Forensic Inference Emails 2012 - 2015 Part 2

Thomas W. Young, MD

Cromwell's Rule

Samuel Cooper's painting of Oliver Cromwell is from the National Portrait Gallery, London.

How certain should we be that we are certain? Is there a problem with claiming to be certain about anything?

Well...there is.

In his book, *Understanding Uncertainty*, British statistician Dennis Lindley presents to us Cromwell's Rule. Lindley cites Oliver Cromwell, a former English parliamentarian and politician, who wrote in a letter to the Church of Scotland in 1650, "...think it possible that you may be mistaken."

If one does not think it possible that he or she is mistaken, then no possible evidence exists that will persuade that person otherwise. In other words, if I think that it is impossible for the moon to be made of cream cheese, then someone who travels to the moon and brings back cream cheese will not even persuade me that I am wrong.

If I were to claim to be that certain about anything, I am giving up my right to claim that I am a scientist. Claiming to be unmoved by evidence — solid, factual evidence — goes against being scientific. Being scientific means that I am open to discovery and evidence — even evidence that might change my mind.

"Wait a second, Dr. Young," I almost hear you say. "Didn't you write something called 'The Inferential Test is Always True. Think of it as a Law'? Aren't you violating Cromwell's Rule by claiming to be that certain about the Inferential Test?"

No. If an event is ***logically derived***, then a claim of certainty is not only appropriate but also necessary. According to Lindley, "Nothing, ***except logic***, is incapable of being influenced by evidence" (page 91 of his book -- the emphasis is mine).

By using the numbers, 0 and 1 — 0 meaning "always false" and 1 meaning "always true" — Cromwell's Rule (He calls it the Convexity Rule when using probability numbers) means that any event not derived logically needs to be given a number between 0 and 1. For example, the moon not being made of cream cheese might have a probability of 0.99999999999999999999 but not 1.

On the other hand, the statement, "If 1 + 1 = 2, then 2 - 1 = 1" would be assigned a probability of 1 because it is derived logically (or deductively — same thing).

The reason I am so bold in claiming that "The Inferential Test is Always True" is because the IT was derived logically, just like the example above. Of course, it is more complicated than the example above but it still has a value of 1 for probability.

The IT is a ***theorem*** of deductive logic and not a ***theory*** of science.

Lately, the IT is being recognized more and more by prosecutors, and I am more often cross-examined about it. "Dr. Young," they ask, "Isn't it true that your theory has not been accepted in peer-reviewed literature?" "Dr. Young, what is the error rate of your theory?" "Dr. Young, how many of your colleagues accept your theory as true?" After all of this questioning, they ask the judge to not allow me to testify. They try to make the judge believe that I am bringing something novel or strange into the courtroom — something that is not accepted.

These prosecutors are engaging in an *equivocation* fallacy, changing the definitions of words in the middle of an argument in a subtle way, confusing the differences in the definitions of ***theory*** and ***theorem***. A theory is a set of beliefs — beliefs that may or may not be true — used to explain phenomena. A theorem is a statement derived logically. A theory should be assigned a number between 0 and 1 — not 0 or 1. A theorem is assigned a number of 1.

It is true that I have not been successful in persuading my peers to publish anything about the IT. I am not certain why they do not like it, but I have a strong suspicion that it makes them very nervous. It points out mistakes made by scientists almost daily.

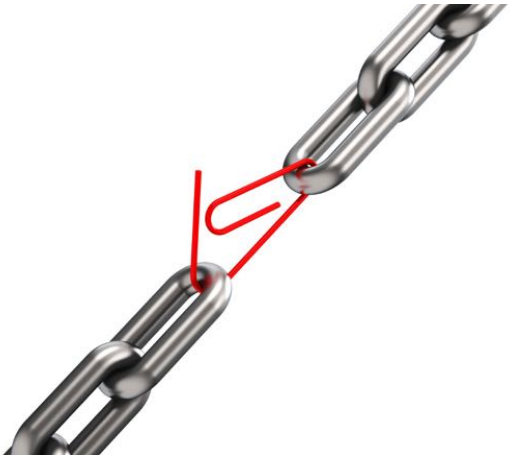
Whether or not the IT is published in peer-reviewed literature will not matter in the end. A scientist will suffer the consequences of unsound inference eventually, one way or another.

Remember what happened to Dr. Charles Smith.

The Weakest Link

Image courtesy of iStockphoto, delta_art.

There are times during an investigation or even at its conclusion when witness accounts are not sufficient for comparison to physical evidence discovered by scientists. At such times, scientists may employ the part of the IT that states, "...unless there is only one plausible explanation for that evidence."



That is fine; however, this inference should be made with great caution.

Why? Because in the chain of deductions that link past events to physical evidence, it represents the weakest link.

There is really nothing wrong with the inference. If an event is the "only plausible explanation," then it is reliable to be reasonably certain of that event. The inference is deductive.

The problem is not so much with this valid deduction as it is with human frailty and limitation. Humans make the weakest link as weak as it is.

We may believe that an event is the "only plausible explanation," but due to a lack of knowledge about the case, a lack of scientific knowledge, or a lack of imagination, we may conclude wrongly. There may be other — and often are other — plausible explanations that we haven't thought of.

Here is the warning for all reading this email.

If we make an effect-to-cause inference to a single explanation, we should recognize it at the outset as the weakest link. This recognition should spur us to learn more about the case. It should spur us to dig into the scientific literature and learn more science. It should spur us to be more imaginative — to consider other possibilities that we haven't considered yet, to consider more potential leads. The form of this type of inference should be a warning — a flashing red light at a railroad crossing — that unless we are careful, there is danger ahead.

Are there really no other witnesses to talk to? Is there not some video camera somewhere that recorded what happened? Is there some element of recently discovered science that we as scientists and investigators have not considered? If there are items we have overlooked or not imagined, they may appear at a later date to embarrass us and to point out our lack of care in investigating the case. The corners that we have cut will come back to haunt us. The explanations we do not know now but may learn later may put our reputations and even our careers in jeopardy.

If we find ourselves in the position where we have to rely on the weakest link, we should do so tentatively and carefully. We should employ terms of uncertainty, such as "I think right now...", "Given the available information, I believe...", "It may be...". Also, it would be wise for us to say that if further information comes to light, we may change our opinions. That would be the safest thing to do.

Unfortunately and all too often, too many colleagues look at the weakest link and think it is the Rock of Gibraltar -- at least that is the way they testify under oath. Too many think that running a few laboratory tests to "rule out" explanations will be sufficient, failing to realize that there are possibilities that no currently available laboratory test can rule out. Too many disparage witnesses as liars at the outset rather than consider carefully what they have to say. Too many think that floating a theory for complex past events works reliably as an "only plausible explanation." Too many do not want to change their approach to a case because they think it is too different from what they learned to do in graduate school or fellowship training. Too many do not want to learn basic logical principles because it requires one to dig in and do hard work.

Too often, people who think like this end up in positions of influence and leadership, advocating the writing of "position papers" to somehow validate their ideas. If any position paper is written (and I do not recommend them at all for any reason), they should be written with extreme caution, taking into consideration that it is possible that we might be mistaken.

In the emails to come, we will carefully consider "the weakest link" and logical ways to make it stronger.

Scientific Facts

Illustration from Spitz WU (ed). Spitz and Fisher's Medicolegal Investigation of Death. Springfield, IL: Charles C. Thomas, 2006, p. 627.

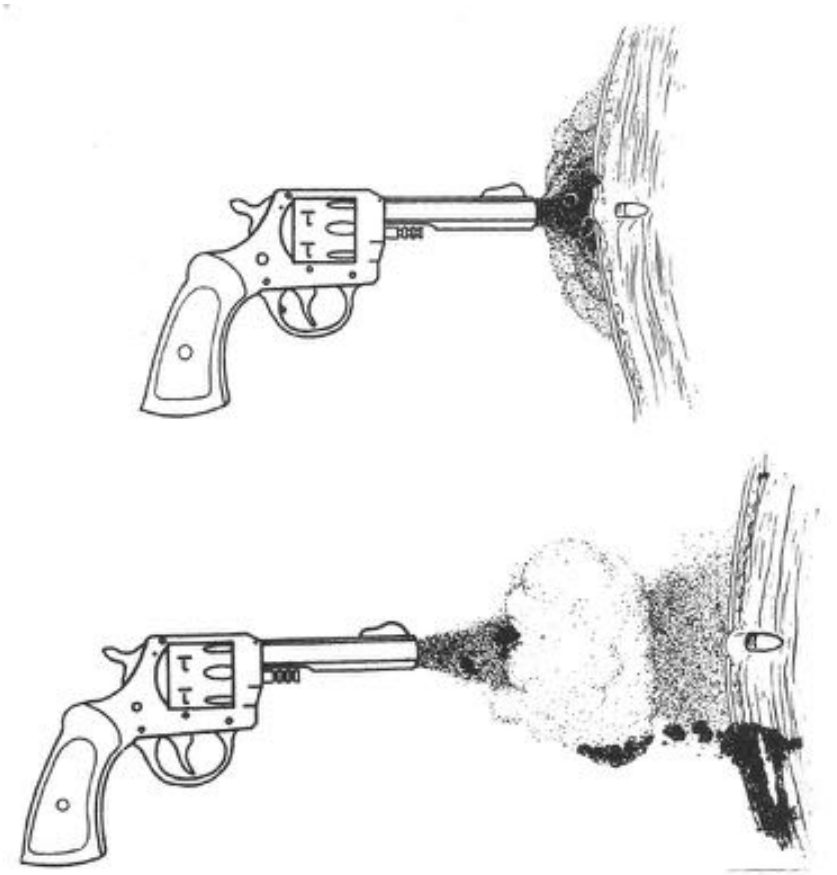


FIGURE XII-26. Diagram of close-range shots: (Top): At a distance of 1 to 2 inches from the target, particles of gunpowder are centered around the bullet hole, while waves of soot disperse over a much wider area (see Figure XII-2a). (Bottom): As the muzzle-to-target distance increases, the dispersion of particles increases in diameter, while the density of particle scattering decreases. At a distance of 6 or 7 inches, abundant gunpowder and little if any soot are deposited on the target (see Fig. XII-2b.)

One way to infer from scientific evidence to a single plausible explanation is through the use of scientific facts.

Let's review quickly. A *fact* is something that is observed. A *belief* is something that is not observed that may or may not be true (beliefs are often not true).

Scientific facts are items observed by scientists. In order for something to qualify as a scientific fact, much more than the consequent physical evidence in the present has to be observed. Scientists also have to have reliable observations of the antecedent past events and only the antecedent past events leading to the consequent physical evidence. If P is a symbol for the antecedent and Q (which follows P in the alphabet) is the consequent, then scientists have to observe for themselves or know from the reliable observations of others not only Q but also P and only P leading to Q ($P \rightarrow Q$).

If a scientist is designing an experiment, the scientist has to observe P. He also has to observe only P leading to Q in the experiment. If the study involves observations in the form of case reports, a valid study involves having reliable witness observations of the antecedent events and how the witnessed events (and nothing else) led to the consequent physical evidence.

When in court testifying in a gunshot wound case, I am often asked for my opinion of the range of fire. The drawings above from Werner Spitz's excellent textbook demonstrate that various items coming out of the muzzle of the gun (smoke, gunpowder particles, a flame) may affect the skin and underlying tissues depending on how far away the muzzle of a gun is from the skin surface.

An opinion of range of fire is an effect-to-cause inference to a single explanation. I don't fire a gun or even observe a gun being fired. Instead, I rely on numerous observations made by

numerous scientists and others over numerous years who fire guns and watch guns being fired. I have to rely on scientific facts.

These facts were established before a case where I might testify ends up in court. The scientific facts were established independently from the case. This is important because such scientific evidence is not subject to confirmation bias.

In order to infer backwards to a single explanation, I have to place my observations into one of a few finite categories defined by the scientists. Is the wound from a pressed contact gunshot? A loose contact gunshot? An intermediate-range gunshot with gunpowder stippling? An indeterminate range wound? Depending on the category, I can make statements that apply to most firearms. The category itself is the only plausible explanation.

Even though I am saying a belief and not a fact in the courtroom (I didn't fire the shot or observe the shot being fired), I am able to be reasonably certain because of the strength of the factual observations and scientific work of numerous scientists who came before me. The strength comes from what is called an argument of enumeration — the belief I express is most likely true because of numerous observations of numerous scientists under numerous kinds of circumstances over numerous years, reinforced by numerous peer-reviewed articles from numerous peers. In fact the opinion can be so strong as to be considered the only plausible explanation.

Still, I have to be careful. I still could be wrong. It is still best if I listen carefully to witness accounts with an open mind and compare the accounts with the physical evidence. That is the best way — if it can be done.

Why is it the best way? Consider this:

- It takes only one well-documented case report to say something is possible. Only one well-documented case report is needed to use the first part of the IT.

- But it takes numerous data points compiled under a wide variety of circumstances — all subject to and resistant to falsification (*modus tollens* or MT) — to declare that an event is the only plausible explanation.

- Even many scientists can still be wrong about something being the only plausible explanation. One little fact can falsify reams upon reams of scientific theory — showing eventually that something is not the only plausible explanation.

This argument alone is persuasive enough for me to focus on witness accounts if they are present. What about you? Are you persuaded?

Scientific Facts?

Image courtesy of iStockphoto.com, MachineHeadz.

Whatever happened to the Shaken Baby Syndrome?

We seem to hear less about this condition from experts in the courtroom these days. Child abuse pediatricians and others do not seem to want to talk about it. Instead, they suggest using terms like "Abusive Head Trauma" and "Non-accidental Head Injury" in the courtroom rather than committing to a specific mechanism for head injury like shaking, avoiding the issue of how the injuries occur. Maybe they sense that many are starting to pick up on the absurdity of the notion of shaking causing whole-brain damage, subarachnoid/subdural hemorrhages, and retinal hemorrhages.

In spite of this, these doctors soldier on, never admitting that they may be mistaken, never accepting that people are currently doing jail time for something that these scientists claimed before but might be embarrassed to admit now.

We have been wandering for over 40 years in the shaken baby wilderness. In all those years, there is yet to be one verifiable well-witnessed case of shaking a baby (P) and only the shaking causing a "triad" of brain swelling, subarachnoid/subdural hemorrhages, and retinal hemorrhages ($P \rightarrow Q$). Don't you think it is time that we put all of this to an end?

Well, we should. Let's design some experiments. Scientific experiments.

We can randomly assign several infants to control and experimental groups, where the only difference between the two groups is that the experimental infants are shaken. The data collectors and analyzers will not know which infant belongs to which group until the end of the study. Following the shaking (or non-shaking), each infant will be monitored for vital signs, neurological status, oxygenation, intracranial pressure, and other variables we can think of. Someone will examine the retinas of the infants immediately after the shaking (or non-shaking) and regularly thereafter. Also, computerized tomography and magnetic resonance imaging will be performed in both sets of infants — immediately after the shaking (or non-shaking) and regularly thereafter. If the shaken baby hypothesis fails to be falsified, we can continue experimenting with a wide variety of shakes with varying directions, frequencies, and intensities. If the hypothesis holds up after many infants are examined and we find no other explanations for the physical findings, we might be able to say that shaking is the only plausible explanation for the "triad."

"Dr. Young!" you might say. "Are you serious? Don't you realize that what you are suggesting is both criminal and highly unethical?!"

Okay. I admit it. But before you get all ethical and "high-minded" on me, why don't you consider the "greater good"? Don't you think that destroying the lives of a few infants might be a much

lower societal price to pay then destroying the lives of countless numbers of souls for another 40 years?

Also, I realize that performing these experiments might cost some money. Perhaps the Department of Justice can supply us some grant money! After all, wouldn't it be cheaper to spend some money on a few experiments rather than pay the costs of incarceration of numerous people for numerous years as a result of the shaken baby theory?

[We pause this email for a quick review. A theory is a complex set of beliefs. Complex means more than one event or possible explanation.]

Or perhaps there is an even better way — one that doesn't involve the destruction of any lives.

Why don't people just learn the IT and apply it?

If people in the seventies had known and applied the IT, they would have realized that claiming the Shaken Baby Syndrome as true would be as reliable as claiming to know the winner of the Powerball before the balls are even cast. Both are not only unreliable, they are impossible.

"Consistent With" What?

$$P \rightarrow Q$$

$$\sim Q \rightarrow \sim P$$

$$Q \leftrightarrow P$$

Several times I have listened to fellow forensic pathologists give testimony in court. On occasion they will talk about what they found at autopsy and what it is "consistent with."

"My findings are consistent with..." Shaken Baby Syndrome, Child Abuse, Battered Child Syndrome, Excited Delirium Syndrome, Abusive Head Trauma, Non-accidental Head Injury, Restraint Asphyxia, Strangulation, and other theories for complex past events.

Of course their findings are "consistent with" their theory! These doctors wouldn't have it as a theory if their findings weren't "consistent with" it!

Using "consistent with" before a theory is utterly meaningless. Even though factual evidence may be consistent with a theory for complex past events, using such a theory in a particular case is highly, highly, highly likely to be wrong. We know this from the IT, because it is "surmising past events from physical evidence" which one cannot do reliably.

I could hold up a container of cream cheese next to a full moon at night and say, "The color is consistent with my theory that the moon is made of cream cheese." How meaningful is that?

If facts are consistent with facts, then the inference is highly likely to be true. The facts could be what witnesses observed or what scientists found. What witnesses observed can be consistent with what other witnesses observed ("What he saw could explain what she saw."). Scientific evidence can be consistent with other scientific evidence ("What I found at autopsy could

explain something else that I found at autopsy."). The valid forms of *modus ponens* and *modus tollens* listed above in simplified form (first two statements in logical operator notation) guarantee a truthful conclusion if the premises are truthful. If a premise is not truthful, it can be detected through a careful use of these argument forms. Once again, we are dealing with factual items that may or may not be explained by science. We are not using theories. "Consistent with" does not mean "This is actually what happened." It only means, "This could happen."

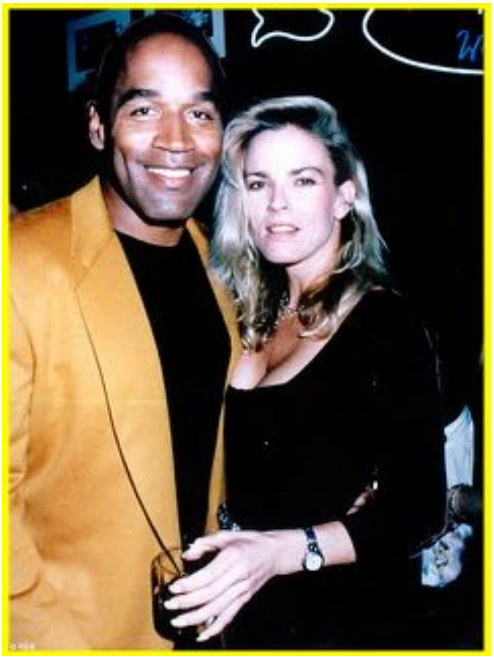
The third statement above in logical operator notation is what a scientific theory looks like logically. The double-headed arrow indicates a *biconditional* statement. "Q is true if and only if P is true." "The scientific evidence is true if and only if the baby was shaken." This is the weakest link that I have been writing about — the only plausible explanation.

If we choose to use this, we don't use "consistent with." We say instead, "This is the Shaken Baby Syndrome," "This is child abuse," etc.

But scientists testifying in the courtroom are hesitant to come out that strong. They want to hedge their bets and say "consistent with" instead.

In truth, very, very few items in the universe can be truthfully said to be the only plausible explanation. As we learn more and more about the universe, we find more and more exceptions to dearly held scientific theories. Look what happened to Isaac Newton. Everything held together pretty well until objects began to approach the speed of light. Now we have Relativity, thanks to Albert Einstein. In time, that theory may be replaced with a better one.

Using a theory in the courtroom to explain complex past events is not good. Scientists should not be inventing or using theories in the courtroom. They should be paying attention to what witnesses observed and explaining that instead.



Circumstantial Evidence

Photograph of OJ Simpson and Nicole Brown Simpson taken from oj—simpson.blogspot.com.

The only plausible explanation may also apply to circumstantial evidence cases.

Circumstantial evidence is indirect evidence. The criminal act is not witnessed by anyone directly (except possibly the defendant); however, there is sufficient witness evidence before and after the criminal act and sufficient physical evidence generated from it to offer what may be the only plausible explanation.

The kind of inferential process involved with circumstantial evidence is known as *induction by enumeration*. Induction is reasoning to a

conclusion that is probable in contrast to deduction which is reasoning to a conclusion that is certain. Enumeration means the counting of data items. If the number of truthful data items is high — if there is a lot of truthful information to support a conclusion — then a truthful conclusion becomes more probable.

Scientists should not offer opinions in court based on circumstantial evidence. Circumstantial evidence is supposed to be considered by a judge or jury — people who hear all the evidence and assess the number of all available truthful data items — and not by a scientist who is involved in only a portion of the case. Scientists are supposed to infer deductively, offering opinions (conclusions) that are certain. On the other hand, jurors and judges are supposed to infer inductively, coming to a conclusion "beyond a reasonable doubt" — something highly probable that does not have to be certain.

A few more terms having to do with induction. An inference that is highly probable for truth is *strong*. An inference that is less probable for truth is *weaker*, and the least probable of a group of inferences is the *weakest* — the weakest link.

Court cases based on circumstantial evidence are often lengthy because they involve the presentation of numerous data items. One of the lengthiest court cases, for example, was the *People of the State of California vs. Orenthal James Simpson* which took place in the mid 1990's.

I doubt if anyone reading this email has not heard of this case. It involved wall-to-wall media coverage for more than eight months.

Both the witness evidence data before and after the criminal act — where OJ Simpson was alleged to have stabbed and murdered Nicole Brown Simpson, his estranged wife, and Ronald Goldman — and the physical evidence data pointing to this criminal act were overwhelming in number, making it a strong circumstantial evidence case.

One of the strongest items had to do with DNA: the DNA profile matching OJ Simpson was found in blood taken from the crime scene and in a "trail of blood" leading away from the scene. DNA evidence is strong evidence because it involves numerous data items. DNA evidence involves billions of possible base-pair combinations. The large numbers are what makes DNA so strong.

But even the strongest of circumstantial evidence cases has the weakest link.

As you may remember, OJ Simpson was found not guilty in the criminal trial. The defense argued that the evidence — as strong as it looked — could not be trusted because of integrity issues: the evidence was mishandled ("Contamination!") and racist evidence collectors in the police department planted evidence.

Such an argument is *cogent* (cogent is a word like valid but used with induction). The largely African-American jury did not trust the police — perhaps because of prior experiences with law enforcement officers. If one cannot trust the police because of past experience (numerous bad past events), then why should one trust the evidence the police bring to trial, even if it seems strong?

But I am sure jurors trust their own two eyes! If bleachers were set up at the crime scene when the crime occurred and the jurors watched it happen, it would be hard for them to argue about police integrity. Two eyes — or twenty-four in the case of jurors sitting in bleachers at the crime scene — will trump DNA evidence any day!

Circumstantial Evidence?

Although "child abuse," "battered child syndrome," "shaken baby syndrome" and "abusive head injury" are considered to be scientific theories, prosecutors present them in the courtroom as circumstantial evidence cases. Once again, circumstantial evidence is indirect evidence — there is no witness to the criminal act by someone (other then possibly the defendant), but the criminal act by the defendant is supposed to be accepted "beyond a reasonable doubt" because of witnessed items before and after the criminal act and physical evidence pointing to the criminal act and the defendant. How well do these cases stack up as circumstantial evidence cases?

Before we answer that, there is one more item I need to mention about circumstantial evidence. The final conclusion to be drawn by the jury is in the form of a *hypothetical category*. "Hypothetical" describes a belief subject to being tested or proven — a hypothesis. A "category" is a set of items sharing the same characteristic. A "hypothetical category" is a set of the same hypotheses. In the case of Nicole Brown Simpson, what happened to cause the death falls under the hypothetical category of "multiple stab wounds," and the crime falls under the hypothetical category of "murder." "Murder" as a set of items with a single characteristic means crimes involving a violent act against another person that causes the person's death AND the premeditated intent to cause the act. The logical operator, AND, combines two or more events into a single category. Operators like AND, OR, AND NOT, *or* NOR can take two or more events and combine them into a single category (notice how I used the italicized word, *or*, to combine the capitalized words into a single category called "logical operators").

Hypothetical categories are needed in these cases because the complex timeline of one event following another is not witnessed. In such a situation, "the only plausible explanation" — a singular conclusion — has to be in the form of a single hypothetical category in order for the logic to be valid and the conclusion to be sound (truthful). The only plausible explanation — where a single cause is inferred from the consequences — has to be a hypothetical category. A hypothetical category for a crime also allows the courts to mete out justice in a uniform and fair fashion within a population.

Crimes that fall under the hypothetical category of "child abuse" do not make good circumstantial evidence cases. They are very, very weak circumstantial evidence cases.

The strength of a circumstantial case is from *induction by enumeration*. Truthful data events are information. Information is strength. Circumstantial evidence cases require a lot of truthful information to make the conclusion strong.

How much information is learned in the typical child abuse case? Very little. In the hospital, the history for the medical record is taken from the person who accompanies the child to the hospital and not from the "suspect" or defendant — the person who actually saw what happened. Although much data is collected in the medical record, much of that data is relevant to patient care and not relevant to finding out what happened and who is responsible for what happened. By the time the child dies and makes it to the autopsy table, the information gathered for the autopsy pathologist is often indirect and hearsay. The death certificate is often completed shortly after the autopsy without the pathologist ever hearing a first-hand account of what happened, without knowing what was at the crime scene, and without having done a thorough and exhaustive investigation to collect truthful data. Subsequent police investigation involves interrogation techniques filled with ACCPE and DACPE (remember the emails on the Reid Technique).

And what about the crime scene? Is it like the OJ Simpson case with lots of blood all over the place? No. The typical crime scene in a child abuse case has very little blood and not much call for DNA testing. There is not much to see other than evidence related to a resuscitation.

In these cases there is hardly any truthful data, making them very, very weak as circumstantial evidence cases, but they are presented in court as if the evidence items are numerous and strong. The pathologist recites a lot of data from the witness stand about what was found at the autopsy and engages in ACCPE. "These numerous injuries are consistent with child abuse" is the kind of testimony often offered, but the pathologist uttering these words does not realize how weak this is.

Hopefully by now, you are starting to get the picture if you haven't gotten it before. This is not good circumstantial evidence. This is a deception that only an understanding of logic can cure.

“No Evidence” Is Not “Evidence”

Image courtesy of iStockphoto.com, photodeti.

In the email entitled "How Science Stays "Stuck on Stupid, Part 1," I described a study entitled "Lack of Evidence for a Causal Relationship Between Hypoxic-Ischemic Encephalopathy and Subdural Hemorrhage in Fetal Life, Infancy, and Early Childhood," published in 2007. Hypoxic-ischemic encephalopathy (HIE) is a hypothetical category meaning brain damage from a lack of oxygen or blood flow in the head. "In this study," the authors wrote, "no support could be given to the hypothesis that HIE in the young in the absence of trauma causes subdural hemorrhage."

An *ad ignorantiam fallacy* is where a statement is false because it hasn't been shown to be true. Another way to say this is that the hypothesis of HIE causing subdural hemorrhage is false

because there is no evidence that it is true. "No evidence" becomes "evidence" that HIE causing subdurals is false.

But "no evidence" is not "evidence." To claim otherwise is a fallacy of logic: an *ad ignorantiam fallacy*.

The authors did not find evidence that HIE causes subdural hemorrhage because they did not recognize the cases where it did. Circular argument problems in the study design prevented them from seeing the evidence. You might want to review that previous email for further details.

Now I am going to tell you something that you may find surprising. Even though "no evidence" being "evidence" is a fallacy of deductive logic (inferring to certainty), "no evidence" can be useful in an inductive inference (inferring to probability). In other words, "no evidence" of something may make that something less likely to be true.

The reason why this works for induction is because "no evidence" is not "evidence"!

If we were to assign each item of evidence — each item we observe and assume to be true — a value of one and we were not to assign a value to an item that has not been observed or discovered (because it is not evidence), then multiple items with a value of one can be added together to make a larger number and items with no value will not add up. With induction by enumeration, the larger value makes an inductive inference more probable.

If a dead body is discovered in a house and there is no evidence of injury, no evidence of property damage, no evidence of a struggle, no evidence of a break-in, and no evidence of anything valuable missing, then the statement, "no evidence of foul play" would be useful in the investigative, inductive sense. It doesn't mean that there could not have been foul play; it simply means that foul play is not likely.

Also, the same could be said of an infant in the intensive care unit who has brain swelling, subdural hemorrhage, and retinal hemorrhages. If there are no scalp abrasions or tears, no broken bones in the skull or elsewhere, and no other indications of trauma in the body, then a traumatic cause for the brain swelling, subdural hemorrhage, and retinal hemorrhages becomes unlikely.

But why play around with "likely" and "unlikely" — with something that may or may not be the only plausible explanation — when we can listen to witnesses as described in the first part of the IT? Using the example of the child in the intensive care unit, if the caretaker described an event where the infant could have had a lack of oxygen or blood flow in the head — maybe a seizure disorder, a spell without breathing, or a spell without heart function — then the child could end up with brain swelling, subdural hemorrhage, and retinal hemorrhages without traumatic findings. A lack of oxygen or blood flow in the head causing brain swelling, subdurals, and retinal hemorrhages is known to occur frequently in infants according to numerous physicians who have noted this causal connection numerous times. There would be no need to

presume shaking — the mechanism too many doctors have used for decades to explain how a child gets brain swelling, subdural hemorrhage, and retinal hemorrhages without traumatic findings.

Hopefully in time, more and more will understand: We can listen to a witness with an open mind and see if what he says fits what the scientists find, but we should not make up a theory from what the scientists find and expect that theory to be true.

The Death Certificate

Another activity that involves the "weakest link" — an inference to what may be the only plausible explanation — is when a doctor or coroner fills out a death certificate.

A death certificate, like a birth certificate, is an important legal record; however, the death certificate differs from the birth certificate in one important way: even though the birth certificate contains only factual information, the death certificate has more than just factual information. The death certificate also asks the doctor or coroner for his or her opinions. Opinions are not facts; they are beliefs that may or may not be true (and are often not true).

The death certificate requires the doctor or coroner to infer from effect to cause (affirm the consequent) to a hypothetical category. Hypothetical categories are pigeonhole conclusions following backward, effect-to-cause inferences -- the weakest link. As such, inferences like this need to be done very, very carefully, realizing that there is a substantial possibility that the opinion is wrong.

What are the two hypothetical categories? They are:

1. Cause of Death, and
2. Manner of Death.

The image above the text in this email is a portion of the death certificate from the Commonwealth of Kentucky (USA). The red box encloses the items having to do with "Cause" and the blue box encloses the items having to do with "Manner." The other items in most of the death certificate are factual — items that witnesses have observed.

The reason why hypothetical categories are needed is for simplification. It would not be enough to say, "What happened is consistent with what witnesses observed," because that would require having to give a lengthy description of witnesses observed. Hypothetical categories simplify complex past events, allow people to conceptualize events, and also make it easier to make legal and public health decisions.

Unfortunately, when we simplify something, we often make it less accurate. We often lose important details.

There is no guarantee that these pigeonhole opinions are to a "reasonable degree of medical certainty" — the standard required for courtroom testimony from medical experts in the United States. Filling out a death certificate just means that the doctor or coroner is doing the "best he or she can" when offering opinions. The inferences are inductive — to what is probable — rather than deductive — to what is certain. Sometimes the courts do not realize this when they consider death certificates as evidence.

In other words, the doctor or coroner is like a jury: just as jury members look at available evidence and then make the best decision they can, the doctor or coroner does likewise.

With this in mind, what strategy can be used to support that the doctor or coroner did the "best he or she could" when offering these important opinions? The answer is to:

1. Reason forward from witness accounts to physical evidence as much as possible; then, when this is done, to
2. Reason backward with the strongest argument possible that the conclusion for Cause or Manner is the only plausible explanation.

We will use this approach in the next email when we consider Manner of Death.

Manner of Death, Part 1

Image courtesy of iStockphoto.com, NemanjaZs.

What do you think of the picture to the left? Doesn't that just about say it all?

Reasoning forward in time — from left to right, from past to present, from cause to effect — involves comparing facts in the past with facts in the present. Everything is factual, and inferences from these facts can be so strong that they can be characterized as "reasonable medical certainty."

On the other hand, inventing stories or theories from facts in the present — reasoning backward in time, from right to left, from present to past, from effect to cause — is so weak that it can be characterized as mythology.

Didn't ancient Greeks and Romans look at nature all around them in the present and invent stories of past events to explain what they saw? Isn't that how we got college courses in Mythology?

I guess not much has changed from then to now.

Now, on to Manner of Death. Remember that the strategy that will allow us to claim that we did the "best we could" in filling out the death certificate is to first reason forward, then to use what we learn from reasoning forward to reason backward to a single explanation — the only plausible explanation.

Thankfully, whoever invented the manner of death classification did a brilliant thing. The hypothetical categories of homicide, suicide, accident, and natural by apparent design are all *mutually exclusive* and *jointly exhaustive*.

Mutually exclusive means that there is no overlap in the categories. Some homicides cannot be suicides. Some suicides cannot be natural deaths. Etc. Without mutual exclusion, we cannot infer to a single explanation that is certain in a logically sound manner.

Jointly exhaustive means that all manners put together contain all possibilities. There is no situation where a death cannot be a homicide, suicide, accident or natural. Without the categories being jointly exhaustive, we cannot infer to a single explanation that is certain in a logically sound manner.

Now let's define what the categories mean. Using the Boolean operators of AND and AND NOT — such as what you might use in a library or internet search — consider the following (remember that such operators combine two or more characteristics into one hypothetical category):

A *natural death* is a death by internal causes (something taking place inside the body). This is compared to a *violent death* where the death is by external causes (something outside of the body introduced into the body).

A *homicide* is a violent death where a person or persons killed another AND there was evidence of intent.

A *suicide* is a violent death where a person killed himself AND there was evidence of intent.

An *accident* is a violent death where a person is killed AND NOT any evidence of intent.

If the manner cannot be narrowed down to only one plausible explanation (another manner has not been eliminated), then the manner is *undetermined* or cannot be determined. If there are two possible manners, you might as well flip a coin because the demonstrable probability of one over the other is 0.5 - "fifty-fifty." Flipping a coin is not acceptable death investigation practice.

Think about what you have just read. I know you have questions at this point, but maybe the next email will answer them.

Manner of Death, Part 2

For review, here is how I defined the manner of death categories in the last email:

- A *natural death* is a death by internal causes (something taking place inside the body). This is in contrast to a *violent death* where the death is by external causes (something outside of the body introduced into the body).
- A *homicide* is a violent death where a person or persons killed another AND there was evidence of intent.
- A *suicide* is a violent death where a person killed himself AND there was evidence of intent.
- An *accident* is a violent death where a person is killed AND NOT any evidence of intent.

You may recall that the purpose of forensic science is to answer the questions, "What happened?" and "Who (if anyone) is responsible for what happened?" The hypothetical categorization in the death certificate that addresses "What happened?" is the cause of death, and the hypothetical categorization that addresses "Who (if anyone) is responsible for what happened?" is the manner of death.

"Responsible" means having to be accountable and to accept blame. In order for someone to be held responsible for a behavior, that person has to have *intent*. To intend means to do something on purpose, to make a decision to behave a certain way. Homicide and suicide as manners require some form of intent in order to assign responsibility. Without intent, calling something a homicide or a suicide is meaningless.

If a death was intended, that means there is a greater likelihood that some form of societal correction or consequence is needed. On the other hand, if a death was not intended — like an accident or a natural death — then a societal correction or consequence is not as likely. Notice that I am using terms of probability rather than certainty. Manner of death classifications that include intent give notice to interested parties that a death may need to be looked at carefully because the need for corrective action may be likely.

Intent may be variable. For example, a homicide may range from a premeditated intent ("cold blooded murder") to an intent to disregard the safety of others (for example, shooting a person on a boat while trying to shoot seagulls). A suicide may range from a premeditated intent ("typical" suicide) to an intent to disregard personal safety (for example, Russian Roulette). Defining the intent in criminal proceedings is left up to the courts. For death certification purposes, all that is needed is evidence of some form of intent — no matter how it is specifically defined criminally.

"Wait a minute, Dr. Young," I almost hear you say. "Aren't you making this up? Where does the National Association of Medical Examiners (NAME) — an organization that has addressed manner of death in various ways — give the definitions that you give? Where do you get your definitions?"

Decisions about manners of death made by an organization like NAME involve *conventions*. Conventions are ways of doing things that are acceptable to members of an organization. These ways may or may not be logical or scientific (although logic and science are what is hoped for). For one reason or another, NAME has chosen not to define all of these terms carefully — particularly the term, accident. Instead, they give examples that may be acceptable conventionally. Regardless of convention, in order for a system to be both logical and useful to interested parties, categorizations like manner of death should be mutually exclusive and jointly exhaustive — if that is possible — in order to argue that we are doing the "best we can." If you were to look at the manner-of-death examples in the NAME publications, you would find that most of their examples fit the definitions I have offered. I would argue that the definitions above are needed to say that we are doing the "best we can," to have something that is logical and also useful to the society we serve.

Perhaps you disagree? Well, I am ready to hear your counterarguments.

Before we get into Cause of Death, we need to review Diagnosis and Treatment. See you next email.

Diagnosis & Treatment

Image courtesy of iStockphoto.com, michaeljung.

According to a song sung long ago by Frank Sinatra:

> Love and marriage, love and marriage
> Go together like a horse and carriage
> This I tell you brother
> You can't have one without the other

Well, I would argue that you can have love without marriage and marriage without love. You can even have a horse without a carriage and a carriage without a horse. But scientifically and logically, you can't have diagnosis without treatment and treatment without diagnosis.

Why? Because "one without the other" — treating without a diagnosis or a diagnosis not tested by treatment -- is like "shooting in the dark" — an activity that is unlikely to "hit the bullseye." It is hard to argue that "shooting in the dark" is doing "the best you can" — especially when you can turn on the treatment light for a diagnosis and the diagnosis light for a treatment.

In the health care setting, a diagnosis is a hypothetical category. Over the years, many scientific facts have been gathered to characterize disease in a population, and many diseases have been categorized scientifically. A diagnosis is what the doctor *thinks* is wrong with the patient — a hypothesis. It is backward reasoning to what is hoped to be the only plausible explanation for a patient's disease, and that backward reasoning is to a hypothetical category — a diagnosis.

Inductively, other diagnostic tests are ordered to increase the number of data points supporting a diagnosis. The diagnosis may become more and more plausible with more and more data points; however, "the proof of the pudding is in the eating" — the diagnosis is ultimately tested by the treatment. If the treatment is successful, then the diagnosis is likely to have been

correct. If the treatment is not successful, it is "back to the drawing board" (forgive my frequent use of clichés in this email!).

How much treating is going on in the courtroom? Certainly there is punishment that is meted out, but punishment is not testing. Diagnoses offered in a courtroom are simply untested hypotheses.

I recall reading one consultation note from a child abuse pediatrician who later testified in court. She wrote, "Thank you for allowing me to care for your patient," at the end of her report found in the medical record.

Doctors are so accustomed to the diagnosis and treatment paradigm ingrained into them from medical and dental school on that they believe that forensic opinions are diagnoses. This child abuse pediatrician did not take care of anybody, particularly the child. She offered no suggestions for any treatment; instead, she likely made a bad situation a whole lot worse.

Health care is kind of like a systematic, scientific crapshoot — where odds are assessed and bets are placed. Unlike the manner of death classification, available diagnostic categories are not mutually exclusive nor jointly exhaustive. There is no logically sound way to claim that a diagnosis that cannot be tested is correct or anywhere close to certain. There is no logically sound way to claim that a particular diagnosis is the only plausible explanation. All that is left to do is to get the inference into the likely "ballpark" so that a treatment has a strong chance of working. Successful treatments are what saves health care and keeps it moving forward. Regardless of the diagnosis, everyone leaves happy when the treatment is successful.

But one cannot treat events that are past and no longer exist — the events considered in a courtroom. Offering diagnoses on the witness stand is like betting a large sum of money at the roulette wheel — an almost sure way to "lose your shirt."

"Okay, Dr. Young, if treatment tests a diagnosis, what tests a forensic opinion in court?"

The Inferential Test, of course.

"Wait a second, Dr. Young! Are you saying that something I recently heard about may be the most important thing in forensic science?"

Well...yeah!

The Inferential Test. Learn it. Live it. Love it.

Cause of Death, Part 1

Now let's talk about Cause of Death. From this point on, things become a lot more complicated and — in most cases — uncertain.

You wouldn't know this to talk to most forensic pathologists. They consider Manner of Death to be uncertain and Cause of Death to be easy. I believe this has mostly to do with familiarity. Forensic pathologists are familiar with making diagnoses because of their medical training, so

they are comfortable with determining causes. The process seems natural to them, unlike finding out the manner of death which requires one to look beyond the autopsy table.

Nothing could be further from the truth. All it takes is a little understanding of logic to make this plain.

Consider the portion of the death certificate (Commonwealth of Kentucky) in the image above. Note that Manner of Death (outlined in purple) occupies a tiny box with only a few categories. As mentioned before, these categories — other than "Pending investigation" and "Could not be determined" — are mutually exclusive and jointly exhaustive. It is possible and even "easy" to rule in and rule out categories to reach the only plausible explanation.

If something like this were to be set up for Cause of Death, the space would have to occupy more than a little area on the death certificate. It could take reams of paper to list all the hypothetical categories for all possible and even plausible causes in any particular case. The categories would not be mutually exclusive — there could be a lot of overlap among categories. Also, the categories would not be jointly exhaustive — a vast number of both known and unknown possible causes could exist for any particular case that we might not consider. Sure, one could rule out a particular possibility, but that doesn't come anywhere close to ruling out all other possibilities. Furthermore we don't have the advantage of treatment like we do in the health care setting to test hypotheses.

Clearly, there are cases where the cause of death is "easy." For example, if a pathologist discovers a condition at autopsy from an uncomplicated recent event that is not compatible with life — such as a ruptured myocardial infarct or a ruptured aortic aneurysm in a natural death, or a gunshot or stab wound to a vital portion of the anatomy in a violent death — the cause then becomes the only plausible explanation. That is easy.

Unfortunately, most cases are not like that. Most autopsies yield results that are not that characteristic and not that clear. Coming up with a cause from just autopsy results then

becomes ACCPE. Speculation takes place, and there is no possibility of testing by treatment or by the kind of diagnostic testing available to living, functioning patients.

The Cause of Death portion of the death certificate (outlined in red above) asks the doctor to write the cause of death in his or her own words — this way, saving reams of paper. Furthermore, there is more than one line to list cause (even though the bottom line or underlying cause is the most important). This is further indication of how complex these kinds of inferences can be.

In light of all this uncertainty, how do we assign a cause of death that is both useful to the people we serve and that allows us to make the claim that we are doing the best we can?

Do you remember the strategy? It is to:

1. Reason forward from witness accounts to physical evidence as much as possible; then, when this is done, to
2. Reason backward with the strongest argument possible that the conclusion is the only plausible explanation.

In the next email, we will further discuss how to do this with Cause of Death, particularly in those cases where the events are not well-witnessed (such as natural deaths).

Cause of Death, Part 2

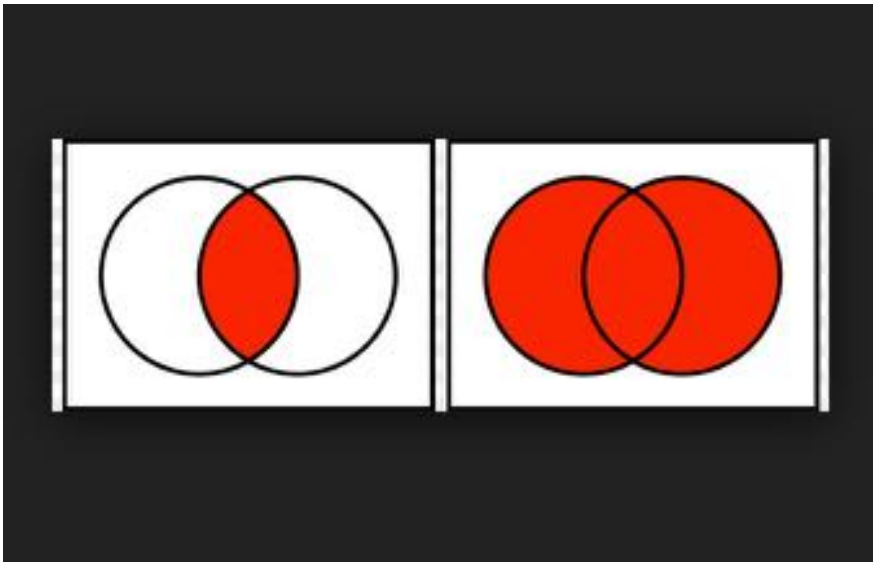


Image taken from Wikipedia.com for Venn diagrams.

Once again, the strategy:

1. Reason forward from witness accounts to physical evidence as much as possible; then, when this is done, to
2. Reason backward with the strongest argument possible that the conclusion is the only plausible explanation.

I will make my next five points quickly and briefly. If you have any questions, please feel free to email me.

- I cannot emphasize enough the importance of point number 1. Even the best diagnosticians in health care settings know to do this. They pay close attention not only to the History of Present Illness but also to the Past Medical History and the Review of Systems in the initial patient workup. This is all witness data. Furthermore, they are attentive to the clinical course where numerous people observe and track the course of the disease and treatment in the Progress Notes and the Nursing Notes — more witness data. The great diagnosticians know to focus on these items — even looking up old medical records if necessary — before considering a wide variety of diagnostic tests because they know they need to let the witness information guide their choice of tests. This gives the greatest yield for the best diagnosis — it is "where the money is." Both good forensic and diagnostic doctors sense that unless they thoroughly evaluate anamnestic data, they cannot make a strong argument for a diagnosis or cause determination to be the "only plausible explanation."

- If a cause of death is not violent — if it is a natural death — then the cause is less likely to be accurate. The determination is less likely to be the only plausible explanation. The reason is that deaths by external causation — violent deaths — can be observed and described by witnesses, but internal events and causes are not readily witnessed — except perhaps by advanced imaging techniques in the health care setting. This void in observation becomes an even greater problem when the death occurs suddenly and unexpectedly without monitoring or observation of internal conditions. Thankfully, natural deaths are less likely to be prosecuted, so the exact determination of the cause of a natural death is not as critical in the social or legal sense. Still, many people want to know what caused a natural death, so we need to do the best we can.

- In natural deaths, the forensic doctor assesses likelihood and takes his or her best shot, realizing that there will be no testing by treatment to support the determination. At times, the nature of the internal lethal condition, the quantity of the data supporting a determination, and the prevalence of a disease condition in a population may make a determination the only plausible explanation. If there is more than one condition discovered at autopsy or otherwise possibly present that could be the cause, then assessments are made of how lethal a condition is and how common. Also, if the death occurs close in time to the manifestation of the disease condition, the two are more likely related causally. All of this is assessed when one tries to do the best one can. For more information on this, see what I have written in my treatise, "Diatoms,

Retinal Hemorrhages and Other Forensic Tests..." posted in the Writings section of my website.

- If there are two conditions that are both common and lethal, why not combine the two conditions into one using a disjunct (OR)? For example, let's say a person collapses suddenly and unexpectedly and is discovered to have both severe coronary artery narrowing and an enlarged heart at autopsy. There is also a history of high blood pressure. The cause of death could be listed as: Coronary Atherosclerosis or Hypertensive Cardiovascular Disease. Notice the Venn diagrams in the picture above this email. Consider the enclosing rectangles to be all potential causes of sudden death, the circle on the right to be Coronary Atherosclerosis, the circle on the left to be Hypertensive Cardiovascular Disease, and the area where both conditions are present to be where the circles overlap. Using a conjunct (AND) as is commonly done in death certification limits the determination to the shaded area, where the cause is less likely because the area is small. If both are combined using "or", the area is larger (both circles are completely shaded); consequently, the determination for cause is more likely. The use of OR is an inclusive OR, meaning "and/or" is the same as "or" logically.

- Several doctors reading these emails may have noticed that I did not include the portion of the death certificate listing "Other Significant Conditions" as part of this discussion. Other Significant Conditions are typically conditions that may influence an outcome but are not a part of the causal chain. They are typically factual (capable of observation clinically or at autopsy) and their assessment of significance is forward-reasoned rather than backward-reasoned ("If the condition is present, then it could be significant or influence to the outcome.")

In the next email, we will consider another item that definitely has something to do with a doctor doing the best she can. What is it? Find out four days from now.

When To Autopsy

Image courtesy of iStockphoto.com, bjolo.

Many deaths are reported to a coroner or medical examiner office, but only a few of these receive autopsies. If we were to autopsy every dead body that darkened the door of a coroner or medical examiner office, would we be doing a good job? Would we arguably be doing the best we can?

The answer is no. First of all, autopsies are expensive and resources are limited. Autopsies should be performed only in cases where they are needed.

Secondly, performing autopsies in the coroner or medical examiner setting does not require permission from the family. Performing autopsies when they are not wanted just makes people angry — particularly family members.

So when should autopsies be performed?

You may recall something I posted in the Writings section of my website — an article entitled, "Forensic Science and the Scientific Method." In that article, I describe the **Forensic Scientific Method** — an application of the Scientific Method for past events.

The Forensic Scientific Method is:

1. Acquisition of primary witness and other anamnestic evidence
2. Anticipation of future questions
3. Acquisition of physical evidence
4. Comparison of consistency of alleged events (hypothesis) with physical findings, obtaining additional data as needed
5. Assessment only to a reasonable degree of scientific certainty, recognizing the limitations of science.

You may recognize the similarity with the Inferential Test. The Forensic Scientific Method reflects the Inferential Test but as a method rather than a test. It is a description of what should be done to learn the truth behind the injury or death.

Perhaps the most critical part of the Forensic Scientific Method is step number 2: Anticipation of future questions. The forensic doctor's ability to do this is a reflection of his or her experience and intelligence. Good forensic pathologists know how to do this very well.

Anticipation of future questions means that at the outset, the forensic pathologist predicts what issues a particular case will bring with it in the future. What will people be asking? It is very gratifying to provide answers to questions people will ask before they even know to ask the questions. Knowing what will likely be asked will guide the pathologist in the collection of physical evidence, including the performance of an autopsy.

Notice what precedes step 2. It is the acquisition of witness/memory evidence (anamnestic means something that is remembered). This makes a good witness investigation critically important. If much is known about why someone likely died, an autopsy may be unnecessary. For example, if an old person with a long history of heart disease is found dead at home and there is nothing suspicious about the surroundings or the circumstances as reported by others, then an autopsy is likely not needed. It is acceptable and appropriate for the treating doctor to sign the death certificate without an autopsy because that doctor knows more about the patient's medical condition than the coroner or medical examiner. All the coroner or medical examiner needs to do is reassure the doctor that there is no need for concern about injury or foul play.

However, if little is known in step number 1, it is important to do an autopsy. If a person is unidentified, it is important to do an autopsy. A vast amount of data becomes available when a person's identity is known; in other words, if you don't know who someone is, you don't know much. An autopsy is done in order to learn more.

Frankly, if the family, the police or the prosecutor is suspicious or concerned, it is important to do an autopsy — even if the forensic pathologist is not suspicious or concerned. It is better to take 30 minutes or so (or however long is needed) to do the procedure then to spend hours, days or even years having to defend your decision not to do one.

Forensic Timing

Image courtesy of iStockphoto.com, Nastco.

Detective fiction has left an amazing legacy — a legacy of myths that persist in the minds of scientists and law enforcement officers to this present day. They are:

•The myth that if you are smart enough, you can reliably surmise past events from physical evidence,

•The myth that if the suspected criminal confesses to the crime, you have solved the case, and

- The myth that a doctor can view a dead body at the scene of death and tell you when that person died.

We have already dealt with the first two myths in previous emails. Now we get to deal with number 3.

Determining the numerical age of something by inspecting physical evidence is ACCPE. It is junk science. Claiming to be certain about such a determination is a fool's errand, an impossible task. There are variables too numerous to count and not accounted for in any given case that make such determinations unreliable.

Yet the medical and forensic science literature is replete with studies where such exercises in timing are performed. No one has told these scientists about the IT, and many certainly have not figured it out...yet.

Scientists like anthropologists — who look at a skeleton and determine the age of the skeleton. Radiologists — who look at x-rays of fractures and tell you how old the fracture is. Pathologists — who look at healing reactions in tissue and tell you when the injury occurred. Toxicologists — who use calculations to tell you what the blood alcohol level should be after drinking a certain volume of alcohol for a certain period of time. Entomologists and botanists — who look at insect and plant activity around a dead body and tell you when that person died.

Now I agree that many of these scientists hedge their bets. They give a range of times within which they believe the person could have died and call these estimates. Even these ranges are unreliable. In many cases if not most cases, there is insufficient data in the literature to assign ranges. It is highly unlikely to find a study in the literature that replicates the variables in any particular case — variables that are mostly unknown. Time ranges simply represent the scientist's best guess based on intuition and "experience" — “experience" often based on

ACCPE done over and over again. Such ranges fall short of the factual basis needed for the reasonable certainty required by the courts.

Have I disappointed you? Well, I have some good news. You don't need to throw out or disregard all of those timing studies because there are uses for them. The uses are limited but there are still uses. Here they are:

- For crude estimates during an investigation

During an investigation, it is perfectly acceptable to make an estimate so that leads can be developed. It is preferable that such crude estimates are not written down, but if they are, they should couched with terms of uncertainty. Such estimates are frequently wrong, but you do not need to worry about that. If the estimate you make is discovered to be wrong once more data is collected — data in the form of witness accounts and other physical evidence — you can crumple up the paper where the estimate is written and throw it away without any qualms of conscience.

- For application with the first part of the IT — where witness accounts of the past are compared to physical evidence in the present for consistency or inconsistency.

Consistency is another way of saying, "It is possible" and inconsistency is another way of saying, "It is not possible." With witness accounts, the unknown variables are now known and can be tested for fit. For example, it is not reasonable to blame the babysitter who has been with the child for 30 minutes for a head injury she did not witness when the subdural hematoma on CT scan is chronic (estimated to be months old). Such a scenario is "not consistent."

Could you still be wrong or even uncertain? Of course! Still, if you want to claim certainty for a determination of consistency or inconsistency on the witness stand, the inference is at least valid for certainty.

Science Good, Witnesses Bad?

Recently, my brother, Ben (Benjamin W. Young, DDS, MS — a subscriber to these emails) sent me a link to a YouTube video, entitled, "A roomful of people condemn five innocent men." http://wimp.com/innocentmen/

In the video, a man furtively snatches something from the lap of the main speaker and runs away. You can see the thief in the image above. The audience was asked to identify the thief in a photo lineup, and most of the answers were wrong. You can watch the video for yourself for this demonstration.

Do you realize what is going on here?

This is an attempt to minimize the value of witness accounts in the courtroom setting. "Witnesses are not reliable," they say. So if witnesses are not reliable, what is? Scientists?

I believe many scientists would like you to believe that. If witnesses are discredited in the mind of the public, it allows scientists to get up on the witness stand and say whatever they want to say without being held responsible for inaccuracies. It is *carte blanche* to affirm the consequent for complex past events (ACCPE).

But think a little more. How do we know who really took the item? Everything happened too fast for us to see the thief. His back was to the audience. People were also not prepared to observe. How do we know?

Because the scientists who are witnesses told us how they set up the demonstration.

I have never said that witnesses never lie and always give right answers. I have said that witness accounts can be tested by physical evidence. Witness accounts and physical evidence go together like diagnosis and treatment: logically, "you can't have one without the other."

Think of it this way (and for good measure, I will include "love" and "marriage"):

Romance: Love leads to marriage; a marriage tests the love that led to the marriage.

Scientific method: A hypothesis leads to an experiment; the experiment tests the hypothesis that led to the experiment.

Health care: A diagnosis leads to treatment; the treatment tests the diagnosis that led to the treatment.

Forensic scientific method: Past events lead to physical evidence; the physical evidence tests the witness accounts of the past events that led to the physical evidence.

"You can't have one without the other." It seems that Frank Sinatra had a point after all.

Don't be fooled, ladies and gentlemen! When it comes to immutable laws of the universe (and the IT is one of those), you can run but you cannot hide. Scientists can be artful, but in the end, they will be found out.

Dear Prosecutor

Image courtesy of iStockphoto.com, Peopleimages.

Dear Prosecutor,

This is an open letter to you. Others on the email list will read this, but consider this just between you and me.

Perhaps right now you are preparing to cross-examine me, looking for items I have written and said or items that have been written and said about me to use against me. If that is what you are doing, then knock yourself out. Do what you think you need to do.

I consider your job to be very important, believe it or not. You stand between us citizens and the bad guys, making sure justice is meted out. I appreciate that.

And at the end of most trials, when you have taken a case with lots of direct and circumstantial evidence and have argued that the evidence points to guilt "beyond a reasonable doubt," when you finally make that persuasive argument that a defendant should be found guilty, you do a good thing. After a successful case, your relaxation in the easy chair with your favorite beverage is well deserved. You should pat yourself on the back. Good job, counselor.

But there are some cases that when you win, you lose. Those are the cases for which you should not pat yourself on the back because you have caused harm. You have destroyed a life. In those cases, you lose when you win because now you have blood on your hands.

Whenever the child-abuse pediatrician or forensic pathologist you employ as an expert surmises complex past events from physical evidence — events that no one has ever witnessed — and that doctor vigorously and vehemently insists that those events took place because of what he or she found at an autopsy or in the hospital, that supposedly learned individual is highly, highly likely to be wrong. I have taken much time and effort to point this out in multiple emails, multiple lectures I have given, and multiple articles I have written. I have tried to explain this in a way that is straight-forward and easy to understand. Perhaps I have failed in this, so I will keep searching for ways to do better.

Even though I might fail in communicating important information, I do not think you are stupid or incapable of understanding. I also do not think that the child abuse pediatrician or forensic pathologist who may have recently confronted the logic I present is stupid or incapable of understanding. This is the power of a closed mind — that in spite of all I present or how I present it, one will not understand because one chooses not to understand.

You choose instead to believe the medical examiner you have relied on for many of your cases. You don't think he or she is wrong because you don't want him or her to be wrong. You put your faith in that doctor, that person you count on to lead you out of darkness and into the light of medical truth.

But doctors are human, too. They have their own built-in biases. They are slow to change.

This certainly has been true of medical examiners and forensic scientists in the professional organizations of which I am a member. Before now, they resisted what I have said and written. “Logic is too hard to understand, and I am just not interested,” they often say. Or they also say that Dr. Young is some kind of nut.

After seven years of trying to get doctors to pay attention and understand, I finally got to present the IT in — of all places — Seoul, South Korea. I finally got this accepted by my peers for presentation, but this had to be done outside of the United States!

In spite of this, no one can argue that the logic I present is wrong. No one has been able to do this because I am not wrong. The logic is sound.

Consequently, you can look forward to a whole lot of wailing and gnashing of teeth in the future. Once the general public realizes what is going on — and they will eventually — I do not want you to have been on the wrong side of the argument.

Dear Prosecutor, in the quiet of this moment, even at this late hour, consider carefully what you are doing and turn back before it is too late.

Sincerely,

Thomas W. Young, MD

Sudden Infant Death, Part 1

Image courtesy of iStockphoto.com, ConstanceMcGuire.

A topic that has generated great confusion among scientists over several decades has been the topic of “crib death” or Sudden Infant Death. An understanding of the Inferential Test would clarify this confusing topic.

You may have noticed that the title of this email does not use the word, “syndrome,” after Sudden Infant Death. Why? Because Sudden Infant Death is not a syndrome!

“Syndrome” in my dictionary has been defined as “a group of symptoms that consistently occur together, or a condition characterized by a set of associated symptoms.” Can you see the problem?

First of all, “symptoms” occur in a living person who has a disease or condition. Death is not a symptom because the person is not alive.

Secondly — and very importantly — the word, syndrome, indicates a single condition leading to a set of associated signs and symptoms. In other words, a syndrome involves surmising a single cause for multiple effects. In a sudden infant death, you have a single effect (death) with a set of potential causes that are too numerous to count! It turns the word, syndrome, on its head!

Surmising a cause to a sudden infant death is “surmising complex past events from physical evidence” (“physical evidence” meaning an autopsy). It is ACCPE. Such surmising is highly, highly, highly, highly likely to be wrong.

The developing human organism is exceedingly complex. There is a lot that can go wrong that thankfully does not go wrong in most cases; however, in about 1% of live births, something does go wrong during infancy or even later. What goes wrong is not discoverable because it is a past event that no one has witnessed. There was no physiologic monitoring of a child who is found unexpectedly dead.

You may believe I am being picky here over the definition of a word like syndrome. I am not being picky. Words shape our conceptual framework. Definitions are critically important. We can waste great money and resources, and we can even put people in jail who don't deserve to be in jail if our thinking is sloppy (like it is here, unfortunately).

Over many decades, we have implicated sudden infant deaths to an enlarged thymus, to sickle cell trait, to a bacterium like *Helicobacter pylori* (I even co-authored a presentation where this was considered!), and to “unsafe” sleeping conditions. This last hypothesis was proposed many decades ago, but now it has been brought back in a new form and is currently popular among pediatricians and forensic pathologists. We even have a “triple-risk model” for Sudden Infant Death Syndrome (http://www.firstcandle.org/cms/wp-content/uploads/2009/12/Triple_Risk_Model.pdf) — an oversimplified conceptual model for a vast array of potential unknown causes. It is important to recognize that these are hypotheses without requisite evidence, yet the purveyors of these hypotheses sound very certain about them — just as they sounded in decades past.

Let me offer a few analogies. We recognize in adults that a sudden unexpected death has a host of different causes. It may be from heart disease of many varieties — some common and some rare — or it may be from conditions arising outside of the heart — like pulmonary embolism or a ruptured aneurysm. Consequently, it doesn’t make sense to think that in a developing infant most deaths are only caused or most likely caused by a problem with the developing brainstem. What about the developing heart? Or the developing metabolism? Or the developing ____? You can fill in the blank if you care to (but I wouldn’t recommend it).

Also, many pregnant women miscarry or have spontaneous abortions. We recognize that the cause of a spontaneous abortion is unknown in the vast majority of cases, but we don’t have a concept of “Spontaneous Abortion Syndrome.” It would be absurd to assume that there is a single, underlying cause for all spontaneous abortions, just as it is absurd to assume that there is a single, underlying cause for crib deaths.

The IT states that “…one cannot reliably surmise past events from physical evidence.” It is true here as well. It is also true that there are very, very few items in the universe that have only one explanation compared to those that have more than one explanation. It is not likely at all that Sudden Infant Death is one of those items that has only one explanation.

There are many implications for this topic that you may not have thought of yet. Stay tuned and keep reading.

The Texas Sharpshooter

Image courtesy of iStockphoto.com, antonbrand.

We interrupt our regularly scheduled emails about Sudden Infant Death to bring you the story of a man who aspired to great things.

Once upon a time there was a farmer who dreamed big. Unlike other farmers who toiled in the field all day long from before sunrise to after sunset, this farmer was a bit on the lazy side. He sat on a log, taking potshots with his rifle into the siding of his barn — an activity he did nearly every day — as he dreamed of one day becoming a lawman!

Suddenly, he snapped out of his reverie and discovered something amazing about the siding of his barn, something that would turn out to be life-changing!

As he studied the side of his barn, he discovered patterns! Patterns!

Most of the holes in the barn siding fell into clusters. Armed with this discovery, he grabbed some red paint and a paint brush from the nearby shed and drew concentric circles around the clusters. From that moment he knew he was not just another boring farmer. He was indeed a Texas Sharpshooter!

Our farmer was aware that the county was looking for someone to replace the retiring sheriff. The county commission had hired a search committee. One of the major requirements for the new sheriff — in fact, the most important requirement — was that the replacement be a man skilled in the use of firearms. A person who would hit his target every time he shot.

In great haste, the farmer contacted the chairman of the search committee and showed him the targets on the side of his barn. The chairman was impressed.

Furthermore, the chairman took into consideration existing political realities. He knew that the commissioners had given him a budget for his search but the funds were limited. He also knew that time was short because soon they would be without a qualified person to serve as sheriff. He also realized that if the search committee was successful in finding a suitable candidate, there was a good possibility that the county commission would award the search committee more money for more searches.

The chairman thought briefly about setting up targets and asking the farmer to shoot against the targets in the presence of the search committee, but wouldn't that take up more time? More money?

Also, if it turned out that the farmer could not shoot after all, who could be found to be the new sheriff?

So it was decided. The search committee provided photographs of the targets in the side of the barn, and the commission appointed the farmer to serve as the new sheriff.

And everyone lived happily ever after!

…or did they?

We return now to our regularly scheduled emails…

Sudden Infant Death, Part 2

What would we need to do if we really wanted to find the causes (not cause, but causes) of Sudden Infant Death?

Well, it would require technology that currently does not exist.

We would need to be able to monitor the vital signs of infants remotely, wirelessly, and in a way that would not disrupt their lives.

We would also have to do this with large numbers of infants because Sudden Infant Death is a relatively rare event. It would take a large sample of infants to generate enough cases where death occurred suddenly and unexpectedly.

We would expect to deal with large numbers of false positives from the monitoring — much like the TSA (Transportation Safety Administration) these days has to deal with large numbers of false positives when screening for a rare event like terrorism. Dealing with false positives can be expensive and problematic.

Also, it is not clear what items should be monitored. Hopefully, time and the experience that comes with trial and error might give us clues as to what should be monitored and how it could be monitored.

We would learn quickly what items are not a cause of Sudden Infant Death thanks to falsification via *modus tollens*.

And even as we might identify the more likely causes of a Sudden Infant Death, we would not be able to guarantee that we discovered all causes.

How close are we to doing this? You already know the answer: we are not even in the remotest ballpark of this! The effort to do this currently would be exceedingly costly.

But we need answers! Families and politicians are clamoring for answers! What do we do?!

All that is left to do is to draw red circles around clusters of gunshot defects in barn sidings — as described satirically in the last email. That does not work, particularly for events that are exceedingly complex like Sudden Infant Death.

Consider the definition of Sudden Infant Death Syndrome: it is the “unexplained death, usually during sleep, of a seemingly healthy baby less than a year old” (mayoclinic.org). How did researchers come up with “less than a year old”? They drew a red circle!

Regarding those risk factors — including “unsafe sleep environments” — it is helpful to remember that the risk factors often touted in the literature are common but the problem of Sudden Infant Death is relatively rare. That means the risk factors are more common in infants who do not die suddenly and unexpectedly. In a perverse way, you could look at them as risk factors for not dying suddenly and unexpectedly and this would be more likely to be true. Check out the Bayes’ Theorem calculations I do in my probability article in the Forensic Inference Series on my website — it might help you understand what I am writing here.

Also, if the child has slept in the same “unsafe sleep environment” numerous times and only dies one time, we could state that the “unsafe sleep environment” is most likely not the cause of a sudden infant death and most likely a risk factor for not dying.

In other words, everything we think we know about this topic is unlikely to be true!

But for the savvy death investigator or medical examiner, what I have mentioned here should not prevent us from doing what we need to do. Find out how as I continue to explain in the next email.

Sudden Infant Death, Part 3

Let’s pretend you are a coroner or medical examiner, and a case of a sudden and unexpected death of a child occurring in your jurisdiction is reported to your office. What do you do?

First, you remember the Forensic Scientific Method. It will guide you in what you will do:

- Acquisition of primary witness and other anamnestic evidence
- Anticipation of future questions
- Acquisition of physical evidence
- Comparison of consistency of alleged events (hypothesis) with physical findings, obtaining additional data as needed
- Assessment only to a reasonable degree of scientific certainty, recognizing the limitations of science.

You then send an investigator to interview witnesses, especially primary witnesses — people who were with the child when the event happened or the body was discovered. It doesn’t matter where these people are: the investigator must go to where they are. A timeline of events from even as far back as the pregnancy and birth to the present is constructed — all from primary witness accounts and other anamnestic evidence (video and audio recordings, for example). Also, the investigator should obtain the child’s medical records — from the past and from the treatment recently rendered by ambulance personnel and hospital health care providers.

The investigator visits where the event took place. The child may be at the hospital receiving treatment, but that doesn't matter. The investigator should examine the scene of the event with the primary witnesses present.

If the child is an infant, the investigator should bring a doll. He or she should have the primary witnesses reenact with the doll what was found and what was seen. A doll can demonstrate what words cannot adequately express. The investigator should take pictures or video of the reenactment.

If the investigator suspects that there is an external cause to the event, such as overlaying in the case of sharing a bed with an adult or even smothering, the investigator should kindly and tactfully ask the primary witness if such an event took place. The answer should be recorded — verbatim, if possible. No investigation is complete without giving the primary witness or witnesses an opportunity to answer the question that many people may ask in the future. Finally, when you as the coroner or medical examiner compare the alleged events with the physical evidence obtained through an autopsy, from other testing and from items at the scene, you assess how well everything fits. If the evidence is all coherent (meaning that it all "fits"), then the hypothesis as alleged by primary witnesses is affirmed. If the evidence is not coherent, you keep investigating and obtain additional data.

If the child is found unresponsive or dead and there is no account or evidence of any external cause to the trauma, it should be recognized that infants and small children can die suddenly and unexpectedly from unknown internal causes. Such events — although relatively rare — are more common than infanticides for which there is no evidence of infanticide. The manner of death in such cases is "natural" because there is no evidence of homicide, suicide, or accident. Regarding the cause, if the child is an infant, I use the acronyms of SIDS (Sudden Infant Death Syndrome) or SUID (Sudden Unexpected Infant Death). Regardless of the scientific basis for these terms, you as a coroner or medical examiner want to assure that the family receives the resources and support from the SIDS Foundation (http://www.cjsids.org/). These acronyms on a death certificate will guarantee that.

If a death investigator is careful to follow these procedures, he or she will avoid the pitfalls that lead to false arrests and imprisonments. I will discuss these pitfalls in the next email.

Sudden Infant Death, Part 4

What are mistakes made by coroners and medical examiners in cases of Sudden Infant Death that could lead to false arrests and imprisonments? Here are three examples I can think of:

Allegations of suffocation

Rather than doing a careful, forward-reasoned investigation, some coroners, medical examiners, pathologists and police officers fall for the latest-fad hypothesis for SIDS. They look at situations having to do with sleep position, bed sharing, and "unsafe" sleep environments, and they accuse the primary caretakers of being grossly negligent. They call these cases, "suffocation."

Yet they fail to realize that the infant slept in that same situation night after night prior to her death and survived. Still, this time it must have been suffocation!

The death investigator, after learning all the available information about a specific case, must ask the question, "Would it be possible for the child to breathe in this situation." If it is impossible, then suffocation is the only plausible explanation. If it is possible, then you have to accept the statements of primary witnesses when they do not describe any harm.

Why? Because they were there to see what happened and you weren't! That would make their observations more likely to be true than your guesses!

Cardiopulmonary resuscitation (CPR)

Often when a primary witness discovers the lifeless body of a child, that person may try to save that child in the best way he or she can. That often involves performing CPR.

They may not know how to do it. They may compress the child's chest too forcefully, or they may place their hands in the wrong position (like over the abdomen).

And even persons who are knowledgeable in CPR (such as emergency medical technicians and doctors) may perform proper compressions for a long period of time, eventually leading to internal injuries in the child. They may also manipulate the child's face forcefully, trying to establish an airway. They may even tear the upper lip frenum — a fold of tissue between the upper lip lining and the front of the gum — as they try to open the airway and intubate.

But pathologists and medical examiners who do not focus on primary witness information may mistakenly conclude by ACCPE that injuries associated with these events — bruises, scrapes, lacerations, fractures, internal organ injuries — are from child abuse.

In reality, it is not that hard to tell at autopsy which injuries are from CPR and which are from trauma while the child had a beating heart. In situations with CPR, there may be massive organ damage — such as to the heart, the liver, or the small bowel mesentery — but there is often little more than a bloody ooze in a body cavity. Without a blood pressure from an actively beating heart, highly vascular organs will not bleed much. These organs may ooze from the CPR, but often this oozing leads to small volumes of blood loss that do not explain the death.

The situations involving CPR may vary greatly, but if the investigator focuses on the IT, he will avoid this pitfall.

The final example of a common problem that leads to false arrests and imprisonments will take a little bit more space to explain. Stay tuned to the next email!

Sudden Infant Death, Final Part

Now for example #3…

Effects from lack of oxygen / lack of blood flow

Most autopsies in cases of sudden infant death — where a baby is found dead in a crib or bed — are negative (no abnormalities); however, an autopsy may disclose a patch of old blood pigment in the dura — the membrane in the head surrounding the brain.

This is a remarkable finding in an infant who is only a few weeks or months old. How can such an old blood stain containing a metabolized red-brown pigment called *hemosiderin* show up in someone so young? Did it occur while the infant was a fetus? Or perhaps it occurred from bleeding during the birth?

During the last decade and a half, hospital pathologists in the United Kingdom have disclosed something very interesting. In that country, many autopsies are done in the hospital setting in both traumatic and non-traumatic cases. In many of the autopsies performed on fetuses, infants and young children, they found thin and relatively small blood collections in the subdural "space" (not a "space" in reality but in concept) located between the dura and the filmy coverings of the brain — the meninges. They saw these collections mostly in fetuses, less frequently in infants, and even less frequently in small children over one year of age. They saw these collections in both trauma and non-trauma cases.

In hospital cases, particularly cases not associated with trauma, there is ample opportunity to monitor a patient's care because records covering the clinical course of an infant or child are extensive. Also, autopsies in academic settings in the UK are carefully performed and allow a careful assessment of the brain for changes related to a lack of oxygen (*hypoxia*) or blood flow (*ischemia*). They found in many cases — not all but many — a correlation of hypoxia and ischemia with thin subdural hemorrhages. They found these changes in children who had diseases associated with hypoxia and ischemia, who had no evidence at all of anything traumatic.

A little knowledge of physiology can explain why this could be. Blood vessels are not inanimate tubes but living structures that require oxygen to function. Also, blood clotting requires oxygen to work properly because clotting involves an interaction of blood proteins with living cells that require oxygen. A lack of oxygen or blood flow to blood vessels for a period of time will allow cells to disintegrate, so when oxygen or blood flow is restored, these damaged blood vessels will leak and not clot right away. In a fetus and less so in an infant or small child, the dura has many venous channels. When blood flow and oxygen are restored after a temporary cessation, these vessels can leak and blood can seep into the subdural "space" as a thin collection.

A similar kind of bleeding can happen in the retina — the visual membrane in the backside of the eyes. If blood flow and oxygen are restored after a temporary cessation, retinal veins damaged from the lack of oxygen can leak and not clot. This can be made worse when the brain is swollen — a consequence of a lack of oxygen and blood flow to the brain — because the veins that drain the eyes go through the space where the brain is located. An increase in pressure in that space can cause blood flow to stagnate and cells to suffer further consequences of a lack of oxygen and blood flow.

Have you noticed anything here that you might have heard of before — like the "triad" (subdural hemorrhage, retinal hemorrhage, brain swelling) that comprises the Shaken Baby Syndrome?

In my forensic case work, I pick up patterns right away because I am accustomed to reasoning forward from witnessed cause to effect rather than reasoning backward by surmising cause from effect. Many of the cases I review have witness or physical evidence elements related to a lack of oxygen or blood flow. The cases are complex, but witness accounts often provide reliable information and fill in the complexities. Witness accounts make my job easy.

The Inferential Test — learn it, live it, love it. I love it!

Next email, we will cover another seemingly perplexing phenomenon often confused with child abuse.

Brittle Bones, Part 1

Image courtesy of iStockphoto.com, stockdevil.

Let's pretend that you are a pediatrician and you are seeing an infant or small child in your office for some nonspecific complaint or problem. During the workup you decide to order x-rays and — lo and behold! — you discover fractures. Numerous fractures. Fractures throughout the body in varying stages of healing.

Is this child abuse?

Perhaps, you order a few more tests and you rule out *osteogenesis imperfecta* — a rare genetic disease that leads to the kinds of fractures described above — and you rule out a few other rare conditions. Now that that has been done, it can only be child abuse!

Right?

From about 1990 to the present, Colin Paterson, a physician and scientist from the UK, has disclosed cases where infants for some unknown reason develop fractures very easily during the first six months or so of life. He reported cases of infants in the hospital setting, where infants had no fractures on admission and developed them while under hospital care. A hospital setting is a controlled environment where numerous items are monitored and recorded and access to the child is monitored and restricted. It is not the kind of environment where someone is going to abuse children readily and easily. Dr. Paterson termed these and other cases as "Temporary Brittle Bone Disease" (TBBD).

Over the years, Dr. Paterson has had many critics. In one published response to a letter to the editor of the British Medical Journal in 2011, Dr. Paterson admitted about the letter writer, "Much of what he says about temporary brittle bone disease (TBBD) is true. We still do not know its cause or causes. We still have no specific diagnostic tests. We cannot exclude other causes of fractures in every one of our published cases."

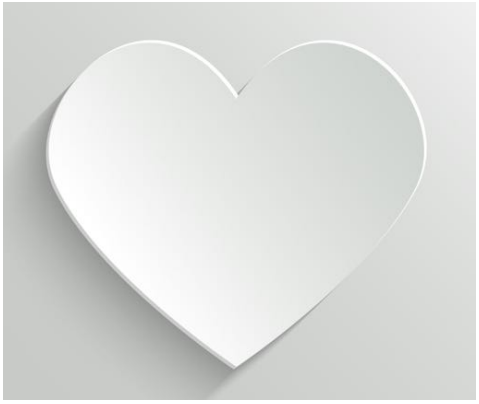
If you have been carefully following what I have written to this point, you can see that what Dr. Paterson wrote is the case. The developing human is highly complex. Development prior to adulthood proceeds most actively during the embryonic and fetal periods and comparatively less actively during the first year or two of life. If there is a factor or if there are factors missing during the most rapid and critical portions of development that are supplied later on, then such a condition becomes temporary and in the past. Determining what that factor or factors were is not possible because of the complexity of development and because the past events in a case cannot be tested by diagnostic tests or treatment.

Dr. Paterson did several things right. One thing was not to call this the "Temporary Brittle Bone Syndrome." Labeling past events as a "syndrome" is ACCPE. Such an inference is unreliable and highly, highly unlikely to be true.

In spite of this, the vast majority of doctors who testify in courtrooms throughout the world do not understand concepts like ACCPE. They somehow think that a differential diagnosis list can be formed, that other causes on the list can be ruled out, and that they can settle on what should be called their "favorite diagnosis."

The majority of experts are specialists in some area of clinical medicine. Each specialist has his or her own favorite diagnosis to explain the cause of — for example — bones that are broken in infancy.

What is your favorite diagnosis? To be continued…



My Favorite Diagnosis

Image courtesy of iStockphoto.com, Kumer.

After reading the heading of this email, you may wonder what my favorite diagnosis is.

Well…let me see…my favorite diagnosis is:

NOT GUILTY!!!

But, seriously, folks. Isn't it time for us to deal with the foolishness of a favorite diagnosis?

A diagnosis is a hypothesis. In health care or repair settings, this hypothesis is tested by diagnostic testing and by treatment (or repair). A past event is not accessible for diagnostic testing or treatment because the past event no longer exists in the present. Consequently, a diagnosis of a past event remains an untested hypothesis — at least not tested in the way most physicians prefer to test.

"Favorite" means preferred. It is an indication of bias. "Out of all the diagnoses that exist, I prefer this one, and I prefer it over and over again," one who has a favorite diagnosis might say.

"Wait a second, Dr. Young! No doctors do this! No physicians announce that they have a favorite diagnosis!"

Wanna bet? How about…

Child abuse pediatricians.

Out of all the diagnoses or hypotheses that exist, child abuse pediatricians have chosen “child abuse” to describe what they do. What is it that they do?: They diagnose and treat (treat?) “child abuse.” That in essence makes it their favorite diagnosis in spite of what they might claim.

There is money to be made with that diagnosis. Plenty of government and extramural funding is in place to support child abuse “diagnosis and treatment” (http://www.childrenshospitals.net/AM/Template.cfm?Section=Search3&template=/CM/HTMLDisplay.cfm&ContentID=42086). It is a diagnosis that adds to the bottom line. That might make it anyone’s favorite diagnosis!

“But Dr. Young, don’t you make money from your favorite diagnosis?”

Point well taken. Verdicts of "not guilty" in cases where I am involved can only help me.

And I can understand your thinking. I thought the same way when I was a government-employed medical examiner. I thought defense experts were simply “hired guns” who looked for ways to help defense attorneys get “not guilty” verdicts. These experts would look for ways to criticize my autopsy reports. “Dr. Young didn’t weigh the pancreas!” they might say in order to distract juries from rendering guilty verdicts.

I thought that way about defense experts until I understood the Inferential Test. Properly understood, the IT mitigates bias. It allows witness accounts to be tested fairly and accurately. In that sense, what my favorite diagnosis is becomes irrelevant. What the witness said outside of my influence becomes critically important.

I do not benefit financially to tell you about the IT; in fact, if everyone understood the IT, my services would no longer be needed and I would be out of a job. But I will tell you about the IT anyway!

What does this have to do with brittle bones? Keep reading!

Brittle Bones, Part 2

When it comes to fractures in infants, child abuse pediatricians are not the only ones with a favorite diagnosis.

Another favorite diagnosis is “Vitamin D deficiency.”

This diagnosis is favored mostly among a few defense experts — mostly radiologists — who carefully study bone radiographs. They have seen problems with bone mineralization in several infants — both in infants who have fractures and do not have fractures. Vitamin D is an important component of bone mineralization, both during and after pregnancy. These doctors talk about ordering laboratory tests for Vitamin D in both living and dead infants, thinking that a

low level in the present will make it more likely that the fractures in the past were caused by low Vitamin D. Also, these doctors implicate a deficiency of Vitamin D for a wide variety of other conditions. Vitamin D deficiency in their minds has become a common, largely unrecognized problem.

Unfortunately, what they do not seem to realize is that they are making the same inferential mistake as the child abuse pediatricians. When both kinds of doctors float untestable hypotheses before a jury, they are subject to dealing with the same kinds of problems on cross-examination as they try to defend their weak positions.

Here is another problem not considered by these doctors — a problem having to do with what conditions are "common" and what are "rare."

Favorite diagnoses are offered over and over again because they are favorite diagnoses. This gives the illusion of a condition being common rather than rare. A condition is common in the minds of these experts because they have diagnosed that condition many times.

Perhaps one day, the favorite diagnosis of Vitamin D deficiency will be tested with large studies conducted by multiple institutions in a forward-reasoned ("prospective") way. This, of course, will not happen unless pediatricians in general are willing to give up their favorite diagnosis of child abuse as a cause of infant fractures. A favorite diagnosis ends all further interest, inquiry and study of other diagnoses by the majority of doctors. If a diagnosis is not favored by a majority, then the minority wants the studies to prove their favorite diagnosis.

But even with successfully performed, large, forward-reasoned studies, Vitamin D deficiency may be demonstrated to be a cause of infant fractures but it won't be the only cause. This makes it impossible to know for certain whether or not Vitamin D deficiency was the cause of the fractures in a specific court case.

There are other conditions that can cause problems with bone mineralization — problems that can be disclosed through witness accounts. If a pregnant woman, for example, is treated for a heroin addiction through the use of a substitute narcotic called suboxone, the fetus may become sluggish in the uterus. There is then decreased stress placed on fetal bones (decreased fetal bone loading), so the bones do not become as strong and as well mineralized. Once the birth takes place, the bones have to "catch-up" with the mineralization, and these changes become apparent in infant radiographs.

In other words, problems with maternal D deficiency and decreased fetal bone loading can look the same. A reason for decreased fetal bone loading may be apparent from the witness accounts but not always. A deficiency in Vitamin D is not something that is readily observed by witnesses.

If floating a favorite diagnosis is not a useful strategy in court, how can an attorney use these scientists effectively to win a case? Stay tuned for some strategy suggestions for brittle bone cases.

Brittle Bones, Final Part

Now for some strategy…

In many countries, the prosecution carries the “burden of proof.” This means the prosecutor has to prove the case “beyond a reasonable doubt.” All the defense needs to do to show the jury that the prosecution has not successfully carried that burden is to demonstrate that there is “reasonable doubt.”

In brittle bone cases, this can be done easily with the aid of experts, including radiologists. For one thing, we already know that the prosecution typically cannot carry their burden in a brittle bone case because abusive trauma to the infant has not been witnessed. Consequently, their case is based on ACCPE which makes it highly, highly likely to be wrong.

If a defense-expert radiologist discloses problems with mineralization in a brittle bone case, his or her testimony introduces reasonable doubt. The state argues that abusive trauma is the “only plausible explanation” for the fractures, but now this scientist has demonstrated that there are other plausible explanations besides abusive trauma — explanations that are even more plausible than abusive trauma.

Let’s say the radiologist discovers subtle changes indicating a “metabolic” bone problem. “Metabolic” in this situation means that there is some problem — some missing factor or factors at the unseen, molecular level — that is causing the bones to be brittle. Brittleness is then a natural disease problem and not an abusive trauma problem. “That missing factor might be Vitamin D. Or it might be decreased fetal bone loading. Or it might be any of a host of factors that are yet to be discovered,” the expert could say.

The testimony of the expert has now introduced a strong “induction by enumeration” argument. Induction, once again, is an inference to what is probable and not certain. Metabolism is complex, so many things could potentially go wrong in a developing infant. If numerous conditions other than child abuse can cause these kinds of fractures, that would make child abuse highly unlikely. Consider “child abuse” as a number in the numerator of a fraction and all the other possibilities as a number in the denominator. This is an odds ratio that demonstrates the unlikeliness of child abuse as a cause for the fractures.

But even without the simple math, all the defense attorney has to do to persuade the court and jury is to introduce only one other plausible explanation to have reasonable doubt.

Even in cases where there are multiple fractures but no evident mineralization problems, another strong argument can be made through expert testimony.

Consider this. Soft tissue is soft, and bone typically is hard — even in infants (Why do you think they call soft tissue “soft”?). This means that with abusive trauma, the soft tissue will be damaged more easily than the bone. Soft tissue damage is what leads to signs and symptoms. Blood vessels and nerves that are damaged are soft tissues, and these damaged structures lead to blood loss, swelling and pain.

On the other hand, bones that are not properly mineralized are nearly as soft as soft tissues. This means that they can be broken with minimal surrounding soft tissue injury.

If there are no significant abrasions, lacerations or contusions — soft tissue injuries — and if there are minimal signs and symptoms of injury in a multiple fracture case, that makes it more likely that the bones are nearly as soft as the soft tissues. There you have it: reasonable doubt!

So far, I have written 63 emails, but I have still more to say.

Do-It-Yourself Science, Part 1

Image courtesy of iStockphoto.com, Avesun.

These next emails will bring new meaning to the words, “Do Not Try This At Home!”

I believe we are all familiar with disclaimers often seen before entertainment videos that depict death-defying deeds of derring-do. The producers of these videos do not want the woefully stupid among us to injure themselves and then to sue.

Prior to the television program on MTV called “Jackass,” the following disclaimer was aired:

WARNING: The following show features stunts performed either by professionals or under the supervision of professionals. Accordingly, MTV and the producers must insist that no one attempt to recreate or re-enact any stunt or activity performed on this show.

The following can be said truthfully to you, dear reader, about science: Do not try it in the courtroom or outside of the courtroom — even while under the supervision of professionals. Do not try it in any court case.

On occasion, law enforcement officers and the forensic scientists who help them will set up reenactment experiments or use standard tests in novel ways. Sometimes they do this to confirm a preferred theory for past events. Sometimes they do this to falsify a witness account. Sometimes they will do this in the courtroom, and sometimes they will do it outside the courtroom and videotape it.

So what is the problem?

What makes science meaningful is not simply the single experiment that seems to show something. What makes science meaningful is what has been performed over a long period of time by numerous scientists. The scientific method anticipates that many scientists will test and retest the work of others. Hypotheses are not simply accepted uncritically but they are tested over and over again. This takes years.

Scientific studies are peer-reviewed and criticized. It is not easy for these studies to pass muster. For scientists, the work is often tough and unrewarding. Most hypotheses are falsified — demonstrated to be incorrect — and only a very few that are not falsified stand up over time.

Furthermore, the published scientific studies that may apply to a court case have taken place *prior to* and *independent from* the court case.

Scientific experiments performed during the investigation of a case are not peer-reviewed nor published. They have not passed the kind of rigorous muster that scientific studies have to pass. Also, it cannot be argued that such experiments and novel tests used in a court case took place *prior to* and *independent from* the court case. As such, the experimental re-enactments and novel testings are simply exercises in confirmation bias.

Thankfully, most attorneys sense that such "science" is not helpful, but there have been more than a few famous cases where these kinds of mistakes were made. One is the famous O. J. Simpson murder case, where the prosecutors asked O. J. to try on the gloves that he was alleged to have worn when he murdered Nicole Brown Simpson and Ron Goldman. Often, gloves damp with sweat can shrink and become stiff when not worn after a long period of time — just ask any weekend golfer who struggles to put on a golf glove. When O. J. Simpson struggled to put on the gloves, his attorney — the famous Johnny Cochran — was able to utter those now famous words, "If the glove don't fit, you gotta acquit!"

Really helpful, right?

In the next email, we will consider a famous court case from Australia which serves as a great warning to avoid "Do-It-Yourself Science."

Do-It-Yourself Science, Part 2

Do-It-Yourself Science in a courtroom case is often used:

1. To affirm a law enforcement theory, or
2. To deny (falsify) witness accounts.

Novel testing or re-enactments designed for a specific court case have several fatal problems:

1. Novel tests and re-enactments involve fallacies of formal logic: ***affirming the consequent for complex past events (ACCPE)*** in number 1 above, or ***denying the antecedent for complex past events (DACPE)*** in number 2 above. As such, whatever the result turns out to be is highly, highly likely to be misleading.
2. Novel tests and reenactments have not undergone peer review or rigorous testing by other scientists because they have not been used *prior to* the court case (remember that novel tests and reenactments are specifically designed for the court case). As such they are subject to the inductive *fallacy of incomplete evidence*, making them incredibly weak scientifically.
3. Novel tests and reenactments are not impartial or blind because they are not *independent of* the court case. As such, they are subject to *confirmation bias*, making them incredibly weak scientifically.

First, let's talk about number 1 from the first paragraph of this email — where novel testing or reenactments are used to affirm a law enforcement theory. Are there any examples of this?

Well…there are.

Consider the Lindy Chamberlain/dingo case from Australia, a case that is now more than thirty years old. Books have been written about this case. By itself, it could serve as a textbook for how to use forensic science improperly.

You can read a synopsis of this case on my website (http://www.heartlandforensic.com/writing/is-sherlock-holmes-reasoning-backwards-a-reliable-method-for-discovering-truth). It is case #1.

The case can be summarized as follows:

1. The mother of the infant, Lindy Chamberlain, saw a dingo leave the tent prior to finding her baby missing from the tent, and
2. Law enforcement and forensic scientists believed Lindy Chamberlain murdered her infant child.

Regarding the law enforcement theory, law enforcement officers and forensic scientists utilized several novel tests that were designed for the case. One of those tests was to submit the infant's clothing (discovered later after the disappearance) to a forensic pathologist in London, England. This doctor perceived in the garment the bloody hand print of an adult female. He also perceived that the child's neck had been cut with a knife or scissors.

Now look at 1, 2 and 3 in the second paragraph above. Do you see the problem? Not only was the testing done in support of a theory that was highly, highly likely to be wrong but also the testing was not done prior to and independent of the court case. There were no articles written or scientific studies performed prior to the case — or even since the case — about the reliability of determining if blood stains on garments could be determined to be bloody hand prints from adult females. There are so many problems with the science of this that I doubt the test would ever darken the pages of any scientific periodical. Also, the confirmation bias in the analysis is all too evident.

Yet, because a scientist says it, a jury has to believe it! Unfortunately, the defense attorneys for Ms. Chamberlain failed to make even a sensible argument for why this novel scientific test not only should have been rejected by jurors but also rejected as evidence by the court.

In the next email, you will see the novel things that forensic scientists did with fetal hemoglobin in the Chamberlain case.

Do-It-Yourself Science, Part 3

Consider for a moment the numerous tests and procedures that are available in the health care setting. Before any test or procedure is put "on-line" for patient care, a lot of science goes into its development.

For clinical laboratory tests, a test is run repeatedly — prior to any patient care use — and tested against a standard for accuracy. Tests are tested for precision — how often does a result close to the same value come up with repeated testing of the same sample? Scientists test a normal, healthy population to determine statistically what the "reference range" is — this allows a comparison of "normal" with "abnormal." Further evaluations are performed to see how well a test or tests predict a certain condition and how often the tests are falsely positive or falsely

negative for that condition. Even with all of this testing, it is already acknowledged that no test perfectly performs or predicts in the way that is hoped. All of this is anticipated and measured.

This is all-too-often not the case with forensic science tests.

The detectives in the Chamberlain/dingo case mentioned in the last email were bound and determined to try and convict Lindy Chamberlain. They knew in their gut that she was guilty; it was simply a matter of demonstrating that she had murdered her infant daughter and concealed the remains.

During their investigation, detectives and forensic scientists came up with the idea of testing the floorboard of the family car for fetal hemoglobin. Hemoglobin is the protein in human red blood cells that carries oxygen. Fetal hemoglobin formed in the fetus persists after birth for about four months, so its presence in the floorboard of the car — so their thinking went — would prove or confirm that the family killed their infant daughter in the car or transported the infant's bloody clothing to a place of concealment — perhaps even to where the garment with the bloody hand print of an adult female was found. The theory was quite elaborate and perhaps even a long shot, considering that there was no evident blood in the floorboard of the car, but it was worth a try!

So they tried it. They took the samples and had forensic scientists test them and — lo and behold! — the test was positive!

Gotcha!!!

Anyone who knows the IT would spot the problem here from a mile away. Since law enforcement theories of what happened are complex events that are not witnessed and since it is not at all reliable to surmise past events from physical evidence, it is highly, highly unlikely that such theories are true. This would make any positive test for physical evidence used in support of a law enforcement theory highly, highly likely to be a false positive. Any kind of testing of law enforcement theories — even with accurate and precise tests — is unreliable. It is "junk science."

And sure enough, later testing of the floorboards of cars of the same make and model as the Chamberlain's demonstrated the same positivity — the same false positivity for fetal hemoglobin.

As is currently practiced, forensic science has a "wild, wild west" mentality to it. "If tests serve to convict suspects," the thinking seems to go, "then those tests are good enough for us." Even though we would never be able to get away with such thinking in clinical medicine, sloppy thinking seems to be tolerated and even encouraged in the forensic sciences.

"But Dr. Young, aren't you being cynical?"

No, I am not! This is because I know and use the IT. With the IT, all of this confusion disappears — like fog on a warm summer morning. If you know the IT, you see the problems — and the solution.

Do-It-Yourself Science, Part 4

After thinking about what I wrote in the last email, I realize that I may have raised a lot of questions in your mind.

“Dr. Young,” I can almost hear you think, “you said, ‘If you know the IT, you see the problems — and the solution.’ Well, I see lots of problems but I don’t see a solution!”

I used many terms in the last email regarding laboratory testing — terms like “false positives,” “false negatives,” “normal,” “abnormal,” “reference range,” and “predictive values.” How do all of these terms apply to forensic science tests?

Well, the answer is simple if you know the IT. The answer is, “They don’t!”

The first part of the IT involves comparing witness accounts to physical evidence. A test discloses physical evidence, and the witness accounts are either consistent or not consistent with that evidence. Whether the result is “normal” or “abnormal,” “positive” or “negative” does not apply. It is simply a matter of whether the evidence “fits” or “does not fit” witness accounts.

On the other hand, tests that are used to *affirm the consequent* — to surmise a cause from an effect — have to use *hypothetical categories*. I have already mentioned this concept in previous emails. Hypothetical categories (“diagnoses,” “manner of death”) are man-made and conceptual. They are imperfect. They are like the targets painted around holes in barn sidings. Sometimes results will fit a category and sometimes they don’t. All of the terms above and the terms used in the last email for diagnostic testing in a health care setting are applied to hypothetical categories. The first part of the IT does not use hypothetical categories.

“What about the last part of the IT where it mentions only one plausible explanation? Isn’t that an inference to a hypothetical category? And if it is an inference to a hypothetical category, wouldn’t the terms mentioned above (false positive, false negatives, normal, abnormal, reference range, predictive values) apply?”

I am pleased, hypothetical person, that you remember so well what I wrote previously! Yes, an inference to the only plausible explanation is an inference to a hypothetical category — like “manner of death;” however, if there is truly only one plausible explanation, the terms above cannot apply. There cannot be a false positive if there is only a true positive. The terms only apply if there is more than one plausible explanation.

And if there is more than one plausible explanation, you shouldn’t be making that inference in the first place on the witness stand! That is because you are not certain, and the court requires "reasonable medical certainty.”

But if you make improper inferences from testing, such as what was done by investigators in the Chamberlain/dingo case, than words like “false positive” would apply. In fact, improper inferences make “false positives” highly, highly likely. That is why I can use words like “false positive” when describing tests that are applied while affirming the consequent for complex past events (ACCPE).

In other words, if you understand the IT, you can avoid all the complication and confusion associated with most diagnostic testing. Understanding and applying the IT makes everything very, very simple.

Of course, making everything very, very simple is what many scientists hate! Many scientists would prefer to use statistical jargon on the witness stand and sound very learned as they deal with the problems and complexities that simple folk do not understand! All the while, they do not realize how foolish they have become by doing this!

We have discussed how novel testing is used for ACCPE. What about reenactments used for DACPE (denying the antecedent for complex past events)? Well…that's next.

Do-It-Yourself Science, Final Part

You may recall that Do-It-Yourself Science in a courtroom case is often used:

1. To affirm a law enforcement theory, or
2. To deny (falsify) witness accounts.

We have discussed number 1, so now it is time to discuss number 2. Number 2 involves the formal fallacy of ***denying the antecedent for complex past events (DACPE)***.

"Wait a second, Dr. Young!" I can almost hear you think. "Isn't *modus tollens* — that Latin term that you seem so fond of — intended to deny witness accounts?"

You are right, but unfortunately, you are not thinking far enough. MT is *denying the consequent*, not *denying the antecedent*. This means that the physical evidence from the case itself — the eventual outcome of the witnessed events — is supposed to be used to test the witness account and not novel reenactments. Novel reenactments — the items used in number 2 intended to replicate witnessed past events for the purpose of denying them ("proving" them to be impossible) — are not the consequences of the witnessed events. Instead, a novel reenactment provides a replicated antecedent to show that it doesn't lead to the observed consequences in a case. If that replicated antecedent does not lead to observed consequences, then the witness account is wrong!

Right?

If you are confused at this point, do not despair. What I will write now should help make what I wrote above understandable.

Novel reenactments involve more than one item or event — unlike the forensic tests previously mentioned. That is because past events also involve more than one event. Unfortunately, those who try novel reenactments fail to understand two basic points about past events:

1. Past events are *unique*. This means that nothing before or since has occurred in exactly the same way twice.
2. Past events are *vastly complex*. Numerous items relevant to an issue follow second-by-second in succession — often quick succession.

Both of these characteristics make it *impossible* to *exactly* replicate past events in a novel reenactment. Inevitably, the likelihood that some factor will be left out or not considered in the reenactment is very, very high. As such, performing reenactments is simply a futile exercise in silly science. It doesn't take much for an outside expert to spot where a reenactment falls apart.

In the Chamberlain/dingo case, investigators did not believe that a dingo could kill a child stealthily and not leave any evidence of the killing. They did not consider dingoes to be highly effective killers. The detectives and forensic scientists attempted to demonstrate through a novel reenactment that dingoes are *not* highly effective killers.

Notice at this point that they were attempting to prove a negative -- "...*not* highly effective killers." You may recall from previous emails that trying to prove a negative is logically unsound ("Why 'Thinking Dirty' Does Not Work").

They used dingoes in the zoo and starved them for five days; then they provided beheaded baby-goats dressed in disposable diapers and infant jump suits with all the buttons fastened. On videotape, the experimenters demonstrated how the dingoes left the clothing and diapers in shreds, unlike what was seen (or perhaps not seen) in the Chamberlain case.

All the while, dingo experts prior to and independent of the Chamberlain case had observed dingoes in the wild on numerous occasions. These experts did not see any problem with the Lindy Chamberlain account and its evidentiary outcome.

Science applied in the courtroom is at its best when it is from peer-reviewed, published observations and testing that have occurred *prior to* and *independent of* the case. Do-It-Yourself Science as novel tests and reenactments designed for the case are misleading.

Alcohol and Behavior

Image courtesy of iStockphoto.com, alzay.

The next few emails will cover how to apply the IT to forensic toxicology testing. First we will start with the most commonly used and abused mood-and-mind altering substance in the world for millennia. That substance?: Ethyl alcohol, ethanol, or simply — alcohol.

On many occasions, attorneys look at the result of a blood alcohol test and ask me, "Doc, how would someone behave with this level of alcohol in his system."

Often when I am asked this, I sigh. This is not much different than another question commonly asked me: "Doc, how much force did it take to cause this injury?" Of course, blunt force injury is another topic, so I will not digress.

But by now you should know what the problem is with both of these questions if you know the IT. The question asks me to surmise past events (behavior in the case of alcohol) from physical

evidence (blood alcohol level). Any response I would give to questions like these is not reliable. That is why I sigh.

The way I usually answer alcohol questions is to address what scientists and many, many others already know about alcohol and its effects. This answer falls under the heading of "scientific facts." Alcohol impairs judgment. It impairs motor coordination and reaction. It depresses the nervous system, causing one to be more sleepy or even black out. It impairs short term memory when used excessively. It makes one less inhibited socially — that is why it is a favorite substance at parties (and why the modern verb, "to party," often implies the use of alcoholic beverages).

Alcohol also has a dose-response relationship — a higher volume of the substance causes the effects above to a greater, more marked degree.

Also, alcohol use over time develops tolerance. Changes in the liver, the nervous system and other organs will allow a chronic user to behave more "normally" even with higher alcohol levels.

Of course, the attorneys know all of this, but they want to know how a specific alcohol level in a specific person causes him or her specifically to behave. It is kind of like being asked the question, "Define the universe, and please give three examples." It is impossible to answer, just as it is impossible to surmise reliably the past events that led to the physical evidence. There are too many variables. I can't observe or even predict what goes on in someone's mind.

But there is one thing that I can do reliably. I can look at the witness accounts of someone's behavior over a period of time and tell you if the witnessed behavior and the blood alcohol level are consistent or not consistent with each other.

For example, intoxicated-appearing behavior is not consistent with a negative blood alcohol. Perhaps the behavior is due to something else but not alcohol.

Also, if a person has a high blood alcohol level and witnesses say he only had two beers over five hours and he was "stone-cold sober," there is something wrong. The two are not consistent with each other.

Blood alcohol testing is very important in a court case. Still, we have to apply the testing in a fashion that is reliable for certainty — particularly from the witness stand. Someone in the courtroom needs to test the application of the test.

Of course, the test that tests the testing is the Inferential Test.

The Widmark Formula

Back in the 1930's, scientists studying alcohol elimination in the human body knew that alcohol was different from other drugs. Alcohol elimination in a person seemed to occur at a constant rate and was not affected by the amount of alcohol in the body. This constant rate was

$$BAC = \frac{G(1 - e^{(-k*t)})}{(W*\tau)} - (\beta*t)$$

Figure 1: Modified Widmark formula for estimating BAC including parameters during the absorptive phase of alcohol metabolism. W = subject weight in kilograms, t = time elapsed since drinking began, G = grams of alcohol consumed, τ = distribution, β = elimination rate, k = absorption rate constant.

considered by Swedish physician E. M. P. Widmark when he developed the Widmark formula. With this formula, a blood alcohol level could be estimated in the past or future for any given amount of alcohol consumed over a given period of time, or an amount of alcohol consumed over a period of time could be estimated from a blood alcohol level.

Experts in forensic toxicology have used the Widmark formula on the witness stand for years, offering opinions to a reasonable degree of medical certainty. Some of these experts have even refined the technique. None of these experts understand the IT.

Consider the article on "How To Extrapolate Alcohol With Certainty" (http://www.forensicmag.com/articles/2011/08/how-extrapolate-alcohol-certainty). The author admits at the outset that the courts want to know how well measurements of items like alcohol in the blood perform, so the courts insist on knowing the "confidence limits" for each measurement. For example, for a made-up value of "10 mg/dl plus or minus 2 mg/dl," the confidence limits would be the "plus or minus 2 mg/dl." For any method — such as blood alcohol measurement — such limits can be determined and calculated through careful, repeated testings of samples.

But in this article, the author does not suggest applying such calculations to *measurements*; he wants to apply them instead to *estimates*.

An "extrapolation" is a form of estimate. "What will the alcohol measurement be at a certain future time?" or "What would the alcohol measurement have been at a certain past time?" are extrapolations. These are not measurements but simply estimates that a scientist cannot know or observe with any certainty in any particular individual. The reason why such estimates cannot be known or observed is because one cannot measure something at any other time other than the present. A measurement is an observation — an estimate is a guess.

The picture above the text in this email is from Figure 1 of this article. It is a modified form of the Widmark formula. Notice how many factors there are to be considered in the equation. This is complex. Many assumptions have to be made, and none of these assumptions are measured or certain when they are offered in the courtroom. If these assumptions are not warranted or if the estimates are way off, the scientist or the courts would have no way of knowing or measuring this. Adding "confidence limits" to such estimates would be like putting lipstick on a pig!

When you know the IT, this is easy to spot. "One cannot reliably surmise past events from physical evidence" applies to the way these experts use the Widmark formula on the witness stand.

"So Dr. Young, is there a logically valid way to use the Widmark formula on the witness stand?"

I'm glad you asked, O Hypothetical Reader! If you have a witness account or accounts for how much a person allegedly drank over a period of time and if you have a blood alcohol measurement, you can compare the two for consistency or inconsistency using the Widmark formula. The variable for calculation using the two constants above would be all the physiologic parameters. If the physiologic parameters as a group are within a normal range, then the constants observed by witnesses and scientists are consistent with each other. If they fall outside a normal range, then the observed constants are not consistent with each other.

"But Dr. Young, what if a person has an unusual way of handling alcohol physiologically that is not like anyone else?"

Then test the individual's alcohol physiology directly during the investigation of a case. All you need is a known quantity of alcohol for the individual to consume, needles and syringes for collecting samples for blood alcohol measurements, and a clock. You can see if the individual in question has something other than normal physiology. Such measurements are not "novel" — they have been performed by scientists for many decades.

"Has any expert other than yourself considered using the Widmark formula this way?" Not to my knowledge. Maybe experts will one day…once they understand the Inferential Test!

Drug Overdose, Part 1

Image courtesy of iStockphoto.com, Semary.

Do you remember the strategy for determining the Cause of Death? It is to:

1. Reason forward from witness accounts to physical evidence as much as possible; then, when this is done, to
2. Reason backward with the strongest argument possible that the conclusion is the only plausible explanation.

This strategy certainly works for deaths from drug overdose.

But there are two problems with investigating drug overdose deaths:

1. Even though the death is externally caused (the ingestion of a drug), the effects are not readily witnessed because they are phenomena that occur inside the body. In that

respect, they are like natural deaths with all the uncertainty for cause of death determination that often comes with those deaths.
2. The type of testing for a drug involves a measurement with a number. That numerical result may be the way it is because of numerous factors that are not readily observed or accounted for.

Item number 2 above is particularly a challenge when a person has died. The usual physiologic processes that are somewhat predictable in humans are replaced with the chaos that comes with deterioration and disintegration brought about by death. The use of a number and its meaning becomes even more uncertain.

But for numerous toxicology experts who do not understand the IT, that uncertainty does not seem to exist; otherwise, why would they publish items that do not reflect uncertainty?

Consider, for example, "Winek's Drug & Chemical Blood-Level Data 2001" (http://www.abmdi.org/documents/winek_tox_data_2001.pdf). These are tables listing numerous drugs, their "therapeutic or normal" levels, their "toxic" levels, and their "lethal" levels. These tables are like the reference ranges published for tests in a hospital laboratory, but they only look like reference ranges. They are not reference ranges, nor do they reflect the science involved with the measurement and calculation of reference ranges for clinical laboratory tests.

The introductory sentences to these tables have several disclaimers. "We have gathered the data in the table from the literature and from personal experience," it states. None of the literature is cited, and there is no mention of what is involved in this thing that they call "personal experience." As I have written before, personal experience is often no more than repeated confirmation bias. People who cite personal experience often mean, "Trust me because I know what I am doing," as they affirm the consequent for complex past events.

Notice the next sentence: "The values are not considered absolute, but are to be used as a guide in evaluating a given case. The values can be affected by dose, route of administration, absorption differences, age and sex, tolerance, method of analysis, pathological or disease state, postmortem redistribution, etc." In other words, Dr. Winek and company agree with me and acknowledge that there are numerous factors that are not readily observed or accounted for. It is clear from what they write that the results are highly uncertain, but it is not clear how with such uncertainty they can publish numbers that look like reference ranges for clinical laboratory tests.

The final sentence in the introduction simply adds insult to injury. "It should be obvious that kinetics, even pharmacokinetics, are not applicable to the moribund state." In other words, there are problems using data like this after someone has died. I agree.

But notice the website where I obtained the document. ABMDI is the "American Board of Medicolegal Death Investigators." These are the folks who officially accredit death investigators who work in coroner or medical examiner offices. Why do they put these tables containing information that doesn't work for dead people on their website?

Do you see how pervasive the problem is? Do you see how an understanding of the IT could solve the problem? If you are not sure how the IT could solve the problem, see you next email!

Drug Overdose, Part 2

“Dr. Young, if we can’t rely on published numbers for toxicology results — even if they look like reference ranges but are not — how can we know if someone has taken too much of a drug? How are we to interpret numbers that we receive from the toxicology laboratory? Can’t you provide us any kind of guidance for what we should do?”

Well, I will do the best I can.

First of all, you cannot interpret any result from the toxicology laboratory without having as much information as you can get about what witnesses observed in the case. You need to find out a person’s history with a particular drug (a history is essentially a collection of witness accounts). You need to know that person’s observed activity prior to when he or she was found dead. You also need to know the circumstances surrounding how the body was found, its condition at the death scene, the surroundings. In other words, even if the way the item that caused the death is not directly witnessed, you need to develop a strong circumstantial evidence base to support a cause of death as the only plausible explanation. Evidence, of course, means what is “evident” — what is measured or observed.

Part of that information base includes a careful autopsy. All persons who are suspected of dying from drugs must be autopsied. Looking to see if a drug level falls within something that looks like a reference range is not enough. Doing that does not allow one to get away with not doing an autopsy.

There is much to be learned from an autopsy in a drug death. For example, what is the condition of the liver? Dead or diseased liver tissue does not alter drugs well and allow them to be eliminated, so enormously large levels of drugs may be found in a person with liver failure — even if the drugs had nothing to do with the death. The same could be said for damaged kidneys.

Also, looking at the urinary bladder is helpful. If someone is in a drug-induced coma for a while, they will not respond to “calls of nature” — to get up and go to the bathroom. A urinary bladder markedly distended with urine — like up to the level of the belly button — may give one information that would not be learned without an autopsy.

Also, once the result comes back from the toxicology laboratory, you should learn the “scientific facts” about the drug. “Scientific facts” you may recall are the items that are observed about a drug by numerous scientists over a long period of time prior to and independent of your case. The scientific literature is replete with information about drug testing in normal people, and there is also information about what scientists found when investigating deaths from the drug. That information often includes the numerical results of toxicology tests.

That information may or may not apply to your case. There is still uncertainty. Still, the more data that is collected — data in the form of observations and measurements and not in the form of estimates and speculation — the more likely that you will find the “only plausible explanation” for a death associated with drugs.

One very helpful source of information about drugs is the book, *Disposition of Toxic Drugs and Chemicals in Man*, edited by Randall C. Baselt — now in its tenth edition. It is encyclopedic. Each drug is listed, followed by a lot of wordy prose. It is essentially a compendium of the medical literature for each drug. Following the wordy prose, the published articles are listed from which the information was derived, and those lists can go for several pages. It is not light reading by any means, but I believe it is the best source of information available for drugs. With as much at stake as there is in these investigations, why not rely on the best information?

And why not remember the IT when you look at these cases? The IT and the Forensic Scientific Method are not just the best way — frankly, they should be the only way.

Missing The Forest For The Trees

Image courtesy of iStockphoto.com, gelynfjell.

A few weeks ago, while I was waiting outside of a courtroom — something that forensic experts often spend time doing — I had an opportunity to speak to a retiring judge.

He was not wearing the usual black robe that judges wear. Instead, he had on a hat and a warm coat — something suitable for winter weather in Ohio. It was his last day of work, and he was looking forward to the rest of his life.

At that time, the judge mused out loud to me, and I took the opportunity to listen to what he had to say. What would a judge — a retiring judge — find so important to say to someone he had barely met?

He said that lawyers are “tree people” who forget that jurors are “forest people.” In preparing for trial, lawyers often loose sight of the perspective that they need to persuade jurors. Lawyers often focus on minute points of law and subtle arguments when all jurors want to see is the big picture. Jurors want to see a pattern that makes sense — something that will allow them to sit back and make important decisions about the total case.

When I heard what he said, I had to smile. Lawyers are not the only “tree people” around. Scientists and doctors are also “tree people.”

Certainly it is important to study trees, branches, stems and leaves. Scientists do this well. Unfortunately, such detailed study and application fails when we as scientists miss the forest for the trees.

We have spent much time lately considering specific tree-like applications of forensic science testing. In the next several emails, we are going to step back — way, way back — and study the forest.

The Supremacy of Logic

Image of Mr. Spock downloaded from pixgood.com.

Imagine for the next few moments a wagon wheel…or a bicycle wheel…or any wheel with a central hub and radiating spokes.

Now imagine little post-it notes placed around the rim of the wheel — post-it notes with a variety of subjects written on them — subjects like: religion, political science, law, economics, literature, grammar, mathematics, foreign languages, history, music, computer science, and -- of course -- science. Biological science. Physical science. Medical science. Dental science. Forensic science.

Now in your mind's eye, follow the spokes inwardly from the post-it notes to the hub of the wheel. If you were to post a note on the hub of the wheel, what should go there?

There is no question in my mind what should go there. It is logic.

Logic is fundamental. It is the supreme study that supports all other studies. It enables us to understand how we should know what we know about anything.

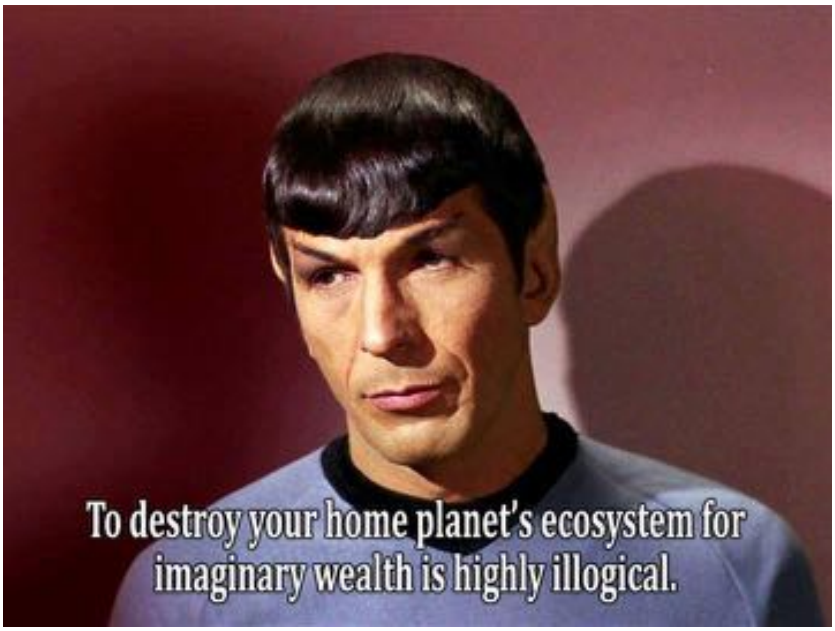
My online dictionary defines logic as "reasoning conducted or assessed according to strict principles of validity." Knowing those "strict principles" can only serve to guide us as we study the subjects all around the rim of the wheel. On the other hand, a lack of knowledge of those principles may lead us in all kinds of strange directions, no matter the subject.

In spite of its importance and supremacy, logic is not required to graduate from college in the United States. I never took a class in logic. It was never required for application to medical school. No one is required to take it for other professional schools that I am aware of. If it were up to me — from what I know now — I would require a course in logic to be taken in college as a requirement for graduation. College is where one is supposed to learn how to think critically, so how can colleges claim that they teach critical thinking when logic is not a requirement?

When a person lacks the tools and skills for critical thinking, that person becomes a mere technician who only knows what his or her teachers teach and does not go far beyond that. Why should the courts be content to rely on experts who lack such critical thinking skills? Why should jurors have to rely on experts who cannot discern when they really know and when they do not know?

Unfortunately, what our systems of education greatly lack is supplied by popular culture and the media.

When I was growing up, "Star Trek" was on the television in America, and some form of that crazy story has been told and retold for many years in other television shows and in movies. The characters of Star Trek were supposedly smart enough to be able to travel around the



galaxy at warp speed, but the only character who had any logical understanding was a pointy-eared alien: the pedantic Mr. Spock. The television series seemed to imply that human beings were not expected or able to be logical.

Several years ago, it dawned on me that what my colleagues and I were doing in death investigation did not work reliably. I approached the leaders of my professional forensic organizations — the National Association of Medical Examiners (NAME) and the American Academy of Forensic Sciences — with my concerns. I suggested to the president of NAME at the time that NAME should form an ad hoc committee to study forensic inference. At first, there were only four or five people who were interested in participating, but they dropped out a short while later. The president shut down the committee after a few weeks, and the topic has not been considered seriously by them ever since.

Whenever I talk about the subject of inference with my colleagues, they look at me as if I had pointy ears. All the while, they do not realize that their house is burning down around them.

Dear Medical Examiner

Image courtesy of iStockphoto.com, lovleah.

Dear Medical Examiner,

This is an open letter to you — something similar to what I wrote to the prosecutor a while back.

First of all, before I write anything else, I want to tell you that I care about you. I care about you so much that I am willing to take some risks in possibly offending you. Please consider what I write below to be from love, and please open your mind and heart. Do not presume negatively.

From the beginning, you have advocated that professional medical examiners should be the ones to run death investigation systems. Medical doctors are the ones with all the education, and we should consider ourselves to be the most qualified to do the job, right?

Have you ever wondered why coroner systems have not been replaced by medical examiner systems after all these years if what medical examiners do is far superior to what anyone else

does? Furthermore (and I hate to write this but I must), have you ever wondered why the vast majority of scandals published in newspapers about death investigation involves mistakes made by medical examiners and not coroners? Do you also realize that the most scandal-plagued death investigation organizations in the United States are state medical examiner systems — where the ones doing death investigation from top to bottom are doctors? I know this because I have been keeping an eye on the news for many years now. I also note that most of the cases I receive from attorneys as a consultant — cases where major inferential mistakes have been made and people have been wrongly accused — come from medical examiner and not coroner offices.

Do you think it is possible that you have dropped the ball — that you have blown it? Do you think faulty inference might be one of the major problems? Frankly, I believe faulty inference is the most significant problem plaguing medical examiners. I also believe that you would be far ahead of the game if you would finally address this problem.

I am not writing this letter to the stubborn among us, who refuse to consider even for a moment that they might be wrong. Nothing I write will convince them. Many of these would do well if they were to retire and pass from the scene before anyone gets an idea about the horrible mistakes they have made. I am writing to those of you who sit on a fence and do nothing.

By the time you read this email, you might have gleaned from what I have written before that there are many problems. Perhaps some of you are on the subscription list for these emails, or maybe some of you have received these emails from some other source. None of you has offered any argument to point out where I am wrong. Instead, you do nothing. Nothing at all.

There has been at least one article on inference that has been published in a forensic pathology journal that I am aware of: Oliver WR. Inference in Forensic Pathology. *Acad Forensic Pathol* 2011;1(3):254-275. The article does not address any problems with the way we infer but instead offers its support for what is currently done. It is medical examiner apologetics. How helpful is that when the house is on fire?

Do you remember Dr. Charles Smith? He was the pediatric forensic pathologist from Canada who affirmed the consequent for complex past events for an entire career. When his mistakes finally caught up with him, his forensic pathologist colleagues who were making the same mistakes either had little to say or joined in the accusation. Will that be your strategy when the public over time starts to understand what has been going on? Do you think having little to say will work when that happens?

Why not for once in your lives get ahead of this problem rather than react when it is too late? Why not be proactive?

It is not too late. You can finally engage in this topic and quit thinking of logic as something for pointy-eared people. If you offer something helpful and point in the right direction, maybe the career you save will be your own.

Sincerely,

Thomas W. Young, MD

The IT is the Structure of a Forensic Science Revolution, Part 1

Image courtesy of iStockphoto.com, johan63.

I am not the only person to have used the words, “logic” and “science” in the same sentence.

Following World War I and extending to the 1960’s, philosophers of science — termed *logical positivists* — thought of science as objective and logical. Although they recognized that scientific discovery is something not governed by logic but rather by inspiration and intuition, they thought the evaluation and assessment of scientific discoveries should follow rules of logic — by comparing observable facts with other observable facts in a deductive fashion.

The ideas of logical positivists never caught on, even during the years that they were expounded. In the 1960’s, a philosopher of science named Thomas Kuhn recognized that logical positivists failed to take into consideration how scientists actually behave. He embarked on a study of the history of science in order to gain some insight as to how science really works (as opposed to how science should work).

What he discovered from history is that the process of scientific discovery was a lot more complex than he imagined. For example, he could not reliably determine the date and time that someone actually discovered something. Science, so it seemed, was and is something that goes beyond the individual. It involves a community of scientists and how that community processes new ideas and discoveries. The process of science takes time — sometimes even centuries — before ideas take hold and are accepted.

Prior to Kuhn, a philosopher named Karl Popper proposed that science — in order to be science — has to be falsifiable. Popper made specific reference to *modus tollens* in his writings. Scientific theories can be readily shown to be false deductively, but they cannot be shown to be true deductively. For that reason, according to Popper, in order for something to be called “science” (and not be “metaphysics”) it has to be capable of being falsified.

But Kuhn discovered that scientists typically did not spend their time falsifying scientific theories. If a scientist came up with something that seemed to falsify a favored theory, other scientists presumed that the problem was with the scientist who came up with that something rather than the theory itself.

This is understandable. It is plausible for the scientists who come up with falsifying observations to be mistaken. Also, it is very hard to ditch a theory that seems to have great explanatory power and has the support of many other scientists.

Kuhn put his observations and his ideas in a book that is now a classic in the philosophy of science, a book entitled *The Structure of Scientific Revolutions*. In that book, Kuhn proposes his own theory for how science seems to work. Like any theory invented to explain complex events — particularly events that involve human behavior — his theory has weaknesses. This has been pointed out by critics over many years since the book was written; nevertheless, Kuhn's theory provides an interesting perspective on this complex endeavor called science.

Kuhn's theory has its own set of terms that have been repeated over and over again — terms like "prescience," "normal science," "revolutionary science," "incommensurable," and "paradigm." Rather than use those terms, allow me to describe what I believe he expresses using terms I have already used in the emails. Here it goes…

At first, scientists make some observations and do some experiments and it leads them to come up with a theory. If that theory explains events well, other scientists get on board and become productive, generating more and more papers that establish that theory. Over time, however, other scientists make observations that go against the established theory. More and more of these anomalous observations pile up, and it leads to a crisis. Eventually, the crisis is resolved by the establishment of a new direction — a new theory.

Do you see anything here that seems similar to what is going on with the Shaken Baby Syndrome?

What does any of this have to do with the Inferential Test?

The IT is the Structure of a Forensic Science Revolution, Part 2

You may wonder how any of what I wrote last time has anything to do with forensic science. What does it have to do with science offered in testimony in a court of law?

Well…what I wrote about the philosophy of science has little to do with forensic science. Forensic science is a different breed of cat. I only bring up the topic because of the confusion about science that exists in the minds of jurists. That confusion is reflected in what has been decided previously about science in the United States — complex decisions reflected in *Frye,*

Daubert, Joiner, Kumho, and Rule 702. In order for the courts to understand properly how to use science and scientific expertise in the courtroom, it is important to understand the differences between normal science and forensic science.

Kuhn grappled with issues having to do with *scientific discovery* and how to evaluate items that are being discovered. Science in the courtroom, in contrast, is an *application of the science that has already been discovered*. That application is specific for the courtroom setting: the question is "How does the science already discovered apply to this particular court case?" Kuhn did not address this question.

Kuhn in his theory described what happens when two incompatible ("incommensurable") scientific theories collide. Another theory may take over, but that does not indicate that the new theory is any better than the old theory. The answer to which theory is better or more accurate is often not knowable.

But what currently happens in the courtroom is different. It is not so much that one theory collides with another theory. It is that the theory offered in the courtroom collides with logic. The theory offered in the courtroom has to do with complex past events. These are the items that are considered when trying to make decisions about crime and punishment. The courts too often do not understand that a scientist cannot get up on the witness stand and tell you what happened.

Well…let me rephrase my last sentence. Scientists all too often do get up in the witness stand and tell you what happened, but they should not be believed when they do that. Why? Because doing that collides with logic.

As I have stated before — even under oath — the IT is not a *theory* of science. It is a *theorem of deductive logic*. Kuhn was not advocating for anyone to throw away logic, nor was he saying that scientists have thrown away logic in the way they do their work. Theory may collide with theory, but theory should not collide with logic. Logic always applies. It is *immutable* — a fancy way of saying that it does not change. That is unlike science, which is expected to change.

Not only is the IT not a theory but the IT also does not allow the offering of theories in the courtroom. What witnesses saw and heard are not theories like those offered by scientists. They are observations — observations that can be tested easily with principles of deductive logic. When normal scientists say that deductive logic is not readily applied to what they do, they speak correctly. The same cannot be said about forensic science offered in a court of law. Deductive logic is readily and easily applied and should be applied.

Consequently, we do not have to wait for several centuries for scientists to agree with each other and move in the same direction. The courts do not have to be subject to such constraint. The logic can be applied now — this very moment. Those who want to do what is right do not have to wait any longer.

Although the IT differs from the kind of scientific revolution described by Kuhn, it is in itself the structure of a forensic science revolution of its own kind. I will describe how in one final email. Then I will go away.

The IT is the Structure of a Forensic Science Revolution, Final Email

Forensic Science is in trouble. Even forensic scientists sense this.

Ever since the National Academy of Sciences released their major study entitled “Strengthening Forensic Science in the United States: A Path Forward” in 2009 — a treatise that essentially labels forensic science as “not being scientific enough” — forensic scientists have been on high alert. This has been reflected in the topics for some of their annual meetings.

Shortly in February of 2015 (I wrote this email in January, 2015), the American Academy of Forensic Sciences will hold another annual meeting. The topic for the Plenary Session this year is: “Human Factors in Forensic Science: Why Cognitive Bias Can Lead to Flawed Expert Opinions and Testimony, How Its Influence Can Be Minimized, and What Challenges Testifying Experts and Judges Can Expect to Face (continued).” There will also be a workshop lasting all day entitled, “Cognitive Bias Issues in the Forensic Analysis of Pattern and Impression Evidence and in Medicolegal Evaluations.” Several speakers during that workshop will address “Shaken Baby Syndrome/Abusive Head Trauma (SBS/AHT)” and “Non-Accidental Head Injury.”

Something is clearly going on here.

Yet none of the speakers will breathe the words, “Inferential Test,” during any of these sessions. You can bank on it!

Imagine for the next few moments child abuse pediatricians and forensic pathologists some time in the future sitting before judges in court hearings. One by one, the judges address these doctors.

“Doctor _____, why did you ignore the Inferential Test? It is obvious that you were wrong, but you kept on and on. You now know the damage you have done to innocent people and their families. You now know the vast resources in time and money that you have allowed to be wasted. You now know how little the public trusts you. Are you now willing to accept responsibility for your careless and reckless behavior?!”

Then the apologies come out. Apologies to innocent victims. Apologies to aggrieved family members. Apologies to the court. Apologies to the public. Tearful apologies. Apologies offered in the same way Dr. Charles Smith apologized in 2008 before the Goudge Inquiry in Canada (http://netk.net.au/Smith/Smith72.asp), in the same way the Northern Territory, Australia, Coroner apologized to the Chamberlain family in 2012 after the Chamberlain/dingo case (https://picsandstuff.wordpress.com/tag/azaria-chamberlain/).

Will this ever happen? Maybe. Maybe not. I don’t know.

But this I know: Given the logic, I am reasonably certain that the IT is true. If the IT is true and if more and more people understand and accept it, then it will revolutionize law enforcement, forensic science, and the legal system.

Thank you so much for your patience, for putting up with me through 78 emails! You may not agree with all that I wrote, but that doesn't matter to me. What matters to me is your interest and your engagement in a topic that I believe is so vitally important. Your interest in what I have written means more to me than you will ever know!

There are several others still in the email pipeline and several others who continue to join the list. Eventually, I will archive these emails and distribute them as an archive. I encourage you to reread the emails you have received. Please stay engaged in this topic and persuade others to join you!

And if there is anything I can do for you in the future, please let me know.

See you in court!