

Robert Shaler
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What I am going to do today is talk a little bit about what we learned from our experience in the World Trade Center.

I also want to talk a little bit about one of the questions that you brought up yesterday concerning the DNA lab where we do DNA testing and the beginning of the laboratory, since I was involved in that.

Just to give you an idea of what things were like when that disaster happened, I want to go through these really quickly. These are laboratory people. They work for me, and they went down to set this up or to help set up a temporary morgue. You will see that the World Towers aren't standing - so many people had to run for their lives.

There are a number of things that happened really quickly when that disaster took place. The basic lesson that we learned is a lot of this can be prevented just by planning ahead of time. Tuesday was the day that it happened. This is Wednesday. You can see a number of things going on. Of course there were bomb threats going on, so everything is kind of in disarray. The FBI was calling us. Family Assistance Centers had to be set up so we could deal with the families. None of this had been planned in advance.

Then, on Thursday we had to order new storage facilities and get whatnot in. We had to establish shifts for people. We had samples coming in the door. We had to order reagents and supplies. We still had our homicides and rapes that we had to worry about - we didn't expect that they would stop and interestingly all the rapes in Manhattan would stop for two weeks, which was a help. Then of course, there was another bomb threat. We had to collect samples from the families and, just to give you an idea, there are a lot of things going on in a very short period of time. The Family Assistance Center was switched from one place to another at Pier 94 - just all kinds of things going on.

On Friday, we set up a scheme with the New York State Police laboratories to divide responsibilities. They were going to handle all of the family samples, while my laboratory was going to handle all of the World Trade Center site samples.

Again, a lot of things were going on. There was a bomb threat at the Medical Examiner's office so we had to evacuate in the rain. A lot of this angst, anxiety, and work could have been prevented by a little planning.

We received about anything and everything you can think of. Most of the tissues were of nothing typical. They ranged from mummified samples to badly decomposed samples, to

just plain bones and splinters, and from jaw bones to just about anything you can think of. Mummified samples were commonplace and we had to get DNA from these kinds of samples. This is showing the anthropology triage where we passed on samples of bones that were burned beyond the point of being able to do anything with them.

The sample flow was that we had samples eventually going from the landfill from the World Trade Center site, all coming to the morgue, and then coming to my laboratory and the Medical Examiner's office. The family samples were collected from Pier 94 and also by the Laboratory Corporation of America for those families that did not live in New York City. We went to the New York State Police Laboratory in Albany, and one of the problems we had there was that we had no data transfer capability between the two laboratories, which was a problem. It took approximately a year and a half to solve that problem.

Basically, from day one, Wednesday, we figured we had twenty thousand people who had died. We had thirty five thousand World Trade Center samples, and we had fifteen thousand personal effects. In reality, we ended up with a total of 2,749 people, give or take a few that we don't know about because of illegal aliens. We had twenty thousand plus samples that came into the laboratory and about fifteen thousand personal effects from the family members.

This became the DNA challenge. What we didn't have basically is a comprehensive plan. New York City had a disaster plan. DNA was not a part of that disaster plan. In fact, DNA was not considered part of the revised New York City plan until just recently. We did not have sufficient in-house capacity to do all of the DNA typing. We did not have DNA matching software or statistical analysis software. We did not have a usable Office of the Chief Medical Examiner IT infrastructure. There was no established coordination of collection plan. The laboratory itself did not have a disaster plan. As you can see, we weren't really prepared for this.

Interestingly, the most critical decision that we had to make occurred within the first forty eight hours or so. Interestingly as well, most of these decisions can be planned in advance, which is nice to know.

The kinds of questions that we have to ask are what do we want to accomplish, who is going to do it, what resources are you going to commit to it, and what is your desired end statement. What that means is -- are you looking at one hundred percent identification of the missing? Are you going to do a complete medical and legal investigation? Are you going to re-associate all of the fragments incurred in all of the investigation? Are you going to be willing to accept outside help? And if you are going to do that, what is that help going to be, and who is that going to be?

One of the things that you need to begin to look at then is the number of victims. At the World Trade Center, we really didn't know the total number of victims until 2004, because it took that long to get to what we call the "manifest." That manifest is still not complete because we still don't know how many people were aliens, and there are also a

number of unidentified DNA profiles. These came from the families that never wanted to be notified and never sent samples in so we could make an identification with enough people who were illegal aliens who were working in the restaurants and whatnot in the World Trade Center.

The conditions of the remains would dictate the kind of testing scheme that you have. Is there extensive fragmentation? Is there extensive degradation or decomposition? How long is the recovery effort going to be? What are the political expectations? I mean, what does the mayor of the city of New York expect of the Medical Examiner's office and of the laboratory? This is critical, because this really affects your operation.

At 2 o'clock in the morning, we had Mayor Giuliani coming into the office and he was demanding that we make an identification on somebody who had been recovered that day, who was the firefighter, who was the husband of his secretary. He wanted that person identified, so we had people in the laboratory all night working on a piece of what was essentially human jerky, trying to get a DNA profile done.

What does the public expect? The public expects a number of things from the people doing the work. They need - they expect - to be kept in the loop. They expect to be part of the communication process and invariably, they are not. That is a big problem, and something that has to be addressed.

Also, what is the philosophical approach that the agency has to a response in a recovery operation? What are the morgue operations? How are they going to be set up? How are the bodies and the remains going to come in, and how are they going to be distributed to the places where they have to go? And what are the long term issues?

The bottom line is that the recovery and rescue operations are fairly quick. The identification, notification, and storage of remains is a long term-process. In fact in April of this year, we have just seen an end to this work. We have been working from 2001 until 2005 to get this work done.

There are certain lab-specific decisions and the management is critical for these. These are questions that can all be answered in advance. The disaster assessment itself is something that has to be done immediately when the disaster takes place - the identification of the victims and how you are going to do this, the DNA technology you are going to use, how you are going to coordinate DNA information with the families, how you are going to collect the data, and how you are going to collect the ante mortem data.

All of these are things that could have been planned in advance for the World Trade Center, which, of course, they were not.

The laboratory scheme that began first was the sending of samples to the Medical Examiner's office, to my laboratory, and to the New York State Police Laboratory. We had decided that since we couldn't do the work in-house, we had to get bigger

laboratories to help us. We chose the Bode Technology Group in Virginia to do the bones and Myriad Genetics in Salt Lake City to do the tissue extracts. The flow of data came back to the New York State Police - where the FBI had set up a sample of a CODIS network, which is similar to the nation-wide network, except that it is not connected to it - and that data was then downloaded and given to my laboratory. We did all of the identification.

Decision trees are important. These are the kinds of things that can be done in advance. Our first decision tree wouldn't occur until October 2001 when we had our first KADAP meeting, which was set up by the National Institute of Justice.

Vendors - we had to reconsider outsourcing the vendors. Are you going to be doing DNA testing? How are you going to deal with the data? How are you going to do the matching? Are you going to do it in-house, or is it going to be done by a vendor?

Stress management. These are incredibly stressful times and someone has to be concerned. The management has to be concerned with the staff and dealing with the stress of the staff.

You should establish Memorandums of Understanding with the different agencies that you are going to be working with. These, again, can and should be established ahead of time as Howard well knows. Howard's company, as a matter of fact, worked for many, many months without being paid because it took that long to get the contracts in place.

Public relations is critical because the public and the media are always going to be asking questions, so media screening and appointments are important. There has to be a public relations person in charge of this. There has to be a controlled release of information.

At one point in time, two different people were giving out information about the DNA laboratory. Although the information going out was similar, it wasn't identical. Therefore, I made myself the point person, so that only one person was giving out information. The Chief Medical Examiner didn't want to deal with the press at all. I became more or less the point person, along with our public relations person, to deal with the press and the media. There has to be one person, regardless of who that is, so that the same story is coming out all of the time. You cannot afford to have secondary stories. The central story is critical to establishing credibility.

You're going to be asked questions all the time that require speculation. How long is it going to take? What percentage of the number of people can you identify? How many do you expect you can identify? You have no clue what the answers are because you don't know, so speculation is possible. At one point, I was asked how many remains did I think we were going to get, because they were still coming in the door. I said, "Probably around 20,000." Then, the next day, another reporter asked the same question and I said, "Well, maybe 500,000." 20,000 was right on. 500,000 was a bit of a stretch.

Then, of course, it's important to have literature that explains the process. We actually developed a booklet at KADAP that explained the DNA identification process to the families.

The bottom line is that you are not telling the truth. If you don't tell the truth, they are going to find out. As soon as it's determined that you are not telling the truth, you've lost more credibility than was gained before that. We've found that as hard as the truth is for some of these families, they wanted to know the bottom line. What are the chances that they're going to find their loved one, and what are the chances that you're going to give them back to them. You don't want them to lose hope but, then again, you don't want to deceive them.

Help. Help can come in two different forms. Management is critical. We didn't have managerial help at the World Trade Center. What we needed was a Project Manager who could be there full time. We had that person for a while, and that was funded by the National Institute of Justice, but when that funding went away, that person went away.

Scientific help is also critical when you're dealing with a situation like the American Airlines Flight 587. It's a fairly routine kind of identification process. We did that in-house, using spreadsheets to make identifications and we had identified the 265 people within a month, exactly a month from the day it happened.

The Trade Center was a different situation. There were entirely different, much more complex scientific issues we had to address, added to the fact that it was a historic event for this country. I didn't want to be the person who was going to be making all of these decisions. I wanted someone to say, "Lenny, this is my problem. What are you thinking?" and then get all of the information. The bottom line is I either had to do it or to not do it, but at least I had somebody in my corner to work with me on this. That somebody was about 30 scientists and we'd convene every couple of months to discuss these issues. That was critical to the overall success of this project.

This is kind of the list of the group of people, the government agencies, the different companies and the universities that we were working with.

The National Institute of Justice funded what we called the Kinship and Data Analysis Panel that Fred already mentioned. This was the group of 30 or so scientists. It had a changing face over time but by-and-large, it stayed the same. They were essential to this.

Family Assistance Centers are another part of this that was essential. For airline crashes, they're mandated that the airline set up a Family Assistance Center and most of these are worked through contract with Kenyon International. In the World Trade Center, this was set up by the City of New York. You have to have a family coordination plan. Families will form groups and there will be two representatives of these groups. You have to be able to meet with these people. We met with them regularly and this really saved the reputation of the Medical Examiner's Office in this whole process.

Sometimes, web sites are set up. New York City had its own web site, but each of these family groups had their own web sites as well. Again, it is controlled information. It's truthful information, but it has to be controlled information. You cannot tell them what you're thinking and what you're speculating. However, you must be sure to tell them what you're doing and what you plan to do. If you're able to meet with them on a regular basis and tell them what you're planning, you get feedback on how they feel about that and how that information should be released to the different families.

Consent forms – we did have consent forms for collecting samples from the family members. The consent forms were specific for making identification. Les, I think, was one of the first who brought up the issue of the IRB. I think this wasn't until around 2002, when we started getting into some of the research necessary to analyze some of these samples. Then it became the issue of do we need IRB consent. The Chief Medical Examiner did not want to go to the IRB because he thought that it was within the city charter that the Medical Examiner's office has the right, has the responsibility, to make identification using any means available to them.

But, we were embarking on something entirely new. We were doing research on these samples. We were developing new methods. We were enhancing old methods. We eventually went to the IRB. The IRB waived it and said that we didn't have to be.

That was done in retrospect because we had already been working and doing this all along so it was kind of a CYA approach, but with the IRB.

The family collections were a problem because they were spearheaded by the NYPD. They were initially going to be worked by the Medical Examiner's office and in my perspective, I thought we should have been there. However, we're still a small agency and I think we would have been overwhelmed. It didn't matter, because the NYPD decided they were going to do it.

Basically, everything was done by hand. It was not done electronically. There was no monitoring of what they were doing so there were recording errors, inaccurate data, and multiple collections taking place. There was no prior attorney and no standardization. They came to us for how to do kinship analysis. We had half an hour to put this thing together, so we gave the NYPD this one sheet of paper and then they went with it.

Needless to say, we didn't get what we needed to get. They had no kinship training so they had no clue as to what kind of questions to ask the families. Everything was done by hand and then transcribed. There was no concurrent review.

As you can well expect, we had a lot of errors and eventually about 40% of my staff was consumed trying to solve these errors so we could put the right names on the right pieces. One of Howard's staff members, Mike Hennessey, was the person who spearheaded this in my laboratory and without his work. I think we all would have been badly vexed.

Currently, the Office of Emergency Management is the lead agency and the police department and the medical examiner's office are all going to be a part of the Family Assistance Center it sets up in the future. The Medical Examiner will be a physical presence there. It will be responsible for all DNA collections, as well as DNA consultations and genetic consultations so that we can make sure that we get the proper samples from the family. The DNA laboratory will provide consultant support as well at the Family Assistance Center to make sure that the samples we collect are important and necessary.

The problem with the World Center work is that we had insufficient or no ante mortem DNA for probably 1,500 families so we had to go back to these families. We set up a DNA hotline so we could reach out to these families. This delayed the whole identification process a lot. The DNA hot line opened in January 2002. We had over 13,300 calls. We set up over 3,500 appointments and 10,000 consultations with family members. So we collected over buccal swabs from family members. This became critical for making identifications for a number of these families.

For DNA testing, you have to develop a strategy. The incident itself will predict what the quality of the remains are going to be. These are decisions that can be preplanned. In advance you can determine if *this* happens, then we're going to do *this* or if *this* happens then we're going to do *this*. Of course, we didn't have a chance to preplan this. In late September 2001, we began noticing that the DNA was badly degraded. In fact, we were getting samples with almost no DNA profiles at all. We began looking at alternate technologies right away. Again, this cuts into the research issue of the research on World Trade Center samples.

In November 2001, we began developing miniplexes or mini STR approaches. We started doing mitochondrial sequencing in September 2001. We began looking at snips that were used for paternity type investigations in November 2001. Solara was the laboratory we chose to do the mitochondrial sequencing because we decided we were going to mitochondrial sequence all the remains and we needed someone who could do it fast. They had good sequencing capability.

Then the snips was done by a group of bioscientists in Dallas, Texas, at a forensics laboratory. Mini STRs were, of course, done by John Butler and then in Virginia.

To give you an idea of the timeline - how long it took to do the research -they began the research in November 2001. We didn't get our first data until December 2002. On that day, we had 5 brand new identifications from this new technology. The newer technology was going to work.

We didn't receive mitochondrial sequences until June or so of 2002 and those were just the family members. We didn't begin receiving sequences from the remains until 2003. We didn't receive the final mitochondrial DNA sequences until 2004. The final data from the snips arrived in 2004. You can see that from 2001 September up until 2004 we were still receiving data.

You can decide what your strategy is going to be before the incident takes place. The incident itself, like I said, will dictate the testing strategy. For the World Trade Center, we had highly fragmented baked remains, decomposing remains, bones, bone splinters, small pieces, and big pieces. As you can well imagine, those buildings falling down were like a huge crucible, just stirring everything up and grinding things to a pulp. We had no choice – there was also extensive commingling - but to develop a degraded DNA testing strategy.

For American Airlines Flight 587, we had burned bodies and mired fragmentation, but the recovery process was fast, with minimal degradation so we had traditional DNA testing strategies, the same kind of testing that's done in every crime laboratory in the country and throughout the world.

The tsunami was sort of an in-between situation. There were little or no fragmentations so the bodies were virtually intact. Some of the recovery was fast but some of it hasn't occurred yet. There'll be dead bodies washing up for years, so we're going to have a fast and a long term recovery process. Environmental conditions are harsh with extensive decomposition and DNA degradation. Entire families were lost so you have to have a DNA strategy. You have to have a kinship analysis strategy. Basically, what's going on now is conventional STR testing. Sometime we're going to have to adopt a degraded DNA testing strategy in order to identify those people who wash up later in the year.

The micro-environment of the World Trade Center site caused us the main problem. We were dealing with samples – this is the typical STR profile that shows the degradation where you have the smaller loci beginning to lose signal.

We learned that we have to expect the unexpected. We expected we were going to have amplification failure. We found that there were PCR inhibitors in the extracted DNA. We found sequence changes in the primary binding region and extensive co-mingling which means that we had mixtures that we had to deal with. We also had limited target templates, which means we were looking at a low copy number type of testing strategy. We had extensively degraded DNA.

We divided the DNA testing into four phases. We did conventional testing, which is the normal stuff we do everyday in the crime lab. We had to go back and do a re-analysis. At the very first KADAP meeting, it was suggested that we go back and re-examine the sample, which is exactly what we did. To go back and reanalyze everything that did not give optimum results the first time took around 9 months to do. Then we looked at those alternate technologies I already talked about.

The fourth phase is yet to come. This is probably going to come within the next year, in which we're actually going to begin data mining for identification. We've hired a company that's going to be looking at the data electronically – to pull every very weak peak, peaks which are still above the noise level but something that we would not pick up on in our normal review.

The final statistics, the DNA statistics, are that we developed 53,000 STR profiles, a little over 45,000 mitotypes, and over 17,000 profiles. We made 1,592 identifications and over 10,000 of the remains are associated with them.

Some of the identifications, to give you an example, were pretty tough. This is an example where we have a personal effect that has a partial profile. In other words, we have a number of negative loci and the statistics were not enough for us to make an identification. The virtual profile from multiple testing of one of the remains is virtually a full DNA profile.

The problem with that is can we fill in these blanks so that we can make these loci and do these loci, in fact, have these alleles? We had to go back and look at the electropherograms manually because these weren't picked up by the instrumentation. You can see that for the D3 locus, for example, you have the 17 and the 18, although the allele machine didn't call it. Going back and looking at the data manually, you can see that it's there. We have consistency there.

We have the x and y. You can see that we do have the y here. We have an imbalance in the piece because we're looking at very, very small amounts of DNA. We do have the x and y. We have the 11 and 15 at the D8 locus. You can see we have the 11. We have the 15. This is the kind of thing that we have been spending the last year to a year and a half on, the kinds of identifications using this approach.

What we'll do is we'll get in here and we'll say we have absolutely no inconsistencies and we can fill in. In this instance, we were able to fill in all these lines so we're fairly certain we have the right identification. So then, we can cap these statistics and we can report out.

Now would we do this in regular case work? Probably not, because these are below our calling threshold. This is something that has to be done or you can alter the calling thresholds if you do a proper validation.

What are the implications for case work? The implications are that partial profiles, the interpretation of partial profiles, are turning out to be a problem in crime laboratories throughout the country. When you get into partial profiles, you're there because you have degraded DNA or you have small amounts of DNA. Regardless of whatever the reason is, you are looking at what we call low copy number DNA testing. I believe that we need to get a hold of our technical readers in this country to be trained and to show them how to deal with these kinds of issues.