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IN THE SUPERIOR COURT OF WASHINGTON FOR KING COUNTY

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MONICA NICOLE WILSON and KAY M. WILSON, as GUARDIAN OF MONICA NICOLE WILSON, KAY M. WILSON and DAVID R. WILSON,

Plaintiffs,

v. Case No. 87-2-20931-8

OVERLAKE HOSPITAL MEDICAL CENTER, INC., a Washington corporation, and STIG ANDERSEN and JANE DOE ANDERSEN, husband and wife, and their marital community, STIG B. ANDERSEN, M.D., INC. G.P., and JOHN DOE INDIVIDUALS 1-20, and JOHN DOE CORPORATION,

Defendants.

DEPOSITION OF A. JAMES BARKOVICH, M.D.

Friday, July 26, 1991

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Reported by:
CAROL A. KAREN
CSR NO. 8189

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BE IT REMEMBERED THAT, pursuant to Notice of taking Deposition, and on Friday, July 26, 1991, commencing at the hour of 10:00 a.m. of the said day, at the offices of the deponent at 505 Parnassus Avenue, Rm L-371, San Francisco, California, before me, CAROL A. KAREN, certified court reporter in the State of California, personally appeared,

ANTHONY JAMES BARKOVICH, M.D.

called as a witness by the defendant, who being by me first duly sworn, was thereupon examined and interrogated as herein set forth.

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LOPEZ & FANTEL, 1510-14th Avenue, Seattle, WA 98122, by CARL A. TAYLOR LOPEZ, ESQ., appeared as counsel on behalf of the plaintiff.

HOUGHER, MILLER & STEIN, 200 West Thomas Street, Suite 580, Seattle, WA 98119-4289, by MARY K. McINTYRE, appeared as counsel on behalf of the defendant.

ALSO PRESENT: LAURA MOYER, VIDEO OPERATOR

VIDEOTAPE OPERATOR: The date is July 26, 1991. The time is approximately 10:05. We are located at the offices of U.C.S.F. Medical Center Long Hospital at 505 Parnassus Avenue, San Francisco, California. We are taking the deposition of Dr. James Barkovich in the matter of Wilson versus Overlake Hospital Medical Center, Case No. 87-2-20931-8 on behalf of Mary McIntyre.

My name is Laura Moyer. I represent March Productions, which is located at 12 Shell Road, Mill Valley, California 94941. The telephone number is (415) 383-3306.

At this time I would like to ask the persons present to introduce themselves for the record. Please state your name, the firm you are working for, the location of the firm, and who you are representing in this matter.

MS. McINTYRE: I'm Mary McIntyre. I represent Overlake Hospital Medical Center. My law firm is Hougher, Miller & Stein, and I am from Seattle, Washington.

MR. LOPEZ: I am Carl Lopez. I am from the law firm Lopez & Fantel. I represent Monica Wilson, one of the plaintiffs.

VIDEOTAPE OPERATOR: Will the court reporter please swear in the witness, Dr. Barkovich?

(Witness sworn.)

VIDEOTAPE OPERATOR: Dr. Barkovich, are you aware that this deposition is being videotaped?

THE WITNESS: Yes.

VIDEOTAPE OPERATOR: Thank you.

ANTHONY JAMES BARKOVICH, M.D.,

having been first duly sworn, testified as follows:

EXAMINATION BY MS. McINTYRE:

MS. McINTYRE: Q. Good morning, Dr. Barkovich. Would you tell us your full name and give us your business address, please?

A. My name is Anthony James Barkovich. My address is Neuroradiology Section, University of California, San Francisco, in San Francisco.

Q. All right, and is that on Parnassus Avenue?

A. Yes, 505 Parnassus Avenue, and our mailing address is Box 0628, and our zip code is 94143.

Q. Thank you, Dr. Barkovich. What is your occupation and special area of practice?

A. My occupation is physician, and I am a pediatric neuroradiologist.

Q. All right. Now, what does your specialty of pediatric neuroradiology involve?

A. Well, radiology is a specialty that involves imaging and X-rays. It started out with just X-rays,

x-rays of various parts of the body, and recently, as we have gotten more and more technological, special studies such as ultrasound and computed thermography, better known as CAT scans, and more recently magnetic resonance scanning.

Neuroradiology is a specialty that focuses on doing those studies looking at the brain and spine, the nervous system, and what a pediatric neuroradiologist does is focus even further on diseases that specifically affect children and the manifestations of diseases on the pediatric brain and pediatric spine, and it's important to make that distinction because children get different diseases --

THE REPORTER: Excuse me. Can we go off?

VIDEOTAPE OPERATOR: The time is 10:10 and we are going off the record.

(Discussion off the record.)

VIDEOTAPE OPERATOR: The time is approximately 10:15 and we are back on the record.

MS. McINTYRE: Q. All right, Dr. Barkovich, we are back on the record after resolving our technological problems here. Why is it important to make a distinction between the focus of a pediatric neuroradiologist as contrasted to a regular neuroradiologist?

A. The difference lies in the fact that the

pediatric brain is really different than the adult brain. It's not fully developed yet, so the response to injury is different, the response to infection is often different, the infections kids get are -- tend to be different, and because the brain is immature it looks different than an adult brain on sophisticated imaging scans, and *so* you have to be aware of how the brain develops and at what stage of development it is in order to really make an accurate reading of the studies.

Q. **All** right. Dr. Barkovich, would you tell us about your current practice today as a pediatric neuroradiologist? Give us an idea of some of the things that you do.

A. Okay. Well, what we do here in pediatric neuroradiology, we're constantly doing studies on patients with pediatric neurological disease, kids with brain tumors, kids with strokes, kids with funny infections, or very commonly kids with funny neurological symptoms that are difficult to explain, and what we'll do is various types of imaging studies, whether it be an MR scan, or a **CT** scan, or an ultrasound, or sometimes an invasive procedure such as a myelogram or an arteriogram where you actually inject dye into the patient to visualize certain spaces and use that information to try to come up with a diagnosis, and it turns out that certain disease processes cause specific patterns of damage.

And by seeing the pattern of damage you can zero in on certain types of disease processes, and often it's very helpful in making a diagnosis, and then once you make the diagnosis, of course, you can hopefully treat, and if you can't treat, you can determine whether it's a genetically transmittable disease, which is to say you can -- it's very important in counseling the parents as to whether -- you know, what the chances are that they are going to have another child with this kind of problem if they do have more children.

So those are the kinds of things we do, and my day is spent doing these studies, evaluating these studies, talking with clinicians, pediatricians, pediatric neurologists, pediatric neurosurgeons, geneticists, talking with them about their patients, what the problems are, and trying to advise them what would be the best study to do, and sometimes just looking at studies, maybe a child is referred here from another hospital that already has an MR scan, or a **CT** scan, or an angiogram, and so I will go over those studies with the clinician and determine if they were adequate, and if they were adequate what we can learn from them, what they tell us.

Q. All right. Do you regularly review MR scans then taken of infants and children?

A. Oh, yes.

Q. Now, when did doctors first start using MR

scans?

A. Well, the first prototype scanners came into use around 1980, but the first clinical in-house scanners didn't really show up until about 1983. Those are the very earliest scanners.

Q. Have you been continuously reviewing MR scans of infants and children since 1983?

A. Yeah, about -- we actually didn't start doing any kids probably until '84.

Q. All right.

A. But I was at this institution when the first MR scanner went in in November of '83.

Q. And can you give us any idea, Dr. Barkovich, of how many MR scans you have reviewed of infants or children during your career?

A. I have no idea.

Q. Would it be thousands?

A. Yeah, I think that's fair to say. I probably review 50 a week.

Q. All right.

A. You can kind of guess, you can calculate what that adds up to over a number of years.

Q. Okay. What about cranial ultrasounds, do you also routinely review those in your practice?

A. Yes.

Q. And if I asked you the same question, how many

of those have you done?

A. The answer would probably be similar.

Q. Okay. Do you have any academic appointments, any teaching responsibilities currently?

A. Yeah, well, part -- one of the main parts of my job is teaching. I'm the head of the neuroradiology fellowship here at U.C.S.F., and we have actually eight fellows this year who are learning radiology and part of my job is to teach the fellows.

Any time -- basically, any time I'm reviewing a scan I have a fellow there, and I point out different things to him. I also give a formal conference every Tuesday morning from 9 to 10 which is attended by the pediatric neurologists, pediatric neurosurgeons, pediatricians, pediatric radiologists, as well as neuroradiologists, actually, the pediatric ophthalmologists usually come, too.

And we go over cases, and that's -- you know, I stand up in front and go over the cases and make teaching points, and we have discussions about the various patients. Usually, they are current clinical cases in the hospital as well as maybe scans that were sent either to me or to the neurologist or to the neurosurgeons from outside institutions for review.

Q. All right. Now, are you an associate professor of radiology, pediatrics, neurology and neurological

surgery here at the University of California at San Francisco?

A. Yes.

Q. And do you have teaching responsibilities in all of those areas?

A. Yeah, I need to -- I need to clarify that because basically I do radiology. I don't do pediatrics, I don't do neurology, I don't do neurological surgery, but I have appointments in all of those departments because I do teach all of their residents.

I mean it's important for neurologists, pediatric neurologists to know something about pediatric neuroradiology. It's important for the pediatric neurosurgeons to understand pediatric neuroradiology, it's important for the pediatricians. Because I hold conferences for all of them and attend their conferences, they were nice enough to honor me with appointments in their departments.

Q. All right. So basically, you would be teaching resident doctors in those departments the basic aspects of pediatric neuroradiology, the things that you look for in these studies?

A. Yes, that's right.

Q. Now, you mentioned that you were director of the pediatric neuroradiology fellowship training program?

A. Actually, the neuroradiology fellowship training

program, yeah.

Q. Okay. Now, what is a fellowship training program?

A. Well, what it -- there are different levels of training in medicine, and everyone goes to undergraduate school, to college, and then you go to medical school which is usually four years, then you do an internship which is a year of training, then you specialize, and that's called a residency, and residencies can be anywhere from three years -- for example, pediatrics is a three-year residency, to I think six years is neurosurgery, and then some people choose to -- after they finish their residency training, to subspecialize, and you do that by fellowship training, and what that is is one or two years of -- I guess, some fellowships are actually three years -- of very intensive study of a particular field.

And so what a neuroradiology fellowship is is two years of very intensive training of doing nothing but neuroradiology, and it entails very long hours and lots of weekends, and we hope that at the end of your two years you're an expert in your subspecialty.

Q. All right, and you're the director of that fellowship training program in neurology then here?

A. Neuroradiology, yeah.

Q. At the -- neuroradiology at the University of

California?

A. Yes.

Q. What are your responsibilities as a director of that program?

A. Well, it's basically setting up a curriculum, and I don't do it all by myself. We do it as -- the faculty does it together. We decide what conferences we want to hold, how many conferences, when we're going to hold them, who's going to speak about what at the conferences, where the -- how the fellows should rotate among the various places that our fellows go, how much time they should spend in each place, how many conferences they should prepare as part of their learning experience, and then it's also part of my job to every three months collect evaluations from all the other attendees and then sit down with each fellow and tell them whether we think they are doing okay, or if they are a little weak here, need to really brush up on it, so I have to sort of keep an eye on everybody and make sure that they are progressing the way we want them to progress.

Q. All right. Now, do you have the fellows in the training program actually look at scans and studies with you?

A. Yeah, absolutely. What we try to do is have them look at them first and make up their mind, rather than just sort of come hopping along for the ride, if you

will. So we will have them look at all the studies and then we will sit down with them and ask them what they think and, depending on how well they do, spend various amounts of time instructing them on that particular case.

Q. All right. Now, do you give -- do you have a weekly teaching session of neurology in pediatric residents?

A. Yeah, I think I just mentioned that, that we have a weekly pediatric neuroradiology conference with neurology residents, neurosurgery, pediatrics, as well as radiologists.

Q. And, Dr. Barkovich, have you won any particular -- received any particular recognition or awards for your efforts in education?

A. Yeah, well, the neurology residents were nice enough to give me an award last year as the outstanding teacher, so that was real nice, that was very unexpected.

Q. Dr. Barkovich, do you do any research at the present time?

A. Yeah, I actively -- I'm always doing something, and at the present some of the topics I'm interested in are perinatal and neonatal asphyxia, what are the effects on the children, how are they manifest on imaging studies.

What we're trying to do is actually right now trying to get together a big multi-institutional study of children who are asphyxiated either at birth or in the

first few days of life, and try to follow them both with clinical studies, laboratory studies, neurologic exams as well as a number of imaging studies to try to see what factors can be used to give the best prognosis as early as possible to try and get them into the best occupational or physical therapy or whatever as early as possible. So that's one thing.

I'm also very interested in researching normal brain development and in particular abnormalities of brain development to try to figure out exactly where the process of normal development has gone wrong. You have to really understand how the normal process works before you can understand what went wrong and when.

Q. Are you looking at MR scans or radiographic studies?

A. Look at --

Q. In that research?

A. Yeah, and we also look at pathologic specimens, but what I found is that MR studies in some ways are better than pathologic specimens because the pathology -- pathologists only get to see the brains of children who are so badly injured that they die, and we get to see the ones who are mildly affected, moderately affected and very severely affected. *So* I think we get a better spectrum, and by seeing that I think it helps you to understand the processes better.

Q. How long have you been involved in that research, Dr. Barkovich?

A. Oh, probably about five years.

Q. Before we go too much further I had better have you tell us about the education you have completed to become a pediatric neuroradiologist. Would you do that, please?

A. I guess we will start at medical school. I went to medical school at George Washington University in Washington D.C. It was sponsored by the U. S. Army because I couldn't afford to go to medical school otherwise, and as payback to them, I did my internship, and residency, and fellowship training at Army institutions, and did my internship and residency at Letterman Hospital here in San Francisco, did my fellowship at Walter Reed Army Medical Center in Washington D.C., and was fortunate enough to be able to rotate on a couple of rotations at pediatric hospitals, at Children's Hospital in Washington D.C. and the Hospital for Sick Children in Toronto, Canada.

And that's what really got me going in pediatric neuroradiology, because when I came back to Walter Reed I sort of became the pediatric neuroradiologist at Walter Reed and saw all the pediatric cases there, and then I came out here to fulfill my Army obligation at Letterman, and I got a clinical appointment

here at U.C.S.F. and became -- it turned out I knew more about pediatric neuroradiology than anybody else in northern California, so I just started doing all the pediatric neuroradiology, and the more you see, the more you know, and suddenly, without my knowing it, I became an expert. So here I am.

Q. So here you are. All right. Dr. Barkovich, are you involved -- are you involved as a chairman of any professional organizations dealing with neuroradiology?

A. Well, I am the chairman of the Pediatric Training and Standards Subcommittee of the American Society of Neuroradiology, which is the national organization of neuroradiologists.

Q. And what is the focus or the purpose of that organization?

A. The ASNR, or my subcommittee?

Q. Let's talk about the ASNR first.

A. The ASNR, the function is to help educate, keep neuroradiologists at the cutting edge of neuroradiology.

Q. And what's the focus of your subcommittee on pediatric neuroradiology?

A. It's to make sure that all neuroradiology fellows get adequate training in pediatric neuroradiology.

Q. And how do you do that?

A. By establishing minimum standards for training in pediatric neuroradiology in all fellowships.

Q. All right, so you help establish standards that medical schools and institutions across the country use?

A. Yeah, mostly fellowship programs. In order for a neuroradiology fellowship program to be accredited, it has to meet certain standards, and what we have done is establish standards, minimum standards for training in pediatric neuroradiology that make a neuroradiologist competent to interpret pediatric films, pediatric studies.

Q. Are you involved with any other national organizations, Dr. Barkovich, dealing with requirements for residents going into the practice of neuroradiology?

A. Well, I'm on a couple of committees dealing with resident education in neuroradiology and in -- and in MR, magnetic resonance imaging. I'm on a committee of the American College of Radiology for creating a teaching syllabus for residents in neuroradiology, and I'm obviously doing the pediatric neuroradiology section, and I'm also on a Joint Committee of the Society for Magnetic Resonance Imaging and a Society for Magnetic Resonance in Medicine again for resident training in, this time, magnetic resonance imaging, but in particular in the pediatric neuroradiology aspect of it.

Q. All right. Now, you mention magnetic resonance imaging. Is that the same thing as an MRI?

A. Yes.

Q. And is that the same thing as the MRI scans that

we're going to be talking about for Monica Wilson?

A. Yes, exactly the same thing.

Q. Dr. Barkovich, I looked at your CV and based on my count, you have written 61 papers, two books and then a number of chapters for books. Does my count sound about right?

A. Yeah, I will take your word for it.

Q. Okay. Would you tell us the titles of the two books that you have written?

A. Well, one of them is just called Pediatric Neuroimaging, and it basically deals with ultrasound, CT and MR scans of pediatric neurological diseases.

The other one is really kind of a little book, it's called The Practical -- it's called The Practical MR Atlas of Normal Brain Development, or something like that, and it's just a little booklet that shows how the appearance of the brain on MR scans changes from the newborn period until you reach maturity, until you reach adulthood, and it turns out that it's very confusing for people who don't see pediatric scans regularly because the pediatric brain looks very, very different than the adult brain for the reasons that we talked about earlier.

Q. Do you happen to have a copy of either of your books here so we could just show them to the jury?

A. Well, we're in an office that has our

neuroradiology library in it, and I suspect that there is a copy of one of the books. This is the big book.

VIDEOTAPE OPERATOR: Set it, stand it right there.

MS. McINTYRE: Q. Okay, is that a textbook?

A. Yes.

Q. I won't have you show us all of the book chapters that you have written, Dr. Barkovich, but would you just tell us the titles of the chapter or what the chapters dealt with?

A. I think all the book chapters, I'm going to have to -- I don't really remember them *so* I'm going to have to refer to here -- one of them was on congenital malformations of the brain, one of them was on normal and abnormal brain development, another one was on imaging of the phakomatoses, which is a particular group of diseases that affect the brain, and the other was on the effect of MR imaging on pediatric neuroradiology, because it's really revolutionized pediatric neuroradiology. We can see diseases and abnormalities that we never dreamed of before. It's become very important.

Q. Okay. Now, are all of your 61 papers basically devoted to neuroradiology?

A. Yeah, I think *so.*

Q. Okay. And I won't make you go through each one

of the papers, but can you just tell us, Dr. Barkovich, whether some of the papers that you have written are particularly relevant to this case?

A. Yeah, I think the paper I did on the MR of perinatal asphyxia which came out, I guess, about six months ago in the American Journal of Neuroradiology has a significant bearing on this case.

What that paper does -- did, was it looked -- in that project we looked at a large number of patients who suffered some sort of asphyxia around the time of birth, and they were of many different gestational ages at the time of birth so there were some kids who were -- a lot of the kids were premature, and then there were a lot of kids who were term, and some kids who were post-term, and what we found was that you could correlate the pattern of brain damage with the gestational age of the infant at the time of asphyctic episode.

Q. All right.

A. So by looking at an MR scan you can tell pretty well if the child has had an asphyctic event and, furthermore, about what time it occurred, so, you know, if -- you know, we're not real exact. I mean we can basically tell the difference between late second trimester, early third trimester and late third trimester.

Q. Okay. So let me make sure that I'm understanding you. Based on your studies, you believe

that you can tell when a baby sustained an insult based on the type or the pattern of damage that you see in studies of the brain?

A. Yes.

Q. Now, Dr. Barkovich, can you do that even though an MR scan is taken after the time damage occurred? I mean, for example --

MS. McINTYRE:: Do we need to stop?

REPORTER: Please.

VIDEOTAPE OPERATOR: Okay, the time is approximately 10:40. We're going off the record.

(Discussion off the record.)

VIDEOTAPE OPERATOR: The time is approximately 10:45 and we're back on the record.

MS. McINTYRE: Q. Dr. Barkovich, we're back after more technological difficulties. Let me ask my question again. Can you make these predictions about the time that damage to the brain occurs even though an MR scan is taken some years later?

A. Yeah. It turns out that the pattern of damage is what's specific, and once a brain is damaged, it remains damaged and the pattern doesn't change. In fact, in our study we looked at patients, I think the oldest one was 19 and as late as 19 years after the injury the pattern of damage was still unmistakable. So that doesn't seem to be a factor.

Q. All right. Are there any other papers that you have written that you think are particularly applicable to this case? And I can go through and ask you about some of them that I have noted, if you would like.

A. Okay.

Q. All right. You have written some papers on anomalies of the corpus callosum in correlation with further anomalies of the brain. Would that be --

A. Yes, that would apply because what we find is that the corpus callosum tends to be thin when there is damage to the white matter, as is seen in Monica's scan.

Q. All right. And you have written several articles regarding development of the corpus callosum?

A. Yes.

Q. You have also written an article on MR of normal and abnormal myelination.

A. Yes.

Q. Does that deal with anything that we're talking about here?

A. Not really, not really. You can get delayed myelination in asphyctic brain damage, but it's rarely seen past the age of two and since Monica's scan was at age 8, it's really not applicable.

Q. Okay. I also see an article that you wrote, Pediatric Neuroimaging update, 1989 to 1990, Current Opinion in Pediatrics. What was that about?

A. Oh, that was just a review article that summarized the pertinent papers on the subject of pediatric neuroradiology in the past year. There were some papers that we reviewed that may have been pertinent to this, but review articles don't really count.

Q. Okay. I see you did write an article about cerebral palsy MR findings in 40 patients.

A. Yeah, that one actually is applicable here because what that paper showed was that a significant number of cerebral palsy children had developmental brain abnormalities.

Q. What do you mean by that?

A. That means that those are injuries -- well, developmental brain abnormalities are either caused by genetic defects or caused by injuries that occurred in the first half of gestation.

Q. All right. I see that you have also written another article on CT and MR of profound perinatal and infantile asphyxia.

A. Yes.

Q. What was that about?

A. Well, in that article which has only been submitted for publication, I haven't actually heard back from the journal yet, we looked at children, infants who suffered basically cardiocirculatory arrest, which is to say their heart stopped beating and they stopped getting

any blood to their brain and just --

MS. McINTYRE: I guess technological problems again. We will stop.

VIDEOTAPE OPERATOR: The time is 10:50. We're going off the record.

(Discussion off the record.)

VIDEOTAPE OPERATOR: The time is 10:50 and we're back on the record.

MS. McINTYRE: Q. Dr. Barkovich, because of your expertise in pediatric neuroradiology, have you given presentations across the country in or dealing with pediatric neuroradiology?

A. Yes.

Q. Could you tell us about some of the presentations that you have given?

A. Well, --

Q. I know you have given a number of them. Can you tell us --

A. Basically, you know, some of the present -- I don't know if you're talking about the paper presentations or the invited lectures.

Paper presentations, I have given a number of papers on similar subjects, developmental brain anomalies, asphyxia, cerebral palsy, that sort of thing at big radiology meetings, Radiological Society of North America, American Society of Neuroradiology meetings,

Society of Magnetic Resonance Imaging, and Western Radiological Society Meetings.

I have also spoken at a number of -- been invited to speak at a number of conferences in this country and in Europe, and I have also been a visiting professor at a number of teaching pediatric hospitals.

Q. All right. Where have you been a visiting professor?

A. Well, as best I can remember, Children's Hospital in Los Angeles, Children's Hospital in Orange County, Cincinnati Children's, Children's Hospital in Washington D.C. and at Free University in Amsterdam. Those are the most recent ones, anyhow.

Q. Okay. Have you given a number of seminars or presentations in interpretation of the MR scan?

A. Yes.

Q. Have you given those courses or presentations across the country?

A. Yes.

Q. Do you have any editorial responsibilities, Dr. Barkovich?

A. Yes.

Q. Would you tell us about those, please?

A. I review papers and I'm on the editorial board for the American Journal of Neuroradiology, I'm the editor of the neuroradiology issue of a journal called Current

Opinion in Radiology, and I review papers for a number of journals, American Journal of Radiology, American Journal of Neuroradiology, Journal of Computer-Assisted Tomography and Neurology.

Q. And why are you reviewing the papers?

A. Well, scientific papers don't just get sent in and published. They have to be reviewed. It's what is called peer review, and what that means is that when somebody writes a paper, a group of people write a paper, once they think they have it as good as they are going to get it they send it into the journal.

What the journal then does, or at least what we call peer review journals, which are the ones that are prestigious, the journal then -- one of the journal editors then sends the manuscript out to two or three reviewers who are experts in whatever field the paper is written in, and then the reviewers look at the paper and try to determine whether it's worth publishing, whether it's good enough to be published or if there are some flaws in it, either flaws in logic, or flaws in their data.

You try to pick those up and then we send our comments back to the editor who then assimilates our comments and sends a letter back to the -- sometimes they will just Xerox the copy of our review sheets. In other journals the editor assimilates our comments and puts in a

few of his own and then will send the manuscript back to the author or authors saying either, "Yes, it's a great paper. We would like to publish it if you make the following revisions,'' or, "Well, it's okay, but we're not going to publish it unless you do the following things," or finally, in the really not so good papers we will say -- it will say, "We're sorry, we're not able to publish this paper. Our reviewers don't think it's worthwhile for the following reasons," and always try to give reasons.

I do it for a number of journals because I think it's a real important job. It takes a lot of time, but, you know, what you want to do, try to do is keep the quality of the journals up to snuff and not let -- I just don't like to read bad papers in a journal so you want to make sure that the papers are good and well thought out and that they have analyzed their data properly.

Q. And that's because practicing physicians rely on those journals and papers?

A. Absolutely, yeah, that's what keeps them up-to-date.

Q. Are you Board certified, Dr. Barkovich?

A. Yes.

Q. And what areas are you Board certified in?

A. I'm Board certified in radiology. There is not as of this time a neuroradiology Board exam. However, we're in the process of trying to get one. We just got

the fellowship program accredited. That was the first step in getting an actual Board exam, and we hope within four or five years to have a neuroradiology Board exam.

Q. Are you licensed to practice medicine?

A. Yes.

Q. Where are you licensed?

A. In California.

Q. Dr. Barkovich, perhaps you could put up an MR scan and I then ask you if you could give us a basic overview of the brain, the structures in the brain and their function, keeping in mind that we're lay people.

A. Okay, what I want to display here is that an MR scan is very versatile, and so you can see that these images look very different, these images on the left look very different than these images on the middle. That's because by using MR you can effectively cut the brain. You're not actually cutting anything, but you can get an image of the brain in any plane that you want.

So these are what we call sagittal images. These cut the brain from side to side and on this midline sagittal image, for example, what we have, this is what we call the cerebrum. You've heard of the cerebral hemisphere. This is the main functional part of the brain. This is the part of the brain that thinks.

This structure is the corpus callosum. This is a big collection of axons. Axons are basically

the wires that transmit signals from one part of the brain to the other and this is an accumulation of axons that transmit information from one side of the brain to the other. This would be the brain stem which transmits information to the face and to the spinal cord, and the spinal cord transmits information to the rest of the body.

This, these images in the middle are axial images. These cut the brain from top to bottom. This is the cerebellum, which has the function of largely modifying information that comes down from the cerebral hemispheres and what happens if you have an injury to the cerebellum is you lose coordination of your motions. It's basically something that coordinates.

This is the brain stem, which looks a lot different when you look at it in this axial section than it did when we look at it before, and then as we come -- now we're coming up from the bottom toward the top of the skull.

These are the eyes, eye balls, if you will, and as we come up higher we get into the cerebral hemispheres, and this would be the right cerebral hemisphere and the left cerebral hemisphere.

Now, in these hemispheres -- let's go to this image because I think it shows things better -- you have the gray matter, the cerebral cortex, and remember

when you were a kid everyone told you to eat fish because it gives you -- it's good for your gray matter, and the gray matter are the cell bodies. This is where most thought and actions are generated, and they have connected to them long processes that are called axons and dendrites, and the axons and the dendrites communicate with other neurons, and in order to get the other neurons they usually go through this part of the brain.

See this lighter area in here? This is called the white matter, and those are -- those axons are the wires that I talked about before that transmit information from one part of the brain to another part of the brain. It can either be from the front to the back or from side to side.

Q. Could you show us that white matter again, Dr. Barkovich?

A. Sure. You can see the outer darker part here, that's gray matter. That's cerebral cortex and underlying it is this white matter. See this area that's brighter, higher signal intensity? That's white matter. And those are just -- those are just axons. Those are wires, the wiring of the brain.

And then in the deep part of the brain you have more gray matter. These are what we call the deep gray nuclei or vasoganglia, and these are older nuclei that have importance in some older functions like pain,

the sensation of pain. They also tend to modify actions and smooth out actions.

If you injure the vasoganglia you can have wild arm motions or what we call athetoid motions, or you can get Parkinson's disease where you can get a tremor. And these very dark areas are what we call the cerebral ventricles, and these are areas that are just filled with fluid, spinal fluid, and the function of the spinal fluid isn't really clear. It's part shock absorber, it partly supplies nutrients to the brain, but all of the functions aren't really known. And that's basically a tour through the brain.

Q. All right. Thank you. You can sit down then for a minute. You said earlier that if a baby sustains an insult to the brain around term, for example, that that insult would look different, the damage in the brain from that would look different from what you would see from a insult producing damage earlier in the pregnancy.

A. Yeah, that's right.

Q. What do you typically associate with damage from asphyxia around term, the time of birth?

A. Well, what I look for is damage in specific areas of the brain, and those areas that tend to be damaged are areas that have been called the intervascular boundary zones, or more commonly referred to as watershed areas, and the analogy I like to use is with watering your

lawn.

Now, the brain has three major blood supplies, three big arteries, if you will, hoses that go to the brain to bring blood, the anterior cerebral artery is the first, the middle cerebral artery, and then the posterior cerebral artery. Now, if you're watering your lawn you want to make sure that all of the areas of grass get watered, right? Because if some area doesn't get watered it's going to burn while everything else is green.

The brain does the same thing. There is overlap of these vessels. Now, if you drop the water pressure in your water system there are going to be certain areas of your lawn that aren't going to get watered, there are certain areas that if all those sprinklers overlap and you decrease the pressure going to them there are certain areas that are going to get burnt, and the same thing is true in the brain.

If you drop the blood pressure there are certain specific areas of the brain that don't get enough blood, and those are what we call the watershed areas, and typically in a term infant those watershed areas are out peripherally, involving the more peripheral white matter and the cerebral cortex.

Q. All right. Now, did Monica Wilson, the baby involved in this case, have damage to these more

peripheral areas of the white matter and to the cortex?

A. No, she does not.

Q. All right. And, Dr. Barkovich, when you said that this is the kind of damage you will see from asphyxia around term, what are you meaning by term?

A. Well, in our study we started seeing this kind of peripheral watershed damage starting at about 36 or 37 weeks gestational age, and it continued up through about 44 weeks.

Q. All right.

A. So even post-term.

Q. So Monica did not have the type of damage that you would associate with asphyxia from 36 weeks gestation until term, her birth?

A. That's correct.

Q. Dr. Barkovich, Monica had ultrasounds and a CAT scan and an MRI study done in this case. Can you tell us a little bit about each study, why they are done, and how they differ from each other?

A. Sure. The sonogram was done first and that's typical. Sonograms are usually the first study we do on a baby who is either a premature baby or maybe is having some sort of problems that might be attributed to the brain, and the reason we do sonograms first is because sonograms are portable. You can take the ultrasound machine, which is what you do sonograms with.

Q. Okay.

A. The better term I guess is "ultrasonograms," but "sonograms" is easier. You take the ultrasound machine to the neonatal intensive care unit, you put it up right next to the incubator and there is a transducer, we call it a transducer, which looks just like a microphone, just like this thing, and it turns out that baby heads, as anyone who has had a baby knows, have openings between the bones of the skull, what we call the anterior and the posterior fontanelle, and that's really valuable because there is no -- ultrasound waves don't go through bone, but since there is no bone in the middle of the brain -- in the middle of the skull, there is what we call a sonographic window, and you go up there and you angle the transducer, and what comes out of the transducer is little sound waves, and the sound waves go in and when they hit surfaces some of them reflect back.

And depending upon the type of tissue it hits, more or less of the sound waves bounce back, and by modifying those with the computer, you can get a reasonable picture of the brain, at least the central part of the brain, and any disease, damage, pathology, whatever you want to call it that's going in there. So we always try to do sonograms first.

Q. And for our purposes "sonogram" is the same as a cranial ultrasound?

A. Yeah, "cranial ultrasound," "sonogram," they are the same thing.

Q. Okay.

A. So we always try to do those first because they are non-invasive, they are portable, the baby never has to leave the incubator.

Q. Okay. Now, Monica also had a **CT** scan.

A. Right. A **CT** scan is different. It's not portable. It uses instead of sound waves, X-rays, and basically, you put the child -- in this case they would have put Monica on a little table and run the table into what looks like a big donut, and within the solid part of the donut are -- depending on the type of scanner, one or several X-ray tubes, and then a bunch of X-ray detectors and what they do is they do -- they put X-rays in from a bunch of different angles all the way around the head and then use a computer to analyze that data and reformat pictures of the skull and brain, and it's a little bit limited in that you can only get slices that are in the plane of the donut so you can get different angles of the head, but you have to do that by angling the head, which is often very difficult.

Q. All right. Now, Monica also had a MR scan done in September of 1990, I believe. How does an MR scan differ from a CT scan and from a ultrasound?

A. An MR scan also isn't portable so it's like a CT

scan in that sense. It's different from a CT in that it uses magnetic waves instead of X-rays to do the imaging, and it's kind of complex, but basically, if you put energy into a substance you always get energy back out, and the energy comes back out in the form of magnetic waves, too, and by just modifying the energy that you put in, you can get spatial information from the energy coming out, which is to say where exactly that piece of information was coming from within the head, and then again you use computers, pretty sophisticated computers to reconstruct images of little sections of the brain, and the beauty of MR is -- well, there are many nice aspects of it.

Number one is with MR by changing the rate at which you sample the portions of the brain, the rate at which you put in those magnetic waves you can make the brain look different and get different types of information.

The other nice thing about MR is that you can angle your scan in any way you want so what we traditionally -- whereas in CAT scans traditionally we just go from the top to the bottom of the brain, what we call axial or transverse scans, with MR we do axial scans, we do sagittal scans, side to side, and we will often do coronal scans which images the brain from front to back. And if you really want to you can image it at funny odd angles to try to see certain things better.

Q. So does this mean you can get more information about the condition of the brain with a MR scan?

A. Yeah, yeah, MR is the best study we have available right now.

Q. Dr. Barkovich, did you review Monica Wilson's MR scans, CT scan and cranial ultrasounds?

A. Yes, I did.

Q. And would you put up Monica's ultrasounds and tell us how you interpreted them, please?

A. Sure.

MS. McINTYRE: And I would like to mark the cranial ultrasounds as Defendant's Exhibit **31** and offer them. Do you have any objection?

MR. LOPEZ: No.

(Defendants' Ex. **31**, cranial ultrasounds of Monica Wilson, was marked for identification.)

A. Okay, there are five sheets of film here and I'm going to put them all up. Actually, I think I will put **up** four of them. The two on the left were done on the 12th of April, **1982** and the two on the right were done one week later on the 19th of April, **1982.**

Q. So the first set of ultrasounds were done when Monica was about three days old?

A. Three days old, yes.

Q. Okay. Will you interpret those ultrasounds for

us?

A. Sure. Okay, these scans, the sheet of film on the left is from a sagittal scan, which means they took the transducer and they angled it from front to back and got an image basically from front to back of the brain, and they are primarily focusing, according to this, on the left half of the brain. This "LT" means left.

And what we see is that there is a large, bright mass. Now, the term ultrasonographers use is "echogenic," meaning that it creates more echoes of the sound waves, which is more sound waves bounce back to the transducer.

An echogenic mass adjacent to the left lateral ventricle, and here you can see a little bit of the ventricle or these bright reflections more anteriorly, and then this one is labeled "right," so this is the right side of the brain, which is a similar level to what we *see* right here, but here you can see that there is not this big echogenic mass. So this is a normal side.

Q. All right. Could you show us --

A. This is the abnormal side.

Q. -- show us the echogenic bright mass that you're referring to --

A. Sure.

Q. -- on the left side of the brain?

A. It's right here, and you can appreciate that

it's much brighter than surrounding brain tissue.

Q. All right. And do you have an opinion to a reasonable degree of medical probability --

A. Let me show the ax -- the sag -- the coronal, excuse me, image first.

Q. All right.

A. This is now taken in a plane from front to back, which they do by angling the transducer from side to side, and what this shows is a little bit of the lateral ventricle, this is the midline, here is the other ventricle. The ventricles are actually even a little bit big here, which is a little surprising with a big hematoma. Okay, this is --

VIDEOTAPE OPERATOR: Can you go back and point out the hematoma again? I didn't get that.

THE WITNESS: Yeah.

A. This is the hematoma, or this is the big echogenic mass which I think is a hematoma and I think subsequently proved to be a hematoma. And you can see that there is some enlargement of the ventricular system, which is rather unusual when there is a big space occupying mass.

The other thing is I don't see a lot of associated brain edema, at least not in the other hemisphere.

Q. What's the significance of that?

A. Well, you would think that if there was a significant asphyctic event, which is to say if the patient had been significantly asphyxiated at the time of birth three or four days earlier you would expect to see edema because the edema tends to maximize about between two and five days after an injury.

Q. All right. Now, why do you expect to see edema after birth if there has been asphyxia at birth?

A. Well, edema is a pretty complicated subject but basically, asphyxia damages blood vessels, and when blood vessels are damaged fluid from them leaks out into the brain, and so there is too much fluid in the brain and too much fluid in the brain is brain edema by definition.

Q. All right. So does the absence of cerebral edema on these scans lead you to any conclusions regarding whether Monica Wilson experienced asphyxia at birth?

A. I would say it makes it unlikely.

Q. All right. You said that her ventricles were a little big and that that was --

A. Well, the left side, the ventricle on the left, the ventricle on the left side looks a little big. On the right side it's compressed by the hematoma.

Q. All right. Now, you're using the term "hematoma." Does that mean the same thing as "hemorrhage"?

A. Well, a hematoma is a localized collection of

blood.

Q. Okay.

A. So hemorrhage is actually the process of bleeding and hematoma is the collection of blood that results.

Q. All right. Do you have an opinion to a reasonable degree of medical probability regarding what the bright echo dense areas in the left side of the brain represent?

A. I just said that it was a hematoma.

Q. Okay.

A. Which is a collection of blood.

Q. All right. If we put up the MR scans now --

A. Okay.

Q. Dr. Gillis -- Dr. Barkovich, sorry, would you give us your interpretations of the MR scans --

A. Sure.

Q. -- that were taken for Monica?

A. Okay. Well, the MR scans have several abnormal findings. We pointed out the corpus callosum before, which is the bundle of axons that connects one cerebral hemisphere with the other. This corpus callosum is much too thin. It's diffusely thin.

Sometimes if you just have a hematoma or a focal area of injury you will get thinning of the corpus callosum but it tends to be much more localized, but this

is diffusely thin, and that would indicate that there is a diffuse loss of cerebral white matter.

A couple other findings on this scan, the cerebellum looks a little bit small and the pons, especially the belly of the pons, this anterior portion looks small, and then there is this large -- appears to be fluid-containing cyst area of encephalomalacia.

Q. What's that?

A. Encephalomalacia is just an area of damaged brain.

Q. All right.

A. In the left parietal lobe.

Q. Is that in the area where the baby earlier had the hemorrhage?

A. Yes, it is.

Q. On the ultrasound?

A. Now, we get out of that plane now and go into the axial plane, which is again where we cut the brain from top to bottom, and the findings here again are that the pons, which is this middle portion of the brain stem, is a little small, and when we come up a little higher we start seeing this hole in the brain, this area of encephalomalacia or this cyst, whatever you want to call it. It's basically an area that's filled mainly with fluid. I don't know that it's truly a cyst because sometimes on MR you can miss little strands of tissue

running through it, so I don't know that it's a pure cyst.

The other finding here is that there is just not enough cerebral white matter. Normally there is a significant amount of white matter between the lateral ventricle and the cortical gray matter, and here you can see that the cortical gray matter comes almost right up to the ventricle, and you see that at basically every level, just not enough white matter in this brain.

And so when you don't see enough white matter in the brain it's normally because it's been damaged in some way.

Now, what I don't see here -- and I'm going to get to these other images. These are a slightly different way of looking at the same information. What I don't see here is any thing of the cortex in the watershed region.

Remember, we talked about the watershed regions and said that those are areas that if there is not enough blood getting to the brain will be damaged, and those areas lie right about where my pen is going here, right about here, right about here and right about here.

Now, you can see that in one of the watershed areas there is damage, but that's due to the hematoma, and you don't get just watershed damage to one watershed area from asphyxia. It happens to all four of them. Then the fact that we don't see any thinning of the

cortex, no damage to the subcortical white matter in any of these areas makes asphyxia at term so unlikely as to be almost impossible in this case, or at least there was not asphyxia significant enough to cause brain damage.

Q. All right.

A. If there was -- if it was, that's where we would see the brain damage.

Q. And you say again when you're using the asphyxia term are you meaning there was no significant asphyxia to cause brain damage from 36 weeks gestation to birth?

A. Right, right.

Q. Okay.

A. The other place I look on these scans is on these images. Now, these, you can see it's a little different here. The fluid in the ventricles is white. These are what we call T2-weighted images, and basically the way you get T2-weighted images is to just wait longer between sampling. Remember, I said you put the electromagnetic waves in and then you put them in again, and depending on how you space your sampling you can get the brain to look a little different.

But here we've made the brain darker and the fluid whiter. Now, this is a real useful sequence, and the reason it's useful is because damaged brain has a higher water content, and so what you look for is areas of bright signal on the T2-weighted image to indicate damaged

brain that may not be apparent on these other images we looked at, and so what you want to do is again look at these watershed areas for damaged brain and I don't see any evidence of it. I don't see any T2 prolongation. There is a little bit of damaged brain right adjacent to the lateral ventricle here on the right, here on the left, but, you know, this periventricular white matter damage is not at all typical of what you see in asphyxia at term.

Q. All right. That brings me to my next question then, Dr. Barkovich. Do you have an opinion to a reasonable degree of medical probability, first of all, regarding the cause of the decreased white matter in Monica's -- depicted on Monica Wilson's MR scans?

A. Well, I think there are two possibilities. Now, this is typical of the pattern as a result of decreased blood flow to the brain from about 28 to 34 weeks gestational age in the first half of the third trimester, so I suppose it's possible that she had an episode of hypotension or asphyxia, whatever you want to call it, in utero at about that time.

However, I have also seen a number of patients now who had this pattern of brain damage when the mother had chronic urinary tract infections, and it's been shown experimentally that endotoxin, which is a substance, a really complex molecule that is made and sent out into the blood by certain types of bacteria, particularly

gram-negative bacteria such as are usually involved in urinary tract infections.

It's been shown that endotoxin causes damage to the periventricular white matter, and as I say, I have seen at least three young children with the same pattern of damage in mothers who had urinary tract infections and had completely normal deliveries and normal perinatal courses.

Q. Now, let me stop you and ask you a question. You're saying that if there is a gram-negative bacteria causing a urinary tract infection, that the gram-negative bacteria can produce endotoxins. Are endotoxins byproducts?

A. Endotoxins are products of the bacteria.

Q. Okay. And --

A. They secrete these toxins into the blood.

Q. All right. And would a fair analogy for the endotoxins be like they are poisonous substances?

A. Yeah, yeah, they are a toxin. They are poisonous substances. Now, the exact mechanism by which they work I don't think has been fully elucidated, fully figured out.

Floyd Gillis did a number of experiments in the '70's where in experimental animals he put endotoxin into their peritoneal cavities, in their belly, and looked at the pattern of brain damage. What he found was that

there was significant periventricular white matter damage in them.

Now, his interpretation was that this was -- damage was a direct result of the endotoxin, that the endotoxin gets into the blood vessels to the brain and is poisonous to the brain and causes damage to the brain, and he didn't have a good explanation as to why it was periventricular.

These is a Japanese -- a study by some Japanese authors on endotoxin in rabbits where they measured blood flow in different parts of the brain, and they showed a marked reduction in the blood flow to the periventricular white matter with only a very small reduction in blood flow to the outer portions of the brain, to the cerebral cortex.

Q. And was that due to the action of endotoxins?

A. Well, that's what they -- yeah, it was caused by endotoxins so their theory was that this periventricular white matter damage has caused a decreased flow to the -- blood flow to the periventricular white matter.

Q. All right.

A. As a result of the endotoxin.

Q. Now, I guess there is still some debate about how actually the endotoxins do cause damage in the brain, but is it pretty much universally recognized amongst pediatric neuroradiologists and neuropathologists that

endotoxins from gram-negative bacteria will cause damage --

A. Yeah.

Q. -- in the baby's brain?

A. I don't think anyone has any question that endotoxin causes brain damage.

Q. You mentioned, Dr. Barkovich, that there were some small areas, I think, in the right periventricular?

A. Yeah, right over here you see there are some areas of high signal -- abnormal high signal. These are in the white matter adjacent to the ventricle, right next to the ventricle.

Q. Okay. Would those areas be consistent with damage from endotoxins?

A. Yeah, absolutely.

Q. Okay. Why don't you go ahead and have a chair?

A. Thank you.

Q. Do you have an opinion to a reasonable degree of medical probability, Dr. Barkovich, regarding the cause of Monica Wilson's too thin corpus callosum?

A. Yeah, I think her corpus callosum is too thin because -- as a result of the damage to the white matter. As I said, the white matter runs through the corpus callosum. If you damage the white matter the corpus callosum will get thin just because there are fewer of those wires running through there.

Q. All right. So this -- the same mechanism that is causing the -- let me strike that and start over. So you're saying that the corpus callosum is also too thin or too small because of damage from endotoxins?

A. Yes.

Q. All right. Now, you mentioned that it's well known that gram-negative bacteria which produce urinary tract infections can cause this endotoxin damage. Is there any evidence that Mrs. Wilson had urinary tract infections with gram-negative bacteria during her pregnancy with Monica?

A. Well, yeah, she had Klebsiella, which is a gram-negative bacteria, and E. coli, Escherichia coli, both cultured from her urine several times, and both of those are gram-negatives and both of them produce endotoxins.

Q. All right. So both of those organisms are known to produce endotoxins which can cause this type of brain damage?

A. Yes.

Q. You also said that Monica's cerebellum and pons were small. Do you have an opinion to a reasonable degree of medical probability regarding the cause of those conditions?

A. Yeah. There is no evidence of later damage to the cerebellum or pons. You rarely see a small pons as a

result of something that happens at term or later, so I would suspect that the pons is small because the cerebellum is small.

The pons is kind of a relay station for fibers from the cerebellum as they go down to the spinal cord and up into the major part of the brain. So I thin the pons is small because the cerebellum is small.

It's really hard to say whether the cerebellum is small because of some congenital genetic problem or whether it might also have been due to the endotoxin. People who have done endotoxin studies have looked at the cerebellum less than the cerebral hemispheres, but I certainly think it's very possible that the cerebellum is small as a result of the endotoxin, too.

Q. All right. Do you believe that the pons and cerebellum are small because of asphyxia from 36 weeks gestation until birth?

A. No, I don't think so.

Q. And is that because there is a complete lack of any findings associated with birth asphyxia?

A. You can get involvement of the cerebellum in profound asphyxia, but it has to be very, very severe, profound asphyxia. You know, the cases where I have seen cerebellar involvement are when kids, you know, have no blood going to their brain for 20 or 25 minutes.

Q. Okay.

A. It tends to be relatively spared in most cases.

Q. All right, so it's your opinion to a reasonable degree of medical probability that Monica's small cerebellum and pons are not due to asphyxia around the time of birth?

A. Yes.

Q. Do you have an opinion to a reasonable degree of medical probability regarding the cause of the intercranial hemorrhage, left intercranial hemorrhage that Monica had?

A. Well, I think that might be a little more difficult. That kind of hemorrhage is unusual in term kids. It's not uncommon in premature kids. To see it in a term baby you have to implicate either a coagulation defect, and my understanding is she did have too few platelets, that she had thrombocytopenia.

Q. All right.

A. So she did have a coagulopathy, as we call it, and sometimes a coagulopathy in itself will cause a spontaneous hemorrhage. If you have a preexisting injury and a coagulopathy then that's going to make it even more prone to injury.

Q. All right.

A. So I think it's certainly a possibility that the brain being already damaged as a result of the endotoxin periventricular brain damage made her even more

susceptible to a bleed that resulted from her coagulation defect. And I would say that would be the most likely, although, I tell you, a lot of kids have bleeds and we just never find a reason for it.

Q. Okay. Let's do it this way, if we assume that -- let me back up and ask you this question. When a child has damage to the brain from endotoxins is that damage frequently bilateral, on both sides of the brain?

A. From endotoxin?

Q. Yes.

A. Yes.

Q. So if we can see damage around the right ventricle in the periventricular area from endotoxins is it likely that Monica also had damage on the left side of the brain in that area from endotoxins?

A. Yes, I think -- to be honest with you, everywhere around the ventricles was damaged. We may not see remnants of it everywhere, but the fact ,that there is not enough white matter in any of the -- anywhere around the ventricles means that there was diffuse damage. Also the fact the corpus callosum is thin in its entirety, I think the whole of the periventricular white matter was damaged.

Q. And that's all due to endotoxins in your opinion?

A. Yeah, I would think so.

Q. All right. So if a child has preexisting damage in the brain like you have described and then the child becomes thrombocytopenic with platelets of 50,000 and below, would those two conditions likely result in a hemorrhage?

A. Well, I think they could. I mean if -- I don't know what the answer would be if you had 100 kids in that situation how many of them would hemorrhage. I can't answer that.

Q. All right.

A. But I think that there are no other likely causes in this child.

Q. All right. So what do you believe is the most likely cause of Monica Wilson's hemorrhage in this case?

A. Well, I guess the most likely would be the coagulopathy probably in conjunction with some preexisting brain damage.

Q. All right, and by "coagulopathy" you're meaning --

A. Low platelets.

Q. Low platelets. Dr. Barkovich, you are testifying as an expert witness on behalf of Overlake Hospital in this case?

A. Yes.

Q. And are you being compensated for your time?

A. Well, --

Q. You hope.

A. I expect to, yes.

Q. All right. And is that customary when doctors or nurses testify in cases?

A. Yeah.

Q. They do receive payment for their time?

A. It's part of our section policy because basically it's taking you away from work, and so Dr. Norman, our section head, has established that policy.

Q. All right. One other quick question. Do you have an opinion, based on the ultrasounds that you have reviewed, regarding when Monica's hemorrhage occurred?

A. Well, it looks like a reasonably acute hemorrhage and it was done on the -- the scan was done at age three -- three days, so Monica was three days old at the time they did the ultrasound.

I would say from the appearance of the hemorrhage it really hasn't -- hemorrhage starts out as just a big collection of blood cells and then it undergoes a process we call organization where the clot kind of retracts, so it turns into a big clot, and then you get some fluid around it, and that happens over a matter of days. I would say she is still in the acute phase before there has been significant retraction of the clot, and so I would say within three days or so of that scan.

Q. Okay.

A. I don't know that I can time it any better than that.

Q. All right. Now, let me ask you this question, do you think that the timing of the hemorrhage made any difference in terms of Monica's condition and her ultimate outcome?

MR. LOPEZ: I guess I will interpose an objection. I don't think there is a foundation established that Dr. Barkovich has the expertise to answer that question.

MS. McINTYRE: Well, let me go ahead and then lay some foundation so that I can ask you that question, Dr. Barkovich.

Q. Did you review the University Hospital records for Monica Wilson?

A. I saw some of them, yes.

Q. All right. And did -- was there any surgical intervention when Monica's intercranial hemorrhage was discovered?

A. No, there was not.

Q. All right. And what do we mean by surgical intervention to treat a hemorrhage?

A. Well, when a hemorrhage gets very large to the point where it compresses the brain so severely that it endangers the rest of the brain, surgeons will go in and -- "evacuate" is the word we use -- the hemorrhage, which

is to go in and remove the clot to allow the brain to expand.

Q. All right.

A. When they evacuate the clot you're still left with a big hole in the brain.

Q. Okay. And that procedure was not done at any time for Monica -- was not done?

A. Yes.

Q. At any time for Monica?

A. Right.

Q. Let me ask you to assume that Monica Wilson's hemorrhage had occurred in utero on April 7th and that Monica had been delivered on that date, do you believe that there would have been any difference in Monica's outcome?

A. Well --

A. Again, I will interpose the same objection. I don't think that Dr. Barkovich has the expertise to testify with regard to these issues. He is certainly a neuroradiologist, but as far as outcomes that occur in patients, I don't see the expertise.

MS. McINTYRE: Q. Do you feel qualified to answer that question, Dr. Barkovich?

A. Well, let me just say that in cases like this I often discuss the cases with the neurosurgeons when they come down and decide whether or not to operate, and the

big question is usually how much compression of the brain there is. Is the patient going to herniate is the big question. Is the blood clot so big that it's going to compress the brain down through the tentorial opening, what we call the tentorial incisura and cause significant brain damage as a result of that.

If -- that's usually manifesting clinical symptoms as well as radiological findings, and the surgeons usually depend on both the clinical symptomatology and the radiological findings. Speaking from the radiological findings, and not --

Q. Good.

A. -- from the clinical findings, there was not a lot of mass effect on the brain in that ultrasound.

Q. And what does that mean?

A. That means that the brain was not severely compressed by that hematoma.

Q. And what is the significance of that?

A. The significance of that is that in that case, in a relatively sick newborn surgeons will usually choose not to operate, figuring that the trauma of the surgery is going to be at least as severe as the effect of the hematoma.

Q. All right. Dr. Barkovich, are you aware of any treatment in utero that could have been given for the endotoxin damage that the baby was experiencing?

A. Well, that is clearly beyond my area of expertise.

MS. McINTYRE:: All right. I think we will stop here. I don't have any more questions. Thank you.

VIDEOTAPE OPERATOR: The time is 11:40 and we are going off the record.

(Recess taken.)

VIDEOTAPE OPERATOR: The time is 12:00 and we are back on the record.

MS. McINTYRE: Q. Dr. Barkovich, I have an additional question to ask you. Monica was microcephalic at birth with a head circumference of 32.2 centimeters. Would that condition be consistent with a lack of white matter in the brain secondary to endotoxin damage from infection?

A. Yes, it would.

MS. McINTYRE:: All right, I have nothing further.

EXAMINATION BY MR. LOPEZ:

Q. Dr. Barkovich, you became a radiologist I guess in 1984 or Board certified maybe in 1984?

A. Yes.

Q. And I think you mentioned that you were not a pediatrician and didn't have a pediatric specialty?

A. That's right.

Q. Okay, and I think you also mentioned that you weren't a neurologist and that you didn't have a neurology specialty?

A. That's correct.

Q. On the urinary tract infections and endotoxins, what would be the sort of doctor that would be expert with regard to that? Would that be gynecologic or an obstetrician-gynecologist?

A. Who would be an expert in what, in urinary tract infections.

Q. Yeah, urinary tract infections or endotoxins, those sorts of things?

A. Well, I guess the person who would be the most expert would be an infectious disease specialist.

Q. What about -- and that's something -- that's not within your specialty?

A. No, but the effects of infectious diseases on the brain are within my specialty.

Q. The -- now, you already mentioned that you have been retained by Overlake Hospital to testify in this case?

A. Yes.

Q. And you have also been hired to give expert opinions in other medical malpractice cases, as well?

A. Yes, that's true.

Q. In what percent of those medical malpractice cases do you appear for the defense?

A. Probably -- I don't know, probably pretty close to 50-50.

Q. Has that percentage changed over the years?

A. I don't think so.

Q. Was there a time when it was 80% for the defense?

A. Yeah, I would say when I first started I was contacted more by defense attorneys and, you know, when I first started doing it it was probably about 80% for the defense and 20%. I think recently plaintiff attorneys have sort of caught up with the fact that neuroradiology is very important in these cases and I have been contacted more and more by plaintiff attorneys. It turns out that sometimes the films favor one side and sometimes they favor other sides.

Q. How much per hour do you charge for legal consultation?

A. $500.

Q. And it's the same for testimony?

A. Yes.

Q. I really didn't realize how new MRI -- do I call it a science? I'm not sure. How the field, how new the field of MRI really is. It sounds to me like it's really gotten going over the last five or six years. Is that a

correct observation?

A. Well, yeah, MR has been around for a long time. It was used by chemists.

Q. Oh, I see.

A. Since the 1940's. It's only been applied to imaging since the early '80's. I think the first image of an MR -- on an MR I ever saw was of an orange in 1979 in Science magazine, and I guess in '82 maybe they started running a clinical scanner in London, and we had one of the first sites, U.C.S.F. had one of the first sites in the country and it opened in November of '83.

Q. You were discussing a study that you have done that tries to correlate MRI findings with the timing of asphyxial injury. Is that -- was that a fair description?

A. Yes.

Q. Okay. And as I understand it, that's the first study that attempted to do that. Is that true?

A. Yes.

Q. Okay. And when did that study -- it was published at the end of 1990, is that what you said?

A. Yes.

Q. How many patients did that study involve?

A. I don't know, I think 25.

Q. Okay. Do you recall how many of those patients were involved, were term babies?

A. Probably about 10.

Q. Okay.

A. Probably about 40% of them, I think.

Q. The -- actually, I'm not trying to trick you or anything?

A. No, I honestly don't --

Q. I have a copy of the study you can look at.

A. Oh, thank you. I really don't remember. Thank you. I was pretty close.

Q. You were pretty close. I think it was eight, but I'm not sure.

A. Okay, yeah.

Q. You can hold on to that.

A. Okay.

Q. Because I have actually a few questions about that.

A. Okay, thank you.

Q. Now, as I understood the study, several of the MRI's of term infants were done immediately after birth.

A. Yes, some were done -- I'll look it up.

Q. Sure, you can look it up.

A. Some were done in the -- three of them were done within the first month after birth.

Q. Okay. And I think you found that that was actually a bit too early to reveal some of the things that would be revealed later?

A. Yes, that's true.

Q. With the passage of time on MRI, and how many -- let's see, how many -- were any of the term infants MRI'd? Is that a verb?

A. You can use it any way you want.

Q. How many of the patients were MRI'd eight years after birth?

A. I would have to look. None. We had a 4-year, 5-year, 18-year, 19-year, 4-year. There were none of them exactly eight years.

Q. And I couldn't tell from looking at the study if any of the infants also had intrauterine growth retardation. Do you know offhand or is that something that was looked at?

A. That wasn't something that we looked at.

Q. Okay. In your opinion, does Monica have periventricular leukomalacia?

A. That's a vague term. She has got periventricular loss of white matter and periventricular white matter damage, so in a strict sense, yeah, I guess she does have -- at least say first that the term periventricular leukomalacia means periventricular white matter softening, that's what leukomalacia is, so I would say on the basis of this that she probably does have some periventricular white matter damage.

Q. And is that a -- is one of the causes of that condition -- not in Monica, but in general, because I know

your opinions about Monica, but in general is one of the causes of periventricular leukomalacia thought to be asphyxia?

A. In premature infants it can be.

Q. How long does it's take damage from periventricular leukomalacia to show up on a sonogram after the damage takes place?

A. Well, you know, there are some people who would argue that periventricular leukomalacia doesn't usually even show up on sonograms or variably shows up on sonograms. I would say you see it very quickly because the first thing you see is edema, which is increased brain water in the periventricular tissue.

That isn't in itself diagnostic, though, of periventricular leukomalacia and can be seen in normal patients, especially normal premature patients. And sometime usually three to six weeks after the injury little cystic areas appear in the periventricular region, and those are due to cavitation, and only when you see that cavitation can you make that diagnosis on the basis of ultrasound.

So I guess the question is -- the answer to that is three to six weeks.

Q. Is there something that shows up in a week or two?

A. You can see what I described as echogenic areas,

which is largely edema and then secondarily some tissue damage, sometimes even some hemorrhage.

Q. We have mentioned sonograms a few times. I don't think we have ever mentioned that sonograms are the same as ultrasounds. Is that true?

A. Yes, it is. I think I mentioned that.

Q. Good. I hope -- I just wanted to make sure that at some point during this week we said that. As I understand edema -- believe me, I may not, but edema in the brain would be a swelling in the brain?

A. Edema I guess is defined as just too much water. It causes swelling.

Q. Okay, so it would be fair to say that edema causes swelling?

A. Yes.

Q. Okay, and can asphyxia cause edema in the brain?

A. Yes.

Q. How does that work?

A. Well, theoretically, the -- if there is not enough blood getting to the brain or not enough oxygen in the blood getting to the brain you get damage to the walls of the blood vessels, and then the blood vessels get leaky and fluid from not actually blood -- red cells, the holes aren't that big, but the fluid from within the blood vessels, the serum, the plasma leaks out through, it's called vasogenic edema. It usually takes a few days for

it to really -- well, it takes -- you never see it before six hours, and then it usually maximizes in terms of its mass effect between two and five days after the injury.

Q. Can asphyxia cause ischemia?

A. Well, ischemia is part of asphyxia, okay? Asphyxia is --

Q. How does that work? Can you explain that?

A. Yeah, sure. I'm surprised, if Dr. Gillis has already testified, he didn't give you a lecture on it. Asphyxia is a term that sort of encompasses both hypoxia, which is too little oxygen, and ischemia, which is too little blood. Now, some people make a big deal of talking about hypoxia and ischemia and don't use the word, never use the word asphyxia. Other people say that any time you have hypoxia you're going to have ischemia. The reason for that is a little complicated but it has to do with the fact that the blood vessels get injured by the low oxygen pressure and, therefore, have a hard time maintaining blood flow to the brain, so ischemia, which is not enough blood getting to tissues, is a part of asphyxia but asphyxia includes both not enough oxygen and not enough blood getting to the tissues.

Q. Would you describe the hemorrhage that Monica had as a lobal hemorrhage?

MS. McINTYRE: A what?

A. Lobar?

Q. Oh, lobar, lobar hemorrhage.

A. It's largely restricted to the parietal lobe, yes.

Q. Can you have a lobar hemorrhage in a term infant following birth asphyxia?

A. I would say that it would be very unusual. It happens.

Q. You were discussing decreased white matter in Monica. Can I get you to agree that decreased white matter is a nonspecific finding?

A. Yes.

Q. Okay. And it can be compatible with birth injury?

A. It is sometimes seen in birth injury, yes. As a matter of fact, I will take that farther. You always see decreased white matter in asphyctic birth injury, but the pattern of white matter damage is the key.

Q. You also -- it's also true, though, that -- isn't it, that one can have asymmetric damage in a asphyxiated brain?

A. Yes.

Q. Have there been any subsequent studies to your study attempting to correlate MRI with the timing of injury?

MS. McINTYRE: No.

Q. You can answer. Not that you know of?

A. Not that I know of.

MR. LOPEZ: Okay. I have no further questions. Thanks.

FURTHER EXAMINATION BY MS. McINTYRE:

MS. McINTYRE: Q. Dr. Barkovich, Mr. Lopez asked you whether you were a pediatrician or a neurologist and you indicated you were not. Are you, however, a specialist in determining the existence of diseases and abnormalities in the brains and central nervous systems of children?

A. Yes.

Q. Now, Mr. Lopez asked you about the research which you have recently published correlating brain damage with particular times of gestation based on the distribution or the pattern of the brain damage. Have there been studies before the one that you did, first of all, looking at brain damage in children with ultrasounds and with MR's?

A. There have been a lot.

Q. All right. And have there been a lot of studies finding brain damage to have occurred earlier -- in utero earlier in the pregnancy based on ultrasound and MR studies?

A. Yes.

Q. And Mr. Lopez then asked you whether there had

been any studies since the one that you did looking at correlating the time of an insult with the gestational age of the baby and the particular pattern of damage that one sees.

Have you seen this 1991 article by Dr. Skolnick in the Journal of the American Medical Association titled "New Ultrasound Evidence Appears To Link Prenatal Damage To Cerebral Palsy"?

A. No. Do you want me to read it?

Q. Would you just take a glance at it and see if Dr. Skolnick is trying to follow some of your leadership in predicting the time of brain injury in infants based on radiographic studies?

A. (Witness reviews paper.) It looks like what they are doing is just looking at the evidence of the cystic degeneration in periventricular leukomalacia, which as we stated earlier tends to happen between three and six weeks after injury, and I think I saw this paper presentation, actually, at the RSNA in Chicago last November, and basically, they just found that a lot of the kids already had the periventricular cyst at the time of birth, indicating that injury had happened before the time of birth. But it's really not the same as what I did, but comes to some of the same conclusions.

Q. Okay. Now, I think you said earlier that periventricular leukomalacia from asphyxia occurs with

premature babies, but not with term babies?

A. Well, the predominant damage in premature infants is in the periventricular region up until about -- through about 34 weeks. Beyond that time, the damage tends to go peripherally out to the cerebral cortex, which as we explained earlier is the covering of the brain, and what we found in this study, and we have seen a large number of parents since then in which it also seems to work, is that beyond about 36 weeks the kids have cortical damage and they have cortical damage in the watersheds areas and we have also seen now several kids, I think three kids who had asphyctic damage at 38 weeks, which seems to be kind of like a bridge where there is very limited cortical damage, but some, and then by about 40 weeks the cortical damage becomes more significant.

So I haven't seen anything since then. The cases we have seen since the time we wrote this have only helped to confirm our opinion about it.

Q. Okay. In your opinion, to a reasonable degree of medical probability, does Monica Wilson have periventricular leukomalacia due to asphyxia around term?

MR. LOPEZ: Let me just interject an objection again. I think the doctor has -- I believe there hasn't been a foundation established that that's within his expertise.

MS. McINTYRE: Well, I believe that you

already asked the doctor a number of questions about that, so I think you waived the objection, but let me ask it this way.

Q. Dr. Barkovich, do you know what periventricular leukomalacia is?

A. Yes.

Q. And have you reviewed many ultrasounds and MR's where that condition has been present?

A. Yes.

Q. And do you feel competent to determine the existence of periventricular leukomalacia on an ultrasound or an MR?

A. Yes.

Q. And --

MS. McINTYRE: You made me forget my question. That was the whole point of your objection.

THE WITNESS: He did a good job.

MS. McINTYRE: Q. Are you familiar with the pattern of damage that you would see in a baby who has periventricular leukomalacia due to asphyxia?

A. Yeah.

Q. In your opinion, did Monica Wilson have periventricular leukomalacia due to asphyxia around the time of her birth?

A. No.

Q. Why not?

A. Because around the time of birth you don't just get periventricular leukomalacia. You get involvement of the cerebral cortex, as well.

Q. All right, and Monica Wilson did not have that involvement?

A. That's right.

Q. Does that mean that if Monica Wilson had periventricular leukomalacia due to asphyxia that the asphyxia would have had to have occurred before 36 weeks gestation?

A. That's my opinion.

Q. Why is that your opinion?

A. Because the studies that I have done, and they are consistent with other studies from the pathological and radiological literature, indicate that periventricular leukomalacia restricted to the periventricular region and not involving the cortex, is seen as a result of asphyxia almost exclusively in premature infants.

Q. All right. Then, Dr. Barkovich, I believe you said that if a baby has PVL from asphyxia you also usually see edema and swelling within a short period of time, three days?

A. I think I already said that I don't think this is -- that in term kids you don't get isolated periventricular leukomalacia as a result of asphyxia.

Q. Okay, so in your opinion Monica Wilson does not

have periventricular leukomalacia due to asphyxia around term?

A. Yes.

Q. You said that that it was very unusual to see a lobar hemorrhage due to asphyxia in a term infant?

A. Yes.

Q. Why is that very unusual?

A. I don't know.

Q. You just don't see it?

A. You just don't see it very often.

Q. Dr. Ames, the neuroradiologist who did the MR for Monica interpreted it and he said that he found small zones of nonspecific signal abnormality in the right periventricular white matter. Were these the areas on Monica's MRI that you showed us earlier?

A. Yes.

Q. And are these the areas that you believe are consistent with damage due to endotoxins?

A. Yes.

MS. McINTYRE: I have no more questions, thank you.

THE WITNESS: Thank you.

MR. LOPEZ: I have no questions.

VIDEOTAPE OPERATOR: Before we go off the video record I would like to add that the total number of tapes used for today's deposition was one, and at this

time it is 12:30 p.m., July 26, 1991. We are off the record.

(Whereupon, the deposition was concluded at 12:30 p.m.)

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Anthony James Barkovich, M.D.

CERTIFICATION

I, CAROL A. KAREN, a Certified Shorthand Reporter for the State of California, duly authorized to administer oaths pursuant to Section 2093(b) of the California Code of Civil Procedure, certify that I am a disinterested person herein; that the foregoing is a full, true and correct transcript of the proceedings had at the taking of said deposition; that the within-named witness in the foregoing deposition was by me duly sworn to tell the truth, the whole truth and nothing but the truth, and that said deposition was thereafter transcribed into typewriting.

I further certify that I am not of counsel or attorney for either or any of the parties in the foregoing deposition and caption named.

IN WITNESS WHEREOF, I have set my hand this 26 day of July, 1991.

CAROL A. KAREN, CSR #8189