OFFICE OF SPECIAL MASTERS

No. 90-1366V

(Filed: September 22, 1997)

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MICHAEL C. JARVIS, by His Father and Next Friend, LEO C. JARVIS,	*	
Petitioners,	*	
vs.	*	PUBLISHED
SECRETARY OF THE DEPARTMENT OF HEALTH AND HUMAN SERVICES,	*	
Respondent.	*	
* *		

Ronald C. Homer, Esq. & *Kevin P. Conway, Esq.*, Boston, Massachusetts, for petitioner.

Vincent J. Matanoski, Esq., United States Department of Justice, Washington, D.C., for respondent.

DECISION

ABELL, Special Master:

This case concerns the eligibility of Michael C. Jarvis (Michael) for compensation under the National Childhood Vaccine Injury Compensation Act (hereinafter Vaccine Act, or Program.)[(1)] Petitioner claims that as a result of the administration of an oral polio vaccination (OPV) on 8 March 1964, Michael suffered a seizure disorder with permanent sequelae. Petitioner filed a petition on behalf of Michael on 25 September 1990. On 16 June 1992, respondent filed a report denying petitioner's eligibility for compensation.

This is one of three cases presenting the same generic issue to the court.[(2)] It is an issue of first

impression in the Vaccine Program. In each of these three cases, the respective petitioners allege that the OPV can and did, in fact, cause a seizure disorder or seizures with resultant neurological sequelae. Because seizure disorders are not listed in the Vaccine Injury Table corresponding to OPV, the petitioners must pursue their claims via causation-in-fact. Causation-in-fact claims are separated into two primary issues: (1) C*an* the particular vaccine cause the alleged injury; and (2) *Did* that vaccine cause the alleged injury in the case at bar. The three cases were consolidated and tried together on the first part of the causation-in-fact analysis. The issue before the court that is the subject of this opinion is whether the administration of an oral polio vaccination *can* cause a seizure disorder or seizures with resultant neurological sequelae. A negative finding on that issue will result in the dismissal of the three cases. If the court were to answer that question in the affirmative, a separate trial in each case would be necessary to determine whether the OPV did, in fact, cause the seizure disorder in the respective cases.

During the week of 19 February 1996, the petitioners presented the testimony of Dr. Wolfgang Ehrengut. Dr. Ehrengut was retained by all three parties. His testimony, which filled four days, was limited to whether OPV can cause seizures -- the first prong of the causation-in-fact analysis.[(3)] During the week of 27 January 1997, respondent presented the testimony of three medical experts: Dr. Jerome O. Klein, Dr. Walter T. Hughes and Dr. Samuel L. Katz. As in the first hearing, the testimony was limited to the first part of the causation-in-fact inquiry. Upon the close of testimony on this issue, a briefing schedule was set. Petitioners filed a joint brief on 6 May 1997. Respondent filed her brief on 28 July 1997. Petitioners filed a joint reply on 2 September 1997.

For the reasons stated below, the court finds that petitioners have not met their burden of proving that the OPV can cause a seizure disorder or seizures with resultant neurological sequelae.

I. STATUTORY FRAMEWORK

In order to demonstrate entitlement to compensation in an off-Table case, *to wit*, by causation-in-fact, a petitioner must affirmatively demonstrate by a preponderance of the evidence that the vaccination in question more likely than not caused the injury alleged. §§ 11(c)(1)(C)(ii)(I) and (II); *Grant v. Secretary of HHS*, 956 F.2d 1144 (Fed. Cir. 1992); *Strother v. Secretary of HHS*, 21 Cl. Ct. 365, 369-70 (1990), aff'd, 950 F.2d 731 (Fed. Cir. 1991).

The Federal Circuit in *Grant* summarized the legal criteria required to prove causation-in-fact under the Vaccine Act. The court held that a petitioner must

show a medical theory causally connecting the vaccination and the injury. Causation in fact requires proof of a logical sequence of cause and effect showing that the vaccination was the reason for the injury. A reputable medical or scientific explanation must support this logical sequence of cause and effect.

Grant, 956 F.2d at 1148 (citations omitted); *see also* Strother, 21 Cl. Ct. at 370.

To establish causation-in-fact, this court employs a two part test. *First*, petitioners must provide sufficient evidence that the vaccine in question is capable of causing the alleged injury. *Second*,

petitioners must prove that the vaccine actually caused the alleged injury in this particular case.

With respect to the first prong of the test, petitioners must demonstrate the biological plausibility of their theory. While it is not necessary to show that a majority of scientists and physicians subscribe to this theory, petitioners must demonstrate that a sufficient minority have accepted it. Petitioners must proffer a scientific pathogenesis underlying the alleged causal relationship. Epidemiological studies, while not dispositive, lend credence to the claim of plausibility. Articles published in respected medical journals, which preferably have been subjected to peer review, are also persuasive.

As stated in the legislative history for the Vaccine Act, "evidence in the form of scientific studies or expert medical testimony is necessary to demonstrate causation" for petitioners seeking to prove causation-in-fact. H.R. Rep. No. 99-908, 99th Cong. 2d Sess., pt. 1 at 15 (Sept. 26, 1986), *reprinted in* 1986 U.S.C.C.A.N. 6344, 6356. In this regard, the United States Supreme Court's decision in *Daubert v. Merrell Dow Pharmaceuticals*, Inc., 113 S. Ct. 2786 (1993), is instructive. While that case dealt with the admissibility of scientific evidence and here we are assessing the scientific validity of evidence already presented, *Daubert* is helpful in providing a framework for evaluating the reliability of scientific evidence.[(4)] The Court in *Daubert* wrote:

[I]n order to qualify as "scientific knowledge," an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation -- *i.e.*, "good grounds," based on what is known. In short, the requirement that an expert's testimony pertain to "scientific knowledge" establishes a standard of evidentiary reliability.

Id. at 2795. The Court goes on to suggest a key criterion of scientific reliability is whether a theory has been tested and subjected to peer review and publication. *Id.* at 2796-97. While acknowledging that publication is not a *sine qua non* of admissibility, the Court found the submission of a novel scientific theory to the scrutiny of publication is a component of "good science" and the fact of publication is a relevant, though not dispositive, consideration. *Id*. at 2797. Finally, the Court noted, while not a precondition, the general acceptance of a scientific theory within the scientific community can have a bearing on the question of assessing reliability while a theory that has attracted only "minimal support" may be viewed with skepticism. *Id.*

The second prong of the causation-in-fact test is case specific. The court will address the second prong only after an affirmative finding on the issue of whether the vaccine can cause the type of injury alleged. To satisfy the second prong, petitioners must show, by a preponderance of the evidence, that the vaccine caused the symptoms that manifested in this case. Petitioners do not meet this affirmative obligation by merely showing a temporal association between the vaccination and the injury. Rather, petitioners must explain *how* and *why* the injury occurred. *Strother*, 21 Cl. Ct. at 370; *see also Hasler v. United States*, 718 F.2d 202, 205 (6th Cir. 1993), cert. denied, 469 U.S. 817 (1984) (inoculation is not the cause of every event that occurs within a ten day period following it). All traditional tort theories of causation, including but not limited to proximate and intervening causes, are applicable, and must be addressed.

II. FACTS

In this case, as in the two companion cases, a comprehensive stipulation of facts was filed.[5]

To briefly recapitulate, Michael Jarvis was born on 5 June 1962. On 8 March 1964 he was administered an OPV. On 13 March 1964 Michael was hospitalized with a high fever and seizures. By 16 October 1968 his condition had improved so that he only rarely had mild seizures. By May 1966, it was apparent that Michael was developmentally delayed. By October 1968, it was apparent that he was a severely brain injured child. Michael remains severely retarded. He has never been diagnosed with paralytic polio.

III. MEDICAL EXPERT TESTIMONY

A. Dr. Wolfgang Ehrengut[6]

1.

Petitioner filed Dr. Ehrengut's medical expert report in support of his case. It is Dr. Ehrengut's opinion that OPV can cause seizures. For the purpose of analogy, Dr. Ehrengut pointed out that other viruses, such as measles and smallpox, can invade the central nervous system and cause neurological complications including seizures and encephalitis. P.Ex. 27 at 7; Tr. at 9. He stated that it is well known that the attenuated vaccines from these viruses can enter the CNS and cause "the same clinical and neuropathological pictures." P.Ex. 27 at 7. After a study of one child who suffered a convulsion one week after an OPV vaccination, Dr. Ehrengut was "therefore convinced that the causal connection between seizure and OPV exists." *Id*.

During his testimony, Dr. Ehrengut stated it was important, and indeed it is a fundamental assumption underlying his theory, that immunization complications can anatomically mimic the clinical manifestations of the disease. Tr. at 9. Therefore, he opined, it can be expected that OPV can cause the same symptoms as wild poliovirus. *Id*.

Dr, Ehrengut referenced the study of Dr. David Bodian of Johns Hopkins University. R.Ex. T. Dr. Bodian's study demonstrated that a small amount of polio-induced lesions may be found in the motor cortex of the brain and they are usually mild. *Id*. at 493-495. Dr. Ehrengut opined that this "irritation of the neurons" can cause seizures. Tr. at 14, 25.

2.

Also in support of his case, petitioner filed various articles, some of which were authored by Dr. Ehrengut. There are two such articles, written by Dr. Ehrengut, that are of particular importance to the issue at bar:

1) *Convulsions Following Oral Polio Immunisation*,[7] International Symposium on Immunization: Benefit versus Risk Factors, Brussels, 1978, Developmental Biology Standard, vol. 43, pp. 163-171, S. Karger, Basel (1979);filed as P.Ex. 28-T2; and

2) *Oral Poliomyelitis: Immunization and Convulsive Disorder*,[8] Clinical Pediatrics, Volume 192, pages 395 to 397, F. Enke, Stuttgart (1980);filed as P.Ex. 28-T1.

In Article One, Dr. Ehrengut reported 59 cases in which seizures were observed within 30 days of the

administration of OPV. The data was collected in Germany between 1964 and 1974 from a population of vaccinated children up to seven years of age.

3.

Petitioner also filed the medical expert opinion of Dr. John Tilelli. Dr. Tilelli is board certified in pediatrics, toxicology, emergency medicine and pediatric critical care medicine. He relied in substantial part upon Dr. Ehrengut's studies. As Dr. Tilelli was not called to testify on behalf of petitioners, and therefore was not subject to cross-examination, his report is of marginal value to the court. In any event, upon review, the court found Dr. Tilelli's report to be vague and conclusive, based largely on temporal association and imprecise comparison to other viruses.

In addition, petitioner referred to the report of Dr. Mark Geier, a geneticist whose report was filed in a companion case. Once again, Dr. Geier was not called to testify in support of petitioner's case and as such, his opinion is of marginal value. Dr. Geier's opinion, which is in an area outside his expertise, was not persuasive to the court.

B. Dr. Jerome O. Klein[(9)]

1.

Dr. Klein was asked to comment upon the studies of Dr. Ehrengut, which formed the basis of the latter's opinion that the OPV can cause seizures. Dr. Klein questioned the validity of those studies. Tr. at 359. In his analysis of Dr. Ehrengut's "Article One" (*Convulsions Following Oral Polio Immunisation*, P.Ex. 28-T2), Dr. Klein opined that the article was ambiguous. Tr. at 361. There was no explanation of how the data was reported. *Id*. There was no definition or criteria for the seizures that were reported. Tr. at 362. And while the article does distinguish between "doubtful" and "probable" seizures, it omits many alternate causes that could explain the seizure events. *Id.* He stated there was no attempt to rule out other causes such as hypoxia, toxins, hypocalcemia, hypoglycemia, familial causes, neurocutaneous syndromes, mumps, measles, arboviruses and enteroviruses. Tr. at 362-363.

After raising issues regarding the quality of the information gathered, Dr. Klein described what are in his opinion statistical deficiencies in Article One. Of greatest import, the 31 "probable" and 27 "doubtful" cases collected were placed in the same cohort. Tr. at 363-364. Dr. Klein opined that this would dilute the value of the information taken from such a cohort. Tr. at 364.

Dr. Klein believes that Dr. Ehrengut's Article One is merely a "descriptive paper." Tr. at 365. He opined that Dr. Ehrengut did not establish a cause and effect relationship, but merely presented observations upon which his colleagues were to comment. *Id*. While Dr. Klein was not personally aware of any study done in response to or following up on Article One, respondent did file a published criticism.[(10)] Tr. at 366; R.Ex. RR.

Dr. G. Joppich published a letter in a German medical journal in response to Dr. Ehrengut's study.[(11)] In his letter, Dr. Joppich believed it necessary to publish a critical analysis "because a number of serious reservations can be advanced." R.Ex. RR at 1. Dr. Joppich first cited the lack of a "control group of children, the same age, not vaccinated, for the same period of time, and insufficiently large numbers," as detrimental to the scientific value of Dr. Ehrengut's theory. *Id*. He criticized the method of obtaining retrospective information based predominantly on a temporal relationship as a "scientifically highly

problematic procedure." *Id*. His next point of attack was on Dr. Ehrengut's failure to attempt to differentiate the allegedly OPV-related convulsions with the rather significant number of background occurrences in the population. *Id*. Dr. Joppich stated that the number of seizures expected in the general population in question would actually be higher than that observed by Dr. Ehrengut. *Id*. at 2. In other words, the latter's observations do not tell us anything out of the ordinary. Dr. Joppich opined that "[t]he proof of a causal relationship with the OPV is thus not at all given" in Dr. Ehrengut's Article One. *Id*.

In response to Joppich, Dr. Ehrengut published Article Two (*Oral Poliomyelitis: Immunization and Convulsive Disorder*, P.Ex. 28-T1).[(12)] Because Article Two was not written in standard scientific publication format, (including sections entitled materials and methods, results, discussion, summary, and conclusions) Dr. Klein opined this paper was intended as a letter in response to the criticism by Joppich. Tr. at 373. Upon review, the court finds Article Two to be little more than a reiteration of Article One.

Dr. Klein analyzed the chart on page 20 of the translation (page 396 of the original text) of Article Two. He opined that the method of data collection was ambiguous. Tr. at 373-378. The chart showed that there was one reported convulsion within 8 days of an immunization. From this statistic Dr. Ehrengut attempted to extrapolate a rate of convulsions among a population of immunized children that is greater than among non-immunized children. Tr. at 378. In Dr. Klein's estimation, a rate based upon one occurrence is not scientifically valid. *Id*. He stated that a valid study would have a control group of children of the same age, who were not vaccinated, and were observed during the same period as children who did receive the OPV. *Id*. Such statistical analysis was not performed by Dr. Ehrengut. As in Article One, Article Two contained no definition or criteria for seizure, and there was no attempt to rule out alternative causes of the seizure. Tr. at 379-380.

One of Dr. Klein's concerns with Dr. Ehrengut's studies was his attempt to establish a frequency of seizures, post-OPV immunization, in comparison with what is a common event. Tr. at 380. Idiopathic epilepsy occurs in 2 to 6 per 1000 people. *Id*. Febrile seizures occur in approximately four percent of children. *Id*. With such a common event as the background for the study, Dr. Klein believes that Dr. Ehrengut has failed to prove a statistically significant relationship between seizures and OPV. *Id*.

Dr. Klein, drawing upon his experience as an editor for numerous scientific journals, opined that Dr. Ehrengut's papers would not pass initial peer review. Tr. at 381. He stated that the articles would have been sent back to the author for clarification. *Id*. He offered that the papers might be useful as provocative descriptive papers, but that they are not scientific studies. *Id*.

Dr. Klein opined that, even if Dr. Ehrengut's studies were accurately conducted, they would not necessarily be relevant in the United States because of the differences in vaccines manufactured at home and abroad. Tr. at 382. The vaccines in America and in Europe are different products and have different safety standards. *Id*.

Upon further investigation, the court determined that the Clinical Pediatrics journal is published six times per year, has a subscription rate of approximately 1000 (which is quite modest in Dr. Klein's estimation), and is not peer reviewed like the more prominent scientific journals. Tr. at 392-393. Investigation into the publishing standards and processes of the Developmental Biology Standard journal were unsuccessful. Tr. at 396. It is not clear whether papers are peer reviewed prior to publication in that journal.

Dr. Klein opined that he would not consider a seizure to be a symptom of poliomyelitis. Tr. at 384. In

fact, he stated that a seizure would be an indication that some disease other than polio was present in the textbooks contemporaneous with the period of maximum experience with the wild poliovirus. Tr. at 384-385. He defended the older literature by stating that, while those textbooks may have been written in the 1960's, they were written by the doctors with the most clinical experience with poliomyelitis. *Id*.

In the literature contemporaneous with the greatest clinical experience, there was a strong negative association between seizures and polio. Tr. at 385-386. Mental retardation was not considered a symptom of polio because, while the afflicted were grossly impaired, their mental faculties were entirely intact. Tr. at 386. Dr. Klein is aware of no researcher in the United States who has concluded that OPV can cause seizures. Tr. at 386.

C. Dr. Walter T. Hughes[(13)]

1.

The primary focus of Dr. Hughes' testimony was the pathogenesis of the wild poliovirus. As he explained, the poliovirus enters the body orally. Tr. at 468. It may be transmitted through the air or by hand contact. *Id.* After entry, the only way an infection occurs is by the attachment of the virus to cell surfaces. Tr. at 469. The virus will attach to the mucus membrane in the pharynx or in the intestinal track. *Id*. Cells have particular receptors which attach to certain viruses. The cells with receptors that allow the poliovirus to attach are located in the pharynx and the intestines. Tr. at 470. Only after the virus has attached to a receptor cell will the virus begin to replicate. Tr. at 472.

Dr. Hughes testified that, after the replication has begun, the virus reaches the lymph cells. Tr. at 472. These are the cells that elicit the immune response. *Id*. The body then begins to fight the virus by producing antibodies. Tr. at 473. Three proteins are produced, which are generally referred to as immunoglobulins, and specifically identified as IgG, IgM and IgA. *Id*. The IgA is a local antibody that stays at the surface. *Id*. It is important for polio immunization because, when these proteins are made, the virus cannot attach to cells after entry into the body. *Id*. IgM is a systemic antibody that circulates through the entire body. Tr. at 474. It is the first antibody that is produced and is important in the diagnosis of an infection. *Id*. After the IgM increases, it is followed by the IgG. The IgG, or gamma globulin, is a systemic antibody that remains in the body for life. Tr. at 474.[(14)]

Dr. Hughes explained that the presence of the virus in the bloodstream, referred to as viremia, is first noticed approximately on the fifth day after exposure, peaks at about the seventh day, and then diminishes. Tr. at 475-476.[(15)] This dissipation is due to the development of antibodies which neutralize the virus. Tr. at 476. Once the IgM antibody attaches onto a virus particle, it inactivates the virus. *Id*. Once inactivated, the virus cannot replicate and is discarded by the body as dead tissue. *Id*. Approximately 95% of people who are exposed to the wild poliovirus remain asymptomatic throughout the infection and spontaneously eradicate the virus. Tr. at 478.[(16)] With the other 5% of people exposed to poliovirus, the immune system was unable to clear the virus. Then, with the viremia, the poliovirus exclusively attacks nerve cells - including the brain, spinal cord and peripheral nerves. Tr. at 479.

2.

Dr. Hughes then gave a general exposition on the manner in which the central nervous system functions. First the brain sends an electrical pulse to the spinal cord, through the anterior horn cells in the spinal cord, to the peripheral nerves. Tr. at 480. Then the peripheral nerves stimulate the muscle to contract. *Id*.

He stated that a muscle can only contract or relax and that it must have a "message" from a nerve to do so. *Id*.

Dr. Hughes explained one manifestation of polio infection which attacks the upper spinal cord and brain directly. He referred to these occurrences as bulbar cases. Tr. at 481. Trauma, such as surgery, can induce such an attack. In such cases, patients experience problems with respiration, and sometimes paralysis, of all extremities and of the muscles of respiration. Tr. at 482. He explained that if the respiratory muscles such as the chest muscles or the diaphragm cannot move, the result can be oxygen deprivation to the brain. *Id*. Such cases, he opined, are serious and often fatal. *Id*.

Dr. Hughes explained that another way in which poliovirus can infiltrate the central nervous system is through the neuropathways. Tr. at 482. Although medical science has yet to determine exactly how this process occurs, it is believed that the virus replicates in cells in contact with the infected cell. *Id*. As the virus must have a cell to replicate, it is transmitted by fusion with adjacent cells. Tr. at 482-483. When asked what happens to a nerve cell that is infected with the poliovirus, Dr. Hughes responded as follows:

The virus kills the cells, kills the nerve cell in almost all instances. In a few nerve cells, in some nerve cells, the virus will damage the cell. It may cease to function, but it may recover. Usually, when the virus reaches the brain or spinal cord, and enters those nerve cells, it kills the cell. And after that nerve cell is killed, I think it's easy to understand what happens. It just cuts the line of communication. So that nerve cells [sic] then has no electrical transmission down to a muscle.

... So that if the nerve cells that are affected are to the muscles of the lower extremities, to the legs or the arms or whatever cells, then the cell is dead. It can't transmit the message. The muscle can't respond, so you get paralysis. ... The muscle is just limp.

Tr. at 483.

Dr. Hughes went on to explain that, because a convulsion is a rapid contracting of muscles, which receive the signals from active nerves, if the nerves are dead and the line of communication from the brain severed, the convulsion cannot occur. Tr. at 484-485. He stated emphatically that it is "not possible to have a convulsion in a paralytic site." Tr. at 485. If a site in the body has been affected by the poliovirus, there is no way that site can convulse because it cannot respond to the signals from the brain. *Id*. When the herpes virus infects and damages brain cells, it causes them to hyperact and set off electrical discharges which in turn cause seizures. Tr. at 503. In contrast, the poliovirus destroys the cells it infects. *Id*.

Dr. Hughes explained that the site most often affected by the poliovirus is the anterior horn cells of the spinal cord. Tr. at 486. As opposed to other viruses, such as the herpes simplex virus, that affect the central nervous system diffusely, the poliovirus targets very specific areas of the CNS. Tr. at 486-487. The poliovirus most often affects the spinal cord first then the lower part of the brain. Tr. at 487. In 90% of paralytic polio cases, the spinal cord alone is affected. Tr. at 488.

Dr. Hughes reviewed and commented upon the analysis of the brain tissue by Dr. David Bodian of Johns Hopkins University. R.Ex. T. Dr. Bodian studied, *inter alia*, the presence and location of the polio infection in the brains of persons who had died as a result of the disease. These were cases of considerable severity. In discussing the illustration of page 493 of Dr. Bodian's article (R.Ex. T), Dr. Hughes pointed out that the polio disease concentrates in the spinal cord. Tr. at 491. Dr. Hughes further elaborated that the disease may move up into the bulbar part of the brain, which is the lower part of the brain controlling respiration, facial nerves, and swallowing. Tr. at 492. Dr. Bodian's illustration shows a

less concentrated infection of polio in this area of the brain. Dr. Hughes next reviewed the sparsely affected area of the cerebellum, which controls balance. Tr. at 492. Finally, Dr. Hughes noted that the presence of the poliovirus in the cortex, specifically the precentral gyrus (the upper brain), "is not very common involvement ... at all." Tr. at 492. He opined that it is very unusual to find the virus in the cortex. Tr. at 493.

Dr. Hughes quoted from a section of Bodian's article to support his theory:

It is important to emphasize, moreover, that although lesions appear in certain functional centers in the central nervous system, symptoms attributable to such injury need not necessarily result. Such injury must reach a certain threshold of severity, varying with the margin of safety of each center before a clinical effect is observed. ...The obvious explanation of this is that severe lesions and concentrated damage to nerve cells are usually necessary to produce dysfunction at the clinical level; therefore one must look for centers which are severely involved for the site of origin of clinical signs.

R.Ex. T at 486-487. Dr. Hughes opined that a certain threshold of damage to a site in the brain must be surpassed before it causes any discernable disease. Tr. at 497. He stated that the presence of a pathological disease does not always result in clinical symptoms, and that the human body is able to tolerate a certain amount of damage without developing any symptoms thereof. Tr. at 498.

Dr. Hughes opined that the distribution of poliovirus in the brain is consistent. Tr. at 499. In all polio cases involving infection of the brain, a distribution of the virus in the brain, similar to that of Dr. Bodian's illustration, would be the result. Tr. at 499. If the cortex were affected, Dr. Hughes stated that he would expect to see symptoms such as loss of memory, cognitive abnormalities and behavioral changes. Tr. at 500. However, those symptoms are not associated with polio. *Id*. To a degree of medical certainty, Dr. Hughes averred that a sudden onset of high fever with a concomitant seizure would not result from a polio infection. Tr. at 513.

After a nerve cell has been killed by the poliovirus, Dr. Hughes explained, scavenger cells called macrophages and neutrophils come in and discard the dead tissue. Tr. at 489. Once a brain cell is dead, it is not replicated as in other parts of the body. *Id*.

Dr. Hughes testified about the biological mechanics of the Sabin Oral Polio Vaccination. He stated that, through a process of growing and regrowing the wild poliovirus in the laboratory, the virus can be weakened so that its neurovirulence is diminished. Tr. at 525. The neurovirulence of the poliovirus is the measure of its ability to affect nerve cells. *Id*. Each lot of vaccine is tested by injecting it into the brain tissue of animals to ensure that its neurovirulence does not increase or that the virus does not revert back to its "wild" state. Tr. at 526.

Dr. Hughes then proceeded to explain the pathogenesis of the attenuated virus after vaccination with OPV. When the attenuated virus is introduced into the human body via OPV, the virus attaches much like the wild virus, albeit primarily in the intestinal mucosa. Tr. at 527. The progress of the vaccine is identical to the wild virus except that the OPV is attenuated at the intestinal site. Tr. at 528. As the attenuated virus moves to the lymph system, it elicits the same antibody response. *Id*. The typical result, due to the weakened state of the vaccine-induced virus, is that the body evacuates the infection and the person is immunized against further polio infections. *Id*. Infrequently, viremia will occur, particularly with type 2 of the poliovirus. *Id*. This is what occurs in cases in which the vaccine recipient develops paralytic polio despite the intent to immunize. Tr. at 529. Dr. Hughes opined that in some cases, the

ineffectiveness of the vaccine is due to the immune deficiencies of the vaccinee rather than a defect in the vaccine itself. *Id*.

Dr. Hughes stated he was not aware of any studies which concluded that a person who was vaccinated with OPV could have symptoms such as headache, nausea, stiffness, or pain in the absence of the paralytic form of the disease. Tr. at 530. One would not manifest the symptoms without having the polio disease. Tr. at 530-531.

Dr. Hughes explained that, on the rare occasions when a person develops paralytic polio after the administration of OPV, the incubation period is longer than that of the wild virus. Tr. at 533. This is because a certain amount of a viral infection must exist before clinical symptoms arise. *Id*. And due to the attenuated state of the OPV-induced virus, it takes longer for the infection to reach the clinical threshold. *Id*.

Dr. Hughes testified about the affliction of polioencephalitis. He explained that, as used by such experts as Dr. Bodian, the term refers to an inflammatory process in the lower part of the brain, but technically it could be any part of the brain above the spinal cord. Tr. at 545-546. This condition occurs in approximately one to two percent of all cases of paralytic polio. Tr. at 546. In his experience, Dr. Hughes has never seen a patient with any type of polio exhibiting seizure activity. Tr. at 547.

Based upon Dr. Bodian's study of the location of damage in the brain from polio infection, Dr. Hughes testified that he would not expect to see resultant seizures. Tr. at 549-550. However, he offered a few rare exceptions to this rule. If the poliovirus damages the areas of the brain that control the respiratory function, the brain could suffer from hypoxia which could result in seizures. Tr. at 550. Because the poliovirus kills brain cells rather than stimulating them, the only way it would be reasonable to theorize that seizures could occur is if there were paralysis affecting the respiratory function thereby creating a loss of oxygen to the brain and damaging other brain cells. Tr. at 550. As he explained Dr. Bodian's article (R.Ex. T at 495), Dr. Hughes explained that encephalitic symptoms are due to cortical hypoxia rather than direct damage to the cortex from the viral infection. Tr. at 552. In another instance of oxygen deprivation, a carbon dioxide build-up in the blood may result in a reduction in oxygen that is carried to the brain. Tr. at 555. Also, severe damage to the brainstem could affect the respiratory function. *Id*. In any of these hypoxic scenarios, paralysis would be the chief cause. Tr. at 556. Dr. Hughes opined that he would not expect patients manifesting such symptoms to survive. *Id*.

In Dr. Hughes' opinion, Dr. Ehrengut's papers were anecdotal. He made observations but no conclusions were proven. Tr. at 514. Dr. Hughes testified that he was not aware of any precedent for seizures occurring after a polio infection unaccompanied by any other symptoms. Tr. at 509. He was aware of no literature offering proof that polio causes seizures. Tr. at 510. In sum, he opined that one would find seizures after polio infection only in instances where there was a reduction in the oxygen level in the brain which would be the result of paralysis of the respiratory function. Tr. at 510, 556.

D. Dr. Samuel L. Katz[(17)]

1.

Dr. Katz gave testimony regarding the clinical symptoms manifested after infection with the wild poliovirus. He pointed out that a majority of people so infected have a "totally silent" infection of the intestinal tract with no apparent symptoms. Tr. at 688. Five to ten percent may exhibit a mild illness

with symptoms of fever, gastroenteritis, headaches or malaise, and then completely recover with no more serious sequelae. *Id*. Two or three percent may have asymptomatic meningitis, which is the presence of inflammatory cells in the spinal cord. *Id*. Such a person might exhibit symptoms of headache, stiff neck and nausea and then fully recover in a few days. *Id.*

Dr. Katz described the most severe clinical manifestation of the polio disease as follows:

[T]he smallest number, this varies with the particular virus and particular epidemic, it may be one in one hundred, it may even be less frequent, will go on and develop weakness or paralysis of the lower extremities initially, sometimes involv[ing] the upper extremities, that is, the arms; [it] may involve the muscles of the abdomen and the trunk; and in the most severe cases [it] may involve some of the centers in the brain that control breathing and blood pressure.

Tr. at 688-689. In reference to the noted variability, Dr. Katz explained that there are three serologically distinct types of poliovirus, referred to as numbers one, two and three. Type 1 typically caused the most severe illness, Type 2 is usually the most benign and Type 3 is in the middle. Tr. at 689.

2.

Dr. Katz then discussed the pathogenesis of the polio disease in complete agreement with Dr. Hughes' explanation.[(18)] Tr. at 690-691. When queried whether he would expect to see seizures as a result of a polio infection, Dr. Katz responded as follows:

No. Actually what you are seeing is exactly the opposite of seizures. A seizure is an uncontrolled involuntary activity which is stimulated by nerves which send messages to muscles to contract and to relax in different fashions. What happens with polio is the opposite in that the nerves that ordinarily send those messages are destroyed or faulty, so they can't send any messages to the muscles.

Tr. at 692.

Dr. Katz opined that the wild poliovirus does not affect the area of the brain in which seizures originate. Tr. at 695. He also stated that polio viruses have never been associated with mental retardation, and that the virus does not affect the parts of the brain that control thinking, mentation or cognition. *Id*. Dr. Katz stated that:

The only way poliovirus or poliovirus infection might possibly cause that kind of brain damage is that in the patients I was discussing who lose the ability to breathe and to handle their necessary ventilation, they get starved for oxygen, and you might get a secondary effect on the brain from so-called hypoxia, equivalent to what happens when someone drowns or someone is choked. But that's why you have respirators and ventilators and iron lungs, to prevent that sort of [thing from] happening. But that's the only way I could even hypothesize something occurring of that sort.

Tr. at 695-696.

3.

Dr. Katz testified that in rare instances, individuals can contract paralytic polio from OPV. Tr. at 698. He stated that it is usually the Type 3 virus that causes the paralytic disease. *Id*. He opined that when patients contract polio from the vaccine, the pathogenesis of the disease is indistinguishable from that of the wild poliovirus infection. Tr. at 698-699.

Dr. Katz testified that the vaccines made in the United States are not identical to those manufactured in Europe, and that the standards for licensure are more stringent in America than they are abroad. Tr. at 700.

Dr. Katz, who has served as a reviewer for manuscripts submitted to epidemiological journals, gave a critique of Dr. Ehrengut's studies during his testimony. When asked to comment on Dr. Ehrengut's studies, beginning with the first study, Article One,[(19)] Dr. Katz testified as follows:

[T]here are a number of features that make the studies difficult to interpret. First of all, of course, ... they are not studies in the sense of planning a protocol and following a given set of criteria to try to have diagnostic standardization of what one is seeking. ...[T]he first [study] is a collection of anyone who reported what might have been a seizure [and it] is accepted as having [been] a seizure. And if it occurred within a given number of days of having been fed polio vaccine, that was said to be probably due to vaccine.

There are a number of features that are missing, of course. One is, we know that polio vaccine is given at an age when children have the onset of seizures of many different causes are likely to have the start of their seizures.

Secondly, these children are getting many other medications and vaccines at the same time as the polio oftentimes; diphtheria, tetanus toxoid and pertussis vaccine. Other vaccines may be given. We don't know what their relationship may be to any unusual events that occurred.

Third, of course, there are no diagnostic techniques that have been used to ascertain that the patient who had the seizure really had polio virus in his or her intestinal tract.

Fourth, we don't have any history of whether any of these patients either had previous seizures or later seizures related to other events. There are just a number of things that reflect on this just being anecdotal information and not critically reviewed scientific data.

Tr. at 701-702.

After a long exposition on the steps necessary for a proper protocol for a scientific study, Dr. Katz concluded that Dr. Ehrengut's Article One contained no protocol. Tr. at 704. He stated that there was a "great deal" of information missing that the reader would need to understand the significance of the data described. *Id.* He observed that the only criteria for the study was that "you had been fed polio vaccine and that some time in the next month you had a seizure." *Id.* One of the major flaws according to Dr. Katz was the failure to attempt to differentiate seizures that occurred coincidently. Tr. at 705. Considering, the fact that two to four percent of children at the age of immunization have seizures, which is a rather large background number, it is particularly important to have very specific discriminating factors in the protocol to be able to distinguish random seizure occurrences. *Id*.

When asked what the deficiencies with anecdotal reporting are from a scientist's viewpoint, Dr. Katz responded thusly:

Well, you have anyone reporting anything that he or she thinks fits into the wastebasket that you're collecting rather than having a set of diagnostic criteria as to what you define as a seizure. How long did the seizure last? What part of the body was involved? Was there a fever or not a fever at the time? You know, you go on, and you establish how you define what a seizure is from the point of view of your study. Whereas [Dr. Ehrengut's study] seems to be just a matter of using the term "a seizure." A seizure

can mean many different things to many different people.

Tr. at 706-707.

When asked about Dr. Ehrengut's second study, Article Two,[(20)] Dr. Katz opined that the study was insufficient and that many more children would have to be observed before any conclusions could be made on the data. Tr. at 709. Dr. Katz stated he had no indication that either Article One or Article Two was peer reviewed. *Id*.

Dr. Katz, who has had extensive clinical experience with patients afflicted with polio, stated that he had never seen a seizure disorder caused by wild poliovirus. Tr. at 694. Nor is he aware of any cases of seizure disorders associated with the polio vaccine. Tr. at 699. He stated that anecdotal reporting is insufficient to establish a causal relationship. Tr. at 707.

IV. DISCUSSION

1.

Respondent argues that petitioner must prove that OPV can cause a residual seizure disorder, not merely seizures. Resp. Br. at 2. Petitioner disagrees and states that the relevant inquiry in the instant case is whether OPV can cause seizures. Pet. Reply at 6. The court is rather perplexed, and somewhat disturbed, that this dispute as to the issue at bar should first surface in the post-hearing briefs. From the early stages of this proceeding, the court has understood quite clearly that the issue in this case is whether OPV can cause a seizure disorder or seizures that are sufficiently serious to cause neurological sequelae.[(21)] At no point during the progress of this or any of the three consolidated cases did either party express anything other than complete accord with the court's stated objectives.

The court is not interested in events that do not cause injury. Petitioner filed this claim for damages as a result of a Table vaccination. A petitioner cannot establish entitlement to an award under the Vaccine Act simply by demonstrating the manifestation of a benign event with no sequelae. A single seizure that causes no neurological injury is not compensable under the Act and the court would not, and will not, waste finite resources investigating a causal relationship between such an event and a Table vaccination. Section 11(c)(1)(D)(i) requires that petitioners prove they "suffered the residual effects or complications of such illness, disability, injury, or condition for more than 6 months after the administration of the vaccine...." Thus, by the Vaccine Act, proving that a vaccination can cause a single seizure event does not satisfy the statutory mandate for entitlement unless that seizure event has caused sequelae lasting over six months. Appealing rhetorically to logic and common sense, why would the court travel to London, England, and Boston, Massachusetts, listen to eight days of testimony, read 846 pages of transcript, 65 pages of legal briefs, and countless exhibits, medical articles and expert reports, just to decide one issue that, even if found in favor of petitioners, would not be dispositive or even advance the inquiry past the preliminary stages? From the beginning, this court has endeavored to answer the question: Can OPV cause a seizure disorder or seizures capable of causing serious neurological injury. That does not mean that petitioner must prove that OPV can cause a "residual seizure disorder" as defined under §14(b)(2) of the Vaccine Act.[(22)] However, petitioner must prove more than a causal connection between OPV and one benign seizure event.

Petitioner cites *Lenander v. Secretary of HHS*, No. 92-659V, 1996 WL 614802 (Fed. Cl. Spec. Mstr. Oct. 25, 1996) in support of his claim. At issue in that case was whether there was sufficient evidence that Steven Lenander first manifested symptoms of paralytic polio within thirty days of the administration of OPV. An ancillary issue arose as to whether Steven exhibited indicia of seizure activity after the OPV. The court considered the opinion of *both* experts that such a symptom would be atypical in a polio case. The court held that, assuming the seizures were correctly recorded in the medical records, "such factor would not rule out a diagnosis of polio." *Lenander*, slip op. at 10. In *dicta*, the Chief Special Master alluded to medical literature that "supports the possibility, albeit rare, of convulsions accompanying polio." *Id*. Specifically, the Chief Special Master listed the following literature: William E. Bell, M.D. et al., *Neurologic Infections in Children*, 2d ed., W.B. Saunders Company, Philadelphia, 1981, at 312; S.A. Kinnier Wilson, *Neurology*, Edward Arnold & Co., London, vol. 1, 1940, at 238; and John H. Menkes, M.D., *Textbook of Child Neurology*, 3d ed., Lea & Febiger, Philadelphia, 1985, at 364.

This court has reviewed each of these articles and concludes they are inapposite to the case at bar. The seizures discussed were in conjunction with the paralytic form of the disease. That scenario is not present in the facts of this case, or any of the three consolidated cases, and is substantially different in terms of pathogenesis. The court does not dispute that a seizure may accompany an affliction with paralytic polio. However, in that rare instance, the seizure would be a result of an injury to the brain caused by anoxia due to paralysis of the respiratory muscles. It would be the lack of oxygen that injures the brain, not the direct effect of the poliovirus on the brain cells.

The issue in *Lenander* was not whether OPV caused seizures, but whether the existence of seizures ruled out a diagnosis of paralytic polio. The court's ruling was sound, but its *dicta* does nothing to advance petitioner's theory in the case at bar. *Lenander* simply allows a petitioner to recover an award under the Vaccine Act, even when the injured person has manifested seizures. The court gave no further guidance on what type of seizures would be included in this ruling -- whether they are a part of a preexisting disorder or a new onset, febrile or afebrile, benign or nefarious, with or without neurological sequelae. Such specification was not necessary in that case because it was an ancillary issue. The primary issue in the case concerned the effect, if any, that the occurrence of a seizure would have on a diagnosis of paralytic polio. If a child had a preexisting, benign seizure disorder, and then manifested a seizure after an OPV, surely petitioner would not claim this to be proof of causation linked to the polio vaccination. Yet this type of presentation would not rule out a diagnosis of paralytic polio according to *Lenander*. That is the meaning of *Lenander*, and as such, it is inapposite to the issue in the instant case.

Petitioner also draws upon the Vaccine Adverse Event Reporting System (VAERS) for support. R.Ex. AA. While 6 convulsions post-OPV were, in fact, reported from 1991 through 1995, this minuscule number compared to the number of vaccinations administered is irrelevant when the method of reporting is considered. The VAERS is a passive surveillance system, much like the study conducted by Dr. Ehrengut. The VAERS records reported statistics without further investigation or background testing and, by its own admission, it records events that "happened after vaccination purely by coincidence." *Id*. The VAERS is not a scientific study, subjected to peer review, upon which the court could rely to establish a novel theory of causation.

Petitioner cites medical articles that purport to show the presence of poliovirus in the cerebrospinal fluid. Pet. Reply at 10. Standing on this observation, petitioner claims that the poliovirus can thus affect the cerebral cortex. *Id*. at 11. Such evidence may be probative but it hardly fills the logical gaps in

petitioner's theory. Dr. Bodian's study proved the presence of polio lesions in the cortex in small amounts. R.Ex. T. However, as discussed by Dr. Hughes, the level of damage to the brain must reach a certain threshold before clinical symptoms manifest. In addition, the mere presence of poliovirus in the cerebrospinal fluid does not inform the court as to if and how the polio infection can cause seizures. Petitioner must present a logical medical theory by which this can occur.

3.

With respect to the mechanics by which OPV allegedly causes seizures, Dr. Ehrengut's opinion essentially devolves to this: (1) the attenuated poliovirus from a vaccine can mutate, become neurovirulent, and act as the wild poliovirus does; (2) lesions from wild polio infection can be found in the cortex; (3) seizures result from malfunctions in the cortex of the brain; and therefore (4) the OPV can cause seizures. A fatal flaw in this syllogistic logic is the failure of Dr. Ehrengut to describe how a brain cell infected by the poliovirus can cause a seizure. This crucial premise is absent. The simple analogy to other enteroviruses or the smallpox virus is not persuasive because Dr. Ehrengut never explored the possibility that these viruses affect the brain in very different manners. If they affect the brain differently, it is reasonable to assume that the clinical symptoms from such an infection would be different. A logical theory cannot be deduced when vital premises remain absent or erroneous.

The presence of lesions does not logically mandate the occurrence of seizures. Dr. Ehrengut's theory fails to successfully negotiate that hurdle. The explanation of all three of respondent's experts that the poliovirus acts to destroy nerve cells so that they cannot send the electrical impulses necessary to cause muscular movement was very persuasive. Petitioners had no effective response to this point. The court must agree with respondent's experts that a seizure disorder is the opposite type of indicium one would expect to arise from poliovirus infection.

Dr. Ehrengut claimed that the attenuated virus can mutate and become neurovirulent and thus act as the wild poliovirus. If that is the case, we would expect to see the symptoms from such a mutation mimic the clinical manifestations of a wild polio infection. However, Dr. Ehrengut was able to produce no evidence that wild polio infection can cause seizure disorders. He produced no evidence, in the form of a published study or otherwise, that seizures have been observed *and* were causally related to wild polio infection. Wild poliovirus is not known by the medical community to cause seizure disorders; thus there is nothing for the attenuated virus to mimic.

4.

Petitioners' case is centered around the opinion and studies of Dr. Ehrengut. In consideration of the testimony heard, and after a thorough review of Dr. Ehrengut's work, the court must conclude that petitioners have not met their burden of proving, by a preponderance of the evidence, that OPV can cause seizure disorders or seizures with resultant neurological sequelae.

Dr. Ehrengut's first study (Article One - *Convulsions Following Oral Polio Immunisation*), leaves many doubts and unanswered questions. To begin with, the process of collecting data by random reporting is not scientifically persuasive. The article claims that "[a]ll seizures occurring within 30 days after the immunisations that came to our knowledge, were thoroughly collected, together with the medical and hospital records." Yet of the 58 vaccinees reported to have had seizures, in two cases the sex of the child was unknown. How thorough can the information on a subject be if you cannot determine the sex of the child? Not very, the court must conclude.

Recognizing that convulsions can be caused by other factors, Dr. Ehrengut attempted to purify his study by separating "probable" from "doubtful" cases. A reported seizure was placed in the "doubtful" category if certain conditions were present. These conditions included intercurrent infections like pneumonia or otitis media, patients with previous seizures, patients with brain tumors, etc. However, this winnowing of tainted data was a seemingly perfunctory exercise, in that Dr. Ehrengut included both "probable" and "doubtful" cases in the same statistical analyses. In addition, Dr. Ehrengut conceded that the "majority of our cases consisted of febrile convulsions...." P.Ex. 28-T2 at 170. Febrile convulsions are not an infrequent occurrence and are generally benign. Merely recording such events in some loosely temporal relationship with polio vaccinations is not persuasive. Temporal proximity is insufficient.[(23)] Petitioners' burden to prove causation requires far more than that.

Dr. Ehrengut does not conclude in Article One that OPV causes seizure disorders. In fact, a troubling paragraph reveals the inconclusiveness of this study:

The collection of our cases was made by chance since the above convulsions are not notifiable. Therefore our analysis gives only minimal figures. A prospective study will be necessary to clear the impact of these convulsions in [oral polio immunizations].

P.Ex. 28-T2 at 170. In any event, Dr. Ehrengut's focus was on the occurrence of a seizure event. As respondent correctly argues, the occurrence of a benign seizure is insufficient to establish entitlement to an award under the Vaccine Act. Petitioner must prove that OPV caused the injury claimed: to wit, a seizure disorder with neurological sequelae. Dr. Ehrengut has failed to persuade the court that OPV can cause a seizure, *a fortiori*, he has failed to establish a causal connection with a seizure disorder.

V. CONCLUSION

The burden to prove causation-in-fact in an off-Table case can be difficult when a novel theory is alleged. In such instances, petitioner must first convince the court that the alleged injury can be caused by the vaccine in question. With no case precedent to rely upon, petitioner in this matter had to demonstrate a logical and medically sound theory as to the mechanics of how the injury occurred. In addition, the theory must be accepted to a certain extent by the medical research community. The theory need not have the endorsement of all or even a majority of experts in the field, but a significant minority must support petitioners' alleged theory. Petitioner has not proffered satisfactory evidence to explain the mechanics, or pathogenesis, of how an immunization with OPV can cause a seizure disorder or seizures with resultant neurological sequelae. Dr. Ehrengut's observations were *sui generis*, unpersuasive and certainly not accepted by the medical community. The court cannot recognize a new theory of causation based upon his collection of anecdotal data, which, most significantly, was not subjected to peer review. Respondent's experts were far more persuasive. In addition, the court is aware of no peer reviewed studies that conclude OPV can cause seizure disorders. Petitioner's theory advanced no further than conjecture. The court cannot accept a theory founded on such a basis.

The court will accept that a very serious manifestation of paralytic polio, such as bulbar polio, can result in seizures due to paralysis of the respiratory muscle with anoxia as the sequela. Such a seizure is immediately caused by brain damage due to oxygen deprivation. However, *sans* paralysis, the court

cannot accept the theory, proposed by petitioners, that OPV can cause a seizure disorder. Petitioner has failed to satisfy the first prong of the causation-in-fact test -- whether OPV can cause a seizure disorder or seizures with resultant neurological sequelae. Thus petitioner has failed to prove a causation-in-fact case under §11(c)(1)(C)(ii). Accordingly, this petition is DISMISSED with prejudice pursuant to Vaccine Rule 21, for failure to prove a *prima facie* case for entitlement under the Vaccine Act.

In the absence of a motion for review filed pursuant to RCFC, Appendix J, the clerk is directed to enter judgment accordingly.

IT IS SO ORDERED.

Richard B. Abell

Special Master

1. The statutory provisions governing the Vaccine Act are found at 42 U.S.C.A. § 300aa-1 *et. seq.* (West 1991 & Supp. 1997). Hereinafter, all references will be to the relevant subsection of 42 U.S.C.A. § 300aa.

2. The other two cases are *Constandis v. Secretary of HHS*, No. 95-151V and *Buker v. Secretary of HHS*, No. 90-3455V.

3. References to the transcript will be made as follows: Tr. at ___.

4. In *Daubert*, the Supreme Court held Federal Rule of Evidence 702 is binding on federal courts with respect to establishing the admissibility of scientific evidence. *Daubert*, 113 S. Ct. at 1795. It is noted that the Federal Rules of Evidence are not binding on this tribunal.

5. *See* stipulation of fact - filed 5 February 1996.

6. Dr. Ehrengut was born in Germany and currently resides in Hamburg. He attended medical school at the University of Munich and also attended the University of Würzburg. He became a medical doctor in 1947. He practiced at the University Children's Clinic in Munich until 1955. In 1960, Dr. Ehrengut became the head of the Institute of Immunization in Hamburg. He received a diploma as a specialist in pediatrics in 1962. He was an associate professor of immunology at the University of Hamburg. He was associated with various studies around the world and retired in 1984. However, he continued to lecture after retirement. After a review of the *curriculum vitae* and the voir dire testimony at the hearing, the court finds Dr. Ehrengut to be qualified as an expert.

7. The court will refer to this article as "Article One."

8. The court will refer to this article as "Article Two."

9. Dr. Klein received his bachelor's degree from Union College in 1952 and his medical degree from Yale University in 1956. He is board certified in pediatrics. He has held numerous teaching positions at Harvard Medical School and Boston University School of Medicine. He is a member of the Vaccine and

Related Biologic Products Advisory Committee of the Food and Drug Administration and a member of the Scientific Review Committee for Vaccine Trials. He has held the position of editor for several peer reviewed publications including Infection, which is published in Germany, Vaccine Bulletin and the Report of the Committee on Infectious Diseases. His publications number approximately 300. He has had extensive experience with poliomyelitis and polio vaccines. After a review of the *curriculum vitae* and the voir dire testimony at the hearing, the court finds Dr. Klein to be qualified as an expert in infectious diseases.

10. The article, filed in German as R.Ex. MM and in the English translation as R.Ex. RR, is cited as follows: G. Joppich, *Poliomyelitisschluckimpfung und Krampfleiden*, Klinische Pädiatrie, 192: 393-394 (July 1980).

11. Dr. G. Joppich is the Chairman of the "Committee on Vaccination of the German Association for the Fight Against Illnesses Caused by Viruses, Inc."

12. While Dr. Klein is familiar with many European pediatric journals, he was unfamiliar with the journals that published Dr. Ehrengut's Article One and Article Two. Tr. at 368. Dr. Klein has been on the editorial board of the German medical journal, Infection, for 16 years.

13. Dr. Hughes received his medical degree from the University of Tennessee College of Medicine in 1954. He is board certified in pediatrics. He has had extensive experience with polio both clinically and in terms of research. He was active in research on the pathogenesis of infectious diseases at the St. Jude Children's Research Hospital in Memphis, Tennessee. He was the first president of the Pediatric Infectious Disease Society. He was a professor of pediatric infectious diseases at the Johns Hopkins University School of Medicine. He is currently involved in AIDS research. He has published numerous articles. After a review of the *curriculum vitae* and the voir dire testimony at the hearing, the court finds Dr. Hughes to be well qualified as an expert in pediatric infectious diseases, with particular experience in the pathogenesis of infections.

14. The poliovirus has three distinct variants. Production of antibodies to combat one type of poliovirus does not immunize the person against the other types of poliovirus. Tr. at 477.

15. He explained that the virus is present in the throat and in the excreta from two to four days after exposure. Tr. at 476.

16. According to Dr. Menkes, 90 to 95% of people exposed to poliovirus will be asymptomatic. R.Ex. D at 6. Dr. John H. Menkes is a well respected pediatric neurologist who has testified before this court on numerous occasions, and has authored the oft cited: *Textbook of Child Neurology*, 3d ed., Lea & Febiger, Philadelphia, 1985.

17. Dr. Katz received his bachelor's degree from Dartmouth College in 1948 and his medical degree from Harvard University in 1952. He is board certified in pediatrics. He had extensive experience both clinically and in terms of research with polio. He has been a member of many societies involved in the study of infectious diseases. He has served as a reviewer for journals dealing with subjects such as epidemiology and infectious diseases. He has written numerous articles about vaccines. After a review of the *curriculum vitae* and the voir dire testimony at the hearing, the court finds Dr. Katz to be well qualified as an expert in infectious diseases with competence in epidemiology, microbiology and immunology.

18. Dr. Katz opined, as did Dr. Hughes, that when the poliovirus attacks nerve cells, it kills them. The

result is that the dead nerve cells can no longer send impulses to the muscles. Tr. at 691.

19. As stated, Dr. Ehrengut's first study is referred to in this decision as "Article One." It is the article entitled: *Convulsions Following Oral Polio Immunisation*, published in 1979.

20. As stated, Dr. Ehrengut's second study is referred to in this decision as "Article Two." It is the article entitled: *Oral Poliomyelitis: Immunization and Convulsive Disorder*, published in 1980.

21. In an order dated 28 November 1995 in the *Constandis* case, a companion case, the court directed petitioner's expert to address the issue of "whether the OPV vaccine can cause a residual seizure disorder," and "did, in fact, the OPV vaccine cause Nicole's seizure disorder."

22. Section 14(b)(2) states as follows:

A petitioner may be considered to have suffered a residual seizure disorder if the petitioner did not suffer a seizure or convulsion unaccompanied by fever or accompanied by a fever of less than 102 degrees Fahrenheit before the first seizure or convulsion after the administration of the vaccine involved and if --

...

(B) in the case of [any Table vaccine other than MMR], the first seizure or convulsion occurred within 3 days after the administration of the vaccine *and* 2 or more seizures or convulsions occurred within 1 year after the administration of the vaccine which were unaccompanied by fever or accompanied by a fever of less than 102 degrees Fahrenheit.

23. *See Strother v. Secretary of HHS*, 21 Cl. Ct. 365, 369-70 (1990), aff'd, 950 F.2d 731 (Fed. Cir. 1991); *see also Hasler v. United States*, 718 F.2d 202, 205 (6th Cir. 1993), cert. denied, 469 U.S. 817 (1984)