**The Design of the Biohazard Symbol**

First, my thanks to Dr. Wilson and to Dr. Linden for their opening remarks that set the stage for our discussions over the next three days. A special appreciation to my longtime friend and co-worker, Emmett Barkley, for his role in creating this retrospective look at Biological Safety and the NIH Laboratory Safety Monograph.

This invitation to be with you is a welcome home for me in many ways – a connection with my roots. In addition to being a Commissioned Officer in the Public Health Service at the National Cancer Institute when we developed and published the Biohazard Symbol, I had worked earlier in the Research Facilities Planning Branch. But my homecoming also relates to an earlier period, when my family lived a few miles up Georgetown Road. My father, Lloyd Runkle, was a construction engineer at NIH in the facilities branch when the hospital was built. And, partly due to my dad’s connections, my first real paying job was as a laborer, in 1953, when I worked for the contractor installing laboratory furniture in the hospital, now known as the Clinical Center.

Another connection is my graduation from Bethesda Chevy Chase High School in 1954 and my attendance at what is now Montgomery College before transferring to Georgia Tech, my alma mater. A few years after graduation, basic training and work for an architect, I joined that same NIH facilities branch where my dad had worked. So my roots to this area are deep and I thank you for welcoming me back.

Now, I’d like to pose some questions to consider:

* How did we know that a Biological Warning Symbol was needed?
* What did the Biohazard Symbol mean and what impact did it have?
* What process was used to validate the need and to demonstrate the value?
* Did the symbol achieve the goals?
* Who was helped?
* Would I recommend doing it again? If so, what changes?
* Was this a proper role for the Federal Government?

***How did we know that a Biological Warning Symbol was needed****?*

***What did the Biohazard Symbol mean and what impact did it have?***

as Emmett Barkley mentioned, in 1964, responding to an urgent request from Dr. Kenneth Endicott, Director of the National Cancer Institute, the Special Virus Leukemia Program was funded by Congress in an attempt to determine whether or not there was a viral cause to cancer. Multiple scientific sections of NCI were created to address specific at aspects of this research. Due to the planned use of human and animal viral material and the risk of contamination of experiments as well as possible subsequent human infections, a Biohazards Section was created, led by Dr. William Payne.

One of the first steps that Bill Payne took was the creation of a Biohazards Scientific Advisory Committee. The leader of this team was Dr. Arnold Wedum, and his staff at Fort Detrick, in Frederick, Maryland. The Advisory Committee also included:

●Dr. Stewart Madin, and Mark Chatigny, of the University of California’s School of Public Health and Naval Biological Laboratory;

●Dr. Richard Bond, University of Minnesota School of Public Health, and

●Dr. G. Briggs Phillips, Fort Detrick and NASA.

Based on their collective knowledge and expertise, the committee members helped design the scope of the proposed Biohazards Contract, which they then recommended we initiate.

Two NCI staff members were assigned to write the scope of work and to solicit proposals for an R&D contractor to conduct investigations into safety policy and practices, validate correct aspects and to recommend appropriate changes to NCI. I think it is safe to admit now that the NCI staff members selected were Emmett Barkley and me!

We were young, hard workers with scientific and engineering backgrounds, we were totally clueless about the Federal procurement process, and due to our Commissioned Officer status were not eligible for overtime, which saved NCI lots of money! But we had great teachers at NCI, including Bill Payne, Walt Magruder, Executive Officer, and several individuals in the contracting division.

In a spate of work by Emmett and me (prior to his escape to earn his PhD), we proceeded as if we knew what we were doing, with constant oversight by Dr. Wedum and the rest of the Scientific Advisory Committee and NCI contracting specialists. We developed the scope of work, solicited proposals, and then panicked at the overwhelming quantity of material submitted for our review and evaluation. We ultimately recommended award of the Biohazard R&D contract to the most responsive bidder, and in June 1965, NCI completed negotiations with the Dow Chemical Company, specifically their Pitman Moore Division based in Indianapolis, IN.

Dr. Endicott wrote at the time the contract was signed that he “considered this particular area (of research) to be one which has a tremendous potential impact on, not only future research within the NCI, but, all of the NIH.” Dr. Endicott may have been one of the few government scientists and leaders to understate the impact of any planned research. Now, many years later, the Biohazard Symbol has achieved worldwide adoption and use in the laboratory as well as applications in a broader environment never envisioned.

***What process was used to validate the need and to demonstrate the value?***

Charles L. Baldwin, who served as a leader of the Dow Biohazards Research and Development Department in Indianapolis, was tasked by Dr. Payne and the Advisory Committee to visit and study biological research laboratories across the United States. The purpose of these investigations was to understand how biological research was being conducted in the early 1960’s, what kinds of accidents had happened, what types of protective equipment were in use, and other matters. They particularly focused on how the WWII biological warfare effort and the work in specific Department of Defense laboratories (such as Ft. Detrick, Plum Island, and Dugway Proving Grounds) had resulted in the development of new tools to use to protect laboratory workers and the exterior environment from contamination by infectious agents.

I have a great deal of respect for Chuck Baldwin, and want to recognize today his leadership and the critical role that he played in these studies. I wish that he could be standing here today, sharing the story of the development of the Biohazard Symbol and, frankly, helping to answer some of the questions.

Among the many results of this early investigation in government, university, and private research facilities was the realization that there was no uniform method of identifying potentially biologically hazardous areas within a building. Both workers as well as visitors were at risk. These Dow scientists and support teams identified a critical common factor – the need to know at all times where the potentially infectious agents were located.

During the study, the team was impressed with the concept of containment of suspected agents through creation of barrier systems, such as solid walls, use of pressure variations between spaces to control air movement, controlled movement of scientists, technicians and materials, and development of methods to inactivate the infectious agents themselves. The team also observed warning symbols then in use for radioactive hazards, and some for chemical hazards, but found nothing standardized for biological hazards.

The team noted that, like radiation hazards, biological hazards are usually impossible to detect by sensory examination only and that due to the nature of being invisible, odorless and tasteless, a different set of procedures was needed for warning about potential biological hazards. The Dow team noted many different types of home-made signage indicating the potential hazards. When they returned to their offices, they conducted literature searches to validate the field discoveries and to better identify and catalog signs that existed. In 1966, Chuck Baldwin and the Dow team reported to NCI that no universal **symbol** for biological hazards existed. Based on their report, NCI staff and the Advisory Committee strongly supported the recommendation that a universal warning symbol be developed.

Now, let’s step back and look at background about **symbols**. Webster’s dictionary defines a **symbol**as “something that stands for or suggests something else by reason of relationship, association, convention, or accidental resemblance; especially: a visible sign of something invisible (such as the lion is a symbol of courage).”

Chuck and I subsequently published an article in the journal *Science (1)* on October 13, 1967, describing the lack of a universal warning symbol for all biohazards prior to 1966, and I quote:

“In biology laboratories … a number of different symbols are in use; none of these has been universally accepted, and none imply or encompass all possible biohazards.” (1) Science, October 19, 1967, Vol. 158, No. 3798, pages 264-265;

<http://www.hms.harvard.edu/orsp/coms/biosafetyresources/1967-10-13-Science-paper-Biohazard-Symbol.pdf>

This lack of a universal symbol posed a danger to the entire biological studies community, as well as everyone else, because of the possibility that the variety of symbols could cause confusion.

Containment facilities within laboratories, as well as control of infectious agents, had begun the process of keeping workers safe. However, the Dow contract team reported that accidents still occurred. There had been numerous accidental infections of laboratory personnel in the twenty years leading up to this research.

Baldwin’s team began to work on ideas for the new symbol, assembling not only Dow scientists, but their marketing people and industrial package design department. In formulating the design for the proposed biohazards symbol, six criteria were established, mainly dealing with the psychology of recognition and retention. These criteria, in order of their importance, are that the symbol be:

1. striking in form in order to draw immediate attention;
2. unique and unambiguous, in order not to be confused with symbols used for other purposes;
3. quickly recognizable and easily recalled;
4. easily stenciled;
5. symmetrical, in order to appear identical from all angles of approach; and
6. acceptable to groups of varying ethnic backgrounds and nationalities.

Using a testing process based on the field of mass market psychology, Baldwin’s team presented the symbols that they had developed, mixed in with everyday commercial and public symbols, to selected groups across the country to see which one was the most agreeable and most memorable, yet had no other hidden meaning. They created survey groups similar to the approach used by the Dow marketing department to test labels for Dow products; they reduced the original 40 biohazards symbols they had developed down to a group of six, and mixed them with 18 other different commonly used symbols. The other everyday symbols were recognizable ones, like the peanut man for Planters peanuts, the Texaco star, the Shell Oil symbol, the Red Cross and the swastika. Test subjects rated each of these 24 symbols with their association of what each one meant.

A week later, the Dow team went back to the same people, with the same set of six proposed biohazard symbols, plus 36 everyday symbols, some new and some of the symbols used the previous week. The subjects were asked which symbols they remembered the best and then were asked to rank the meaningfulness of the symbols.

Two symbols earned the highest “memorability score.” The biohazard symbol ultimately chosen scored highest on the memory score, while scoring lowest on the meaningfulness score – it was unique and memorable yet had no inherent meaning.

Finally, after extensive research, Baldwin’s contract team had produced what they believed to be the perfect warning symbol for biohazards -- blazing orange color to stand out in front of one's eyes, three-sided and perfectly symmetrical to avoid confusion if looked at from different angles, and a dominating picture to attract one’s attention.

The next major step was presenting the concept to the scientific community. Based on advice from the NCI Scientific Advisory Committee, we contacted the journal *Science* and were pleased to have our publication accepted in 1967.

The next step was to get the authorization from the various agencies that could and should adopt the symbol. The first adopters were the Centers for Disease Control, the Occupational Safety and Health Administration and, of course, the National Institutes of Health, strong evidence of acceptance.

And that was it. The symbol now can be seen on countless biohazard labels, tapes and signs and in labs across the world.

So let’s return to my opening questions:

***Did the symbol achieve the goals?***

Yes. In the area of reducing laboratory acquired infections however, it’s difficult to quantify any direct benefit from the use of the symbol, because the use of containment cabinets, pipetting aids, immunizations, directional airflow, and training, all help prevent exposures and illness among laboratory personnel.

But the symbol has accomplished great things regarding biosafety. Its unique design makes it easily recognizable as a warning sign of biological hazards. People don't wander into laboratories posted with the symbol which is a constant reminder of a biohazard. You see it everywhere on sharps containers in labs and even in airport restrooms, on containment equipment, and shipping materials. The message is always clear:

***Be careful, use good technique, and disinfect surfaces where you handle microbes.***

Airlines, FedEx, UPS trucks and other means of transportation all require packages containing microbes to have the symbol displayed on the outer surface. If a labeled package is crushed during shipment, the symbol initiates immediate action to decontaminate the material and the entire shipment and to call CDC. Thus, the shipping of materials is far less hazardous today. All of these accomplishments are direct benefits of the symbol’s development.

***Who was helped?***

The initial answer is the scientists and workers in U.S. laboratories. But since the publication of the 1967 article, the Biohazard Symbol has become recognized worldwide as warning of laboratory hazards, so we’d need to include scientists in other countries as well.

After leaving NCI and Bethesda, in my subsequent professional career and prior to my first retirement in 2003, I worked up and down the East Coast, as well as in England, the mid-west and now in Idaho. Wherever I have worked or lived, any laboratory or medical facility that I visit uses the symbol as we designed and described it in the “Use Standard” that was developed by Dow under the contract.

An additional area of benefit, not included as part of the original project, includes hospitals and doctors’ offices. Not only does the symbol address the issues of biological safety in laboratories, it has become ubiquitous in hospitals and physicians’ offices, thus protecting an entirely different community of individuals from the potential hazards of blood-borne diseases.

Another question was:***Would I recommend that we do it again, and, if so, what changes would be appropriate?***

I alluded to the “Use Standard”(2) that we developed. In hindsight, the way in which that Use Standard was made available may have been one area where we inadvertently hurt the adoption, and subsequently caused occasional misapplication or plain misuse, of the Symbol. As a result of space limitations, the journal *Science* was unable to allow inclusion of the “Use Standard” with our article. Our article noted that the “Use Standard” had been developed and that we had submitted the symbol and

(2) Use Standard published by National Cancer Institute, revised 9/9/66

“Use Standard” to what was then the United States of America Standards Institute for

inclusion in their “Standard Specifications for Industrial Accident Prevention Signs”. The Standard described in detail the proportions of the symbol, the colors and the words to be used, while noting never to obscure the face of the symbol, and that the symbol was only to be used or displayed to signify the actual or potential presence of biological hazards.

We clearly didn’t provide easy access to the Use Standard. So if I were to try again, I would focus on how to share both the design and the Use Standard across the world. Today the journal article would likely be published on the internet, with a link to the Use Standard itself, complete with full color pictures.

By this time, the symbol has been adopted and incorporated into OSHA standards as well as others, but by disconnecting the symbol from the “Use Standard”, we may have caused some of the misuse that has been observed

Imagine the chagrin of Chuck Baldwin, who was reported in the 1990’s to have encountered a seminar speaker at a conference who, as a gift to attendees, designed a necktie with a pattern of biohazard symbols. Although Chuck said the tie itself was beautiful, he sent the man “kind of a nasty letter saying this symbol was not designed to be used sartorially.”

But Chuck might be even more amazed if he could see what is going on today. There are drink cups, mugs, hats, chain charms, T-Shirts, beer coolers and even a Biohazards video game in Japan, known as Resident Evil in the U.S. Even tattoos are available with the Symbol.

But wait... In an inspired and perhaps macabre turn, a biohazard tattoo on a man or woman has come to mean: "I am HIV positive." In a manner that neither Chuck, I, the NCI, nor any other of the participants could have ever imagined, perhaps this unexpected use of the symbol is really a true application of what the original mark was designed for: **a warning**. The biohazard symbol serves in this case as an alarm that the material in this container (the human being) presents a "risk or potential risk to the wellbeing of man, either directly through his infection or indirectly through disruption of his environment,” a direct quote from our article. So who is to say that the symbol on a human being is inappropriate?

***Would I recommend that the symbol be developed, knowing what I know today?***

My answer is a resounding YES to this question. In spite of the occasional misuse of the symbol, far more good has been achieved than any slight harm from its possible misuse by the commercial sector. People recognize the symbol across the globe, in laboratories, in hospitals, physicians’ offices, airport rest rooms and many other locations. It serves a critical function in telling people to be alert, and to avoid certain spaces, and accomplishes this quickly, effectively and with little maintenance, interpretation or oversight.

A final question: ***Is this kind of activity a proper function for the Government?***

I am confident that development of the Biohazard Symbol WAS a perfect opportunity and an appropriate mission for the Government and one that no private organizations could have ever accomplished. The ability of the government to contract with experts such as the Dow team ensured the resources and separation from commercial interests necessary to facilitate the development of this kind of **symbol**. The symbol has been used to protect the scientific community and, by adaptation, the average worker and general public in hospitals, medical, and public settings in a way no other approach could have achieved. I am sure that Dr. Endicott would be extremely proud of the success of the Symbol.

Thank you for the chance to be with you these next few days. I look forward to the rest of our time together.

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