UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

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In the matter of: *
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FORUM ON SAFETY, MOBILITY AND *
THE AGING DRIVER *
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NTSB Board Room and Conference Center
490 L'Enfant Plaza
Washington, D.C. 20024

Tuesday
November 9, 2010

The above-entitled matter came on for hearing,

Pursuant to Notice at 9:00 a.m.

BEFORE: DEBORAH A. P. HERSMAN, Chairman

APPEARANCES:

NTSB Technical Panel:

DEBORAH A. P. HERSMAN, Chairman
BRUCE MAGLADRY, Director, Office of Highway Safety
STEVE BLACKISTONE, Acting Chief, Safety Advocacy Division
ELISA R. BRAVER, Ph.D., Transportation Research Analyst
DEBORAH BRUCE, Ph.D., Project Manager, Office of Highway Safety
IVAN CHEUNG, Ph.D., Transportation Research Analyst
DENNIS COLLINS, Senior Accident Investigator (Human Performance), Office of Highway Safety
STEPHANIE DAVIS, Safety Advocate, Office of Communications
MITCH GARBER, M.D., Medical Officer
ROBERT MOLLOY, Ph.D., Chief, Report Development Division, Office of Highway Safety
KRISTIN POLAND, Ph.D., Senior Biomechanical Engineer, Vehicle Performance Division

Witness Panel 1:

ANNE McCARTT, Ph.D., Senior Vice President, Insurance Institute for Highway Safety (IIHS)
SANDRA ROSENBLOOM, Ph.D., University of Arizona
BONNIE DOBBS, Ph.D., University of Alberta
ANN DELLINGER, Ph.D., National Center for Injury Prevention and Control, Centers for Disease Control and Prevention (CDC)

Witness Panel 2:

STEWART WANG, M.D., Ph.D., University of Michigan
RICHARD KENT, Ph.D., University of Virginia
STEPHEN RIDELLA, National Highway Traffic Safety Administration (NHTSA)
STEPHEN ROUHANA, Ph.D., Ford Motor Company

Witness Panel 3:

DICK SCHAFFER, Federal Highway Administration (FHWA)
JOSEPH COUGHLIN, Ph.D., Massachusetts Institute of Technology (MIT) AgeLab
THOMAS BROBERG, Volvo
DAVID EBY, Ph.D., University of Michigan Transportation Research Institute (UMTRI)

Interested Parties:

RICHARD ASHTON, International Association of Chiefs of Police (IACP)
THOMAS MANUEL, American Association of Motor Vehicle Administrators (AAMVA)
BARBARA HARSHA, Governors Highway Safety Association (GHSA)
JONATHAN KING, National Institute on Aging (NIA)
BETH ALICANDRI, FHWA
JOHN MADDOX, NHTSA
SCOTT SCHMIDT, Alliance of Automobile Manufacturers (AAM)
KELI BRAITMAN, IIHS
JUREK GRABOWSKI, AAA Foundation for Traffic Safety
JACOB NELSON, AAA
RODNEY PEELE, American Optometric Association (AOA)
ELIN SCHOLD DAVIS, American Occupational Therapy Association (AOTA)
JANA LYNOTT, AARP
NANCY BELL, AARP
JULIE LEE, AARP
ELINOR GINZLER, AARP
JEFF MICHAEL, NHTSA

I N D E X

I N D E X (Cont.)

P R O C E E D I N G S

(9:00 a.m.)

CHAIRMAN HERSMAN: Good morning. My name is Debbie Hersman and it is my privilege to serve as the Chairman of the National Transportation Safety Board. I would also like to recognize my colleagues who are here in the room with us this morning, Member Mark Rosekind and Member Earl Weener. If you all would please stand so people know who you are?

Very good. I know we'll have some breaks and I encourage all of you to interact with the other Board members during those breaks.

Welcome to the NTSB boardroom. We begin a two-day public forum on Safety, Mobility, and Aging Drivers.

Many of you are familiar with the Safety Board for its role in investigating transportation accidents and determining the probable cause of those accidents. However, the Safety Board also has the opportunity to bring leading experts together with the goal of understanding safety risks and identifying solutions, even when that activity is not tied to a specific accident. Today we meet for that purpose. We're convening this public forum to explore the safety issues related to the aging driver and to discuss possible strategies to prevent and reduce accidents, injuries, and fatalities within this growing population.

America is aging. Baby boomers are now well into their middle years. People on average are living well into their 70s

compared with their 40s a century ago. And more and more seniors are on the road than ever before. In fact, 30 million licensed drivers in the United States are 65 or older, and the forecast is, in 15 years, in 2025, this age group will comprise more than 20 percent of the entire U.S. driving population. That's one in every five drivers on the road.

There's no precise way to define the term "aging driver." Just as no two 17-year-old drivers have the same set of driving skills, capabilities and experience, neither do 70-year-olds to 80-year-olds or to 90-year-olds. Driver performance varies widely in every age group and age alone is not a good predictor of how well one will perform behind the wheel. Factors like cognition, motor skills, medical condition and injury tolerance are also predictive. So when we talk about the aging driver, we mean age in relation to one's capabilities, not age as in old or senior.

Older drivers tend to be conscientious and safety oriented. They wear their seatbelts. They may choose to forego driving when it's dark or when the weather is poor. They are less likely to speed or drive intoxicated. And they drive fewer miles than do other age groups. The good news is that drivers age 70 and older involved in fatal crashes has decreased in the past decade by 20 percent, even though the number of licensed drivers in this age group and the miles logged has increased. Despite these encouraging numbers, we also know that when there is an

accident, it is the older driver who is more likely to be killed or seriously injured. They simply don't fare as well as younger drivers.

This forum is an exciting opportunity to better understand highway safety trends and to discuss ways to minimize the safety risks for a growing segment of drivers. Whether we are the older driver deciding whether or not to set the keys aside, or the older driver's family or community, we are all responsible for making sure that no matter what your age or destination, everyone arrives safely. While many of these issues we will discuss are topics that have been explored by other organizations in recent years, this is the first time that the NTSB is analyzing them in this format.

We are very fortunate to have some of the leading experts in highway safety, academia, the medical community, and industry here with us today. I'd like to take a moment to recognize some of the groups that will be participating in the forum: AAA, the AAA Foundation for Traffic Safety, the Alliance of Automobile Manufacturers, the Insurance Institute for Highway Safety, the American Association of Motor Vehicle Administrators, the American Occupational Therapy Association, the Governors Highway Safety Association, the American Optometric Association, the International Association of Chiefs of Police, the National Institute on Aging, the Federal Highway Administration, the National Highway Traffic Safety Administration, and AARP. Thank

you to all of the participants for sharing your time, your insight and your expertise.

As for our roadmap for the next two days, this morning we will begin with a discussion of safety metrics, accidents, injuries and fatalities, and how we use those metrics to assess the risks associated with aging and mobility. As part of this discussion, we will also consider the travel characteristics and the travel needs of an aging population. We will then break for lunch.

And I'm pleased to announce that during the lunch break, both today and tomorrow, we will be showing the documentary "Old People Driving," by director Shaleece Haas. This documentary chronicles the stories of Milton, age 96, and Herbert, age 99, as they confront the end of their driving years. I encourage you all to take the opportunity during the lunch period to view this documentary.

This afternoon we dedicate a panel to occupant protection for aging drivers and passengers. This is an important issue because the core of our mission here at the NTSB is to prevent death and injuries. We know that older drivers face an increased likelihood of injury, hospitalization, and death as a result of a crash. And because older drivers have decreased injury tolerance, we will also examine how to better protect older drivers in crashes, as well as the limitations of current occupant protection systems and the potential benefit of new technologies.

We will then turn to highway and vehicle design and how changes to those designs can affect the aging driver's performance. Intelligent transportation technologies are also emerging as safety enhancers, so we will discuss ITS advances as well. The improvements to the vehicle environment discussed by this panel benefit not just the aging driver but drivers in every age group.

Tomorrow morning we'll resume by focusing on driver performance, how we qualify driver capabilities such as self-screening and driving assessments, and how we remediate performance decrements once those decrements are identified. We will then conclude the program with state programs and practices, including state licensing schemes and the role of medical review boards in state safety programs.

I know this is a lot of ground to cover in two days. It is my hope that our dialogue will be honest and open. For some, our discussion may be eye-opening, while for others it may be an opportunity to dispel some of the many myths and misunderstandings about the aging driver. But even more significantly, this forum likely represents a collaborative launching point towards improved highway safety for us all.

Now for a few housekeeping items. As a reminder, please silence your cell phones and familiarize yourself with the emergency exits that are available in the front of the room and behind you where you came in. We welcome the public to view the

forum, both those in the audience as well as those viewing via webcast on the NTSB's website. Copies of the agenda are available in the lobby outside of the boardroom, and the agenda, along with the biographical information of the participants and descriptions of the parties, is also posted on the Safety Board's website.

So we've invited 20 panelists and over a dozen organizations to take part in this forum. Notably, there are more organizations participating as parties in this forum than is generally typical at an accident hearing. This stems from our desire to fully air the range of voices on this topic. For the invited parties, I urge you to work through your spokesperson and to rotate the responsibility of spokesperson as we move through the panels. You will find question cards on your tables and you can pass your questions to the spokesperson on those question cards.

Because we have such a full agenda, we appreciate your cooperation in helping us keep on schedule, and ask that panelists respect time limits and keep discussions focused on the subject at hand, rather than slip into topics covered by other panels. We recognize that all stakeholders are not represented in person at this forum. Because it was not possible to accommodate everyone who wanted to participate, those individuals and organizations who wish to submit written comments may do so until November 30th, 2010.

Finally, I'd like to take a moment to thank the NTSB

staff for their efforts in organizing and preparing for this forum. Undertakings of this scope do not simply happen. They are the end product of many months of long hours of meticulous preparation and planning. Thank you to the staff for your hard work and dedication. In particular, I'd like to recognize the technical staff who really made this forum possible: Dr. Deb Bruce, Dr. Rob Molloy, Dr. Jana Price, and Dennis Collins of the Office of Highway Safety; Dr. Mitch Garber, Dr. Elisa Braver, Dr. Ivan Cheung, and Dr. Kristin Poland from the Office of Research and Engineering; and Stephanie Davis, Steve Blackistone, and Danielle Roeber from the Office of Communications.

We also have some excellent administrative, technical, and press support that's provided by Avis Clark, Vickie Wall, Antion Downs, Rochelle Hall, Christine Fortin, Robert Turner, and Bridget Serchak.

So with all of those housekeeping items taken care of, we're actually ready to begin, and we'll begin with our first panel and they are going to focus on safety data assessment of transportation risk and aging. So we'll begin with a discussion of safety metrics to help qualify what we know about the risk of aging drivers. Because past forecasts have projected an increase in accidents and injuries associated with aging drivers that has not materialized, we would like to understand why.

This panel will examine the demographics of the U.S. population, at-fault accident rates by age, the injury data for

drivers, passengers and pedestrians. The discussion will factor in consideration of exposure measures such as the number of licensed drivers, active drivers, and trips or trip miles traveled by age group. We will also discuss how crashes differentially affect aging travelers.

My colleagues here at the Safety Board, Dr. Deb Bruce and Dr. Elisa Braver, have organized this panel. Dr. Bruce, would you please introduce the panelists?

DR. BRUCE: Thank you, Chairman Hersman. First I'd like to introduce the four panelists and then we'll return to your opening comments.

Anne McCartt from the Insurance Institute for Highway Safety is the senior vice president. Dr. McCartt recently coauthored a study with Ivan Cheung on crash trends of older drivers, released by IIHS in June of 2010. We've asked her to talk about some of those findings today. She received her B.A. from Duke University and her doctorate from Rockefeller College of Public Affairs and Policy, State University of New York at Albany.

Our second panelist, Dr. Sandra Rosenbloom, is a professor of planning natural renewable resources, gerontology, and women's studies at the University of Arizona. She directed the Roy P. Drachman Institute for Land and Regional Development Studies, a research and public service unit of the university, from 1990 through 2004. Dr. Rosenbloom has a master's in public policy and a Ph.D. in political science from the University of

California at Los Angeles.

Dr. Bonnie Dobbs directs the medically at-risk driver center and research programs within the division of care for the elderly, both under the faculty of medicine and dentistry at the University of Alberta. She is a professor in the faculty of medicine and dentistry. Dr. Dobbs also participated in a Safety Board forum on medical issues of noncommercial drivers in 2004. Dr. Dobbs has a B.A. in psychology and a Ph.D. in gerontology, with specializations in psychology, human ecology, and medicine, from the University of Alberta.

Ann Dellinger. Dr. Ann Dellinger is an epidemiologist and team leader for the motor vehicle injury prevention team at the Centers for Disease Control and Prevention. The center she's affiliated with is the National Center for Injury Prevention and Control. Dr. Dellinger conducts research in motor vehicle safety, focusing on older drivers, occupant protection and pedestrian injury, global road safety, and injury risk behavior.
Dr. Dellinger received her B.S. in biology from the University of San Diego, her master's degree from the Graduate School of Public Health at San Diego University, and her doctorate in epidemiology from the University of California at Los Angeles.

We've asked each of you to get us started this morning with summary remarks in your area of expertise. We'd like to take about 20 minutes to cover that, and I'll help us do that by sort of stepping in and introducing the next topic as we go along.

Dr. McCartt, would you begin by talking to us about the trends and limitations of safety data and within that context tell us what we know about the safety of drivers 70, 80 and 90 years old? Dr. McCartt, there's a green light. That's it, thank you.

DR. McCARTT: The crash rate per mile traveled begins to increase at about age 70. This is true for fatal crashes and for crashes of all severity. And as we've heard and we all know, the population of people 70 and older is increasing and is supposed to increase dramatically soon, so that by 2040 it will have doubled.

When we look at the percent of the population with licenses, if we look at middle-aged drivers, we can see for about the last decade that percent has been pretty stable. When we look at older drivers, these are three: 70 to 79 -- 70 to 74, 75 to 79, 80 and older, you can see very dramatic increases in the percentage of people holding onto their licenses, especially the oldest drivers, 80 and older.

So when you put these things together, what we expected to see when we look at crash deaths of older people was an increase, but in fact we've seen just the opposite. So if we go back to 1975 and we look at crash deaths of older people, after a steady upward trend, what we found, they peaked in 1997 and then they've been coming down and coming down very strongly.

Two points I want to make about fatal crashes of older drivers. First, most older drivers involved in fatal crashes are driving a passenger vehicle, as opposed to more and more younger

people driving a motorcycle, for example. And in a fatal crash involving an older driver, the people who die are primarily either the driver, the older driver or the older driver's passengers, who also tend to be older.

So we want to take a closer look at these trends and we did so by looking at the fatal crash rate first, first the fatal crash rate per licensed driver, and we looked at this middle-aged group as a comparison. You can see for this group, in the last couple of years their fatal crash rate has come down. But when you look at the older driver trends, you can see again, especially for the oldest drivers, a very dramatic decline. So for drivers 80 and older, their fatal crash rate has come down by half.

We had two questions after this initial study. Two things could explain this. One is that older drivers might be getting into fewer crashes. And the second thing that might explain it is maybe they're also doing better at surviving crashes when they're in one.

So we turned to the best data that we could find to look at nonfatal crashes. We weren't able to do that using a national database. So we went to 13 states' crash databases and we did a similar analysis where we look at a middle-aged, per-licensed-driver crash rate. These are nonfatal injury crashes here for these 13 states. We did see a decline. But again, when we look at the older drivers, their decline was larger.

When we look at property damage-only crashes, these are

the middle-aged drivers, their crash rate actually went up a little. When we look at older drivers, their rates were down. So the answer to the first question is yes, the crash risk overall for older drivers has come down.

To look at the second question of survivability, we again looked at these 13 states and we measured survivability in terms of the percent of older drivers who died in a crash and compared them to middle-aged drivers. These are the middle-aged drivers, a slight increase in the percent who died in a crash; looking at older drivers, down. So the answer to the second question is yes, their crash risk has gone down and when they're in a crash, older drivers are less likely to die and in a stronger way than compared to middle-aged drivers.

I think in the questions we'll talk more about this. We don't have good explanations yet for this. These are some of the hypotheses we have. It may be, and there's indication that this is the case, that older drivers are healthier, in better physical condition. Emergency medical services and medical treatment may have improved, especially for older drivers.

We think there's probably some answers in their travel patterns. Taking a preliminary look at the latest National Household Travel Survey, older drivers are driving more in the aggregate and also on average, and we know for drivers of any age, drivers who don't drive a lot of miles have higher crash rates. So we think either the quantity or the patterns of driving may

help explain some of this.

And then, finally, it may be we know that older drivers tend to self-regulate, at least some of them. And so if they're doing this, if there's an increase in this self-regulation, that might point to some answers.

And then, finally, just a last point. Again, I think we'll talk about this in the questions. There are some really important limitations in trying to take a look at understanding why older driver crashes are down. We don't have, as I said, a good national sample of nonfatal crashes that would allow us to look in detail at the crashes of older drivers. We don't have perfect licensure data. And we know that they may be particularly problematic for older drivers if a state has a pretty long renewal period. It may be that the numbers may overestimate how many older drivers are licensed.

And then, finally, as I indicated, we do have a National Household Travel Survey. The sample is still being weighted, but we only have these surveys every few years and they could be more detailed than they are. And, you know, I certainly would like to make the point that a really important exposure measure for any age group, but maybe especially for older drivers, is their travel patterns. Thank you.

DR. BRUCE: Thank you, Dr. McCartt.

Our next panelist, Dr. Rosenbloom, our question to you is, what do we know about where people live and how that affects

their travel patterns?

DR. ROSENBLOOM: Increasingly, older people live in low-density and suburban areas. About 75 percent of older people either live in suburban or rural areas nationally. But they're overrepresented, for example, in rural areas, where you could have -- we're talking about 1 in 5 drivers might be over 65 nationally, but it may well be 40, 50 percent in some rural areas. And folks as old as 80 and 85, 90, can still be driving because that's their only option. One of the issues is, if folks are living in low-density areas, their alternatives to driving are less.

And in this, and as in so many things, there are significant differences between women and men. Women are substantially more likely, women over 65, to live alone, so that they have no other driver in the house when they start to have problems. They're significantly less likely to have financial resources to allow them to purchase services or alternatives, have goods delivered to them when they no longer feel safe in driving. We know that older women generally cease driving much before older men, because they don't feel comfortable. It's often not some kind of sharp medical reason or because they've had a crash but because they don't feel confident.

But at the same time we know that over the last three or four decades older people have been driving longer, they have longer trips, they make more trips, and the folks who have driven their whole lives will not have made the kinds of -- will have

made the kinds of life decisions about where to live and so forth, based on the convenience and access and flexibility of the private car, and it's hard to see how we can substitute for that.

So there is a tremendous tension between mobility and safety. I know that we're focusing largely on safety, but I think that we have to deal with the fact that a lot of people will keep driving maybe when they no longer want to or when they are no longer safe because they simply have no other alternatives.

It's very common -- I speak on this a lot -- that someone will get up in the audience and say, oh, well, my mother won't have any problem when she stops driving; she will use one of the community resources available to her. And later on in our discussions, if we have time, I have some slides that show how unlikely it is that there are enough community resources to deal today with the vast number of older people who might want to cease or just reduce driving. The resources aren't there. And if we want to talk about safety, I think one of the things we have to talk about is how to provide mobility for people that want to stop driving or should stop driving.

In addition, I think that there are important issues about self-regulation, but we have tremendous evidence that older drivers, and particularly women, self-regulate. But I want to make the point that long before you give up driving, self-regulating can, in fact, seriously impact your quality of life and your mobility. It's one thing to make three right turns instead

of making a left turn. That doesn't really have a lot of impact on your life. It's quite another to avoid all congested areas, to avoid driving in the morning peak, the noon peak or the evening peak. It's quite another to avoid certain routes and so forth. And we know that older drivers do that. They stay off of the freeways and highways. They tend to be on smaller roads and so forth. And these things actually do, in fact, impact people's mobility and lifestyle and we have to be talking about that. And that tension between wanting to keep people safe but also wanting to keep them mobile is, I think, something we have to consider as we consider safety issues.

I also think that land use is a major issue. I'm a city planner and that's something that we look at a lot. But older people are aging in low-density places, and that's continuing. That's another reason why their trips are longer. One of the things we do know about the travel patterns of older people, for example, is that once they retire they tend to make longer non-work trips than younger people. We think that because you remove the constraint of having to shop or take care of activities near your work location, once you're freed from those constraints, older people seem to be more interested in going to different places to shop and different locations for socializing. And I think all of these patterns interact with safety issues in a profound way.

So what I'd like to leave the panel with is that you

cannot address safety issues independent from how people live their lives and where they're living, and we have to deal with them both. Mobility and safety are two sides of the same coin and often we are forcing older people to choose between them and that's not acceptable. Thank you.

DR. BRUCE: Thank you. Next, we turn to Dr. Bonnie Dobbs. We've asked you to help us understand aging from the driver's point of view and, for that matter, from the traveler's point of view. What are the special mobility considerations for an aging population?

DR. DOBBS: Thank you, Deborah. I'd like to spend the next five minutes describing a focused and integrated approach for enhancing the safety and mobility of what I see as the most at-risk segment of the older driver population and that's the medically at-risk driver. The approach has relevance to the older driver population in terms of enhancement, enhancements in safety and mobility. The framework that I present has relevance to the topics that I've been asked to address today, and that is, what are the functional abilities necessary for driving, the impact of medical conditions, considerations related to transportation for seniors, and premature driving cessation.

The framework that is on the overhead is the focused and integrated approach that I use as my approach to research, and the three pillars are: How do we identify older people -- how do we identify drivers in general who are at risk because of medical

conditions? Once we've identified them, how do we assess that driver for determination of driving competency? And finally, for those that we have determined are no longer safe to drive, how do we support those individuals? I'm going to spend just a few brief moments on each of the three pillars.

In terms of identification, we know that the changes associated with normal aging are unlikely to affect a person's ability to drive, but rather the role of illness plays a critical role and that's particularly important for the older driver population because of the age association of many illnesses, such as dementia. Because of the prevalence of dementia, because of the prevalence of medical conditions, it seems to me that we need broad involvement, and that includes involvement of the medical community, the law enforcement community, the individual, families and friends, the community at large, and certainly licensing authorities.

To assist each of these communities we need evidence-based screening tools and we also need a coordinated system. So we need the community, the medical community talking or working collaboratively with the licensing community. We need individuals' families coordinating or talking with the medical community. So we need to develop a more coordinated system.

As I mentioned, a key component is it's one thing to screen or identify someone who may be at risk, but because of the importance of driving for mobility and independence, we want to

ensure that when a license is revoked, that the person really is at risk, and for that reason we need evidence-based, standardized protocols. And those protocols are important because what they do is that they protect those who are safe to drive, in other words, ensuring that we're not revoking driving privileges from those who are still competent. But we're also protecting not only the individual but other road users from those who are unsafe to drive. It's politically unpopular to talk about revocation of driving privileges, but my perspective is, if someone is no longer safe to drive, let's remove their license, but let's support them. And that allows me to talk about the third pillar, in terms of support.

When I think about support for the medically at-risk driver or for any driver, it's in terms of psychosocial and mobility. We know that moving from the driver's seat to the passenger's seat is one of the most difficult transitions that an individual will make. There is the psychological component and we know from our research that we have to assist the individual and the family with that transition. We have developed evidence-based driving cessation support groups to help people make that transition and to help their families.

We also know that mobility is critical and often, if you look at mobility in the community, we tend to think of mobility in terms of public transportation, buses, LRTs, and taxis. Unfortunately, for the medically impaired driver and often for the

frail older driver, those forms of transportation are simply unacceptable. So our focus has been on developing more responsive alternate models of transportation to keep people mobile and independent.

DR. BRUCE: Thank you, Dr. Dobbs. Dr. Dellinger, one of the findings from the IIHS report that Dr. McCartt spoke about concerned the increased fatality risk for the very old driver. What can you tell us about fragility and crash involvement?

DR. DELLINGER: Thank you. It's a pleasure to be here today and be able to speak to you about this. I'm going to give you my bottom-line message up front and then I'll explain. And I think that the issue of crash involvement and fragility or frailty is trying to answer the question of responsibility.

The main question around the issue of crash involvement and frailty or fragility is that older drivers tend to have higher crash rates when you take into consideration how much they drive. So is this because they truly have more crashes or is this because they're more likely to be hurt or killed in a crash? And then they'll end up in our databases and either will appear that they're more of a problem than they are or appear that they're a problem and they're not. So that's the issue that we're trying to get at.

The answer is critical because if you're causing, say, more than your share of crashes, maybe the safety measure that we need is to take you off the road. In short, you're responsible.

But if the answer is that you're just more likely to be hurt, the safety answer might be to improve vehicle safety features or roadway safety features. In short, you're physically frail, you're not responsible.

So research has investigated many of the factors affecting crash involvement and I'm going to mention just a few that I've put up on this slide here. How much do you drive? So the low-mileage bias that was mentioned by Dr. McCartt, drivers who drive a lot tend to have fewer crashes and drivers who drive fewer miles tend to have more crashes. So is this because they've self-restricted to slower speed urban roads where they're more likely to have potential conflicts and crashes, or is it because of a reduced driving ability, so they're driving the minimum that they need to get by? Crash involvement may not differentiate between a causal action that you've done, you've caused a crash, so you're responsible, and crashes that someone else caused but you couldn't avoid it.

Factors affecting whether your physical frailty will lead to injury or death in a crash include whether you were buckled up, how safe your vehicle was, and what kind of medical care you received. So that's a mix of factors that you have control over and factors that you have no control over as a driver.

Part of crash involvement is whether you're a risk to yourself or others on the road or both. Researchers have

quantified this risk in addition to quantifying the proportion of excess crash involvement that can be explained by fragility or frailty. And I keep using fragility and frailty at the same time and people typically use them interchangeably. It's just interesting that the medical people tend to say frailty and the traffic people tend to say fragility. But from the literature, they normally are used interchangeably.

So in general, when you look at the literature, there is some excess risk to other road users, typically to passengers of older drivers who are themselves frail or in fragile health, although the excess risk is small when you compare it to, say, teen drivers or young adult drivers.

The contribution of frailty to excess crash involvement is interesting to quantify and, in fact, the proportion has been estimated at 60 to 95 percent of the excess crash involvement. Several studies have estimated it at about half of the excess crash involvement. It's hard at this point to put an exact number on it, but it is a significant proportion of the excess crash involvement among older drivers.

So when you take into consideration frailty and fragility, a low-mileage bias, and maybe the types of roads that older drivers are driving on, it makes a difference in your consideration of how much of the excess crash involvement is the responsibility of the drivers themselves or not. I think I'll stop there. Thank you.

DR. BRUCE: Thank you. The way we've structured the format for the panel this morning, we're going to now take an opportunity between Dr. Braver and myself to ask you questions. I've targeted these questions to individual panelists, but I want to take this opportunity to encourage all of you to step in. I mean, this is meant to be an interactive discussion at this point.

And by way of foreshadowing, we're going to do the question and answers from the Technical Panel to the panelists until about 10:20, which gives us about a half an hour. So for you to sort of set your time. And thank you so much for the timing on your opening remarks. We really appreciate your respect of the clock.

After we do the question and answer from the front of the table, we'll turn it over to the parties and you will have 50 minutes or so to ask questions. We will help rotate that through the different tables. And again, just to reiterate, we've asked that one person from the table be a spokesperson for that table and that the questions that you want to ask you're writing on the question cards, which helps sort of make the questions very succinct when they come around.

So as we get started again, I'm going to turn to Dr. McCartt. The earlier studies that warned us that we were facing an older driver problem and your June 2010 report seems to tell us that those drivers are not the problem that we anticipated. What might've changed from the earlier studies to

today?

DR. McCARTT: Well, I think the challenge in this is we can think of lots of things that have changed, but our study of safer vehicles, for example, we know through research that we've done and others have done, we're all driving much safer vehicles than we used to. But the key in our study is that whatever explains our findings has to be a factor that has affected older drivers more so than middle-aged drivers.

If you think about vehicles, for example, one, it's a challenge to look at that, but older drivers tend to drive older vehicles. We know that more people are buckled up. But again, it has to be the key to answering the questions that arise from our study are these factors have to be something that have affected older drivers much more strongly than middle-aged drivers.

So, you know, I talked about a couple of the possibilities. Certainly improved health and basically, you know, better physical conditioning of older drivers stands out. How we do the studies to see whether that's part of the answer, we're not sure how to do that. And again, I think travel patterns are important. When we get the data from our latest travel survey, again, the preliminary findings show that older drivers are driving a lot more overall and on average.

But we need to look at beyond just the quantity of driving. We need to know if -- it's been suggested, for example, we know older drivers tend to have certain kinds of crashes.

Their crash risk at intersections is particularly high because they tend to drive in more urban areas. Has this changed? Are they driving on high-speed roads, which would have a lower crash risk and are safer if you crash? These are the things that we want to try to take a look at. But again, it's very challenging to figure out how to do the studies to come up with the answers. So basically we're not sure.

DR. BRUCE: Thank you. You alluded to this in your opening comments, but I wanted to get a quick answer to a very succinct question, which is, people worry about older drivers posing a risk of injury to other road users. How do older drivers compare with teenage drivers, those in their 20s and those ages in middle ages from 30 to 60?

DR. McCARTT: Older drivers do less harm to other road users compared especially to teens and people in their 20s.

DR. BRUCE: Thank you.

DR. McCARTT: You know, again, they are mostly a danger to themselves and to their passengers, who also tend to be older.

DR. BRUCE: And then the last of my three questions to you. Self-restriction, such as limitations for time of day of travel or avoiding unknown routes, appear to be common in older drivers. Does this get rid of the excess risk of older drivers dying in crashes or the risk of them being involved in crashes? In other words, does self-restriction solve the risks that they might pose to themselves?

DR. McCARTT: Well, I don't think we have the answer to that question. I think that it sort of leads to a series of other questions. Do the right people self-restrict? You know, we're doing a study now that's following older drivers over a five-year period, asking them about their impairments, visual, physical mobility, diseases, for example, and then their travel patterns, in trying to -- you know, we have a couple of questions, but one is, does it look like the right people are self-restricting? Again, these are self-reported impairments. And then to see whether as people report increased impairments over time, does that translate into increased self-restricted driving? So I don't think we know the answer to that question.

Another thing, though, I would point out, and there may be other people talking about this later, is, there are state programs, and we looked at one in Iowa, that attempt to identify drivers of any age, but especially older drivers, who maybe should be restricting their driving. Iowa then administers a road test and can remove the license, renew the license without restrictions, but for some drivers places restrictions. And we interviewed drivers in these categories and we found that the drivers who reported the greater impairments were the drivers that Iowa was identifying for a road test and then getting restrictions. And another thing that we found was that the older drivers tended to comply with the restrictions, but they also in general affirmed or strengthened the restrictions these older

drivers also were making.

So there is a lot of evidence, I think, that older drivers do self-restrict. But whether it's the drivers who should always be self-restricting, I think in the long run that would not be -- that would not totally eliminate crash risks, the higher crash risks.

DR. BRUCE: Thank you.

DR. BRAVER: So Dr. McCartt, you've been showing a very dramatic decrease among drivers who are 80 and older and you've said that these drivers are driving more than in the past. But I'm also wondering whether this age group might contain a lot of people who are holding on to their licenses because we use licenses for all sorts of purposes, at the bank and in airports and so forth, and whether you might have a large proportion of people in their 80s nowadays who hold on to the license but in fact are not active drivers. Is that one possible explanation for that very, very dramatic decline?

DR. McCARTT: Well, I keep pointing to the National Household Travel Survey. There may be other surveys that aren't national that might answer some of that question, but that's one of the questions I think we could answer when we have travel patterns. Although I should point out that survey does not specifically ask if someone is a licensed driver. They ask if they drive. But that is a possibility. I would guess that that wouldn't fully explain the large declines. But, you know, again,

without travel -- without a good survey with detailed travel data, I don't think we can answer that.

DR. BRAVER: Well, as a follow-up question, do you expect the National Household Travel Survey, when it becomes available, the latest version of it, to provide adequate data on the amount of driving and type of driving performed by older drivers?

DR. McCARTT: Well, I'm a researcher, so probably I would never say anything is adequate, but I think it would go a long way. It would, for example, talk about the numbers of trips, the length of trips, to some extent the types of roadway circumstances for older drivers. So I think it would go a long way. It has information on the vehicle being driven, for example. But it's a sample -- it's a very large sample, but still whether for the very oldest drivers there will be adequate data to look at everything we want to look at by state, for example, in our study -- I could mention in our study, in our models that included the 13 states, we controlled for state, but we did find some differences among the 13 states.

And so one of the things we would really like to look at more is, you know, whether by state, whether by urban/rural, we'd like to look at the geographic component of what we're seeing in crash trends. And a national sample, even a very big national sample, quickly becomes problematic when you get down to a state level or, you know, a city level, for example.

I wanted to point one more thing out because a couple of people have asked about the question of gender in our study. We did a couple of studies, but in the second study we didn't specifically look at whether there were differences in men and women in these trends that we saw. So we did take a look at that. Ivan, my coauthor, took a look at that and we found that the declines for women were somewhat stronger but not significantly so. So whatever is explaining these differences, it's not -- the answer doesn't seem to lie in differences among gender, the genders.

DR. BRAVER: Thank you very much, that's very interesting. I'm now going to turn this over to Deb Bruce, who's going to ask some questions of Dr. Rosenbloom.

DR. BRUCE: Hi, Dr. Rosenbloom. I can't do this without my glasses. What's that telling us?

Where people live dictate their travel patterns. And so the first general question is, what do we know about where seniors live? You alluded to it in your opening remarks and I'm curious of what kinds of knowledge we have about the types of trips they do take and where that trip information comes from.

DR. ROSENBLOOM: Could I have slide number 2, Jana? Thank you. Well, as I suggested, older people live in low-density places. These numbers are from the census and one of the problems with the census is determining what's suburban. You can live 30 miles from downtown Houston, downtown Tampa, downtown Phoenix and

be considered in the central city. So these numbers actually underestimate the percentage of older people living at fairly low densities. And that trend is strengthening.

I invite you to read this chart from left to right. Because the younger cohorts are very suburban and they're moving through and the cohorts behind them are even more suburban. And so what we're seeing is, as people age in place, and they mostly do age in place, the largest percentage of older people are going to live in very low-density areas and somewhere around a little less than a fourth are going to live in rural areas. So what this means is the car is really the only feasible mobility option in many of these areas.

And we have to be looking at -- and people talk about, well, what if older people move back to the central city? But that's not what they're doing. Let me see chart -- could you put up 4, please? This is Brookings Institute data. The census does not every year figure out a one-year move rate. These are people who moved home and these are in thousands. This is not a percentage. But -- wait a minute, that's not -- well, leave that one up. Okay.

And what you can see is older people are substantially less likely to move than younger people. They're substantially less likely to move state, so they're not moving very far. We think that a lot of the movement at older ages is into care facilities. The idea that older folks move from Chicago or

Detroit to Tucson or Tampa or Houston, actually they're less likely to do that than they were 20 years ago. It's just that they're so many more older people. So those of us who live in the Sun Belt states, we see a lot of older folks coming in, but they're actually a smaller and smaller share of the total population. Most people stay in the home where they were when they were still in the labor force, and what we need to be talking about then is mobility and accessibility and walkability in those kinds of communities, because as older people encounter difficulties with driving or just don't feel like driving, there are very few options in those communities.

So what we're seeing is people staying in low-density communities. In fact, for every person in 2006, 2007, which is my slide number 4, but apparently not this anymore -- there it is. Now remember, not many older people are moving, but for every older person who moves from suburb to central city, which may not, I need to remind you, mean moving to much higher densities, there are two people moving the other direction.

So the stories about older folks moving to the downtown of an area, and you see those in the papers sometimes, those are what we call man bites dog stories. They're reported on because they're unusual. In fact, older people that do move are going the other way.

And let me show you something else. Could I see number 8?

No, it's a map of Tucson. There we go, that's it. I'm sorry, this is a really terrible picture and I'm not sure the colors are going to show up. In sort of to the left is Tucson, Arizona. The shaded areas are the city of Tucson or incorporated cities. The little map that you can't see on top is north of Tucson. The map to the side is south of Tucson. And those red dots, which are hard to see, are active adult retirement communities like Del Webb. There are also informal groupings of folks who moved out sometimes in trailers. And if you can see the red dots, you'll see that almost all of these are on the edge of the metropolitan area and these are folks largely who moved in from the Snow Belt to the Sun Belt. So they didn't come to the -- when they moved out of Detroit and Chicago and Cleveland and came to places like Tucson -- and we did this in Phoenix and other folks have done it in some other areas like Tampa -- where they move is to the edge.

So most older people don't move. They're aging in place in low-density areas. But those who do move, particularly out to other states, are moving out in the boonies and they're moving to communities -- many, many of these communities have no resources, transportation resources whatsoever. There's no bus services out there. These are people who move when they have a car and don't have it in their mind that they're not going to have a car sometime in the future.

DR. BRUCE: Thank you. And I have one last question and

I hope it's on a positive note. Can you give us some urban planning examples that would be of benefit to seniors? I mean, I'm thinking of in-fill for older people in aging neighborhoods. And I know you've worked in other countries. Do you have any experience with public policies or public transit systems that you know of in other countries that would serve as examples for us?

DR. ROSENBLOOM: Well, yeah. I agree with my fellow panelists that public transit is not generally the answer because traditional public transit services are not meant for older people, they're meant for commuters and so they don't serve the destinations older people want to go to. They report frequently that they don't like the vehicle starting before they get to their seats and all of the other kinds of inconveniences that the rest of us put up with when we use public transportation.

But there are some services that have been tried abroad, particularly in Scandinavia, where they're called community buses or service routes, where they're regular public transit but in smaller vehicles. Older folks report liking smaller vehicles, particularly being closer to the driver so if they had some problem, the driver can see that they haven't made it to their seat and so forth. And they're rooted to the origins and destinations that seniors are more interested in.

They're public transportation, anybody can get on board and pay the fare. But these things have been very successful in a number of countries in Europe. They're more expensive than

traditional public transportation services, but they're not more expensive than door-to-door services.

And I wonder if you could show me slide 20, please? This is -- when it comes up, I just took some public transit systems at random, and you may know that the Americans With Disabilities Act requires public transit operators to provide at least curb-to-curb services. Some of them provide door-to-door or even door-through-door. I did not cherry pick these. The only thing I was looking for in my somewhat random selection is to get both Sun Belt and Rust Belt cities.

The first column is the annual number of trips that these services -- that are provided by the transit operator in that community in their ADA service. If you look, the next column is what percentage of the total system ridership of all the services each of those providers provide, what percentage are these ADA trips, and you'll see it's very small. The highest is Miami at 2.4 percent. Then, if you look in the next column, you'll see what a one-way paratransit trip costs.

So if you take Mrs. Jones, just take her to the doctor in Boston, that costs you $33.21. If you take her to the doctor and bring her home, it's $66.42. And, in fact, the number for the largest 50 systems in the country is about $37 a one-way trip. Which explains the fourth column, which is the percentage of total system costs these ADA services require. And look at some of those systems. Miami is spending almost one out of every four

transit dollars to provide these ADA services to a very small percentage of its total ridership. What this means is that these systems are not very likely to -- this is today. These systems are not very likely to expand.

I wonder if I could see my slide 22, please? This is a study that I did a couple of years ago for the Institute on Medicine, which was mandated by Congress to look at the extent of disabilities. Now these are not just older people, these are all people who reported to the census that they had a serious disability. And all I did was divide the number of trips by the number of people who might be eligible for those services.

So in Chicago, for example, the average person of any age with a serious self-reported disability got less than one-fifth a trip a year. Now, in fact, what happens is the overwhelming number of people who are eligible for these services never use them at all and a small number use them frequently. But then the last column calculates for each system, given their 2004 costs, which, you know, you just saw on the previous chart, were somewhere between $25 and $45 a one-way trip, though those were 2008 data. And I just said, well, what if the transit operator provided for every person with a serious disability of any age, what if they just provided them with one round trip a year? And so you're talking about in Atlanta, for example, $290 million more a year just to provide people with serious disabilities with one trip a month.

So these options are not going to be -- these are not realistic options for the very large number of older people who are not going to be able to drive. So I do think that there are public transit options that are more geared to older people, but I think the answer really is to use the underutilized capacity in cars, all those empty seats in cars. And I'm a very big advocate of volunteer driver programs, which are much less expensive than these kinds of things and are a way to provide services in the low-density areas where public transit and these kinds of services are not going to make sense. Thank you.

DR. BRUCE: Thank you very much. This is very interesting. I really appreciate that. You've covered a lot of the questions that we were going to ask.

I'm going to now move on to ask some questions of Bonnie Dobbs. I know that you have an expertise with the whole area of premature driving cessation, that is, you know, giving up driving although the person still drives well. So I wanted to ask you a couple of questions about it. What evidence is there that safe drivers are misjudging their own skills?

DR. DOBBS: Thank you. The issue of a determination of driving competency, particularly self-determination of driving competency, is an interesting area. And when I think about the senior population, it's often -- people often think of the senior population as being a homogeneous population and, in fact, there's more heterogeneity in the senior population than in any other age

group. So when I think about whether people can accurately assess their ability to drive, I think about a framework, if you think about a person's real competency and then their perceptions of competency. And if you look at the framework that's up on the overhead, you can see that there's four cells. And if we look at the combination between real competency and perceptions of competency in the first upper left cell, you can see that there are a group of people that are competent to drive and they perceive themselves as competent to drive. And the likely outcome of that combination is that those individuals will continue to drive and appropriately continue to drive.

The next cell in the upper right corner is when individuals do not perceive themselves as being competent to drive, or sorry -- thanks, Deb -- sorry, where the individual is no longer competent to drive but they perceive themselves as competent to drive. And in this case the individual likely will continue to drive, but that will be an inappropriate continuation.

In the lower left cell is where the person is competent to drive but they perceive themselves as incompetent to drive. The likely outcome, predicted outcome, would be inappropriate driving cessation.

And then in the fourth cell in the lower right corner is where there is real -- where the person is no longer competent to drive, they recognize that they're no longer competent to drive and there's appropriate driving cessation.

So how does that have relevance to self-perceptions of competency? If you look at the first upper left cell, that likely represents the majority of healthy older drivers. They perceive themselves as competent to drive; they continue to drive. The upper right cell represents individuals with a dementia. So they perceive themselves as competent to drive but they're no longer competent and they continue driving. And interestingly, research that we have done indicates that if you ask them to rate their driving competency, they likely will -- most often they overestimate their driving competency, such that they perceive themselves even better to drive than an age-matched individual. So using screening tools in this population, self-screening tools, is not going to be helpful at all. They perceive themselves as competent to drive and will continue to drive.

Interestingly, the lower left cell, where the person is competent to drive but they perceive themselves as not competent, that's likely representative of older females. We know when we look at the data that older females often engage in premature driving cessation. I think that this cell is interesting in that we can likely do some interventions to have them continue -- to give them training and increase their perceptions of competency and keep them mobile.

And then the ones that appropriately restrict their driving, those are the ones that we have to provide alternate transportation for.

DR. BRUCE: Dr. Dobbs, I've read something that I just want to almost lead you into a quote because I like it so much. How much longer can we expect to live than we drive?

DR. DOBBS: Thanks, Deb. This is research done by Foley, et al., and men outlive their driving careers by 6 years and females outlive their driving careers by 10 years, based on the research from Foley and colleagues.

DR. BRUCE: Thank you.

DR. DOBBS: So most of us should prepare for the day where we will no longer drive.

DR. BRUCE: There is news in that.

Dr. Dellinger, you've been the cleanup panelist for two rounds in a row. I'd like to turn to you and I thank you for your opening remarks. They were right on.

A recent study from CDC shows that the annual average cost of traffic accidents are about $500 per licensed driver and older drivers have an average annual cost of $118 per driver. That's such a difference. Why are the costs so much less for licensed older drivers?

DR. DELLINGER: Right. If I can explain to the audience a little bit about what we did in that study and then I think that will -- it will make sense. I'm from the Injury Center at CDC, so you'll understand when I tell you that when we do cost studies, and in this one in particular, we added medical costs, medical spending and productivity losses; what did you lose because you

couldn't work? We're less concerned, say, with property damage costs, travel delays. That's not what we're about. We're more about injury prevention. So it's a very conservative cost estimate of motor vehicle crashes in the U.S. So to tell you that first.

We estimated $99 billion for a year. And to cover that cost, because it's a great way to get people's attention, that would mean $500 every licensed driver would have to pay to cover the medical and lost productivity costs of all driver crashes. And it would be fatalities, hospitalizations and you visited an emergency department. We captured all of those costs plus lost productivity.

This human capital approach, one thing that it does because of the lost productivity, the work part of it, it undervalues children, women and the elderly. Why? Because we either don't make any money as children or as women. I'm sorry to say, we make less money than a lot of the men. So the men's costs will be higher. The $118 per capita for older male drivers was an average, and for older women it was $67.

So the differences here are largely due to our methodology, which takes the medical spending plus the productivity losses, and the productivity losses are a bit skewed, I guess, is the way to put that. Does that make sense?

DR. BRUCE: Yes.

DR. DELLINGER: And also, as an aside, deaths usually

don't cost as much as hospitalizations. So if you die you're accumulating less --

UNIDENTIFIED SPEAKER: Debt.

DR. DELLINGER: Yes, less cost than someone who has an extended hospital stay, for example, which you might do if you're older and you have underlying medical conditions and then you get injured in a crash.

DR. BRUCE: Well, thank you very much.

We're running a little bit low on time here. We wanted to allow the parties time to ask questions, too. So I would like to ask the entire panel to make some brief remarks about their recommendations for future research, bearing in mind that we want to leave time for the parties to ask questions.

So let's see, since you've been -- keep coming last, why don't you start out first, Dr. Dellinger?

DR. DELLINGER: Okay. And one question that might have come up, that I think we discussed, were what risks to other road users and what kind of research in that category do we need and what kind of exposure measures? And I guess my point there is there have been several studies on risk to other road users by older drivers, teenage drivers, and I'm not actually sure we need to do that again. The results are fairly consistent. So my answer to that is we probably don't need another study that shows the risk of older drivers to other road users. I think we have that covered.

DR. BRUCE: Thank you.

Dr. Dobbs.

DR. DOBBS: Thank you. I guess when I think about the older driver population and an area of research that is sorely needed is in terms of providing alternate transportation. We know right now that there are challenges in providing transportation to seniors and that's only going to escalate over the next two to three decades. When I look at the research that has been done on alternate transportation for seniors -- and that's transportation that's outside of the traditional public systems, so buses, taxis, LRTs, paratransit -- we know that there are a number of organizations in the communities that are providing transportation for seniors, but there are more gaps in that transportation provision than there are strengths. And research that we've done in Alberta indicates that in order to build a responsive model that will meet the demands today and in the next two to three decades, we need leadership at both the local, the state, at the federal level. We have a need for more intersectorial collaboration for alternate transportation for seniors. There's a need for the identification of new funding streams to start building the alternate transportation models that are needed, and we need implementation of innovative, sustainable models.

It's interesting when you look at alternate transportation for seniors. Most of the organizations are working tirelessly. They do a lot of work in terms of fundraising so that

they can provide the transportation to seniors at a cost that is acceptable. However, that approach often ends up being a barrier in that they spend most of their time fundraising so that they can afford to provide the transportation. So I think that when I look at transportation for seniors right now, there's a lack of capacity building and there's a lack of sustainability, and research is needed and implementation in order to address those needs.

DR. BRUCE: Thank you.

Your thoughts, Dr. McCartt, on directions for future research.

DR. McCARTT: I would mention three. The first is following on our studies, as I said, to try to dig down deeper and look at geographic differences, for example, to try to understand better why we're seeing this very positive change.

The second would be -- and I know you have a panel on this -- has to do with vehicles. You know, I think when you look at highway safety, one of the real amazing things is how much better we are doing at protecting people in crashes. And of course, older drivers have benefited from that, as have other ages. But I think all we can do to look at how -- to look at the particular issues of older drivers in terms of crashworthiness.

And then a different thing about vehicles are all these new crash-avoidance technologies which people are looking at as being very promising to preventing crashes from happening at all.

And there's a lot of discussion, but it's hard to do research on this, about how older drivers may either find them confusing or how will they benefit compared to younger drivers. So I think that's a promising area.

And then, finally, I think we still need to continue to look at restrictions by states, because when there are bad crashes involving an older driver, you know, it's always the first thing to try to figure out a way to impose restrictions on older drivers. And I think there's still a lot we don't know about the effects of visual requirements or other special restrictions that are placed on older drivers which in the end affect their mobility. So that would be the third area I would suggest.

DR. BRUCE: Thank you very much.

Dr. Rosenbloom, your, you know, brief thoughts on directions for future research.

DR. ROSENBLOOM: I'm very interested in the whole issue of premature driving cessation. I do a lot of work on that here and abroad. And the whole issue of women who -- it tends to be women who give up driving earlier than they need to and they have fewer resources to fall back on. And increasingly women are entering their senior years living alone and with no family members. So I'm very interested in that.

I'm very interested in the whole issue of whether men and women receive safety messages differently. There seems to be some evidence about that, and that may be related to how we can

keep older women driving safer longer, as we're trying to get older men who are unsafe to stop driving.

I think we need to look at the whole range of -- women, for example, are much more likely to accept rides from -- to ask for and accept rides from other family members and friends and people in the neighborhood. So I'm interested in seeing what kinds of alternatives might be more appropriate for -- it may be that the systems that we look at will be very gender-based because women will be willing to look at options that men aren't and I think we need to be looking at that.

And I want to disagree a little bit with Dr. Dobbs. I'm not sure that we need a lot of research about why things are so expensive; they are. I think what we ought to be looking at is how we can develop a package of options, which could include people moving to facilities that serve them better. I don't necessarily mean nursing homes or assisted living, but whether we can find a way for people to live in their own neighborhoods, for example, but not in the same 2500-square-foot house that they lived in when they were in the workforce.

DR. BRUCE: Well, thank you very much. This has been a very interesting set of presentations and questions. Since this is going to continue, I'm now going to turn this over to Chairman Hersman to work with the parties.

CHAIRMAN HERSMAN: Wow, this is great. And you've certainly helped me understand my parents a lot better by

explaining who decides what to give up when.

How are the panels doing? Would you all like a short break?

Okay, we'll move to the parties and we're going to just go in a round robin and allow each of the tables to do questions. We'll begin with NHTSA.

MR. MADDOX: Good morning and thank you for the presentations. All very interesting. It looks like we have a couple questions here. A question for you, Dr. McCartt. You mentioned that you thought that our national databases were not sufficient for answering these questions. Are there other databases in other countries or insurance databases or others that would be useful or we should look to for comparisons?

DR. McCARTT: Well, I have to say I'm not really familiar so much with databases in other countries. As you know, we have a sister agency, the Highway Loss Data Institute, and we get claims data for something like 85 percent of the insurers, and we do studies looking at older driver trends using those data.

The difficulty, the limitations to the HLDI data are that it's a huge database, a huge sample size, but not a lot is known about the circumstances of the crashes. So without doing a special study, there are some issues that can't be studied very well. But it is a database that we use.

MR. MADDOX: Okay. Do we continue with our table?

CHAIRMAN HERSMAN: Sure.

MR. MADDOX: Okay, thanks. This is a question from Jonathan King from the National Institute on Aging. Pardon me, my throat's a little sore. What would be the best estimate of the cost of premature driving cessation in older drivers, given just the cost of paratransit and cost of providing goods and services to older adults in their homes? Should I repeat that?

DR. ROSENBLOOM: Well, if that was directed to me, I have no idea what the dollar costs are. But I think that if someone prematurely stops driving, they probably don't qualify for most of those community-based services. You have to be fairly, significantly disabled to qualify for ADA service. And I think it's hard to quantify the social isolation and the lack of interaction, and I think there's a lot of evidence that those kind of symptoms lead to earlier -- to morbidity. And I think it's tragic, but I don't know that anybody can put a dollar figure on it.

MR. MADDOX: Thanks.

This must be from you, Beth. How do the demographic changes related to people staying in the labor force longer affect older driver issues? And it's not addressed to anyone, so if anyone wants to take that one, staying in the workforce longer.

DR. ROSENBLOOM: Well, actually, it's women who are staying in the labor force longer. And so I don't know. Presumably they'll keep their driver's licenses if they have to keep working and don't have any alternatives. But I think that's

an interesting question, but one I don't know that anyone has done any research on.

MR. MADDOX: And then we've got one last question. Someone -- and I don't remember which panelist it was -- mentioned that seatbelt usage rates for older drivers is perhaps different. How does it compare to the average-age driver, if you will? And then, secondly, does seatbelt usage use rate change for drivers who are under restrictions, restricted drivers?

DR. McCARTT: I may have mentioned that, but if I did, that's not what I meant to say. I don't think that the belt use for older drivers is problematic compared to younger drivers. And I don't know about belt use and how restricted drivers -- how that relates to restricted drivers.

I wanted to follow up one thing about our insurance database. I should've mentioned this. When we did our study, we did -- in our discussion to our paper we do talk about when you look at trends in the insurer claims database, they aren't seeing the lower -- they're not seeing the decline in claims rates for older drivers compared to younger drivers. There are some differences. Their data relate to newer vehicles and these are crashes reported to insurers, not police-reported crashes. So those are two different reporting systems.

But it is different and, again, we tried to figure out why that might be and we're not sure why. But I should mention that it does present not as positive findings, you might say, for

older drivers relative to younger drivers. And these are crashes of all severities and the data are dominated by very low severity, not injury crashes.

DR. DOBBS: Could I address the issue of restricted driving? The issue of restricted licensing is interesting, in that I think that most often it's predicated on the recognition that mobility is so central to our mobility and independence, and restrictions in driving are appropriate, I would argue, for some segments of the older driver population. For example, individuals with visual impairments, restricting their driving to daytime-only makes sense. But often those restrictions are generalized or extended to individuals with cognitive impairment, and in those instances it's inappropriate. And my analogy would be that we wouldn't think about letting an alcohol-impaired driver drive within a five-kilometer radius of home. We wouldn't let an alcohol-impaired driver -- we wouldn't restrict an alcohol-impaired driver to driving between 10:00 and 2:00 in the afternoon. And that's essentially what we're doing with an individual with a cognitive impairment who's no longer safe to drive. The difference between the alcohol-impaired driver and the cognitively impaired driver is the alcohol-impaired driver may sober up and the cognitively impaired driver won't.

I think that the reason that the restricted licensing looks so attractive is because of the woeful inadequacy of alternate transportation to allow these people to stay mobile. I

would prefer that we put our efforts towards developing responsive models of transportation to keep these people mobile, as opposed to using something like a restricted license and just keeping our fingers crossed that they're not going to crash.

MR. MADDOX: That's all ours.

CHAIRMAN HERSMAN: Thank you. And we'll move to the back table. Do you all have an appointed spokesperson? Please go ahead.

MS. LYNOTT: Good morning and thank you. At our table, our first question has to do again with the premature cessation of driving, and are there other sources of premature cessation and ideas of how we should address these? So things like doctor's orders to stop driving that may not be really substantiated.

DR. DOBBS: In terms of the role of illnesses and the role of the medical community, to my knowledge, there are no data that indicate what the prevalence of, in terms of doctors advising departments of motor vehicles about driving cessation when it's inappropriate. However, I suspect that that does occur.

What that suggests is that we need to provide the medical community with better tools to help them identify people who may be at risk and then we have to do a better job of implementing the protocols that allow the person to be referred to or assessed at motor vehicles or through an evidence-based driving assessment to ensure that when physicians do identify people as at risk, that they are assessed using evidence-based protocols and

that we're revoking privileges of those people who are unsafe but leaving those people who are still safe and still competent on the road.

DR. ROSENBLOOM: I'd like to say that, looking at it from the other side, I do a lot of focus groups here and abroad and one of the things women say the reason they give up driving is that their husbands tell them they're bad drivers. And there's a lot of evidence about that. And actually NHTSA has a study that showed something similar, too. So there's a lot of research about that.

So the other side of the question is, can we find ways to -- that people can test themselves to assure themselves that they are good drivers? And there's a small AARP study where they asked people who went through -- is it called mature driver now? I can't remember what the AARP program is called now, where the men who went through rated themselves before the program as good drivers and after the program as good drivers. The women rated themselves worse before and better after. And what seems to be occurring is that women are getting -- are seeing, okay, this is what good driving is and I'm doing it, so I feel better now. And I think that we need to be looking at, in terms of premature driving, if we can get some evidence-based things that tell safe drivers, oh, I am a safe driver and here's some proof I can say to my husband or just to myself to feel good about driving.

MS. LYNOTT: Okay, thank you.

Our next question is for Anne McCartt. And is it true that despite decreasing numbers of fatal crashes among persons age 70 and older, the share of all traffic fatalities that are of this age group is increasing? And we pulled this latter stat from a recent white paper that was written for TRB's Towards Zero Deaths conference that was held this past summer, I believe.

DR. McCARTT: I'm not sure I follow your question. You're saying that even though older driver fatal crashes are going down at a faster rate than middle-aged drivers, they're an increasing percentage of all the deaths?

MS. LYNOTT: Correct.

DR. McCARTT: I don't know if that's the case or not, because I know that we've seen very strong declines in teen crashes. I don't know if that's correct or not. It doesn't sound logical to me, but maybe when you look -- I mean, again, our study looked at passenger vehicle drivers, which wouldn't actually support your hypothesis because motorcyclist deaths have gone up among younger drivers. We didn't look at that. So I don't know if that's the case or not. It would be easy to check. I can check while you're asking people other questions. But I don't know.

MS. LYNOTT: Thank you. And a following question has to do with barriers and the use of cars, volunteer driver programs, you know, any type of program that's outside the traditional options, whether these be insurability, training, education, cost

of gas, et cetera. So Dr. Dobbs and Dr. Rosenbloom, if you might address some of the barriers.

DR. DOBBS: The barriers that we've identified in alternate transportation service provision -- and just for clarification, alternate transportation service provision is transportation outside of traditional modes, such as public transit, paratransit. Alternate transportation service provision often is provided at the community level by community organizations, seniors organizations, church groups.

Typically, the model is such that alternate transportation service providers for seniors rely primarily on volunteer drivers. Some organizations use a blend of paid drivers and volunteer drivers. When you look at the service provision across those two, the paid driver/volunteer driver model is a more responsive model because it allows the service provider to provide transportation not only on weekdays, but weeknights or weekdays and weekends, daytime and evening.

And we know that when we look at senior transportation that often their what's called life-enhancing [sic] transportation needs are met -- so they get to the doctor's; they get to the grocery store -- but they're life-enhancing transportation needs are not met, so the ability to go social events, the ability to attend religious events. So using a blend of paid drivers and volunteer drivers is more responsive; it's more costly.

We also know that funding streams, there often are not

dedicated funding streams, so alternate transportation service providers, as I mentioned earlier, spend a great deal of their time and their resources fundraising to provide what they perceive as being affordable transportation for seniors.

Interestingly, that perception, that assumption, that transportation should be provided at no cost or little cost is a barrier, in that all of us pay for transportation until we're 65 years of age. For some reason there's this assumption that as soon as we turn 65 we should have our transportation subsidized. When you talk to seniors themselves, most of them say, I quite expect and I'm quite willing to pay and pay more than what my service provider is charging me. I recognize that there are segments of the older driver population that don't have the resources for transportation and we do need to subsidize that segment, but for the most part, I think that there's more capacity from the seniors themselves to assist with building better models of transportation.

MS. LYNOTT: Thank you.

DR. ROSENBLOOM: Yeah, I think it's a given there's not enough money, because there's a huge demand and there's not enough service. But some of the other issues are not as pressing. It turns out insurance is not that big a problem. People talk about it a lot and some of the volunteer systems do provide additional insurance coverage. You can be covered under the national agency or the agency service and that sometimes, I think, makes drivers,

volunteer drivers feel better. But there's not a lot of evidence that these people are running around getting into terrible crashes. So it's less of an issue than you might think.

One of the problems that I see is that when any of these services get to any size, they run quickly into diseconomies of scale. And I remember early in my career the Red Cross was running a service in El Paso, Texas, and I went down there assuming -- I think I had a contract from the Texas Department of Transportation. I went down there assuming they would have the cheapest costs of any big city in Texas and, in fact, they were somewhere in the middle and I couldn't understand that; they had volunteer drivers.

Well, they had to have a lot of people sitting around called coordinators or social service providers for the drivers who didn't show up. When you have a large system of drivers and a lot of them are themselves seniors, then they don't feel well or it's raining or -- and so you have to have all of these paid backup drivers.

So I think one of the problems is -- I don't want to do too much about this thousand points of light business, but I do think that a lot of little services might -- thousands and thousands and thousands of little services might actually be a better way to do it. Once you start to aggregate them up, then the drivers' wages go up, then you have to have dispatchers, then you have to have backup drivers, then you start to be a business.

And I have looked at the -- and the Beverly Foundation has as well. We've looked at some of the costs of some of the well-known volunteer systems and they're running $20 to $25 a one-way trip with volunteer drivers in their own cars. So I think the problem -- there's an issue there of how big you can get before you start to be very expensive.

DR. DOBBS: The one area where there are opportunities is certainly the use of technology, in terms of allowing the local service organizations to start using technology to do the scheduling of rides, and there's cost efficiency in that.

MS. LYNOTT: Thank you.

If our group has time for one more question? Okay.

Sandy, you mentioned that land use is major issue and, as a city planner, could you talk more specifically about what some of the potential land-use solutions might be?

DR. ROSENBLOOM: Well, I think it's very heartening that the Federal Transit Administration has taken on, along with their promotion of transit-oriented development, an understanding that you have to have affordable housing at the same time.

One of the problems is that land value goes up a lot around light rail and very good transit service and you gentrify. And there's some neighborhoods in San Francisco where they put in service simply to hit populations of elderly people and force them out because the rents went up and the prices went up. So I think we have to be looking at a coordinated way to make sure that in

denser areas with more transportation choices, with more land-use choices, that you can walk to grocery stores and all of those sorts of things, that they remain affordable.

Now there are plenty of older people with a lot of money, but there are plenty who don't have it and I think we have to be watching to make sure that as we provide more desirable neighborhoods, the people that we're looking at can actually live there, afford to live there.

DR. McCARTT: I wanted to just follow up. I don't have the information to answer the question. It's a really good question and I should know the answer.

And it is possible, when you look at the deaths, if you -- our study looked at older drivers. But if you look at deaths and you include children and pedestrians, I don't know how the total package has changed, but it gives me an opportunity to reiterate the importance of exposure measures. The reason our study was interesting or important, maybe, is that this is not what we expected, because we have more older people, more drivers, and the best indication we have is that older drivers are driving more. So deaths are always the ultimate measure that you're always trying to reduce, but especially when you're comparing age groups or different types of drivers, it's critical that you have an exposure measure.

So I just wanted to clarify. I think our study was not focusing on deaths. It was focusing on deaths per licensed

drivers. And if you look at population or VMT, vehicle miles traveled, you tend to see the same patterns.

CHAIRMAN HERSMAN: Thank you. And we'll proceed to the next table. It looks like the Alliance of Automobile Manufacturers is going to be designated to ask questions for the table.

MR. SCHMIDT: Yes, and excellent presentations so far and excellent questions by the other panels. This is for the whole group and it's kind of a two-part question. Data is lacking on the effectiveness and validity of many screening methods, assessment programs, and associated licensing policies. What, if any, of the above should have national priority for data collection? And also the second part: How should priority areas be defined for large-scale national epidemiological studies to address those issues?

CHAIRMAN HERSMAN: Could you repeat the first part --

MR. SCHMIDT: I realize I was probably rattling.

CHAIRMAN HERSMAN: Could you repeat the first part of your question, please?

MR. SCHMIDT: Okay. Sorry to be so -- it's a long question and I tried to rush through it. Data is lacking on the effectiveness and validity of many screening methods, assessments, and licensing policies. What, if any, of the above should have a national priority for data collection itself, the actual collection of data for those?

DR. McCARTT: Well, I think there are a couple of efforts underway. I know California and Maryland have both been very progressive in looking at the development of screening tests that could be -- that could produce reductions in crashes. And I know California isn't just focusing on older drivers. They've done a series of studies comparing, you know, drivers of all ages and different screening instruments.

So I think the priority with a lot of countermeasures in older driver safety is relating them to crashes. So I think the priority would be whether through random assignment or through other very strong research methodologies to try to get to that goal, which is to identify specific screening instruments that would not only change driving behavior or self-reported behaviors or test-track behaviors, but actual crash reductions. And that won't be easy, believe me.

DR. DOBBS: I can talk about what's happening in Canada. We have just developed a new screening tool for the identification of cognitively impaired drivers, and in one of our jurisdictions in Canada, the Province of British Columbia, the new screening tool, which is called the SIMARD-MD, has now become the screening tool for cognitively impaired drivers and it's a requirement by their department of motor vehicles, as is an evidence-based driving evaluation. And in Alberta, the screening tool is increasingly being used by the medical community. Looking at our website, the screening tool is also being used a lot or being

picked up a lot by the medical community, the occupational therapy community in the United States.

I think it would be -- it is really important for us to start looking at the effectiveness, the efficacy of these tools, when they're introduced. And I would love to see research done. We're doing research in Canada, but it would be nice to see some research done at the state level in the United States as well.

The screening tool, the SIMARD-MD, focuses on cognitively impaired drivers, but we need the same type of development and then an implementation and results of that implementation for motor conditions and sensory conditions, visual conditions. So to me that would be a priority, particularly when you look at the demographics that are coming out, as we know, as I said earlier, that it's most often illness, not age, that impairs a person's ability to drive. So if we can start targeting the at-risk population, then there should be reductions in collisions as a result of identifying the appropriate drivers who are at risk.

MR. SCHMIDT: The next question is for Dr. Rosenbloom. Is there evidence of changes in the patterns of driving of older drivers that may help explain their greater crash reductions compared with younger drivers?

DR. ROSENBLOOM: No, I think that's what's ironic about it. They're driving more. They're driving to different places. They appear to be driving in situations they didn't before. Peak-period traffic is spread out so much that you can't avoid it, so

they're driving more in congested times, just because they can't avoid it. So I think it's sort of interesting and I think that's the issue that's been raised. They're driving more, they're doing all of these things more, why aren't they getting into more crashes? And I don't think we have good data on that.

DR. McCARTT: I think also we don't know the relationship. Why are they driving more? Maybe they're healthier, you know. So I think all of these things are bound up together in terms of looking at sort of the root cause. You know, it's hard to ferret that out.

DR. DELLINGER: Well, I was just asked to pipe in. We can't really explain fully the huge drops that we've seen in the last couple of years, overall. So for the first time in decades, we have only 34,000 deaths a year in 2009. I mean almost 34,000 deaths. On the one hand, it's amazing that it's gone down that far. On the other hand, I'm not willing to say that 34,000 deaths is anywhere near good news. Part of the good news maybe is that older driver safety seems to have improved more than anybody else and we've had the shocking safety gains over the last couple of years. But we can't fully explain it.

People talk about the economy and differences in discretionary driving and that might affect older folks and teens more than it affects people, say, that are working every day. But a lot of it's guessing. I mean, even when you put together the economy and safer vehicles and then, on the other side, driving

more, we can't explain it. It's interesting. We can't explain it.

DR. McCARTT: I think also that, you know, I seem to be the bearer of bad tidings about data, but the National Household Travel Survey, the last one was conducted during the gas crisis and during the downturn in the economy and that will make it -- now the last one was also during a recession, but not as bad a recession. So if we didn't have to have national travel -- if it weren't only every, you know, seven or eight years that we do a survey, you know, we would be able to understand a lot of these things.

But I think it's going to be just a fact of life, that the latest travel data we have were collected during a very unusual period. Thankfully -- hopefully unusual. But that will make it challenging -- especially when you're trying to look at how one age group differs from another, that will make it very challenging to draw conclusions on how things have changed since 2001, 2002.

MR. SCHMIDT: Okay. Another one for the whole panel. We know sandwich boomers are struggling with how to cope with aging parents and their driving skills and safety. But is there research that looks at the influence adult children have on their parents' driving decisions and/or cessation?

DR. McCARTT: I think that question goes back to the accuracy of self-assessment or the accuracy of assessments. We

know that self-assessment of driving competency is pretty inaccurate in at-risk populations. We know that most older people overestimate their driving competency; everybody's better than average.

Research that we've looked at in terms of family members, caregivers, making assessments of driving competency, and these assessments are compared to actual on-road driving assessments where the individual was determined to be safer and safe to drive based on a road test, is that family members are not very accurate, either. Caregivers, spousal caregivers tend to be less accurate than sons and daughters who live nearby, and I think that there's some good reasons for that.

If you have an older couple, if it's the gentleman whose driving competency is being questioned -- she doesn't drive, the wife doesn't drive -- she is going to be less reluctant to admit or to disclose that his driving has declined to an unsafe level, because if his driving privileges are revoked, they're both immobilized. That may change with the baby boomers because there are more females licensed to drive in my cohort than in my mother's cohort.

Having said that, so the next group would be sons or daughters and if they're living close to their parents, they may be a little bit more accurate. Certainly asking sons and daughters that live a distance away, they have no greater insights than you or I. My take on the situation is that if you have

someone, a family member or a neighbor, that you are concerned about their driving, the most evidence-based assessment is to have them have a road test.

MR. SCHMIDT: Okay.

DR. ROSENBLOOM: There actually is a lot of -- leaving aside whether the kids are right or not, which is not trivial, but there is a lot of evidence about parents and kids, and what a lot of it shows is that older parents don't want to listen to their children or their family members. They just don't. Where, as I said earlier, that women are more likely to listen to criticism than men are.

But I found some funny things. I did a major study for the British government where I interviewed a lot of adult children of older drivers in Britain and comparative in the United States, and while they both expressed -- both sets of kids expressed concerns either about their parents' current driving or what would happen in the future, that I found that Americans were much more worried about what it would mean for them if their parents stopped driving. And I liken it to why parents let teenagers, who are, you know, much more dangerous, why would you let your teenagers drive all the time? And it's because it makes your life easier. Once those kids get a license and you don't have to cart them around, your life gets easier.

And what I'm seeing among adult children of older drivers in the United States is yes, they're worried, but they're

equally worried about what is it going to mean to me when my mother stops driving? And it's not just the driving. It's will she come live with us? Will we have to move her to a care facility?

And I saw a sort of -- you know, it's hard to interpret what people say sometimes, but I see a sort of willful ignoring of some bad signs about their adult -- their parents, because they see this crushing wave of responsibility hitting them, which I think gives us a window for policy. Because if we can be talking to baby boomers who are now experiencing problems with their parents and they can see the burdens that they're going to carry because there are not enough transportation and mobility options, that maybe we can get the baby boomers -- not for themselves, you never sell people on what it's going to do for you, because they never want to see themselves as in that position. But if we can say, okay, here's all the burdens you're going to carry for your parents; don't you think you might want to fund some more public transit and some more alternative services so those burdens don't hit you?

DR. DOBBS: Dr. Rosenbloom's point is a good one. It's interesting, the longer I've worked in this area, the longer I'm starting to realize that for -- particularly for illnesses, the driving is the canary in the coal mine and particularly for cognitive impairment. So if mom or dad have word-finding problems or if they have memory problems, the families can usually explain

it away. But when driving becomes affected, then they can no longer explain it away and that's when action starts to occur. So driving can become the early or not-so-early indicator of cognitive decline. And we know that in the primary care setting, two-thirds of all dementias are missed and 90 percent of mild cognitive impairment. So the driving issue really does need to be on the radar screen.

The other point that I think is really important is that, often when driving privileges are revoked because of illness, the blame is put on the driving, that mom or dad -- there now has to be all of these lifestyle changes because they could no longer drive. Well, in fact, it's because there's an illness and the lifestyle changes are going to occur. The loss of driving privileges means that the family has to step in or somebody has to step in and make the arrangements. But those arrangements were going to have to be made anyway. It just becomes the red flag for it.

CHAIRMAN HERSMAN: Thank you, thank you all for your honesty in answering the questions. It's very refreshing.

We'll move to the last table. GHSA will ask the questions for the last table.

MS. HARSHA: There we go. The first question is for Anne McCartt, and it has to do with subgroups within the aging population.

CHAIRMAN HERSMAN: Barbara, if you could just pull the

microphone close? There you go.

MS. HARSHA: Okay. Do you see -- thank you. Are there differences within the aging population? In other words, are there differences in crash risks between those drivers who are, say, 65 to 75 and those who are maybe older than 75? Did you find that in your research?

DR. McCARTT: Yes. In our study we had three older groups. We had 70 to 74, 75 to 79, and then 80 and older. And consistently what you saw was that the beneficial or the improvements we were seeing were the strongest for the very oldest drivers. And I believe in our initial study we did take a look at 65 to 69 and I believe we found that they weren't that different, actually, in our study. They may be in other ways, but in our study, using our method, they weren't that different from the middle-age group we were looking at.

MS. HARSHA: I want to have you make some projections, if you can. Do you expect the decrease in crash risk in older drivers to continue in the future?

DR. McCARTT: Do I expect our study, the improvements that we saw, to continue?

DR. ROSENBLOOM: You would have to know what causes them, wouldn't you?

DR. McCARTT: I would say yes, but -- I'm intrigued by the question and I couldn't answer very well, because there are lots -- whenever you're looking at a group and you're looking at

other groups, there are other great things going on and we were partly looking at not just are they doing better but are they doing better than other groups? And children, for example, I mean, the gains that we've made for children in crashes is just phenomenal.

But yes. And I don't have a scientific reason for that, but I think that what really stood out for me in our study was just the consistency of what we were seeing. So it was almost every year there was a decline in deaths. You know, we looked at all of these different severities of crashes in these states and it was very consistent. And I didn't talk about it today, but we looked not only at whether older drivers were less likely to die, we looked at whether they were less likely to die or be seriously injured.

So I think that what was compelling to me was the strength and the consistency of what we were seeing. And while we can't explain it, what that says to me is it's part of something that's, you know, maybe long-lasting. The big question, which one of the other panelists mentioned, is what just happened in the last couple of years. And I agree, we don't really understand it and -- but putting that aside, yes, I think whatever is happening will continue to happen, but I could be wrong.

MS. HARSHA: We have to think about older drivers, not just the current older driver population but people who will become older drivers in the future, people -- our cohort and

people our age. And so when you think about future older driver populations, do you think that -- can you project whether they will continue to have a reduced crash risk? Or are there any differences that you think might occur between people who are older now and people who will be older in the future?

DR. McCARTT: Is this for me?

MS. HARSHA: Yes.

DR. McCARTT: Well, it's hard to be objective about this, because I'm going to be older pretty soon. I'm already older, but I'm going to be 70 and older. But yes. Again, this is purely speculative on my part, but -- you know, there's an expression which I never get right, but the new 70 is 60, or whatever. I just think older -- I think people who are older are really different than they were certainly 20 years ago, maybe even 10 years ago. And, you know, I think it has to do with health, but also just lifestyle.

But again, I have to -- you know, I'm looking at myself here and my colleagues and I think, yes, we're going to be -- if I look at my -- my parents were different than their grandparents and I think I'll be different from my parents. I think I'll -- my travel patterns will be different, my health will be better. Now, I'm not representative of the population as a whole and there are, you know, lots of people who won't be healthier than their parents. But yeah, I think what old age is, is not what old age used to be.

MS. HARSHA: Sandy, that same question is for you. Do you think that there will be a difference in terms of lifestyle and demographics and geography?

DR. ROSENBLOOM: Well, one of the things that Anne said that surprised me is that while women increased safety faster, there were no statistically significant differences. One of the things -- if she hadn't said that, what I would've guessed is that more women are hitting their 65th birthday with a lot of experience under their belt. They're coming into their senior years as better drivers with higher exposure over that -- you know, the 3,000 low mileage bias. And that's what I would've guessed, that women are coming in with now 30 and 40 years of driving in some hectic situations, with screaming kids in the car and all of that.

So even if she can't see it statistically, I still suspect that that's some of it, that women are just more experienced drivers now. And also I think that people do have a healthier attitude toward these things. Safety is a hard sell, but I think it's slowly -- you see it coming into people's behavior.

DR. DOBBS: I don't know what the data look like in the United States, but Paul Bose from Transport Canada, he and I looked at data last year in terms of the baby boomers, and we looked at the female and male crash rates, and historically, in terms of the older driver population, that male crash rates are

higher than female crash rates. And what we found in our Transport Canada data is that the baby boomer females are looking more like the male baby boomers, both in terms of amount driven, but also in terms of crashes. So based on those projections, we can expect our cohort, the baby boomer cohort, the females, to look more like the males.

The second consideration is that while there is a segment of the baby boomer population that is going to be healthier than their parents, there also are going to be segments of the baby boomer population that are in poorer health. If you look right now -- and I'm sure that the statistics in the United States are similar to Canada -- diabetes is at the epidemic proportions. Cardiovascular disease is at epidemic proportions. Right now in the United States one in seven Americans has a dementia. So, 3.4 million Americans 71 and older have a dementia and that's projected to increase sevenfold with the aging of the baby boomer population. So there may be segments of the baby boomer population that will be safer to drive as we move through our senior years, but there's increasingly going to be segments of the population that will be at risk.

CHAIRMAN HERSMAN: Do you have any more questions?

MS. HARSHA: No, we don't.

CHAIRMAN HERSMAN: Okay, thank you all very much.

Mr. Magladry.

MR. MAGLADRY: Excuse me. Just one quick question.

Would any of you care to comment on the current or future role of doing things like shopping for my drugs online or by telephone, or my groceries in that way, things that can actually meet your daily needs without causing a driver to get out on the roadway?

DR. ROSENBLOOM: I just saw a study that said that online shopping encourages in-store shopping, that it was not a substitute, it was a complement for that, that you troll online and look at various things and then you then go out to a store and look at them, too. So it's a really interesting question that a lot of people are addressing, the extent to which online shopping and those sorts of things will substitute for travel, or almost all improvements in communications technology and travel technology have led to more trips. Now, because we can easily call somebody in Europe, we're more likely to go see them. So it may well be that all of these online kinds of things don't, in fact, substitute. But I don't think we fully know that.

DR. McCARTT: The one area that I think is interesting is the social networking that's occurring, and particularly when you look at life-enhancing needs for social interaction. Increasingly, people can have those needs met through the Internet. So I don't know of any research that's being done in that area, but I think it's an interesting area, that people may be able to meet more of their social needs without having to get in the car.

CHAIRMAN HERSMAN: Thanks, that's a great question. I

think that goes back to what Ms. McCartt said about, that we're not going to be the same seniors that our parents were, and I think things are changing.

I have a question for all of you. Is there any agreed-upon age at which we would say someone is an older driver? And so I guess this also goes back to is 70 the new 60 or is 80 the new 70? What is an older driver and do we have a definition? Maybe, Dr. Dellinger, I'll go to you.

DR. DELLINGER: The short answer is no. I think we've used 65 and 70 as the most common ages to talk about older drivers. I think 65 because that's when, traditionally, Social Security started. I don't think there's any biologic or physiological reason that we decided to use 65 and above. We can use 70 and above. I think that those U-shaped curves for crash involvement, you can make a case for 70 and above. You can probably also make a case for 75 and above. But there's no right answer to that.

CHAIRMAN HERSMAN: And I have a number of questions, and so if you all want to jump in. Drs. Rosenbloom and Dobbs, I was very interested and kind of in a little bit of an intersection of some of the issues that you all raised. I was intrigued by your chart that showed how people self-select and who self-selects and that women tend to stop driving before they really should or could, but also by the statistic that you used, that women outlive their driving ability by 10 years and men by 6.

How does all of this kind of work together to demonstrate how people are making the right choices in self-regulating or not? How do you reconcile all of that different information, as people are living longer and women outlive men, but they also self-select earlier? What does that mean for us as a society?

DR. DOBBS: I'll take a go at it and then Dr. Rosenbloom can take a go at it. In terms of self-selection -- well, first, in terms of men outliving their driving careers 6 years, women, 10 years, that's due in part because women live longer. Again, it's going to be interesting to see whether that trend holds for the baby boomer population.

The other is whether the trend, in terms of premature driving cessation, will hold for the baby boomer population. My sense is that it likely will not. I agree that we are not going to look like our mothers in that our driving habits are clearly very different than our mothers' driving habits were when they were our age. And so I think that we're basically going into the unknown. I guess if I was going to project at all or predict at all, I suspect that there will be a certain segment of the female population that will look like the current population in that they may stop too soon, but overall, I think that the female boomers are going to look more like male boomers and that we won't be prematurely stopping our driving.

DR. ROSENBLOOM: I think there's two conflicting things

going on here. I do agree that probably the baby boomer women are going to look more like baby boomer men. On the other hand, women are so much more likely, when they're drivers, to sit in the passenger seat. And I think they're going to show a slide in a minute. If you look at older women drivers, they're hardly ever driving -- if they're in the car with another driver, usually a male driver, they're not driving.

Okay. So this is already women over 65. So you can see, as they get older -- these are women drivers now, not just women, these are women drivers, and how often they're actually driving the vehicle that they're in and it's never more than 43 percent. And it gets less and less and less. So even though we know -- even though women are coming into the senior years as drivers with all of this experience, they're still sitting in the passenger seat, which puts them at risk for that low-mileage bias.

And I looked -- and I didn't bring it with me. I looked all the way back, all the way through, back to 17-year-olds. If a women is in a car with a man, she's not driving most of the time. So I see two conflicting things. I see women with all of this driving experience that look more like men, and then I see all these women who are sitting in the passenger seat. And some well-known Swedish researchers, Liisa Hakamies-Blomqvist, has looked at it and says, well, if women drive as much as men, they have the same driving patterns, et cetera, and her solution is that women should insist on driving when they're in the car with a male

driver. And it's very clear that men often have a very different psychological investment in driving. And so I can just see all of these fights across America: No, let me drive today so five years from now, when you're too decrepit to drive, I'll be able to. And I don't see that happening.

So I see this dangerous situation, even among the very youngest women, they're still driving only 8 miles for every 10 miles driven by men and these older women are driving three -- women drivers are driving three and four miles for every mile driven by a comparable guy. And so until this balance changes, I'm still worried that baby boomer women actually won't still look like baby boomer men.

DR. DOBBS: Your question is a good one because it speaks to the need for research priorities, and perhaps what we need to do is we need to start looking more at the 55 to 64-year-old age group, because that's what we're going to be dealing with in large part over the next 20 to 30 years.

CHAIRMAN HERSMAN: Well, I have to say this is all a little bit frightening because I feel like you're holding up a mirror on my life, and so I'm kind of questioning some of the decisions that I make in my family. I always just tell myself that my husband's a really bad passenger and so I'd just rather him drive.

But, you know, regardless, I think one of the questions that I was a little bit troubled with is how do you undo 40 years

of conditioning for women who might have been told, you're not a good driver? And so if they're prematurely stopping driving, they're not confident or they're not comfortable, and how appropriate is it for us to say, no, you should drive, when, in fact, that individual doesn't have confidence or comfort behind the wheel? And is that an appropriate thing for society to be doing?

DR. DOBBS: I think you're right on. If people do not feel like they're confident to drive and they don't wish to drive when they can meet their mobility needs in other ways, who are we to push them to be behind the wheel? It has to be an individual choice. We can as a society empower them, give them driver training, attempt to increase their confidence, but if they don't feel confident to drive, then I don't think that we have the right to say, you have to be behind the wheel.

DR. ROSENBLOOM: Yeah, I have this vision of police coming to your house and asking how many miles you've driven, and if it's not enough, they give you a ticket.

What we see in the data and we can't quite -- there's a little uptick in the number of women driving between 80 and 85 and we think -- and you see it in lots of datasets, in the British and Australian datasets I work with, too, and I think what's happening is that's the age when their male -- their husbands die or become incapacitated and they start driving.

No, of course, we shouldn't force anyone. But I think

if people are competent drivers and we're not offering them meaningful alternatives, then I think we do have to provide ways for women to judge whether they are, in fact, safe and to encourage them to keep driving if they are, because we're not giving them anything else. Until we give them something else -- I mean, I think that's the question for society at large. There are environmental issues, of course. But until we have mobility options for people, then I think we have to help women see if they're competent to drive and if there are fears.

It's a vicious cycle. You don't drive, so you don't drive, so you don't drive, and then pretty soon you're below 3,000 miles a year and you're running into the same issues that, when you go out, you're more likely to have a crash. So I think we have to offer women a way to assess whether they're competent drivers, and in most cases, I suspect that will mean they see that they're more competent than they thought they were and they'll drive more.

CHAIRMAN HERSMAN: Mobility sounds like it's a big piece of wellness. And so I wonder if you all envision or if you're familiar with any scenarios in other countries where the state or healthcare or medical services might pay for driver assessments or evaluations to keep people driving?

DR. DOBBS: In Canada, in all provinces, with the exception of one, having a driver assessment is user pay. The Province of British Columbia now is paying for a driver assessment

for medical reasons. And that's precedent-setting and it will be interesting to see if it results in policy change across the other provinces and territories.

My argument would be that when a physician, because it's often the physician that's charged with determination of driving competency and reporting in to motor vehicles, if they're having -- if they're being charged with that responsibility, they're having to make that assessment. They refer out for CAT scans. They refer out for blood tests. Those are paid for by the healthcare system. If they're referring for a driving assessment for medical conditions, then it should be paid by the healthcare system.

CHAIRMAN HERSMAN: Great.

A couple of data questions. Are any of you all familiar with any statistics -- we're talking about passenger vehicles. Are any of you all familiar with any statistics about older commercial drivers? The Safety Board investigates accidents primarily involving commercial vehicles and we do see that there are many cohorts. Whether it's truck drivers or school bus drivers, these are things that many people may elect to do in their retirement. And so they certainly have a high-mileage component, but they also have maybe some other challenges. Can you all speak to that?

DR. ROSENBLOOM: There was just a study released by one of the cooperative research programs of the Transportation

Research Board on older commercial drivers, and I recommend it to you because in one -- there is not a lot of research about older commercial drivers, so they reviewed -- it's a very good review of all the research on older drivers, period.

And then what they concluded was that older commercial drivers are doing the same thing that all older drivers are: they're self-regulating, they're staying out of dangerous situations, and their greater experience makes up for any physical deficiencies. They are not having higher crash rates as commercial drivers. So I recommend that report to you.

CHAIRMAN HERSMAN: And that report has been submitted to our docket. And so I thank you for summarizing it for the audience.

One other question I have about data, and I don't know if Ms. McCartt or others -- you all have looked at this, but how does the composition of the population potentially affect the data? When I say this, I drive in an urban, you know, highly congested area. My parents live in a very rural area. The way that people drive is very different. And I've also experienced going to Florida during the wintertime and I see that there's very different driving patterns on the road. And so what is potentially more of a risk, is it more of a risk as we have a higher number of drivers on the road that may be older drivers that may have some performance issues, or is it more of risk having a mix of population of drivers that, you know, you've got

some very young, fast drivers and you've got older drivers who may be self-selecting or going slower because that's maybe how they feel comfortable? Do we have any understanding that as we get to 2025 and one in every five drivers on the road is going to be an older driver, will that change the statistical information that we're looking at?

DR. McCARTT: That's a tough question. If you look at what I think is the best exposure measure of vehicle miles traveled, the latest data we have, 2001-2002, it does show that when you get to a -- old enough, that the crash rate, whether it's the overall crash rate or the fatal crash rate, goes up. I think the issue of the severity of the crash gets complicated because, as we've heard, when you're looking at fatal crashes and probably serious injury crashes, what's going on is not so much that the older drivers are riskier, but that they're more likely to be injured or killed, as are their passengers.

So I'm not sure what the answer to your question is. And again, if part of what's changing about older drivers is that they're beginning to drive more than they used to on safer highways, you know, that's a factor that, you know, has to be considered, too, so --

DR. DELLINGER: I'll just pipe in. So today I think we've heard a lot of good news about older drivers and their risk on the road and their risk to others, for example. And I think we're having this conversation because we thought, a few years

ago, that this burgeoning baby boom population, when 1 in 5 drivers is going to be over 65 in a couple of decades, was going to be this horrible thing. So I think the question is complicated because even now we don't see that.

So what we were hoping would not happen, doesn't look like it's going to happen. So now we have to change our whole viewpoint about what it means to have one in five or one in four drivers on the road that are older, when they're not even looking now like we thought they were going to look. So I guess that's a long way of saying we don't know. We don't know, but I think we're confident enough to say it's not as -- it won't be as bad as we thought it might. We don't know why it's not going to be as bad as we thought it might be, but it's not going to be as bad.

CHAIRMAN HERSMAN: Well, and maybe it might even be better for all of us than that. My last question, I think, Dr. Dobbs, we're going to have some panels who talk about some of the medical issues with respect to screening and things like that later. But I wanted to get a sense from you -- and I'm not talking about older drivers, I'm talking about all drivers. Is there are a particular medical condition that you think that we really ought to be paying attention to?

DR. DOBBS: That's easy to answer. Yes, dementia. Dementia clearly is the medical condition that needs to be on the radar screen. And it's interesting that -- I think that when you mention the word dementia, people often think about Alzheimer's

disease, and certainly it's the most common form of dementia. But there are many illnesses other than Alzheimer's disease that can result in a cognitive impairment with or without dementia.

So in terms of the medical conditions, that's the condition that, from my perspective, we have to be most concerned about. When you look at the traffic data, individuals with dementia have crash rates that are two to eight times higher than individuals without dementia. We know that they are very much a high-risk group.

CHAIRMAN HERSMAN: And what do you recommend as the best way to address any driver that has dementia?

DR. DOBBS: For individuals with a progressive dementia, the question is not will their driving become unsafe, the question is when will their driving become unsafe? For that reason, we absolutely need the medical community to be engaged. For the medical community, we need to give them evidence-based screening tools. We now have that screening tool that they can use to identify when their patient may be at risk. In addition to the screening tool, we need to embed, particularly in primary care practices or family medicine practices, because they're the physicians that are going to be seeing the people with dementia, we need to embed the evidence-based protocol.

We need to have the medical communities working with the driver fitness communities, the DMVs, in order to streamline the reporting system. And then we need to have, for example,

reimbursement for physicians for engaging in the medically at-risk driver issue. We need reimbursement for driving assessments so that the cost of a driving assessment doesn't fall on the user. So we need to work really hard, I think, over the next two, three, four years to get a scientifically-based, integrated system in place to address the issue.

CHAIRMAN HERSMAN: Fantastic.

DR. DOBBS: And then we need to get the alternate transportation systems in place.

CHAIRMAN HERSMAN: Sure, sure. A fantastic, succinct answer. Thank you very much. And thank you to everyone on the panel. You all have done a great job of setting the table for us. It's almost lunchtime. But we know that what you've built is the foundation for the next few panels. It will really help us in our discussions and conversations. So thank you for your participation.

Before we break, I want to remind everyone that at noon it's show time and we've actually gotten special dispensation to be able to eat and drink in the board room while you watch the movie. I know our staff are all about to fall on the floor. So bring your lunch back. And this actually was originally a movie theater, and so please come back to watch Shaleece Haas's work. And you won't want to miss this. It's a really poignant portrayal of Milton and Herbert and the decisions that all of us are going to face one day.

So we are adjourned. The movie starts at 12:00 and we'll reconvene at 12:30.

(Whereupon, at 11:30 a.m., a lunch recess was taken.)

A F T E R N O O N S E S S I O N

(12:40 p.m.)

CHAIRMAN HERSMAN: Welcome back. And I really appreciate Ms. Haas allowing us to show the film. I thought it was a great personal story about the decision that all of us are going to face, and it was very well done.

So this panel, the second panel for today, is going to discuss occupant protection for aging drivers and passengers. The panel is going to explore the details of decreased injury tolerance with age and the complications associated with recovery, given crash injuries. The panel will also focus on the current limitations in occupant protection systems for protecting older adults, and new technology that can be incorporated into the vehicle design to improve the outcome for older adults in a crash.

Dr. Kris Poland and Dr. Mitch Garber have prepared questions for this panel. Dr. Poland, will you please introduce the panelists?

DR. POLAND: Thank you, Chairman Hersman. If it's all right with you, I plan to introduce each panelist before their opening remarks.

So to begin, Dr. Stewart Wang is director of the University of Michigan program for injury research and education, as well as the director of research for acute care surgery. Dr. Wang, would you please begin your introduction to this occupant protection panel?

DR. WANG: Thank you for that introduction. I'd just like to comment that this morning I very much enjoyed the panel discussion. Certainly on the frontlines of taking care of elderly patients, it seems to me that the elderly problem continues to be quite substantial. Most of my unit these days is full of geriatric trauma patients.

I'd like to begin by speaking a little bit more specifically regarding the issue of fragility, frailty and aging, as I'll be touching on those subjects. Elderly individuals are more fragile in that they sustain more severe injuries. Given a specific mechanical load, they break more easily. This is different from the fact that the elderly individuals are also more frail in that they experience a worse outcome given a certain injury. They do poorly. What's important is that there is very substantial variability between individuals, and I'll touch on that.

Now let's touch first on the issue of fragility. We all know that older folks tend to break more easily, but it's very important to touch on the fact that they don't break more easily in every single specific location. So if you look at the NASS data -- now this summarizes crashes over a period of 10 years that we looked at, and these are just for belted drivers and frontal crashes at 30 miles per hour. And across the bottom there you see the age, and on the Y axis you see the predicted risk of an AIS-3+ injury. And where you see that all the lines generally go up, the

one place where you see it going up the greatest and the quickest is in the thorax. And if you look specifically at thoracic injuries, what you see is that rib fractures are very, very frequently observed in the most elderly population.

And I'd like to relay a common story that we see all the time in the surgical ICU. There's been a motor vehicle crash, a patient comes in with chest injuries, and in the elderly, these almost always involve rib fractures. And because of these rib fractures, it causes a lot of pain. These elderly patients typically have decreased pulmonary reserve. They end up on the ventilator for support. Once they're on the ventilator, you have difficulty clearing secretions and we know that the longer they're on the ventilator, the more likely they are to get pneumonia.

We also know that elderly patients have very limited physiologic reserve in all areas and tend to get a lot more complications, and what typically happens is, after a period of time in the ICU, where their different organ systems are being stressed, they experience organ failure and not infrequently, death.

So this is a slide to just summarize some of the things that we find. If you look on the upper left there you see the rib cage and the very nice looking ribs on a younger person, and on the bottom left there you see that they're quite muscular, with very prominent abdominal muscles in particular. And if you look on the upper right you see an older chest with these ribs that

look rather moth-eaten. You can almost see through them in locations. You see that there's a difference in the geometry. And if you look on the bottom right, what you see there is almost a transparency of the abdominal muscles. Okay. And that's because it's become infiltrated with fat. And this is based on the CT setting here. It looks transparent.

So the muscles have become replaced with a lot of fatty tissue. And this happens the same in the intercostal muscle, which is that strip. We've been looking this on CT scan. This is very important because the muscles and the hard tissues together are what is able to resist injury.

Now this issue of muscles is something we've been looking at quite closely and we found that it very significantly affects both fragility, as I mentioned, and also frailty. We know it affects fragility, because the more muscle they have, the less likely they are to get severe fractures, but it affects frailty as well. And we what we found is that body condition in the specific core muscle mass predicts survival after surgery.

Now if you think about it, as a surgeon, we inflict trauma on patients all the time. We just hope that they can recover from it. But there is some sort of benefit from it. Okay. And for many, many years we've been trying to find the best predictors of frailty and what we find is that body factors, particularly muscles, are much better predictors than models incorporating age or comorbidities.

Okay. And what we've been doing, for instance, is looking at psoas muscle, which is a core muscle, and if you look at it -- and this is on the upper right there -- is a chart showing mortality on the left. You can see it gets up between 60 and 70 percent. Okay. And across the bottom are terciles of psoas muscle, core muscle area. And what you see is that people that have the smallest amount of core muscle experience the highest level of mortality. And this by far the best predictor. It's better than a -- it's the best predictor we've ever found to predict mortality in the ICU for respiratory failure.

So you go, that's nice. Well, this is for abdominal aortic surgery repairs, and you see the same thing. It's the smallest group that has the highest mortality rate and the highest group has the best mortality rate after an elective abdominal aortic repair. And you think that's -- we go on. This is for liver transplant, okay, and it's the same exact thing. We found the same thing after pancreatic transplants, after major abdominal organ surgeries, after many things.

So let me give you a scenario. You're hiking with two friends, A and B, in the Grand Canyon, you're bitten by a snake and you need to get anti-venom in two hours or you're not going to do well. So who do you send back up to get it? And if all you have is age, that seems to be a pretty simple solution, right? Let me give you a little bit more information. By weight -- and I'm not really stacking the deck here. You have a friend who's a

bit overweight and the other guy's normal. The younger guy is a couch potato. He plays video games all the time. Whereas the older guy actually likes to exercise quite frequently, does a lot hiking, walking, biking. Okay, habits? The younger guy's a smoker and drinker. The older guy is a nonsmoker. Okay. And in terms of medical condition, they're both diabetics, but the younger guy happens to be very noncompliant and the older one happens to be a diabetic who's controlled just on diet alone.

Now, who would you send? Okay. For me, we can argue about this, but I would send B. But I think all of you, despite the large disparity in age, you kind of gave a little thought after you got the additional information. And I would say that what we found is that their bodies would be very different on CT scans. It's not the fact that they have a comorbidity but how they deal with the comorbidity.

So from a trauma surgeon's perspective, and all I'm interested in is in saving lives and I don't -- you know, they come to me after having sustained their injury, and what we have found is that what really matters is the body condition and not the age. Okay. And what we have learned to do is to focus on the individual patient.

Medical treatment over the last several decades has gotten better, but I think a lot of that is because it has become more personalized. We know that the population is comprised of a diverse group of individuals, and effective treatment and

prevention requires that differences between individuals be taken into account. Treat the patient and not the disease is what they teach us in medical school.

And that brings us to the issue of crash injury and potentially dummies. In the past, I think the population of America was like this. And this is not to scale. But I would say that in the last several decades the population has certainly gotten to be more -- there are segments of the population that are more fragile or frail because people are living longer, life is safer.

There's also a substantial amount more variability. Just think about the issue of obesity. The size of the patient population, the individuals, has changed substantially. And while crash dummies are very nice and they represent a standardized segment of the population, my personal opinion is that this is going to become a problem as the population becomes even more fragile and frail and there becomes -- and there is even more patient variability.

So in summary, age is a very poor descriptor of condition, as are preexisting medical conditions or comorbidities. Body characteristics are much better indicators of fragility as well as frailty. Patient variability is a fact of life and must be addressed. It can't be ignored, it can't be averaged, it can't be designed, and it can't be regulated away. And in medicine, we've improved results by personalizing or tuning the handling and

treatment of vulnerable populations such as the elderly.

My assessment is that current crash injury databases collect no specific or objective data regarding occupant characteristics. Even the best provide, if possible, age, height, weight, and just a number of comorbidities, none of which are sufficient. We need a more detailed and in-depth understanding of this complex problem in order to improve treatment and prevention. And I think that the federal agencies and National Institutes of Health, including the CDC, that have the necessary scientific and technical expertise in live human disease research should take a greater leadership role to address this growing public health problem. Thank you very much.

DR. POLAND: Excellent. Thank you, Dr. Wang. I'd like to proceed with our second panelist. Our second panelist is Dr. Richard Kent. Dr. Kent is a professor of mechanical and aerospace engineering at the University of Virginia, with additional appointments in biomedical engineering and in emergency medicine. He is also head of automobile safety research at the University of Virginia, Center for Applied Biomechanics.

Dr. Kent, could you please proceed with your opening remarks?

DR. KENT: Yes, thank you, Dr. Poland. Sort of following up on what Stew started with, I'm going to talk a little bit about some of the characteristics of our body that change as we age. And certainly they are related to individual variability

as well. But there are some things that generally trend with aging that have pretty important consequences for crash protection. And I'm going to start reiterating one of the points that Dr. Wang made, because I think it's a critical one, and that is this change in the distribution of injury pattern.

This happens to be the pattern of injury by body region for drivers that are killed in frontal crashes. This is not the risk of injury; this is the proportion of injury, given that an injury happens. And we see this general trend, periodically, of head injuries decreasing as age increases, whereas thoracic injuries make up a larger proportion as age increases. And this trend persists. It's not just fatal injuries to drivers in frontals. This persists by crash mode. And, in fact, it persists in all sorts of trauma, including things like even falls or motorcycle crashes. So this seems to be an intrinsic aspect of aging.

And the other thing that's important is over 75 percent of those injuries are rib fractures. And if you look at the injuries that older folks die of in the hospital, they will frequently die of injuries that are no more severe than the rib fractures. So it's not, you know, massive cardiac lacerations or things like that that are killing folks. It is rib fractures and sequelae that develop from them.

I think the other thing that's important to recognize here is that this injury distribution reflects really three

somewhat independent aspects of aging. And Dr. Wang touched on a couple of those: the fragility issue, which is the risk of sustaining an injury given an exposure; the frailty, which I think of as sort of a conditional probability, the probability of not doing well given that an injury happens, and that could be expressed in terms of something like dying; and then the third thing is the environment, which, as we heard a bit this morning and we'll hear more about today, changes also with aging. And the biomechanics really, I think, can help us understand the fragility part and why it is that it is easier to injure a person as they age, again, given the individual factors as well.

But I want to talk about this issue of length scales. This is the way engineers tend to think about things. If we start at the very smallest length scale, we can look at things like material property changes in the human body. And we're all very well aware of things like osteoporosis, that are correlated strongly with age. So the porosity in the bone decreases with aging. Also, the percent of the bone that is the inorganic compound, so the mineral, goes down with aging. Those are separate and distinct characteristics. Both change with age and both tend to reduce what we call the fracture toughness of bone.

And, in fact, there are other factors. It seems like every time we learn something new about aging, it turns out to be something that reduces fracture tolerance or toughness in bone. So even things like collagen cross-linking, a filling of lacunae

as you get older, all of those things tend to decrease the fracture toughness of bone. And we've yet to find many things that happen with aging that increase it.

And then there are also -- if we keep moving up on this sort of idea of length scales, if we go to the cross-section of a rib, for example -- so we've gone up now. We're not looking at a material; we're looking at a structure. And what I'm showing on the lower right-hand corner of this slide here are micro CT images of the cross-sections of ribs. And on the left you see the rib bone from a younger individual and on the right from an older individual.

And what you see is this cortical shell, the heavy, dense, really load-bearing part of the bone, which is the outer shell there that shows up very dense in these images, has decreased in thickness from young to old. And this is a significant trend. It's been observed in lots of populations. I'm showing you a scatter plot here where you can see the individual variability that Dr. Wang was talking about, but also a general trend to decrease in cortical thickness.

And what happens there essentially is, the way your bone grows is bone is deposited on the outer surface of the bone and it's resorbed on the inner surface of the bone, and as that occurs during development, the bone grows. But what happens when you reach adulthood and on into senescence is the apposition stops on the outer surface, but the resorbtion on the inner surface

continues. And so what happens is the bone essentially eats itself away from the inside and so you end up with bones that have similar outside geometry, but the cortical shell thins with aging.

And then we can go up to larger-scale changes. Dr. Wang showed a nice example of a change in ribcage morphology and I'm going to show you one that's even more dramatic, if you can run those videos. These are CT scans on -- well, they were. Maybe they don't run. Maybe we can go to the next slide, which is just an image capture from that, from those videos.

But what you see on the left is a CT scan of a ribcage from a 17-year-old, and the ribcage on the right is from a 64-year-old. And in addition to sort of the porous appearance that Dr. Wang mentioned, you can see a pretty dramatic change in the shape of those ribcages and we have found that the ribs tend to get more horizontal or perpendicular to the spine as one ages. And you can see this probably anecdotally. It manifests itself in sort of a barrel-chested appearance as we get older.

And if you look at the way, for example, a seatbelt might load something like those two structures, in the case of the left, that seatbelt load is going to induce deformations like rotations at the spine, which is the kind of rotation that ribs do very well. That's what we do when we breathe. And so that's a kind of loading that the ribcage can tolerate. On the right, you can imagine sort of deforming that chest like a barrel, where instead of putting the stress through the joints at the spine,

you're putting the stress through the ribs themselves. And so structurally, the structure is at a disadvantage for anterior loading.

And so just to conclude, then, the biomechanics of aging are a challenging problem, but I think they're key to the idea of passive safety for older drivers. We did a study where we estimated that the aging of America over the last decade generated about half as many serious injuries as increased seatbelt use prevented. Okay, so this is a pretty big deal. And again, I think understanding the biomechanics is a key part of the solution and incorporating it into things like federal standards and safety countermeasures is important. Thank you.

DR. POLAND: Thank you, Dr. Kent.

Our third panelist is Mr. Stephen Ridella. Mr. Ridella is chief of the Human Injury Research Division at the National Highway Traffic Safety Administration. Prior to coming to NHTSA in 2002, he worked at General Motors Research Labs, EASi Engineering, and at TRW Automotive, addressing biomechanics analysis and restraint system design and performance.

Mr. Ridella, could you please continue with your opening statement?

MR. RIDELLA: My pleasure, Dr. Poland. Thank you very much for inviting us. I'd like to talk about NHTSA's older occupant research. An approach that we have identified for research has two goals, which would be to eliminate crashes due to

aging and to reduce transportation-related fatalities and injuries due to aging. A fourfold process could entail understanding the problem by data, older occupant safety, older occupant protection, and pedestrian safety. I'll only touch on the data and the vehicle approach, specifically the biomechanics research, that we're currently working on at NHTSA.

In terms of data, there's an extensive body of existing research, as identified through NASS studies and others, with respect to injury incidents by age. But the Crash Injury Research and Engineering Network that is part of NHTSA's data collection and analysis can inform us more of injury causations and mechanisms. And I'll touch on a little bit about how we'll use that data in the future.

But I think what's necessary is specific injury analyses for older occupants with respect to both gender and body mass, preexisting medical conditions and comorbidities, as Dr. Wang mentioned, and also to dive in-depth more to causation and mechanisms with respect to crash direction and crash severity.

Regardless, the analysis does show that age affects severe injury outcome for almost every body region in every crash mode. An example follows. There's some work that was done by the University of Michigan to look at a combined NASS and CIREN analysis. CIREN has the ability to add more serious injury cases to an analysis, while NASS gives us the power of national representation.

And we look at the risk of chest and head injuries in a specific population, when you control for whether it's gender, belt use, the driver of a normal BMI, in the passenger car in a side impact, typical of currently regulated conditions, the thoracic and head injuries dominate as age goes up. In fact, it's almost a fivefold increase in risk for a serious injury of the thorax and at least a twofold increase in risk of head injury, serious head injury, in the older population, everything else being equal.

When you look at just NASS data and look at rib fractures as a function of both age and crash severity, it does go up in all age groups as a result of increased crash severity. But even at the low crash severities -- sorry. I went backwards. There we go. And even at the lower crash severities, the increased risk for older folks, it goes up to at least 15 percent. This indicates at low crash severity, the increased risk, we should perhaps do something more in this area with respect to both crash types as well as dummy development, because our dummies currently only look at crash speeds in the moderate to high severity range.

So emphasis on older occupant research that we do at NHTSA is data. As I mentioned earlier, the Crash Injury Research and Engineering Network, looking at injury causation and mechanisms, we have over 300 cases of older occupant injuries with in-depth analysis and we'll be publishing extensively off of this

work in the future.

With respect to injury biomechanics, we're focusing on thoracic injury research and head and brain injury research. As I mentioned in the previous slides, those are the two areas where we see the most potential for older occupant protection. We're evaluating crash dummy response. We're evaluating the current dummies that we have for older occupant biofidelity. We're determining the suitability of those dummies to predict older occupant injury as a result of the analysis that we do with CIREN and NASS data. And we'll determine if we need to revise injury criteria based on age.

One thing that's apparent, the use of computer models must increase, and computer models of the older occupants, human occupants, is, we think, a frontier that needs to be explored to evaluate restraint systems and vehicle designs of the future. With respect to that, we're doing work where we're characterizing age and gender changes in ribcage ages across all ages. From the youngest to the oldest, we're collecting CT scans to develop parametric ribcage models using inputs such as age, gender, and the size of the occupants, and then changing the shape, the mesh size, the density of the bone, as Dr. Kent mentioned, the density of the bone and other mechanical properties to create a model that can then be used in a variety of restraint and vehicle conditions.

This video, which thankfully works on my computer, or at least my presentation, indicates what Dr. Kent was trying to say.

As you get older, the morphology changes, the bone density changes, and the protection and the restraint interaction will change as the occupant ages.

Similarly, for head injury research, we're characterizing age and gender changes to the head and brain. We're taking CT scans of a variety of occupants, from the youngest to the oldest, and developing a parametric head computer model. Inputs such as age and gender and other information that we get from the CT scans will go into a brain model, where we'll change the shape, size, and mesh density, thickness of the bone, the thickness and changes that we see in the morphology of the brain, and input that into what we have published recently, a SIMon brain injury model, to help us predict brain injury in older occupants as well as younger occupants and see what the differences might be as a result of input.

So in summary, we have identified an approach for older occupant injury research. We want to understand injuries and the causation as a critical path to future development of projects aimed at the most frequent injuries, as I said, brain and chest injuries. This will again help us to determine what dummies we need to use, models, test procedures that address reducing the incidence and severity of injuries for older occupants. Thank you.

DR. POLAND: Thank you for that overview of NHTSA's biomechanics research. Our final panelist is Dr. Stephen Rouhana.

Dr. Rouhana is Ford's senior technical leader for safety and passive safety research and advanced engineering. He has also helped Ford lead the development of inflatable seatbelts and pediatric crash dummies.

Dr. Rouhana, your opening remarks, please.

DR. ROUHANA: Thank you, Dr. Poland. Thanks for inviting me. I'm going to talk about taking what we've just heard from the other three panelists and putting that into systems in vehicles that can actually make a difference, we hope.

Excuse me. If I can start with a look at a summary of what goes on with aging, we have three takeaways from this slide. Young kids think they know how to drive but don't have the experience and they drive too fast. This is the fatality rate, by the way, per hundred billion vehicle miles versus age. And older occupants, as you see, 85 plus, they don't get into as many crashes but they are overrepresented in terms of the fatalities. And then the third thing to take away from this, this is the only piece of scientific evidence I know of that shows there's a benefit to middle age.

In the 1970s, Renault, the automotive company in France, put load-limiting seatbelts into an experimental fleet, which they then allowed people to drive and every time there was a crash, they studied the injuries and the crash kinematics. And when I was at General Motors in my former employment, we did a study that looked at the survival, the forces that people were experiencing

and the injuries that they experienced, and we came up with a relative tolerance graph, shown here. So in the age category of 16 to 35, that's the best you can do in terms of your tolerance to belt-loading. By the time you're in the age category of 36 to 65, you have half the ability to withstand belt-loading on your chest. And by the time you're over 65, you have one-quarter of the ability to withstand belt-loading.

This is some work that was done at my current employment at Ford Motor Company, by Tony Laituri and others in my lab. They looked at NASS data and they did a whole series of models using mathematical models under similar crash conditions to what's found in the field. And this graph shows AIS-3+, which is a serious thoracic or chest injury risk, as a function of Hybrid III 50th percentile male chest deflection. So the Hybrid III is the crash test dummy that's used in frontal impact.

And the takeaway from this graph is that, if you're 20 years old and you have -- and you're in a crash in which a Hybrid III dummy would get 60 millimeters of chest deflection, if you were a 70-year-old in that same crash, if you're -- I'm sorry. If you're a 20-year-old, you would have a 25-percent risk of injury when you get 60 millimeters of chest deflection, and when you're a 70-year-old, you would have about a 90-percent risk of chest injury in the same crash with the same chest deflection.

So we wondered, is there a way to reduce the chest injury risk for older occupants? And we answered that with, maybe

with an inflatable belt. And I should say that this was in the context of a research project to try and enhance not just safety for aging people but safety for people in the rear seats of our vehicles.

And so what is an inflatable belt? It's a tubular airbag sandwiched between two pieces of shoulder belt webbing. In the event of a crash the airbag inflates across the chest within 10 to 20 milliseconds. And this is what the system looks like. You can see there's a shoulder belt retractor and then there's standard webbing that goes to a D ring, which is the little loop that holds the belt to the B pillar of the vehicle. And then the shoulder portion of the belt actually has an airbag placed inside that inflates to about six to eight inches in diameter. Then, on the left side, there's a lap belt retractor and a standard lap belt. The lap belt does not inflate.

This is a little close-up of the inflator and the latch plate and the buckle. So the inflator is actually attached to the buckle. It's a stored gas canister with inert gas, helium and argon, that upon a crash receives an electrical signal from our crash module, restraint control module. The electrical signal fractures the diaphragm in that canister and allows the gas to flow through the buckle and it also flows through the latch plate to inflate the shoulder belt.

This is a video of the inflation as it occurs. So you see the gas in the canister. A crash occurs and the diaphragm

bursts, the gas flows through the buckle, through the latch plate, into the shoulder belt and inflates the shoulder belt within 10 to 20 milliseconds.

Now I'm going to need to come out of my PowerPoint presentation and play this in Windows Media Player here. This is a crash test that we've done with a small female dummy on the right side and a six-year-old child dummy on the left side, showing the inflation in slow motion. And one of the things you can see is that we capture the chin and that reduces the forward excursion of the head. We also expand the area of the belt on the chest by five to seven times, which reduces the pressure on the chest to one-fifth or one-seventh of what it would be normally, and that reduces the likelihood of injury.

Can I go back to the presentation? Yeah.

So some of the benefits we expect from inflatable belts are, because we're inflating the shoulder portion, it increases in size, it also -- as it increases in diameter, it pulls the ends of the belt closer together, which takes slack out of the system, and we have a load limiter associated with it to help reduce the chest loads. Then the increased size of the bag helps reduce occupant head excursion. By reducing the head excursion, we reduce that pulling on the neck so we limit the occupant neck loads, and by the increase in the size of the bag we distribute the pressure over more of the chest, resulting in less risk of chest injury.

This is from a frontal crash test using the Federal

Motor Vehicle Safety Standard 208 pulse. And these are just some of the results. We've normalized everything to the standard belt, which is in red. The inflatable belt is in blue. So you can see that the head injury criterion, or HIC, has been reduced by about 60 percent. The chest acceleration and, more importantly, the chest deflection, which we believe is the right measure for chest injury, has been reduced by about 40 percent with the inflatable belt.

And I'm happy to say that this system is going into production in the 2011 model year Ford Explorer, which should be out in the first quarter of next year. It's optional currently in the second row outboard seats. But we feel it will have great ability to protect older occupants by reducing their likelihood of chest injury, which, as you saw from my colleagues, is one of the major problems for older adults in car crashes. Thank you very much.

DR. POLAND: Thank you, Dr. Rouhana.

Gentlemen, thank you so much for a comprehensive overview of a clearly challenging problem.

Chairman Hersman, I'm going to try and restrict my questions to a period of time to give the parties time, but I feel like I could talk about this all day. So I apologize if I go overtime.

I think it's interesting that you have separated out fragility and frailty. This morning, when we were hearing the

discussion, it seemed like those two words were interchangeable. And I guess what I'm gathering from what you've said to me so far is that fragility is the chance for me to get an injury, given I'm in a certain type of a crash, and that frailty is the outcome; once I have that injury, if I have a rib fracture, how likely am I to recover from that injury and what kind of decrement am I going to have. Is that correct?

DR. KENT: Yes, I would say that was actually very well stated. And in fact, we have done some work looking at the relative importance of these two things as one ages. I don't know if we can pull this slide up here that I'm showing. But we looked at, again, sort of mathematically describing this phenomenon where this thing we're calling fragility would be expressed as a risk of injury, given an exposure, and the frailty metric would be a conditional probability of death, given an injury.

And what I'm showing you here is the rate at which these two things change with age. So here I'm showing the relative probability of any injury, of an injury, given exposure -- that's this fragility metric in this dashed line -- and this frailty metric, which is the probability of death, given an injury. And I've normalized everything to one at age 20.

And what we see is that this fragility issue, this risk of getting an injury in the first place, goes up by about a factor of 8 over the age -- from 20 to 80; whereas the frailty thing, you know, the risk of dying once you get an injury, only goes up by

about a factor of 2. And so in terms of what's more important for aging or what changes more with aging, we found it to be this fragility issue. So the fact that they get hurt in the first place is the big -- maybe where the low-hanging fruit is.

DR. POLAND: Okay. So you're basically saying that we need to prevent the injury from happening in the first place. It's not that we need to improve the medical treatment in a certain way so that the outcomes are better, but it's prevent the injury in the first place.

DR. KENT: Well, I mean, they're both important, but I would say that maybe that's more important, yeah.

DR. POLAND: Okay. You've talked a lot about different types of injuries and I'm going to maybe have a couple questions hidden in here. And you've talked about chest injuries. So I guess my first question to you is, when I'm looking at trying to prevent injuries to the older adult, what part of the body am I most interested in? Is it the chest or is it the head? Because typically I hear, for children, I want to protect the head. But is it different for older adults? Is it not the head that's the most important part of the body to protect anymore?

MR. RIDELLA: Well, I think we clearly heard the chest was probably the major one. The injuries that we see, and in fact, every case that we've seen in CIREN with any older occupant, has a chest injury. And getting to the point that Rich made a little while ago about frailty, we see that for a given age or for

a given injury, like chest injury, their outcome, not just in terms of death but quality of life, is even down, much more reduced for the older occupant than the younger occupant. So I would say that the chest is definitely the top and head not far behind.

DR. POLAND: Okay. So just to be clear, when we talk about chest injuries and then we go into rib fractures, if I sustained a rib fracture, is that an injury that I may die from or is it only like -- I think Dr. Wang talked about this earlier. Is it only because of the additional complications with breathing difficulties, because it's difficult to get a deep breath because my chest hurts because I fractured my ribs, and then it leads to some complications? Or is a rib facture just a really, really severe injury and people die from this?

DR. WANG: The patient's condition has a very substantial influence on the outcome after rib fracture. So we see football players all the time at the University of Michigan with some bruised ribs or some rib fractures, or some younger people that fall off their bike, and what we typically do is, you know, give them some Motrin and ask them to take, you know, a nice hot soak, that they'll be sore for a couple of months but that it'll get better. And they're in a bit of pain, but certainly they can manage it with some pain medication.

Now, what typically happens with an older person is they have very limited cardiopulmonary reserve. So you need to be able

to breathe, you need to be able to move your chest wall to expand it out, you need to be able to pull down on your diaphragm in order to pull the air in, and you only have enough oxygen in your system, you know, to live for a couple minutes. So this is something that you have to be doing all the time. And what we find is that the older folks tend to have a limited reserve. Okay. And so when they get a couple rib fractures, pretty soon they're not moving their air very well, they begin to desaturate, then that whole vicious cycle that I showed then occurs. So it's much, much more impactful in an older person than it would be in a young person.

DR. POLAND: Okay, so you're telling me that I need to protect the chest and that older adults typically have rib fractures that can have a very poor outcome for older adults. And you've also told me that as people age, they don't tolerate belt-loading as well as they do when they're younger. So Dr. Rouhana talked about this a little bit, something that can be done to try to decrease the belt-loading, the inflatable restraints are certainly an interesting option.

Are there additional options for us to look at to be able to make the belt system, to make older adults more tolerant of this belt-loading? Because we want everybody to wear seatbelts, but we certainly don't want the seatbelts that they're wearing to cause injury in and of themselves.

DR. ROUHANA: I think the data shows that you're almost

always better off with the seatbelt on, even if you're an older occupant. There are many technologies that are currently available or are being researched on to address this frailty of the chest -- or sorry, fragility of the chest. For example, in many vehicles today there are load-limiting shoulder belts, so as you move forward in a crash, you'll apply a load to the seatbelt and the load will build up to a certain value and then the belt will start to, in a controlled fashion, pay out and that reduces the force or keeps the force at a constant level, hopefully below the level that's required to break your ribs. But as both Dr. Kent and -- actually, all three of my colleagues have shown the rib cage really deteriorates with age and so that load gets lower and lower as you get older and older.

So force limiters can only go so far, so low, in terms of the force before you start allowing the occupant to have too much excursion forward, in which case they may start going through the air bags or hitting things in the compartment that you don't want them to hit and then head injury could be the problem. So load limiters are one mechanism or tool in the arsenal.

We've also been doing research on what are known as four-point belts, which are double shoulder belts. We got that from racing. We've done a lot of studies, GM has done a lot of studies, looking at race drivers. And you see these crashes all the time; they're 200 miles-an-hour around an oval, the car crashes, parts fly everywhere, and people get up and walk away.

And so we've been trying to find out what is it in that environment that we can pull into the passenger car environment, and one of the main things that we have considered is the double shoulder belts. So a four-point belt is two shoulder belts connected at the lap. We have done a lot of research on that and we are hopefully continuing that research until we can come up with a solution we can put in a vehicle.

MR. RIDELLA: One thing we've been looking at, the agency, is advanced restraint systems, but a follow-on to that has to be adaptable restraint systems, and Dr. Wang touched on it, in terms of the individual -- in other words, the restraint system would adapt to the individual, whether it's their body condition, the crash condition, and perhaps even gender. So the next generation of restraint systems might indeed take that tact of going beyond just what Steve's mentioning, but beyond it to adaptability for the individual.

DR. KENT: I think there's also, there's an intermediate phase between the two systems we're talking about where this full adaptability is sometime in the future but not now. But the load limiting, there are systems now that are extremely clever with regard to load limiting. And so one system that we've looked at in my laboratory is a load limiter that adapts the load limit based on the speed of the crash, and so you only get as much belt force as you need.

And so in a low-severity crash, the belt load limit will

actually be quite low. And that's good for everybody, but it's disproportionately good for older people because they tend to get hurt in lower-severity crashes. And so if you can really offload the chest if it's not needed, then that should have a disproportional benefit for older folks and that's, I think, a much more kind of proximate technology than the full adaptability that Steve Ridella was talking about.

DR. POLAND: So I guess it's kind of a pie-in-the-sky question. You know, you've kind of talked about how age isn't necessarily the predictor, but it's the condition of the body. Is there some way -- again, kind of pie-in-the-sky type of thought process, that you can measure the condition of my core muscles, like Dr. Wang was talking about, some measure that can give some prediction of my outcome and then have my car know what I am, so that when I'm driving my car or when my husband is driving the car or when my mom drives my car, that these intelligent systems can appropriately deploy to maximize the benefit for the driver or the passenger?

DR. WANG: There are a number of different techniques which I think are becoming available. For instance, we've processed so far about 10,000 CT scans, full-body CT scans, on surgical patients and trauma patients, so we're getting a much better idea now of being able to predict sort of condition based on measurement of specific points.

So it may be fairly simple in the future, just to show

up at a dealership or anyplace -- you know, people get bone densitometry readings quite frequently. There are now ultrasound machines which are very fast, painless, and obviously without exposure to radiation, which can measure core muscles very quickly, and with a few parameters measured on the outside, I think it's fairly feasible to come up with an objective measure of a subject's condition, of a patient's condition. And I think that could be used to adjust some of the settings, as Dr. Kent talked about and Dr. Rouhana talked about.

DR. KENT: I think we do need to acknowledge, though, that the biomechanics is probably a few decades behind in terms of knowing what you actually do with that information. So I think there is technology that could tell you all sorts of things about the person. The question is, then, what do you do? And, you know, questions of individual variability and tolerance and where you put loads on an individual are certainly yet to be answered.

DR. POLAND: I guess that kind of leads me to my next question, which is -- and I'm going to address it to Dr. Rouhana to start with, but I think Dr. Kent and the others will probably want to join in, as well. But we've seen a lot of advancements in child safety and I think some of that is because of the amount of testing that's involved and the encouragement for these safety systems to become really excellent to be able to provide protection for children.

Are there tests? The Insurance Institute has a best

pick. NCAP has a star rating system. Is there something that manufacturers can design to encourage them to adapt their vehicle to better address older adults? And along what Dr. Kent was just saying, do we even have the technology to biomechanically assess this? If you make a change, do we know what that injury value needs to be? Do we know how much chest deflection is okay for an older adult to be able to even have some sort of a rating system?

DR. ROUHANA: Okay, there are several parts to that question. I'll try and remember them all. The first is, is there some sort of a standard protocol that we use to assess our vehicles for elderly occupants? And the answer to that is, really, no. NCAP, FMVS-208, the IHS testing, doesn't really address older occupants, per se. That said, we are doing research. We just published some research last week, in fact, on our Ford finite element human body model, that we have determined what its age is and we've made a younger version and an older version so that we can go ahead and look at different restraint systems with the two versions and see how they affect the aging population.

The other part of this equation, which we're not talking about, really, as biomechanics, is ergonomics. We do a lot in our research to try and make our vehicles friendlier for older people to drive, bigger numbers and things like that on the speedometer, and we look at ingress and egress issues. But that's probably a different subject for a different day. Did I answer all the

questions?

DR. POLAND: Yes. And I'm actually also being hurried on a little bit here to keep us on schedule, so I'd like to turn it over to my colleague, Dr. Mitch Garber, to see if he has some follow-up questions based on our discussion so far.

DR. GARBER: And like Dr. Poland and perhaps unlike many others in the room, I could talk about this sort of stuff all day, as well. But in order to keep this moving along, I think I've just got one point of clarification that I wanted to go over and then maybe I'll come back at the end after the parties and perhaps the Board has discussed this.

You talk about fragility and frailty and you gave us some very specific definitions of those terms. I think we all sort of have in our mind the 80-year-old great grandmother when you talk about that, that's who we have, that's the picture that we look at and think of. And in fact, we're seeing an epidemic of obesity in this country and particularly in the aging population, we're seeing them become obese. I don't think we tend to think of those people as fragile or frail, but I would like for you to address how those terms may apply to that population, as well, because, again, it's hard to think of a 280-pound great grandfather as being fragile or frail when, in fact, they may be at increased risk. And perhaps you could discuss that just a little bit.

DR. KENT: Okay. There's a lot in that, in the answer

to that question. But so in looking at this issue, what I have found is that the literature is absolutely replete with studies showing that obesity is an independent risk factor of death following a car crash, but the literature is sorely lacking studies of which of the factors is it, is it fragility or frailty? And if you go into -- you know, it's a difficult question to study because the question of, you know, what's the risk of getting an injury in the first place is really the hard one to answer because we have really good fatality data, but once you start looking at injury, the question gets much more murky. And so pretty much all of the literature is sort of contaminated with this combining of serious injury and death, and so what that incorporates is both the fragility and the frailty.

You know, from some of the limited biomechanical studies we've done in our lab, we see obesity makes the bones a lot stronger. If I test a rib cage from an obese cadaver, those ribs will be stronger than a comparable rib cage from a thin person and, you know, it's the way bone remodels; it's been carrying a load around and so the bones do tend to get bigger. But then there are all sorts of issues about kinematics and how people move in crashes that may disadvantage an obese person in terms of restraint performance. And so it's a complex question and I think getting at the answer to your question is difficult and we don't have it now.

DR. WANG: If I could address that a bit? In the

obesity epidemic we've certainly been seeing, and what we've noticed, is that it is highly correlated with an increase in severity and also the number of lower extremity factors. And where it begins to play in from our perspective is that I think in the obese population -- well, in the elderly population, obesity plays a much greater role in terms of frailty and that's because in the heavier-set population -- and what we typically have is that they're a little bit more fragile and they get more lower extremity injuries, but what tends to happen is that the obese folks have a much more difficult time getting back to weight-bearing and ambulation, okay. And what that typically means is a very prolonged hospital stay during which their complication rate goes up markedly.

On top of that, when you have a very heavyset person who has a difficult time weight bearing -- and the elderly just generally tend to have a harder time recovering strength, so that means a very substantial impact on their long-term sort of quality of life. Okay. So I would say that certainly in the elderly, obesity is having a very substantial impact more on frailty even more so than fragility, even though we clearly see a fragility effect.

DR. ROUHANA: And I think Richard's right. It shows up in every analysis. We did something with rollover recently where the most severe cervical spine injuries, when you look at the population, they were the oldest group of people and they were

also the fattest people and so it just shows up over and over again in these analyses.

DR. POLAND: Chairman Hersman, I'd like to turn it over to the parties, please.

CHAIRMAN HERSMAN: Well, thanks a lot, guys. It's not New Year's, but I think you've encouraged all of us to have a resolution to get a little bit more exercise and build up our core strength, so Pilates and yoga are in my future.

I have been asked to make sure that each of the parties' spokespersons for the table, if they could please identify themselves by name and their organization for the people who are watching, who are not here with us. So we'll go to the first table, FHWA.

MS. ALICANDRI: I'm Beth Alicandri. I'm with the Federal Highway Administration's Office of Safety. And we have one question from our table. No? Do you have one? Just one.

Funding for crash biomechanics has decreased steadily over the decades with only a handful of government agencies and a couple of larger car companies doing the work. I should've let John read this question. How could we best maximize the effectiveness of our research efforts to lead to earlier deployment of technological improvements?

MR. RIDELLA: Okay, I'll take a stab at that. The answer is correct, there's been a larger emphasis in the last several years on crash avoidance than active safety technology.

But when you go to conferences worldwide, and recently I have, the number of people of doing research or collaborating on injury biomechanics is still quite high and there's still -- all of us in the community think there's a lot left to do.

What we're finding and what we're really trying to do is more international collaboration. We've recently started some collaboration in rear impact dummies and side impact dummies with governments and research agencies across the world. We've been meeting quite regularly for the last year. There are consortium in Europe that are joining together companies, academia, governments, to look at biomechanics research and we're starting to join those things, as well, to leverage the dollars and the expertise that's around the world in this area. So that's one area that we can best maximize our resources.

DR. ROUHANA: I guess I'd like to weigh in on this one, too. We continue to do research at Ford, but there used to be much more public money for research in this problem, and injury from automotive crashes is the number one cause of death between the age of 1 and 34, and it's not getting the attention, I think, that it needs in terms of the public dollars that are out there for research compared to some of the better-known causes that are out there that are getting funded. So I think there is a lot of room for improvement there.

DR. KENT: Maybe I can just, from the perspective of the guy chasing the money, as a university research lab, I certainly

have noticed that phenomenon. And a couple of comments. One is that in recent years in particular, there's been sort of an increased level of funding coming out the DOD and other sort of military focus groups and it's because, you know, crash injuries are a big deal in wars and this kind of thing. And so there has been a little bit of an increase there in terms of the ability to look at some of these questions.

Another thing that has recently been discussed, at least, is the VA. You know, veterans have disproportionate crash involvement and the VA also has tons and tons of money and this might be a good way to spend it, frankly, is try to keep these guys out of the hospital. And so there have been some of these more military focused areas where we've been trying to proceed down these paths that have maybe dried up.

I also just heard that Ford had record profits this quarter, so I don't know.

(Laughter.)

DR. ROUHANA: We'll see if that translates into a research budget.

MR. MADDOX: Can I do a follow-up, Kris?

DR. POLAND: Please.

MR. MADDOX: The other part of that question was how do we maximize the effectiveness of the money that we already have?

DR. ROUHANA: I think Steve has hit on it, by seeking out collaborations where we maximize the number of people and the

number of labs that are participating and each person brings their own perspective and can really contribute to the project.

MR. RIDELLA: One thing we did recently is have a focus thoracic injury research symposium out in Arizona, and you find that people are doing similar research around the world. Well, then the best thing to do is to say let's not be redundant and try to focus people in different areas so we can maximize the results.

MS. ALICANDRI: It turns out we do have another question at our table for Drs. Wang and Kent. This is from Jon King, National Institute on Aging: How truly modifiable are the fragility risk factors for older adults? That's the first question. And the second one is: Are older women at greater risk due to greater reductions in bone mineral density, osteoporosis, et cetera, et cetera?

DR. WANG: I'll try to address the first question is how modifiable are they? We are in the process of studying that right now. We certainly think that -- for instance, we've been seeing these very substantial effects of core muscle on operative outcome. We believe a substantial number of those things can be addressed, whether it's by intervention, placing -- a lot of surgeries, for instance, are -- it can be delayed so that people can get conditioning. Now, obviously in a trauma situation that's not possible and these patients are coming in. And there, I think I'll say that, you know, you can't really -- you can perhaps modify the entire population, in general, is one thing.

I believe, however, in working with a lot of automotive engineers in southeast Michigan and elsewhere, I believe that there are a substantial number of technologies which are, I think, on the near horizon, which, if they're adapted for a more elderly, more frail, occupant, I think can provide substantial benefit. So I think, in that way, as I think that a smarter, more tuned, vehicle system can prevent a number of injuries because you don't have time -- the patients are going to come in because of the trauma and you can't say, well, you're going to get into a crash in two months, you're going to go out and do exercise.

However, the frailty issue can be addressed over the long term. I think there are interventions, whether it's nutrition or exercise, specific regimens where that can be addressed.

MS. ALICANDRI: And the second part of the question was are older women at greater risk due to greater reductions in bone --

DR. WANG: We do see that. We certainly see that trend. What we see is actually a very -- equally large contribution from muscle mass and conditioning. We, as I mentioned, have processed over 10,000 total body CT scans and we see very substantial differences.

The other thing that's interesting is that men and women are quite different and they get -- surprise, it's a news flash. But they get completely different patterns of injury, okay. So

men and women get very -- you know, there are certain types of crashes where, you know, men will get, for instance, in a frontal crash -- let's get away from the chest a little bit. In a frontal crash, men will tend to, you know, will tend to get posterior acetabular fractures, whereas women rarely -- it's an odds ratio of about 9 to 1. And whereas if you flip it around to a side impact crash, it's about 9 to 1 females. And what's interesting, it's actually a younger female, okay, that are more likely to get some of these other factors. So while osteoporosis in general goes down, there are much more substantial gender differences which we are only now beginning to get an inkling of.

DR. KENT: Maybe one quick comment on that. I actually have some data here that illustrates -- I think the answer to your question on the gender question is it should, but it often doesn't manifest itself in very clear ways.

What I'm showing you up here is relative risk, again, plots as a function of age. And this came out of combining, again, a whole bunch of exposures, you know, motorcycle crashes, falls, and there were attempts made here to control for exposure. So the idea here is that this is the risk of injury given a comparable exposure as a function of age. And on the left is men and on the right is females and all of it's expressed relative to men at age 20.

And it's a lot, but the point is that women have about a 20 percent greater risk of dying at a given exposure and it's

almost constant across the entire age spectrum. And in fact, it almost maintains into preadolescence that that ratio stays reasonably constant and I cannot tell you why. Certainly things like osteopenia and osteoporosis do manifest themselves at younger ages in women, although they do show up in both genders. And the other thing that tends to make that a difficult question to answer is there's this whole size issue whereas men are bigger. And so is this just simply a size manifestation or is there actually some genderness issue in here? And I would say getting to a quantitative answer to that is probably in the future. I don't think we have a good one now.

CHAIRMAN HERSMAN: Hum, I don't like those numbers too much.

Thank you for your questions. Any more questions at the first table?

(No response.)

CHAIRMAN HERSMAN: We'll go to the second table and if you could also identify yourself with your name and your organization.

MS. BELL: Sure. Nancy Bell from AARP. And the first question for the whole panel: Would an older crash dummy aid in the development of more effective occupant protection for older drivers and passengers? What is involved in aging a crash test dummy? Does an older dummy change the injury criteria in injury criteria performance levels for frontal and side impact test

procedures? And what effect, if any, would this have on current vehicle design?

DR. ROUHANA: A lot of questions. It's good questions, too. I'm not sure I would want to go to an old crash test dummy. I know there is some thought about that. I think the best way to handle this might be by modeling. As I mentioned, we just made an old version of our human body model and can use that to simulate various restraints.

An older dummy would look like a dummy with perhaps different response force deflection properties of the chest. It may have different rib angles, as both Dr. Wang and Dr. Kent have shown, that the rib angles change as a function of age. The injury criteria, most likely, would remain the same. I think chest deflection is the criterion of interest for old people as well as young people. Did that cover it all or --

MS. BELL: Would there be any resulting effect on vehicle design?

DR. ROUHANA: That's a really tough question to answer. One of the things that hasn't come out is it sounds simple that we can have systems that automatically adjust for an occupant's age, but it's not quite that simple because age is only one of the variables in crashes. The amount of room you have in the vehicle limits how far you can allow the occupant to move. So if you have a load-limiting shoulder belt, for example, and you make the load limit really low for an older person, as I said earlier, you're

going to end up with a lot of excursion. All crashes are different, of course. You have angles to crashes. Crash pulses are different. So there's a lot of factors that have to be factored in to this adjustable restraint system that make it a little bit more challenging. That's not to say we couldn't do it, but it's going to take significant amount of effort, I think, to do an adjustable system in that regard that encompasses everyone.

Bio-variability is enormous. We have to accommodate from the smallest occupants to the largest occupants and from age 8, in most states, onward to the oldest person who's in a vehicle has to be accommodated, so -- and there are all sorts of different shapes and sizes. It's a complex problem.

MR. RIDELLA: One of the things we're kind of immune to or say, blind to, is the effectiveness of these restraint systems because of the way the dummy's designed or what it measures. Current crash dummies only measure chest deflection in one dimension at one spot. But we have a project of an advanced crash dummy that looks at ribs that are angled properly, like a human's, and measures at four different locations on the chest. This slide shows some advanced technology where we're actually putting LEDs on each of the ribs of the dummies and we can measure deflection at any point along the rib in three dimensions.

Question is we don't know what that actually means. We know that the chest deflects when a belt is loading. In fact, all of us had pictures of these -- amazing pictures of both post-

mortem human subjects and dummies and the amount of deflection you can see. So we have to figure out what that means relative to an injury predictive that the current dummy just does in one dimension, but now in three dimensions at multiple spots. I think it will make us evaluate restraint systems in a different way by having more advanced capability in a dummy and more advanced criteria, but we still have to work on what that criteria means.

DR. ROUHANA: That will be something that will be applicable to all ages, not just the elderly.

MR. RIDELLA: Correct. Sure.

DR. ROUHANA: Yeah.

MS. BELL: Talking about occupant protection as a system, could you talk about the airbag, how that comes into play with the older occupant or driver and working with the restraint system?

DR. ROUHANA: Before we had airbags, we just had belts and we broke a lot of chests. The risk from belts alone is, especially for elderly occupants, is quite high. With the advent of airbags, we now had the ability to change the amount of load going through the belt. We could reduce the amount of force by having the airbag come out and take some of the forces of the restraint. And so the risk of injury for a combined restraint is somewhat in between what it would be for an airbag alone, which distributes the load completely and has the lowest risk for chest injury. So airbags do work in conjunction with the seatbelt to

reduce the risk. More importantly, I think they reduce the risk of head and neck injury, but they are positive forces in chest injury protection.

MS. BELL: I think one of the things that's been discussed on this panel and the panel prior to this is that death from rib fractures often occur subsequent to the accident, up to 30 days, possibly longer than 30 days after the accident. Do you feel that these deaths that ultimately occur from the rib fractures are accurately reflected in the fatality data or to what extent do you think they're reflected?

DR. KENT: If I could just pull up my slides here. Give me one second. So this is sort of getting to this maybe an even bigger issue. So here I'm showing you some -- maybe if we can get this slide up. Here I'm showing you just some proportions. If you pull out fatal data in the U.S. and look at, say -- I'm calling it a young group; it's actually kind of a middle-age group, age 30 to 45. If you try to compare the oldest group to teenagers, it really gets crazy, but here I'm just comparing to age 30 to 45 and then a group that's age 75 and older. And you see a lot of different things that go to this sort of crash exposure issue, but one of them is this delayed death question.

And so it's about 30 percent of people over 75 who die in a car crash die a day or more after that crash, whereas it's only about 10 percent in the middle-age group and it's very low in teens. And that's somewhat counter-intuitive. You might think

these young, robust people hang on and try to live and -- but no, what they do is they kill themselves quickly in this crash -- it's so severe, massive head injuries and this kind of thing; whereas the older folks don't have those kind of crashes.

And I have a couple of examples of some case studies we did where -- I just pulled out some random cases here because they illustrate the point. This is a FARS case of a 39-year-old female; so again, not a teenager. But this is a single-vehicle crash with a drunk driver at night, goes head first or roof first into a tree and there's a massive intrusion in the roof and this person dies immediately of massive head injuries. And that's an archetype, really, of a fatal crash. It's not the kind we study, but the typical fatal crash is that they tend to be pretty crazy events.

And then we pulled out some of the older cases, if you go to the next slide. Here's a 75-year-old male, was in a minor crash, died 16 days later of complications from a preexisting bowel condition. Okay, that's in FARS. Here's one, an 89-year-old drove slowly through a fence across a yard, hit a house, backed up, hit the house, backed up, drove into the house a third time and then died six days later of a cause that's not known, was not -- but it's in FARS.

We found several cases in FARS with heart attack listed by the medical examiner explicitly as the cause of death. And so these cases do show up in FARS. And we see all sorts of cases of

sort of moderate severity, belted occupants who die.

And one of the things that I think is very illustrative, if you go to the next slide, this is the driver gender distribution by age in FARS, and if you look over at the right there, you see in the age 65 plus, you see 45 percent male, 40 percent female. Fifteen percent are coded as either unknown or pregnant females. So probably not many of them are pregnant females, so what that means is 15 percent don't even have the gender coded. And this reflects the fact that investigations of elderly driver fatalities are not done very thoroughly because it's not apparent they're going to die.

And so when a young person dies, you know it and it gets a lot of investigation. They survey the scene. They take a lot of photos. When an older person dies, there are no pictures, generally. There's no investigation. And in fact, I found cases where the police report had been denoted no injury or minor injury, which had later been whited-out and fatal had been checked. And so it's not apparent that these guys are going to die in these crashes. And so it's a very good question, what is an elderly fatality and when should it be included as sort of being caused by the crash? It becomes gray.

MS. BELL: And as a follow-up question, I guess, what you just said, do you think that calls into question the lowering fatality rates that were discussed during the first panel today?

DR. KENT: I hadn't really thought about how that might

be affecting that kind of data. I don't know. I don't know how pervasive this kind of thing is or how much it affects the database in terms of overall trends. I haven't looked at that.

MS. BELL: Then, I think, as our final question, are there after-market design options to address the needs of older drivers and passengers who are likely under-protected by the current designs on the market?

MR. RIDELLA: I've seen things like protectors for -- or, say, comfort devices for belts. Typically, I don't like those because they may interfere with the belt's performance, but in general, most of those products, we don't know what their effectiveness is. We just don't test them and we don't think actually they're that effective, so -- the belt ones are the ones that we see the most, just for comfort reasons and for, you know, ease of use to put them on and off.

DR. ROUHANA: Some of the after-market belt devices that aim to get the belt off the shoulder actually change the routing of the shoulder belt and cause an increased risk of submarining, sliding under the belt. So I don't like to see those systems at all. We do a lot of evaluations with our belt systems to try and get them to get good kinematic performance and dynamic performance and when you start altering the geometry of the system, you can run into a lot of problems.

MS. BELL: Thank you.

CHAIRMAN HERSMAN: Thank you. IIHS for the third panel,

for the third table.

MS. BRAITMAN: Good afternoon. I'm Keli Braitman from IIHS. Thank you for your presentations. They're all very interesting.

We have a few questions. Since motor vehicle safety standards such as FMVSS-208 drive restraint system design, do you think any changes to that standard would help vehicle manufacturers further optimize belted performance for the older population?

MR. RIDELLA: I like to say I'm just a research guy, so I'll let Steve answer it.

DR. ROUHANA: Well, currently Federal Motor Vehicle Safety Standard 208 requires us to test unbelted and that can drive restraint system design, in particular, the airbag design, to be very aggressive or more aggressive, perhaps, than it needs to be because we have to protect 50 percentile male, 168-pound occupant, in a 30-mile-an-hour Delta V, which is a lot of energy to manage. So that could cause compromises in what we do with the belt system because it has to work with the airbag. So I guess the answer -- the short answer is yes, I think that there are aspects of the regulations that could have an effect on performance for all occupants, actually, not just elderly occupants.

MS. BRAITMAN: Thank you. This next question is similar to a question that the other table asked, but it's a little bit

different. Are modeling procedures from injury measures on dummies sufficient for predicting patterns of crash injuries for older population and, if not, what else should be done?

MR. RIDELLA: I think modeling will take us a long way. We just need to understand better the material properties of the older folk. Stew certainly showed some interesting data relative to muscle versus fat. Some of those material properties aren't well known for, let's say, fat or the distribution of fat or bone changes, so a lot more work has to be done. I'm sure Dr. Kent would be happy to know that because he could do more work like that, but it is necessary.

We are investigating those things, looking at rib properties and looking at brain properties. It's going to take a while, but we just can't do it by scaling or by, you know, what we think is right. There's a lot of literature out there, but it takes detail analysis of individual tissues to really come up with these solutions.

DR. ROUHANA: I guess one of the things I'd like to say about modeling, though, is the dummy is a model. It's a model of the human, also. It's a physical model and it's named appropriately because we make a lot of approximations in developing those models. The mathematical models that we have developed, not just Ford but the whole industry, there are many different models being developed around the industry. Steve mentioned SIMon, which is a model of the brain and skull.

These models are much more detailed -- excuse me. They're much more detailed than the crash dummy can be. The crash dummy is a tool. It's meant to be repeatable and reproducible, so that when we run a test in our lab and NHTSA runs a test in one of their contract labs, we get the same answer, hopefully. And because of that, to make it a laboratory tool, many, many compromises have been made. It's a good representation of the human and we've done a lot with the dummies. As many people this morning have noted that, you know, the number of fatalities have come down.

I think a lot of that is due to the economy in the last three years. In fact, Michael Sivak from the University of Michigan had a study on that. But -- got off track, sorry.

The fact of the matter is that the computer models, I think, can give us much more detailed answers. The caveat is that, as Steve said, there are many properties we don't know and the computer models are only as good as the properties that we put into them, so there's compromises everywhere, I guess.

DR. WANG: If I could also address that question? I think there is a very substantial and, in fact, glaring deficiency right now. I think the modeling is going to be very helpful, I think adding additional properties. But as Dr. Rouhana mentioned, what you end up with is much more detailed, hopefully with models, sort of detailed injury locations, okay, and specific injuries. And what we've done is, in looking at our very large substantial,

very large set of crash cases, we see differences in the location and the specific sites of injuries and how they're related to each other.

Now, very different than a young person versus an old person. Young person, those ribs tend to collapse, you get internal injuries, pulmonary contusions, whereas in an older person, the ribs break in a different spot, which leads to lung lacerations and liver injuries and whatnot. So I think what's necessary is a three-dimensional injury mapping.

All the current injury databases now are basically lines with a specific injury and a score. They don't give you the three-dimensional location. And what you need to see is the exact location in 3D space as well as how they relate to each other and to the location of the force loading on the exterior surface of the body. And all that now is very easily obtainable by processing of CT scans, and I believe that's absolutely necessary to support modeling. You have to have a target for any sort of test that you have. You have to have a valid target. So I think that's a very substantial and glaring deficiency right now.

MS. BRAITMAN: Thank you.

And one last question from our table. There is a lot of information on polypharmacy effects on cognition. Do you have any thoughts on polypharmacy effects on bone density, fragility and/or frailty?

DR. WANG: As a trauma surgeon, I don't believe I'm the

best, the most qualified, person to say that. We certainly see polypharmacy. A substantial portion of the American population seems to be on multiple drugs at this time. What the interaction of those effects are on osteoporosis, in particular, I cannot say.

MS. BRAITMAN: Thank you.

CHAIRMAN HERSMAN: Okay. Thank you very much for those questions. And we'll proceed to the final table and I think AAMVA's going to lead this time.

MR. MANUEL: My name is Tom Manuel and we're from AAMVA, and we just have one question; you kind of touched upon it earlier. But are there gender differences in terms of the older driver and crash biometrics and what are the policy implications of this difference? And one of the things that I was thinking about was we talked about in the last session that females tend to be the passengers when there's a male present in all age groups. I mean, are there any implications for protecting those passengers specific to gender, perhaps, or what are the implications, policy implications?

MR. RIDELLA: Well, I'll start with that. We certainly see very substantial gender differences and we know that these -- we attribute many of the differences in injury patterns to the anatomic differences that we see between the genders. My personal feeling, again speaking from the outside and not being one that designs the dummies or the -- designs the dummies or the test devices, is I don't believe that there is sufficient gender

specificity in the tests. I think when you -- we certainly -- when you lump all the injury risks together, you kind of lose a lot of that understanding and so my personal opinion is that there is not sufficient gender specificity in the test devices.

DR. ROUHANA: That aside, we still do use small female dummies in our both regulatory and consumer level tests and side impact dummies that, I mentioned earlier, we're developing and helping to evaluate worldwide have both the mid-size male and the small female based on more recent biomechanical data of, let's say, fragility of females relative to males.

DR. KENT: Let me make one quick comment. The front passenger position -- I don't have this kind of data, but one thing we've been looking at lately, which has become kind of a hot research issue is the rear seat, which sort of goes to your point about non-drivers. We do know some things about the rear seat that do have policy implications, I think, and this, what I'm showing you here is the effectiveness -- this is the fatality effectiveness of the rear seat as compared to the front seat, and so a positive number means that the rear seat is safer compared with the front seat for the same kind of an exposure. And if there's been a historical truth in automobile safety, it's been that the rear seat is safer; it's an intrinsically safer environment than the front seat. And it's only in recent years that this has started to become untrue and it's become untrue for older drivers.

And so what you see there is up through about age 50, the front seat has positive -- or the rear seat has positive effectiveness and then when you get into the older age groups, the rear seat becomes negatively effective. So in other words, the front seat is actually safer than the rear seat for the oldest occupants. And there are some working hypotheses on why that is. One of them, if you go to the next slide, is this, illustrated here, where this is the percent of various kinds of technology that are in the driver's seat and we see things like pretensioners and load-limiters.

This data is a little bit dated now. If you were to go up through the current time, you would see, essentially, all of them, 100 percent, that these technologies have come into the driver seat. And that's been largely motivated by consumer information and federal compliance tests, which involve dummies in the driver seat. But there are no such tests involving dummies in the rear seat, and so the rear seat sort of -- you know, it's still a safe environment, but intrinsically, the front seat has caught up because we've been working so hard on it, I think, and so that's starting to show itself and so there may be some advances to be made there by incorporating some of this technology from the driver's seat into that -- into the rear seat. And there may be policy issues that could drive some of that.

DR. ROUHANA: I'd like to weigh in on that one, too.

What this graph doesn't show is the driver for the fact

that there are pretensioners and load-limiters in the front seat. Of course, there's always, there's -- and I didn't mean that by the car driver, I meant that by the major factor, I guess I should've said that. There's always a driver in the vehicle and one-third of the time there's a passenger and one-tenth of the time somebody in the rear seat.

Nevertheless, vehicles, themselves, have become, have been forced to become, for all of our sakes, more fuel-efficient, which makes them typically lighter. Also, a lot of the design trends in recent years have been to shorten the front end. And both of these trends, making them lighter and more stylish, tends to drive the crash pulse up. And the crash pulse is the reason that we have pretensioners and load-limiters in our vehicles. The crash pulse is the acceleration that you experience because the structure of the vehicle is much different now than it used to be.

And that, if you were to plot the structure, if you were to plot NCAP stiffnesses as a function of time, which would be a good thing to do, my guess is you would see that the NCAP stiffnesses also follow the same trend. And so these technologies are needed and it's time for them to come to the rear seat, which is why we put our inflatable belts in the rear seat.

CHAIRMAN HERSMAN: Dr. Bruce.

DR. BRUCE: I just have a very short question. It's actually going back to Dr. Kent. When you talked about your delayed death slide -- and you don't need to bring it up because

the question's actually for Dr. Wang. When you see your sequence of injury failure that's going on, how long does that typically take?

DR. WANG: That can take in the order of weeks to months. What happens is that -- and I think this goes back to one of the issues that Dr. Kent brought up is that the young people, we tend to get a very early read on them and -- they have enough reserve that they begin to get into convalescence. What happens with the older folks is they tend up on a lot of intensive care support for quite a period of time. In these days with advances in critical care, which have been very substantial over the last two decades, we're able to keep folks going for weeks and then afterwards, they typically then kind of dwindle and then they -- so it can be months before that pops out.

DR. BRUCE: So it would be fair for me to say that the delayed death number is an under-reporting?

DR. WANG: Yes. I think -- and I'm not familiar with Dr. McCartt's, you know, database, but I would say that there would be -- we'd be quite concerned about that. And then, I think, if you add on top of that not just death, but the very poor, long-term outcome, okay, you would have to follow that out much longer because there will be a much larger portion of the elderly population that fail to return to full function, whereas in the elderly [sic], they tend to, you know, bounce back and have that recovery function much, much more substantial.

DR. BRUCE: Right. And just for the record, you were using FARS data, so that would've been a 30-day window.

DR. WANG: Thank you. Yes.

CHAIRMAN HERSMAN: Thank you. And Dr. Price, I'm going to keep you busy trying to pull up a couple of slides. Dr. Kent had a slide that showed head injury and thoracic injuries, and one arrow was going one direction and the other was going the other direction, and what I'm trying to understand is why does head injury, if I read this chart correctly, why does head injury decrease with age? Is it because of the operation of the vehicle, speed, or belt use? What's going on here?

DR. KENT: I should've made that point more clearly. The risk of injury to any body region goes up with aging. So this is not numbers or risk; this is proportion. So when an injury does happen, it's more frequently in the thorax in an older person. So they actually have a higher risk of injury in the head, as well.

CHAIRMAN HERSMAN: Okay.

DR. KENT: It's just --

CHAIRMAN HERSMAN: Thank you.

DR. KENT: Yeah, it increases faster in the chest.

CHAIRMAN HERSMAN: Yeah, okay. Thanks. That's exactly what I needed. I was having trouble understanding that. And I think when you kind of talked about the exemplar accident where you have the 39-year-old female driving into the tree, I'm like

oh, well, it's because they're having these catastrophic, high-speed or drunk driving accidents, but we're not seeing that in the older driver. But they have as many head injuries, just the proportion is not as high?

DR. KENT: I don't know about numbers, but the risk is higher in older folks, but their exposure is less; they aren't driving as much. So the total number of head injuries, there's probably more head injuries in the young, but the risk is higher in the old. And the proportion is higher in the young, so proportionately, younger people will have head injuries more frequently.

DR. ROUHANA: I think it's also true that older people do not get into the severe-type crashes that younger people do.

CHAIRMAN HERSMAN: The speed and things.

DR. ROUHANA: Speed, right.

CHAIRMAN HERSMAN: Okay.

DR. KENT: Yeah, it's the environment issue which is also important.

CHAIRMAN HERSMAN: Great. And you had another slide and it was the one that had the category of unknown and pregnant female. And I don't know if there's a gender bias because last time we had, for women on the -- now we have the for men. But I'm just confused as to why unknown and pregnant women are in the same category.

DR. KENT: I think my post-doc put them that way. I'm

not sure why.

CHAIRMAN HERSMAN: Okay.

DR. KENT: But there are some that are coded as pregnant -- I think I was trying to make the point that that's pretty clueless in either case. If you're coded as unknown or 65 plus as pregnant female, in both cases you probably missed, and so that's why I kind of combined them to show that, you know, over 10 percent of the database is coded clearly --

CHAIRMAN HERSMAN: Improperly.

DR. KENT: -- incorrectly.

CHAIRMAN HERSMAN: Yeah, good.

DR. KENT: Yeah.

CHAIRMAN HERSMAN: Okay. And, Mr. Ridella, I think, you know, we've kind of talked a lot about the dummy types. I'd be curious as to what type of dummy -- I know you're talking about modeling and you think modeling is a great solution, but there's a reason why we have dummies. And so we've talked about obesity. We've talked about fragility or frailty. What do you think is the single most critical area that we're missing in our family of dummies? What would we benefit most if we're going to go through the effort of putting together a new dummy? What is it that we don't do well in our modeling now?

MR. RIDELLA: I think we do well everywhere, and we touched on it and I think Dr. Rouhana did too, the word that comes to mind is biofidelity, and that means how lifelike is the dummy,

how well does it mimic not just the injury but also the kinematics. In other words, when we look at CIREN crashes we try to deduce where was the occupant initially, where did it go, and then we try to recreate that in a lab. The dummy doesn't always want to go where the human went and so part of that is a process of we don't want to break the dummy because if we make it too lifelike it'll break over and over again. It gets kind of expensive and guys like Steve get complaints because they don't want to keep replacing dummy parts.

But if we can think of technology and make dummies smarter, more biofidelic, more lifelike to respond to the crash direction, the crash forces, and then to have the instrumentation that can predict the injury. That's why we're moving into rotational brain injury criteria, multi-point chest sensing, acetabular load cells so we understand what's happening at the pelvis, more complex lower extremities and more lifelike lower extremities, which we recently completed a project on. Those are all great things to move forward with. What comes with them is complexity of dummies get more issues of calibration, repeatability, durability, and reproducibility from dummy to dummy that we have to tackle. And we will do that, but it's a process we have to go through. Hope that answered your question.

CHAIRMAN HERSMAN: It sounds like all dummies need to have better biofidelity, but is there one kind of prototype human that's not well represented in the dummies? I think that's what

I'm trying to understand. You know, when we talk about dummies performing like human beings, what's the dummy that's the heaviest, and when we look at obesity, are we able to capture that?

MR. RIDELLA: Dr. Kent would like to weigh in on that. Go ahead.

DR. KENT: To weigh in, so to speak. Well, a couple of comments. I guess to the very last question you asked, we have done some work looking at a fat jacket for one of the dummies. You know, the rib cages of obese people are actually quite like the rib cages of anyone else and so if you can get down to the bony structures, they're about the same. And so it is -- I mean, there's visceral fat, for sure, but the thing that affects, say, crash kinematics the most is the subcutaneous fat and we can represent that and we've started looking at that. But again, it gets into issues of repeatability and robustness and all of that.

And so the point I was going to make is that, you know, we had this question about resources. To my mind, you know, the resources required to develop a new dummy, to get worldwide acceptance of it, and to get people to start using it, that actually has never happened in my lifetime. You know, we got one right around the time I was born, but -- and we've been working on them ever since. And it's very hard and it takes a ton of work and I just don't see that as the best use of resources would be to build yet another dummy.

We can work on ways of making them better and also, I think, ways of interpreting what they tell us. Things like SIMon, you know, SIMon uses a dummy input to drive a model and give us more information about what a human would experience in that exposure, and those kinds of things seem to me to be a better use of resources, is interpreting the dummies we have rather than trying to build another one.

CHAIRMAN HERSMAN: Okay. I was interested in the back seats and I'm really glad that the last table asked the question and you were able to put up some slides on that information. If you could pull up that slide that Dr. Kent used that had the back seat information? And I think, Dr. Rouhana, you tried to kind of shade a little bit of information in there about one-third of the time there will be a passenger and one-tenth of the time, back seat. Help us to understand the data a little bit more with respect to the benefits that -- let's just say a front seat passenger, not talking about a driver, just a front seat passenger -- the benefits that a front seat passenger gets out of having the combined airbag and seatbelt versus a back seat passenger not having an airbag. And so maybe you can talk us through your data here again. Whoever feels like they have something to add here.

DR. KENT: So this effectiveness issue, to sort of start trying to understand this a little bit, we've done a couple of things in my lab. One is we've started looking at the distribution by body region; where are these injuries happening?

And it's the chest, surprise. And in fact, it's the chest even in the young. And so the chest seems to predominate in the rear seat more than it does in the front seat. And so that's one clue.

And then we started looking at restraint performance in the rear seat and there are challenges in the rear seat that are unrelated to the lack of an airbag. An airbag is a load path but there are other load paths in the front seat that are not in the rear seat, like a knee bolster. And we have quite a bit more flexibility -- and certainly, Dr. Rouhana can speak to this more than I can, probably, but the design of a front seat is much more able to be changed than the design of a rear seat. The rear seat is tightened to the chassis of the vehicle. It has huge consequences if you try to change it.

And so a front seat, a driver's seat, the seat pad is very ingeniously designed to restrain your pelvis. It's an extremely important part of the restraint system. In the rear seat it's difficult to get that same kind of pelvic restraint and so in the rear seat testing we've seen, it's actually been pelvic motion that has been, I think, the most concern to us because that tends to load the lower portion of your chest; it tends to keep the torso reclined which increases neck bending moments and things like that. And so the rear seat poses some challenges.

A lot of them -- actually, this inflatable belt addresses very elegantly, ones that Dr. Rouhana didn't mention, things like restraining the pelvis. Actually, it helps restrain

the pelvis if you inflate the shoulder belt. And so there are things being done back there along those lines. And so I think -- and a lot of -- good news is a lot of restraint manufacturers see this as the next market. They see this as an area where they can sell some technology and so there is quite a bit of work in this area.

CHAIRMAN HERSMAN: And I don't know if the slide's still up out there, but I'm -- and I apologize. I'm just not understanding exactly what the data's telling us and I think, in particular, I'm stuck on the zero to five. I think these age groups, the passenger age groups, zero to five are not in the front seat so explain to me what's going on here. And really, we're hoping that 6 to 8 aren't in the front seat and the 9 to 12 aren't in the front seat. So help me understand what these two colors are showing us and where the passengers are.

DR. KENT: So yeah, the -- well, they're not supposed to be, but they are.

CHAIRMAN HERSMAN: Okay.

DR. KENT: So there are children in the front seat. And so what that is, is comparing the relative fatality risk of kids in the front seat versus kids in the rear seat. And what we see is that it's about 50 percent more effective to be in the rear seat for children. But that actually is true across the age range up to about age 50. It's about, you know, 50 percent safer to be in the rear seat than in the front seat. So there are kids in the

front seat. We encourage parents to put them in the back, but there are still kids in the front.

CHAIRMAN HERSMAN: Where's the airbag, though?

DR. KENT: So in this case, the blue line is representing cases where there is an airbag that deploys in the front seat. The red line is from older vehicles where there's not an airbag that deploys in the front seat. And so it's a little bit confusing. It's not really the reason I was putting this slide up.

But the rear seat, the decrease in rear seat effectiveness is more pronounced if there's an airbag because the airbag provides more benefit to the front seat. And so it makes the rear seat seem proportionately less safe just because it makes the front seat more safe. So the effect is bigger if there's an airbag, which is why I have the blue lines. But the point's the same, it's just the magnitude's a little greater if there's an airbag.

DR. ROUHANA: One thing that might help with the confusion is that this was a study done by NHTSA published in 2005, so the data is more than 5 years old; it's probably more like 10 years old. And there were a lot more kids in the front seat 10 years ago than there are today, so --

CHAIRMAN HERSMAN: Yeah, as a child passenger safety technician, I just don't like to see any, you know, data that's showing us kids in the front seat and that -- you know, that the

airbags are effective. That kind of is a challenge depending on how they're restrained. But what I was curious, Mr. Rouhana, does the belt with the airbag provide the same benefit or have you been able to quantify that when you were talking about a combo airbag and seatbelt versus the seatbelt that has the integrated airbag in it?

DR. ROUHANA: We have tested -- I showed that one slide with a standard belt. That standard belt test, I believe, had an airbag in it and we reduced the chest deflection over that system. We've also tested this in side impact and compared to the inflatable belt; a standard belt by itself; and a standard belt plus a combo airbag, side airbag, head and thorax airbag, and we even see reductions in side impact of chest deflections from the inflatable belt, so I think we will have a much more effective system for the people in the rear seat.

CHAIRMAN HERSMAN: Great. And thank you very much for sharing that video with us and it did go very quickly, so I see, Jana, that you're very close to that slide again and I don't know if -- I'm going to pass off to Dr. Garber, but if we could show the video again while we're transitioning? You know what, it's okay if you can't -- Dr. Garber, do you have some additional questions?

DR. GARBER: Yeah, if I could -- just a couple of follow-up things that I wanted to sort of get on the table. We've talked a little bit, and I think Dr. Wang, in particular,

addressed to a certain extent the issues of exercise. I mean, you'd love to have your patients exercise for a couple of months before they get into their accidents.

Can you comment more specifically on what the effect is of exercise in the older population with regard to those types of markers of fragility and frailty like bone mineralization and muscle mass and what that does as far as their ability to withstand some of these impacts? I know that surgeons are fond of talking about physiological versus chronological age, and perhaps tell us what it would mean for an 80-year-old who's exercising, doing weight training, running, those sorts of things, versus a 60-year-old who, perhaps, is sedentary.

DR. WANG: And I have a discussion slide which will come up here shortly. I'm not sure I can answer exactly your question. The question of whether -- you know, how exercise affects core muscles, but we haven't studied that in a prospective fashion. We certainly see that in our patients with a history of good activity, that they appear to have good core muscles and we've kind of made that association.

The other thing that we've done is we've studied patients that are in the ICU, that large cohort I showed you that had a very high mortality rate. We know that the psoas muscle can change acutely within the course of a couple weeks of being critically ill. It can decrease by cross-sectional area by 20 percent or so. So we certainly know that it can drop very

substantially in size. How quickly it can go back up, we haven't sorted out yet and we have a number of studies which we're prospectively going forward to try to study that.

So this slide is something that's kind of, I think helps to drive home the point, if I haven't already driven the point home, that age and comorbidities are insufficient, okay, and that condition is much better. So what we did is look -- and I mentioned that we've studied this in aortic surgeries, in liver transplant surgeries, and multiple surgeries, and what we've found that the psoas muscle is by far the best predictor, far better than age or comorbidities.

And what was interesting is we took the 10 worst -- so this is the 10 percent worst psoas area and we looked at how they matched up compared to the 10 percent with the highest age and the 10 percent with the largest number of comorbidities. So in the past we've always used age and comorbidities as our assessment of frailty, okay, or fragility and what we found is that the psoas muscle seems to indicate something different, okay. And in fact, it's this psoas area which is by far the best predictor of poor outcome.

DR. GARBER: And that leads to another question, is to what extent does that or any other markers that you're looking at represent a reflection of actual medical conditions that individuals may have, the comorbidities that you're talking about but also those aging-associated conditions such as emphysema or

cardiac disease or diabetes, how do you separate those from the effect just of aging itself?

DR. WANG: Yeah, it's very difficult. I view this as a psoas muscle. So in order to have a good psoas muscle you need to have good nutrition, okay. You can't have chronic disease, which is, you know, which is causing you to be ill and not being able to exercise. So this is just a marker, okay, and it's very difficult to separate out those other processes. And right now all this is, is something that we have found this is by far the best marker that we found so far and we're attempting to sort out the factors that contribute to it.

DR. GARBER: And then one last question for me is, we've talked a lot about the data which are mostly fatality data with regard to the older occupants, but we didn't really discuss too much, except sort of referentially, what the effects are of even relatively what we might consider minor injuries on long-term disability for these occupants. I know that we've had some discussions at some conferences about lower extremity injuries particular in older adults. Even things as simple as sprains and contusions may result in long-term kinds of disability, and I'd like you to discuss that just a little bit, if you can.

DR. WANG: It's hard to speak about it in generalities. What happens is that in these patients and the more frail -- and I'm going to get away from the use of the word elderly, but in the very deconditioned patients, very small injuries are able to just

push them over the edge. So we oftentimes see -- and typically, these frailer, more deconditioned patients are the elderly. But I mentioned multiple patients with a couple rib fractures end up with the pneumonia. And certainly, when we did -- in our CIREN population, I think about 80 to 85 percent of our fatalities had rib fractures and in quite a substantial portion, all they had were rib fractures.

Now, we also have a substantial number of patients who have sustained what we would consider relatively minor orthopedic injuries, okay. But again, because they're deconditioned, what ends up happening is that they're unable to get up to weight bearing very quickly. They end up going to a nursing home, being bed-bound for very substantial periods of time and end up with one complication of another and they end up being readmitted. So even small orthopedic injuries can lead to fairly -- can lead to very poor outcomes in a sufficiently deconditioned patient. We see this over and over again, so this is a very common anecdote. I can't give you the exact sort of injury and what its effect is in more detail.

MR. RIDELLA: The point about less severe injuries, we tend to focus on fatalities and higher AIS scale injuries, but lower extremity injuries tend to be on the lower side, the AIS-2+ injuries. Mild traumatic brain injury is an area that doesn't get a whole lot of research in this field, does in others, sports, obviously, but something that we think we can a handle on also by

doing further research on and see where that goes in the future, so that's one area we're going to focus on, also.

DR. GARBER: Thank you. Those are all the questions I've got.

CHAIRMAN HERSMAN: Dr. Poland.

DR. POLAND: I think I just had maybe two more questions. But first, let's show that video again. I think Jana has it ready so we can see the belts inflating in the rear seat.

(Video played.)

DR. POLAND: And Dr. Rouhana, those are six-year-old children?

DR. ROUHANA: The dummy on the left is a six-year-old child in the booster seat and on the right is a small adult female representative of the fifth percentile of the female population in size and weight.

DR. POLAND: We'll be interested to hear more about that when you come to our child passenger forum next month. I've heard some information about these belts also being potentially beneficial in rollover crashes. First of all, I guess, is that true and is there any consideration for having this type of a restraint system in the front seat?

DR. ROUHANA: Well, currently we have airbags in the front seat and those are mandated by Congress, so we believe that there would be marginal incremental benefit from putting the inflatable belt in, as well, because we also have load-limiters

and pretensioners in the belt system. And we haven't really assessed the rollover performance of the belt systems at this time, although I believe NHTSA has.

DR. POLAND: Okay. And then my last question: In the first panel we talked a lot about crash rates and when crash rates started to increase and it looked like we were seeing some increases around the 70-year-old range and then maybe some more increases around the 80-year-old range, or possibly it was the fatality rates that we were looking at for that U-shaped curve where we had high rates for the young and then -- was that fatality rate that I'm talking about -- so, and then a higher fatality rate for the old. Is that when injury tolerance starts to decrease? Is it at that 75-year-old range or is it earlier than that?

DR. ROUHANA: It really depends on what injury you're talking about. For bony injury, I think we see an increase from about the age of majority on as you start losing bone mass. However, as -- I think maybe Dr. Kent showed the organs, the abdominal organs -- or maybe it was Dr. Wang, I don't remember who -- don't age quite the same way and so for lung injury, unless it's secondary to a rib fracture, we wouldn't expect to see a major change with age.

DR. KENT: Yeah, but, you know, overall risk of fatality, given a similar kind of an insult -- I showed those plots relative to age 20. They go up from age 20. So it starts,

and you can see biomechanical consequences of aging in the early 20s, unfortunately; you know, things like calcification of the costal cartilage starts to show up very young and that predisposes you to thoracic injury. So unfortunately, it's pretty young.

DR. POLAND: So even at age -- after age 20, we're starting to see some decreases associated with lost tolerance to injury just because we're getting older?

DR. KENT: Yes.

DR. POLAND: Thank you very much. Thank you, gentlemen. I appreciated having the opportunity to speak with you on this panel. I think I could talk about it all day long, but we've just about reached the end of our panel session. Thank you, Chairman Hersman.

CHAIRMAN HERSMAN: Thank you. This has been a great panel, very informative. Thank you for your slides, your data, and the presentations, the videos. All of it was great.

I did want to recognize Ms. Haas. If you could please stand in the back? Ms. Haas did -- was awarded an honorable mention at the 2010 Los Angeles International Film Festival for the video that we got to see at lunch and I'm sure that you all can understand why. She also, in 2003, was a founding member of one of my very favorite programs and that's the oral history project that's called StoryCorps. So I could totally hear those two gentlemen sitting down to tell us their stories on a program like StoryCorps. Thank you for sharing with us that excellent

video.

And Ms. Haas will be available if you all would like to talk to her during the break. So thanks so much to our panelists and we will adjourn.

We actually get a very generous break of 30 minutes so you can go get a cup of coffee or a soda and we'll come back at 3:00 for the last panel of the day.

(Off the record.)

(On the record.)

CHAIRMAN HERSMAN: Welcome back for our last panel of the day. We'll be examining highway and vehicle designs targeted to improve the performance of aging drivers. FHWA has nearly a decade of experience with the Highway Design Handbook For Older Drivers and Pedestrians and is preparing to release their next edition in 2011.

The panel today will look at what we've learned and where we're going with highway design guidelines for aging drivers and then we'll also consider the role of advancing automobile technology in improving safety for aging drivers and pedestrians, with opinions from both researchers and manufacturers. In addition to the specifics of the infrastructure and vehicle design changes, the panel will consider the more general question of how technology will shape the future of public policy and drive innovation.

Dr. Robert Molloy and Mr. Dennis Collins are leading the

panel this afternoon. Dr. Molloy, will you please introduce the panelists?

DR. MOLLOY: Certainly. Our first panelist is Dick Schaffer with the Federal Highway Administration. He's the aging road user program manager at Federal Highway and he's developing the latest update to the 2001 Highway Design Handbook For Older Drivers and Pedestrians.

You can give us your presentation.

MR. SCHAFFER: Excuse me. Thank you, Dr. Molloy, Chairman Hersman.

I'd like to preface my remarks by saying the handbook is really a document that is all involved in gains in safety and mobility. We really are working towards the countermeasures for older road users and which will benefit all users, not just simply the older road user, because we have all drivers of all ages on our roadways. And this is also designed to leave engineers and road designers with some flexibility with modal needs conflict between pedestrians, for example, between bicyclists and even between pedestrians, predominately. And we're also trying to reach a balance between different modes.

First of all, we're going to be growing. As you know, the baby boomers -- and I'm just on the edge of that -- is coming of age for when it comes around to getting to 65 and we're going to grow from 40 million up to 71.5 million by 2030 and we're going to be a large piece, if you will, of the road users.

And at the same time, we're looking at how, you know, everything is affected, cognitively, physically, with the road user and at the same time, we're looking at -- let's see, move ahead here -- how the 1998 older driver handbook, design handbook -- if you really look at it, that's our first document. That was done over 12 years ago and that's the first practical information source on the older driver, and it gives recommendations on design, operations, and traffic engineering. And it does include pedestrians within the intersection area.

Three years later that was updated into the 2000 Highway Design Handbook For Older Drivers and Pedestrians. So just wanted to look -- and it's spanning the data and recommendations on older pedestrians and drivers. It was based on recommendations from local and state level practitioners and that's why we really wanted to update it because they saw, from 1998, they were missing a few things.

Now, since then, 2001, we have an older driver training course. This is taught by our resource center in which we take this around the country to really show traffic engineers and traffic specialists how to -- why this is important and how to use it.

Now, we're looking at updating this in 2011. We're going to incorporate new research and the 2009 MUTCD. That's a very important part of our entire document because that's what we reference and that had to be really included and it's why we

couldn't do this beforehand. It expands the range of applications to -- from the 2001 handbook and it identifies innovative techniques and best practices, and those, for example, where there may not be hard research -- because this has been a research document, it still is -- but we definitely want to show around the country where there may have been -- there surely are some practices that local communities have used, taking some of those measures.

And it's going to be looking at a web-based version and it's going to improve the access to info in use by professionals for all users. This is why we're looking at not just the driver, we're looking at the older pedestrian, surely, and any particular other modes.

Now, we're looking at intersections where the highest conflict exists for not just all road users, but surely the older road user. They're looking at -- most of the actual crashes and collisions occur within those intersections. That's also where most of the pedestrians, elder pedestrians, are simply because they follow the actual marked crosswalks more than those younger than them.

Interchanges where you have off-ramps and on-ramps to freeways where accelerations and de-accelerations, braking, have to be done very quickly and getting on and off the freeway relatively quickly. Roadway segments where you're looking at maybe a continuous left turn lane, other particular measures that

are recurring on that roadway that need to be looked at. And we want to provide pedestrian refuges for sure where those exist and where they're needed simply because pedestrians need a place where they can be within the roadway and they can move safely across that roadway. And we've also promoted the countdown pedestrian signals, which you will find in the 2009 MUTCD.

Dr. Molloy.

DR. MOLLOY: Thank you. Thank you very much for that presentation.

Our next presenter is Dr. Joe Coughlin. He is director of the U.S. Department of Transportation's New England University Transportation Center. He's based at MIT. He's also the founder of the MIT AgeLab, doing research on the impact of aging on automobile design and public policy. You can give us your presentation.

DR. COUGHLIN: Thank you very much, Madam Chair and ladies and gentlemen. Thank you for having me.

I'd like to briefly discuss the convergence, if you will, of new technology and older age and have us think about some design considerations that we may want to think about in the future of the car as well as the future of the rest of us. If the auto industry is asked and researchers are asked, this is essentially what we're looking for: We'd like to get the driver out of the front seat. We'd like to have something that looks a lot more like avionics than we would like to have what we

currently think is the car.

This is not new. This was something that was developed in the 1939 World's Fair and it's continuing to be the trajectory of what we're looking for today.

And this is who we think we're designing it for. We think we're designing it for the new, the fun, the lead adapter of every technology. But ladies and gentlemen, the actual buyer looks a little different because, you see, the high tech, the high design and indeed, the high price, goes into cars that are bought most often by the 55 plus. Therefore, the new lead adapter of new technology is not the young and the fun, but those of us who are older and still fun. But the problem is we no longer have a mental model, shall we say, of how these new technologies work in a car and how it changes how we drive.

We have new systems that are going to require us to relearn how to drive. If you think about it, the car has been remarkably the same for decades, at least to the driver. Under the hood, it's different. But now it is changing dramatically inside. No one told us essentially how to drive antilock brakes; no one has prepared us for active safety. So let me talk about three things: load, learning, and longevity. These are the three ideas I'd like to leave you with.

First, driver workload certainly changes over time. This is a picture inside of our Aware Car that detects different biological, physiological, and eye-tracking activities of the

driver. Technology adoption does increase, believe it or not, with older adults. It gives them greater confidence. Our work with The Hartford shows, with survey data nationwide, that older adults, if it is related to safety, will use technology. They're also more likely to self-regulate using the technologies that are likely to distract.

But there are natural age changes that require us to change how we get to the driver overall. More importantly, we have just discovered some recent data in our own lab that indicates that certain disease categories may change how we're actually able to manage workload in the car.

Moreover, there seems to be an issue of distraction of these new technologies, not in the way you think, but younger drivers trust new technology almost implicitly, to the point where they no longer look to see if there's a toddler or a truck behind them. They wait for the warning to go off. Our research also shows, however, that older drivers will use the technology but will be distracted if the technology system goes off and it's not readily apparent as to why it did.

Longevity. This is an issue, if you will, of thinking about the car overall and how we age. The fact is, is that birthdays do not kill; health conditions do. As we live longer, we will have greater comorbidity. We will be taking more medications. 110 million Americans already, regardless of age, have one chronic disease; 60 million with two.

Can we imagine a car that not only detects how you're driving but detects your state, your well-being? And so our driver well car -- and this is one of the vehicles we have instrumented out, indicating how we can manage the idea of how older drivers tend to be safe drivers because they self-regulate their behavior. Can we envision a car that will help coach and monitor overall well-being for the driver and change its performance in real time to match the driver and have cues, whether it's an orb or a light such as this, to actually say that you're running out of your performance range or you should be improving your overall performance behind the wheel?

Let me end with a few recommendations on product policy, process, and policy. First off, we need to conduct research, if you will, on how we understand and adopt technology across the lifespan. This has not been done in the auto area, let alone in many other areas. More importantly, we need to develop quantifiable guidelines to mitigate the impact and interactions of design, workload, and age on driver performance.

Stimulate lifelong education with technology included. That is, that if a car is going to be changing as rapidly as we think it's going to be, just because you're 25 no longer makes you a good driver because you recently graduated from a driving program. This is something we need to think about across the lifespan.

Related to that, reinventing the car delivery

experience. The way we buy our car today is no different than, frankly, our parents and grandparents: We take the car; we're excited; the dealer's excited; here's the air conditioning; here's the entertainment system; here's how you adjust the seats and here are the keys. We need to do more of what we see in Europe and some other places where the delivery experience is an education experience that gets you familiar with the new technology, of what to expect and how to drive.

Lastly, a policy issue, which is recognizing -- I believe we have a new emerging class of driver. In law, what we talk about is a reasonable man standard. With the aging of the population, with far more women on the road, we now need to engineer not just to the reasonable man standard who happens to be 5'10", 25 years old, and 165 pounds, but to a reasonable older, smaller woman standard and what that means in terms of design, as well as technology.

And then lastly, developing public standards around human automation, learning and trust, acceptance across the lifespan for the car and beyond.

Thank you very much for the time.

DR. MOLLOY: Thank you very much, Dr. Coughlin.

Our next presenter is Mr. Thomas Broberg, Senior Technical Advisor for Safety with the Volvo Car Corporation. He's been on the management team of Volvo Car Safety Center since 1999 and he's also pursuing a doctorate right now looking at safety in

the aging population.

Your presentation, please.

MR. BROBERG: Thank you. Thank you, Madam Hersman, Chairman. It's a great pleasure to be here.

Actually, I deliberately changed the title here to All Drivers and the Vehicle Design for All Drivers. And why is that? Well, at Volvo, we have our own internal vision and that is that in the future, cars should not crash. We've also set up an ambition to work towards this vision, and that is that by 2020, no one should be killed or injured in a new Volvo.

The strategy to move in that direction is quite holistic. We're looking, of course, into the crashes and what happens before the crashes, but we also divided the events before a potential collision into different phases. And these different phases, of course, have challenges as we move back in time before a collision and how it relates back to the driver.

Well, what we know -- and this specifically in relation to the older drivers in Sweden and at Volvo, it's quite similar to what has been shown here previously today with the statistics data showing the frequency of collisions, the high increased risk of injuries, the bathtub curve, as well as self-cessation for older drivers. And the knowledge, of course, is coming back to this, studying real-life accidents and to use that as a basis for how we better understand both accident causation and, of course, injury risk and injury causation.

This specific accident here, which I've picked, is one of our recent -- it's a Volvo against another car. In one of the cars you had an 18-year-old driver with a three-month old license and in the other, you had a 73-year-old driver and a 75-year-old passenger. The young driver actually came over on the wrong side of the road and the old driver tried to swerve out, actually hit the curb of the road, but could not avoid the collision. Luckily, in this event, the outcome was good, so all the participants have recovered.

But of course, we have to ask ourselves what actually caused this collision. Would technology have helped, in this case, the younger driver, to avoid the collision? And in other circumstances, it could have been the older driver that was the cause of this accident.

So the challenge here, really, for us is to understand and know the driver, because we're all different. We're all different as human beings. There are 5 billion variants of us out there. And when we design technology in our vehicles, we really have to understand the differences between us, or if there is any differences in our behavior when we drive our motor vehicles. So this is really the challenge, as we see, when we move to the future.

And this relates, of course, to all drivers, but more significantly to the growing population of older drivers, to really understand the factors that are necessary there. And what

we do is to try to build knowledge, and that's actually one of my main subjects working with safety at Volvo, is looking into the aspects of the older driver population and driver behavior related to the older drivers. What factors are important? And when we know those factors, how should we address them from a technical perspective?

Well, we do have some knowledge already today in relation to what is causing accidents. There are a few big ones, distraction being one, of course; alcohol involvement; drivers falling asleep. And of course, we're addressing this and this is just a few examples of technologies that are in the cars today.

And as you see here, we're actually addressing all the different phases that we have in our strategy with different types of technologies. And what's really the emphasis here is to push it to the left, try to help drivers stay out of a critical situation in the first place.

We have already launched technologies that help drivers avoid collisions in certain circumstances, crashing into pedestrians and so forth. We have dynamic systems that help drivers if they're in a critical situation, like if the car is sliding and you have dynamic stability and traction control to help you stay on the road. But we're also looking into how we can assist drivers to be in a good state, both from a distraction point of view with actually trying to reduce the workload from the car for the drivers with, for instance, our IDI system,

Intelligent Driver Information system; likewise, the driver alert control addressing drowsy drivers or unconcentrated drivers. So the car can actually recognize what the driver, how the driver's actually performing with the vehicle.

And this is actually one of the keys here. We're starting to give a car senses. Today the cars can see and they can also feel. They can feel what the driver's doing or actually what the driver's not doing. And in certain situations, where it's appropriate, the car can actually help the driver avoid collision autonomously.

So the basis of knowledge is really how we proceed in order to meet our future, the crash-free future, take us down to zero. And the knowledge of driver behavior and how drivers adapt to technologies is a key enabler for us as we move forward. And we also have to humbly, of course, recognize that when our company was founded 80 years ago, cars were driven by people, they are today, and of course, they will be also in the future. And it's with that basis that we have to design technology. So we have to design technology around the human being and not the other way around. And the key there is understanding the human being.

Thank you.

DR. MOLLOY: Thank you very much, Mr. Broberg.

Our next presentation will be given by Dr. David Eby with the University of Michigan Transportation Research Institute. He's a research scientist and head of the behavioral sciences at

that institute. Dr. Eby's topics of research include driving and dementia, older driver decision-making, risky behaviors among young drivers, use and nonuse of safety restraints, impaired and distracted driving, and the use of in-vehicle technology to advance, enhance safety and mobility.

Proceed with your presentation, please.

DR. EBY: One of the good things about going last in a session is most of the points that you want to make have already been made, so I'll go over this quickly.

The presence and use of advanced technology in vehicles is increasing. We've already heard that in several presentations today. And this includes technology that is original manufactured technology, technology that's built into cars -- some of the technologies that we were just hearing from Volvo -- but also ematic technologies. Cell phones and smartphones can do all sorts of things and people bring those into cars to help them drive, such as navigation systems, and all of these technologies are going to be much more common in the future.

We know the U.S. population is aging, so is the population of many other Western countries, and with that aging comes functional declines based on medical conditions and medications that can impact safe driving. And advanced technologies have the potential to increase the safety of older people, as well as their quality of life.

Now, we've heard a lot about different kinds of

technologies. There's all sorts of technologies that are available. Here are some example technologies. I know the most about route guidance systems. These are systems that provide turn-by-turn instructions to people as they drive. They use GPS signals to locate vehicles and the design features can vary widely, including providing turn signal turn symbols for people, but also voice controls to let people know, without having to look at the displays, what the next maneuver is.

There's also night vision enhancement systems. These are systems that use infrared technology that can detect warm bodies out in the roadway, especially under limited view conditions like fog or nighttime, so animals, pedestrians and so on, and that information can then be displayed to the driver, letting them -- warning them of those animals and people out in the roadway.

There's a whole different -- there's a whole set of crash warning systems. There's forward collision warning systems, lane departure warning systems, curve speed warning systems. These are all systems designed to help a person prevent getting into a crash. They use various kinds of sensors, radars to let you know where traffic is in front of you, sensors that can pick up where lane markings are so that it can determine what position in the lane you have, and then provide warnings. In some cases these warnings can be as simple as an auditory alert; they can be a haptic alert where there's a shaking; or in more advanced

systems there can also be some control of the vehicle like braking that takes place without the driver having to do anything.

Finally, there are automatic crash notification systems. These are systems that, in the event of a crash, information is sent directly to an emergency responding system, and that information can be fairly sophisticated including some of the dynamics that are recorded in a crash.

So our research findings, as well as findings of others, show that older people like these advanced technologies and especially the ones that help them go to places that they might not be comfortable going to, as well as the technologies that help improve safety.

Older drivers also use these technologies as much as drivers of other ages. So they can use them, they do use them, and in the case of navigation systems, our research shows that they're used even more than with the younger populations. Older drivers report that many of these technologies actually make them feel more confident while driving and less stressed while driving, which helps them be comfortable going to places and other destinations. It increases their driving space.

Older drivers do report difficulty understanding symbols and the warnings more so than for younger people, and so I think we still have some work to do on developing those symbols and warnings. Older drivers report more difficulty using these systems, especially the systems that require some sort of input.

And older drivers have also told us they would not purchase technology that's labeled for older people.

Advanced technology, to be useful in this population, it needs to be affordable and that, I think, comes with economies of scale. They need to be easy to use and intuitive so if you learn how to use one kind of navigation system, hopefully that information will translate to some other kind of navigation system. The system should enhance safety or at least not decrease safety and it should not increase distraction in the long term. By the long term, I mean many of these new technologies can be distracting until you learn how to use them, so research needs to check out the distraction levels over much longer terms than even, say, a few weeks and see if it still causes distraction.

Technology should recognize and accommodate how older drivers drive and self-regulate. For example, in our studies with navigation systems, we found that people, some older people wanted to co-navigate. They had a spouse that was in the passenger seat, the spouse operated the device and the device we were using, the device could not be manipulated when the vehicle was in motion and that bothered the co-drivers. So there are some differences in the way people drive and technology should take that into account.

And finally, older drivers take longer to learn how to operate advanced technologies. We found that it can take quite a bit longer for them to understand the technologies. However, once they do learn how to use the technologies, they can use them just

as well and understand them just as well as younger people.

People told us, at the hand-off procedure, for example, with a new car, what they wanted was a hands-on demonstration so they can work through it and then they wanted to come back in a few weeks and ask more questions. We need to keep this in mind when we're implementing new technologies. Thank you.

DR. MOLLOY: Thank you all very much for your presentations.

My first question builds upon a theme that you've talked about throughout your presentations, technology, and we're at a time now where technology is becoming much more affordable and realizations of intelligent transportation systems are becoming actually something we can see potential benefits for cars talking to each other, cars protecting themselves. How do you think the work in ITS has included -- how well has it included the aging driver in its research and development?

MR. SCHAFFER: From a roadway perspective, we've talked about that for some time. In our 2001, for example, we addressed ITS directly. Again, this is a guidance document. It is one that we truly recommend that ITS work for the benefit of the aging road user as well as for the pedestrian. But taking, for example, some of those directional signs, that -- we recommended flat out that they be no more than two-phase. You get too much information in multi-phase signs. It really can affect any drivers, especially the aging driver, their attention to the roadway. And so you get

two phases, you're not going to be having your attention off the roadway very long. So that's something we really strongly looked at.

We also were the ones that recommended that a change that finally led to the countdown signals in the 2009 MUTCD, so therefore pedestrians could truly see, not just senior pedestrians, but all pedestrians could know exactly how long they have to get across the roadway.

And so those are some ITS applications I did want to mention from a roadway point of view that have really been used and as far as guidance and actually turned into some standards.

DR. COUGHLIN: If I may respond, as well? I would argue that in the last 20 years from when ITS became ITS from intelligent vehicle highway systems, that the use of information technology has been largely in how to improve the operation of the infrastructure and in some cases to get the vehicles to talk to each other. I would also submit it's only been in recent years that ITS has been used as what does it do for the actual consumer, not the state highway department, not the federal government or anyone managing the congestion on the highways, but to the actual user. To that end, I think that the older driver is somewhere in that list but I don't see a very big push there.

I've seen many papers talk about how it can be of help, but we really need to start asking ourselves at what point do you become an older driver with respect to technology, given the fact

that this is coming faster, it is becoming cheaper and is out there in the cars. I would submit to you that a 25-year-old driver is as antiquated as a 75-year-old driver given the speed which these will be deployed.

MR. BROBERG: Yes, if I may add, as well? I think one of the aspects, I mean, when we started to get the infrastructure, when we started to get the possibilities, I think we still need to put the human aspect of it, the interaction with the driver as such. Not only related, of course, to the older drivers but to all drivers.

And I think Dr. Coughlin here will agree in the sense that there is actually -- well, we need to learn more as to how we can actually both use interaction with the driver to help the driver stay alert as well as to make sure not to overload the driver with information or interaction to have worse performance in those cases. So there are two aspects and I think the lack there is really knowledge from a behavioral science point of view.

DR. EBY: It's my opinion that in the last decade we have begun to recognize that we need to design for older drivers these ITS technologies, not only design for them but also try and understand how they might use them and what benefits they might get from using these various technologies. In the past 10 years I have seen a lot of interest in that and research is just starting. Sometimes it takes a long time to get research funded, projects going. I know the work at UMTRI, we always have an older driver

group now. We didn't do that in the past but now we do. So I think things are changing, but we still have a long way to go.

DR. MOLLOY: And following up on what you've talked about in the last decade, in the video we saw at lunchtime, we saw a gentleman who basically aged with his car and continued to drive a Model T. And in fact, in some of the basic operations of the vehicle, the operation of vehicles are basically the same as it's been for quite some time. I just wanted you to comment on any changes you've seen in the last 5 to 10 years that have been changes to vehicles that have assisted older drivers.

MR. BROBERG: Well, of course, the changes, I think, we've been trying to do, again, not only related to the older drivers, have been to look at the aspects of how we can make the interaction with the driver more intuitive. So for instance, if you're in a situation where we want you -- if you're in a critical situation and we want you to act in a correct way and you have a very limited time to do that, the interaction with the car has to be extremely intuitive. It has to be in your backbone. So that's one of the principles that we've applied.

And the other end of that and coming back to my holistic picture of how we work with safety, when you're in circumstances where you're driving normally, so to speak, and you have more time to do the interaction, it's very much a question of the state of the driver and trying to understand that. And it's just recently that we're starting to get the technical platform in the sense of

having sensors in the car feeling the environment but also feeling what the driver is doing and what the driver is not doing in different situations. That gives us enablers to actually address these issues.

And as I said in my presentation, we started with some of the obvious ones, maybe not specifically addressing older drivers, but our hypothesis is that if we do something for all drivers it will benefit the older drivers and, more specifically, the research that we do related to understanding the older driver and the older driver behavior, the hypothesis there is if we understand the factors that are important for this group, growing group of drivers and we do something to address those factors, it will not only benefit the older drivers but also the younger ones.

DR. COUGHLIN: I think one of the adages that is true in the industry and is always worth repeating is that you cannot build an old man's car because if you do, a young man will not buy it but neither will an old man. So with respect to Mr. Broberg's comments about making ageless technologies, that is absolutely the case, but let's talk about the technologies that we're seeing change that gentleman's car, the Model T. The Model T today is not only, as Mr. Broberg said, is going to sense how you're driving and know what's going on outside the vehicle, but it's now going to communicate to you in a variety of ways. It will vibrate you from the underside. Your wheel will start to shake. You will hear warnings. Essentially, as we age our channels get a little

blurred whether it's the diminished hearing, vision and the like, now the car's going to be feeling and talking very loudly in multiple ways.

I would suggest that the 25-year-old driver has not been trained how to do data fusion in that sense the way a checked out pilot has been, but most certainly someone who has been driving for 40 or 50 years, which makes them in many cases a better driver, that developed judgment is now going to be challenged to learn anew and that's probably the greatest change. So as the car cockpit changes dramatically, the driver has remained the same and that's where the disconnect, both in terms of policy and personal use, is arising.

MR. COLLINS: I have a question for the entire panel. As an actual investigator, I'd like to know that if we go out to an accident and we think driver age or driver performance may play a role, what features of the vehicle or highway should we be looking at both to help you in your understanding of the problems and to help us in our determination of probable cause.

MR. SCHAFFER: Let's talk about the roadway, first of all, that to the investigators, including the police, are actually going to be looking at. And they're going to be looking at yes, the age of the driver; they're going to be looking at the cause of the actual collision or crash. So therefore, they're going to be looking at some particular factors that led to this particular collision or crash and, as such, that's where true treatments that

we are recommending, everything from stenciling along the roadway -- intersections especially are an area that -- there's so much conflict area in it that older drivers need a lot of conspicuity -- excuse me. They really need to really see things much better than normal. And so therefore, that's why stenciling really matters and that's why slowing them down really matters and for walking. Those things really do matter and so if they're there, those would truly help. But actually in investigation of those accidents or collisions and crashes, that's what we would be looking at, as any ways to improve that particular roadway or that particular intersection.

DR. COUGHLIN: I would look at two things. The first thing is, is that I would hope that investigations both on the local level and certainly on the national level would not be in search of DWO, Driving While Old; that, in fact, what we want to look at is what was the condition of that driver, what was their chronic disease condition, were they taking medications, are there issues that were not age-specific that impacted their performance, much the way it would be if you looked at a commercial carrier, aviation, or anything else.

Secondly, I think we need a new level of discovery brought to the car that we already have in other modes, which is looking at both the failsafe of the technology and whether the technology actually worked or was being used appropriately. So both in terms of looking at disease and as well as looking at how

the technology is being used would be two things I would focus on.

MR. BROBERG: I agree there and I also -- coming back to the second panel today, talking about the condition of the driver. I mean, from our perspective, working both with protective measure or counter-measurement as well as preventative counter-measurements, the condition of the driver in the sense of the aspects that were brought up by the second panel but also brought up here by Dr. Coughlin.

And what I would also urge is to have a standard sort of methodology applied and -- when it comes to in-depth investigations related to the actual causation of the collision. Because looking at in-depth investigations, as we do, we usually know -- well, when we follow a trail there's usually a number of possible causations of that collision, and in order to be able to analyze it, you need to have a good structure. And we've been working for quite some years to develop methodologies in order to address this and we are cooperating with Chalmers University and other stakeholders within an organization called SAFER in Gothenburg, where we have an in-depth investigation team that looks into this and that has now collected, I think, more than 600 or 700 accidents and analyzed, in-depth analyses with interviews with all parties involved and made and applied a very structured methodology in order to see the different possibilities of causation and which ones are the most common ones. So that's the aspect from our perspective.

DR. EBY: I would just like to reiterate some of the points. First of all, I agree, we should not be looking at this in terms of whether it's an aging driver crash but more in terms of whether or not this is a crash that potentially resulted from declining abilities that resulted from an age-related medical condition or medications taken to treat that condition. And some things that you might be able to look at besides what's already been said is looking at potentially cues to certain self-regulatory practices.

For example, one practice that we've seen, people have told us about, is people that have glare recovery problems sometimes wear sunglasses at night. If it's a nighttime crash, their sunglasses -- these are things that might point toward a functional decline in the absence of having actual medical information or driving evaluation information. So that's just sort of an extreme example of the kinds of self-regulatory behavior that you might be able to look at.

MR. COLLINS: Thank you. Mr. Schaffer, can you talk briefly about what elements in the design guide have been most effective in reducing accidents or collisions?

MR. SCHAFFER: Thank you for that question. Yes. What has led to a number of treatments, not just guidelines that these are, but treatments in the Manual on Uniform Traffic Control Devices, we feel have led to safety improvements and, hopefully, less crashes and collisions at those particular locations both

among drivers and pedestrians.

And first, I'd like to speak of intersections where the majority of those collisions and crashes occur, and that is where, in particular, stenciling that particular environment, everything from stop lines to making sure that you have good retro-reflective, not only signals, but also signals in place. And what I mean in place, right over the actual lane that they're going to be using.

As we age, it has definitely become a problem to people, especially when you have at least one turn lane, if not more, for them to understand where that lane is and then to be able to stencil that lane really does matter, and so a mixture of putting those right over the lane as well as stenciling does matter.

Another thing that can help the pedestrian and has worked quite well is reducing the right turn radii. What that does is it reduces the speed in which you can take that particular right turn, and as well as there's other guidance in the document that reduces that speed and at the same time helps the older pedestrian because there's a lot less speed there and there's a lot less -- and generally can help save on the crossing distance. But if they don't on crossing distance, they can also look at a pedestrian island, for example, where they can use that to actually as a refuge island to where they can truly use that for safety purposes.

So there's a number of countermeasures that have been

recommended that truly have led to, one, a standard that's occurring, and a standard that is not only being done for the older driver, that is being done just across the country. That's why they're in the manual itself now and are being done all over the country in all different locations regardless of the age of the population. And so we really feel that that's been truly a success as well as a success in making it safer for the aging driver and pedestrian.

MR. COLLINS: What elements, again to Mr. Schaffer, what elements of the 2001 design guide didn't show the anticipated improvement either for older drivers or for drivers in general?

MR. SCHAFFER: Didn't show. Well, I think that when you don't have changes in that manual that, in 2000, for example, that weren't there -- the recommendations we made in 2001, for example, because of the way the -- it's a guidance document. They take years, in other words, to actually get into, one, to train, to go along and train the trainers, if you will, around the country; and secondly, to actually get into the MUTCD.

That takes years. It's not something that's done and so it takes years, one, to train and get those roadway -- the intersections as well as the -- all segments of the roadway improved in those particular areas, as well as then to get them applied. So when they get around, finally, to where they are being used commonly, takes many, many years. So that is just a process.

And secondly, I wanted to point out that it's a balance. It is not something that you can just say, oh, we're going to do this for the driver because we want to think about the flow of traffic, but you also have to look at the balance between the modes. And I think that's something that we have been very successful in doing. But at the same time, things do take time, if you will, and that is something that's just, I think, the nature of it, but -- the nature of everything, and that over time, we have seen a reduction in those collisions and an improvement in the roadway for seniors.

MR. COLLINS: For the 2011 design guide, what are some of the new elements that you're including to manage or reduce risks for drivers? If you can give us a little sneak preview, I guess.

MR. SCHAFFER: I can give you a slight sneak preview and basically, to start off, we are using the 2009 manual. Now, yes, we made recommendations, the countdown signals and the like, we've done that. But we've also made -- so those are there, but we now can use that manual directly and say these are right there and use them. And but the other thing is we're looking at how best practices are being done around the country that -- and really looking at what particular treatments -- I'll call them treatments or counter-measures are really the most effective.

And that's what we're looking at producing is a document where really, they can see, the transportation specialists, the

engineer, can truly see what's really most effective and how they can balance. Because this is a guidance document, it's somewhat flexible, and it does give them an understanding that, you know, you can do these things for the driver and not really harm the pedestrian in the process. So we really feel that's why this document is going to be, one, much more multi-modal and much more comprehensive than any of the documents, any of the handbooks, excuse me, that we've had before.

So that, I think, is going to be a great change and secondly, we will be able to show while, you know, these best or innovative practices that are being done at places across the country that are using treatments that have been very successful. And so this is why I think this document is now gone into the -- even beyond where we were before, to be much more multi-modal and much more comprehensive in addressing the aging road user.

MR. COLLINS: Thank you.

CHAIRMAN HERSMAN: National Institute on Aging and if I could just remind everyone, for the cameras, to introduce yourself with your name and your organization.

MR. KING: Thanks. This is Jonathan King from the National Institute on Aging asking the questions from our table. The first was asked by John Maddox from NHTSA and it's: What vehicle design requirements should regulators consider to minimize distraction for older drivers?

MR. SCHAFFER: I can start off with -- you might want to

talk to them, but I want to address, really, what you're looking at on the roadway, itself, if you don't mind, simply because that's where a lot of -- if you will, you get around to a lot of conflict area. I'll point out intersections. And I'm sure you've seen certain intersections are just loaded with signs --

MR. KING: Yeah.

MR. SCHAFFER: -- just loaded. It's Sign City and you're wondering, my God, where do I go? Well, that's an issue, to be very honest, and how that's addressed is very important and that's why we address that. And also the fact that as we age, one of the nicest things about a sign can be, is basically can you see it? Can you see it day and can you see it at night, no matter -- and that's where its retro-reflectivity, which was definitely recommended in the 2001 edition and is continuing on, is surely important and back plates, et cetera. Those are the types of things in signage we really are pointing out so everybody can see the signs and --

DR. BRUCE: Mr. Schaffer, could I hear the question again? Wasn't it --

MR. KING: It was on vehicle design, but this is okay, too.

MR. SCHAFFER: Okay, I'm speaking out of -- but I just wanted to point out on the roadway --

MR. KING: No, I think that's important too, yeah. Because that's clearly a part of the distraction is obviously the

signage and the fact that, oh, wait, was that where I was supposed to turn and then you're not looking.

Does anyone have an answer to the vehicle design requirements question?

MR. BROBERG: Yeah, I should probably answer that, working with vehicle design. Driver distraction, of course, is a hot topic and it's also a very, very complex topic. We have started to address it with advanced collision warning technologies. We've also addressed, as I said in my presentation, the aspect of driver workload so the car actually senses how busy the driver is and withholds unnecessary information that could cause distraction. For instance, when you're in the middle of a left-hand turn in a city environment, you don't need to know that you're running out of washer fluid. That's --

MR. KING: Right.

MR. BROBERG: -- sort of information you don't need so we don't have to give that. So the car is actually recognizing this itself.

I would actually like to come back to this from what I said before, this being a complex issue, because there is actually a balance between how you keep the driver attentive and engaged while driving. You don't want to reduce the workload too much because then you may actually end up in a state where you're becoming drowsy or tired or unconcentrated or you put your attention to something else.

So we would like to change and maybe not from distraction but talk more about inadequate attention allocation is a better word for it. So I think we need to really understand that balance, and I know for sure at MIT you've been looking into some of these aspects. But there is actually a balance of what we're doing. Distraction being a major cause, yes, we have to address it and we are addressing it in the terms of both having the car brake itself if you're about to collide into another vehicle, even another -- well, a vulnerable road user like a pedestrian, today we have that technology. And that, of course, helps drivers, not only the older ones but drivers in complex situations where you have a lot of different road users or if you're in a heavy traffic environment.

But really, we can do only so much with a car to help drivers, but we also have to look at what the drivers are doing that are not related to the car, and it can be anything around the car and it can be anything that the drivers bring into the car. So what we can try to do is, again, try to assist the driver in the situations to keep a balance of their attention and try to keep their attention looking forward and their hands on the wheels.

DR. COUGHLIN: If I may just -- if I may, I would suggest that right now we do not have enough data to know whether it's age or disease, so from my researcher's point of view, I would say we need to get better data out there to see how driver

distraction changes and workload changes across the lifespan. We have some preliminary data in my shop that seems to indicate, and my colleagues have developed, that disease such as diabetes, particularly in the motor carrier industry and places like that, may have a very big impact on how much you're able to manage behind the wheel.

That said, the other part of consumer electronics that has now entered the car -- we seem to think that this technology is something that the car industry is developing; they're, rather, migrating it from avionics and the consumer electronics industry. What we should be looking at is not an age-specific fix, but personalization. Do you want that system on? Do you want that display that large or that small? So rather than trying to say one fits all, what we should be looking at is what the baby boomers are very good about, it's all about me, so make it personalized.

DR. EBY: I just wanted to reiterate a few points. We were talking about workload management systems and there is work going on, on the systems right now, the SAVE-IT project just completed a couple of years ago, that was designed to basically come up with a system that can detect what's going on out in the environment where the traffic is, what the potential workload produced by the environment might be and then predict what the workload is for that driver.

Now, I will say that those studies are all very much in

their infancy and we don't know, as was just mentioned, we don't know how workload changes with age and with some of these medical conditions. So the system needs to be eventually smart enough to be able to adjust itself to that driver and a lot more research needs to be done in that area. But I think this is how we're going to manage distraction in cars with all these new technologies coming in.

MR. KING: Thank you. And actually, some of your answers actually addressed substantially the first part of the second question, but the second part may still be open. As vehicles get smarter and safer, do we see potential for drivers to be less attentive to the driving task? And I think that was already addressed. Also, essentially to forget how to be alert, much as we have now forgotten many other things like how to use actual maps. And then similarly, what sorts of behavioral adaptation effects are we expecting to see with these smarter cars? And this was from Beth Alicandri from FHWA.

MR. BROBERG: I would say there's still much more we need to learn from this. The approach that we're taking so far is that we try to promote good behavior from drivers. So for instance, if we implement a technology, say, for instance -- well, lane departure warning, we promote that you use your blinker. And there are some studies -- I think UMTRI has done some studies looking at that and see that it actually helped drivers use their blinker even more because then they didn't get a warning every

time they left their lane to change their lane.

We're also addressing if you take the auto brake technology, as such, we do not want to encourage behavior where you know that the car will brake for me so I don't have to pay attention, so we intentionally make the brake intervention very harsh and very, very late, so we put it outside your comfort zone. So if you're an attentive driver, you will actually think you are about to crash. And we've studied that, of course, using driving simulators, to understand that we promote that behavior in the sense that, yeah, the driver will brake. If he knows that he's about to impact something, the driver will actually brake before the system does. So we're approaching it from that perspective. But it's really from the adaptive behavior there's really much, much more research required.

And we just launched a study in Sweden where we have 100 Volvo cars with all the latest technologies and they will be driven for a long period of time and actually, during the first four months, the drivers were not able to use any of these technologies; we turned them off. And then after four months, we turned them on. And we're just in the midst of analyzing that data so we can actually see this, for the same drivers, if there is a change in behavior with and without these new technologies. But there is definitely more that needs to be done here.

MR. KING: That's wonderful. We get, at NIA, a lot of grant applications, needless to say, on older drivers and driving

and from this session and the session tomorrow morning, I anticipate many, many more. So I would have lots of questions, but I think I'll defer them all, except for one, which started coming in to us a few weeks ago due to a story in the New York Times about the self-driving car that Google's putting together and people started asking us how far away is this really going to happen and what should we do about it.

And I think, from what I've heard from the panel, the idea is that's not necessarily what we want because that's really truly insulating the driver from the driving experience and could be well what we don't want to have happen. Nevertheless, is this something we could see in the near future and, if so, what should we be doing to prepare for it?

MR. BROBERG: Well, we're actually looking into the same aspects and we are involved in a research project in Europe called SARTRE, which is actually looking into self-driving cars more from a platooning perspective to where the driver can actually connect to a road train so that you can do your ordinary business, typically on your way to work. You're in a line of cars and you're just driving and that's actually just consuming time.

So the idea here, being that we can help you both drive more safely if you connect to a road train and plus you have the convenience of being able to do your e-mails or do your SMSs and your daily work on your commute to work. And also, since the technology is quite advanced, we're able to make the traffic flow

more dense so we can add more cars on the road, so to speak, so you have a better flow. And also, you have the environmental aspects of fuel consumption.

So the idea here is that you connect to a road train where you have a commercial driver, a train driver, up front and then as you go, come to your exit, you actually disengage from the train. The aspects with these technologies is that it's a choice of the driver. The driver is making the choice that the car will drive automatically for you.

I think in the pure basis of the automobile is the freedom to be able to drive wherever you want, whenever you want. So that's going to be hard to take away. But there are some situations where actually autonomous driving can be both convenient for you. It's something that a lot of drivers may choose, but it's still the choice of the driver and the driver is always in control.

DR. COUGHLIN: One comment and one warning. The comment is, is that what you buy in your showroom today is at least 10 years old and so in terms of the speed of having an autonomous vehicle here, I'm not quite sure when that'll be, but the premise of my initial presentation was that's where researchers, the industry, and many who are concerned about human error behind the wheel would like us to go.

The warning is the following: the road to autonomy is going to be wrought with many errors and many accidents. How do

we govern an infrastructure that has a mixture of robotic drivers and individual drivers? How do we learn how to use these technologies as they enter the vehicle? So really what we're looking at right now, we're literally looking at older drivers as becoming the lifestyle leaders of this new autonomy technologies over the next 10 to 20 years. So the baby boomers, we are the guinea pigs of the future.

MR. KING: Our question time is up. Next table.

CHAIRMAN HERSMAN: Thank you. AARP for the second table.

MS. LYNOTT: Jana Lynott with AARP and also contributing questions from our table is the American Occupational Therapy Association and the American Optometric Association.

And my first question comes back to road design and I think -- but really, from the perspective of all panelists, because I think your expertise has something to contribute, each of you.

In the last panel session we learned that fragility is a bigger issue than frailty and so we should really be trying to reduce the number of severe crashes, severe and fatal crashes, as much as possible. And there's considerable research that shows how excessive vehicle speed for a given environment, be it an urban thoroughfare or a two-lane rural highway, leads to increased crashes and severity of crashes.

Now, several European countries, Sweden being one of

these, have dramatically reduced their urban road fatality rates, in particular, in large part because of reduced overall road design speeds. And so my question for the panel is have you considered whether traffic calming measures such as narrower travel lanes, roundabouts, tighter turn radii, might actually benefit older drivers in urban areas, in particular, one, because it may reduce the severity of crashes; two, because it should essentially provide increased reaction time by providing a slower speed environment? So I throw that out there.

MR. SCHAFFER: Jana, good question. And basically, we understand that lower speeds are to the benefit, especially within an urban environment and urban intersections, towards all users, especially the aged.

Now, having said that, this particular document, as you're well aware, looks at particular treatments of which speed is really just one of the particular elements which specifically is looked in the manual as far as what warrants -- you know, will bring down that speed. And that gets around to, yes, road diets, complete streets, those particular mannerisms or treatments are for the whole roadway, not just one particular road intersection or roadway segment but, you know, entirely -- in other words, to look at that entire speed there.

Now, having said that, really that's why we're looking, in this particular document, of where our particular treatments in part or as a whole have been used to make such an environment, you

know, whether it's a senior zone or any particular environment, have been used, you know, around the country to make things better, or treatments, if you will, that are not in -- you know, we haven't seen -- there's no hard research; they're innovative, they're totally innovative. So we're looking at that and truly to see, because what we have already noticed is, for example, whether you're going to Tampa, Florida, or you're going to New York City or Houston or, you know, places in Arizona, to where they truly have slowed things down and used a number of our treatments already to make it easier to drive around as well as to walk.

So it's a number of treatments, if you will, used but not in -- you know, if you will, part in, you could call that in a road diet, but more just in the effect of making it safer.

DR. COUGHLIN: Certainly, for any age group, the enemy of the driver is clutter and complexity, so if the roads can be made in such a way where they're calm but still make sense, but also balance the demands that are going on that road. There are many experiments that have been out there to try to traffic calm and, in fact, what has often happened is to increase the stress of the drivers in that area, trying to maintain the trucks, the bikes, the pedestrians, and the cars all in one place. So done well with balance to mitigate clutter and complexity will help the older driver who has true difficulty managing that and the younger driver who's trying to have a cheeseburger on the cell phone and drive at the same time.

MR. BROBERG: Yeah, you were referring to Sweden and the Swedish Road Administration and their work with their vision. And again, yeah, we have a number, increased number of roundabouts in Sweden and there's actually a study showing that, yeah, that decreased the severity of the collision but it also increased the number of collisions. You had more rear end collisions. And consequently, we have developed a brake technology that addresses this in low speed, city safety.

But more importantly, when we're working with our vision, we realize that if we're going to strive for a crash-free future, we have to cooperate. We can't do it with the car alone. The infrastructure is a very important part of it and also, of course, understanding the human being and the driver. So we actually started out in Sweden and we actually have an agreement with the Swedish Road Administration, not only to conduct research together in order to understand and get the know-how, but we also split responsibilities.

So we have clearly declared what we think that we are able to do with the car and what we think that they are required to do with infrastructure, and that has been very positive on their part because then we can focus our resources and actually get more gain and address more issues together. It's no use that we're working on the same issue with different kinds of measures when we can actually split responsibilities. So they can focus their financing plan for the future, as well as we can make sure

that we have -- meet our ambition and our vision.

DR. EBY: I'll just comment on roundabouts. I know, in many jurisdictions, at least in the U.S., roundabouts now are becoming rather common. Five years ago, you never saw them. And I think a mistake that many jurisdictions have made is they have not had enough outreach to the people in the community on why roundabouts are going in, why they're safer, and how to negotiate them. These are new kinds of intersections and people don't know how to negotiate them and even if there are signs, people are still confused.

In the jurisdictions where they've had a significant outreach, training, you know, going out to the various groups, explaining why they're being put in, they're much more accepted. And I think that's something that needs to happen much more often.

MS. LYNOTT: Thank you. Our second question is what are the most important design elements to enhance or improve the driver's vision and where can improvement be made in technology such as night vision, driver behavior, when to wear or not wear sunglasses, and other factors like medical care and vision assessment?

DR. EBY: Well, I think the very first step is an assessment of vision. Many visual problems can be corrected or at least can be mitigated to some degree. Cataracts, for example, almost always can be treated properly. Glasses and prismatic lenses can help improve vision problems. So I think that's the

first place you go is actually try and improve the vision.

Given that, it's hard to do much in the vehicle in terms of vision. You can try and correct night vision problems with infrared systems, but that doesn't help you with all the other problems with driving at night. I think self-regulation is an excellent way to moderate vision problems in driving. If people truly are feeling uncomfortable driving at night or driving in certain situations, they should be evaluated and potentially restrict their driving from those places.

MR. BROBERG: We do take that quite a lot into consideration not only for the older drivers, of course, but for all drivers, the ability to see others and see the traffic environment. We have technologies to help drivers identify vehicles in the blind spot. For instance, we're working with how to design the base geometry of the vehicle in the sense of giving the driver the possibilities to see and monitor what is around you.

We're also taking into consideration where we present the information for the driver about the car and the speed, et cetera. So all those elements, geometrical elements, are taken into consideration. When it comes to some of these more advanced technologies like night vision, for instance, that has to be, again, presented in such a way that it's not actually a distraction for the driver and I think we're starting to see more and more mature technologies. Also, when it comes to driving at

night, the more advanced adaptive light type of technologies may also be a help to feel more comfortable when you're driving at night.

DR. COUGHLIN: I like the question because, frankly, it's a nice segue to a larger discussion which should be around driver well-being and the idea of what can we do physically, nutrition-wise, what are the things we need to maintain in ourselves to become a safe driver for a lifetime. So good eye health is certainly the -- perhaps the first and perhaps obvious but often ignored part of it.

The second part would be, of course, the new technologies whether it's night vision, mirrors and the like, but the third -- and I'm going to kind of crib from my colleague Bryan Reimer at the lab -- you know, the eyes are a very good indicator of where we allocate our attention. So one of the things we should be looking at not just in terms of eye health, but when we choose a car or when we design a car, how can we information dim-out those things that require our attention? Are there certain things that we simply just don't need?

We've done a number of experiments that we find, ironically, there are some gender issues. Women, first and foremost, overwhelmingly in our studies, wanted the clock right dead-center. Why? Because they make more trips than men and they're doing the daily tasks of the household in most cases. Men want some other clutter in there. So we talk about eyes, it's not

just about health, it's not just about the technology, but it's also an opportunity to rethink how we design and dim out and focus in those things that are important.

MR. SCHAFFER: May I touch the last thing and thank you all for on the vehicle. This comes around to technology on the roadway and the roadway technology is very important, one, for the aging driver to have a truly conspicuous environment and so that conspicuity is just wonderful because you can see, you can see day and you can see night.

And because nighttime glare and the like is very difficult for aging drivers and for all drivers. When you can know exactly where the roadway is in any particular environment, you know where the signs are, you can, you know, you can tell that, you can actually -- you know, the roadway signs, you can see, all that matters. And so that makes a much more conspicuous environment with your vision, to be able to see. So what we really are promoting and have been for years with the handbook is that environment.

MS. LYNOTT: Okay. And then I think, in the interest of time, our final question, the federal highway design handbook is a set of design treatment recommendations, and in light of constricting state and local budgets to implement, you know, many important things in the road environment, are there any one or two particular recommendations and treatments in that handbook that you feel should be regulatory in nature as opposed to merely a

recommendation? Is there anything that we really should be pushing to have implemented?

MR. SCHAFFER: Everybody's looking at me. Okay. We make recommendations. What it really comes down to, what comes through, we recommend and that's where this is a guidance document. And it is up to the national committee and others to really determine whether or not this particular treatment needs to be a standard. We don't do that. We just make really good, sound recommendations and it is others, such as the national committee, that will make those decisions. AASHTO, when it comes around to the Green Book, et cetera, they're going to be looking at those and that's why you'll see much different things in this coming Green Book that's going to be coming out in the next year, as well as in the AASHTO bike guide, as well as the pedestrian guide. Those are a lot better treatments and a lot better recommendations.

But we stay with -- again, this is a guidance document and we're not elevating one or the other above and saying this is our top recommendation. We don't go there. We just don't do this. We leave that up to each particular engineer and to -- you know, in our training as well as when it comes around to really looking over time which, you know, to the national committee and others, to determine which one of those truly should be a standard.

MS. LYNOTT: Thank you.

CHAIRMAN HERSMAN: AAA will be asking the questions for the next table.

MR. GRABOWSKI: Hi, good afternoon. I'm Jurek Grabowski with the AAA Foundation for Traffic Safety and my table's represented by the Alliance for Automobile Manufacturers, the Insurance Institute for Highway Safety, and AAA. And we have about five questions, so let's start.

One way older drivers compensate for their related limitations is to select easier or safer roads to navigate. Also, problem intersections are typically able to be identified by mapping systems. Does the panel think that there would be value in navigation systems that can provide a safer route setting in addition to the current fastest route setting?

DR. EBY: I do think that that's the case and, in fact, our University Transportation Center, M-CASTL, is working on a project right now with Paul Green to develop something like that, the idea being that the routing would be more appropriate for the kinds of self-regulation that an older person might do based on some sort of medical condition. So it's in its formative stages but I think it's a great idea.

DR. COUGHLIN: One of the other projects we're working on also with the University Transportation Center funds from DOT is not looking at medical-related issues or whether it's older, but how much does that particular route cause stress. So when you go to your nav system that has fastest route, easiest route,

whatever it might be, we're actually mapping out how different roads present different levels of stress and you can actually color-code it on the road based upon the driving of our Aware Car. So you could also say I want the fastest but least stressful route.

CHAIRMAN HERSMAN: I think that might be called the train.

(Laughter.)

DR. COUGHLIN: Yeah, is it on time?

CHAIRMAN HERSMAN: Yeah. I'm sorry to interrupt AAA. Please continue. I was just thinking about my commute as you were suggesting that and there really isn't a stress-free route for me to get to work. Thanks.

MR. SCHAFFER: I just wanted to point out briefly, with Federal Highway, and I'm not just pointing to the handbook here, but the number of particular guidance documents and counter-measures we promote and that is to give the engineer, to give the transportation specialist and the planners tools in which to evaluate how they can correct, you know, and guide their populations to use particular roadways and to improve those roadways over time. So it's really tools which we feel easily can be done and that's why we promote those and market those at the local and state level so our stakeholders can use those.

MR. GRABOWSKI: Okay. So our second question, there is some concern that with the integration of multiple crash avoidance

systems in a vehicle, some drivers, especially older ones, may not be able to identify the actual crash threat that they're being warned of or know how to react to that threat. Is this a legitimate concern and how can this be addressed?

MR. BROBERG: Yeah, I think I should answer that. Yes, I mean, it's a legitimate concern, of course, and we are already addressing it. If we take, for instance, the number of different warnings that you can have in a car, there is actually a priority. So for instance, if you have a car that both has lane departure warning and forward collision warning, you will have priority with the forward collision warning, so you will not get simultaneous warnings. Also, how the warning is executed is different and, of course, if you're in a situation where you're about to collide with a vehicle in front of you or a pedestrian, we want you to brake, so we want to promote that kind of behavior.

First of all, we're assuming that you're distracted because you're about to drive into something, so we want to grab your attention with an audible signal. And then the next sign for your cue for you is that you have a red light appearing in front of you in the wind screen and that red light resembles the brake light of another car and your natural reaction, when you see a brake light in front of you is to apply the brakes. So that's sort of how we logically, intuitively, try to address these issues and also make sure that we have priority with the warnings.

And also, these priorities are coupled with the

intelligent driver information system in the sense that you will not get other information that is disturbing for you in such situations. So we have a thought process around that and we evaluate it, when it comes to the critical situations, we use driving simulators to evaluate different sorts of drivers, old as well as young.

DR. COUGHLIN: I think one of things we should be thinking about is that the future of the car is more a learning vehicle where there's going to be an algorithm to detect that Joe drives a certain way, his wife drives a certain other way, and the vehicle will throw these warnings out based upon how far you deviate from that and so that should, hopefully, clean up some of the confusion that an older driver or any driver might feel.

MR. GRABOWSKI: Okay, our third question. In relation to older drivers, what new types of data will be collected on the driver's behavior in relation to the new technology and will that be available to crash investigators and researchers and so forth?

MR. BROBERG: Well, we are currently heading a research project where we're looking into these different aspects and as a test bench we're using real cars in real traffic environments where we monitor drivers over -- either in directed experiments, directly. We use advanced eye-tracking equipment. We have longer studies where we have drivers driving for a longer period of time where we're trying to collect data, and this is a research project where we have academia involved. All of that, of course, will be

published when the data has been analyzed and so forth.

And the approach so far has been to -- through in-depth investigations that were made, looking into accident causation, trying to address issues factor by factor and trying to understand how important they are, why they're important, which are the most important ones and, of course, with the ambition to understand how we should address it. So that work is actually -- the work that I'm heading is a five-year project and we're on our second year now.

We're just about to launch a publication on -- where we've studied how drivers, older drivers in relation to middle-age drivers, how they observe and how they make observations when driving into intersections. Intersections are one of the situations where we find that older drivers are more involved in collisions, relatively. So we're doing a lot of that and most of that will be publicly available.

DR. COUGHLIN: I would strongly -- and perhaps I'm misreading your question, but I would strongly urge the stakeholders here before the public forum to take that as a policy question, not as a technology question. Your car already knows a lot about you. We don't have a black box, but we've got a baby black box on board. So the policy questions now are how do we use those data, how can we access that with respect to privacy and then how will they be used in a court of law as well as insurance proceedings? The question is not whether the data are out there;

the question is not whether or not insurance and other investigators can use it; the question is can the policy process catch up to where the technology is already today?

MR. GRABOWSKI: Okay, this is a question for Dick Schaffer. What's the rate of implementation for the design handbook guidelines across the United States? And are there any barriers to implementation? If so, what are they and what strategies are there for overcoming these barriers?

MR. SCHAFFER: We present, as I stated, out to our stakeholders at the state and local level; we train them. This is done by our resource center to really explain what, why they need to, you know, to learn this and what it can do for them, you know. So in other words, what the handbook is recommending and what it truly can do for them. So this is being done around the country, everything from roundabouts to intersection design to retro-reflectivity, numbers of things that are recommended in here that deal with intersections, the roadway segments and the like. It varies by the state, honestly, of -- you know, particular measures that are -- you know, taking those measures and actually implementing, improving an intersection, building a new roadway with these in mind.

So I can't give you, just to say, oh, one state does it this way, this quickly, and one state does it this way, no. But what I can say is that, yes, there is such a time. It's much quicker, for the most part, when you go out and give this training

and, you know, to your states because they see it firsthand and they get to understand it firsthand versus the time it takes for it truly to get into the MUTCD is a lot longer and there, yes, it's a standard, boom, you've -- you know, it's -- there's no ifs, ands, or buts -- it's going to be used.

But when you've taken it in different places around the country, most -- you know, it's going to be used there because they get to a better understanding, where when it gets around to the manual, that takes a good time for it to ever get to the national committee to really say, okay, now we're going to be looking into this, does this really fit, et cetera, et cetera, to really where it's going to be getting into the next version of the MUTCD.

So I think, process-wise, that's why we market it, that's why we take it out and do these trainings with the resource center out to the local level because we feel that we're going to get much better response, that those recommendations are going to be made quicker and those implementations made quicker.

MR. GRABOWSKI: And I think we're done.

CHAIRMAN HERSMAN: And the last table, AAMVA.

MR. MANUEL: My name is Tom Manuel and I'm from AAMVA, and I have two questions. And the first one is -- and you kind of touched upon this. Will the technologies have the capabilities to calibrate or adjust for the varying abilities or skills of each driver -- and what I mean, variabilities, the physical or

cognitive abilities -- or are the technologies more adjustments for environmental factors?

DR. COUGHLIN: The vision that we have for the Aware Car and the vision my colleagues have for the Aware Car is a vehicle that can detect your well-being behind the wheel, your level of stress, your level of fatigue, by looking at a variety of biometric measures, whether it's eye movement, whether it's looking at pulse-rate variations, skin conductants, and some other indicators.

But it's more than just detecting, that's actually the easy part. The question is can you display it to the driver in such a way where you engage the driver and not disturb them or annoy them. But then, can you have the vehicle refresh the driver, can you refresh, rejuvenate, and renew driving performance?

I think the move in technology in general, whether it's your house or indeed in your car, are smart, high-performance environments that will be able to identify variations on how you individually drive from day to day and change performance based upon that. So as we move in that direction, technology will start to compensate for certain capabilities and also certain behavior patterns.

MR. BROBERG: And if I may add, I mean, cognitive or not, but looking at the alertness of the driver, we're already monitoring that today, not specifically looking at the driver as

such, but looking at how the driver is actually using the vehicle and how the driver is positioning the vehicle between the lane markings. So we taught the car to recognize the typical driving pattern between the lane markings of a tired or unconcentrated driver. So we're starting to take humble steps in the aspects of trying to assess the driver already today.

And I agree with Dr. Coughlin here that that will proceed as we get more and more tools to be able to measure the state of the driver and there's more things that we can do; however, the big challenge for us is to understand how to execute that in interaction with the driver. And that's where we need more research in order to understand how drivers behave in such situations.

MR. MANUEL: My second question is, is when you're concerned -- there's a concern about the sudden loss of consciousness or the sudden loss of ability to drive, like we saw -- and we were just reminded about the incident in California a few years ago, this complete collapse of ability to drive or sudden loss of consciousness making you unable to drive. Are there any emerging technologies that will address that?

MR. BROBERG: You mean the sort of like freak kind of accidents? I would say it's extremely hard. Of course, you can relate it back to some of the collision avoidance technologies, but if -- we will never be able to prevent the driver from trying to hit something because the basic philosophy on how we're

designing these technologies today is that the driver is always in control, the driver is always in charge. So the car will never take away control from the driver, so I think it's extremely hard with the philosophy we have today to prevent these kind of situations. I think there are other countermeasures that are required from society and others to prevent this.

DR. COUGHLIN: On a technology level, I agree with Mr. Broberg 100 percent on that with respect to technology in the car, but the little secret that we don't like to talk about is that the real technology to identify a driver that, quote, "has a sudden catastrophe" is really rarely a sudden catastrophe. There are a pattern of problems that are indicative that only their family, their friends, and people who sit in the car with them have seen over time. The tragedy that you speak of in California had a long line of precursors that happened to them. So the best technology in the world are our friends, our family, and the people who sit in the seat next to us to identify changes in behavior.

CHAIRMAN HERSMAN: Okay. Mr. Schaffer, if you could share with me -- I know we're talking about older drivers, but you raised the issue of pedestrians and what I'd like to understand is our pedestrian fatality numbers. Are older walkers or older pedestrians more affected in those numbers, as well, because of frailty?

MR. SCHAFFER: Yes, they are. However, what we have

seen is a reduction in our pedestrian fatalities in this last year. The question is, and we still don't know as to why. However, we have a number of -- beyond the simple older pedestrians, we have a number of countermeasures and tools to use that will make a safer pedestrian environment for everyone, not just the elderly pedestrian.

And so we have -- whether you prepare a pedestrian safety action plan or a pedestrian road safety audit to truly analyze what both the human factors and technical issues are in a particular roadway segment or intersection, we have a number of these tools that can be used, and we are promoting these strongly around the country to make roadways much safer for pedestrians. And that's beyond just simply what we have, you know, in the handbook. So we are moving, I think, real strongly in the pedestrian area to make roadways just safer for all pedestrians.

And we are seeing a reduction. We have to know more, though, as to -- and move more to make sure that this continues, you know, and we hope it will continue to drop, and that all ages, not just the aging pedestrian, will be, you know, will be affected simply because we know that the frailty -- they're walking much slower, they're -- and so, you know, the crosswalks are now being changed to where either they can be flexible, based on where a person is, or they just simply, because of the '09 MUTCD, brings them down to 3.5 feet per second to walk versus the old four feet per second. So these are measures we're really using, both for

older pedestrians and for all pedestrians, to make it safer and to reduce those fatalities.

CHAIRMAN HERSMAN: Do we see a U-shaped curve like we do for drivers, where you have more fatalities of the very young and the very old and not so many in the middle? Like on pedestrians, is it similar to drivers with a distribution of the fatalities?

MR. SCHAFFER: Yes, I understand, and no, not as much as far as the older pedestrians, and we don't see that. And there is a number, yes, but not to the degree of the older driver, no.

CHAIRMAN HERSMAN: Okay, thank you.

MR. SCHAFFER: Um-hum.

CHAIRMAN HERSMAN: You know, I think going back to the technology, I'm interested in the customization and the conversation about customization. It sounded a little bit, Mr. Coughlin, like we were talking about like our desktop and being able to kind of put the things on that we use the most and that are easily accessible to us. I wonder if there's the potential, though, to make our cars too much fun or too friendly.

I also heard Mr. Eby talk about co-drivers and I'm not sure if that was the right term that you used, but a passenger who's kind of assisting and gets blocked out of the guidance, the route guidance, as the car's underway. I think I'm really kind of torn in this area because, on the one hand, we do want to be able to serve people well in their cars, but on the other hand, if we make it too easy for people to work around some of these

protections -- I know in my minivan it has a lockout feature. Once the car's underway you can't put in a new destination or you can't continue to manipulate it. You actually have to stop and pull over and take care of that. Yes, it's annoying when I'm in the passenger seat.

You know, we're at a stop light trying to really quickly get the information in before we have to start rolling again. It is, it's annoying when I'm in the passenger seat and we're trying to do it. But you know what? I also really value that technology, because I know when my kids are driving in the car or the babysitter's driving the car, that they can't do that while they're driving.

And to me, I'm trying to figure out what's the tradeoff between the convenience and the safety part of it and if you can override it and say, well, I'm the passenger, I'm just manipulating this because I'm the passenger. People are really smart. They're going to figure out the way to override it when they're the driver, too. How do we protect people from themselves? I don't know. Who wants to take a crack at that?

DR. EBY: I'll take a crack at that. That was just an example to show how older people potentially might use technologies differently than younger people. I agree with you, it's a nice -- it's probably a critical feature to lock out entry, unless you have a way of knowing that this is a co-navigation or copiloting situation. If you don't know, then locking out the

features while the vehicle's in motion makes great sense.

So it's a balancing act. I'm not saying I have the solutions. I'm simply making the point that if you're going to introduce technologies into these vehicles, you need to understand the interactions that go on inside the vehicle and how people drive of this age group. And that research needs to be done with the new technologies.

CHAIRMAN HERSMAN: Right. And that cohort might be responsible enough to actually make the right decisions, but what happens when their grandkids are going to use their car? And you know, we have a DVD player in the car, we have three kids, and so it comes in really handy on long-distance trips. But I've heard these movies so many times. I never get to see them; I just hear them. So every once in a while, while my husband's, you know, putting the gas in the car or something, you have to push the parking brake in, in order for it to show up on the front screen.

Boy, it's really tempting to want to keep that thing up and you think, well, I'm not really going to watch it, but you just, you know, want to peek down. But it locks you out; it doesn't allow you to do that. And I just feel like we see so many people texting, you know, with a lot of cognitive distractions and they're just increasing and now we have potentially people putting Internet access and web right there in the car.

And so I really liked what Mr. Broberg said about getting on the train, you know, on a train and being able to do

your work in the car. But until we have that feature, what do we really want people to do when they're behind the wheel? What do we want them to have access to? And maybe, Mr. Coughlin, when you talk about personalizing things, how far do we go with that?

DR. COUGHLIN: Yeah, the notion of personalization, you know, you mentioned a nice analog, the desktop. It's funny, you can customize your house and you can customize your desktop, but the second largest purchase in your life you have to take as the designer gives it to you in most cases, except for color and comfort. What I would envision is essentially what's evolving, is a glass cockpit which allows you actually to pick what information you want.

Now, as much as all of us would like to think that we're individuals, we know that as industry gets to know us more, we're all individuals probably in about six or seven segments. So Microsoft or Apple knows that you can customize your desktop as much as you want, but they know it's going to be within a certain set of limits that the system can actually do. So I would suggest that personalization is not only going to make an ageless, safer car, but one that's more responsive, so that when you get into the car, the data that you want, the information that you want, will be in front of you and all the other stuff will be out.

We have a number of people who like to have a tachometer even though they're driving an automatic. They want it to be on their desktop, or on their dashboard. A lot of other people do

not. So I think the personalization may actually help us with information dimming, as long as we know enough as to make sure that people who are info junkies don't put too much on the desktop.

MR. BROBERG: Just to address this from a manufacturer's perspective, because, I mean, this is a fine line for us because we have to make products that are appealing to the customer in the sense that, yeah, this is something that I want to buy. And then, of course, you don't want to annoy the customer, your buyer of your product. At the same time, as you say, you want to protect them from themselves, in the sense that we do have knowledge as to what you should do and what you shouldn't do.

I think the way forward, therefore, is really how we use our knowledge to package this in a sense so that you don't feel that you're getting "don't do this", that you rather feel -- so it's actually a matter of working with both the pinpoints in combination with carrots to try to give you something else. But this is a very intricate problem for us as to how we design the future cars. And there's also only so much we can do, because we can never prevent the drivers or the occupants in the car to do whatever they want. So we have to be very, very clever when we work around that.

CHAIRMAN HERSMAN: I wonder if there are any international lessons that we think can be translated into the U.S. environment or that were just so different that it's very

hard for us to adapt some of those changes.

I was over in Switzerland last week and you know, I'm a transportation person, so it was just -- you know, it was like being on another planet. You know, I came in on a train and outside the train -- and, you know, it wasn't -- everything wasn't in English, but, you know, we had to take a bus to get to a hotel and, I'll tell you what, it was so easy, it was no problem. You know, I wouldn't really even think about trying to take a bus here in Washington on the Metro system half the time, trying to figure out which routes and where the stops are. But this was very -- it was very obvious, and it was very easy.

And so when I think of us, you know, kind of saying, well, when people lose their ability to drive, they need to transition to something else, well, if that something else isn't easy, that certainly makes it hard. But everyone was walking. There were hardly any cars. As far as pedestrian things, everybody obeyed the street signals, you know, with the crosswalks, and they all crossed at the crosswalks and nobody jaywalked. It was really weird. I mean, the whole thing was just like I really felt like I was on another planet.

There was a point where we got to a point where we needed to cross a busy intersection and we could not figure out how to get across the street. We couldn't find the crosswalk. Well, they had built an underground passageway that you walked under the street. So nobody crossed that street because it was

too big and, you know, it would stop the flow of traffic and there were a lot of things going on.

How do we translate, potentially -- oh, and by the way, on the last panel, the whole medical issue, I didn't see anybody who was overweight because they were all exercising and walking. And, you know, I actually felt pretty large while I was over there. But all ages were out walking. You know, it was really impressive. You know, there were clearly multi-generations, younger people helping older people going for their walks, and there just weren't very many cars. There were a lot of people bicycling and they had bicycling lanes and it just really -- from a transportation perspective, I was just so wowed and I felt like, why can't we accomplish something like this in the U.S.?

And so, Mr. Schaffer, I ask you, is it impossible to have that? Is that a transportation utopia that's just not going to happen in the United States? We have such a different relationship with our cars and the way that we move that we can't do that?

MR. SCHAFFER: That's a very good question. They are different cultures and we've seen this on a number of international scans, which Beth happened to go on a number of years ago on the older road user international scan. And that was, correct, Japan and Australia, yes. And so we really wanted to see how they do things for their elderly population. And at the same time we've also done international scans for bike and

ped, which we just did recently in Europe. And so we have really, at Federal Highway, looked at, internationally, what is being done; how can we look at those here?

And that particular scan, getting around the older road user, because -- and I'm not speaking for Beth, but basically what we did find is that, you know, in Japan, it's a different culture. They don't have anything like, as I recall, Beth, this older road user. They just do things differently. And Australia's a bit different. Of course, they drive like the Brits, on the other side of the road and -- but they treat -- you know, it's a different culture. And so that does reflect on how they treat -- you know, and they do walk more and that is affecting here.

Now, in this country we're learning, I believe, that we do have an environment where it's not just the car, it's all particular roadway users. So we can learn from these scans, if you will, that -- and as well as just, you know, with the high price of gas and just being able to be in a more livable environment that's suitable for all modes and for all ages, that you can get around and you can get around safely and effectively. So that is something we're still working on. We're still taking our lessons, if you will, from what we can do better here, as well as learning from our foreign partners of how to do even better.

DR. COUGHLIN: If I may, the transportation system reflects and reinforces a choice in lifestyle. It's less about moving from point A to point B. And the Europeans and certain

Asian communities as well have had a tradition and development patterns with the intensity and density that you speak of, that are sometimes quaint and always kind of preserving a quality of life that they've enjoyed long before the car even existed.

In sharp contrast, for hundreds of years, let alone the last hundred years, the American culture has been not one built around the car, but one built around space and wanting intensity and density to be someplace else. It's only been recently, in probably the last 20 years, that we've looked at the city and urban life as something more desirable. It has taken us upwards of 60 or 70 years to have the urban form such as it is. Today, where 70 percent of people over age 50 live in the suburbs or rural areas where transit alternatives, walking alternatives, not only don't exist, but in my own town where I live, going for a night on the town on Friday night would be a two mile walk to a CVS; not exactly, you know, a party in that sense.

So we need not just to think about the transportation system, but we need to think about what are the activities? What are the things we want to do? How do we want to re-envision the connectivity and engagement as we age, at any age, around that?

So yes, I enjoy visiting Germany, Switzerland, and places that do feel storybook compared to Boston, where transportation is a competitive sport in its own right. But what we really have to renegotiate is how we choose to live with each other.

And I guess the last comment is, is that one of the challenges that we have as baby boomers now, turning 65 come January, every 7 seconds one of us will turn 65, will we be able to wake up one day at age 75 and say, you know, I've never been on the bus, but I think I'll try it. I don't think that's going to happen.

So if I could leave anything with the panel, we need a sense of urgency. The older driver issue, the mobility around transportation in an aging society, actually, I can pinpoint with a footnote, was first put on the nation's agenda in the 1930s when they were talking about the scourge of older drivers that would be 40 and over on the highways. Ladies and gentlemen, we've been aging fast and I'm really worried that I'm going to be stuck with going to CVS on a Friday night.

CHAIRMAN HERSMAN: Well, if you need to pick up your prescription, it might not be a bad place to go, so --

(Laughter.)

CHAIRMAN HERSMAN: Well, this has been fantastic. I know that we all have so many more questions. The dialogue is superb. We really appreciate your expertise and your insights. We thank all of the parties for their excellent questions. I have to say, there were so many I got to mark off because you were there first. And so thank you for your very good questions. We have had a great day. We will convene again tomorrow morning at 9:00 for the rest of the panels. And so we stand adjourned.

Thank you.

(Whereupon, at 5:00 p.m., the hearing in the above-entitled matter was adjourned, to be reconvened on the following day, Wednesday, November 10, 2010 at 9:00 a.m.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: Safety, Mobility, and Aging Drivers

PLACE: Washington, D.C.

DATE: November 9, 2010

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

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Timothy Atkinson
Official Reporter