

SUPREME COURT OF OREGON

Marcum v. Adventist Health System/West, 345 Or. 237

193 P.3d 1 (2008) · No. SC S055431 · Decided September 16, 2008

SUMMARY

The Oregon Supreme Court held that expert medical causation testimony based on a differential diagnosis was scientifically valid and should have been admitted. The court concluded that an expert may rely on the temporal and spatial relationship between a single exposure and immediate, localized symptoms, together with biological plausibility and the exclusion of alternative causes, even without a scientifically established mechanism or high-correlation studies. The court reversed the Court of Appeals' decision concerning the negligence claim and remanded for consideration of alternative arguments regarding the informed-consent claim.

CASE DETAILS

COURT	Supreme Court of Oregon
WRITING FOR THE COURT	Balmer, J.
JURISDICTION	Oregon
DECIDED	September 16, 2008
DOCKET	SC S055431
DISPOSITION	reversed_and_remanded
PROCEDURAL POSTURE	Petition for review of a Court of Appeals decision affirming a directed verdict for defendants in a medical malpractice action after the trial court excluded plaintiff's expert medical-causation testimony under the scientific-validity standard.
STANDARD OF REVIEW	The Supreme Court reviewed the admissibility of the expert medical-causation testimony under the Oregon Evidence Code and reviewed the resulting directed verdict. Scientific evidence must be relevant, helpful to the trier of fact, and not excludable under OEC 403; the trial court acts as a gatekeeper, but the court may not impose an unnecessarily rigid requirement of a scientifically demonstrated mechanism or high statistical correlation.
PRECEDENTIAL VALUE	published opinion; precedential Oregon Supreme Court decision
PARTIES	Deborah Marcum v. Adventist Health System/West, Northwest Medical Foundation of Tillamook, Alliance Imaging, Inc., Alliance

TOPICS

expert testimony evidence medical malpractice appellate procedure standard of review

PRACTICE AREAS

evidence medical malpractice torts appellate procedure

QUESTIONS PRESENTED

1. Whether plaintiff's expert medical-causation testimony that gadolinium extravasation caused her hand injury satisfied the scientific-validity requirements governing expert scientific evidence under OEC 401, OEC 402, OEC 403, and OEC 702.
2. Whether the trial court properly excluded the expert testimony and directed a verdict for defendants on plaintiff's negligence claim.
3. Whether the directed verdict on plaintiff's informed-consent claim could stand when the Court of Appeals had not considered defendants' alternative arguments supporting that ruling.

HOLDINGS

1. Expert medical-causation testimony based on a differential diagnosis or differential etiology is admissible when the particular application of that methodology has a scientifically valid basis. Scientific validity does not invariably require a scientifically demonstrable mechanism of causation, epidemiological studies showing a high correlation, or elimination of every alternative cause.
2. The Court of Appeals erred by treating the absence of a scientifically accepted mechanism of causation or independently verified correlation as effectively precluding the expert from ruling in gadolinium extravasation as a potential cause.
3. The directed verdict on plaintiff's negligence claim was improper because the excluded expert testimony should have been admitted and supplied evidence of medical causation.
4. The Supreme Court did not resolve defendants' alternative arguments concerning the directed verdict on the informed-consent claim and remanded that issue to the Court of Appeals for consideration.

KEY QUOTATIONS

“The function of the court is to ensure that the persuasive appeal is legitimate.” (193 P.3d at 4)

“Rather, admissibility will turn on whether the particular use of differential diagnosis to determine causation meets the more general test of scientific validity.” (193 P.3d at 6)

“Questions as to the weight to be given that testimony, possible weaknesses in the expert's theory, and the ultimate issue of causation were for the jury to decide based on all the evidence.” (193 P.3d at 9)

FACTUAL BACKGROUND

After an automobile accident, Marcum underwent an MRI involving injection of the contrast agent gadolinium. After unsuccessful injections in both arms, the MRI technologist injected the back of her left hand; she immediately reported a sensation that her hand was filling up. Her hand became painful, discolored, and swollen, and she continued to experience pain and impaired hand function. Plaintiff's medical expert attributed the injury to gadolinium extravasation, relying on the immediate and localized symptoms, the toxicity of gadolinium, and the exclusion of alternative causes.

PROCEDURAL HISTORY

Marcum sued the defendants for negligent injury and failure to obtain informed consent after a gadolinium injection during an MRI. The trial court excluded portions of the testimony of plaintiff's experts, including testimony that gadolinium extravasation caused her hand injury, and directed a verdict for defendants because plaintiff lacked causation evidence. The Court of Appeals affirmed, and the Oregon Supreme Court granted review, reversed, and remanded for further proceedings concerning the negligence and informed-consent claims.

DISPOSITION

reversed_and_remanded

REMAND INSTRUCTIONS

The decision of the Oregon Court of Appeals was reversed. The case was remanded to the Court of Appeals to consider defendants' alternative arguments concerning the directed verdict on the informed-consent claim and for further proceedings consistent with the Supreme Court's ruling that the expert causation testimony should have been admitted.

CASES CITED

- Marcum v. Adventist Health System/West, 215 Or. App. 166, 168 P.3d 1214 (2007)
- State v. Brown, 297 Or. 404, 687 P.2d 751 (1984)
- State v. O'Key, 321 Or. 285, 899 P.2d 663 (1995)
- Jennings v. Baxter Healthcare Corp., 331 Or. 285, 14 P.3d 596 (2000)
- State v. Lyons, 324 Or. 256, 924 P.2d 802 (1996)
- Joshi v. Providence Health System, 342 Or. 152, 149 P.3d 1164 (2006)

OPINION

Marcum v. Adventist Health System/West 193 P.3d 1

BALMER, J.

193 P.3d 1 (2008)

345 Or. 237

Deborah MARCUM, Petitioner on Review, v. ADVENTIST HEALTH SYSTEM/WEST, a foreign corporation, dba Adventist Health; Northwest Medical Foundation of Tillamook, an Oregon corporation, dba Tillamook County General Hospital; Alliance Imaging, Inc., a foreign

corporation; Alliance Imaging Management, Inc., a foreign corporation; and Alliance Imaging Centers, Inc., a foreign corporation, Respondents on Review. (CC 040505205; CA A129660; SC S055431). Supreme Court of Oregon, En Banc. Argued and Submitted June 4, 2008. Decided September 16, 2008. Jeffrey B. Wihtol, Portland, argued the cause and filed the brief for petitioner on review. Janet M. Schroer, Hoffman Hart & Wagner, LLP, Portland, and Lisa E. Lear, Bullivant Houser Bailey, P.C., Portland, argued the cause and filed the brief for respondents on review. With them on the brief was Marjorie A. Speirs, Hoffman Hart & Wagner, LLP, Portland. Linda K. Eyerman, Gaylord Eyerman Bradley, P.C., Portland, filed the brief for amicus curiae Oregon Trial Lawyers Association. With her on the brief was Leslie W. O'Leary, Williams Love O'Leary & Powers, Portland. BALMER, J. This medical malpractice action requires us to review and apply the standards for admission of expert medical testimony. Under the applicable evidentiary rules, as interpreted in this court's cases, an expert's medical *2 testimony must meet a test of "scientific validity." Plaintiff here experienced symptoms of pain, swelling, and discoloration in her left hand immediately after injection of a chemical called gadolinium; her pain and the discoloration have continued. At trial, plaintiff proffered the testimony of a medical expert that the gadolinium, instead of going into the vein, went into an area of her hand outside the vein, a circumstance known as "extravasation." As a result, according to the expert, the toxicity of the gadolinium caused both her immediate and her ongoing symptoms. Defendants objected to the expert's proffered testimony, and the trial court ruled that the testimony did not meet the legal standard for scientific validity. The Court of Appeals affirmed. *Marcum v. Adventist Health System/West*, 215 Or.App. 166, 168 P.3d 1214 (2007). We granted review and now reverse. The Court of Appeals described the facts and the procedural background of the case: "In March 2003, after plaintiff was involved in an auto accident, suffering a possible head injury, her doctor ordered an MRI. Plaintiff went to Tillamook County General Hospital and was escorted to an MRI trailer just outside. The MRI technologist, employed by Alliance, informed plaintiff that he would be injecting her with a contrast chemical, gadolinium, used to enhance the MRI image. "Alliance's MRI technologists are trained to advise patients that, if the injection of a contrast chemical causes pain or any other discomfort, they should immediately inform the technologist. If a patient makes such a complaint, the technologists are trained to check for extravasation. 'Extravasation' occurs when a substance exits the vein and enters the surrounding tissue. See *Stedman's Medical Dictionary* 635 (27th ed. 2000) (defining 'extravasate' as, inter alia, '[t]o exude from or pass out of a vessel into the tissues'). The general standard of care applicable to MRI technologists requires that they explain the procedure to the patient and ask the patient to inform them if they feel pain. However, neither plaintiff's technologist nor her treating physician explained the injection procedure, asked her to report pain, or explained to her any risks associated with the injection. "After attempting the injection on each of plaintiff's arms unsuccessfully, the technologist attempted to make the injection on the back of plaintiff's left hand. Immediately after the needle went into her hand, plaintiff complained that her hand felt 'like a glove filling up.' She explained

to the technologist that 'if he was to take the tip of my fingers off he would see the stuff running on the floor. That's how full it felt.' The technologist acknowledged plaintiff's complaint but told her it would be okay and finished the procedure. "Plaintiff manages a restaurant. She normally performs various functions in the business, including food preparation, which involves going to the restaurant's walk-in refrigerator. The day after the MRI, however, when she went to the walk-in refrigerator she had a difficult time handling the cold food and complained that her left hand hurt. Her coworker described her hand as appearing purple, orange, and swollen. After a couple of hours, plaintiff went to the emergency room. She has experienced pain ever since, which has impaired her ability to work. Plaintiff's hand has remained discolored near where she received the gadolinium injection. * * * * *

"Plaintiff filed this action against defendants. In her operative complaint, she alleged that defendants had negligently injured her and negligently failed to obtain her informed consent before injecting her with gadolinium. * * *

"[A]t trial, the court excluded portions of the testimony of plaintiff's two expert witnesses, Dr. Weldon Williamson and Karen Marburger. Williamson, a medical doctor specializing in hand disorders, would have testified concerning medical causation. Marburger, an MRI technologist, would have testified that defendants should have made and kept various records and that, had plaintiff been able to obtain those records, they might have been beneficial in proving plaintiff's claims.

*3 "With respect to Williamson's testimony, the court held an OEC 104 hearing to determine whether Williamson's opinion regarding causation—specifically that gadolinium extravasation caused plaintiff's [vasospastic disorder[1]]—was 'scientifically valid' under the standards prescribed in [State v.] Brown [, 297 Or. 404, 687 P.2d 751 (1984)] and [State v.] O'Key [, 321 Or. 285, 899 P.2d 663 (1995)]. The court ultimately concluded that that testimony did not satisfy the requisites of foundational admissibility. * * *

"Defendants moved for a directed verdict on plaintiff's medical negligence claim based on plaintiff's failure to produce evidence of causation. Plaintiff, while maintaining that the exclusion of Williamson's testimony was error, agreed that without that testimony, she had not produced evidence of causation. * * *

The court directed a verdict in defendants' favor * * * and entered judgment accordingly." Marcum, 215 Or.App. at 169-72, 168 P.3d 1214. Plaintiff appealed, and the Court of Appeals affirmed. The central issue on appeal was whether the testimony of plaintiff's expert as to the likely cause of plaintiff's injury met the test of scientific validity.[2] The Court of Appeals reasoned that the expert had failed to identify a scientifically valid cause of the injury—one that linked plaintiff's exposure to gadolinium to the vasospastic disorder that she experienced. In particular, the court noted that the expert had failed to show, either through studies showing a high degree of correlation between gadolinium exposure and the kind of injury that plaintiff had suffered or through a scientifically demonstrable mechanism of causation, that the gadolinium extravasation could have caused plaintiff's vasospastic disorder. Id. at 184-88, 168 P.3d 1214. Judge Armstrong dissented. While conceding that the issue was a close one, he thought that the expert's testimony was sufficiently scientific in nature and helpful to the trier of fact to warrant its

admission. Id. at 193-98, 168 P.3d 1214 (Armstrong, J., concurring in part, dissenting in part).[3] We begin by reviewing the standards that this court has used to determine whether scientific evidence will be admitted. In *Jennings v. Baxter Healthcare Corp.*, 331 Or. 285, 301, 14 P.3d 596 (2000), the court noted that its prior cases had held that expert testimony is admissible if it is relevant under OEC 401,[4] would assist the trier of fact under OEC 702[5] and is not subject to exclusion under OEC 403[6] because its probative value *4 is outweighed by the danger of unfair prejudice or jury confusion. In this case, as in many others involving the admissibility of scientific evidence, we must determine "whether scientific evidence is probative under OEC 401" and conduct the "relevancy and prejudice analysis implicated in OEC 702's helpfulness standard[.]" *Jennings*, 331 Or. at 302, 14 P.3d 596 (quoting *Brown*, 297 Or. at 417, 687 P.2d 751); see also *Brown*, 297 Or. at 409, 687 P.2d 751 (court must "identify and evaluate the probative value of the evidence, consider how it might impair rather than help the factfinder, and decide whether truthfinding is better served by exclusion or admission"). In *O'Key*, 321 Or. at 291, 899 P.2d 663, this court explained the principles underlying the application of the evidentiary rules to scientific evidence: "Evidence perceived by lay jurors to be scientific in nature possesses an unusually high degree of persuasive power. The function of the court is to ensure that the persuasive appeal is legitimate. The value of proffered expert scientific testimony critically depends on the scientific validity of the general propositions utilized by the expert." (Footnote omitted.) In ruling on admissibility, the trial court performs the "vital role" of "gatekeeper," id. at 307, 899 P.2d 663, screening proffered scientific testimony to determine whether it is sufficiently valid, as a matter of science, to legitimately assist the trier of fact and "exclud[ing] 'bad science' in order to control the flow of confusing, misleading, erroneous, prejudicial, or useless information to the trier of fact." Id. at 306, 899 P.2d 663. This court has set out a number of factors that may be considered in determining the admissibility of scientific evidence: "(1) The technique's general acceptance in the field; "(2) The expert's qualifications and stature; "(3) The use which has been made of the technique; "(4) The potential rate of error; "(5) The existence of specialized literature; "(6) The novelty of the invention [if one is involved]; and "(7) The extent to which the technique relies on the subjective interpretation of the expert." [7] *Brown*, 297 Or. at 417, 687 P.2d 751. Those factors, however, are not an "exclusive checklist," *Jennings*, 331 Or. at 302, 14 P.3d 596, and the "existence or nonexistence" of any particular factor may enter into the final decision on admissibility, "but need not necessarily do so." Id. at 303, 14 P.3d 596 (quoting *Brown*, 297 Or. at 417-18, 687 P.2d 751). Underlying the various considerations and factors described by the court is the fundamental question of the "scientific validity of the general propositions utilized by the expert." *Jennings*, 331 Or. at 303, 14 P.3d 596 (quoting *O'Key*, 321 Or. at 291, 899 P.2d 663). This court has applied the foregoing principles to determine the admissibility of scientific evidence in several cases. The parties discuss in detail this court's decisions in *5 *Brown*, where the court considered the admissibility of polygraph evidence, and *O'Key*, where the court evaluated the admissibility of the Horizontal Gaze Nystagmus (HGN) test as a preliminary method of

determining whether a defendant might be under the influence of intoxicants. As the citations to those cases in the discussion above shows, the cases are helpful in the sense that they describe the general rules for admissibility of scientific evidence. However, they provide limited guidance in deciding the issue before us, because both *Brown* and *O'Key* involved the admissibility of specific techniques or tests, the validity of which turned on scientific principles.^[8] Here, in contrast, the expert testimony at issue focuses on medical causation—specifically, whether plaintiff's injuries were caused by the gadolinium that was injected into her hand and the question is whether the proffered expert testimony about causation meets the standard of scientific validity. That is, the issue is the scientific basis for the causation testimony, rather than the scientific basis for a particular technique or method. This court considered the admissibility of expert medical testimony as to causation in *Jennings*. There, the plaintiff proffered expert testimony that her neurological problems were caused by silicone that had leaked from silicone breast implants. The expert had examined approximately 50 women, many of whom had inner-ear balance problems and loss of sensation in their extremities after exposure to silicone. The expert testified that "the unique thing was that there was an extraordinarily high correlation, 95 percent had the combination of unusual sensory patterns and the inner ear [problem]." 331 Or. at 290, 14 P.3d 596. As part of his analysis, the expert performed a "differential diagnosis," in which he considered various potential causes of the symptoms and then ruled out all but one, the exposure to silicone. *Id.* at 291, 14 P.3d 596 ("In a differential diagnosis, a doctor develops a list of all diseases that might cause a patient's symptoms and then, by a process of elimination, narrows the list."). Although no published studies, peer-reviewed publications, or medical consensus supported his testimony as to causation, *id.* at 292-93, 14 P.3d 596, this court held that the testimony should have been admitted. "Although [the expert's] hypothesis has not been tested by others, that is, in part, because his work is new." *Id.* at 307, 14 P.3d 596. Two aspects of *Jennings* are pertinent to this case. First, this court expressly permitted the use of "differential diagnosis" as a means of determining medical causation. Second, the court concluded that OEC 702 does not automatically preclude the admission of "novel" scientific evidence: "If it is otherwise scientifically valid, a novel conclusion is admissible." 331 Or. at 307, 14 P.3d 596. Thus, although published studies and acceptance of the theory in the medical community are relevant considerations, their absence in that case did not mean that the expert's scientific testimony as to causation had to be excluded. The expert in *Jennings* could not explain the mechanism by which silicone had caused the neurological problems, but he reported a high correlation between exposure to silicone and the specific neurological symptoms in the women whom he had studied. From that correlation and the elimination of other possible causes of the symptoms, the expert reached the conclusion that the exposure to silicone had been the likely cause of the plaintiff's symptoms. This court concluded that the expert testimony on causation was scientifically valid and should have been admitted. 331 Or. at 305, 14 P.3d 596. We turn to the application of those principles to the expert testimony here. As noted, in *Jennings*, this court recognized that *6 "differential diagnosis"^[9] is an accepted technique in which "a doctor develops

a list of all diseases that might cause a patient's symptoms and then, by a process of elimination, narrows the list." 331 Or. at 291, 14 P.3d 596 (citing Mary Sue Henifin, Howard M. Kipen, and Susan R. Poulter, Reference Guide on Medical Testimony, in Reference Manual on Scientific Evidence 439, 463 (Federal Judicial Center ed., 2d ed. 2000)). Put differently, differential diagnosis involves a process by which a medical expert first "rules in" various potential causes and then "rules out" those causes one by one (to the extent possible) by analyzing the patient's condition until the expert can identify the likely cause from among those remaining. Thus, "differential diagnosis" is a general description of a methodology or process accepted by the medical community as a means of determining causation (or condition), rather than a specific scientific technique or test, such as the HGN test considered in *O'Key* or the use of polymerase chain reaction-based DNA testing at issue in *State v. Lyons*, 324 Or. 256, 924 P.2d 802 (1996). For that reason, although differential diagnosis can be the basis for admissible expert testimony as to medical causation, testimony is not admissible simply because the expert conducted a differential diagnosis. Rather, admissibility will turn on whether the particular use of differential diagnosis to determine causation meets the more general test of scientific validity. See *Jennings*, 331 Or. at 305-10, 14 P.3d 596 (concluding, after reviewing expert's basis for including and excluding potential causes of plaintiff's condition, that differential diagnosis provided sufficient basis for expert to testify that silicone exposure was likely cause of the plaintiff's condition). We also recognize, as did the Court of Appeals, that differential diagnosis of medical causation often cannot lead an expert to conclude, with certainty, that event "A" caused condition "B." [10] Rather, in many cases, a number of potential causes will be "ruled in," each of which has some percentage of likelihood of having caused plaintiff's condition; then the expert, by physical examination, testing, or other scientifically valid process, eliminates one or more of the potential causes in an effort to identify the actual cause. Even if the expert is not able to eliminate all alternative causes, the testimony nevertheless may be reliable and admissible if sufficient potential causes are eliminated for the expert to identify one particular cause as the likely cause of the condition. See Note, *Navigating Uncertainty: Gatekeeping in the Absence of Hard Science*, 113 Harv. L. Rev. 1467, 1474 (2000) (courts generally allow admission of differential diagnosis even when technique has not eliminated all alternative causes). Moreover, the basis for establishing the scientific validity of a differential diagnosis will vary depending on the type of injury. In the typical toxic tort case, there may be "a complicated causal chain, a long latency period, or low levels of exposure * * *." Note, 113 Harv. L. Rev. at 1472. In those circumstances, reliable testimony on causation may require "extremely accurate data and methods," peer-reviewed studies, and small and *7 controlled error rates to "rule in" a possible cause. *Id.*; see also *id.* at 1480 ("[O]ther characteristics of the generic toxic torts long latency period, complicated biological explanation, and lack of a single sharp exposure event are likely to make alternative causes seem both substantially probable and difficult to exclude."). In contrast, when the exposure occurs in a single, sharp event, and the injury is immediate and localized, it may be appropriate to "rule in"

the exposure as one of the possible causes of the injury, particularly when there are few obvious alternative causes. *Id.* at 1473 (describing circumstances in which toxic exposure may be considered as cause of plaintiff's injuries, even in the absence of epidemiological studies). Of course, when "ruling in" potential causes of a condition or injury for purposes of differential diagnosis, a trial court should insist that the causation theory be "biologically plausible," that is, that the exposure could have caused plaintiff's injury. *Id.* at 1475 (citing Reference Manual on Scientific Evidence at 163, 204); see also *Jennings*, 331 Or. at 309, 14 P.3d 596 ("What is biologically plausible depends upon the biological knowledge of the day." (Quoting Hill, *The Environment and Disease: Association or Causation?*, 58 *Proc. R. Soc. Med.* 295, 298 (1965))). For that reason, a particular possible cause should not necessarily be excluded on the grounds that the expert cannot describe the precise mechanism of causation or point to statistical studies of cause and effect. See *Jennings*, 331 Or. at 309, 14 P.3d 596 ("There are many generally accepted hypotheses in science for which the mechanism of cause and effect is not understood fully."). In this case, the Court of Appeals accepted the concept of differential diagnosis but concluded that there was no scientific basis for plaintiff's expert to "rule in" gadolinium exposure as a possible cause of plaintiff's symptoms. *Marcum*, 215 Or.App. at 181-82, 187, 168 P.3d 1214. The court reached that conclusion because, in its view, the expert's testimony did not meet the standard required for scientific validity: "Either the expert must be able to identify a scientifically demonstrable mechanism of causation or there must be some independent, verifiable corroboration of otherwise inexplicable causation, as in *Jennings*. Where, however, a plaintiff's circumstances are unique and the expert cannot proffer a mechanism of causation, general temporal and spatial proximity to the onset of symptoms, even when coupled with reports of other adverse effects, is insufficient." *Id.* at 187, 168 P.3d 1214. Because there was no basis to "rule in" gadolinium extravasation as a cause of plaintiff's injuries, the court reasoned, the expert's elimination of other potential causes and his subsequent conclusion that gadolinium extravasation likely had caused the injuries was inadmissible. *Id.* In reaching that conclusion, the Court of Appeals cited the appropriate tests identified in *Brown*, *O'Key*, and *Jennings*, but we think that it applied them in too rigorous a manner, given the context of this case. The court seemed to suggest that, in the absence of a well-understood mechanism of causation or a study demonstrating a high correlation between exposure and injury, testimony as to causation is not permitted because the possible cause never could be "ruled in" for purposes of a differential diagnosis. In *Jennings*, however, this court concluded that the expert's inability to explain the mechanism of plaintiff's condition in that case went to the weight, not to the admissibility, of the evidence. 331 Or. at 309, 14 P.3d 596. And, although plaintiff's expert here could not point to studies demonstrating a correlation between gadolinium extravasation and vasospastic disorder in the hand, our discussion above of the use of differential diagnosis shows that the absence of such studies does not necessarily preclude "ruling in" that exposure as a possible cause of plaintiff's injuries. With that discussion in mind, we return to the expert testimony at issue here. Plaintiff's expert identified a number of reasons that he "ruled

in" gadolinium extravasation as a potential cause of plaintiff's vasospastic disorder: Her symptoms occurred almost immediately after the injection and in the same area as the injection. Her description of her sensations during the injection was consistent with extravasation, and she had no symptoms prior to the injection. Published medical literature suggested that gadolinium exposure can be toxic to tissue in mice, that it can cause inflammation *8 and necrosis (tissue death), and that those toxic effects are likely increased by extravasation because the body has greater difficulty excreting a substance when it is located outside the arterial system. Although plaintiff's expert did not diagnose necrosis in plaintiff's hand, he testified that plaintiff may have necrosis under the skin. The expert also testified that no studies existed linking gadolinium to vasospastic disorder and that no studies were likely to be done because gadolinium extravasation is rare, and particularly so in the hand, as contrast chemicals used in MRI examinations ordinarily are not injected into the hand. Plaintiff's expert also testified as to the scientific reasons that he "ruled out" other possible causes of plaintiff's symptoms. Notably, he ruled out an ordinary case of Raynaud's syndrome itself, because that syndrome almost always appears in both hands (bilaterally), while plaintiff's symptoms manifested themselves only in the hand where the injection had occurred. Through blood tests and other diagnoses, he ruled out other potential causes of plaintiff's symptoms, including connective tissue and autoimmune disorders, such as lupus. He also ruled out allergic or hypersensitivity reactions to the gadolinium. Based on his research, examination, and tests, plaintiff's expert concluded that plaintiff's symptoms probably were caused by gadolinium extravasation. As noted, after reviewing that proffered testimony, the Court of Appeals concluded that it lacked scientific validity because the expert was unable to "identify a scientifically demonstrable mechanism of causation" or provide "some independent, verifiable correlation of otherwise inexplicable causation[.]" *Marcum*, 215 Or.App. at 187, 168 P.3d 1214. A brief discussion of the court's reasoning demonstrates why we conclude that it took too narrow a view in considering the scientific validity of that testimony. First, as to the "mechanism of causation" standard, plaintiff's expert testified that the cause of Raynaud's syndrome (vasospastic disorder) has not been established in the medical community—that is, the condition can be identified, but its mechanism of causation is unknown.[11] He also testified that there was nothing in the medical literature to suggest that gadolinium could not cause plaintiff's symptoms. See *Jennings*, 331 Or. at 309, 14 P.3d 596 (expert's opinion as to causation had not been accepted by the scientific community, but neither had it been rejected). Finally, the expert pointed to tests on mice that showed that the injection of gadolinium was toxic to tissue, causing inflammation and necrosis. He further explained that the studies showed that the toxicity was related to the duration of exposure and that the extravasation would have made the gadolinium more toxic to plaintiff because it would have remained in her system longer than if it had been properly injected. Second, the Court of Appeals certainly was correct in noting that "independent, verifiable corroboration" can be critical in demonstrating "otherwise inexplicable causation." *Marcum*, 215 Or.App. at 187, 168 P.3d 1214. However, injuries may be rare or unique, as

plaintiff's injury was here, and, for that reason or because of ethical or other considerations, studies and comparisons may not be possible. As discussed above, if other legitimate grounds for "ruling in" a potential cause exist, as they do here, then the absence of corroboration is not, itself, necessarily grounds for exclusion. It follows from the foregoing that, by focusing narrowly on the absence of a scientifically accepted mechanism of causation or other verifiable correlation, the Court of Appeals asked for too much. More specifically, the court disregarded the potential connection between the gadolinium extravasation and plaintiff's injuries, because, in that court's view, that potential cause could not be "ruled in." Although the court was properly concerned with avoiding the logical fallacy of post hoc, ergo propter hoc (after this, therefore because of this) reasoning, it failed to give appropriate deference to the expert witness's reliance upon plaintiff's sudden, single exposure and her immediate, localized symptoms, as well as to the biological plausibility of the expert's causation theory. The immediate *9 symptoms that plaintiff experienced in her hand indicate a causal link between the exposure and her symptoms, and her expert's careful differential diagnosis supports that connection. Moreover, the expert's reliance on studies demonstrating the toxicity of gadolinium provide a biologically plausible basis for his conclusion. Applying the criteria identified above, we agree with plaintiff that she had made an adequate showing of a scientifically valid basis for "ruling in" gadolinium as a potential cause of her symptoms, as well as for "ruling out" a number of the other possible causes of her injury. The jury should have been permitted to hear the expert's testimony that, in his opinion, the gadolinium extravasation caused that injury. Defendants argue that permitting plaintiff's expert to offer his opinion as to causation in the absence of a scientifically demonstrable mechanism of causation or studies demonstrating a high degree of correlation between cause and effect undermines this court's emphasis on the requirement of scientifically valid expert testimony. In particular, they imply that such a decision would permit experts to speculate on the causal connection between even brief exposure to toxic substances and later physical symptoms. That concern is misplaced. Here, the exposure event was direct and abrupt, and the symptoms were immediate and localized. In those circumstances, and given the acknowledged expertise and skill of plaintiff's medical witness, his reliance on the temporal and spatial relationships between the exposure and the symptoms (along with the other facts described above) and the biological plausibility of his conclusion as to causation support the scientific validity of his testimony. See generally Note, 113 Harv. L. Rev. at 1484 (significance of differential diagnosis and temporal proximity is inherently contextual and depends on sharpness of exposure event, among other things). The testimony of plaintiff's expert should have been admitted. Questions as to the weight to be given that testimony, possible weaknesses in the expert's theory, and the ultimate issue of causation were for the jury to decide based on all the evidence. Based on its decision regarding Williamson's testimony, the Court of Appeals affirmed the trial court's directed verdict on plaintiff's negligence claim and on her informed consent claim. Our disposition of the evidentiary issue means that we reverse the lower court rulings with respect to the negligence claim. Defendants, however, advanced

alternative arguments before the Court of Appeals as to why the directed verdict on the informed consent claim was proper. The Court of Appeals has not considered those arguments, and we therefore remand to that court so that it may consider them. The decision of the Court of Appeals is reversed. The case is remanded to the Court of Appeals for further proceedings.

NOTES

[1] The parties sometimes refer to plaintiff's condition as "vasospasm," "digital artery disease," or as "similar" to Raynaud's syndrome, a condition in which an artery "clamps down" abnormally in response to cold. It is undisputed that plaintiff suffered some kind of immediate injury to her hand at the time of the injection and that she continued to experience symptoms of vasospastic disorder.

[2] The parties do not dispute the professional qualifications of plaintiff's expert, Williamson, who is a vascular surgeon and a member of the Department of Vascular Surgery at Oregon Health and Sciences University. Williamson is an expert on the treatment of vascular impairment to the hands and fingers and has done substantial research in the area and published book chapters and journal articles on that subject. He is also the author of a chapter in a 1998 medical textbook on the methodology for differentiating the causes of vascular problems in the hand and fingers. The parties also do not disagree as to Williamson's diagnosis of plaintiff's condition. The sole dispute concerns his testimony as to the cause of plaintiff's condition and whether his expertise permits an opinion as to that cause.

[3] The Court of Appeals also rejected two assignments of error related to the alleged spoliation of evidence. Plaintiff did not petition for review of those issues, and we do not consider them.

[4] OEC 401 provides:

"'Relevant evidence' means evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence."

[5] OEC 702 provides:

"If scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training or education may testify thereto in the form of an opinion or otherwise."

[6] OEC 403 provides:

"Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay or needless presentation of cumulative evidence."

[7] To that list, the court joined 11 additional considerations:

"(1) The potential error rate in using the technique; "(2) The existence and maintenance of standards governing its use; "(3) Presence of safeguards in the characteristics of the technique; "(4) Analogy to other scientific techniques whose results are admissible; "(5) The extent to which the technique has been accepted by scientists in the field involved; "(6) The nature and breadth of the inference adduced; "(7) The clarity and simplicity with which the technique can be described

and its results explained; "(8) The extent to which the basic data are verifiable by the court and jury; "(9) The availability of other experts to test and evaluate the technique; "(10) The probative significance of the evidence in the circumstances of the case; and "(11) The care with which the technique was employed in the case." Brown, 297 Or. at 417 n. 5, 687 P.2d 751.

[8] For that reason, the court in Brown phrased many of the factors to be considered in determining admissibility with reference to the "technique" of polygraph analysis whether the "technique" was generally accepted in the field, the potential error for the "technique," and so on. Brown, 297 Or. at 417, 417 n. 5, 687 P.2d 751. Similarly, the court in O'Key consistently phrased the standard for admissibility and its application of that standard as whether the HGN "test" was generally accepted and was the subject of specialized scientific literature, among other considerations. O'Key, 321 Or. at 306, 314-19, 899 P.2d 663 (stating and applying standard).

[9] We recognize, as did the Court of Appeals, *Marcum v. Adventist Health System/West*, 215 Or. App. 166, 175 n. 5, 168 P.3d 1214 (2007), that the term "differential diagnosis" is more properly used to describe the process of determining the disease or symptoms from which a patient is suffering, rather than the process of determining the external cause of the disease or symptoms, and that "differential etiology" is a more precise description of the latter. See Mary Sue Henifin, Howard M. Kipen, and Susan R. Poulter, Reference Guide on Medical Testimony, in Reference Manual on Scientific Evidence 439, 481 (Federal Judicial Center ed., 2d ed. 2000) (defining those terms). However, given the widespread use of the term "differential diagnosis" to apply to determinations of causation as well as of disease or symptoms, we use that term here. Further, we reject defendants' argument that Williamson lacks expertise in "differential etiology." We need not decide whether, as plaintiffs argue, all doctors have expertise in differential etiology as well as differential diagnosis. It is sufficient in this case to say that Williamson had expertise in the causation of vascular disorders of the extremities.

[10] Of course, expert testimony of causation is sufficient if it establishes that defendant's conduct was the likely cause of plaintiff's injury; certainty is not required. See *Joshi v. Providence Health System*, 342 Or. 152, 159, 149 P.3d 1164 (2006) (causation in wrongful death action requires proof that defendant's acts or omissions "more likely than not" caused plaintiff's injuries).

[11] Although the Court of Appeals viewed that fact as a critical reason not to "rule in" gadolinium exposure as a possible cause of plaintiff's symptoms, that fact had to be weighed with the other grounds that the expert gave for "ruling in" that exposure. It is the combination of facts that we review.