

**NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
BOARD OF SCIENTIFIC COUNSELORS (BSC)  
April 12, 2017**

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**THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
CENTERS FOR DISEASE CONTROL AND PREVENTION**

**NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
BOARD OF SCIENTIFIC COUNSELORS (BSC)**

SIXTY-EIGHTH MEETING

**BOARD OF SCIENTIFIC COUNSELORS**

**(BSC) MEETING**

April 12, 2017

The verbatim transcript of the  
Meeting of the Board of Scientific Counselors

Meeting held on April

12, 2017, 8:30 a.m.

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**PARTICIPANTS**

(alphabetically)

KARLA ARMENTI, ScD - BOARD MEMBER  
MICHAEL BEHM, PhD - BOARD MEMBER  
TERRY BUNN, PhD - BOARD MEMBER  
SHARON COOPER, MD - BOARD MEMBER  
THEODORE COURTNEY - BOARD MEMBER  
JEAN COX-GANSER, PhD - RESPIRATORY HEALTH DIVISION, NIOSH  
MARYANN GRUDEN - BOARD MEMBER  
JOHN HOWARD, MD – DIRECTOR, NIOSH  
HONGWEI HSIAO, PhD - DIVISION OF SAFETY RESEARCH, NIOSH  
MARGARET KITT, MD – DEPUTY DIRECTOR, NIOSH  
CHRIS LASZCZ-DAVIS - BOARD MEMBER  
GRACE LEMASTERS, PhD - BOARD MEMBER  
JUDITH MCKENZIE, PhD - BOARD MEMBER  
PAUL MIDDENDORF, PhD - DESIGNATED FEDERAL OFFICIAL, NIOSH  
JOHN NOTI, PhD - HEALTH EFFECTS LABORATORY DIVISION, NIOSH  
STEPHANIE PRATT, PhD - CENTER FOR MOTOR VEHICLE SAFETY, NIOSH  
JENNY ROBERTS, PhD - HEALTH EFFECTS LABORATORY DIVISION, NIOSH  
BONNIE ROGERS, PhD - BOARD CHAIRPERSON  
INGER SCHAUMBERG, PhD - NATIONAL RESEARCH CENTRE FOR THE WORKING ENVIRONMENT  
JASWANT SINGH, PhD - BOARD MEMBER  
RON STOUT, PhD - BOARD MEMBER

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**WELCOME AND INTRODUCTION, MEETING LOGISTICS**

DR. MIDDENDORF: Good morning, everyone, and welcome to Morgantown. I've been trying to figure out if this is the first time that the Board of Scientific Counselors has ever met outside of DC. I've been told that they may have at some point in the distant past, but I think it's been a valuable experience to have the Board come here and I think we'll hear more from the members later about that. But I also want to express appreciation to all the people here in Morgantown who, behind the scenes, have helped to put this on and make it a reality. There's a lot of work that goes into it. We really do appreciate all the work that has gone on, so thank you very much for doing all that and getting this ready for us.

The first issue I want to bring up is emergency exits. We do have an emergency exit back here, behind the glass there is a set of doors and we will go out that, and around the patio, and congregate back in the back over there. So that's where we go if there's an emergency. And also I suggest to the people on the phone you may want to look around and make sure you know what your emergency route is to get out of wherever you are.

We do want to remind you that this is a federal advisory committee, the Board of Scientific Counselors is a federal advisory committee, and we are subject to all the rules and regulations that a FACA committee is subject to and we will be running our meeting based on that. One of the things that is important for FACA committees is ensuring that there are no conflicts of interest or at least managing those conflicts of interest, and so when we do the roll call, I'll ask each of our members to just identify and say whether or not they've had a change of employment or a change in financial holdings which would negatively impact their conflict of interest. So when we go through the roll call, if you'll let me know that, I'd appreciate it.

The other thing I want to mention is that, for the first time, we are actually not doing minutes per se. We will be doing a transcript of the meeting, and we will be audio taping all of the conversation, and what everybody says verbatim will be taken down, and that will be transcribed, and that will serve as our minutes going into the future. One of the things that we have to do or is difficult for the transcriptionists is making sure that they assign who says exactly what, so if you remember to, if you would identify yourself before you speak, that would be very helpful. What usually happens is that people get into the middle of a discussion and conversations and they forget to announce who they are, so when we do the roll call, I'll ask you to repeat your name after I call it off, state your affiliation, and then say whether or not you've had any changes in your conflict of interest. That way it will allow the transcriptionists to do a little bit of a calibration so they can hear your voice and be able to ascribe it later on.

So I guess with that, we ought to go ahead and start the roll call. We have some of our members who will be on the phone. Karla Armenti, are you on the phone?

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DR. ARMENTI: Yes. Can you hear me?

DR. MIDDENDORF: Yes, I can.

DR. ARMENTI: Okay, great.

DR. MIDDENDORF: Would you say your name and your affiliation and whether or not you've had a change in conflict of interest?

DR. ARMENTI: Oh, sure. Karla Armenti, and I'm with the New Hampshire Occupational Health Surveillance Program, and there's been no change.

DR. MIDDENDORF: Thank you. Michael Behm.

DR. BEHM: Michael Behm, East Carolina University, and there has been no change.

DR. MIDDENDORF: Welcome. This is your first meeting.

DR. BEHM: Thank you.

DR. MIDDENDORF: Terry Bunn?

DR. BUNN: Terry Bunn, University of Kentucky, no change.

DR. MIDDENDORF: Okay. Lamont Byrd is not attending. Sharon Cooper?

DR. COOPER: Hi. Sharon Cooper, University of Texas School of Public Health, no change.

DR. MIDDENDORF: Okay. Ted Courtney? We weren't sure if Ted was going to be able to make it or not. He was going to try and attend by phone if he could. MaryAnn Gruden?

MS. GRUDEN: Yes. MaryAnn Gruden, the Association of Occupational Health Professionals in Healthcare, no changes.

DR. MIDDENDORF: Okay. Chris Laszcz-Davis?

MS. LASZCZ-DAVIS: Chris Laszcz-Davis, The Environmental Quality Organization, no changes.

DR. MIDDENDORF: Thank you. Grace LeMasters?

DR. LEMASTERS: Grace LeMasters, University of Cincinnati College of Medicine, no changes.

DR. MIDDENDORF: Okay, thank you. Judith McKenzie is not attending. Mark Nicas?

DR. MCKENZIE: No, no, this is Judith McKenzie calling in.

DR. MIDDENDORF: Oh, you are in, okay.

DR. MCKENZIE: I'll be able to sit in for some of the conference. So I'm from the University of Pennsylvania Medical Center and no change.

DR. MIDDENDORF: Okay, thank you. Mark Nicas? Okay. Is that you, Mark, or is...? Okay, we're not hearing anything from Mark. We'll check in a little bit later and see if he's been able to join us. Charles Redinger said he—(interruption)

MR. COURTNEY: Hi, Paul. This is Ted.

BOARD MEMBER: Oh, Ted.

DR. MIDDENDORF: Oh, hey, Ted. Welcome. Ted, can you say your name, your affiliation, and just verbal on your conflict of interest changes?

MR. COURTNEY: Okay, Theodore Courtney, I go by Ted. I'm with the Liberty Mutual Research Institute for Safety until June 6 when we close, and that's it. I'm not sure—I don't believe I have any conflicts, change in conflicts.

DR. MIDDENDORF: Okay, thank you. Okay, we'll check Mark Nicas one more time. Okay, not hearing anything. Charles Redinger said he would not be able to make it. Bonnie Rogers?

DR. ROGERS: Bonnie Rogers, University of North Carolina – Chapel Hill, no conflict changes.

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DR. MIDDENDORF: Okay. Jas Singh?

DR. SINGH: Yes, I'm Jas—

MR. COURTNEY: Hey, Paul?

DR. MIDDENDORF: Yes, Ted?

MR. COURTNEY: You guys are really faint. You're not coming through very well. Is there any way to get more gain on your mic?

DR. MIDDENDORF: Okay, we'll get our folks working on it.

MR. COURTNEY: Okay.

DR. ROGERS: Hold it closer.

DR. MIDDENDORF: Thank you for that feedback. Jas Singh?

DR. SINGH: Yes, Jas Singh, industrial hygienist from Big Island no change.

DR. MIDDENDORF: Okay. Ron Stout?

DR. STOUT: Ron Stout, the Procter & Gamble Company, no changes.

DR. MIDDENDORF: Okay.

DR. STOUT: Paul, were you able to get a book for me? Thank you much.

DR. MIDDENDORF: Yes. Okay, we have 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 members. Our quorum is 9. I would ask that people who are on the phone, if you would let me know when you leave the meeting so we can be certain that we always have a quorum, I would appreciate that.

MR. COURTNEY: Will do.

DR. MIDDENDORF: Okay. Just looking at the agenda, just we'll mention that no one signed up to give public comments, so when we get to that portion of our meeting, we will just move right over it and get into the occupational motor vehicle safety presentation. And Dr. Kitt, do you have anything you would like to say?

DR. KITT: Just a few quick announcements. I wanted to identify our very special guest, Dr. Inger Schaumburg, who is the Director of the National Research Centre for the Working Environment in Copenhagen, Denmark and she's been with us for a couple of days. Many of you had a chance to meet her. We're really thrilled she's spending a few days with NIOSH, so welcome again, Inger. A special welcome to Michael and Chris again as our new BSC members. And also we wanted to thank the BSC members who've been participants in judging and reviewing the NIOSH Director's Intramural Awards for Extraordinary Science. This DIA award recognizes outstanding contributions for our scientists and support staff to our scientific excellence at the Institute, and those awards will be given in a few weeks at their NIOSH Science Awards ceremony. So thanks again for your participation in that. And we're going to take a few pictures throughout the day because we don't have the BSC here often in Morgantown, and including a picture we'd like to take with all the members out in the atrium at the break, if that's okay with all of you. So that's it, Paul.

DR. MIDDENDORF: Okay. With that, I think we'll turn it over to Dr. Rogers.

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**AGENDA, ANNOUNCEMENTS, AND APPROVAL OF MINUTES**

DR. ROGERS: All right. Good morning and welcome. Yes, we've never been, I don't think, at least in my tenure, we've never been out of DC, so we're glad to be here. And I really want to say, first, thank you to all of the people here in Morgantown for having us. It was great tours that we had yesterday. That really, those tours were so good. John, hi. The tours were great yesterday, so we really, I think, learned a lot from being here. It really kind of put a face to a lot of things that NIOSH does from the research perspective in particular, so it was a lot of fun, except we did not have any breaks, so they made us really work hard. It was great, but it was great. Thank you for having us. And of course, always, thank you to the NIOSH staff who makes this meeting happen as well. And John, we see you there in DC and I told Margaret you look so lonely, so there you go. But with that, we'll kind of move on and again, just say thank you for having us and thanks, Margaret, and thanks, Paul, and Alberto who's going to be our new person come tomorrow, I think you said. Correct? So we're looking forward to that. Alberto of course has been with us for a number of years anyway, so it's really good—so we know him well. I don't really have any other announcements to make other than that. So we have our minutes to approve, and are there any questions or any additional comments to the minutes?

DR. COOPER: Bonnie?

DR. ROGERS: Yes.

DR. COOPER: This is Sharon Cooper and this is just a very minor correction about something I said in the last meeting. On page 10 at the top, it says Texas Institute of Safety, and it's really Texas Transportation Institute, and I'm only making the correction because it may be relevant to a presentation today too.

DR. ROGERS: Say that again, Sharon. Transportation...

DR. COOPER: Institute. TTI, Texas Transportation Institute.

DR. ROGERS: Got it. Thank you.

DR. COOPER: Sure.

DR. ROGERS: Any other corrections, additions? Okay, if not, can we have a motion to approve?

BOARD MEMBER: I'll make the motion.

DR. ROGERS: Okay. Can we have a second?

BOARD MEMBER: Second.

DR. ROGERS: Thank you. All in favor?

[Multiple ayes.]

DR. ROGERS: Good, thank you. Minutes are approved.

BOARD MEMBER: Aye.

DR. ROGERS: Thank you. And with that, of course we do want to welcome our visitors, as Margaret said, Inger, thank you for being here. I hope you enjoyed yesterday as well. It was fun.

DR. SCHAUMBURG: Yes, I did.

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DR. ROGERS: It was good. So with that, Dr. Howard...

DR. HOWARD: Dr. Rogers. And you can hear me okay in Morgantown, I hope.

DR. ROGERS: Yes.

BOARD MEMBER: Yes.

**DIRECTOR'S OPENING REMARKS**

DR. HOWARD: Okay, great, thanks. Yes, thank you, Bonnie, and I also want to thank Paul and Alberto and all the Morgantown folks for hosting the BSC. It certainly marks a new era in the BSC, and maybe all would like to come to Cincinnati sometime and see what's going on there, and come to Pittsburgh, and maybe Spokane, and points west. So you could have a traveling show, so we're—

DR. SINGH: Is there a place in Hawaii?

DR. HOWARD: Unfortunately, no. And with the budget, it doesn't look like there's going to be, but we can always hold a meeting there. And thanks to Max for putting on the Wikipedia training yesterday and thanks for all of you guys going to it and expressing interest in it because it is a very dynamic and powerful channel for dissemination. So thanks to Max for that. So the first item—you know, and I want to thank Paul and Alberto and everyone in the Divisions for contributing to the director's notes which we've now sort of institutionalized. I'm not going to go through them all, but it makes a nice compendium of information of what's going on in the divisions and I think it's very helpful for you all. Certainly you could ask questions about areas that I don't cover orally here.

But the budget is the first item we always talk about. Unfortunately we don't really have official budget information to talk about. We probably will have the last week of April when the remainder of FY'17 is settled by the House and the Senate. We don't have any official information on that. There was a public release by OMB, a so-called "skinny budget" that came out a few weeks ago which noted a 17.9% decrease in HHS overall, but we don't know anything about the details of that, and we're just going to have to wait until the CR expires on the 28 of April to find out any more specific information on that. Similarly, the FY'18 budget which starts October 1, the President intends to release that, we're told, May 15, so we'll know what that budget contains at that time. So I don't have any official information, however, channeling all good risk assessors, I think there are three options. One is our budget will increase. Two, our budget will stay flat. Or three, our budget will decrease. I would say it's more likely than not that our budget will decrease, that it will not increase and will not remain flat. How far it decreases, again, either in the remainder of '17 which is about 40% of the budget year or '18, stay tuned. I don't have any official information.

Personnel wise, as you know, Dr. Frieden left us on January 20. Rear Admiral Schuchat, Anne, is now the Acting CDC Director and she's going on her first 100 days as CDC Acting Director. She was the Deputy Director and has been at CDC for many, many years in infectious disease. Some of you may have seen her on

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CNN during the Ebola crisis and the Zika crisis. And she has a number of acting folks in place. I personally haven't heard any rumor or any names floating around for CDC director, so you all may have more information than I do. We want to welcome Christy Spring who is now our new Associate Director for Communications. As some of you know, Fred Blosser retired at the end of the year. And Christy, who I think is in Morgantown somewhere there in the room, there she is, thanks for stepping up into that position. We're thrilled to have her and hope that she has a long tenure in that job. Also Michael Loudermilk who was recently at the IRS in, I think, Nashville came to us as our new Associate Director for Information Technology, and Michael is in Atlanta with the rest of the management team. After Michael came, we've sort of completed the management services suite of folks, under Kelley Durst. So we have Martha DiMuzio who is financial resources, Kent Slakey who is human resources, Michael who's information technology, Lore Jackson Lee who's planning and policy, and Denzil Slaughter who is physical facilities. So our suite of management associate directors are complete. I want to thank Kelley for getting all those wonderful people in place and real thrilled that Michael was able to join us from the IRS. One item that I wanted to mention in terms of physical facilities was we recently bought a building. Some of you may wonder, in this period of uncertainty, is this the best time to be buying real estate? Well, in Washington, in budget world, either you use it or you lose it, and so we have the money now. It's a building on the Pittsburgh campus that was used by the Department of Energy for many years. It's a very nice building. It needs some carpeting, paint, et cetera, but we have a building that the National Personal Protective Technology folks are using that we really need to vacate, and this building, when it's all refurbished, will be a fine headquarters for the NPPTL. So that purchase is almost finalized, hopefully next week. It's on the Pittsburgh campus which is a multi, 200-and-some acre facility, so we get the building and about 5 acres and a nice little parking lot to go with it. So we're happy about that.

On the issues in the next section of the notes, things that we're asking for public comment on, two of them are still very active. One having to do with closed system transfer devices, which if you're in the healthcare field, are things that are used to move medications in healthcare settings, and that comment period has been extended to June, still open, Docket 288-A. And Docket 292 is a draft chapter for the NIOSH Manual of Analytical Methods on analysis of carbon nanotubes and nanofibers by TEM, and that's open till the 28 April. The third item was closed yesterday and that is a survey of engineered nanomaterial safety and health practices, so that closed yesterday.

On the new programs and initiatives section, I wanted to highlight our renewal of the National Service, Transmission, Exploration & Production Safety Network, which is called the STEPS Network. OSHA and us and a whole bunch of folks

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who are in the oil and gas industry are cosigners to that. It's a very productive partnership and alliance agreement that we're thrilled to sign. The group meets at these very large oil and gas conferences that are held alternatively in Dallas and Houston every year, and so we're thrilled about that. Also we have a new agreement between our Center of Maritime Safety and Yale University Center for Maritime Safety which we're happy to announce. The fact sheet that I mentioned here, the Zika fact sheet, which is an OSHA-NIOSH publication, it's on the website, we listed the URL. I remind you about that because the summer is coming, and mosquitos come with the summer, and mosquitoes carry Zika, and so it's an important issue for us. It's sort of faded from the public, you know, media, but it still is an issue and we're delighted that this OSHA-NIOSH fact sheet is available for the upcoming season. I wanted to also mention that Stephanie Pratt in our NIOSH Center for Motor Vehicle Safety has a very nice article, a guest post at *Forbes* magazine on self-driving cars that I encourage you to look at. Another agreement that we just signed was with the Board of Certified Safety Professionals, and we are delighted that they came from Indianapolis to Washington to sign it, and they consider us a great technical partner for increasing the professionalization and the education level for Certified Safety Professionals. I'll skip over the Wikipedia section just because you all are now official Wikipedians, but we continue to have Wikipedians-in-residence here, we continue to increase our portfolio in that area, because as you know, Wikipedia is the most used reference source and will be increasing even as we go through time. So we're really interested in improving our footprint on Wikipedia. The last issue that I wanted to mention under sort of new things is a breakthrough that we got after—gee, Maryann D'Alessandro has been working with FDA for many years, five to six years, on the issue of the joint authorities that NIOSH has with regard to respirators, especially N95s, and FDA's authority to approve N95s, so-called surgical N95s. And we've worked out an arrangement to share those. FDA is the—the agreement is working, memorandum of understanding is working its way through FDA. The FDA Commissioner just had his hearing, Dr. Gottlieb, so we anticipate a final clearance. FDA is going to then publish a notice in the Federal Register announcing their intent to exempt the N95s that they no longer intend to review from the requirements in the Food, Drug, and Cosmetic Act as a medical device. So it really helps manufacturers, it helps hospital users, and we're excited about that. So you'll have an opportunity to comment on that Federal Register notice when it comes out. We'll obviously put it on the website and make it known to everybody.

The last item is just to let you know that we have a new app, our Sound Level Meter app, so you can take off those other sound meter apps that you have on your phone and put ours, which is much more reliable. And we're thrilled that we have that because there was a lot of competition in this area and some even

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using our name, and so we're delighted to have our own on there. App development is something that we continue to do and it may be a future update topic that you all may be interested in, especially to come to Cincinnati to be briefed on, because it is a growing area that we think makes an excellent channel for communications.

So the rest of the information is there for your perusal and feel free to reach out to the division director, so that's through Paul, if you have any specific questions about any of those items or wish to have more information about those. So I'm going to stop there and see if there are any questions that you all have.

DR. ROGERS: Any questions for Dr. Howard? Questions from telephone? John, we have no questions for you.

DR. HOWARD: Well, well, okay, very good.

DR. ROGERS: Okay. Do you have any other things you want to share with us?

DR. HOWARD: No, no, I've pretty much done it.

DR. ROGERS: All right, all right. I guess we'll let him go. Okay, good luck with the budget.

DR. HOWARD: Yes, right, thank you.

DR. KITT: We'll Photoshop him into the picture today that we take with the BSC members.

DR. ROGERS: Yes. Yes, we miss having you here.

DR. HOWARD: (Inaudible @ 00:05:04) and I look forward to seeing you all at the next meeting.

DR. ROGERS: Okay, thank you.

BOARD MEMBER: Bye.

BOARD MEMBER: Bonnie, is the next meeting in October?

DR. ROGERS: You know, we haven't set that yet, I guess.

DR. MIDDENDORF: Yes. It's usually in September, October.

DR. ROGERS: It's usually September, yes. So we'll put out a request for dates and see how we work with that, yes.

BOARD MEMBER: How soon will that come out? Because fall in a university is heinous.

DR. ROGERS: Soon, I mean, it'll be soon. We'll set it up soon, yes.

DR. MIDDENDORF: We may want to get a little bit of information on the budget just to find out whether or not we can afford it this year.

DR. ROGERS: True.

DR. KITT: Or whether we'd better squeeze it.

BOARD MEMBER: Maybe all teleconferencing.

DR. ROGERS: Might be just a phone conference, right? All right, so we have no public comments, right, Paul?

DR. MIDDENDORF: No public comments.

DR. ROGERS: All right, so I guess we'll move forward with our presentations then, and our first presentation is the motor vehicle safety.

[Background discussion.]

**OCCUPATIONAL MOTOR VEHICLE SAFETY – ENGINEERING AND TECHNOLOGY-BASED RESEARCH**

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- DR. ROGERS: So we're interested to hear your presentation on motor vehicle safety and we know that's certainly one of the major issues in terms of occupational health and safety and fatalities as well, yes.
- DR. PRATT: Yes, thank you. Today I'm sharing the presentation with Dr. Hongwei Hsiao. I'm Stephanie Pratt. I lead the Center for Motor Vehicle Safety within NIOSH. And today we're going to talk about our program and focus on the engineering and technology-based research that's being done. Here's an outline of what we're going to cover today. First of all, give an overview of the Center for Motor Vehicle Safety, and then I'll turn it over to Dr. Hsiao who will discuss in some detail our current engineering work and plans for the future, and then I'll end the presentation by discussing a midcourse review we just completed for the center, focusing on engineering and technology results and the directions that we've set for the future based on that review, and I'll close with a brief discussion of complementary work that we're doing with partners in this area.
- In the Center for Motor Vehicle Safety, we conduct research and we develop recommendations to prevent work-related crashes and resulting injuries, so very similar to the NIOSH mission overall for any kind of health and safety issue. We coordinate the work that is done across all the NIOSH division labs and offices that either have research or programmatic responsibilities related to motor vehicle safety in the workplace. The Center is hosted by the Division of Safety Research where I work, but we have scientists who work in many other locations. What we do is we share subject matter knowledge, we share information about relevant policy developments and initiatives by partner organizations, and we facilitate effective communication of our research results and prevention recommendations. The reason the Center was established was to address motor vehicle crashes which are the leading cause of workplace fatalities in this country. Between 2003 and 2015, over 23,000 workers died in crashes on or off public highways, and they're the first or second leading cause in every major industry group. And as you can see from this image from one of our infographics, there's also an economic toll for employers as well as a human toll for workers, families, and communities. We work from a five-year strategic plan with five strategic goal areas. The focus of today's presentation is goal number 2 which is to promote the application of engineering and technology-based safety interventions. And I'll read you the full text of strategic goal 2: to reduce the incidence and severity of work-related motor vehicle crashes by implementing engineering and technology-based safety interventions and studying the positive or negative safety consequences of new technologies installed in vehicles. To set the stage for Dr. Hsiao's remarks, I'm going to discuss briefly how we framed our strategy and defined our research niche with regard to engineering and technology research. We are trying to play to our strengths, taking advantage of the expertise and lab capacity we already have and adapting it to motor vehicle safety. At the same time, we are trying to position

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ourselves to address emerging issues like autonomous vehicles. We have chosen to maintain our focus on occupational vehicle use. There are so many interesting topics we might address, but we need to ensure that we are either emphasizing specialized vehicles built for workplace applications or unique technology challenges for the workplace. And finally, we are aware of research being done all over the country in the private, public sectors, and academia. We need to fill the research gaps rather than to duplicate the work that other people are doing. So now I will turn it over to Dr. Hsiao who's going to describe our engineering and technology research.

DR. HSIAO:

Oh, okay. All right, well, thanks, Stephanie. Now I will present our current and future engineering work. I am Chief of Protective Technology Branch within the NIOSH Division of Safety Research. I received my training in human factors in safety engineering from Cornell University and the University of Michigan. This is my twenty-sixth year with NIOSH. I have helped NIOSH in developing and managing engineering programs. Currently five engineers and two postdoc fellows work in the engineering component of this occupational vehicle safety program.

While the Motor Vehicle Safety program is relatively new to us in NIOSH, we are fortunate to have strong engineering and technology teams to take on a good portion of these initiatives. We can describe the relationships between the motor vehicle safety and the engineering and technology program by this simple diagram. Anthropometry, biomechanics, cognitive issues, digital simulation, emerging technology, and fatigue controls are among the engineering research team that's—we have the expertise and also relevance to motor vehicle safety, so I will elaborate on these six research themes with a focus on specialty vehicle driver safety. So it's A, B, C, D, E, F, so that's easy to remember.

A, anthropometry is the science that's defined: physical measurement of a person's size, form, and functional capacity in vehicle safety applications. Anthropometry measurements are used to study interactions among drivers with their driving surroundings, vehicle controls, and crash protection gadgets. Over the past several years, we have conducted a series of national anthropometry studies of truck drivers, firefighters, and emergency medical services workers. The result has been used for cab consoles and seatbelt designs. We plan to begin our national law enforcement officers anthropometry data collection in August 2017, so it's coming. More than 30 data sets and publications resulting from our research available at the NIOSH anthropometry webpage. A few links are provided here in these slides, just for reference.

Biomechanics describes the application of engineering mechanics to biological systems. As applied to motor vehicle safety, biomechanics is used to understand human injury tolls and impact survivabilities. Many organizations have studies of some aspect of biomechanics of passenger vehicles, but not necessarily for

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specialty vehicles such as ambulances. Due to their size, ambulances fall outside virtually all crash testing requirement control by the National Highway Traffic Safety Administration, so seating, equipment mount, cabinets, and the body itself of the ambulances are untested based on current federal regulation language. Jointly funded by NIOSH and the Department of Homeland Security, we had partnered with the ambulance industry to develop a family of impact biomechanics test measures for improvement of ambulance patient compartments for worker safety when in a vehicle crash. Our study result has been used in ten ambulance safety documents published by the Society of Automotive Engineers. This figure shows the ten safety documents and their associated ambulance components. For example, the pink one on the right-hand side, the bottom, SAE J2917, basically is from impact test result related to the base of the ambulance.

In motor vehicle safety field, cognitive issues refer to human sensing, mental process, and decision making during the operation of a vehicle. NIOSH is conducting laboratory-based research on drivers' decision making at a signalized intersection for occupational drivers such as police and firetruck drivers. We aim to maximize our program impact for safe vehicle operation by addressing practical safety questions such as: how do occupational drivers respond to yellow lights? When and where should a driver stop or prepare to stop, especially when operating specialty vehicles? What level of effectiveness an in-vehicle assistant device have to reduce red-light running and enhance intersection safety? Our ultimate goal is to develop science-based safety guidelines and make them available to stakeholders, communities, and professional drivers through research partners and professional organizations. In addition, the research result in driving simulation modules can be used for hazard recognition training.

Digital simulation are commonly used in motor vehicle safety research to evaluate engineering control strategies before a design is fully implemented. The approach is to lessen crash hazards that human subjects and researchers may encounter in field experiments. NIOSH is establishing its capacity in vehicle safety digital simulation, building on our previous experience in digital human modeling. As you have seen in our vehicle safety lab tools, studies of driver/vehicle/environmental interfaces involving various vehicles and task demands are in progress. Besides hardware development, we are building a driving simulations scenario library which includes a series of intersections, roads, townships. Participants can be arranged to drive through the town and intersections, simulating emergency call situations, returning from missions, and even commuting conditions. The simulation module and vehicle dynamic models can be shared with our research partners for collaborative research.

A variety of advanced driver assistance systems are becoming common among many passengers and commercial vehicles. Some of these systems provide warning and rely on driver's adequate response, while others automatically

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interfere with the control of the vehicle. What will be the most appropriate and effective advanced driver assistance system for different emergency vehicles during emergency calls? What are the most effective communication technologies for preventing emergency vehicle collisions like in this situation? Many questions remain to be answered.

NIOSH is evaluating the performance and acceptability of an advanced speed warning system for firetrucks with the goal to reduce truck speeding on unfamiliar rural roads. Firetrucks typically have a higher center of gravity than many vehicles and may be loaded with water, making them more susceptible to rollovers. So the speed warning system uses GPS signal and digital maps to issue an advanced warning when the firetruck approach a curve and safe speed limit.

While there are many aspects of driver fatigue from which physiological exhaustions to mental fatigue, in many cases health condition, changing work shift, repetitive task, and environmental circumstance can complicate or intensify the problem. A study done by NIOSH on truck drivers' sleep patterns shows the importance of drivers receiving adequate sleep the night before they drive. We are building our engineering capacity in evaluating fatigue controls through eye tracking, electrocardiography, and other assessment methods.

So last, but not the least, the era of autonomous vehicle is fast approaching. Human factors issues related to the interaction of emergency vehicle with autonomous vehicle during this transition period need to be proactively addressed. Also, the driver's workload and stress level for safe operation of connected emergency vehicle and for quickly taking over autonomous vehicles in emergency conditions deserve attention. So I will pass the platform back to Stephanie.

DR. PRATT:

We also should discuss a little bit about some of the epidemiologic research we have been doing in NIOSH that involves technology. We have a recently published study from DSR that evaluated a video-based, in-vehicle monitoring system, or IVMS, in two different light vehicle fleets. The research team assessed two different levels of interventions to reduce risky driving behavior. One was lights in the cab that would warn the driver in real time if a risky behavior such as harsh braking was detected. The other intervention was coaching by the supervisor using information from the in-vehicle sensors that triggered the warning lights and supported by video combined with the lights in the vehicle. Although the reductions in risky driving behavior were greater for the warning lights alone than for the control group, the combination of lights and coaching was found to be most effective. So this demonstrates the importance of supervisory involvement in motor vehicle safety. We also have a new project that is based in the Division of Applied Research and Technology in Cincinnati that is going to evaluate fatigue detection technology in an oil and gas industry fleet. The oil and gas industry program under NORA is one of our strongest partners on motor

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BOARD MEMBER:

DR. PRATT:

vehicle safety, so it's good to have that research underway. In addition to describing the driving practices for this group, the researchers are going to be able to link IVMS data to fatigue episodes that's detected by the other technology. And of interest here are the job tasks, time on task, and shift types and lengths.

How about weather conditions?

Yes, any of that would be collected through driver logs and other information that they'll get from the employer. Those are just examples of some of the co-variates we're looking at because the research team has specific interest and expertise in looking at shift work and work organization issues surrounding that technology. We just completed a midcourse review for our Center for Motor Vehicle Safety. We published three different documents. The first two you see here, our progress report and performance measures report, were issued in conjunction with a Federal Register notice that we published last summer announcing a public web meeting and opportunity for public comment via the Docket. The final report, which you see here on the right, was just released a couple weeks ago and that synthesizes the public comments we got and outlines our way forward. Part of the initial work we did to issue the performance measures report and the progress report involved doing our own self-assessment as to how we were doing in reaching each of our five strategic goals. And as you can see here, we did pretty well on goal 2. Overall, we had 46 performance measures in our strategic plan and two-thirds of them were fully or at least partially met. And for strategic goal 2 specifically, we had several that were fully met related to the anthropometry of truck drivers and emergency responders, and then partially met were the advanced driver assistance systems for fire apparatus and the research on intersection safety, which you heard described today by Dr. Hsiao.

So the comments that we got from reviewers and the public fell into several common themes. Regarding in-vehicle technologies, there was a suggestion we should do work on how engineering and technology-based tools in work vehicles affect the safety of all road users. There was specific interest in the use of in-vehicle technologies in emergency response situations, and then also how drivers interact with in-vehicle technologies including tools to help educate workers about those technologies. We got similar comments with regard to connected-vehicle technologies, and by this we mean the vehicle-to-vehicle technology or vehicle-to-infrastructure, and the idea here is to assess the effectiveness in reducing work-related crash risks. And we got specific comments about the emergency response situations, again, and also other kinds of occupational driving. Finally, highly-automated vehicles. There was a suggestion that we should engage companies that use driverless cars as research partners so that we could learn how highly-automated vehicles affect the safety of all road users. And a more general comment is to build enough flexibility into our future strategic plans so that we could have a timely response to emerging issues, and I think we're already doing

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that with regard to the highly automated vehicles.

So what are we going to do based on the comments we received? Well, with respect to research, we reaffirmed that we're going to maintain our current niche which is to really focus on the special-use vehicles, the specialized work vehicles that are operated by workers, and then at the same time, as Dr. Hsiao discussed, we're trying to build a foundation to do research on highly-automated vehicles and also connected vehicle technology. Now, within the policy and communication world, we're not limited to looking just at the specialized work vehicles, so we are considering the policy implications of new technology for all kinds of workplace vehicle operations. Now, there's one thing that we elected not to do that we did receive comments on, and we're not necessarily going to extend our research to assess the effects of technology on all road users, only in the context of specialized work field vehicles that interact with them. If we start looking at all road users, then we risk mission creep and not really doing the work that we ought to be doing. More broadly, we're not going to rewrite our goals or our strategic plan because we only have two years remaining, but we will assess the five-year plan after it's completed and then we'll start on a new ten-year plan. And this matches up well with a coordinated strategic planning effort that's underway across NIOSH which we'll undoubtedly benefit from. And then I should note too that a number of the comments that I highlighted are certainly valid for us to consider for the post-2018 plan, but we're not in a position to act on them in the last two years of this plan.

So I'll close by highlighting a few partnership activities that have a technology component, and one of these is the Road to Zero coalition which has the goal of eliminating traffic deaths in the US within the next 30 years. Some of you may recognize that this is built on initiatives from Sweden, the Netherlands, Australia, other countries that have embraced similar visions and also that have been embraced by a number of large US cities. The coalition is led by the National Safety Council and several agencies in US DOT and NIOSH is a part of this. It's a two-pronged approach. First, in the short term, to reverse the recent alarming increases in traffic deaths, and in the long term, to envision the steps that are going to lead to zero deaths. And the coalition is really hanging its hat on highly-automated vehicles as a large part of the vision for that fatality-free future. Another activity we've been on the sidelines of is MyCarDoesWhat.org, and if you haven't seen this, I really encourage you to look at it because it's of large general interest, not just for the occupational safety community. And this is a national campaign developed by the National Safety Council in cooperation with the University of Iowa to help educate drivers about new safety features in vehicles that are designed to help prevent crashes. And the great thing about this tool is that it uses a variety of delivery mechanisms that would accommodate the learning styles of people of different ages, different education levels. So we did a

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guest blog for MyCarDoesWhat.org and it gave us an opportunity to talk about how users can be workers who are driving company vehicles and often they're driving very new vehicles, and their own personal vehicle might be 10 or 12 years old, doesn't have any of these features, so it is something that employers can steer workers to to help them better understand what is in their vehicles. And then also a secondary message is that employers in many parts of the world are major vehicle purchasers, so they can help raise the bar on road safety for everybody by demanding safer vehicles and asking for safety features to be made more standard in these vehicles.

So the last topic—was there a question? I'm sorry. Okay, the last thing I want to mention is that there is a new subcommittee on automated vehicles that is being led by the National Safety Council, but hosted by the American Society of Safety Engineers, and the aim is to develop standards for automated vehicles in fleets. This is a subcommittee of the ANSI Z15 committee. I have been on this committee since—I think I'm the longest surviving member of this committee. It was formed in 2001 and I've been involved in it ever since. The standard has just been revised for the third time. This is the Z15.1 standard which is called "Safe Practices for Motor Vehicle Operations" and it's designed to cover road safety management for any kind of organization that operates a vehicle. So this new subcommittee is looking at developing a companion standard on the use of highly-automated vehicles within fleets. So this is going to be an interesting process. It's a small committee. We're lucky to be part of this. And in about an hour, I'm going to go to the first meeting, so we'll see how that works out.

We are of course happy to answer any questions you have, but we developed a few for you. The first one would be, within the niche we've established for our work, are there other engineering and technology research topics that we should pursue? And related to that, what expertise and lab facilities should we prioritize for development so that we can better fulfill our mission? And then more broadly on the policy side, would further policy engagement around highly-automated vehicles be helpful, both to guide our own research and to help us provide timely and accurate information to our stakeholders? So I'll stop there and ask for any questions or comments. Yes, Terry?

DR. BUNN:

Terry Bunn, University of Kentucky. Yes, very nice presentation on all of the good work that you guys are doing in the Center for Motor Vehicle Safety. I have one question, and you may have alluded to that in your graphic on emergency vehicles, looking at restraint use and other types of tying down, I've heard in the field, not only with emergency vehicles, but with truck drivers in crashes, when they do occur, that they are a lot of times also injured by flying objects within the vehicle. So not only in an ambulance setting, but also in commercial vehicle drivers such as if they don't have their TV tied down or even a porta-potty, you know, that they may use when they're resting at night. So do you guys have any

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- future plans in that area?
- DR. HSIAO: Okay, well, certainly this is an area that we can do because this has something to do with two components, A and B. The A is anthropometry. We did share our database with seven truck manufacturers and so I'm sure they have some kind of plan to do that, but we haven't actively followed up with them about if they have dealing with these type of issues as you have mentioned, and so we'll follow on that one with all those manufacturers. And number two, certainly this is something to do with the impact test and I believe that the Society of Automotive Engineers would have a certain type of standard and data available, and so I will follow-up with the committee as well from SAE, because I'm also an SAE member. And thank you for those comments and idea.
- DR. PRATT: Another comment, Grace?
- DR. LEMASTERS: Grace LeMasters. I've heard that Uber is getting ready to start automated Uber facilities in Pittsburgh or Philly.
- DR. HSIAO: Right, yes, it's on.
- DR. LEMASTERS: And I was wondering if you've been able to connect with Uber as a partner with evaluating the success of their program and emergency, I mean, crashes and issues.
- DR. PRATT: We have not, to this point. In doing our own planning for the traumatic injury prevention program, which is closely related to—motor vehicle safety is of course a component of that. We are discussing the importance of expanding our research into populations that have nontraditional employment arrangements, and so for-hire drivers such as that would certainly fit the bill. We are doing research already with taxi drivers, so I would see working with the for-hire drivers as a logical extension of that research.
- DR. LEMASTERS: But I mean automated, Uber is starting an automated fleet, so there aren't drivers—is my understanding, correct?
- DR. PRATT: Yes, there is a small fleet, but we have not worked with Uber either on, you know, the vehicles with drivers and we have not engaged with them at all on the driverless vehicles.
- DR. HSIAO: Yes, if I understand correct from the media, they have ten cars that's considered to be autonomous vehicle, and still they have drivers actually inside just to take care of emergency situations, but they let the car drive.
- DR. ROGERS: Kind of like a student driver.
- DR. HSIAO: Yes, sort of.
- DR. PRATT: And in the research and policy communities, that's a huge issue. It's a wide gulf between having a situation where the driver is prepared to take over in an emergency situation and actually having the vehicle, you know, make those kinds of decisions. And you know, in human factors research, they are looking at how long does it take somebody to reassume the manual control of the vehicle in that emergency situation and then also, now that they've assumed manual control,

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- how long does it take them to reestablish their situational awareness? So, you know, we like to think that we can go directly to these fully automated vehicles, but in reality the DOT estimates that it's going to be about 25 years before even half of the vehicles that would be on the road in this country have that kind of capabilities, even partially. So the question is how to make those vehicles coexist and how to ensure the safety of people who are interacting with them.
- DR. LEMASTERS: See, NIOSH could call for one of those Uber automated vehicles and just drive around in the back seat and see how—you could gather information just as a passenger.
- DR. PRATT: Okay, next time we're in Pittsburgh we'll take a field trip.
- DR. LEMASTERS: Say, "We want one of those automated vehicles," and you could collect some information. How often do they have to take over? How well do they stop? You know, it would be...
- DR. PRATT: Yes, well, I think that research is—
- DR. HSIAO: On the way.
- DR. PRATT: —Probably being done, but again, we have to focus on the worker safety element, and it is so interesting and attractive to think about all the basic research that's being done, but in reality, more of that is happening in the US DOT world and may be more relevant to the safety of the general motoring public. So, you know, in NIOSH, we're concerned about the Uber driver, the worker, but we're still concerned with the interaction of that driverless vehicle with workers who are on the road in emergency vehicles, as Dr. Hsiao has described. So it's very tempting for us to cross certain lines into areas that are very interesting, but on the other hand we have to make sure that we stay within our mission.
- DR. LEMASTERS: But that's an emerging issue, right?
- DR. PRATT: It is an emerging issue, absolutely. For so many people.
- DR. LEMASTERS: That was one of your emerging issues.
- DR. PRATT: It is an emerging issue, that's for sure.
- DR. ROGERS: Chris?
- MS. LASZCZ-DAVIS: Chris Laszcz-Davis.
- DR. COOPER: Dr. Pratt?
- DR. ROGERS: Just a minute, Sharon. Chris?
- MS. LASZCZ-DAVIS: Chris—
- DR. COOPER: Okay.
- MS. LASZCZ-DAVIS: Sorry. Chris Laszcz-Davis. Just a real quick question as regards—and actually it dovetails Grace's comment about joint efforts. Is Google a consideration in all of this? I mean, coming from the West Coast, Google and its self-driving prototypes is big news in much of the West Coast, so if one wanted to team up with an innovative, substantive organization for the longer term, Google is a consideration in terms of teaming up. I mean, it's just a comment.
- DR. PRATT: Yes, and another consideration for us might be to try to work more closely with an

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organization like the Insurance Institute for Highway Safety that does crash testing of all types of vehicles because they procure all types of vehicles and then do independent crash testing and have facilities. And indeed, when we did the ambulance work, we partnered with organizations that had crash testing facilities that complemented ours. So, you know, rather than partner with an individual group in the marketplace, we might think about working with organizations that had a broader remit on the testing of vehicles.

DR. ROGERS:  
DR. COOPER:

Sharon, did you have a comment?

Yes, I just had a question, but thanks for the great presentation. I just wondered, and maybe this is part of your strategic plan that I haven't read, but have you ever linked from an epidemiologic perspective the data on fatal and nonfatal injuries and causes of them to the interventions that you're trying to establish so that you can track and evaluate, hopefully, reductions in injury and illness? For example, you know, looking at even from a Haddon's Matrix perspective where you look at pre, during, and post-crash risk factors and agent-host environment to see where you're making an impact and where the highest need is, whether it's on speed, alcohol, you know, weather conditions, what the reasons are from what you're trying to address with the interventions?

DR. PRATT:

We are doing some work right now with the Bureau of Labor Statistics, something we've been trying to do for a number of years, which is we have finally worked out agreements to do case-matching of the Census of Fatal Occupational Injuries, the BLS's census of all kinds of fatal workplace injuries, with the Fatality Analysis Reporting System which is DOT's records of all fatal police-reported traffic crashes in the United States. And the big advantage of this is that CFOI from the Department of Labor was not designed to capture information specific to risk factors of motor vehicle crashes, but on the other hand the data from DOT allows us to look more closely at those risk factors. So we are working on an epi paper right now that will illuminate those factors for fatal crashes. One thing that we're doing in the nonfatal arena right now that's really important, I think, is that we're working with a large company who has provided us with their motor vehicle crash data for about a five-year period, and this is a light vehicle fleet in the pharmaceutical industry. For many years, we have been limited by our ability to describe even nonfatal crashes in the workplace. The data that come from the Bureau of Labor Statistics are extremely sketchy. They are really just, you know, number estimates and they have a little bit of information about the type of vehicle, the demographics of the worker, industry occupation, but nothing with respect to the type of crashes or the risk factors. And we've always suspected, of course, that a nonfatal crash and a fatal crash aren't anything alike, yet in many cases our recommendations are guided by what we know about fatal crashes. So of course with the preliminary data analysis from this study, we are finding out that a nonfatal crash and a fatal crash look nothing like each other. You know, we're

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seeing a tremendous number of backing incidents, we're seeing rear-end incidents, but a lot of times rear-end incidents happen at lower speeds. So, you know, there's not one fatal crash in this four-and-a-half years of data, but the picture of these crashes looks quite different than fatal crashes. So when we publish this descriptive paper, that will be really a great addition to the literature because what tends to happen is companies don't have the capacity to analyze their own data, necessarily. In the case of this particular study, we found that we had to do a tremendous amount of data cleaning up front because the data were never collected with the intention of analyzing them and linking them. Big companies have so many different vendors that they work with in motor vehicle safety. They have a company that they lease the vehicles from. They have a company that's their crash management center where people call in if there's an incident. They have vendors for in-vehicle monitoring systems. So nothing was ever done to conceptualize linking these together, so that's one of the barriers. So after we publish this descriptive paper, going forward we will be using some of their telematics data to look at, you know, different interventions that they've put in place and then to try to link those to changes in crash outcomes. So Sharon, that is down the line, but it is something we've been hampered from over a number of years, just because we don't have good data on the nonfatal crashes in particular. Excellent. Thank you so much.

DR. COOPER:

MR. COURTNEY:

DR. ROGERS:

MR. COURTNEY:

PARTICIPANT:

DR. ROGERS:

MR. COURTNEY:

DR. ROGERS:

MR. COURTNEY:

Dr. Pratt, this is Ted Courtney at Liberty Mutual.

Go, Ted.

Can you guys hear me?

Yes.

Yes.

Hello?

Go ahead, Ted.

Okay, sorry. This call's been cutting in and out on me a little bit. So my question relates to two things, actually, or my comments relate to two things. One, the small truck fleets makes up a big proportion of a lot of commercial operation transportation, and one of the things that I've observed just anecdotally is that safety features that commonly penetrate other parts of the regular passenger vehicle space don't seem to penetrate in the pickup truck and kind of contractor-owned vehicle space very well. So that might be a policy opportunity for you or an intervention target for you, extending from specialty vehicles down into kind of more typical commercial vehicles that are more ubiquitous in the commercial fleet. And then the second comment was that there's evidence coming out of the naturalistic driving studies, I think of a paper by Virginia Tech in the Proceedings of the National Academy recently and also a recent study out of the AAA Traffic Safety Foundation with the University of Iowa, both of which are highlighting the extreme role that distraction is playing in crash risk at this point in time and also

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that, in the Iowa study, for example, they're seeing a pretty steady, monotonic increase in rear-end collisions, and in particular in rear-end collisions with no intervention on the part of the operator, which implies that the operator had no idea that they were about to come into a collision event whatsoever because there's no braking, there's no steering movement, there's nothing. So either they were completely impaired or they were completely eyes-off-task. So both of those are kind of disturbing nearer term trends, and I didn't know if you had anything kind of folded into the strategy to sort of address those.

DR. PRATT: With respect to the light vehicles used for work, we have not talked about doing—I'll let Dr. Hsiao weigh in as well, but I don't believe we've talked about doing anything on the engineering side with those vehicles, but we certainly capture them in epi analyses of data. For example, with our oil and gas program, we did a paper, an accident analysis and prevention, a few years ago where we looked at the types of vehicles that were most often involved in fatal crashes, and actually pickup trucks was number one, accounting for about half of the vehicles in fatal crashes in oil and gas extraction. So we have probably looked at that population more than we've really looked at those vehicles in our analyses. Is there anything you would add to that, Hongwei? And then I'll address the...

DR. HSIAO: Okay, just a shorter one. My understanding is that we actually have that strategic goal related to a lightweight delivery truck, but we haven't done anything associated with engineering intervention because we are too much involved with specialty vehicle, emergency vehicles specifically, and hope that we will be able to learn from there. And when we have enough resource and time, we will move on to that, and that's a good comment.

DR. PRATT: Yes, and then with respect to—

MR. COURTNEY: Yes, I guess from a policy—sorry—from a policy standpoint, I guess what I was suggesting is that, from let's say the epidemiologic evidence you have on the role of pickup trucks and smaller commercial vehicles, is there an opportunity to kind of highlight that to OEMs to suggest that they might look to penetrate safety technologies a bit more aggressively into those types of vehicles than they are currently doing?

PARTICIPANT: Yes.

DR. PRATT: Yes, and I think some of the data that come out of the Insurance Institute—it's the Highway Loss Data Institute where they are analyzing the claims data, you probably know about that, Ted, and that's an area where we can learn about the penetration of those technologies. Because in some cases, they're able to analyze enough claims to make some kind of a determination about the effectiveness of these technologies, and in other cases, when I look at certain vehicle types, there's not enough information even in their data yet, which implies that it hasn't penetrated quite as well. So we have not done so much with making recommendations to the OEMs, but we have certainly talked about vehicle

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purchasing recommendations and there are some good things out there that come from the Global New Car Assessment program. And that's one thing we did with our blog for MyCarDoesWhat as well, which is tried to promote best practice in vehicle purchasing, but we can certainly talk about the OEM level. With regard to distraction, we have not done much work on distraction at all in the lab or on on-the-road in our research. The study I mentioned, it was the IVMS study, did look at changes in cellphone use as detected by the IVMS before and after the intervention, and cellphone use was fairly low to begin with because the companies both had total bans, so we did find a decrease, but it was already coming from a fairly low level. We tend to work more in the policy space there. There are partners we work with who have very good tools. The National Safety Council has a cellphone policy kit. They've recently released a new tool on distraction. So we tend to work more on using the good products that have been developed by others and pushing those out via our communications than we have on doing any basic lab work in that area. We do have a topic page where we bring together good work of others.

DR. ROGERS:

Michael?

MR. COURTNEY:

Excellent, thank you.

DR. BEHM:

Mike Behm. I think you're doing some great work and the presentation was absolutely wonderful. I think about all the technology and the engineering controls, and I was just wondering if you're doing any research in terms of the user experience of all the engineering and technology. And not necessarily in terms of post-crash, but just normal work in terms of how they're experiencing those engineering controls and that technology, and I guess specifically from a qualitative standpoint.

DR. HSIAO:

Okay. That's a good questions, and I only can say that we have this ongoing project related to driver assistant device that do have the components that we are asking the test drivers to tell us about what kind of design in warning systems that they would like or their opinions about different design, and that's the part that we are doing that now. Beyond that, I don't think we have any projects at this point, yes.

DR. BEHM:

I guess from my experience, you know, in manufacturing and construction, sometimes people who are designing things may not get that user input as much as they—

DR. HSIAO:

Right.

DR. BEHM:

—Perhaps should, and so that could be a nice interface. I know I myself, we all, I think—technology changes, we tend to adapt slowly and differently, and so how does that translate to the user experience?

DR. HSIAO:

Yes.

DR. BEHM:

That might be really interesting, and again, I think from a qualitative standpoint.

DR. HSIAO:

Yes, yes. And indeed, we actually—I think Dr. Cho may be here. We just recently

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hired a postdoc. Her expertise is in the usability of devices and that's how we enhance our research capacity.

DR. BEHM: There's so many things, but you're doing some really fascinating stuff.

DR. HSIAO: Yes.

DR. PRATT: And there certainly are guidelines that the National Highway Traffic Safety Administration has issued with regard to the user interface for in-vehicle displays, so, I mean, there is guidance out there already, but it is simply guidance. You know, they're not dictating what it needs to look like. It's to try to bring manufacturers in line and to standardize it as much as possible.

DR. BEHM: Right, thanks.

DR. ROGERS: Any comments further from the telephone? No. Chris?

MS. LASZCZ-DAVIS: Did you want to make a comment? I preempted you.

PARTICIPANT: No, I was just trying to move closer to be able to listen to it.

MS. LASZCZ-DAVIS: Chris Laszcz-Davis. Actually it follows Dr. Michael Behm's comments about securing qualitative feedback. I mean, I can appreciate NIOSH not wanting to be in a position of securing end user feedback. I mean, I think that might be a little bit of scope creep, but on the other hand though, you did say that you're working through organizations like NSC and NSC's interests, I mean, its focus is the end user. Why could they not be asked on your behalf to gauge the effectiveness of guidance that you provide? Otherwise, we never really know whether or not what's being recommended is the optimal set of recommendations or whether or not there are gaps. I think it's a critical piece of gauging effectiveness of any deliverables.

PARTICIPANT: Yes, it is, yes.

MS. LASZCZ-DAVIS: Just a thought.

DR. PRATT: Yes, and that's certainly a valid comment. And we probably over the last year to two years have been engaging much more than we had previously with NSC on motor vehicle safety, and I think in part that is because they have a new CEO, Deborah Hersman, who used to be the chair of the National Transportation Safety Board, so she is very interested in road safety. She spearheaded the development of this Road to Zero coalition. I know she's talked with Dr. Howard about areas of concern like fatigue, and that's something that we've certainly tried to—I didn't have time to cover it, but that's something we've really tried to ramp up our program on. And we said in our—we got lots of comments about the need to continue to develop our program there and we're certainly doing that, based in part on partner interest. And NSC is highly involved in this new ANSI subcommittee on automated vehicles. So we are definitely engaging with them much more in the policy space. We work with them on communication. And one area we haven't worked with them as much, where, you know, it's an untapped opportunity would be more in the research area because they have a large group of member organizations where we could work out research or data collection

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- arrangements possibly with them for evaluation purposes.
- MS. LASZCZ-DAVIS: Thank you.
- DR. ROGERS: Okay. Bonnie Rogers. I had a couple of questions. Do you do work with motorcycles?
- DR. PRATT: We do very little work with motorcycles. And we do get comments from companies that are multinationals because they tend to be less concerned about motorcycles in the workplace in the United States, but they're very concerned about in low and middle income countries, because in Latin America, in the Middle East, in South Asia, they are ubiquitous work vehicles. So they're concerned about risk management in those markets; much less so in this country. You know, there are certainly workplace fatalities involving motorcycles, but based on focusing our efforts on the highest burden, we have not done very much on motorcycles in this country.
- DR. ROGERS: I also had a question—you had mentioned, I think when you were talking about employers having different types of cars for employees, and the same is true for workers when they're doing rental cars, which I think is very dangerous because your car that you have as a person is very different than the rental car that you get today. I mean, coming here this time, it took me ten minutes just to figure out how to get the car started. Honestly, it was ten minutes. And I thought I was going to have to go up and ask somebody to come help because I couldn't figure it out. I couldn't get the windows down, you know, and just trying to back up—and I don't know if it was in a previous presentation or where I read it, but it said that 20% of motor vehicle accidents occur in parking lots, and which is pretty scary.
- PARTICIPANT: I've heard about that.
- DR. PRATT: Well, yes, that's been one of the side benefits of doing our work with this large company because we're not just looking at what's happening out in public roads, we are looking at what happens—any kind of incident that's happening, them being hit in parking lots, them being hit on the side of the road, so any kind of property damage that gets reported. You know, we're getting a sense of what the bottom of that iceberg looks like, where it's windshield glass only. I mean, these are risks that they want to manage. They aren't always worker safety risks, but these things are costing them money, and what they do sometimes to prevent workers from being involved in crashes are also helping to reduce some of those material costs as well.
- DR. ROGERS: And then the other thing is with the GPS stuff, which is a technology, but you know, it's a very complicated thing that workers have to actually deal with, you know, particularly when you're... If you're trying to look at it versus listen to it is very difficult and you know, if somebody's driving along, particularly at a high speed, that could be, you know, really pretty bad, I think. So when you're talking about looking at those types of technology and how do they interface with the driver—is another important area.

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PARTICIPANT: Yes.

DR. PRATT: Yes.

DR. ROGERS: Yes, that's the user interface issue.

PARTICIPANT: Right.

PARTICIPANT: Yes.

DR. ROGERS: And then of course we would always say that people shouldn't be programming their GPS on the fly.

PARTICIPANT: Well, they shouldn't be.

DR. ROGERS: They should have it all set up before they leave. I mean, that would be what best practice would dictate. But I think the comment with Chris and Michael in terms of looking at end user is so important because, you know, the research that we've done with respiratory protection in particular, before looking at—I remember this from being on an IOM committee, looking at—you could have the best respirator, you think, in the world, but if the end user doesn't use it, it doesn't matter. It really doesn't. So that's an important part, is looking at that end user because it's like taking the horse to water, but if it doesn't drink, it really doesn't matter. So that, I think, should be something that, you know, we really want to think about pretty carefully in terms of that whole concept. Yes, Michael?

DR. BEHM: You know, I could just add—and that's why I mentioned qualitative methodology. I think sometimes, as researchers, and I'm not—you know, I mean, I'm pointing the finger at myself here too, you know, we tend to go quantitative so much and I think that qualitative piece is somewhat missing from that end user experience on occupational safety and health. I see that so often, and so that's really...

DR. PRATT: And this goes into the area where there may not, at the end of the day, be a difference between how the worker operating the vehicle reacts versus the member of the motoring public reacts unless we're talking about some kind of an information system that's designed specifically for work purposes. So in that case, what we tend to do is look at the literature broadly to inform ourselves about, you know, what is it saying about how people react? And then that is information that we can synthesize and provide to employers because, you know, we find over and over again that it's the rare employer who approaches us with, "I just read this research study and it said... Why is this?" I actually did have an email from a road safety manager at a big company—

PARTICIPANT: That's great.

DR. PRATT: —The other day who cited something they read in a AAA report. I think it may have been the AAA report on distraction, Ted, and "Why is this? It doesn't look like—you didn't tell me—you told me something different before. Why is this like this?" And so that's the exception rather than the rule. Usually the employers just want to know that we've synthesized what's out there, our research and other good research, and then that we are providing a reasoned recommendation as to how they should handle it. And it's rare that we're just going to look at the

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occupational literature because in many cases it doesn't make sense to not go beyond.

PARTICIPANT: Well, there's so much overlap.

PARTICIPANT: Sure.

DR. PRATT: And then the issue of fatigue as well, you know, and I know it's important to look at fatigue with these groups that you're talking about, but even with healthcare workers, the issue of fatigue is so important with driving. And there was a study that was done by Gold a long, long time ago—

DR. ROGERS: The Harvard study that NIOSH funded that found that—

DR. PRATT: I'm not sure it was that. You know, it was like a two-page article that I read on nurses who were working mandatory shifts, and then left, got in their car, and fell asleep as they're driving home. So that really stuck with me, has stuck for a long, long time. That was probably 30 years ago or something like that. I remember reading that, so that's another important area.

DR. ROGERS: There was the Laura Barger study from 2005 that NIOSH funded that was looking at workplace fatigue risks and they actually found that it was the risk of motor vehicle crashes on the way home.

PARTICIPANT: Right.

DR. ROGERS: And so that study, in part, made changes in graduate medical education, reduced the hours of the shifts. They just increased them again, and I believe we commented, Dr. Claire Caruso in Cincinnati—

DR. PRATT: Yes, and she's worked on it.

DR. ROGERS: Has done a great deal of work in that area and is hopping mad about the change in those rules—

DR. PRATT: And she should be.

DR. ROGERS: Because there's no evidence that—there's nothing that suggests that this is safe for driving.

DR. PRATT: And I wonder too, you know, in the larger cities when you're driving as well and you get backed up in that traf—I've often thought it was the emission from the car ahead of me that made me tired, you know, that I was breathing in something from the tailpipe of all these cars out there, and I would, like, be so exhausted by the time I got home, but I don't know if that's ever been examined or not, but that's what I've—I've often said that to students, you know, when you're in this traffic, you just feel so fatigued and it's just not from the driving. I know it's got to be from these fumes that are coming out of the backs of cars and things of that nature because, you know, they've done those studies with buses that back up and the drivers of the buses are so fatigued as well from the exposure. So that's, I think, another important area. Anyway, Terry?

DR. BUNN: Yes, Terry Bunn. Just wondering about your stakeholder groups. I know you have a lot of great agencies and organizations, but I was also wondering if you have, like, truck drivers, ambulance drivers, police officers within your individual

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stakeholder groups, for especially these engineering controls that are being proposed.

DR. PRATT: Well, as a general rule, we build into all of our projects, we build partners including workers. At the moment, we're doing an audience analysis, on the communication side, we're doing an analysis of our audience and we are showing end users of some of our information products different products that are in different formats, different topics to find out is this something that you would use? What are the pros and cons of using this? And we have segmented it by several different groups. We have a truck driver group, we had an emergency responder group, an oil and gas group, and then also just a general group of people who drive light vehicles like people who are, you know, real estate agents, insurance agents, pharmaceutical reps, and so forth, so we're looking at that from the communications side. And then also our communications people are working with our scientists to study motor vehicle safety within the law enforcement community and they're working on some targeted communication products where they have gone to meet with and are talking directly to officers about what their needs would be. So we are trying to get a good handle on what are the preferred ways to receive information? You know, what would you like to see that you're not seeing? So, you know, we're definitely doing that on both the research side and on the communications side. You mentioned fatigue tools and you may know, Bonnie, that Dr. Caruso developed a fatigue training for nurses.

DR. ROGERS: Right.

DR. PRATT: And I don't know that at that time it had a motor vehicle component. I don't think so.

DR. ROGERS: I don't think so.

DR. PRATT: But she is doing a project now where she's working with the law enforcement community to develop a fatigue training for law enforcement officers and that will have all kinds of information, not just on the driving—it'll have information on driving, but it'll have other types of fatigue prevention information. And fatigue prevention is an area that we're doing a lot of—

DR. ROGERS: Major, major, major.

DR. PRATT: —Work on it because we know that the available information suggests it's a big risk factor for workers.

DR. ROGERS: It is.

DR. PRATT: And we have huge stakeholder interest in especially certain industry pockets like oil and gas, and we are starting to look more at not just the driving during the workday, but we're looking at workers in groups like oil and gas that have nontraditional commutes that are going several hours from the worksite—

DR. ROGERS: Right, exactly.

DR. PRATT: —Their home to the worksite. And of course, the issue for truck drivers has been amplified by the crash where Tracy Morgan was seriously injured, where the

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driver commuted something like 13 hours from his home base to his duty point to pick up the truck, and by law that doesn't even count. You know, the clock starts only when you get in that truck, so there are a lot of questions about hours of service there too.

DR. ROGERS: We'll take one more question and then we'll have to close.

DR. SINGH: Just a comment on your reference to the multinational companies, I think in several countries really the issue is bus safety more than anything else. I have been to a number of plants owned by US companies in Thailand and China, and you will see there will be 2,500 employees and 6 cars in the parking lot, you know, because they bus all the people and then they take them back home. So all their motor vehicle were related to bus accidents, you know, so that's why they're not concerned about certain things.

DR. PRATT: Are they providing the bus transportation, the companies themselves, or are they public transit?

DR. SINGH: Yes, the companies provide it. You know, employees don't pay anything. The companies provide it. And in fact, I took their buses. If I stayed in a hotel and I wanted to go to a plant, they would say, "Wait for the company bus, you know, you ride with the rest of the employees," yes.

DR. PRATT: No, it makes sense as a risk reduction method, as long as the bus is safe.

DR. SINGH: Yes, there...

DR. HSIAO: Can I address to Terry's comments just quickly?

DR. ROGERS: Yes, just quickly.

DR. HSIAO: Yes, okay. Terry, I wanted to answer your question about partnership, all our engineering projects actually involved with partners including professional association, unions, and other government agency at the planning stage, so we make sure that we got input from them as soon as we can actually update or revise our protocol to make it applicable to the real world situation.

DR. ROGERS: So thank you both to Dr. Pratt and Dr. Hsiao. It was really an interesting, I think, presentation, but also many interesting and good comments. Thank you to the Board as well.

DR. PRATT: Yes, thank you.

DR. HSIAO: Thank you.

DR. KITT: So Bonnie, I think we're going to make a few adjustments for the folks in the room, because this is such a big room, we're having some trouble hearing. So Jenny is going to do her presentation from the front—

DR. ROGERS: From the front, okay. Good.

DR. KITT: —And we're just going to move around some of the microphones so that folks can hear. And then when we get to the questions section, we probably will pass around a microphone so people can hear a little bit better, so...

DR. ROGERS: Did you all hear any of that? Okay. So our next presentation is nanotoxicology, and Dr. Roberts will be discussing that, so Jenny.

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DR. ROBERTS: Okay, are the mics on? Okay, can everybody hear me okay now in the back?

PARTICIPANT: It's still a little light.

DR. ROBERTS: Okay, it's okay?

DR. ROGERS: Maybe a little closer to the mic, maybe.

DR. ROBERTS: A little closer to me, thank you. Okay, is that better?

DR. ROGERS: Yes, yes.

**NANOTOXICOLOGY**

DR. ROBERTS: Good. I'm going to switch gears and go from large vehicles to very small vehicles here and we're going to talk about the nanotoxicology program. And what I want to do is give you sort of an overview of some basic definitions, then some framework for our funding stream which is the Nanotechnology Research Center, and then I will dive into some of the work that we've been doing in regards to that. So to begin, to get on the same page, what is a nanoparticle? It is a particle that has at least one dimension that's less than 100 nanometers. Now, to give you kind of a physical idea of what that is, a 1 nanometer particle, you would need about 100,000 of these stacked on top of each other to equal the thickness of a human hair which is about 100 microns thick. We think of these particles basically as two categories, and I'm going to talk most about the first category – the engineered nanoparticles. And these are created for a purpose with tightly controlled physical-chemical characteristics such as size, shape, and surface properties, and these properties are what gives rise to concern about how they may interact in biological systems compared to a larger particle. We're also concerned with incidental nanoparticles which are created as an inadvertent side product of a process, usually a high-energy process like combustion in welding. And just very recently, investigators from NIOSH, Patti Erdely came back from an IARC meeting where they've ruled welding fumes as a class one carcinogen. A lot of that work was done here that was used for that ruling. But I'm going to focus primarily on the engineered portion of that.

So nanotoxicology as a field has grown rapidly over the past 15 years. This is just a schematic with the literature hits for the terms "nanoparticles" and "toxicity" over that time period. This is driven by the modern era of nanotechnology which really begins in the 1980s. If you want to see a really nice timeline, the National Nanotechnology Initiative has a great timeline on their website. And so a lot of research and development goes into these materials, and then in the year 2000, the National Nanotechnology Initiative is formed, we're born out of that in the NTRC, and our first science meeting with the NTRC is in 2004. The first round of funding for the NTRC, there was about six projects, about half of which were focused on nanotoxicology. Now in any given year there are anywhere from 20 to 25 actively funded projects, and a good portion of those are nanotoxicology oriented.

So let me give you a little bit of the framework of the NTRC. There are ten critical

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areas. You may have heard from some of these other areas as well. I'm going to talk about the toxicology and internal dose portion of the program. There is measurements and methods, exposure assessment, epidemiology and surveillance, risk assessment, controls and personal protective equipment, fire and explosion safety, global collaborations, informatics and applications, and recommendations and guidance. So you can see how encompassing this is. It all works together in a flow that you can see on the right-hand side. There's hazard identification, this is where the toxicology plays a really critical role, followed by exposure assessment – will there be exposure in the real world to these materials? And if you take these two elements together, you can then do risk characterization for those materials and then risk management. So this is sort of our pathway to prevention for the exposure to nanomaterials in the workplace. In the past year, there were 24 active projects looking at nanotoxicology in HELD. 13 of those are funded by the NTRC and the remainder are funded directly through HELD which stays in alignment with the strategic goals of the NTRC which I'll talk about in a moment. But very important to us are our extramural collaborators, so academic and government as well as industry. And I just want to say that the industrial component really gives us the ability to model our dose and our material as accurately as we can for the workplace, so those are really important partners for us. As I mentioned, all these projects stay in alignment with the strategic goals for the NTRC. There are five goals overall. Two of those goals, the toxicology work falls into, and these are the first two goals. The first is to increase understandings of new hazards and related health risks of nanomaterials to workers, and so this is where we're going to conduct our toxicology studies, our in vitro and in vivo dose-response time-course studies to look at lung exposure and dermal exposure to some extent, and then to determine also effects in extrapulmonary organs following lung exposure. Another intermediate goal here is to determine whether nanomaterial toxicity can be categorized on the basis of physical-chemical properties and mode of action. And this is important because of the sheer number of materials that are coming out, that are new every single year. They cannot all go through a tox. testing regimen. So what we want to be able to do is say: it has these certain properties about this material, it's going to go into this category of risk, we're going to be concerned about it, we're going to test; or maybe we're not concerned about it because we don't think it's going to be a very biologically active particle. The second goal is to expand understanding of the initial hazard findings of nanomaterials. There are a number of materials that we understand now to have some toxic properties and now we're going to take them to the next level and look at mechanisms of disease, look for biomarkers of exposure and for outcomes of that disease. And then also we want to be able to determine the relevance of our in vitro and in vivo screening, and this is where we really partner with some of the other critical areas such as the exposure

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assessment and the epidemiology team to really understand what's happening in the workplace and if our models are really accurately predicting what's happening in the workplace.

A question we frequently get is how do we identify what we're going to investigate on the toxicology platform? And we do this a couple of different ways, through directives and partnerships with other agencies or organizations, either nationally or internationally, and through our partnerships with industry. And these materials are usually highly produced and highly utilized or they're about to be. Another group of materials that would be of interest to us are ones that are specifically designed to answer a specific research question, and I'll talk about some of those in a minute pertaining to prevention through design and also pertaining to their properties and how those properties act in a biological system.

Okay, and so I'll show you a couple slides with some of the materials that have fit into that first goal where we were looking to characterize these emerging materials and what toxicological properties are associated with them. A big category of nanomaterials are the carbon-based nanomaterials. A lot of that is made up of carbon nanotubes, different forms, multi-walled CNTs, single-walled, double-walled. There are also two-dimensional carbon-based nanomaterials in the graphene family as well as some other forms, carbon nanodots, carbon black in the nano form, that we've looked at. In addition to the carbon-based, we've looked at nanocellulose and a number of nanoclays, and you can see some in the illustrations on the right there of some of those materials. Another major category are the metal-based nanomaterials and we've looked at a really wide variety of these materials as well. Very different compositions and very different shapes and sizes, so we can have wires, spheres, dots, stars, whiskers, nanobelts, all different formations that have been designed for different applications in the field. So those are some of the emerging materials. These are the primarily produced materials or as-produced materials in manufacturing.

We also have groups of materials that answer specific research questions. One of those research questions is prevention through design or safety by design, so a concept that – can you change the surface of those materials so that it's still valid for the application that it's going to be used in, but that it might reduce the toxicity that's associated with this? Adding functional groups to the surface, nitrogen or carboxyl groups is one way that people are looking to do this, and that's being done with our multi-walled carbon nanotubes. On the bottom-right, we have a reactive iron particle that's been coated with amorphous silica to try to reduce the toxicity of that material. Another way we can look at this is to change the valency of the material to see if that changes how it interacts in the system. And this on the bottom-left is a cuboidal particle of cerium that then can be doped with gadolinium to change its oxygen content and change its valence state to see, as an example, how that might act in a biological environment.

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Another group of materials that helps us address a concept is the materials that we use to look at life cycle. So exposure doesn't stop just in the primary manufacturer of the material. It can continue along the value chain of the material as it's incorporated into composites or paints or other materials that might be used further downstream such as in construction operations. And so this is a whole—I'm glad you have the printouts because I'm not going to go through each one of these, but I'll just highlight two at the bottom. On the right is a wood sealant that has been doped with nanozinc particles. The zinc is in there to protect the wood from UV degradation, but this is further downstream from the manufacturing of both of those materials. This would be used in a spray coating operation to coat wood to protect it, as I said, from UV damage. So there could be an aerosol exposure at that point in the lifecycle. The material on the left comes from sanding a composite that contains carbon nanotubes, and you can see the carbon nanotubes jutting out in that red box from that particular particle. So this is an operation that could occur also in a construction site further downstream from the primary manufacturing of this particular material.

And so now that I've gone through our laundry list of all these materials that we look at, I wanted to focus on one of those model assessments that we've done and that's carbon nanotubes. We've worked with carbon nanotubes for quite a while now so I'm going to use that to demonstrate how we go from emerging materials, to in-depth investigation toxicologically, to partnering with our epidemiology and our exposure assessment to really advance our understanding of that toxicology. Before I do that, I want to highlight our aerosol generation systems that we use here because these really allow us to accurately model workplace exposure on the bench and in our animal models, and then I will move into the future with the life cycle which I've alluded to earlier.

So this is the first system that I want to highlight. This is our dry dust acoustical generator. This is what we use for exposures in vivo, inhalation exposures to dry powder. This was developed here along with the software that operates it, and what it is is a drum that contains the material that sits on top of a subwoofer, and that subwoofer beats at a frequency that renders the respirable portion into the air to be delivered to the animals in the animal chamber.

[Phone rings.]  
DR. ROBERTS:

That's—so a little mood music for you. So this was developed here and this, again, is what we use for our dry powder inhalation exposures, and the computer completely operates it and controls it, so it doesn't have to be manned. It's an international standard now that's used in many countries across the world. Not all of our exposures occur as dry powder exposures, however, so this is a schematic of our system where we do wet aerosol exposures or spraying operations. And so it's a similar system in terms of the computer and the animal chamber. In place of the acoustical generator is a spray pump. And the way we regulate the exposure

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in this chamber is to control the flow rate through that pump, so this is how we do our wet aerosol exposures in vivo. And we more recently have another system that allows processing and characterization of aerosols from nano-enabled materials like the composite that I was talking about that was sanded and you could see the carbon nanotubes jutting out of it. And what this is—and it can be adapted for a number of different operations. It's currently set up for sanding, but you could do sawing, cutting, grinding, a number of different types of operations that might render a dust generation. And it's contained within this one chamber. The motor is outside so it does not contribute to the dust that could be collected. And there is a respirable cyclone in there to separate out the respirable fraction of dust to be collected for studies, which is the part we're concerned with in terms of human exposure. So those are some of the systems that we use to try to accurately model the occupational exposure here in HELD for our in vitro and in vivo work. And carbon nanotubes are one of those materials that have gone through the wringer here and we really understand pretty well right now. So I'm going to take you now from the emerging material, to the in-depth investigation of the material, to how it's integrated with exposure assessment and epidemiology studies sort of from the 30,000 foot view. And our work with carbon nanotubes began back in the early 2000s in Anna Shvedova's group with single-walled carbon nanotubes, and she published a paper that showed, in kind of our tier one type of in vivo studies, where we do aspiration in mice, and we give them a bolus dose, and look at a time-course and a dose-response over time, we saw early onset and rapid onset of fibrosis, which was a really unique finding. This is the sentinel paper in 2003 for adverse health effects in response to engineered nanomaterials. It has something like over 500 primary citations and greater than 15,000 secondary citations, and that was sort of the pinnacle paper for the field of nanotoxicology. Since then, we now have an understanding that the majority of carbon nanotubes used in the United States, greater than 90%, are multi-walled carbon nanotubes, and so through a partnership with Shinshu University in Japan, we obtained a particle called Mitsui-7 which is a multi-wall carbon nanotube and similar studies were done with this particular particle, and in fact this particle also caused a rapid onset of fibrosis and to a greater degree than the single-walleds did. In addition, we saw extrapulmonary effects with this material, effects on the cardiovascular and the immune system and in the nervous system. So what we did was we then took this material, and went to the next tier level of testing, and did inhalation studies with this material, and we started with 5 mg/m<sup>3</sup> as a nuisance dust level that should not be exceeded in the workplace, sort of a benchmark dose to use when you're working with a new material. Again, rapid development of fibrosis was confirmed. In addition, there were studies that showed pleural penetration, so the material could poke through the lining of the lung. It could also enter the bloodstream which is shown in the bottom-left, this is

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nanotubes entering glomeruli in the kidney via the bloodstream, so they've left the lung. Another pinnacle paper that had come out of the study with Mitsui-7 is the paper that shows that Mitsui-7 is a tumor promoter and has the ability to promote lung adenocarcinomas, and IARC used this information for its ruling on Mitsui-7 as a class 2B carcinogen. It was also recognized at that point in time that not all carbon nanotubes are created equal, not all carbon nanotubes are going to be as toxic as Mitsui-7, some might be more toxic than Mitsui-7. And the picture on the right is really interesting because Mitsui-7 did something other materials don't do. It actually incorporated itself into the cell division machinery physically to disrupt cell division, and that was I think the first time that that was really illustrated as a mechanism for tumor promotion, and we don't see that with bulk-size materials. That's a very unique nano-specific effect. Mitsui-7 has provided us a lot of opportunities for research. Because it does have toxic properties associated with it, we can do mechanisms of disease with Mitsui-7, we can look at biomarkers for exposure and adverse outcome with Mitsui-7, and then we can use Mitsui-7 in that prevention by design methodology to coat it or change it in some way to see if we can modify its toxicity. So Mitsui-7 has been a great tool. However, Mitsui-7 is not manufactured or used in the United States. So as our research with Mitsui-7 is going on, the epidemiology team and the exposure assessment team have been working in numerous facilities, greater than 14 facilities throughout the United States, to understand what the exposure levels are in different operations, and to understand what the actual form of the carbon nanotubes they're using are, and how we can relate this back to Mitsui-7 and what we know.

So the next slide just illustrates how we move forward to integrate all that information together to move the toxicology forward. One way is we now, working with the exposure assessment team, can understand the symmetry of all our past experiments with carbon nanotubes, so we can take an average level at a certain operation in a facility, model what would deposit in the lung of a worker over time, we can then normalize that to our animal studies, the surface area of the lungs in our animals, and say, okay, the dose we gave our animals is equivalent to 70 years, 7 years, 7 months, whatever it might work out to be. So we've given now occupational relevance to our dosing strategies. Also from this study a number of those facilities, fortunately, were willing to provide their material, so now we have the actual occupationally relevant material. It's all different sizes and lengths, it has different surface reactivities likely also, but fortunately, in that one diameter that is considered nano, the Mitsui-7 fell right in the middle of the spectrum, so all that work with Mitsui-7 pays off as being able to use it as a positive control and a reference material for other carbon nanotubes. And what we can gain from that is we can say we might have four or five different categories of carbon nanotube activity here, if we can characterize that all and plot it against Mitsui-7, then we have a good idea of how toxic or the potency of all these different materials.

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Companies can then look and say, "My material looks like this. I don't want it to look like this," or, "I do want it to look like this," depending on what kind of outcomes we see in terms of toxicity. And then a third way that we partner with both the epidemiology and the exposure assessment is in the study for biomarkers of exposure and disease. So Mary Schubauer-Berigan has set up a cohort with these facilities. There's over 100 workers involved in it. They are giving plasma, serum, and sputum to look for biomarkers, and these markers were partly chosen on in vivo studies done here with Mitsui, but also on other cohort studies where adverse outcomes were observed. These can be correlated to markers for ongoing exposure assessment studies and importantly, we can use what we find from these human studies to validate our in vivo models, which was one of those key points in those strategic goals. What I don't have on this slide is all of this information can then be taken by risk assessment to really understand what the risk is and how to manage the risks for development of things like recommended exposure limits.

Switching gears and moving into the future, so we are sort of in the second decade of nanotoxicology in the Nanotechnology Research Center. We call it version 2.0. We now know a lot more about the lifecycle of these materials. When we began, we knew primarily about the first step there which is production of primary engineered nanomaterials. We now know more about material processing, distribution, and product use and consumption, so we can really expand our research into exposures that may occur later in the value chain of the material. And we are currently doing this with carbon nanotubes, but we hope to move other materials into this framework as well.

And with that, I will acknowledge all the folks in yellow who are all the investigators that are working on—or the principal investigators on all the toxicology projects that are active right now. Thanks to our leadership in HELD on the left and our NTRC leadership on the right, as well as all the critical area coordinators in the NTRC that work with us, and my predecessor in toxicology and internal dose, Vince Castranova, who was the original coordinator and the coordinator for over a decade. And thanks to the engineer and aerosol scientists, as well as our animal care and use caretakers who allow us to do the in vivo studies.

And then I'll just leave you with a little food for thought. We're always wanting to know what's the latest and greatest and newest thing, and does it have new properties that we might need to consider? Another challenge for us is trying to identify who is using nano. They don't all call themselves nanotechnology companies anymore, but a lot of industry uses nano-enabled materials. We need to figure out who those people are and what they're using. We may crisscross paths to a great degree with new initiatives like advanced manufacturing or additive manufacturing. And then another challenge for us is we are entrenched in the world of 'omics, and these studies generate—transcriptomics, genomics,

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proteomics, lipidomics, these generate a massive amount of data, and so we now have a data management plan that we're working with and developing, so this is going to really help us, but communicating this data to those that need it, to the stakeholders, also to folks that are doing risk assessment, this is a huge database. And 50,000 genes, if we see only 5 genes change, is that relevant? Is there an outcome associated with that? Long term studies, that's easier to tell. Short term studies, we have a lot of work to do to try to figure out what those meaningful changes are. So those are some of the challenges that I'll leave you with to think about. Thank you.

DR. ROGERS: Thank you, Jenny. Questions or comments?

PARTICIPANT: So what we're going to do is kind of pass this on this side and then we have a handheld mic there.

DR. SINGH: Yes. Dr. Roberts, my question is about exposure potential and exposure assessment, and my first part of that is that it's easy to imagine who is exposed when they're manufacturing these nanoproducts, but after that, do you think there's any exposure to consumers who use that product, can then the nanoparticle be released under some conditions afterwards?

DR. ROBERTS: Correct. Yes, we do. We actually partner with Consumer Product Safety to a great deal on a number of our projects. There's projects looking at release of nanotubes in other kinds of metals from different materials that consumers would come into contact with. We look at the manufacturing part, but they have a vested interest in release further downstream, and we do find that there is release from certain materials. Outside of the consumer realm, we partner with CPWR to look at construction operations that may result in release of the materials from something like the composites or a spray where they've been used to enable it in some way, shape, or form. So yes, nano release is a big topic. We tend to look at it from the occupational standpoint, but we work with other agencies like the EPA and the Consumer Product Safety to look at it from those other standpoints as well.

DR. SINGH: My specific question is that I work with a couple of oil and gas companies, and it's about nanopaints, and you know they have miles and miles of white paint, that's the titanium dioxide.

DR. ROBERTS: Yes.

DR. SINGH: So I can imagine exposure when somebody's making the white paint from nanoparticles, but what happens, you know, afterwards? When you're applying the paint, I imagine there's not much exposure because it's in some kind of a—but when you want to remove that paint, what is the exposure situation, especially when they're disc sanding and all of that stuff? I know that when you are disc sanding anything, you can actually make some nanoparticles.

DR. ROBERTS: Right.

DR. SINGH: But how do we tell whether that is from just the sanding operation or because the paint was manufactured from nanoparticles of titanium dioxide?

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- DR. ROBERTS: Right, so that would be best taken into a lab for a controlled study. So you can do a lot of assessment in the field to measure what gets released after all these different operations. You're going to have complex mixtures, and like you said, certain high energy processes will definitely generate new nanomaterials along the way. So as we go along that lifecycle, which is what you're talking about, it gets more and more complex as to what the actual exposure is, so that's why it's really important for us to partner with the exposure assessment team who might do the measurements at a workplace, and then we can go back to the lab and try to take it apart and say was it due to this titanium portion of the paint, or was it due to the actual process that caused the release of the particles from the paint? So there's a lot of work to do there. We're still in the very beginnings of working with this lifecycle material to understand that, but you do have to do both together in order to get that answer.
- DR. SINGH: My second question—excuse me, while I have the chance, my second question, are you sure the respirable cyclone—you know, most industrial hygienists are familiar with the particle separation inhalable through respirator.
- DR. ROBERTS: Right.
- DR. SINGH: But that's still up to five microns, you know, they're not—is there any program to develop a special size separator that can go down to—maybe you can have the particle cutoff at 1 micron or even less than 1 micron, where we can tell that mostly it is nanoparticles?
- DR. ROBERTS: I think that we're working toward that technology. There are some separators—we use Moodies and size separators in our—whether they're translatable to the field, easily translatable to the field is the question. There are separators that exist in that range, it's just you're bringing a lot of equipment when you're trying to go out and measure that. I think John Noti will talk a little bit about flu and how it's collected, and flu virus is in the nano size range, so you're actually doing that a little bit there. But yes, there are things that are available. We are really looking at human respirable cutoff when we're doing our occupationally relevant exposures, but we can address that as a specific scientific question in further size separating down, which we do.
- DR. SINGH: Thank you.
- DR. ROGERS: Terry, you had a comment? Was it Ron?
- DR. ROGERS: Terry, Ron, and then Chris.
- PARTICIPANT: Do you want to—yes.
- DR. BUNN: Go ahead, Ron, you're ready.
- PARTICIPANT: Okay.
- DR. STOUT: Ron Stout. What progress or where are we at vis-à-vis baseline medical surveillance? Any recommendations?
- DR. ROBERTS: Medical surveillance is not my area of expertise. That belongs to Doug Trout. I think there is progress in working toward workers that can have sensors for their

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- actual exposure levels and then you can correlate that back to different kind of outcomes if you use the toxicology in the lab. But in terms of what's actually happening to them, in the cohort studies, they're undergoing medical surveillance. So these are the beginnings of that stage, so they can try to figure out—they can do lung function changes, they can do skin tests to see if they've had contact on their skin, but we're really in kind of the earlier stages of that, I believe.
- DR. STOUT: It would be helpful, from an industry perspective, to have some guidelines on what might be the...
- DR. ROBERTS: Right. In our medical surv—we have a person that's involved in one of the critical areas that specializes in that. Unfortunately, it's not my specialty because I can't speak directly to that, but Doug Trout is the person that can.
- DR. ROGERS: Chris?
- MS. LASZCZ-DAVIS: Thank you. Fascinating presentation. You mentioned in the animal studies that pulmonary fibrosis was a major finding, I guess interstitial fibrosis in the animals.
- DR. ROBERTS: Yes.
- MS. LASZCZ-DAVIS: So I just have two quick questions. So you said then for humans you're looking at biomarkers, not lung disease, so what biomarkers?
- DR. ROBERTS: We're looking at biomarkers of lung disease, of potential outcomes for lung disease, and so there's—
- MS. LASZCZ-DAVIS: Which ones?
- DR. ROBERTS: Oh, gosh, there's a large list. Aaron, what's the fibrotic one? I see you back there.
- DR. ERDELY: We put together a panel of about 30 to 40 analysts based off previous published literature, pulmonary studies and things like that, to speak specifically such as KL-6—
- DR. ROBERTS: That's the one I was...
- DR. ERDELY: That seems to correlate in the Indian workers.
- DR. ROBERTS: That's the one that was not coming to mind. Thank you.
- DR. ERDELY: You see KL-6 with blood pathology in Indian workers. That would be a specific example.
- DR. ROBERTS: Right, and then there's a number of matrix metalloproteinases and things like that that are involved in tissue remodeling that you would look for as indicators of lung—but KL-6 was the one that was not really coming to mind.
- MS. LASZCZ-DAVIS: Okay. And I didn't quite catch what you said about, once the nanotube is incorporated into the cell, what happens?
- DR. ROBERTS: Okay, it becomes—without going into real deep detail on that, it enters the nucleus, and then it can become integrated into the machinery that's involved in cell division, specifically the centromeres. So what can happen is—you normally have two poles, the cell divides, your genetic material goes in the two directions of the two new cells. What the nanotubes are doing is they're disrupting that and they're forming their own poles, and so that the cell is dividing in multiple different ways, and that can really be disruptive, obviously, to cell division and then erratic

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growth leading to potential development for a tumor.

MS. LASZCZ-DAVIS: So it's causing erratic growth?

DR. ROBERTS: Yes, yes. It's disrupting the whole cell division, growth cycle.

DR. ROGERS: Terry?

DR. BUNN: Yes, just a couple of questions. As far as your exposure assessment endpoints, you know, looking at pulmonary toxicology, cardiovascular and neurotoxic effects, have you thought about including immune effects?

DR. ROBERTS: Yes.

DR. BUNN: Because I think we know that nanoparticles in general are going to stimulate, elicit the immune response with the macrophages moving in—

DR. ROBERTS: Right.

DR. BUNN: —To try to phagocytize them and you know, I was just wondering as far as—

DR. ROBERTS: Yes, yes, immune is an overriding response that we look at. We look at it in terms of a local pulmonary immune response as well as a systemic immune response. So we do look at that. We take spleen, we take lymph nodes, we look in to see what cells are responding, what mediators are in the blood stream that might be activated. Those are steps we take. I also didn't list on there, but more recently we look at reproductive effects with these materials after inhalation as well. So we try to look at as many organ systems in that exposure that we can because the inhalation exposures are very time consuming, are very expensive to do, so we try to maximize all the organ systems that we can following that exposure.

DR. BUNN: Okay, and then my second question is in regards to dermal exposure. I didn't see that on there. And this is kind of related, you know—well, I don't know if it's specifically worker-related, but it is worker-related too, but just the products that are produced like silver socks, you know, to reduce odors, athletic wear that has the nanoparticles to reduce sweating.

DR. ROBERTS: So we focus very heavily on pulmonary, but we do have two groups that do work in the dermal world, and they do this both in vitro and in vivo. The in vitro models are using 3D skin replicas basically to see if particles penetrate or to see if that might not be a particle penetration, but a dissolution of the particle and then crossing over the skin. We of course have been more heavily oriented toward inhalation, but we do have those dermal components, and then you can use nude mice to also understand the toxicology, dermatitis. There's another group working with not just the physical characteristics of it and its ability to translocate, but also to look to see if they act as sensitizers, if they're doing this in a different way from their parent compound. Because a lot of the metals we know to be sensitizers for skin and allergies, so there is a group looking at that as well.

DR. BUNN: Thank you.

DR. ROGERS: Maryanne?

MS. GRUDEN: I'm Maryann Gruden from AOHP. This is not my area of expertise, so please excuse my ignorance, but my question is are there standards now for PPE use for

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- these processes when they're manufacturing these nanoparticles or...?
- DR. ROBERTS: Yes, well, there is guidance that has been put out, and the guidance documents are available on the website, and they do speak to both engineering controls and what we need in terms of PPE, and in some instances, you would be surprised that the normal PPE does provide a good barrier, but in other instances, you need more. So there are guidance documents that are available and we have a whole critical area that focuses on engineering controls and PPE as well.
- MS. GRUDEN: Thank you.
- MS. LASZCZ-DAVIS: Chris Laszcz-Davis. A couple of questions, if I might. One of them as it relates to combined exposures, I mean, these are singular exposures, and what are the plans long range? I mean, you've done an incredible amount of work so far, but moving forward?
- DR. ROBERTS: Moving forward is that concept of the lifecycle because, as you're saying, there are complex exposures. So even as we move out of that primary manufacturing, which that isolated material, as you said, it gets more and more complex as we go around this chain, and so really we need to partner with exposure assessment to understand what other materials are in that plant as well. When they go in, they're not just looking at the nano portion of it. They're looking at all the other materials that they might be using, exposure that might happen to solvents that are a part of the process of manufacturing and things like that. So we try to incorporate that as much as possible. That's sort of the version 2.0 that we're entering into in the second decade.
- MS. LASZCZ-DAVIS: Thank you. The second question, you know, is that, if I recall your initial graph, I think it was slide two, actually it was a great slide in terms of historical perspective. The science really started coming out in the 1980s, and I can tell you, for many of us who've been in industry, I'm not sure that we began to get our arms around it or even began to hear about it till the last five to seven years. And I think it's just the history of science, it takes a while. It's the research, then—I mean, NIOSH's research, the academicians, the governmental practitioners. By the time it reaches the end users, it's usually quite a ways down. And I think about there's an incredible impact on the construction sector, and I think about the programs in the US and probably elsewhere around the world that deal with construction engineering and construction management, and these young people are being exposed to a number of materials and working for companies that I'm sure know little about this. I mean, does NIOSH see, other than posting on its website, a role in disseminating and pushing that information out practically?
- DR. ROBERTS: Yes. As exposure assessment teams go out to some of those facilities, they will work directly right then and there to make recommendations with them and to help them understand. There is some process to getting our information out. You know, we have to go through public forums and things like that, that kind of delays some of the communication, but any industry can contact us, any industry can set

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up a health hazard evaluation if they're concerned about a certain exposure that might be occurring in their workplace. So there are a number of other routes than just waiting for the documents to come out. And usually when we're working with our stakeholders from the toxicology standpoint, we're communicating with them, even before our publications come out and our information comes out, with what we're finding there. But that is an area where we could probably improve how we disseminate the information out, like, instantaneously as opposed to waiting for us to go through our channels to make it publicly available. I agree.

PARTICIPANT: Are you using Wikipedia?

DR. ROBERTS: I can use Wikipedia, yes.

PARTICIPANT: Is this off...

DR. ROBERTS: So I talked with our Wikipedia expert here today, talking about some of the techniques we use and then how to communicate prevention through design, but we could also incorporate the concepts from our exposure assessment groups and our epidemiology groups to convey some of that toxicologically-relevant information as well. That would be a good outlet.

MS. LASZCZ-DAVIS: Chris. I just wanted to add that, you know, I think health communication throughout all of our divisions and throughout the institute has really been changing over the last couple of years and we are trying to put more and more focus on that to address just what you asked, so...

DR. ROGERS: I had one comment and then I wanted to ask if folks on the phone have any questions. And I think Chris brought up an interesting point about, you know, sort of the knowledge of nanoparticles in just sort of the worldly community. And I have—you know, it was sort of when this first came out, went and tried to—you know, read on it and it was sort of like MaryAnn was saying, I'm not an expert in this field, so I thought, well, I should find out something about what is this stuff about? And I still couldn't figure it out. And you know, then listening to your presentation, I'm just wondering, the different kinds of materials that are out there, I mean, what percentage of them have nanoparticles?

DR. ROBERTS: That's a very good question and that's a question we still try to answer. There is a lot of materials that are nano-enabled now. There is rules about coming out with new products that are going to contain nano-enabled materials, that's the rulings around TSCA and the EPA. But that's one of our challenges, trying to identify what companies are using it, and how they're using it, and how they're incorporating it into their materials. And we'll find out that, as we go back in time, the silver is an example, it may have always been nano, it may have always been in that size range and we just didn't recognize that because we weren't focused on that particular aspect of it. We were looking more broadly at the material. So that's a difficult question and that's something we try to work to—especially to identify the next material that we're going to take a look at.

DR. ROGERS: I mean, do you think it's most or...?

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DR. ROBERTS: I think it's in the makeup you put on your face, so, I mean, it's as common—it can be anywhere. Is it in most? I can't answer that question. That I don't know the answer to.

DR. ROGERS: Yes.

DR. ROBERTS: It's in a lot of materials.

DR. ROGERS: Comments on the telephone? Questions? Thank you, Jenny.

DR. ROBERTS: Yes.

DR. ROGERS: It was a great presentation. Thank you very much.

[Applause.]

DR. MIDDENDORF: We will take a break now, but BSC members, we'd like to meet in the atrium. If you go out the doors, out to the right or down to the left, we're going to try and get a photograph of the whole BSC.

[Break.]

DR. MIDDENDORF: We're ready to start up again. I do want to ask the people on the phone if you'll check in because I need to make sure you're there so that we have a quorum.

DR. ARMENTI: I'm here. This is Karla.

DR. MIDDENDORF: Karla, okay. Other folks on the phone? Sharon?

DR. MCKENZIE: This is Judith McKenzie. I'm still here.

DR. MIDDENDORF: Okay, great. Thank you, Judith. Sharon, are you still with us?

DR. ROGERS: Does he say Noh-ti or Nah-ti?

DR. MIDDENDORF: I believe it's Noh-ti.

DR. ROGERS: Noh-ti.

DR. MIDDENDORF: And Mark Nicas, did you ever join? Okay, how about Ted?

DR. COURTNEY: Yes, still here. Just recovering from a computer, unfortunately, so...

DR. MIDDENDORF: Okay. Okay, we do have a quorum so we can continue on.

DR. ROGERS: Okay. All right, so we'll continue. And Dr. Noti, you're going to be talking with us about the influenza. So appreciate your being here.

**AN UPDATE ON INFLUENZA RESEARCH AT NIOSH**

DR. NOTI: Thank you. Can you all hear me okay? Okay, I'm John Noti. I'm the Branch Chief here at NIOSH for the Allergy and Clinical Immunology Branch. I'm also the Team Leader for the Influenza Transmission Program. In November of 2010 the CDC hosted an international meeting called the Approaches to Better Understanding Human Influenza Transmission. At that meeting there were about 118 internationally recognized participants in the area of flu research. The goals of that meeting were to review the state of the art science and influenza transmission and to identify gaps in our knowledge of influenza transmission. And also to resolve any kind of questions revolving around the relative contributions of the three modes of potential transmission of influenza: Aerosol transmission, contact transmission and droplet spray transmission. So to this end our influenza program is focused largely on three of those major

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gaps that were identified at that program. Our focus is on aerosol transmission. Does it occur? What's the consequences of it? We also focused on the genes in the lung that are responsible for allowing flu to continue, for allowing flu to replicate in lung genes. And then, third, we focused on the protective equipment that's needed to best protect workers that are exposed to flu.

I want to give you a flavor today of what we've been doing over the past few years. Our research approach is through a combination of clinical studies and laboratory research. In order to study aerosol transmission what Bean Chen and Bill Lindsley in my group designed years ago was a unique aerosol sampler called the NIOSH Aerosol Sampler. It's unique in that it's able to fractionate aerosol particles in the air into three fractions: A fraction that's greater than four microns in aerodynamic diameter, a fraction that's between one and four microns in diameter, and then the really fractions that are smaller than one micron are collected in this portion of the sampler.

In our early clinical studies we used a sampler to ask a real basic question. The question was: Is flu actually present in aerosols? And if so on what fraction in the aerosols is the flu present? So what we did was we conducted two clinical trials here at WVU Hospitals. One was at the Ruby Hospital Emergency Department and the other was at the WVU University Urgent Care Clinic. And in that study we positioned samplers throughout the facility. And we also had some of the workers actually wear these NIOSH samplers to assess the potential exposure that these workers might have. And what we found in those studies was that virus was detected on all the rooms where patients congregated. There was... About 15 virus per liter of air was found throughout the facility. About 56 percent of the viruses was actually found in the respirable fraction. That's the fraction that's less than four microns in size that can be easily inhaled into the lungs and causing very robust infection. We also found some of the personal samplers that were worn were also contaminated with virus. So we knew that the health care workers themselves were directly exposed to the virus.

But it's important to know that the PCR that we use, the Polymerase Chain Reaction that we used to detect the virus does not detect infectious virus. It detects total virus, both dead and alive virus. So to address this question we continued our work in the laboratory in a simulated examination room that was designed by the engineer in my group, Bill Lindsley. The room is 10' x 10' x 8' in size. It contains programmable coughing and breathing simulators. And you can also adjust the humidity and air temperature in this room over a wide range.

So here's a picture of Homer. He's our cough aerosol simulator. Homer can cough a wide range of aerosol particles. The aerosol particles are loaded in a nebulizer to create the aerosol that those nebulized particles are transferred to a mixing chamber where the aerosols are dried. And then those dried aerosol particles are transferred to Homer's lungs and Homer can be programmed to

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cough.

And here's Homer's companion, Marge. Marge is a breathing simulator. Marge can be programmed to breath at any rate corresponding to what humans typically breath at. You can mouth fit Marge with respiratory equipment. You can mouth fit Marge with a respirator, with a surgical mask, even face shields. And Marge is equipped with NIOSH samplers so that we can collect. Anything she breathes can be collected in either NIOSH samplers here or a different kind of sampler called/which are SKC samplers. The SKC samplers are more designed to preserve the infectivity of the virus. Whereas the NIOSH samplers are more designed to show you what aerosol fraction those particles or those viruses may reside on.

Here's the exam room that Homer and Marge live in. In our earliest studies what we did was we had Homer cough aerosols of potassium chloride into the room. And in those studies we found that initially particles impact directly on Marge and within minutes those aerosol particles disperse throughout the room. We found that we can outfit Marge with an N95 respirator and block greater than 99 percent of those aerosol particles from passing through the mask. Then what we did was we had Homer cough live virus. So we loaded Homer up with infectious virus, we had him cough, and we were able to detect infectious virus in the aerosols from all three fractions of the NIOSH sampler. We also found in those experiments was that the infectivity of the virus dropped off dramatically after five hours of coughing.

Here's an example of how our aerosol particles spread throughout the room. This was provided by our collaborators at Johns Hopkins University Applied Physics Lab. And as you can see the particles first impact someone on the other side of the room very quickly and then begin to spread all around the room. So you're not protected from aerosols for any long period of time.

Then we asked the question: Is there actually live virus on the aerosols? And then we asked the question: Are the live viral particles present on the aerosols? And what's the protective effect of wearing different kinds of PPE, surgical masks and N95 respirators? And so what we did was to outfit Marge with either a surgical mask... So we put that mask on her very loosely, much like a surgical mask is worn by health care workers in the field. And you find that you can only block about 50 percent of the infectious virus by wearing that mask loosely. Surprisingly, if you take that mask, that surgical mask, and physically glue it to Marge's face, getting a really super tight fit, you can block more than 90 percent of the infectious particles from reaching her. But people don't, obviously, wear surgical masks glued to their face. Instead, they use N95 respirators which are designed to fit very snugly on a worker. And what we did was we outfitted Marge with the N95 respirator. We just loosely fitted the respirator on her face, simulating a poor fit. And in those experiments we can only block... Somewhere around 80-85 percent

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of the infection virus was blocked. But if you properly put that N95 respirator on Marge's face, just like you would in the field, you can block more than 99 percent of the infectious virus from reaching Marge.

We also outfitted Marge with a face shield because there are some instances in the field where you might want to be wearing a face shield to prevent exposure to splashes that are coming from the patient.

So here's an example of Marge wearing a face shield. And here's Homer in action, coughing directly at Marge. And the results show that we can actually block about 95 percent of the infectious particles from getting through the mask/the face shield that Marge is wearing if we have Marge very close, probably within about 18 inches of Homer. But as we separate Marge several feet from Homer, we find that the ability to block these infectious aerosol particles is drastically reduced. And that's because the aerosol particles are able to get around Marge's face shield, just like I showed you in the previous video how the aerosol particles dispersed in the air, you throw on Marge's face shield and Marge is now exposed.

We also wondered what environmental factors may be important for transmitting influenza. In temperate climates you find that flu is seasonal. You find that flu occurs mostly in the dry winter months where people are congregating inside where the air also is dry. So we asked the question: Does humidity have any effect on viral survival? So what we did was we had Homer cough, do a number of cough experiments in our exam room. And we varied the exam room humidity from seven to 73 percent. And we looked at how much infectious virus remained in the exam room. And in general what we found is that after about 40 percent, when the humidity was raised about 40 percent, you block one heck of a lot of infectious virus. The virus is killed quite readily at high humidities. We found that phenomenon to be the same in all aerosol frags. So it didn't matter what aerosol frags the virus resided on. After 40 percent or so or higher, humidities that virus was rapidly killed. So that, in part, may explain the seasonality of flu, at least in temperate climates.

As an aside, we received an awful lot of calls from people when this paper was published, people asking us whether we thought having humidifiers in the rooms of their loved ones was a good idea. We couldn't exactly tell them that. But we can tell them things like, "Well, your mother was probably right when she told you years ago to have a vaporizer, where she raised the humidity and she was putting that old-fashioned Vicks VapoRub all over you. So your mother probably knew quite something that we hadn't realized sometime ago."

Now, as I said, in our early clinic studies we hadn't determined that there was actually infectious virus in the health care facility. We only used PCR to determine that. And so the question still was in our head: What was the source of the infectious virus? Now, the source obviously is the patient, but it is the patient's

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coughs that's a big problem? Or is it the droplets that are spewed off by the patients? Most important, the question still remained: Is there infectious virus in the cough aerosols of patients? So what we did was we went back to the clinic, we did five clinic studies over the past few years. Bill Lindsley, the engineer in my lab, designed a rolling seal spirometer apparatus, whereby the patient coughs into the spirometer and those coughs are collected in this large chamber here. And then those coughs are then transferred to a sampler that's attached to that chamber. And what we found was that initially flu patients cough out very large aerosol volumes, much larger volumes than when the patients are back to good health. We found also that about 65 percent of the virus that was detected by PCR was in the respirable range. So that fraction that's less than four microns in size, that's where 65 percent of the virus was found.

And we also asked the question: Is there infectious virus in these aerosols? And initially, in our initial studies, we could detect a small amount of infectious virus from some of those patients. And then to increase the sensitivity of our infectious assay Françoise Blachere in my lab designed a really neat assay where she combined the PCR and something called a plaque assay. And by combining those two features, the sensitivity of being able to detect infectious virus was dramatically increased. And our later cough study showed that more than half of the flu patients were found to have infectious virus in their coughs.

We've also been involved in a couple very large studies. A lot of our work is through collaborations. Here's a study that came out of the National Personal Protective Technology Lab in Pittsburgh. This is a project that was headed by Ron Shaffer. He was the PI on the grant. This project involves two other divisions of NIOSH, our division here at HELD and DSHEFS in Cincinnati. It's a study that piggybacks on a much larger study called the ResPECT trial. And the ResPECT study was a study that was performed by Trish Perl at Johns Hopkins and Lou Radonovich at the VA. And in that study they were looking to see what the effectiveness is of N95 respirators versus surgical masks in preventing flu infection. And so and that study has been a multiyear study. That study has since wound down. And what we did was we piggybacked on that particular study by tapping into the health care workers in this study. And we collected their gloves, masks, N95s that they were wearing. We also did air and surface samplings throughout the Johns Hopkins facility. And a second goal was to determine the potential for direct contact transmission when someone doffs their personal protective equipment. So in the process of taking the equipment off are you transferring this back to you?

So that study, called the Why Healthcare Staff Catch the Flu Study, actually was composed of two components. It had a lab based component and a clinical component. The lab component was performed here where we went to our lab and we refined our ability to detect infectious virus. And the clinical studies began

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as a two week pilot study where we collected gloves, facemasks, etcetera from the workers. And that two week study brought us into a subsequent year, into a larger eight week study, where we're able to collect a larger number of PPE and take surface samples and air samples from the facility. The results of that study are actually now being written up in manuscripts that are in preparation. One of the big take home messages of that study was that if you look at the amount of virus that's deposited on respirators or surgical masks worn by the patients it's not very high. So that leads to the idea that you may very well be able to reuse these PPE over several days. The practice now is have every patient to take off your mask, your respirator, throw it away, put on a new one. But because the exposures or the amount of virus, it was actually very small on these PPE, that opens up the possibility of reusing the equipment, which is very important if you have an pandemic. And during pandemics you're likely going to have a shortage of PPE. So this study I think addresses that question.

A second large clinical study that we were involved with is called Evaluating Modes of Influenza Transmission Using the Human Challenge Model. This is a study that was funded by CDC back, I think, around 2012. I'm sorry, around, yes, around 2012. The CDC awarded about a million dollar grant to Jonathan Van-Tam at the University of Nottingham and Jonathan Van-Tam assembled a number of people including my team here at NIOSH. And the goal of that project was to assess the relative contribution of influenza transmission by droplet spray contact and aerosol transmission. And the way he did that study was he had... Volunteer recipients were nasally inoculated with the H3N2 virus. And then he allowed those recipients to mingle for a period of days with volunteer donors. Some of those donors wore a face shield. Remember, I said that the face shield is not good at preventing aerosol transfer but it's good at blocking contact transmission. And some of those workers wore nothing at all. And so what was done was for us to sample air that was collected from the samplers that were put throughout the facility. And surprisingly, when we did that study we weren't able to detect any flu in the air, or any flu in our samplers, which is a little bit concerning. But when Jonathan Van-Tam released his findings a couple years later he found that there was essentially no transfer of flu from the patients to the donors. And the idea there was—all of that was very disappointing. The idea there was—that in such a human challenge trial using a virus that's not very robust, one that is actually fairly crippled in its ability to transfer, was not good for this kind of a trial. And unfortunately, any kind of future trials probably are going to require those trials to use a virus that's a little bit nastier. And that obviously will become more problematic, as you can well imagine.

So I'm going to switch gears again on you and talk about studies we've been doing in the past few years where we're looking at the role of genes in the lung. So when the virus infects the lung there's some interaction of the virus with the

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host site of the machinery to allow that virus to survive. And let me give you—just for those who aren't molecular biologists, let me give you—an idea of what typically happens. In the human genome you've got lots of genes and those genes are transcribed into various messenger RNA molecules. And those molecules are translated into various proteins. And those proteins, some of those proteins are used to allow the lung to survive. So just for maintaining a cell in its normal state you need a lot of genes to be activated from the human genome.

Well, the virus has a capability, when it infects, of hijacking the host's cellular machinery. And the way it does it, one of the ways it does it is to activate genes within the lung genome that are called microRNAs. These microRNA genes encode four, small, about 22 nucleotide long, RNAs which, when expressed, they combine two specific sequences of specific messenger RNAs. So if those messenger RNAs are important for the lung cell's survival, if influenza activates microRNA expression for that particular messenger RNA, when the microRNA binds it leaves leads to degradation of that particular messenger RNA and this effects the viral survival. So the virus has a capability of tapping into a host's genetic machinery for its own benefit. So in our lab Sreekumar Othumpangat designed a number of elegant experiments where he asked what might be—or are there any microRNAs that are specifically regulated expression of influenza? There's currently a very broad database of microRNAs that have been identified to be involved in other diseases like cancer and cardiovascular diseases. About a thousand of these microRNAs have already been identified. So what Sree did was he looked at/he identified about 50 of the top microRNAs that were differentially expressed in lung cells that are either uninfected versus those that are infected with influenza.

And this heat map shows the differential expression of a number of these microRNAs. The red block indicates a gene of microRNA that's highly expressed. The green indicates a microRNA that's down regulated, that's low expressed. The black indicates that there's no change in expression of that particular microRNA in these two cell types. The first microRNA Sree looked was microRNA-548 and he found that that microRNA is actually lower after infection. And he found a clever way in which you can manipulate the level of microRNA expression in lung cells. So what he did was the following. He took lung cells that were infected with the virus and then he manipulated the microRNA content in those lung cells in such a way that he was able to express a high level of microRNA-548 in those lung cells. And as you can see, these are lung cells that are slightly green, showing that there's some expression of a specific lung protein called nonstructural 1 binding protein. And in those infected cells you see a small amount of viruses as represented by the expression of the viral nucleoprotein that the virus has. If you then lower, really lower the amount of microRNA-548 in those lung cells, what you find is that you get a dramatic up regulation of this lung protein

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nonstructural binding protein in the cells. And with that you also get a dramatically increased expression of the viral nucleoprotein showing that viral replication is dramatically increased. So by manipulating the expression level of this one microRNA, you can switch on/you can tap into the host's cellular machinery and in such a way that you promote the survival of the virus.

Now, and since then Sree has identified a number of other microRNAs that also seem to be involved in allowing influenza to replicate. These findings suggest that you may be able to use these microRNAs as therapeutics. You may be able to develop therapeutics against these microRNAs to fight influenza. They also may be used as biomarkers of influenza infection. There are some cancers that are regulated by specific microRNAs. And those microRNAs actually are shed from the cancer cells into the blood stream. So they can serve as biomarkers. They've been shown to serve as biomarkers of some cancers and they may possibly serve as biomarkers of influenza infection.

Let me talk about a couple other collaborative projects that we have going. These projects address the idea of being able to prevent a worker from contracting influenza. We have a project with Ken Mead at DART. Ken Mead has a project that was funded by the "OPHR," the "OPH..." the Office of Public Health Preparedness Response Division. It's a grant that researchers here at HELD, folks in my lab, and folks in the Respiratory Health Division, David Weismann's group, are participating in. And the project is this, in recent years we're seeing a very dramatic increase of air traffic, particularly international traffic. And that travel occurs in confined spaces where people are tightly packed and they have to live in those spaces for long periods of times. And during this time there's a potential for, if someone becomes sick on that plane, of transferring infectious diseases like Ebola, like flu variants, to other passengers. So the Association of Flight Attendants recommended that the airlines develop some kind of a system where they could isolate a sick patient during flight. And so Ken Mead came up with the idea of developing an isolation unit. And what Ken and Bill Lindsley in my lab did recently was to fly out to Kansas where a Boeing 747 is used as a tool by the airlines for practicing escape drills, etcetera. And what they did was they took a 3-D scan of the cabin and they went back to the lab and now they will be building a mockup of that airline cabin.

And so Ken's plan is to build an isolation unit called the IsoPass. And this isolation unit will encompass two seats. And one of the seats of the airlines could be left open for a flight attendant to attend to a sick patient within this unit. The unit has air vents here so that the ventilation from the air cabin flows into a vent and then flows out through the ventilation system within the airlines. That ventilation system is HEPA filtered.

Here's a picture of Homer. Homer was redesigned to sit in for a sick patient. Homer is going to be programmed to cough tracer aerosols and eventually flu

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virus, and we'll be assessing whether this IsoPass system effectively isolates a patient from all the other passengers. This is Francoise Blachere who she's a young lady who designed that improved infectious detection system for us. And she's sitting there next to Homer.

Another project we have with fighting influenza infection is a project that was, again, funded through the Office of Public Health and Preparedness. This program, or this project, is headed by Steve Martin in RHD. And again, we collaborate with Steve on this particular project. And so this project asked the question: Can you design a UV system that will effectively irradiate the interior of an ambulance and disinfect an ambulance in-between passenger use? Because as you're transporting passengers some passengers may have some really nasty diseases that could be transmitted to the emergency responders or to other patients. So they asked the question: Can you develop a UV system to effectively disinfect the ambulance? And what they did, initial experiments, they had an ambulance, they outfitted the ambulance with 49 different UV sensors, and then they assessed how much UV light was needed to kill Bacillus spores that were placed next to those sensors.

In the early experiments what they found was it takes about 16 hours of exposure to UV light to kill all those bacterial spores throughout the ambulance. That's a long period of time. So what they cleverly did was they took the interior surface and they painted the surface with UV-reflective paint. They put UV-reflective tiles inside the ambulance. And they also tested the position of that UV germicidal lamp at various positions within the interior to optimize the exposure of all those nooks and crannies within the ambulance. And by doing that they were able to knock down or reduce the disinfection time from 16 hours all the way down to 59 minutes. So that leaves open a distinct possibility of using such a system for disinfecting ambulances and perhaps even other means of transportation, like buses, taxis and so on, for future use.

We also have a number of other collaborations going on. The NIOSH sampler has been used by workers on every continent in the United States so we get a lot of calls for using the NIOSH sampler. There's four projects/four collaborations that we currently have ongoing. We recently responded to an outbreak of H7N2 which is an avian low pathogenic flu virus in cats. And that virus outbreak took place this past November in New York City shelter cats. And there was a lot of cats that got infected. So Angie Webber who heads the program, NIOSH's program, called the Disaster Science Response and Relief Program, coordinated our efforts with the ASPCA workers and the New York City Health Department enabling us to go through these cat shelters and do air sampling and surface samplings. The idea being that we wanted to see what the risk was to the workers. And so those experiments are actually ongoing right now.

We've been involved in a number of other projects with Johns Hopkins' Applied

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Physics Lab. We have projects with Ben Cowling at University of Hong Kong who's used our samplers to assay for virus in animal markets, public spaces and in hospitals. We're working with the Duke One Health Training Program facility. They're using samplers in China, Malaysia and Vietnam. And we're also working with the National Heart, Lung and Blood Institute who has our samples for detecting mycobacterium.

So with that I just want to say that this was not done in isolation. My group is small. It's five or six people at any one point in time. But I have the pleasure of being able to interact with a large body of people throughout NIOSH and some outside of NIOSH so I want to thank... There's a lot of folks that I hadn't mentioned in the Health Effects Lab Division that have helped us over the years. I want to thank those at Division of Respiratory Disease Studies. This is David Weissman's group. The National Personal Protective Laboratory in Pittsburgh. That was where the "Why Health Care Staff Catch the Flu" study originated, DSHEFS, DART. And also thank all the folks at WV Hospitals that allow us to go in and do all kinds of testing for air samples.

I want to leave you with four basic questions, maybe a little—like food for thought, maybe some suggestions would be very appreciated. We're a small group, so are there some clinical trials that we haven't looked at that we might want to engage in to better assess aerosol or influenza transmission in general? For example, are there any human challenge trials that would better assess aerosol versus contact and droplet spray transmission? We're a small team but we are able to actually contribute quite a bit.

Are there some host factors that may increase or decrease the risk of infection? So are there some factors that you might want to/that you can think of that we haven't thought of, that we might address?

Is there a need to assess the risk of the responders? This is that cat flu, that H7N2 project where we were assessing the risk of the responders, the risk of the ASPCA workers to getting infection. So do you think there's a greater need to reach out to other responders and assess their risk?

And then, lastly, we talked about UV disinfection being used to disinfect ambulances. Can we use that UV system, can we incorporate that system into the heating and ventilation air cooling systems in buildings? Can we use that on buses? Can we use the UV system on trains, hospital rooms, etcetera? Is there a large scale study that may be needed? I've talked with David Weissman briefly on this subject and about maybe getting a large scale study that would incorporate UV disinfection in such a trial.

With that, I'll leave it there and I'll entertain any questions.

DR. ROGERS:

Thank you for that presentation. We'll have limited time for questions. And I really want to start with the people on the phone. Anybody over the phone have questions or comments?

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- DR. MCKENZIE: I just wanted to know—this is Judith, University of Pennsylvania. I find this study really fascinating and very helpful, especially in the clinical realm.
- DR. ROGERS: Can you speak up a little bit, Judith?
- DR. MCKENZIE: I'm saying that I find this study fascinating and very helpful, especially for the clinical realm. And I will certainly take away some what I've learned to my clinical practice and to my residents, so thank you very much.
- DR. ROGERS: Thank you for that comment. Grace?
- DR. LEMASTERS: Okay. A very interesting talk. In regard to your questions on future directions, I was wondering if you'd thought about—and I think this would be a pretty easy clinical trial—going into elementary school systems during flu season and just increase the humidity in certain rooms, with adding humidifiers into the room, and not other rooms, and see if you get a difference in influenza of the kids in that space.
- DR. NOTI: Yes, we toyed with going into elementary schools years ago. We didn't pursue it but it's an excellent idea. Schools are loaded with kids who are dripping with flu virus.
- DR. LEMASTERS: And teachers are sick all of the time because of the kids coughing and sneezing. So I was thinking it looks like you only have to increase it to 40 percent humidity.
- DR. NOTI: Right. And that's not bad at all.
- DR. LEMASTERS: Right. And you can have your control in the same school, really, or a different school. And the other, just other brief comment, I know NIH is collaborating with pharma now to repurpose drugs and the drugs have been put on the shelf because they didn't make the third cut. And I was thinking of pharma, who makes these vaccines. It seems like those who make the vaccine could also develop something in order to increase microRNA-548 or decrease the NS1ABP. And I just wondered if you thought about working with pharma in a partnership like NIH is doing now.
- DR. NOTI: We haven't quite got that far yet. But there are therapeutics that are actually in use where they don't use micro-RNAs but they use something very similar called "small interfering RNAs." They're just a little larger RNAs. They pretty much do the same thing. So there are small companies now that have developed some of these RNA molecules that they can inject into people and they've used them to attack a few studies. With the constant changing of the flu virus from season to season, the vaccines become... It's a moving target as to what vaccines or what viruses do you develop a vaccine against. With the ever-increasing mutations that occur in flu virus as the years go on, also makes it a moving target as to how you develop an effective vaccine. So different kinds of therapeutics are needed and there are actually a few that are now in studies. This, we kind of feel, is a new niche but yes, partnering with somebody down the road, once we get to a point of really feeling that, in this case, like microRNA-548 is this really going to be a good target for us, yes.

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DR. LEMASTERS: It's robust but different.

DR. NOTI: Yes, it does. I mean, it makes a dramatic—That particular marker RNA makes a dramatic—change in the expression of a lung gene molecule that's actually involved in infection.

DR. ROGERS: And we'll have one more question then and we'll have to move on. Inger?

DR. SCHAUMBERG: I would like to ask you if you have done any research in waste, people who take away waste from the houses or the streets and put them in the vans, where you sort of do like this in the back.

DR. NOTI: No, I haven't had that pleasure yet.

DR. SCHAUMBERG: Because you will have spreading the virus and bacteria at the back of the van but people will also take the infections with them inside the car. And you wash the car on the outside but we found out they never wash them in the inside. So that was something new. Thank you.

DR. ROGERS: Thank you, Dr. Noti, for that presentation. It was very informative. I wish we had time for more discussion but unfortunately we don't. All right, so our next presentation is going to be on indoor environmental quality and teachers' health in an urban school district. Dr. Cox-Ganser? Thank you, Jean.

**EVALUATION OF INDOOR ENVIRONMENTAL QUALITY AND TEACHERS' HEALTH IN AN URBAN SCHOOL DISTRICT**

DR. COX-GANSER: Well, good morning still, everybody. My name is Jean Cox-Ganser and I'm the Research Team Supervisor in Field Studies branch in Respiratory Health Division. And since about 1999 or 2000 we've had projects in our branch on looking at respiratory health problems in relation to indoor environmental quality. And in particular, in relation to dampness and mold. And what I'm going to talk to you today about is some work that's come out of the initial research studies and how we can perhaps do something more practical.

With just a little bit of background to say that there have been a number of organizations that have done review studies on the literature and have said that there's sufficient evidence of a relationship with damp indoor environments and a range of these health outcomes as I list here. And what's been important over the timeframe is that the Institute of Medicine, in 2004 when they looked/said there was only exacerbation of asthma, but the World Health Organization and a couple of later reviews have said there's sufficient evidence for development of asthma in damp indoor environments.

The Institute of Medicine report and the WHO guidelines in 2009 came out with these statements that are really important for public health, really, because what it is, is that, persistent dampness and microbial growth should be prevented since they may produce adverse health effects. And that, if they occur you should remediate them to minimize exposure to microbial agents. And this is important because, really, at the moment, even currently, the specific agents or combinations of agents in relation to dampness in indoor environments is not

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really fully understood.

Our earlier research, using both microbial assessment techniques in dust and also doing these observational assessments that we decided might be very useful, it did indicate to us that dampness and mold scores were positively associated with respiratory health effects. And we did this work in a very big community college and also in a hospital and found both those situations were true.

It's certainly not just in workplaces or schools that these things are important, but homes. In fact, most of the work on health effects of damp indoor environments particularly in relation to children have been in residences. And Mark Mendell from California did a review in 2016 of studies that used these observation based dampness and mold metrics in homes. And showed that the presence of dampness and mold in homes, indicated by sight or smell, is consistently linked with increased risks of multiple respiratory health effects. And that, mold odor is one of the strongest signs of possible health effects. And as I say, currently he emphasized in the report that we still do not understand what the causal agents are.

Now, we've been interested in working in schools, mostly because over the years we've had many health hazard evaluation requests from schools to help them with dampness and mold problems. And also we know that schools are in poor shape physically. In 1995, which is the last time the General Accounting Office put out a report it was like 33, a third to 40 percent of the schools had very poor conditions that could lead to dampness and mold.

So as I said, what we wanted to try and do is use this observational inspection method, use the smell of mold, visual inspection of the rooms for water damage factors such as stains, the signs of water damage on materials, visible mold, obvious dampness or wetness. So we developed two components of this tool, a form which allows people to do these assessments in a standardized way. And then, more recently, software so that it can be implemented.

And this is what the form looks like and how you do it. So I'll just walk a little bit through it to see in the standardized way we approach it. So there would be one of these forms per room or per area. It could be a hallway so it not always has to be a room. So the inspector would write down a time where you are and all that stuff and then you choose the room type.

And the first thing you do when you walk into the area room is the inspector has to note if there's a smell of mold. And although some people in fact don't seem to be able to smell mold so you really have to be able to test this out on your inspector before you use such a person. And it really is subjective. We understand that. And we ask them to say if it's mild, moderate or strong and if they can pinpoint the source of the mold to note that. And then what we do is go around—and I've done this many times myself. We go around—the room and note if the room has—They

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all have ceilings, walls and floors, but then note if they have—windows, furnishings, HVAC systems, supplies and materials, pipes. And then looking at each of the components if there's nothing found in the way of dampness and mold you can just check that off. And if there is, you then use these scoring systems. And I'll talk about scoring system in the next slide. So you work your way systematically through the components and look for damage or stains, visible mold, wetness or dampness. These were some other things that a particular school system we were looking at was interested in. Flaky paint. Some of the old school systems have a lot of flaky paint if they have damp walls. And some of the paint underneath might have lead in it so they were interested to know that. So this is the scoring system we came up with so that it can be used by maintenance level or people who don't really want to say what square feet it is. In earlier tests we'd found out that was a problem to certain inspectors so we just came up with "none," "a size of about a piece of paper," "between the size of a piece of paper or an internal door, standard door size," and then, "larger than the size of a door." So for each component, for instance, if I came here and were looking at the ceiling tiles and they were a little damp or stains all over the place, in your mind you put that altogether and say what the total size is and score it. So between about 2011 and 2014 we developed a collaboration with the Philadelphia School District and the Philadelphia Teachers Union and they worked with us to help improve the form and improve the software. And they did about 100 planned assessments and also assessed about 60 schools for damage from Hurricane Sandy. And what they had done is they used inspectors that they contract with to do asbestos which they have to do under the rules. And they added on our dampness and mold tool at the same time. And then after we had really worked with them for that long we partnered with them to try and put this together with some health. So we eventually agreed to a study in a number of schools doing the dampness and mold assessment, taking samples for laboratory analysis and doing a health questionnaire. And we did this in 2015 and 2016. So we chose 50 elementary schools across the Philadelphia School District. We chose schools that had more than 350 students to get a good staff size. And we also chose from schools that had had this previous assessment by the Philadelphia School District inspectors so that we could look at some of the historical results. We did a Web based health questionnaire offered to all school employees. And the school district worked with us to get us school email addresses and we'd send out waves of invitations. And then we did dampness and mold assessments in all the areas of these 50 schools. We took floor dust samples from each school, 10 from each school, for a total of 500. And we took that from classrooms from teachers who had participated. And we're going to analyze the dust for markers of microbial exposure. We also in those same 500 classrooms, did CO2 monitoring,

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temperature, humidity and measurements.

So I will say that, as with most epidemiological studies, it's very difficult to get very good participation in health. We worked very, very hard, not only with the emails, but the Union would send their reps out to the schools and encourage participation. And on our site visits when we were doing the sampling and that we would encourage participation. What we ended up with was quite good participation by the teachers, about 66 percent. But the other types of employees didn't participate as much. And I'm going to show you some preliminary analyses I've done on the teachers. They were mostly female, non-Hispanic, White and never smokers with a mean age of 44.

Looking at the results of the questionnaire, about 22 percent of teachers reported having physician-diagnosed asthma, compared to BRFSS in Pennsylvania. That was 15 percent. Current asthma, about 15 percent versus about 10 percent in Pennsylvania adults. And we usually ask a question about the date of diagnosis. And we compare that to the date of hire in the schools and come up with whether the asthma was post-hire onset. And about nine and a half percent. So as you can see, so about the same percentage of teachers reported post-hire onset asthma as Pennsylvania adults report current asthma.

Very high prevalence of respiratory symptoms in the past 12 months reported by teachers, ranging from about 40 to over half of them say they will have these symptoms. Now, there aren't good comparisons, reference populations to compare this to. So what we really compare this to is we will look for relationships within our environmental results.

Some preliminary models that I did on a crude assessment of the dampness and mold scores in the schools. I did find associations between schools being above the median of dampness and mold scores with more wheeze, chest tightness and detects a shortness of breath in the past 12 months. With odds ratios ranging from 1.3 to 1.61. And I had adjusted these for gender, race, ethnicity, age, smoking, hay fever as an indication of perhaps atopy in the teachers and reports of mold in the home.

And I'll tell you a little bit about the dampness and mold assessment. We had five teams of two people each and we were there for two weeks. And we evaluated all accessible rooms and areas for a total of about six and a half thousand rooms and areas. And as you see, a high number of classrooms, offices, libraries and storage areas. There are so many storage areas in schools because classrooms will have cupboards, like walk-in cupboards, where they put their books and things like that.

Some preliminary analyses on the science of dampness and mold in these rooms/areas. About four to five and a half percent of areas had visible mold odor or dampness and wet. But three-quarters of the areas had signs of past water damage or stains. This is a breakdown of sort of "mild," "moderate" and "strong"

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mold odor in the rooms that we'd seen. So 21 rooms had very strong mold odor. Most of the Philadelphia schools that we were in were within an inner city region and in quite poor condition.

This is just a three-dimensional histogram to indicate how visible mold was distributed across the components on this x axis. And the count of the number of times or areas and rooms that it was seen. And the scores were the highest in the front, lowest in the back. So you see most of the visible mold was on ceilings and then walls. And then some on pipes and supplies and materials.

Diagram 4, wet and damp areas. And here you see it's mostly on the floors as one may suspect. And a lot of it, in fact, was in basements. And then this huge percentage of water damage and stains, ceilings, walls. Certainly when we get to the highest scores, which is more than a size of an interior door, you see it's the ceilings and walls with some of the floors.

So in 2016 we sent back to the Union and the School District a report for each of the 50 schools for the dampness and mold. And they've reported that they've been using them to aid in repair remediation. And we have a poster on some of these results I've showed you at American Thoracic Society conference in May. So our future plans is we want to continue analyzing all the data we have. And one of the strong things I think we'll have which we're not using culture to look for the fungi, we're using the newer DNA and RNA techniques. And we'll do sort of like a microbiome approach for both the fungi and the bacteria and see if we can see relationships with the health outcomes. And then a practical outcome that we want to do is we want to make that dampness and mold assessment software available on the NIOSH Web page for use by the public.

So my discussion points. So where do we take this research next? How do we further investigate the importance of mold odors or should we? What other areas of indoor environmental quality and what other occupational groups perhaps could we explore? How can we promote the use of that dampness and mold assessment tool more broadly? And should we adapt the tool for different building types such as offices, public buildings, hospitals and homes? Which wouldn't take that much because I think it would mostly be on having a module that allows people to select different types of rooms and areas. So thank you.

DR. ROGERS: Just one quick question before we take questions. On your slides that have the blue, red and green, the columns, what are those colors?

DR. COX-GANSER: So the green is a report of a score of 3, so that's the highest area, I mean, greater than a size of a door. The 2 is in-between the paper and the size of the door. And the 1 is about the size of a piece of paper. So it's pulling off these—I'm just going to try to go back. Sorry it takes so long. Where is it? So here, off these—0, 1, 2, 3 scoring system there. It's a shift.

DR. ROGERS: Thank you. Questions? Dr. Singh?

DR. SINGH: Two questions. The first one is that the study focused on the impact on the

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teachers. And I realize that it's much easier to follow up with the teachers than the students. But couldn't the results be extrapolated to students? They spend that much time in that environment as the teachers. And my second question is what we're doing, the speciation of the organism would give better indication of—I mean, that's an expensive proposition, I realize. But my first question is really wouldn't that apply the same to the students?

DR. COX-GANSER: Absolutely. It does apply to the students. Over the years I think I have sort of asked, "Can't we study the students?" because they're working, because they're at school. But really our mandate being NIOSH is not really to study the children. So but absolutely the environmental quality portion and the relationships with health. And that's one of the reasons the districts want to work with us, is that they're very interested in the health of the students. And I will say that in relation to the influenza talk, we added a module in into our questionnaire on infections which we had not done before, including flu. So I'll be very interested to see how that links up with maybe exacerbation of asthma and things like that as well. Now, the second question is, second point, we are going to speciate. We're going to speciate using the new DNA/RNA methods. So we are going to speciate. We're not going to use culture methods because in this field it has been sort of realized that culture probably picks up about 10 percent of the species. So we're going to try and go beyond that this time. We also are looking at two markers of biomass. We're looking at endotoxin as a biomarker of the gram negative. And we're looking at ergosterol which is in the cell walls of all fungi and is a biomarker of fungal biomass. And we do those two in our own labs upstairs. And we're, in fact, working with Brett Green and his group in HELD to do the sort of microbiome analysis.

So yes, we're very interested in, because even though from maybe a public health point of view it's keeping these buildings dry and don't have the humidity too high, 40 percent may be okay but if you much higher than that you start getting these contaminants being able to proliferate.

DR. SINGH: Thank you.

MS. LASZCZ-DAVIS: Chris Laszcz-Davis. Just a couple of questions if I might. One of them being is, did you at all take into consideration the ambient foliage, pollens and everything else, that would've contributed to asthma in your study?

DR. COX-GANSER: No. The only way we would... No, I mean, at least we have everything at seasons. The seasons are similar. And what we are going to do is we're going to analysis the dust for cockroach allergen, rodent allergen and dust mite allergen.

MS. LASZCZ-DAVIS: And the reason I suggest that is—and I can't cite any studies at this point other than observations—people who live in different parts of the country who have moved to these parts begin to experience asthma symptoms simply by virtue of the natural environment. And maybe another consideration, if this study is expanded, is a question surrounding what other activities are the teachers

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involved in that might've contributed. So just something for the future.

One other question. I don't know that there has been abundant mold sampling, although they're always presented to people in the occupational health arena. And I really can't speak to the faithful representation of mold on cassettes as they relate to the condition. But is there any opportunity to take the reams of data that's been produced and correlated with the work that you've done so you've got some retrospective studies on this as well?

DR. COX-GANSER: Sort of trying to look at the ecology of the microbial contamination?

MS. LASZCZ-DAVIS: Of the work that's been done in terms of exposure studies?

DR. COX-GANSER: Oh, yes. And in fact, we will, obviously, do that. But as I say, in some of our earlier work that I haven't spoken about we had NORA funding to look at asthma in relation to dampness and mold. And we've done that in office buildings and hospitals, as well as school. And in those we did culture and we have found some relationships with total fungal counts. We've found some relationships with water loving fungi. The EPA, a person who worked for the EPA, had come up with an idea of using the ratio sort of fungi that are in water contaminated areas to fungi that are sort of more outside fungi. It's called ERMI and that has found some relationships with asthma.

So there are scattered results here and there that point to, yes, fungi and maybe particular fungi such as penicillium aspergillus, will be related to these health effects. But some studies find it and then some studies don't. So we're very interested, which is why we took the dust samples and are trying to further that part of it while we also do the public health part of it. Thank you for your question.

PARTICIPANT: Mine is more related, on a material level, related to the impact of the study. I mean, you definitely have findings of water damage and stains primarily on the walls and ceilings and on the floors too. My question is, is, what are the schools doing with this information from the tool that you use?

DR. COX-GANSER: So right from the first time in sort of like 20... I can't remember when we first started working with them. Well, when we first started developing the tool with them and working with the Philadelphia school system, for instance, they would take... Their first approach was to take any time there was visible mold seen reported and at a level of 3 and they would send the inspectors out and look. I think they have perhaps modified that over the years. They also have their own problem reporting systems to look for this. But they certainly have used our tool I would say mostly for the mold odors and the visible mold at the moment to help drive their repair and remediation.

So one of the things that we'd like to do when we start looking at exposure response relationships between these scoring systems to see if we could refine that for them and tell them what may be important and what may not be important in relation to health. Because we often have these questions. We've given these reports out at various meetings at the AIHA meetings and the ASHRAE meetings.

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And engineers always want to know, “Well, tell us what the scores mean and where we can cut things off meaningful for health.” So we want to try and do that as well.

DR. ROGERS: Okay. Grace.

DR. LEMASTERS: Very interesting. I work with Dr. Tina Reponen at Cincinnati.

DR. COX-GANSER: Oh, yes. I know Tina well.

DR. LEMASTERS: And we’ve done, as you know, a lot of mold studies and pollens and so forth. And I would say this would be very helpful if you could make it available either on your website or through Wikipedia, or some way.

DR. COX-GANSER: The tool, yes.

DR. LEMASTERS: Yes. The tool is very nice and very easy to execute. And the second point was in regard to the children. And teachers are a wealth of information about the kids in their classroom. They know who has asthma. They know who has eczema. And they know who has shortness of breath and other allergic symptoms. So a rough measurement while you’re interviewing the teacher would be to ask about her students, right? How many in your classroom do you think have asthma? Eczema, quite apparent. And so forth.

DR. COX-GANSER: Yes, that’s a good idea. In fact, we’re working in collaboration with a group out of Tulsa, Oklahoma, Dr. Richard Shaughnessy. You must know Richard Shaughnessy, I guess.

DR. LEMASTERS: Yes.

DR. COX-GANSER: And they are working with a Colorado school system where they’re trying to gather those metrics and add them in. We’ve done some of this dampness and mold there and they’re trying to add that in. But I agree, it would be great.

DR. LEMASTERS: I think you could do—you could just send a letter to the teachers and say, “While we’re there...” or at least some of them, a sample. The other, just one other point, and I’m concerned about the confounding effect that you may not be thinking about. We published a paper on public schools and 40 percent of public schools are within 400 meters of interstate highways or regular state highways. And traffic related air pollution has been shown to be strongly related to asthma and eczema and allergies. So I was wondering if you might be able to incorporate distance from road in order to control for that factor, which could also be associated with the asthma that you’re finding.

DR. COX-GANSER: Yes, I think that’s a good idea. That’s a good idea because obviously it’s all mapped. But there’s something else that we’re aiming to do, is to take some of the EPA monitoring stations that are around Philadelphia and also take the results from these time periods, and perhaps create variables that may be able to look at the air pollution in relation to these. So we thought that we would try in some way account for the outside air.

DR. LEMASTERS: A quick and dirty way besides getting this massive amount of data through, because we put up 27 networks ourselves and it’s just massive amount—

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- DR. COX-GANSER: Right, to reduce it.
- DR. LEMASTERS: Is just distance from interstate and state highways; that would be much easier done than dealing with this massive amount of air pollution data.
- DR. COX-GANSER: It's a great idea.
- DR. MIDDENDORF: This is Paul Middendorf. Jean, you mentioned that you were using mold odor as an indicator. Have you looked to see if there aren't any components of mold odor that you could use to become a little more objective in that determination?
- DR. COX-GANSER: The microbial VOCs? There have been others across, not only our country, but Germany, Scandinavia. They're looking into the MVOCs . And I'm sure nowadays with the making of the very tiny like sniffers, I think that's probably a good way to go. I think it's worth looking into but what we particularly were trying to do is almost find a way that you can use this kind of thing as a surveillance tool. It's almost like a first screening where you don't need a lot of money, you don't need a lot of training and you can gather good information that does relate to the state of the building, whether it's deteriorating and to the health. So we, particularly, in this practical tool, kept away from that. But from a scientific point of view I think it's a very good idea.
- DR. ROGERS: Are there questions from the phone or comments?
- DR. COURTNEY: This is Ted Courtney. I just wanted to mention an observation I was mulling over from the previous presentation and actually arcs very nicely into this one which is, can NIOSH kind of consolidate the expert perspectives from different indoor air quality initiatives and sort of tweak its recommendations? Because I was very intrigued that humidity was preventative for, or protective for influenza but then I wondered, even before this presentation came up and was a great follow on, that what level humidity do you cross over into having the mold risk be competitive in terms of its increasing? So just trying to find whatever might be the sweet spot for bioactive organisms and kind of relative humidity and other indoor quality standard recommendations.
- DR. COX-GANSER: Yes, that would be great. We'd be willing to work with the influenza people. It would be great.
- DR. ROGERS: That was interesting to see that sort of distinction between the two.
- DR. COX-GANSER: Well, you know, with the chambers they have maybe we could devise some experiments that may answer some of that.
- DR. ROGERS: Sort of a crossover there. Any other comments on the phone? Questions?
- DR. ARMENTI: Yes. This is Karla. I have a quick comment and...I guess comments. This is really great. I think mold is a serious issue, not only in schools, but other buildings, especially after horrible weather events. And I'm just thinking if you can kind of hop on the emergency response, or emergency responder movement, I guess, and do some collaboration there. I'm thinking of New Jersey after Sandy's storm. And there's just so many buildings that maybe a tool like this would be really helpful. So I would highly recommend that you adapt if for different building types

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- for sure. It's really great work.
- DR. COX-GANSER: Thank you. I presented at—
- DR. ARMENTI: Will you be publishing this any?
- DR. COX-GANSER: Oh, yes.
- DR. ARMENTI: Oh, I'm just curious if you're going to publish it.
- DR. COX-GANSER: So yes, apart from publishing dose response relationships and the relationship with health, when we're putting this up on the Web we want to have it with a practical kind of paper, maybe in the Journal of School Health, maybe in some other professional kind of AIHA Synergist, something like that, to start to say that it's out there. Over the years when we've met with people at various meetings and we've had a copy of this form, an earlier copy, on our website, we get lots of requests from various organizations to use it. So we have to get this thing up there. A lot of people will use it.
- DR. MCKENZIE: This is Judith McKenzie. I just want to comment, if I may. I realize, your study, a lot of studies have been done in Philadelphia with asthma but they have focused more on children and asthma. And I think it's nice to actually look at workers, namely teachers. And it's interesting that with the Pennsylvania adults having, and teachers, at least, having a higher incidence of asthma (inaudible @ 00:22:27) asthma occurrence. And it would be interesting also because I think you had mentioned that there was no comparison group in terms of symptoms in the school. And maybe that might be something to see if we can find a comparison in terms of the respiratory symptoms over the past 12 months. But I really like your study. Thank you for doing it. And it's nice that we're focusing on workers in Philadelphia as so much work has been done on the resident children. Thank you.
- DR. COX-GANSER: Thank you for the comment.
- DR. ROGERS: Okay. Thank you very much. And thank you for the comments from the board. And thank you for that presentation.
- DR. COX-GANSER: You're welcome.

**SUMMARY AND WRAP-UP, FUTURE AGENDA ITEMS, MEETING DATES, CLOSING REMARKS**

- DR. ROGERS: It's very interesting, always. So I wanted to thank all the presenters today for all of the good information that has been shared. And again, all the interesting comments I think from the BSC as well that I think really can lead to a lot of good future research.
- And one of the things I think that I wanted to mention from all of the discussions that keeps coming up, is end user, and the effects on the end user. Not only from the equipment that's being used, but also I think you mentioned with medical surveillance. That's an important piece because that really reflects the damage that's done to the end user from the exposures that are happening. So that might be something that in terms of recommendations that that would be a consideration I think for all kinds of research that NIOSH does, is always to consider the end user and the impact on the end user as well. I think that was sort

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of what I really heard a lot today and so I think that's an interesting point. So again, I wanted to just thank you and also thank Paul—And I know he wants to... He's biting at the chip here to say something. But to thank Paul—for his contributions to our meetings and also Alberto as well. And I also wanted to thank Richie, who will be retiring. And as you all know, Richie will be leaving in May, I think, right?

DR. DICKERSON:

Yes.

DR. ROGERS:

And who we have—I mean, I've been with her for six years so all the good travel stuff that she has helped us with. And we have Pauline now. Pauline will be excited to work with us as well. But Richie always did such a great job keeping us in line. I always told her she was like herding the cattle getting us in a very pleasant way to comply. So I appreciate that. But I'll let Paul speak.

DR. MIDDENDORF:

Okay. Well, thank you. On behalf of NIOSH I want to thank each of the board members for taking your very valuable time and sharing your knowledge and expertise with us and with our programs. I know that each of the programs takes the interactions that they've had with your to heart and they learn from it. And it really does help the programs in the long run. So thank you very, very much for taking your very valuable time.

DR. ROGERS:

Well, thank you so much, Paul. We appreciate also the staff here in Morgantown for hosting us. This meeting is really great. Both the tours that we had and certainly thanking Max as well for the Wikipedia. That was my first use of Wikipedia so... Oh, I should tell Dr. Howard, I did make a Wikipedia entry to correct...was it the National Institute "of" Occupational Safety and Health to "for." So there you go. So I have an entry of it since that. It's great. So, so much fun. So the next meeting of course will be sometime in the fall, September/October-ish. And we'll be in touch via email to work out a date for that. So I hope everybody has safe travels home. And always thanking Margaret and Dr. Howard for their participation. But we're eager to learn about the budget and we'll be waiting to hear that breathlessly. All right? All right. So thank you all very much. Have safe travels home.

DR. MIDDENDORF:

Thank you very much, Bonnie.

DR. ROGERS:

We'll miss working with you. But maybe you'll get some relief.

[END MEETING]

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**G L O S S A R Y**

BSC	Board of Scientific Counselors
CDC	United States Centers for Disease Control and Prevention
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
EPA	Environmental Protection Agency
FACA	Federal Advisory Committee Act of 1972
HHS	US Department of Health and Human Services
IRB	Institutional Review Board
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration

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**Appendix A**

**Department of Health and Human Services  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health  
Board of Scientific Counselors (BSC)  
Agenda: Sixty-Eighth Meeting**

NIOSH Offices  
1095 Willowdale Road  
Morgantown, WV

Conference Number: 888-397-9578  
Participant Code: 63257516  
<https://odniosh.adobeconnect.com/nioshbsc/>

**Wednesday – April 12, 2017**

<b>Time</b>	<b>Topic</b>	<b>Presenter</b>
8:30 am	Welcome and Introduction Meeting Logistics	Dr. Paul Middendorf DFO, NIOSH
8:40 am	Agenda, Announcements, and Approval of Minutes	Dr. Bonnie Rogers Chair, NIOSH BSC
8:50 am	Director's Opening Remarks	Dr. John Howard Director, NIOSH
9:20 am	Public Comments	Dr. Paul Middendorf DFO, NIOSH
9:30 am	Occupational Motor Vehicle Safety- Engineering and Technology-based Research	Dr. Stephanie Pratt, Director, NIOSH Center for Motor Vehicle Safety and Dr. Hongwei Hsiao,
10:15 am	Nanotoxicology	Dr. Jenny Roberts Health Effects Laboratory Division
10:55 am	Break	
11:05 am	An Update on Influenza Research at NIOSH	Dr. John Noti Health Effects Laboratory Division
11:45 am	Evaluation of Indoor Environmental Quality and Teachers' Health in an Urban School District	Dr. Jean Cox-Ganser Respiratory Health Division
12:30 pm	Summary & Wrap-up, Future Agenda Items, Meeting Dates, Closing Remarks	Dr. Bonnie Rogers Chair, NIOSH BSC
12:45 pm	Adjourn	

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**Appendix B**

**Board of Scientific Counselors  
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Morgantown, WV  
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**New Members of the Board of Scientific Counselors (BSC)**

**Michael Behm, PhD, CSP**

College of Engineering and Technology; Occupational Safety Program, East Carolina University

**Chris Lasczc-Davis, MS, CIH, FAIHA**

The Environmental Quality Organization, LLC

**Budget**

Dr. Howard will present the most current budget information at the time of the meeting.

**Organizational and Personnel Announcements**

**Dr. Tom Frieden** resigned from CDC Director position on January 20, 2017; present Acting Director is **RADM Anne Schuchat, MD**.

**Christina Spring** has been appointed as the new Associate Director for Communication at the National Institute for Occupational Safety and Health (NIOSH), effective January 1, 2017.

**Michael Loudermilk** has been appointed as the new Associate Director for Information Technology at the National Institute for Occupational Safety and Health (NIOSH), effective Tuesday February 21, 2017.

**Retired:**

**Gregory R. Wagner**, Senior Medical Advisor, retired January 31, 2017.

**Fred Blosser**, Associate Director for Communications retired on December 31, 2016.

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**Currently or Recently Available for Public Review and Comment**

**Docket 288-A:** A Performance Test Protocol for Closed System Transfer Devices Used During Pharmacy Compounding and Administration of Hazardous Drugs; Extension of Comment Period. Written comments were to be received by December 7, 2016. In response to a request from interested parties, NIOSH has extended the comment period until June 7, 2017.

**Docket 292:** NIOSH announces the availability of a draft chapter to be published in the NIOSH Manual of Analytical Methods entitled, “Analysis of Carbon Nanotubes and Nanofibers on Filters by Transmission Electron Microscopy.” Comments will be accepted until 11:59 p.m. EST on April 28, 2017.

**Docket No. CDC-2017-0008:** Survey of Engineered Nanomaterial Occupational Safety and Health Practices—New. The Docket closed yesterday, April 11<sup>th</sup>.

**New Programs and Initiatives**

**NIOSH Experts Join Vice President Biden on Cancer Moonshot**

On December 13, NIOSH staff joined Vice President Joe Biden to provide expertise and input to the Cancer Moonshot project. This bold initiative seeks to end cancer as we know it by advancing cancer prevention, diagnosis, and treatment. NIOSH's work with first responders, including 9/11 responders, prompted the invitation to meet with Vice President Biden. Participants discussed how to share assets and experience that could help achieve the Cancer Moonshot. In attendance included Dr. Dori Reissman and Jessica Bilics from the World Trade Center Health Program; Dr. Teresa Schnorr from Division of Surveillance, Hazard Evaluations and Field Studies.

**NIOSH, OSHA, and National Service, Transmission, Exploration & Production Safety Network Renew Alliance Agreement**

On November 28, at the 2016 OSHA Oil and Gas Safety and Health Conference, representatives from NIOSH, OSHA, and the National Service, Transmission, Exploration & Production Safety (STEPS) Network signed a five-year extension of their alliance, which began two years ago. The renewal affirms the organization's continued emphasis on preventing fatalities, injuries, exposures, and illnesses in the United States onshore exploration and production sector of the oil and gas industry. Specifically, each organization is committed to providing employers and

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workers in the industry with information, guidance, and access to education or training resources that will help them protect the health and safety of workers and understand the rights of workers and the responsibilities of employers under the Occupational Safety and Health Act. During the initial two-year agreement, the alliance participants enhanced a NIOSH database of fatalities in the oil and gas extraction industry, and used the database to help drive the alliance's activities. For example, participants developed and distributed hazard alerts on tank gauging and hot work based on an analysis of fatalities identified in the database.

### **Center for Maritime Safety and Health Studies Signs Partnership Agreement with Yale University**

In February NIOSH's Center for Maritime Safety and Health Studies (CMSHS) finalized a partnership agreement with the Yale University Maritime Research Center to, "Improve safety and health conditions at maritime workplaces throughout the United States." The agreement runs through 2022 and will provide a framework for "Advancing the protection of maritime workers through research and technical assistance, supporting the application of research to practice, developing and promoting best practices, education, and increasing employers' awareness and adoption of effective prevention strategies and technologies."

### **Zika Virus**

NIOSH jointly issued the Interim Guidance for Protecting Workers from Occupational Exposure to Zika Virus with OSHA. Guidance can be found at

[https://www.cdc.gov/niosh/topics/outdoor/mosquito-borne/pdfs/osha-niosh\\_fs-3855\\_zika\\_virus\\_04-2016.pdf](https://www.cdc.gov/niosh/topics/outdoor/mosquito-borne/pdfs/osha-niosh_fs-3855_zika_virus_04-2016.pdf)

### **NIOSH Center for Motor Vehicle Safety Contributes to Forbes**

Self-driving cars are gaining attention, but most U.S. workers will still be driving themselves for decades to come. NIOSH Center for Motor Vehicle Safety Director Stephanie Pratt, PhD, shares how businesses can keep workers safe on the road in her Forbes guest post, "[Until Self-Driving Cars Go Mainstream, How Can Businesses Protect Workers from Crashes?](#)"

### **NIOSH and the Board of Certified Safety Professionals Renew Agreement**

NIOSH and the Board of Certified Safety Professionals recently renewed an agreement to use their collaborative efforts and expertise to improve the protection of workers through effective prevention strategies and technologies. In addition, the partners will encourage students and other

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professionals to choose occupational safety and health as a career and advance their competency in that field

### **Reaching Our Audience Where They Are: Our Work with Wikipedia**

Wikipedia is one of the most widely read websites in the world. In fact, it is read by hundreds of millions of people around the world every year. For the last two years, our ‘Wikipedians in Residence’ have been making improvements to Wikipedia articles, putting our latest research in front of Wikipedia’s millions of readers.

Our partnership with Wikipedia also includes adding video content. It is not often you come across videos while reading Wikipedia, but we are leading the charge in adding rich audiovisual content that goes above and beyond just reading plain text. Over the past several months we have uploaded 98 of our videos and have embedded most of them within Wikipedia articles. For example, when you go to the Wikipedia article on human factors and ergonomics, you’ll also see our video, *Practical Demonstrations of Ergonomic Principles*. We are seeing great results from our efforts as our videos have been viewed on Wikipedia over 50,000 times since we started posting them in February 2016. In fact, some individual videos have been watched more on Wikipedia than on our YouTube channel. We are excited by the potential that videos have in spreading occupational safety and health information to our audience.

### **Workshop on the Integration of FDA and NIOSH Processes**

NIOSH funded a National Academies Workshop on August 1, 2016 to address the joint authorities for respiratory protective devices in healthcare. The Food and Drug Administration (FDA) and the National Institute for Occupational Safety and Health (NIOSH) have responsibilities for evaluating and regulating respiratory protective devices (RPDs) for health care workers. The workshop was focused on exploring the strengths and limitations of several current test methods for N95 respirators as well as identifying ongoing research and research needs. Points brought up by the workshop participants were (1) ensuring the health of health care workers is paramount, (2) reducing confusion and duplication, (3) harmonization and integration are needed, (4) major challenges include comfort, fit, face seal integrity, contamination, effectiveness, stockpiling, expiration dates, supply lines, and hazard assessment and (5) increasing the opportunities to provide feedback on issues regarding respirator performance is critical. A Memorandum of Understanding between NIOSH and FDA is in final clearance to support efforts to unify the processes. The next steps are:

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- FDA to publish a notice in the federal register announcing their intent to exempt the N95s they no longer intend to review from the requirements of section 510(k) of the Federal Food, Drug, and Cosmetic Act
- Allow an opportunity for the public to comment on the proposed exemption
- Finalize the exemption

### **Sound Level Meter App**

NIOSH Engineering and Physical Hazards Branch (EPHB) hearing loss researchers collaborated with an app developer, EA LAB, to create an iOS based sound level meter app that measures and characterizes occupational noise exposure similar to professional instruments. The free app is available to more than 2 billion smartphone users on the NIOSH website

<https://www.cdc.gov/niosh/topics/noise/app.html>

and can serve as a tool to raise workers' awareness about noise in their work environment and help them make informed decisions about the potential hazards to their hearing. In addition, the app can serve as a research tool for scientists and occupational safety and health professionals to collect noise exposure data and promote better hearing health and prevention efforts. Users can compare their noise exposures to the NIOSH recommended exposure limit (REL) and OSHA permissible exposure limit (PEL). As of February 25<sup>th</sup> 2017, the app has been downloaded 35,300 times.

## **NIOSH Research Rounds**

### **Study Finds Link between Paid Sick Leave and Children's Use of Healthcare Services**

Many workers probably know that access to sick leave can help prevent the spread of flu and other illnesses at work. In fact, access to paid sick leave could go beyond workers and help improve their children's use of healthcare services, as well, according to a new study at NIOSH (<https://www.cdc.gov/niosh/index.htm>).

Published in the *American Journal of Industrial Medicine*, the study found that children of parents with paid sick leave were more likely to receive annual flu shots, compared to children of parents without paid sick leave. Similarly, children of parents with paid sick leave were more likely to receive annual well-child checkups compared to children whose parents lacked paid sick leave.

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The study used 2011–2015 data from the National Health Interview Survey for more than 38,800 children under 18 years old. Conducted by the National Center for Health Statistics, this survey collects nationwide information on a wide range of health topics.

### **Hearing Protection Improves after Earplug Testing**

Hearing protection among oil-rig workers improved significantly after they underwent testing for properly fitting earplugs, according to a new study by NIOSH (<https://www.cdc.gov/niosh/index.htm>). The researchers reported the findings of their study in the *International Journal of Audiology*.

In 2012 and 2013, NIOSH researchers traveled to Louisiana and Texas to test hearing protection devices (HPD) among 126 volunteer study participants employed as oil-rig inspectors and engineers. These workers face significant work-related noise from the helicopters that bring them to and from the offshore worksite. To test the level of protection afforded by the workers' earplugs, known as fit testing, they used the NIOSH-developed system HPD Well-Fit™. This simple system, which travels easily to field studies such as this one, involves having workers test their hearing with and without HPDs in their ears. The fit-test system measures the noise reduction provided by each worker's own earplugs. Before the fit testing, less than half of participants had adequate reduction in the noises they might experience on the job. After the testing, more than 85% had adequate protection. Individual fit testing can identify when earplugs do not fit a worker's ear canals and can help to train workers to effectively fit and wear earplugs.

### **Modified "Walk-through" Ladder Tested in Virtual Reality Laboratory**

March was National Ladder Safety Month, but ladder safety is a year-round priority at NIOSH <https://www.cdc.gov/niosh/index.htm>, where scientists study how to prevent ladder-related falls. In a new study published in the journal *Applied Ergonomics*, a “walk-through” ladder was comparable in safety to regular ladders tested in the NIOSH Virtual Reality Laboratory in Morgantown, West Virginia.

In this study, NIOSH scientists compared walk-through to regular extension ladders in the NIOSH Virtual Reality Laboratory, which uses computerized, surround-screen technology to mimic the experience of being at an elevated height. While study participants walked from the ladders to a simulated rooftop and back, the scientists measured participants' body movements and the amount of force on the ladders and estimated the required friction at the ladder base. Both types of ladders had comparable measurements that indicated a low risk of sliding out and causing a fall when positioned at the proper 75.5-degree angle. While the walk-through ladder

made it easier for participants to move from the ladder to the simulated roof, it did not ease the transition back to the ladder. Study participants included 16 experienced and 16 inexperienced male ladder users. The average age of the experienced group was 40 years, and the average age of the inexperienced group was 33 years.

For ladder safety, the scientists recommend placing ladders at the proper angle and tying them to a secure structure at the top and, if possible, the base. To help workers and other user's position extension ladders correctly, NIOSH developed the award-winning Ladder Safety app. This app is available for free download from the App Store and Google Play.

([https://www.cdc.gov/niosh/topics/falls/mobileapp.html?s\\_cid=3ni7d2\\_ResearchRounds](https://www.cdc.gov/niosh/topics/falls/mobileapp.html?s_cid=3ni7d2_ResearchRounds)).

### **Exposure to Surgical Smoke Persists, Despite Available Ventilation Controls**

A recent survey of healthcare workers found that certain surgical procedures often lack ventilation that removes surgical smoke at its source. As a result, some healthcare workers may face serious health problems from exposure to surgical smoke, as explained in an article in the *American Journal of Industrial Medicine*.

NIOSH researchers analyzed data from a targeted, anonymous, web-based survey to examine what precautions healthcare employers and workers take in relation to hazardous substances, including surgical smoke. The NIOSH Health and Safety Practices Survey of Healthcare Workers is the largest federally sponsored survey of healthcare workers in the United States. It addresses safety and health practices relative to the use of hazardous chemicals among more than 12,000 healthcare workers. Of the respondents, more than 4,500 reported exposure to surgical smoke during electrosurgery or laser surgery and answered specific questions about work practices that control surgical smoke. Most respondents were female, white, and between 41 and 55 years of age. In terms of occupation, over one-third were nurse anesthetists, and about one-fifth were anesthesiologists.

The results showed that only 47% of the respondents reported always using local exhaust ventilation (LEV) during laser surgery, and even fewer, 14%, always used LEV during electrosurgery. Respondents who reported always using LEV also were more likely to report that they had received training on the hazards of surgical smoke and that their employer had procedures in place for preventing exposure. Few survey respondents reported that they wore respiratory protection; most wore surgical or laser masks, neither of which provide respiratory protection. Electrosurgery was the most common source of exposure to surgical smoke, with 4,500 respondents reporting they were present during this procedure. In contrast, 1,392

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respondents reported exposure during laser surgery. These survey results can help raise awareness about the importance of local control of surgical smoke by underscoring impediments to LEV use.

### **Respiratory Health Division**

Investigators are evaluating exposures to flavoring chemicals and the respiratory health of workers in coffee processing facilities. In the last 12 months, there have been 13 site visits to coffee processing facilities. One final report has been issued and others are in progress.

A report was published in the March 2017 Morbidity and Mortality Weekly Report (MMWR) documenting US deaths from malignant mesothelioma (MM). There were 45,221 deaths from MM during 1999-2015. Death certificates reported MM as the underlying or contributing cause in 2,479 cases in 1999 rising to a high of 2,873 deaths in 2012 and then decreasing to 2,597 in 2015, the most recent year where data is available. Age-specific death rates increased significantly among persons 85 years and older and decreased significantly among persons in the 45-54, 55-64, and 65-74 age groups. Substantial numbers of cases continue to occur in those younger age groups, emphasizing the need to maintain efforts to prevent exposures to fibers of commercial asbestos and other causative elongate mineral particles.

A report was published in the MMWR in December 2016 using data from the Behavioral Risk Factor Surveillance System (BRFSS) collected in 2013 to estimate the industry-specific and occupation-specific proportions of adults with current asthma by state among workers. BRFSS is the principal source of information on the health risk factors, preventive health practices, and disease status of the civilian noninstitutionalized population of the United States. The study estimated that as many as 2.7 million U.S. workers might have asthma caused or exacerbated by workplace conditions. The industry with the greatest prevalence of workers with current asthma was healthcare and social assistance (10.7%). The occupations with prevalence greater than 10% were health care support (12.4%), community and social services (12.2%), personal care and service (12.1%), arts, design, entertainment, sports, and media (11.7%), and office and administrative support (10.2%).

Work is in progress to study office equipment emissions, including 3D printers (additive manufacturing), in both chamber and field settings. In the last 12 months, we collected data at multiple facilities, including several in South Africa, where we have an ongoing collaboration with university-based researchers. Chamber findings on particulate emissions from 3D printers have been published and several other manuscripts are in progress.

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Indoor environmental quality issues were addressed in 100 Health Hazard Evaluation requests in 2016 that involved indoor dampness and mold. In addition, we collaborated with the School District of Philadelphia to further develop and demonstrate the usefulness of Dampness and Mold Assessment Tool (DMAT) software to assess indoor dampness and mold problems and prioritize buildings for repairs. DMAT software is also being used as part of a larger study of remediation in schools in Boulder, CO.

A Health Hazard Evaluation was completed at a hospital where cleaning staff had concerns about health effects of a sporicidal disinfectant containing hydrogen peroxide, peroxyacetic acid, and acetic acid. We found respiratory health effects associated with relatively low levels of exposure. Initial findings were previously reported in the April, 2016 MMWR.

A web-based version of Spirometry Longitudinal Data Analysis (SPIROLA) software is being developed and will be demonstrated at the American Occupational Health Conference (AOHC) in Denver, CO in April 2017. In addition, presentations at the meeting with representatives from the U.S. Navy, University of Maryland, and OSHA will highlight how SPIROLA is used in a range of settings.

### **Coffee Processing Initiative**

Field Studies Branch (FSB) has received 22 health hazard evaluation (HHE) requests at coffee processing facilities, including the sentinel plant HHE, which remains open. There are 19 other open HHEs in coffee processing facilities. Site visits have been completed at 14 facilities. One final report has been issued, and staff are preparing 11 additional final reports and one interim report. Site visits are planned for four facilities in FY2017. There are two HHEs in the “to be determined” status and three that have been closed without site visits.

## **Division of Surveillance, Hazard Evaluations, and Field Studies**

The American Congress of Obstetricians and Gynecologists (ACOG) and the American College of Occupational and Environmental Medicine (ACOEM) adopted NIOSH provisional guidance on physical job demands/lifting during pregnancy in their clinical guidance statements. Although these statements are not new (2015-2016), the impact from them continues. A draft Current Intelligence Bulletin of the guidelines for lifting during pregnancy is in the review process. To aid dissemination, an accredited online training video is being developed to provide instruction to medical providers in how to apply the guidelines in their clinical practice.

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DSHEFS announces the new leadership for the Firefighter Fatality Investigation Cardiovascular Disease Team: Wendi Dick, MD, MPH. Dr. Dick is a Board-certified preventive medicine physician with multi-governmental agency experience at the local and federal level including OSHA, VA, and Department of Defense (Air Force, Army). The Firefighter Fatality Investigation Cardiovascular Disease Team conducts independent investigations of fire fighter line-of-duty deaths.

### **Division of Applied Research and Technology**

On November 7, NIOSH researchers held a public meeting concerning the draft of a universal closed system drug-transfer device (CSTD) testing protocol entitled, “A Performance Test Protocol for Closed System Transfer Devices Used During Pharmacy Compounding and Administration of Hazardous Drugs.” The protocol is still in development but the meeting allowed the public an early opportunity to address the new draft protocol and the proposed list of hazardous drug test challenge agents as the protocol is being refined. The draft protocol and public meeting notice were posted to the Federal Register on September 15, 2016. Twenty-six people from major pharmaceutical and CSTD manufacturing companies attended the meeting in person along with 15 NIOSH participants. There were an additional 19 online participants.

NIOSH EPHB researchers collaborated with NCEH, CDC (National Center for Environment Health, CDC) and NIDCD, NIH (National Institute on Deafness and Other Communication Disorders, National Institutes of Health) on a CDC Vital Signs article on Hearing Loss in non-occupationally noise exposed workers. Although the focus of the CDC Vital Signs piece in general was on non-occupational hearing loss, the accompanying MMWR article (co-authored by a NIOSH EPHB researcher) focuses on audiogram patterns (notches) that are consistent with occupational noise exposure, because the sample included too few people exposed only to non-occupational noise to do a separate analysis of notches in that group.

The release of the CDC Vital Signs has gained considerable interest and publicity as it relates to noise as a hazard in the general public. MMWR Article:

[https://www.cdc.gov/mmwr/volumes/66/wr/mm6605e3.htm?s\\_cid=mm6605e3\\_w](https://www.cdc.gov/mmwr/volumes/66/wr/mm6605e3.htm?s_cid=mm6605e3_w)

CDC Vital Signs <https://www.cdc.gov/vitalsigns/hearingloss/index.html>

NIOSH EPHB researchers in collaboration with the NIOSH Nanotechnology Research Center (NTRC) completed initial field studies at an additive manufacturing facility that uses advanced materials and intelligent software to 3D print carbon fiber and carbon nanotube filled composite materials for aerospace, oil and gas, medical, automotive, and electronics industries. The focus of

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the site visit was to evaluate worker exposures and process emissions from a Fused Filament Fabrication (FFF) additive machine that used 25% carbon nanotubes in the filament. The company requested additional follow-up NIOSH research to evaluate a new laser additive machine and several new large robotic arm additive machines that were being installed during the NIOSH visit.

A web book of the NIOSH Manual of Analytical Methods (NMAM) 5<sup>th</sup> Edition was published online on February 28, 2017. The content in this web book consists of the guidance chapters and methods from the NMAM which has been packaged into one file. This web book allows users to download the entire NMAM rather than going to each individual book or chapter. The web book is available at: <https://www.cdc.gov/niosh/nmam/>

A successful partnership between NIOSH and Kanomax Japan, Inc. allowed licensing and transfer of proprietary technologies developed by NIOSH, as a collaborative effort with Kanomax, Inc. A new, instrument was developed: the Portable Aerosol Mobility Spectrometer (PAMS). The PAMS is a battery operated, portable instrument designed for measurement of the particle size distribution and concentration of nanoscale aerosols in workplace atmospheres. The instrument is commercially available (<http://www.kanomax-usa.com/product/pams/>). NIOSH researchers and Kanomax, Inc. are currently partnering on development of a portable unit for measuring the elemental composition of aerosols. This partnership began in 2010.

## Division of Safety Research

### March is National Ladder Safety Month

NIOSH is participating in the American Ladder Institute's inaugural National Ladder Safety Observance this month. This safety observance is focused on raising awareness about the importance of safe ladder use. Visit NIOSH's *Falls in the Workplace* page to learn more, and to download our award-winning NIOSH Ladder Safety app. Also, follow us on Twitter [@NIOSH](https://twitter.com/NIOSH) throughout the month for ladder safety tips, tools, and communication products available at <https://www.cdc.gov/niosh/topics/falls/mobileapp.html>.

**A special issue of the Journal of Safety Research** was published in February, dedicated to research presented at the 2015 National Occupational Injury Research Symposium (NOIRS). Publication available at <http://www.sciencedirect.com/science/journal/00224375/60>.

NOIRS was co-sponsored by NIOSH, National Safety Council, American Society of Safety Engineers, Liberty Mutual Research Institute for Safety, and Society for Advancement of

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Violence and Injury Research. The special issue is being provided with open access through July 2017, and comprises thirteen full-length manuscripts, two short commentaries, and several editorials.

### **Center for Motor Vehicle Safety mid-course review**

The Center for Motor Vehicle Safety has completed the mid-course review of its 5-year strategic plan to ensure and document progress on meeting strategic goals and stakeholder needs. Input was received from a public web meeting, the docket, and expert stakeholder reviews, and was accompanied by an internal self-assessment. The final report summarizes comments that were received and outlines next steps for the Center in the near term.

## **Education and Information Division**

NIOSH published Current Intelligence Bulletin 68: NIOSH Chemical Carcinogen Policy. This document describes in a transparent manner how NIOSH will classify occupational chemical carcinogens, will set risk management levels, and will consider analytic feasibility. This policy responds to previous stakeholder input regarding how NIOSH classifies chemical carcinogens. Peer, stakeholder, and public comments were considered in the final policy.

NIOSH developed a new chemical resource web page that provides a comprehensive compilation of NIOSH chemical information and recommendations. Subpages include information about specific chemical topic pages, publications, databases, tools, risk assessment, engineering controls, personal protective equipment, NIOSH blogs, ongoing research, and additional resources. The chemical resource web page is available at <https://www.cdc.gov/niosh/chemicals/>.

NIOSH has released its draft occupational exposure banding guidance and related web products at <https://www.cdc.gov/niosh/topics/oeb/default.html>. This draft methodology provides an alternative proposed process to assess the risks of workplace chemicals that do not have occupational exposure limits. In addition to peer, stakeholder, and public review, NIOSH will hold a public meeting to receive public input on these draft products.

The Safe-Skilled-Ready Workforce program confirmed a partnership with Workforce Tulsa, a workforce development program in Oklahoma, to develop a foundational occupational safety and health program tailored to meet the needs of low-skilled and disadvantaged contingent workers.

NIOSH coordinated a meeting with SUNY Polytechnic Institute Colleges of Nanoscale Science & Engineering, National Institute of Standards and Technology, Science and Technology Policy

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Institute and West Virginia University in Albany on Nov 3-4. The meeting continued the collaboration of the SUNY Poly-NIOSH Partnership to Advance Research and Guidance for Occupational Safety and Health in Nanoelectronics.

NIOSH participated in the peer review panel convened by the World Health Organization and International Labour Organization International Programme on Chemical Safety. This panel is charged with the development and review of International Chemical Safety Cards. Faye Rice of NIOSH drafted six fiber and dust card updates that were reviewed and accepted by the committee.

### **Emergency Preparedness and Response Office**

NIOSH continues to hold ERHMS trainings in person and offers training online. The Emergency Preparedness and Response Office (EPRO) is in the process of updating the training for re-certification to continue offering it for continuing education credits.

The DSRR program is developing infrastructure to protect emergency response and recovery workers by addressing previously identified research gaps from past responses; implementing a framework to quickly begin projects during responses ensuring the research will not interfere with the response itself; and forming a disaster science research NIOSH IRB and related processes.

### **National Personal Protective Technology Laboratory**

#### **Review of NIOSH Respirator Approval Program**

A NIOSH Doctoral candidate completed an evaluation of the NIOSH respirator approval program. This evaluation was performed to identify potential efficiency improvements to support the recently promulgated new fee structure. Once the recommendations are finalized, the National Personal Protective Technology Laboratory (NPPTL) will develop an action plan to address those recommendations.

#### **NFPA 1982 Tentative Interim Amendment**

On December 12, 2016, NPPTL management was formally notified by the National Fire Protection Administration leadership that no additional NIOSH approved/NFPA 1918:2013 compliant self-contained breathing apparatus (SCBA) could be sold until re-evaluated by NIOSH and the Safety Equipment Association (SEI) for compliance with NIOSH and new NFPA 1982 requirements specified in the NFPA 1982 Tentative Interim Amendment. The NPPTL received,

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evaluated and coordinated 17 approval requests with SEI within the window of December 12-21, 2016. All applications were evaluated and discrepancies resolved in this short period of time. Emergency responders now have the latest technology available to protect them.

### **Breathing Air Supplies Peer Review Meeting**

In 2006, a series of underground coal mining catastrophic events demonstrated shortcomings in breathing air supply (BAS) technologies. As a result, the MINER Act of 2006 was passed with the following new requirements: (1) new self-rescuer technology that did not require doffing to replenish airflow (seamless changeover), such as units with interchangeable air or oxygen greater than 60 mins, (2) cached self-rescuers throughout the escape route to support continued escape. NIOSH is leading the development of a new generation of devices to meet the above criteria. NIOSH conducted an in-person peer review meeting of the BAS Project Proposal on January 20, 2017. The peer review panel consisted of representatives from academia, government research agencies, mining companies, mine workers, government regulatory agencies. The proposal is currently being revised based on the comments received.

## **Total Worker Health**

### **Total Worker Health Research Methodology Workshop**

The University of Iowa hosted the Total Worker Health Research Methodology Workshop on March 7-8, 2017. There were 20 experts in Total Worker Health and related disciplines, including several NIOSH representatives, who participated in this successful workshop. Plans for next steps are underway. Several peer-reviewed articles and other publications are expected outputs.

## **Western States Division**

### **New Training Product Addresses Fatigue Management in Alaskan Pilots**

The Western States' Aviation Safety Research program released new training to help educate pilots on the dangers of fatigue and provide recommendations to avoid flying fatigued. The training is computer-based, self-paced, and provides information in four modules that focus on the risks and hazards associated with fatigue, the importance of good sleep, tips for getting good sleep, and mitigating fatigue.

NIOSH researchers in Anchorage talked to pilots and management of air taxi and air commuter operations in Alaska and found that although the new flight, duty and rest regulations didn't apply to them, there was interest in learning how to recognize and prevent fatigue. NIOSH

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worked with pilots, mechanics, and other aviation workers to film all videos onsite in Alaska. The training can be used by any individual pilots regardless of their location or ratings, and contains information that can be useful for anyone wishing to learn more about fatigue.

The information on fatigue prevention for pilots is available for free download from <https://www.cdc.gov/niosh/topics/aviation/> and CDs are available by request by email at [aviation@cdc.gov](mailto:aviation@cdc.gov).

**NIOSH Mini Baghouse Retrofit Assembly for Control of Respirable Crystalline Silica from Sandmovers Awarded Patent**

Sand moving machinery used on hydraulic fracturing sites are configured with a number of modern safety features, but few (if any) include effective dust control technologies. A NIOSH study identified exposure to respirable crystalline silica from the thief hatches of sand moving equipment as a significant health hazard among workers involved in hydraulic fracturing operations. Exposures may place workers at risk for developing silicosis and other respiratory ailments like Chronic Obstructive Pulmonary Disease (COPD) and lung cancer. The NIOSH developed Mini-baghouse Retrofit Assembly (NMBRA) is a highly effective engineering control for respirable crystalline silica emissions from sand movers that can reduce emissions of silica by up to 99%. Fabrication and evaluations of the NMBRA was partially funded through the CDC iFund Program (the only NIOSH project to be awarded funding in 2016). The technology was recently awarded a patent by the U.S. Patent and Trademark Office. NIOSH researchers are currently conducting further field evaluations and pursuing a licensing agreement to commercialize the technology.

**Social Presence Statistics**

**NIOSH continues to expand its presence on social networks.**

<b>Social Media and Public Outreach Accounts and Services</b>	<b>February 2016</b>	<b>February 2017</b>
Facebook	107814 likes	125666 likes
Twitter	@NIOSH account 325000 followers	@NIOSH account 325481 followers

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Instagram	420 followers, 152 posts	833 followers, 486 posts
YouTube	1304 subscribers, 318227 views 153 videos	1678 subscribers, 407912 views 192 videos/clips
LinkedIn	Started in November 2016	388 members
Website Views	1,791,212 site views in February 2016	1,612,263 site views in February 2017
eNews Subscribers	58081	62369
TWH Newsletter Subscribers	64085	68600
Research Rounds Newsletter	57214	60482
Science Blog	Total blog entries: 321 Total comments: 5458 Blog site views (February 2016): 35324	Total blog entries: 390 Total comments: 6548 Blog site views (February 2017): 43791

**NIOSH Science Blog**

January 2017

- Nonstandard Work Arrangements
- USE 2017: Resolve to Be There
- Occupational Exposure to Bisphenol A (BPA) in U.S. Manufacturing Companies
- Occupational Health Issues in the USA
- New NIOSH Sound Level Meter App
- Wearable Sensors: An Ethical Framework for Decision-Making
- Synthetic Biology and Occupational Risk
- New NIOSH Training Offers Fatigue Management for Pilots in the Land of the Midnight Sun
- Occupational Health Internship Program – Apply Now for Summer 2017

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February 2017

- The Art and Science of OELs for Nanomaterials
- Continuous Personal Dust Monitor
- Maintaining a Relationship with your Turnout Gear
- Arduous Duty: Using Three Data Sources to Create a Single Wildland Fire Fighter On-Duty Death Surveillance System
- Black History Month: Recognizing Two Young NIOSH Researchers

March 2017

- Hit the Mark: Firearms training without damaging your hearing
- Short Sleep Duration by Occupation Group
- It's National Ladder Safety Month
- Women's History Month: NIOSH Recognizes Female Leaders

## **Awards**

### **NIOSH and NHCA Present 2017 Safe-in-Sound Excellence in Hearing Loss Prevention Awards**

NIOSH, in partnership with the National Hearing Conservation Association (NHCA), is pleased to announce the recipient of the 2017 Safe-in-Sound Excellence in Hearing Loss Prevention Award™. This year's award was presented to Ryan Lee Scott, deputy sheriff with the Alachua County Sheriff's Office in Florida, who demonstrated initiative and innovation in examining noise exposure among police officers and presenting potential solutions in order to be safer on the job. The award honors those who have contributed to the prevention of noise-induced hearing loss and tinnitus through effective practices or innovations directed to those who are exposed to noise at work.

## **NIOSH Publications**

### **NIOSH Publications (October 2016-March 2017)**

October 2016

- NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings, 2016
- Criteria for a Recommended Standard: Occupational Exposure to Diacetyl and 2,3-Pentanedione
- Immediately Dangerous to Life or Health (IDLH) Value Profiles:

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- Iron Pentacarbonyl
- Acrylonitrile
- 1,1-Dichloro-1-Fluoroethane (HCFC-141b)
- Chloroacetyl Chloride
- Chlorine Pentafluoride
- Furan
- Hexafluoroacetone
- n-Butyl Acrylate
- Butane

November 2016

- A Curriculum for Teaching Workers with Intellectual and Developmental Disabilities about Health and Safety on the Job
- Aerial Lift Hazard Recognition Simulator

December 2016

- Immediately Dangerous to Life or Health (IDLH) Value Profiles:
  - Benzotrile
  - Methyl Isocyanate
  - Bromine Pentafluoride
  - 1,3-Butadiene
  - Diketene
- Preventing Deaths and Injuries of Fire Fighters During Training Exercises
- Fundamentals of Total Worker Health Approaches: Essential Elements for Advancing Worker Safety, Health, and Well-Being
- NIOSH Chemical Carcinogen Policy

February 2017

- NIOSH Program Performance One-pagers
  - Pacific Northwest Agricultural Safety and Health Center
  - Central States Center for Agricultural Safety and Health
  - Great Plains Center for Agricultural Health
  - Northeast Center for Occupational Health and Safety
  - Southwest Center for Agricultural Health, Injury Prevention and Education
  - Western Center for Agricultural Health and Safety

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- Law Enforcement Officer Motor Vehicle Crash and Struck-by Fatality Investigations: A Pilot Program

March 2017

- NIOSH Ladder Safety App Postcard
- NIOSH Ladder Safety App Infographic/Flyer
- National Institute for Occupational Safety and Health: Promoting productive workplaces through safety and health research

**Certification Statement**

I hereby certify that, to the best of my knowledge and ability, the foregoing minutes of the April 12, 2017, meeting of the NIOSH Board of Scientific Counselors, CDC are accurate and complete.

June 2, 2017

Date

M.E. Bonnie Rogers, DrPH, MPH, COHN-S  
Chair, NIOSH Board of Scientific Counselors