17. Disease Monitoring in the Military

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DR. SHELTON: Our next speaker is Colonel Kenneth Cox. He's with the United States Air Force. He is chief of the risk assessment division in the Air Force Institute of Environment, Safety and Occupational Health Risk Analysis. He has a 30-person division which supports the Air Force division and Department of Defense commanders all around the entire globe. He wears many hats and has many responsibilities. He is a board-certified aerospace medicine specialist and an epidemiologist. So we're very happy to have Colonel Cox here.

LT. COL. COX: This is a change in direction from what Mr. Antwine was just speaking about, and it goes back to the previous section where we were talking about bio-terrorism and biological and chemical monitoring. But it does have a connection to chronic issues, and as we go through this material I'd like to point out that many of the new techniques we've developed in response to terrorism-related issues have helped us move traditional public health surveillance forward.

I want to start out talking about the Air Force Institute for Environmental Safety and Occupational Health Risk Analysis (AFIERA), an institute that's going to change its name to the Air Force Institute for Operational Medicine. We will briefly look at some of these enhanced surveillance techniques that are being used for bioterrorism early warning. Then we will see how we can apply these to things such as chronic illness and other conditions of concern.

AFIERA is similar to what Mr. Antwine had just mentioned, in that we're very concerned about the health not only of individuals but also of the environment. Being a military institute, our first focus is on meeting the needs of war-fighting individuals, but we don't stop there.

We extend the same kinds of systems to the family members of those individuals and to the communities that are surrounding our installations. We've learned over the last few decades how important it is for us to work with the surrounding communities.

This is a circular diagram showing unity and interrelation. (Figure 17-1) The surveillance director (SD) is interesting because it's what makes us unique in that we have a full range of laboratory analysis capabilities for both biological specimens and occupational environmental specimens. So whether it's air, water, or soil, we can analyze for various chemicals, biological agents, and radiation. We also happen to be the drug-testing laboratory for all the Air Force, to make sure that we are not developing problems with addiction that might compromise our ability to perform our duties.

My section is RS, which is where the consultants primarily work, and those are a wide assortment of scientists, such as environmental scientists, toxicologists, bioenvironmental engineers, public health officers, preventive medicine physicians, such as myself, and a number of different disciplines that can cover the wide gamut of needs for health risk assessments. We also have a small detachment overseas, because the forces in the Pacific area are so remote that it's difficult for us to respond quickly from a central location. Inside of the circle is an epidemiology section, which is what we're going to focus on now. So we're sort of like a mini-CDC for the Air Force but without the same robust number of staff and funding as CDC.

Figure 17-2 is a mockup, and I hope people don't think that they missed the news and that a bridge had been blown up when they weren't looking. This is just to illustrate that there's a great deal of concern about types of outcomes that could occur with terrorist activity or naturally occurring events in some cases, but the real focus has been on biological terrorism since episodes with anthrax last fall.

What could we learn from that event? One thing that we've learned is that traditional public health continues to have the same goals it's always had, and there's really no reason to change that. We still want to prevent, if possible, all kinds of illness or injury, and when we can't prevent them, then we want to minimize them. And in order to do that, it helps to find these problems early as opposed to late. So certainly, in the bioterrorist attack with anthrax, if you can recognize it in the first couple of days, you have the opportunity to give antibiotics to other people who have been exposed and prevent the illness from occurring in them. If we find out about it ten days later, then most of the people who are going to get sick will, and there will be less opportunity to help them. So the methods are very traditional, and the circle illustrates that to do surveillance we need data.

So we have to have systems that give us data, and we'll see some of the qualifications that data must meet in order to be useful. Once we have the data, we need to analyze it, figure out what it means. Then we need to get that information out to people who can do something with about it, because epidemiologists in general don't have authority to go out and change things. They only have the responsibility to alert individuals who are in a position, and have the authority, to take appropriate action.

The action is the most important part. We can holler and scream all we like, but if nobody does anything it doesn't matter. So part of our job is to motivate the decision makers to take action, and then to help them by monitoring what happens so as to see if the actions were effective or not.

Now let's look at some of the things that are involved. (Figure 17-3) This was originally set up for infectious diseases, but I modified it to apply to any kind of exposures that result in some long-term disease. The point is that if you found it by traditional surveillance techniques, it might be way out here on the graph. The total large rectangle indicates the number of people that suffered because of that exposure, that either became ill (possibly permanently), handicapped in some way or died.

However, if by using enhanced surveillance techniques and you find the problem much earlier in the course, then the area in that box is dramatically less. So, pretty obvious, but the trick is, can we do it? If we want to do it, there are a few things that we can think about, and this can apply to any kind of surveillance system that we want to use. It needs to be responsive for chronic diseases as well as acute infectious diseases, and we have to have people actually getting us the data in a timely fashion, and the data have to be fairly high quality if we're going to make any reasonable analysis from it. (Figure 17-4)

We think of the data in terms of signals, and a lot of the mathematics and statistics are based on the kinds of techniques used in submarine warfare for figuring out from all the noises underwater what might be a submarine versus a whale. So we need to learn to sort out the noise and find the signal of interest, that's the whole goal. There are ways we can do that, and one thing we're doing is adding new data streams or, as we call it, new signals, one of which needs to be environmental exposure data. One of the lessons we've learned is that we don't have a great repository of exposure data.

Figure 17-5 is an illustration of how you can use different sources of data for enhanced surveillance. It focuses on the flu, but it could just as easily be anthrax, because a flu-like syndrome is what you get with early anthrax disease. The vertical line indicates where retrospectively they were able to determine that there was an outbreak of influenza in a community. You see where the peaks start after the line in every single one of those categories, for example, school absenteeism and sales of cough remedies. The question is, is can you use this data? Some data are hard to get and not readily available. Other data may be last month's data rather than yesterday's data. It may be last month's data. And depending on the system, the data may or may not be accurate. Since we can't collect every single piece of data in the world, even in today's electronic age, we have to figure out what gives us the best representation of this group or community or society.

Given that, here's some of the data that we've been using because the Department of Defense does have a bioterrorism early-warning system that they follow. You would think inpatient data would be very valuable. The trouble is that it's not timely. It takes a long time to get all the lab data in and for docs to make their final diagnoses, and then even longer to dictate it.

In the case of ambulatory data, though, we have a significant percentage of data that gets entered into a computer system every day. Not 100 percent, so yes, we're back to a representative sample. Within about four days, usually 90 percent of the health care encounters that occur on any given day are finally into the system. We found that we can track that, and we're going to see a couple of examples of how that works. We'll mention open sources—despite how good our electronic systems are, we still frequently learn about outbreaks first from CNN, so we do have people in our system monitor these kinds of news sources, because we are responsible for the health of the forces around the world, and some of the systems break down overseas.

Figure 17-6 is an example of what we've been able to do in the military using a system where every day, around 5:00 am, it goes down to a central server that happens to be in

Denver and pulls up all the ambulatory data from the day before. And then it graphs and does some statistical work behind the scenes. It compares that day with the previous six similar days, so if it was Monday's data, it would compare Monday's data with the previous six Mondays. Then it looks to see if it's outside of two standard deviations based on that six comparable days' worth of data. There are alarms that come on if the data is outside of two standard deviations. This one is fairly obvious. You can tell that something was going on, and yes, it was a legitimate outbreak.

So we can find outbreaks with this system. The problem is that the system is very sensitive because of data quality issues, and so you get lots of false alarms.

Respiratory is another category which includes all the flu-like illnesses, as well as bronchitis, pneumonia, otitis and asthma. So this is a sensitive but nonspecific system, and we have to be able to dig behind it. We have to have a system where we can reach out to the local people and ask them "Well, do you know something? Do you know that this is going on?"

On the more subtle side, this is what we frequently see. (Figure 17-6) This is a chart from Randolph Air Force Base with respiratory data. You can see how this jags all over. It looks more like some kind of an EKG than potential health events. But those are expected patterns. These places don't have open clinics on weekends, and so it drops down, then it bounces back up on Monday. If you were looking at this, you wouldn't see much, but by looking at different syndromes on the same day's data, we could see that the fevers had a spike, (Figure 17-7) even though the respiratory systems didn't.

So again, you see the need for multiple data streams instead of relying on one particular one. Fortunately, we have another complementary system in the Air Force—we're also in charge of influenza surveillance around the globe. Figure 17-8 gives us some insight into the patterns for influenza, and the highest peak corresponds to that same week that we were seeing the fever spike on the previous slides. There was a lot of influenza in our local community at that time, and we were able to advise the San Antonio Metropolitan Health District about that, and so they in turn had the opportunity to alert their network of providers to say "If you have elderly or other high-risk patients, you might want to have a lower threshold for providing them with influenza immunizations."

So these systems start to interrelate and you can see the advantages of that. But it's not a perfect system. People get busy and miss data, systems break down, computer servers crash. Sometimes the data gets dumped a week late, so you suddenly get alarms on things that happened last week, which are too late to do anything about, and they're usually spurious and artificial because of that.

Another question is how does this relate to what you people in the audience do? My premise is that it's quite similar. Another question is why has it become so important for us to have what we call real-time surveillance? It's important to identify some of these potential peaks or clusters ourselves, instead of waiting for some neighborhood committee to contact the media and say, "We have 16 cases of asthma in four square blocks here," or "We have 17 cases of leukemia outside of the Air Force or Navy air station."

So why are people concerned about these things? A few decades ago, nobody was worried about that. These are my own personal opinions based on what I've seen in the communities outside of Kelly, but there is some literature that supports these conclusions. In general, people don't want any involuntary risks anymore. So an individual is perfectly willing to accept the risks of using tobacco products or drinking or eating excessively, or choosing a sedentary lifestyle, but they don't want the risk of some industrial site that has put chemicals in the ground underneath their house.

So that's where we need the science to be able to answer some of these questions, but we also have to deal with the health risk communication issues at the same time. Because of past practices and the fact that we didn’t always communicate in an open manner, scientists lost a significant amount of credibility. Another surprise to me, and I haven't seen much written about this, is that people now seem to be very unacceptable of illness and/or dying. It’s not uncommon for someone to be outraged that their 87-year-old grandmother has suddenly been diagnosed with chronic leukemia and insist that it is someone's fault. She shouldn't be sick. 50 years ago we would have been deliriously happy to have an 87-year-old grandmother. Somewhere there was a change. Maybe we oversold technology. Maybe we oversold our ability to intervene in heroic ways in medicine. We're going to have to come back to a more reasonable approach and recognize that people do die, and things do go wrong with humans and health.

One of the hardest things is to live with uncertainty, and I think that's at the bottom of this. Nobody likes uncertainty, but we used to accept it because we didn't think we knew everything. Now we are nervous and scared to have to deal with uncertainty. So we have to learn how to communicate uncertainty and how to get people to understand it without feeling threatened.

So what are some of the examples? Big ones from the military have been Agent Orange and what happened after the Gulf War, Desert Storm. Some people may not realize this has happened after every conflict, going back at least as far as the Civil War. After every major American war, there has been an unexplainable syndrome where people had things that were wrong. They were multisystem. They frequently ended up with a number of recognized diagnoses, but they all perceived it as stemming from their activities on the battlefield. And so that's an ongoing issue that we need to learn how to address. Then there's the worrisome issue of vaccine phobia, including our pediatric population. We have more and more parents who are absolutely refusing to bring their children in for their routine vaccinations, and that includes the military.

To show that the Department of Defense has been listening and is concerned about this, the president codified what we'd already been working on it. (Figure 17-9) This is a formal document that says we need to monitor and take care of the health of our people, including their beneficiaries, and this requires us to gather data from every aspect of their lives, from when they enter service until they die.

The next slide (Figure 17-10) illustrates the kinds of surveillance systems that apply at any given phase. Our challenge is to cover every one of those phases and be able to deal with the specific aspects of exposures and to look for related health events.

Some pieces are missing. (Figure 17-11) These are the things we want to work on. (Figure 17-12) One of our initiatives is that we need a more systematic cancer event surveillance system. We're not there right now.

This doesn't have to be real time. I don't need to look at all the cancer diagnoses from yesterday, but the tumor registries need to be more accessible. We need to be able to gather information from civilian sources as well as military and put them together to see if there are clusters that we don't know about. We need to start to put some science and some data behind this so as to reassure people or to discover the missing links and then be able to protect them by appropriate actions. We can't do that without the data.

It's the same thing with reproductive health. Whether it's vaccines, whether it's jet fuel in the ground, whether it's radiation or other concerns, we don't have a good system that allows us to look for miscarriages, which frequently occur before the individual even realized she was pregnant. To count those and know whether we have more or less than we should is challenging. Certainly the more obvious birth anomalies that occur could be tracked much more consistently than is done now.

So we do have a set of initiatives in various stages. We have a mortality registry to help us track the causes of death for active duty people more effectively. We want to enlarge that to family members as well, but there are funding issues. We are establishing a cancer surveillance system, and we're moving into several other areas that will help us to look at environmental exposures and try and determine health outcomes that may or may not be related to those.

Let's look at a few snippets of the future. There are lots of new laboratory techniques, things that we can use in the field, such as portable polymerase chain reactions that we can take out to where the conditions are.

There's lots of new software and things that use mapping and addresses as opposed to just codes and a population. We can look at the relationship geographically to either an industry of concern or a plume of concern, so that we can really start to do a lot more than just look at how many people have a specific condition. We can start to try and derive those relationships that everyone has questions about. If we start getting better environmental exposure data, we can look at direct comparisons and make hypotheses and track them.

We already know that pollutants in the air lead to increased respiratory disease, episodes of asthma and things like that, so it's not new knowledge, but we can apply that to other conditions as well if we have a steady data stream that's dependable.

So I would just conclude by saying that we do have a lot of leading-edge techniques that are being investigated, and we hope that we're going to be able to apply those to environmental exposure issues that include both the pediatric population and the adult population. We should be able to cover both of these at the same time, thereby conserving our resources while still getting the best bang for the buck.

I think that should do it.