# The correct interpretation of Dr. Andrey Feuerverger's 1:600 odds calculation

There has been plenty of discussion focused on the validity of the numbers and the assumptions used in Dr Andrey Feuerverger's calculation that results in a 1:600 odds claim. While that discussion is certainly interesting, there is a more fundamental issue associated with the very **interpretation** of this 1:600 odds calculation.

I am a mathematician or, strictly speaking, a former mathematician. After earning my Ph.D. in mathematics from Ohio State University, I worked at Bell Labs and then in the corporate business world for about 15 years before starting my own management training and consulting company (Exequity Inc.). However, I have not severed my ties with the academic and scholarly community, and I still teach operations management, project management, and quantitative business courses in some MBA programs. (I earned my MBA from the Kellogg School, Northwestern University, in 2001.)

First, I would like to point out that Dr. Andrey Feuerverger's calculation is nothing very fancy, involving only very basic mathematical probability that is taught in many undergraduate programs and business schools. It is conceptually no deeper than a problem I could include on a take-home final exam for my MBA students. Actually, several decades ago, when I was a teaching assistant at the State University of New York, I remember giving my undergraduate freshman class problems that required this level of understanding of mathematical probability.

Second, I am willing to accept the 1:600 result that Dr. Andrey Feuerverger has computed. However, it is the **INTERPRETATION** of this 1:600 result that is of crucial significance here. The media are touting this 1:600 result as:

*Interpretation A:* **"There is only a 1 in 600 chance that this is _NOT_ the Jesus family tomb." OR, equivalently, "There is a 599 in 600 chance that this _IS_ the Jesus family tomb."**

This interpretation is mathematically, statistically, and semantically flawed, and I am sure that Dr. Andrey Feuerverger is well aware of that. I am really shocked that an individual of his stature would not set the

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record straight on this and try to make sure that the public knows the correct interpretation. Then again, the truth does not always make for good business or popular TV. Using numbers and language precisely often runs contrary to the goals of advertising! It is generally more advantageous to advertisers to word numerical results and statistical findings in a manner that <u>appears</u> precise and impressive without necessarily being so.

If you read through Dr. Andrey Feuerverger's calculation at the end of the PDF file on the Discovery Channel website, it is clear that he is restricting his "population" (in a statistical sense) to the roughly 1,000 <u>tombs</u> found in the geographic area in question. He is not basing his calculation on the overall Jewish populace in the area and the time period in question. So, the <u>correct</u> interpretation of his 1:600 odds calculation is:

**<span style="color:blue"><u>Interpretation B:</u></span> "There is a 1 in 600 chance that this particular cluster of names would occur in one of the roughly 1,000 tombs discovered so far"**

An alternative but <u>equivalent</u> (to B) interpretation of the 1:600 odds result is:

**<span style="color:blue"><u>Interpretation C</u></span>: "<span style="color:red"><u>If the Jesus family did indeed have a family tomb</u></span> (that was among the 1,000 found), then there is a 599 in 600 chance that this particular tomb found is indeed that of the Jesus family"**

Clearly, these latter and correct interpretations (B and C) would not sell the TV program very well! What Dr. Andrey Feuerverger has calculated here is known in probability theory as a "conditional probability" (more about that later!). This means that you are calculating the probability of one event on the condition that another has occurred.

If Cameron wants to invoke probability to make his point - and I commend him for trying to do that – then the more relevant probability that he should have gone after is:

**"Suppose that (for argument's sake) the cluster of names in question did in fact occur in Jesus' family (assuming that Mariamne was part of that family). Then, what is the probability that there would be at least one other Jewish family in the geographic area in question that had the same name cluster?"**

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I suspect that if this probability is calculated it would burst Cameron's bubble and sink his story faster than the Titanic! I would be happy to calculate this probability but would need (ideally) the following data:

1. The name cluster that would make sense to work with (based on the facts known to leading New Testament scholars)
2. The frequencies of these names from a gender perspective. For example: 1 out of every 6 women was named Mary, 1 out of every 12 males was named Jesus, etc.
3. The appropriate geographic area and time period (example: 10 to 110 AD) to consider for this calculation and the population of males and females in that area during that entire time period
4. The percentage of families at that time that would have had family tombs

If I could get help assembling this data, I will be able to quickly compute the probability.

There is another avenue one can take here that uses Dr Andrey Feuerverger's own calculation to calculate a probability far more relevant to Cameron's claim! To explore that avenue, let's get back to the notion of conditional probability! Recall that the correct 1:600 odds interpretation is:

*Interpretation C:* "*If the Jesus family did indeed have a family tomb (that was among the 1,000 found), then there is a 599 in 600 chance that this particular tomb found is indeed that of the Jesus family*"

Those of you mildly comfortable with quantitative concepts and probability terms should be able to follow the next few computations. The others can just skip the computations and read the text conclusions.

Let B be the event that the 1,000 (approximately) family tombs found to date in the area in question included the Jesus family tomb among them; and let A be the event that the particular tomb found is that of the Jesus family. In the language of probability, Dr. Andrey Feuerverger has calculated:

**P(A|B) (read as "*the probability of A given that B has occurred*") and he estimates it to be about 599/600**

We know from classical probability theory that

P(B) * P(A|B) = P(A and B)        (* stands for multiplication)

Now, P(A and B) is the probability that the Jesus family had a family tomb AND that the tomb discovered is that of the Jesus family. Note that the media are taking P(A|B) (Feuerverger's 599/600 number) and wording it in a manner that makes it appear to the general public that it is in fact P(A and B). This is a fallacy and an out right deception! It behooves Dr. Andrey Feuerverger as a respected member of the academic community to set the record straight here.

To calculate P(A and B) we would need to estimate P(B) and THEN use Dr. Andrey Feuerverger's 599/600 number. Note that several experts, including Professor Amos Kloner (of Bar-Ilan University in Israel) have strongly asserted that there is a very small, if any, likelihood that the Jesus family had a tomb to begin with. So, for illustration only, suppose we assumed that there was a 1 in 10 chance that the Jesus family had their own tomb to begin with. This means that P(B) would be roughly 1/10. Using the formula above:

P(B) * P(A|B) = P(A and B)

We see that P(A and B) = (1/10) * (599/600) = 0.1 (approximately). This immediately slashes the probability of the discovered tomb being that of the Jesus family down to 0.1 or 10%. In other words, there is then only a 10% chance that the discovered tomb belongs to the Jesus family – a number not likely to draw a runaway TV audience for Cameron!

Finally, I would like to note that, in the spirit of intellectual honesty and fairness, I sent two e-mails to Dr. Andrey Feuerverger at his University of Toronto email address (copies below). The e-mails requested a detailed write-up of his assumptions and calculations (and an interpretation of the results, of course). The second email was copied to the University of Toronto President, Dr. David Naylor. Neither of them has responded to date.

I would really love to have an open and honest discussion (maybe on this blog!) with Dr. Andrey Feuerverger and find out if he agrees or disagrees with what I have claimed above. If anyone can induce him to enter into a discussion that would be great!

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Joe D'Mello

Date: Wed, 28 Feb 2007 08:59:07 -0800 (PST)
From: Joe D'Mello <joedmello@yahoo.com>
Subject: Fwd: Request for assumptions & calculations
To: andrey@utstat.toronto.edu
CC: president@utoronto.ca

Dear Professor Feuerverger,


Since I did not hear back from you on the email I sent yesterday (copy below), I sent a
formal request today to Discovery Channel requesting the assumptions and details
underlying your calculations, and am also copying your president, Dr. David Naylor, on
this email. I'm sure that as a respected faculty member of a university of worldwide
repute, any professional assertions you make, especially in matters that have profound
historical significance, will have sound documentation and analysis, and will pass the
highest levels of academic scrutiny and peer review.

The brief numerical calculation in the pdf document on The Discovery Channel website
raises more questions than it answers, and it appears to me that the logic is flawed.
However, I cannot be sure unless I can inspect the detail and assumptions underlying
your calculations. Will it be possible for you to send me these? Better still, could you
kindly post that detail (at a level comparable to that of a scholarly research publication)
on the Discovery Channel website, so that fellow academics can have the opportunity to
understand and appreciate your work?

 Best regards,

 Dr. Joe D'Mello


***Joe D'Mello <joedmello@yahoo.com>*** wrote:

 Date: Tue, 27 Feb 2007 08:49:19 -0800 (PST)
 From: Joe D'Mello <joedmello@yahoo.com>
 Subject: Request for assumptions & calculations
 To: andrey@utstat.toronto.edu

 Dear Professor Feuerverger,

  As a fellow mathematician I am sending you this email to request your
 calculations (and associated assumptions) for the probability numbers being
 circulated in the media about the 600:1 odds (attributed to your calculations)
 that the tomb belonged to Jesus's family. I am generally suspect of media
 coverage, and want to get the real scoop directly from you, so I can get a
 better understanding of the assumptions and the true interpretation of these
 odds. I would appreciate any information you can provide in this regard.

 Best regards,

 Joe D'Mello

Chicago, USA


Joe D'Mello