful or not, we'll learn a lot that will be applied in the future. That's just the way one does things.

But it is a big project, it's certainly on paper, and you never start out any of these projects without at least theoretically seeing a good advantage. That's why you do it and hope that your theories and your ideas and things are right.

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Chapter 07

Surgery vs. Radiation Therapy; Long-Term Complications with Radiation Therapy

B: Overview;

Codes

A: Overview;

A: Definitions, Explanations, Translations;

B: Multi-disciplinary Approaches;

B: MD Anderson History; B: MD Anderson Snapshot;

D: Understanding Cancer, the History of Science, Cancer Research;

D: The History of Health Care, Patient Care;

D: Technology and R&D;

B: MD Anderson Culture;

C: Patients; C: Patients, Treatment, Survivors;

James S. Olson, Ph.D.

Do you remember when they dismantled the Cyclotron?

Peter Almond, Ph.D.

No, I wasn't here, but I . . .

Lesley W. Brunet, MA, CA

I want to [?], because you said something about as you went forward as the treatments come out, the long-term complications got too high, what period was this?

Peter Almond, Ph.D.

It's certainly five, ten, fifteen years. So we started neutron therapy in the late sixties, I think here, with A&M, for example. So we've now got a very long experience. Of course, the Cyclotron went out in the late 1980s. That program was stopped maybe in the 1990s, but anyhow, it's been over ten years. So now we've got those follow-ups. But we treated for a long time.

But certainly, even after two or three years on certain patients, you could tell the complications were going to be more severe. I will say this: They were no more severe than some of the complications forty years ago, X-ray treatments which at times could be very, very severe.

James S. Olson, Ph.D.

Of an untreated tumor?

Peter Almond, Ph.D.

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That's the problem. What's the alternative? Or of surgery. Surgery can result in a lot of complications and difficulties.

What Fletcher always used to say about radiation therapy, very often the known complications, he would very often know that there would be sort of not a way out, but at least you could deal with the complication either with surgery or some other form of treatment. So for him, it was let's try this, and if you get a complication, then we can deal with that surgically, rather than go ahead surgically and do it first. Your quality of life might be better. So I think you always have to look at that and say, "Well, let's try this." The complications, you know, I think the quality of life is going to be better. If you have complications, for example, he would, with the head and neck people, one of his big arguments, they'd get a larynx tumor in and the surgeons always wanted to take the larynx out. Fletcher knew he could treat it and save the voice box.

James S. Olson, Ph.D.

Then they can speak the rest of their life.

Peter Almond, Ph.D.

They can speak for the rest of their life and they could swallow for the rest of their life and all the rest of it. That's why he used to get, in some of the cases, so upset because there were the complications of the surgery. Sure, they were cured of the cancer. Quality of life was just terrible, and he said, "You know, I can treat them. I'll have cure rates that are 90-something percent, and for the 10 percent, we can go back and do the surgery." Whereas the surgeons, that was way back when, wanted just to go ahead and do the operation. It was in those areas that we would really have some [unclear] discussions.

James S. Olson, Ph.D.

I've seen some letters, yes.

Peter Almond, Ph.D.

I've seen his staff in tears, literally in tears. It was interesting.

Lesley W. Brunet, MA, CA

[Inaudible] tears, screaming at them?

Peter Almond, Ph.D.

Yes, or just so upset at the animosity and the fights that would go on in the clinics. Not in front of the patients. But he wouldn't mind stating what he thought.

James S. Olson, Ph.D.

He also seemed worried, too, very often that somehow they didn't refer enough patients to him

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for him to sustain his studies.

Peter Almond, Ph.D.

That was the other thing, and I don't know what it's like now, but way back then you would put in and enter into a national trial on the sort of promise that you would get so many patients to treat, and when that didn't happen, then he would get very upset. That happened on a lot of cases and to some extent on the neutrons also because patients had to be entered into the trials. There was a national neutron trial going on and we had to submit patients and the head and neck and breast was always a problem. He used to get upset because he couldn't get patients to do studies. That was the fight between the surgeons, and then when the chemotherapists came along, that was just you'd have was a three-way fight going on for the patients.

James S. Olson, Ph.D.

How about Felix [N.] Rutledge, in Gynecology? Did he get along better with Fletcher?

Peter Almond, Ph.D.

Oh, yes, he and Felix were very good friends, yes. He and [William S.] MacComb had an excellent . . . there were people that Fletcher got along very well with and there were people who he didn't get along very well with and there were people that learned to get along with him even though it was difficult. Now, Felix was a very good friend of his, yes, and would work very closely with him.

Lesley W. Brunet, MA, CA

He's still alive, isn't he?

James S. Olson, Ph.D.

Rutledge? I don't think so. I think he died.

Peter Almond, Ph.D.

I don't know.

Lesley W. Brunet, MA, CA

I think I'm getting him mixed up with [Marvin M.] Romsdahl.

James S. Olson, Ph.D.

Romsdahl's still alive.

Peter Almond, Ph.D.

Romsdahl's still alive.

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James S. Olson, Ph.D.

I see him in the library here, big, tall fellow.

We're getting close to three o'clock for your wife there.

Peter Almond, Ph.D.

Yes. Okay.

James S. Olson, Ph.D.

Perfect. Thank you very much.

Peter Almond, Ph.D.

Give me a call if you need anything else.

James S. Olson, Ph.D.

I don't know. I'm trying to think of something.

Peter Almond, Ph.D.

I'm in and out like you are, and I don't have any sort of set duties. So it's not. . . .

Lesley W. Brunet, MA, CA

You're doing a lot of work in the history [?] lab.

Peter Almond, Ph.D.

Yes, but I'm just doing that and writing some things. I will have some teaching responsibilities in the fall, but that's not going to take too much time.

End of Tape 2 of 2 and Interview 1

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