REALTIME FILE

Pacific ADA Center
NATIONAL NETWORK LEARNING SESSION:
EMERGENCY STAIR TRAVEL DEVICES
JUNE 13, 2019

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>> Lewis Kraus: Welcome to the Emergency Management and Preparedness - Inclusion of Persons with Disabilities webinar series. I'm Lewis Kraus from the Pacific ADA Center, your moderator for this series.

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I also want to note for you that the webinar is being recorded and it can be accessed at ADA Presentations in the archive section next week.

This is the fifth year of this webinar series which shares issues and promising practices in emergency management inclusive of people with disabilities and others with access and functional needs. The series topics cover emergency preparedness and disaster response, recovery, and mitigation, as well as accessibility and reasonable accommodation issues under the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, the ADA, and other relevant laws. Upcoming sessions are available at www.adapresentations.org/schedule.php, under the schedule tab in the emergency management section.

These monthly webinars occur on the second Thursday of the month at 2:30 eastern, 1:30 Central, 12:30 Mountain, and 11:30 a.m. Pacific time. By being here you're on the list to receive notices for future webinars in this series, and those notices go out two weeks before the next webinar and open that webinar to registration.

You can follow along on the webinar platform with the slides. If you are not using the webinar platform, you can download a copy of today's PowerPoint presentation at www.adapresentations.org in the schedule section.

At the conclusion of today's presentation, there will be an opportunity for everyone to ask questions. You may submit your questions using the chat area within the webinar platform and the speakers and I will address them at the end of the session. So, feel free to submit them as they come to your mind during the presentation. To submit your questions, you type them into the chat area text box, as shown on the screen, or press control m and enter text in that chat area. If you're listening by phone and not logged into the webinar, you can ask your questions by e-mailing them to adatech@adapacific.org.

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Today's ADA National Network Learning Session is entitled Emergency Stair Travel Devices. Safe efficient travel along stairs is a key component of an emergency evacuation plan, in a high-rise or any building where the evacuation path includes stair ways. There is a wide range of emergency stair travel devices, each with a unique combination of features to promote occupant and operator safety. The webinar will provide an overview of several devices of the carry-type, track-type, or sled-type design categories. additionally, the results of a FEMA-funded study of both physical demands on device operators and consumer opinion of the devices will be included. Recent efforts to establish a performance standard for the devices will also be presented.

Today's speakers are Steve Lavender, an associate professor in Integrated Systems Engineering and Orthopaedics at the Ohio State University. His research focuses on the development and evaluation of ergonomic interventions recent projects include the

development of ergonomic interventions for the patient handling tasks in the fire service, the identification of factors that affect the adoption of ergonomic interventions, the evaluation of emergency evacuation devices used in high-rise buildings, and the design of hospital patient room designs that facilitate the work for all hospital staff members.

Glenn Hedman is a Rehabilitation Engineer and Clinical Associate Professor at the University of Illinois Chicago. His research is focused on performance criteria for emergency evacuation devices he is a past President of RESNA, the Rehabilitation Engineering and Assistive Technology Society of North America and serves as Chair of the RESNA Assistive Technology Standards Committee on Emergency Stair Travel Devices used by individuals with disabilities.

All right. Steve and Glenn, I now turn it over to you.

>> Thank you.

>> Steve Lavender: Thank you, Lewis. And good afternoon or I guess maybe it's good morning to some of our Pacific coast friends. Today we have an opportunity to spend some time talking about how we can evacuate individuals with disabilities from high-rise buildings safely and efficiently. When we got into this, it was basically looking at it from an ergonomic perspective and trying to understand, ok, what is going to work well for the evacuators but also what works well for the people being evacuated.

When we take a look -- obviously, you know, if you have fires and that kind of thing, you have to get people out, get people out quickly. Well, there's people who need assistance in that process and there are different device that can help them out.

Not all evacuations have to be in an urgent mode. There are power outage that require the evacuation of a building. That could be for some period of time and those people need to be moved. It's not like we have to get them out as quickly as possible, but we still need to get them out so there's different levels of urgency that come into play here. Obviously, the pictures we're seeing, if there's smoke, there's fire, that suggests urgency, clearly.

When we take a look at the people who have to do this, the firefighters, the EMS responders, you know, we know that from an ergonomic standpoint these people have a significant number of injuries. There's plenty of literature that suggests that these people are at greater risk of injury relative to others in Health Services. A lot of these injuries are sprains and strains, back injuries account for a large percentage of lost time. There's data out there that shows that firefighters -- hey, a good chunk of these sprains and strains and muscular pain type events are happening while performing non-fire emergency tasks such as moving and carrying people. And some literature from, like, 20 years ago points out that stairs and heavy patients are certainly contributing factors to this problem.

Our objective was to evaluate different types of stair descent devices. You'll see the term SDD in our slides as we go forward. That can be used to evacuate individuals with motor disabilities from high-rise buildings.

What we wanted to do initially was look at the biomechanical demands, the physiologic demands, and also look at the efficiency with which these different types of devices could be used. There's been some prior work here. People have looked at different types of devices, mostly looking at performance times -- in other words, how long it took to evacuate with, for example, a manually carried stair chair, a drag mattress. This one particular study, they didn't quantify the physical demands on the EMS responders or providers.

Another study looked at a comparison of track-type stair chairs. They looked at two different types of these things. It used what's called the three-dimensional static strength

prediction program, which is a biomechanical modeling program to look at compression and sheer forces on the evacuator's spine, and they found there could be substantial differences between these two different types of track-chairs.

So, when they did this, they also used two operators which suggested there was some load sharing between those operators, which is an important thing and we'll come back to that.

So, specifically, our aims were to quantify the differences among the different types of existing evacuation devices with regards to the physical demands that are put on firefighters and EMS personnel.

We wanted to quantify the variation in evacuation times, because obviously, you know, if it goes very, very slowly, then that could be a problem. Especially if you're evacuating a high-rise building and you have others trying to use the stairwell at the same time, taking into account how that evacuation speed compares with normal pedestrian flow could be very important here.

The other piece we were looking at, we wanted to determine the impact of selective environmental factors: specifically the width of the stairs and whether or not the evacuation was urgent; and we wanted to assess some of the usability issues associated with these devices from the perspective of the first responders.

And finally, we wanted to understand the consumer's perspective. For the people that are actually riding these devices, it's important we understand how they feel about them and how we make decisions as to which are the best devices to use.

So, our approach was to recruit some firefighters and ask them to communicate through essentially a laboratory setup where we had them carry, roll, slide devices down flights of stairs and the measured physical demands were three ways: We looked at electromyography which were getting signals like skeletal muscles that indicate how hard the muscles are working; we looked at heart rate to get an overall indicator of physiologic demands on the evacuator is and we looked at some self-report data.

So, the task, while we had them secure the occupant in a device -- here on the upper right corner you see our occupant, our Rescue Randy mannequin secured or strapped into one of the evacuation devices. Once the occupant was in place, the task was then to transport the occupant down three flights of stairs which then included two landings, which are particularly important. For some of these devices, you get down to it and it's like, well, the stair travel is one piece and what happens on the landing could be very different and could really change how you think about these different devices.

Our experimental design, from a research perspective we were considering device design, looking at staircase width, and we were looking at urgency. In two of the three studies that I'm going to talk about, and I'll talk about the difference in a second.

With regards to device type, we looked at hand-carried devices, devices with -- that have tracks that allow somebody to roll the device essentially down the stairs, and then we looked at sled type devices which are slid down the stairs.

What you see in the upper right corner is the top view of our mannequin being hand-carried down the stairs. This was kind of the default, the hand-carry approach, where there's no device used at all.

We have in the lower left corner what we call the fabric seat which has basically a piece of fabric that has handles sewn in that allows a person in front and the person behind to grasp the handles and carry the occupant.

Then we had two different types of stair chairs. We have the basic stair chair which is the middle picture, which is basically some sort of canvas-covered chair. It's got some followed-up handles that are actually folded down right now. But the key thing by this stair chair is it's carried by two people and the person behind the torso would be going down the stairs facing forward but the person leading would be holding the handles that you can see folded along the legs of the chair in this picture. They would be going down the stairs facing backwards.

And then we have what we call the extend handle stair chair. The handles are a little bit longer both in the back and the front, but the key thing is by the handles extending out in front, that allows the lead person going down the stairs to actually carry the stair chair facing forward as they go which allows them, obviously to see the stairs and that facilitates the evacuation process.

So, here are some pictures of these being used. Here's that extended handle stair chair in the upper left corner. You can see the lead person here is facing forward. The evacuator in the back is holding the handles right behind the torso.

Now, in all of these conditions we collected data on the person who was what we called the follower position. It's the follower position that actually carries more of the weight. It's going to be the more physically demanding task as you're responsible for the torso whereas the person in the front is carrying the legs.

In the top right you see the basic stair chair. Again, the lead person here, actually Glenn, is walking down the stairs backwards. So, that control how fast one could actually descend the stairs. And then you see the manual carry, down in the lower left and the fabric seat being carried by the participants in the lower right.

You might notice there's a device on the individual's back here. That's called a lumbar motion monitor, if you look at that picture on the lower right. And that's measuring how much bending and twisting is going on in that person's spine as they're doing the task.

The track-type chairs, we had five of them. We had a chair put out by Garaventa which we refer to as the long track. Basically it's because the tracks were significantly longer than some of the others. Basically these tracks would allow three stair nosings to be bridged rather than two.

The rear-facing seat put out by Glider is a device where, as it suggests, the occupant is actually looking backwards or facing the evacuator. There's two sets of handles. There's an upper set of handles that would be used on the stairs and then the evacuator would shift to the lower set of handles and lift up, basically tipping the chair on to some wheels that are on the very front of the tracks. Those allow it would be walked around the corner when you get to the landing.

I should also note that the Garaventa has a built-in braking system and a hand brake as well. The others do not have that.

The other thing I want to point out is that with these track-type devices -- you saw the pictures going down the stairs with the hand-carry devices. Those were all carried by two people. We did the tests with the track-type devices. These were single-person evacuations and the reason was, we found that one person could do this and that would facilitate programs more people being evacuated in a shorter amount of time.

The device in the upper right which we refer to as the narrow stair chair, is put out by AOK, it's got four wheels and then tracks on the back side that when you tip back, roll it off the top of the stairs, the tracks are rolling down the stairs. When you get to the landing, you can go

on to four wheels and roll through the landing on four wheels, and then tip back again as you start the next flight of stairs.

I'm going to skip over to the standard one down below. It's put out by Ferno, which has a very similar wheel and track configuration. It's just that it's a little bit wider than the narrow stair chair. We thought the narrow stair chair could be important when we start talking about, well what if you have narrower staircases and we'll get to that in a minute.

And then we have what we call the 2-wheeled chair. And the two wheels comes from the fact that you see there's two wheels in front and there's tracks in the back. There are four wheels, but once you start going down the stairs, you fold up the back wheels and so that you're on the tracks and then when you get to the landing, you're on the front two wheels. Kind of like working a hand truck as you go around the corner and then you slide off the top stair nosing and pick up the tracks again and start going the next flight of stairs.

We had six sled-type devices in the study. The first one is what we call the roll-up. It's like a piece of plastic that has handles and straps and can be rolled for storage.

Now, one point I want to make on this is this had a system involved where you could actually loop the strap around the railing and belay the sled down the stairs. When we showed that to the firefighters, they all kind of looked at the ground and shook their head and said, well, we wouldn't do it that way. So, we didn't. We basically had the follower hold the strap. And you can see the leader in the upper left corner of the slide who is actually not doing a whole lot on the stairs but perhaps steering -- really they could push back a little bit, but primarily going down the stairs was controlled by the person on the uphill side.

The next figure to the right shows what we call the corrugated. It was basically like a waxed cardboard box with straps that would probably be the least expensive option and allowed, again, somebody to be slid down the stairs.

The third picture is what was called -- what we called the wheeled device, the real name is Subway Sled. But basically this is a device that has a whole bunch of rollers under the torso and a high friction material under the legs of the occupant that would be engaging with the ground or the stairs.

The evacuator, which in this case it's designed to be evacuated by one person, would be in front. What you do is you push down on the front to engage this high-friction material as that's your braking system, and then you walk down in front of this until you get to the landing. Then you pick up the legs holding the strap, and the rollers under the torso allow you to glide it around the corner and then you start again down the next flight of stairs.

The device on the right, the inflatable, also the real name of that is the Hover Jack put out by Hover Tech, and this is a device that it's designed so that you can inflate -- there's four chambers. For the evacuation we only inflated two chambers, but you could use this device to raise somebody up to bed level if they've fallen on the floor and transfer them. So, you might find this in a nursing home for that purpose, but it's also an evacuation tool. It has a trio on the bottom that's designed to protect the inflatable chambers and slide relatively easily across the floor. Again, it has straps for the leader and the follower to hang on to in that process.

The next device there, down in the lower left is what we call the hardshell. It was actually called Lifeslider. This is a device that, again -- it's supposed to be a single person evacuation device. It's like a hardshell sled. The occupant is seated in this not so much in a laying down position but more of a reclined, more upright, position. There is a strap that a person can put around their waist and guide it down the stairs or there is a handle behind the

backrest that you can use as well. And then once you get to the landing, there's a whole bunch of rollers underneath the sled that allow you to push it through the landing; although it really was much easier if somebody else helped steer from the front and pull it through.

And finally, the last sled is what we call the fabric mat, which was basically a mat with a cushion for the occupant that cocooned the occupant. Again, there were straps in the front, straps in the back that the leader and the follower would use to control the descent and then pull it through the landing as well.

Just some context here. We were doing this study right around the time Hurricane Sandy rolled through New York City. These were pictures that showed up on the internet of sleds being used. Now, I do have to kind of laugh a little bit at the one on the left because, well, there's a sled but they're carrying it, which isn't really the intended way for these things to be used. It's supposed to be slid down the stairs. From an ergonomic perspective, it's much easier on the evacuators to do so, and you don't need four people doing the evacuation. Two can do it quite safely.

And then you'll see there's some other people being slid around. There's a person going down the stairs in the middle picture. You can see the sled. You -- it's hard to see the person, per se, but these people are taking an occupant down the stairs. And likewise, here's somebody going down the corridor in a facility that had to be evacuated.

We think that staircase width is going to be an important variable to consider. There are codes that describe what the minimum staircase widths are based on building capacity. So, we wanted to evaluate that. We looked at a 36-inch width, a 44-inch width, and we wanted to look at 56 inches, but it turns out our staircase was only 52 so that's what we had to work with.

We take a look here, and what we have is -- the way we controlled that was he we put tape marks on the floor and said, look, you can see the black mark -- the first tape mark is basically saying that's 36 inches wide. Likewise, on the landing you could see where it's been marked out. The next one is the 44-inch width. And then the whole staircase could be used for the widest condition. On the landing we also controlled the staircase width by putting up some barriers such that it constrained the space that the evacuator had to work with.

Urgency, we considered by providing instructions given to the research participant prior to each run and the non-urgent. The instructions were you could take as much time you need during the descent. And the urgent conditions, the situation requires you to leave the building as quickly as possible. And then they would hear this repeated message as they were doing the task, "This is an urgent condition," and that would go on until the task was completed.

Our research participants came from a population of firefighters in the Columbus, Ohio, area. We had 12 subjects in each study. It turned out they were all males. Females were welcome to participate but the reality is there aren't very many female firefighters in the area. As such, we didn't have very many. Our average experience was nine years. That ranged anywhere from 1.5 to 23 years. All of our participants signed IRB approved consent documents.

As I said, our occupant was a Rescue Randy weighing 160 pounds this way we had a consistent occupant across all of our conditions.

What did we measure? We measured the duration of the evacuation. We looked at those electromyographic signals I mentioned before where we were seeing how hard the muscles are working. Specifically we were looking at two back muscle groups, the erector

spinae, which is along the back, lower back, and parallel with your spine, and then your latissimus dorsi, which as you can see in the picture to the right, connects to the spine but also wraps around the upper part of the back and actually connects to the underside of the arm. So, when this muscle contracts, it does transfer loads to the spine, but it also is used in pulling tasks which might occur on the landing, for example. We looked at some shoulder and arm muscles, namely the deltoid muscles of the shoulder and the bicep muscles to see what was going on with elbow flexion.

Our physiologic measure was basically looking at heart rate. And perceived exertion ratings, we looked at the spine motion, I showed a picture earlier that described that lumbar motion monitor. And we collected some usability information after the experiments he would do an interview with the participant.

This is what our perceived exertion scale looks like. It's basically how hard physically was this task for you. And this is essentially a scale, if you're familiar with that literature. Zero was not at all, as far as it was extremely easy. And then 10 would be very, very hard to go.

Ok. Let's talk about some results. The first thing I'm going to talk about is stair decent speeds.

First of all, with wider stairs you go faster. Ok? I'm looking at -- this is data averaged across the different devices used at the 52-inch stair width and the 44-inch stair width. We're looking across devices here. It turns out that the sleds couldn't be used in the 36-inch staircase width. They just did not make the corner on the landing. So, we didn't even test in that condition. But, you could see with the wider widths, you're able to go faster mostly because it's a lot easier to get through the landing.

Here's the stair descent speeds for the hand-carried devices and I'm just looking at the 44-inch staircase width here because that was the only width that we actually looked at the manual carry. The manual carry was very physically demanding. We didn't think it was appropriate to do that in an all-three staircase widths, so we wanted to limit the amount of exposure guys had to do that. That was a tough one to do.

What you're seeing is that the staircase descent speeds for the manual carry for basic stair chair and the fabric seat were all essentially about the same. That horizontal line above all three of those bars in this bar chart indicates that they're not statistically different. The extended handle stair chair, on the other hand, was significantly faster.

The violet-shaded area shows the range of descent speeds that had been published by others from samples looking at pedestrian descent speeds in evacuation drills. And what you can see is that the manual carry, the basic stair chair and the fabric seat are quite a ways below that range such that if those were being used, they would become part of the bottleneck in an evacuation process. The extended handle stair chair could be evacuated well within that range. In fact, it was toward the top of that range, indicating that that would not be a problem under those situations.

As we take a look at the track-type devices, focusing in on the 44 and the 52-inch staircase widths, what we see is all of those devices, first of all, are within the range of pedestrians. You could see, again, relative to the violet bar in the background. But we see that the fastest devices were the two-wheeled device, the narrow device. But, again, you could see that there's some subtle differences based on those horizontal lines above the bars. So really, the one that was fastest here was the two-wheeled device. But all of them, again, allowed for stair decent speeds that were within -- well, toward the high end of the pedestrian range. So, these would not slow down the escape flow traffic in high-risk evacuation process.

Looking at the sled-type devices, there are some differences here. What you see is that the fabric mat, the corrugated, and the rollup devices were all significantly faster than the wheeled, the hardshelled and the inflatable. You could see that those three that I just said -- wheeled, hardshelled and inflatable -- were not statistically different, nor were the first three I mentioned. But I do want to point out that you will see that even the fastest sled devices were still about .3 meters per second. And I'm just going to go back one slide. You'll see that the pedestrian range doesn't -- is somewhere around .45 meters per second. So, none of these devices were even close to the pedestrian evacuation speeds. Such that that could be an issue.

If we take a look at the heart rate data what we find is the extended handle stair chair for the hand-carried device was significantly lower than either the fabric seat or the basic stair chair. And everything was lower than doing this manually. As I said, that was noted by our participants. It could be a pretty physically demanding evacuation to do the manual carry. But the extended handled stair chair made this significantly easier than any of the other devices. If we look at the sled -- I'm sorry -- the track-type devices, the standard stair chair was significantly lower with regards to the heart rate than the others that we were looking at.

Now, something to consider here, as you see the heart rates here, this is percent max heart rate, we're -- we're in the 40% to 50% range. Going back one slide, it's about the same for the hand-carried devices but keep in mind, we're doing this evacuation with one person as opposed to two people. So, one person is doing the work of two people here and we still have about the same physiologic demands. In terms of getting somebody out the door.

If we look at the sled-type devices, this is a pretty complex chart and that's because there's the six devices and for four of those devices there's two roles, the leader and the follower. And this is color-code such that, for example, if you look at the far right, the fabric mat follower hard rate is linked with the yellow stripe bar, the fabric mat leader, the fourth bar from the right.

There's some very subtle differences here as indicated by those horizontal lines. Basically not a lot of variation in the heart rate across the different devices I mean, you could see that for some of these there were some certain elevations, and some are a little bit better. But overall I would say the fabric mat and inflatable tended to be better than the wheeled, the hardshell, and the corrugated. But the differences are small.

If we look at the muscle use, the way we characterize the muscle use was to look at the signal multiplied by the duration. That kicks into account that you may be using a little bit more muscle activity, but if you're not doing it wrong, then it's not nearly as fatiguing.

So, what we see is with the hand-carried devices that extended handle stair chair, in part because you're at higher descent speed, looks a whole lot better than the basic stair chair and the fabric seat which are equivalent. And the manual carry is significantly higher look at these back muscles. The latissimus shows similar trends but values were lower. Again, this wasn't so much a pulling task. This is a carrying task. That's where the erector spinae is going to be more involved.

If we look at the stair decent device that use the tracks, then what we're looking at is, again, the erector spinae we're seeing the standard and the long track had the lowest back muscle use. You look at the latissimus dorsi, and here we see that the long track has the lowest latissimus dorsi use. Again, keep in mind that that had the braking mechanism built in. It basically didn't require somebody to be pulling back to get it down the stairs. The narrow device had a higher latissimus dorsi and that one rolled very easily down the stairs. So,

something to consider.

This, again is just showing, ok, here's that narrow stair chair going down the stairs and the latissimus dorsi is this muscle indicated by the red arrow. And that's being used to pull back to constrain the speed of the device.

When we look at the deltoid muscle, what we find is the standard stair chair and the narrow stair chair are significantly less when it comes to working your way through the landing.

There was a whole lot of activity required with the long track and the rear-facing as those two types of chairs, even the two-wheeled chair, went through the landing. And very similar results with regards to the bicep, in particular with the rear-facing. And the two-wheeled became much higher because you're basically using your bicep to support that load as you're rolling that through on two wheels.

And this is just a picture showing, ok, here's what's going on here. This is the long track. You get to the bottom of the stairs, and what happens is you kind of have to -- the top picture on the left and the bottom picture on the left show that basically what you have to do is you actually have to lift up a little bit on the back of it to get the thing off the bottom step. And that was very physically demanding. So, that was a challenge.

The bicep gets used with the two wheels. As you can see, this guy is rolling the occupant through the landing on two wheels; so he's holding it at this angle that requires a fair amount of bicep use. And likewise, with the rear-facing, you can see it has to be kept up quite a ways and there's a lot of bicep and deltoid use to get around the corner. It has to be tipped up that far because this thing is so long, that's the only way you can get around the corner.

So, if we look at the sled-type devices, we can look at the erector spinae response, the back response. What we see is that fabric mat for the follower when you're on the stairs was actually the best. This is data going down the stairs. And then the differences between the others are pretty subtle.

If we take a look at the landing data, what we find is the biggest loads that we're concerned about are from the leader -- hang on a second.

The biggest loads are with the leader. What you find -- what's happening is it takes a lot of effort to drag these things through the flat part of the landing and it's the leader that has to do the dragging.

So, now what we have is the bicep muscles and, again, it's looking at who is doing all of the work with the biceps it's the people who are the followers here because what they're trying to do is they're trying to lift a little bit to help get this around the corner as they're going through the landing. So, basically, anywhere there was the follower role was particularly high. Although, you know, some subtle differences there.

Ok. If we summarize these measures, what we see is, ok, what are some of the positives and negatives with these things. Well, with the hand carry what we're seeing is, hey, there's -- they're less expensive. That's a positive. But there's higher physical demand and they're certainly slower unless that lead person can face forward.

With the track-type device we have reduced back muscle use and they're faster. Some of the negatives are, you know, there's more latissimus use. But when you get down to it, it wasn't all that much. So, it wasn't a big problem. And keep in mind with the track-type device -- what it should say here is this could be done by one person.

The sled-type device had low muscle demands on the stairs and certainly higher demands on the landing but transferring in and out is certainly more physically demanding.

So, there's a lot of information on this slide. This is the follow-up interviews for the

hand-carried devices. I just want to touch on a few things. Basically, the positive comments here were that they were lighter -- the basic stair chair, for example, was lighter and smaller but, hey, you had to really be careful about synchronizing with your partners going down the stairs.

The extended handle stair chair that the hands could be shoulder width apart, it was a little bit wider than the basic stair chair and that made it more comfortable and you could certainly go faster, but there were some negatives in that, ok, the width makes it a little more difficult to get around tight corners, like in the 36-inch stairwell.

With the fabric seat, it's a handy device, doesn't take up much space, doesn't take up a lot of room to get around the corner, but people were talking about their hands were hurting by the end of the trial. And you can't stop part way to take a rest if you need to. I mean, we were only going down three flights of stairs. If you had to go down a much longer distance, this could be really, really difficult. It would be very awkward to set somebody down so you could take a rest.

And the manual carry, well, you know, if you need it, it's certainly gets the job done but it would be hard to do for more than a couple of floors. It's very difficult to grab the occupant, especially if it's a larger individual. You can't see the stairs if you're the follower. And you're walking backwards obviously if you're the lead person. Again, it's very difficult to stop and rest in that process.

If we look at the track-type stair chairs what we find is the narrow chairs, as would imagine, works well with narrow spaces. It's easy to get around the corners with that device. One of the good things is it's got the four wheels so that when you get to the landing, you could roll on four wheels, get around the corner. One of the things that our participants noted is it tended to rock side to side a little bit because it had a narrower base, as you were going down the stairs, and that made some of them a little uneasy.

The two-wheel device was pretty simple. It didn't take a lot of effort to operate. It goes easily on the stairs. But, it's harder to maneuver on the corners as you're on the landing. The standard, easier to operate, again, four wheels on the landing, very easy to use as far as rolling it off the top of the landing and getting on -- picking up the tracks. That was not much of a problem. It had very minor cons associated with that.

The long track, the participants like the braking mechanism, the more controlled speed, but they found it very difficult to transition from the stairs to the landing. And many noted that the handle was too low so that they were bent in this very awkward posture.

The rear-facing, the descent was smooth. They liked that the patient was facing them so they could see what was going on with the patient or with the occupant. On the flip side, though, it's hard to maneuver because of the length. This thing is pretty long. And getting it around the corner required some extra effort on their part, took more energy.

With the sled-type devices, the two-handle straps with the corrugated were good length. But the length of the whole device made it difficult to get around the corner.
The fabric mat typically had more positives associated with it. The wide straps, good length good friction. Didn't really note any negative features.

The hardshell, they didn't note -- they basically focused on the lack of control; that it was hard to turn, the strap was too long, the slap could slip was some of their major concerns.

Likewise with the inflatable, they were more concerned with the negative features, that it was top-heavy and that there could be some rocking as you went around the corner; it's hard to get around the corner; it's bulky.

And the rollup, this was easy -- rigid material that protected the occupant. It was easy to get around the corner. But some were concerned it could slide too fast. And the long, thin strap was difficult to grip but then again it was designed for the lay operation but -- belay operation but nobody wanted to use it for that.

And the wheeled, well, they didn't like being in front of the occupant going down the stairs.

There's some data at the bottom as far as what percentage would recommend to the fire service and building owners for these different devices. You can see the corrugated for building owners, 67%. The fabric mat was pretty well. The hardshell not so well. The inflatable not so well. The rollup does ok. But the wheeled also was not -- did not do too well.

So, Glenn, I'm going to turn it over to you and you can tell us about the consumer opinion study.

>> Glenn Hedman: Thanks, Steve.

Steve covered a lot of ground and results, but just to remind ourselves that's all related to the firefighters that were in the study and especially generically the operators of the devices. We were very glad to be able to include, though, a consumer opinion piece to this study so that we were able to work with consumers and get their opinions on the same devices.

So, this consumer opinion portion of the study had two components to it. First was a survey we did with the individuals to get their perceptions of the 13 devices you've just seen in order to get their opinion on certain features, how do they feel about using the devices, things like that. We'll move on to the questions themselves in a moment.

In addition, once we had that information we offered the opportunity to try out any of the device that they wanted to for maximum of five. It would be, I think, we felt too involved to try many more than five. That decision was purely optional. Really participation in this part of the study was to just give their opinions on the devices whether they wanted to try one or more or not. If they did, however, we had a similar set of questions that we would go through to get consumer opinion after they had a chance to try out the device. And the amount of distance covered was similar to the flight and a half of stairs that Steve described in the first portions of the study.

As we made the devices available to consumers to look at, we had them all laid outside-by-side. And we would spend up to five minutes at each device. So, we went through them one at a time. And during this interview process we showed each -- consumers went through one at a time -- a short video showing the device in use. Many consumers had general impression of some of the devices, but we felt to be on an equal footing that they should have a basic knowledge of how that given device is used on the stairs. So, either used manufacturers video if those existed, cutting it down to a 60-second clip that showed the actual use on the stairs. And if the manufacturer did not have available a video, we took some video ourselves of the devices in use at the Ohio state location where the first portions of the study was done. We were able to show that 60-second clip as well. So people got a chance to look at the devices from any angle they wanted, go through the questions that we had, and see the devices in use.

We in particular, were interested in four general impressions first of all, how did consumers feel about the level of difficulty getting into or on to the device? What about the transfer out of the device, because in some cases the demands on the occupant are different transferring in versus transferring out? What sense of safety would they have about using the

device? Again, based on their impression visually looking at the device and seeing it in operation.

Sense of security they would have about being asked to use the device. Very often that related to the amount of strapping that was present on a given device. And then fourth, how nervous would they feel about using the device itself? And this is a bit different than the questions about safety because some of the responses that individuals gave to us with respect to safety were more related to how substantial the frame was, the size of the device, distance off the ground, things like that. But nervousness often related to how they felt the device would perform as they were in it and traveling down the stairs which brought in some issues that frankly involved demands on the operator of the device and were those demands, in their minds, reasonable.

You see the first bank of questions, five questions, which we kind of had a five-point scale here, five responses, regarding the transfer into the device, how difficult would it be, very defensively easy, how would that transfer out be, how safe do you feel -- would you feel riding in the device, how secure do you think the straps would hold you, and how nervous would you be. So the five responses are kind of the level of difficulty, the level of unsafety, and how unsecure would you feel or how nervous would you feel.

So that's how we framed that off. We also gave them a chance to indicate, again, based on their initial impressions, would the device we're looking at right now be considered acceptable in your mind as far as being able to be outfitted in the building that you live or work in or would use if you visited a building that required these. We'll have some results on that.

Again, the bank of questions after a ride were posed to the individual, the transfer into and out of the device and, again, the research team perform the transfers, or assisted with the transfers as necessary, and virtually all did require some level of assistance based on the design of the device. How safe did you feel while riding the device? How securely did you feel? If the straps held you? And how nervous would you be if you were asked to repeat the ride in that given device?

We added a sixth question here for the post ride survey because the level of comfort that a person would feel in the device not easily predicted if you're just look at the device but once you have a sense -- a chance to try it, you'd be able to see and comment on the comfort level of the seat, support level of the back rest, lateral support, things like that. So an added question in that case.

We also posed that question would the device be acceptable to you for use in an emergency situation? And then kind of open-ended questions in a couple of instances here. So, any issue that we weren't really covering in our set bank of questions and if the person had further opinions on it. Any device features that they saw or experienced if they tried out the device that they particularly liked or disliked. And anything else, any other ideas, maybe design features that were not present on a given device that gave people an opportunity to make comment on that.

The results, total number of participants was 14. What we did as a method of reaching out to consumers was a couple of things. Talking with the Center for Independent Living serving the city of Chicago residents with disabilities named Access Living, got permission to come into the building. That was their conference room you saw a couple of slides ago where we had enough space to lay out all 13 devices and what we did is set up shop for one full workday.

At the front desk -- we put the word out ahead of time for anybody signed up for

programs or attending a meeting or staff members if they were interested in participating, we were going to be there and they could stop by anytime. The entire participation really ranged from about 30 minutes to 60 minutes. Again, most dependent on if they wanted to try out a device.

We had a total of 14 individuals come by and volunteer. Eight male and six female. Ranging in age from 29 to 63 years with an average of just over 49. Different -- certainly different body types, body weight ranging from 106 to 365 with an average of 208.6 as you see. Wide range of disabilities also. You can see the list there ranging from amputation, arthritis, and some individuals talked with us about having multiple disabilities, stroke, diabetes, hearing impairment, low back pain, low vision, paraplegia, quadriplegia, post-polio and spina bifida and we used a -- they used a variety of mobility aids from cane to powered wheelchair or in one case bilateral prosthesis. So, a wide range of participants, a wide range of abilities, wide range of mobility devices that were used.

We want to acknowledge that this was really a first effort to reach out to consumers to get consumer opinion -- back to slide 54 here. The bins of data are not very large. We cannot comment on any pattern of responses based on male versus female or disability type or mobility aid that's used. But we felt it was a worthwhile effort to run this pilot study to begin to collect data on consumer opinion. We're kind of reporting in aggregate naturally here. It would be good to follow this up with a chance to reach out to more consumers and get more data so we can see if there's any trends based on disability or mobility aids.

So, let's talk about some results. The transfers in and out, some patterns emerged. Again, the height of the bars here reflects the difficulty in getting in and out. So, the higher the bar, the more difficulty. You see kind of a subtle spread of the data even within a given device such as the track type, two-wheeled device, ranging from four individuals -- we found it very difficult to an additional four that rate it difficult and one person that rated it somewhat difficult. So, we're not only showing sort of the total number but kind of the of level of difficulty in the responses there. And, again, the sample size here ranged from 12 to 14. We had, again, 14 participants overall in this portion of the study.

So, which devices did best as far as level of difficulty transferring in and out? The devices with the shortest bars. So, the hand-carried devices in some instances rated quite low, basic stair chair, carried as Steve mentioning and the extended handle were rated with not a great deal of difficulty or no difficulty in transferring in and out. The track type had two leaders, really the standard track type chair and the sleds, the inflatable model.

So what are some of the design features of the ones rated fairly high than the shorter bar devices? Each of these in the hand-carried and track type had firm seats and firm backs. And also, those firm seats were at a similar height from the floor as compared to wheelchair seat height. It was not a transfer going down or uphill. And going to a firmer surface, set of surfaces, I think was valued by the individuals.

In the sled category, the one that did the best, the inflatable with the shorter bar, is just a larger target area almost if you want to consider that as far as what size/surface a person is being transferred to. It's not a queen-sized mattress but it is a rectangular shape that has a lot of space on it. So, I think individuals felt like it was a more than adequately sized surface to transfer to and from.

>> Steve Lavender: Also, Glenn, it wasn't on the floor.

>> Glenn Hedman: That is true. The sleds are laying on the floor and don't have much thickness to themselves, so they are right down there.

All right. As far as safety goes, you can see some patterns as well. Again, the hand-carried extended handle version that Steve showed us early on as well as the standard track type device rated pretty well as far as a sense of safety in that fewer numbers of individuals cited any feeling of lack of safety in the sled category. The inflatable as well as hardshell gave people a sense of safety as well.

So, the extended handle hand-carried and track-type standards were kind of standard frame sizes so they didn't perhaps appear too narrow or too small to handle as they would use the device.

And regarding the sleds, the hardshell was the one with tangible, rigid border around the individual. Again, they saw example in the video. It gave them a sense of safety in that they were protected from perhaps bumping into the side wall or the landing as they went down. Again, the inflatable sled type device larger than most. And given the nature that it was inflatable implied a bit of padding if there was any contact with the walls or landing corners down there. So, those design features gave people a sense of safety as they were viewing them or using the devices.

On to the feeling of nervousness. Inflatable and the sleds did well as far as the extended handle and the standard track type as you see there. Kind of a pattern that you're seeing about the frame size and the design of the frame itself, the standard width of the seat, backrest height and certainly kind of impressive size I think of the inflatable device rather than the thin-shelled sleds or thin-fabric sleds.

So, getting to that last question, which of the devices would be acceptable to use in an emergency situation? Which ones did well? Again, the hand-carried extended handle device as well as track-type standard size, and the inflatable. Those ranked highest. Again, we're talking about 12 to 14 respondents in each of these questions. So when you get to a six or five, it's still a significant number having positive impressions about using a given device in their building. But some of the outstanding ones are circle there had which I've mentioned.

Some overall trends that we saw in the responses to the questions after people had a chance to try the devices out. I think, Steve, we've had given individuals try as many as three devices after their initial impressions were given where some people just tried out one or two that were of interest to them.

Regarding the issue of transferring in and out, responses either remained the same from their initial impression or improved a bit. Regarding a feeling of nervousness, they stayed the same or improved a bit. Insecurity as well, their ratings stayed the same or improved for that given device.

Regarding safety, there was kind of a mixed bag of results. In some instances after trying a given device a person rate it as less safe or their feeling of safety as being reduced. For five individuals their rating remained unchanged. In two instances they felt a greater sense of safety after having tried the device.

Bottom line, big picture result here, is that kind of tallying all of these responses, in about half the instances, individuals did change their mind about a given device. Sometimes it stayed the same. Sometimes their opinion got better. Sometimes their opinion got worse. But it illustrates the importance of not only knowing about all of the devices out there, viewing the training materials and the videos, but also being able to try the device out if possible. And generally the manufacturers and distributors are going try to make their devices available certainly for trial use if they're asked.

Compiling this altogether -- Steve, I don't know if you want to jump in here.

Combining the firefighter results regarding the percentage of their maximum heart rate with the consumer preference rating, that acceptability standard, kind of mixed results here. Well, are there any devices that place fewer demands on firefighters or operators of devices and are rated highly by consumers?

Steve, you want to comment on this at all?

>> Steve Lavender: Yeah. So, when you look at the data, what jumped out at us is the more you could be in the upper left corner of this array of data, the better off you are. So, you see that the standard track-type device and the inflatable sled-type device and the extended handle manual carry device were the three that are circled there, well, those had the highest consumer preference rating while at the same time tended to have the lower heart rate values, indicating that they were also best for the evacuators.

The heart rate value for the fabric mat was relatively low also but you could see that the consumer preference rating was also not very good. So when we're looking at it, we're looking at probably that standard track-type stair chair and the inflatable and the extended handle stair chair, when you combine these two criteria, start to look pretty good.

>> Glenn Hedman: Thank you.

Just to mention some limitations of the study that we recognize. The weight of the occupant in the first four aims, the firefighter participant, we again chose Rescue Randy for that standardization, but firefighters and operators of the devices are more and more being asked to handle individuals that can assist in evacuation of individuals that are significantly bigger in size and body weight, and also the short duration of evacuations going down the flight and a half of the stairs in the first portion of the study --

>> Steve Lavender: It was three flights.

>> Glenn Hedman: Considering straight run through, you're right. We weren't asking people to go down from the 10th floor down to a ground level.

>> Steve Lavender: Right.

>> Glenn Hedman: Again, significant starting point I think for recognizing the need to address the issues of the occupants and operators.

We're going to finish up quickly now with a little bit of information about the development of the performance standard by the RESNA committee. Again, I chair that committee. We've worked since 2009 on developing standards. In 2013, we came out with the very first standard which covered track-type devices what was done in the subsequent years is we've updated that such that we've come out with a brand new version that has just been approved by all parties as of about two weeks ago.

So, the key points for the new standard, 2019 version, is that the performance measures were broadened so that it doesn't apply just to track-type devices, devices of any design type can try to imitate compliance with the standard.

We also broke up the standard into two parts: One that manufacturers are responsible for, just agreement on how we refer to the devices and how we measure them, and things like that; and then their performance, how stable they are, how many weight capacity they have and things like that.

Other issues of the 2013 version, though, as far as how often they're inspected once they're in place, where they're installed, are they maintained, really are out of the purview of the manufacturers and really dependent on building managers and building owners in order to carry out. So, there's two distinct sections of the standard now so parties can imitate compliance with one or the other based on their responsibilities.

So, the 2019 version still looks at the important occupant features. Here you see myself in one of the track-type devices indicating the strapping that's present on this given device. The standard gets into how many straps need to be present, where they need to be located, things like that. Beyond that there are the important issues of weight capacity, how stable a device is, and how maneuverable is it. Section two again deals with where it's stored, is it inspected, is it maintained.

The end of that section also includes an inspection report form so that a building manager can obtain this particular section and use this form as a checklist to indicate the frequency of inspection. Again, it's supposed to be at least yearly. And if it's used during the year, it should be inspected after each use. But section two comes with the inspection results form. So, once somebody buys that, they can use that form over and over as their inspections take place.

Back to section one, regarding those occupant features, we kept the minimum weight capacity of a given device in order to indicate compliance is 350 pounds. We looked at the data for general population as well as individuals with disabilities and were comfortable with keeping it at 350.

The test method for this, though, is performed at 1.5 times that weight capacity or a loading in the device of 525 pounds. We'll go through how we do that. We're using not Rescue Randy as a mannequin or simulated occupant but the Resident WSC1 standard mannequin which is in this case constructed of aluminum plate and steel plates by wheelchair testing facilities during durability tests. There's a lot of literature that they've written up about the relative mass of the base versus the torso versus lower extremities. But we're benefiting from their research and coming up with a standard way of loading the chair. We didn't want to go with a product such as Rescue Randy because then the standard would be dependent on that being available, not changing in its design, and we couldn't guarantee that.

Here's an example of one device being tested in the weight capacity and for getting up to that 525 pounds we're allowed to add weight to the bias and the torso in order to get up to that 525. The standard weight of the WC1 mannequin is 220 pounds. So, we're taking that up quite a bit.

Starring stability, generic drawings to show because it's not a chair anymore, necessarily. It might be a sled or it might be a fabric seat for that matter. So the device, supported in a manner such that travel on horizontal surfaces of here one track device showing stability 10 degrees forward, again as traveling on horizontal surfaces and laterally 10 degrees so the device does not tip over. And, again, it's loaded with that mannequin.

The third part of stability is stability downward. So, that 32.5 degrees associated with a seven to 11-stair ratio between tread height and tread depth is what it has to be supported at and not lose contact with that surface.

Regarding maneuverability, the standard stair width based on occupancy is shown here. And the devices -- it is loaded with the mannequin. As it travels through that 180-degree turn, it is allowed to make contact with partition one, partition two, or partition three but it physically needs to be able to travel through that space which is not necessarily an easy thing to do based on the limited stair width standing size and the device size.

Key points about the new standard. Again, approved by our Standards Committee, approved by the RESNA full Assistive Technology Standards Board, and also approved by [Indiscernible] as it ran a public comment period for the new version. It's achieved all -- gone through all of those hoops. So, it's fully available right now.

I should mention it does cover device that are going to be put in place as of January 1, 2020. If somebody needed a standard applied to a device right now, they could seek out the 2013 standard, but, again, we're trying to address the future use and broaden the standard application. Again, section 1 covers the occupant features, the standards of weight capacity and maneuverability, section two going on to storage location and the inspection schedule and any maintenance on a device.

I just mentioned the application for January 1 and the different sections there. Steve has already summarized some of the pros and cons of the track type, hand-carried and sled-type. I know we're finishing up here.

We do want to acknowledge FEMA's support for the entire study that began in 2009, allowed us to do all five aspects of the study including the consumer opinion parted. And we greatly appreciate their support.

You've got our contact information as well as Yvonne Meding of the RESNA office if you're interested in obtaining a copy of the 2019 standards, you can contact Yvonne by phone or by e-mail and she will be glad to help you out.

Thanks very much. We're all set and open for any questions.

>> Lewis Kraus: Ok. Thanks. Steve and Glenn. Great presentation.

For everyone, we are getting very close to the top of the hour and we want to be respectful if of your time. It looks like if we take one question, we're going to go a little over. So, feel free to leave if you like but we're going to take one question here.

So how often do people need to be retrained on how to use evacuation devices? Do you have any input on that?

>> Glenn Hedman: Actually, the standard on section 2 does address the fact that the building occupants should be trained on the use of the device. That is suggested for new employees, basically. So the frequency of that training is not a requirement. We do kind of recommend that annually a meet willing take place -- meeting take place about the entire evacuation plan and that would include training on the devices that need -- are present in that building.

>> Lewis Kraus: Ok. Let's see. One more. Somebody just wrote me. They were also explaining -- questioning the same thing about the comfort level for a person with disabilities and were looking at -- was the mat sled type appears to be uncomfortable as being dragged on the ground or stairs and doesn't appear to have any neck or head support. Is that true? It looked to people like the mat or sled-type doesn't have any neck or head support.

>> Glenn Hedman: Steve, you want to comment on that?

>> Steve Lavender: It a mattress, a relatively thick pad, that was just under the whole body. There was no extra padding that would be under the neck or head. But in reality, you could shove a sweater, jacket, pillow, something else in there as well if you wanted it. That wouldn't have been a problem. I think it's one of those things where -- we all rode in these devices, too, because we wanted to try them out. It was one of those things where you could feel you were going down the steps. If you focused on it you could feel the stair nosing, there's no lie there. But was it terribly uncomfortable? No. Would it get you out of the building? Yes. So you kind of have to look at it that way.

>> Lewis Kraus: Great. Ok. Thank you.

All right, everyone. We realize many of you may still have questions for our speakers and apologize if you didn't get a chance to ask your question. There's their contact information on the screen. Feel free to contact them with your questions. If you have a more general question about the ADA or something that relates to this, you can contact your regional ADA

Center at 1-800-949-4232.

You will all be receiving an e-mail with a link to an online session evaluation. Please complete that evaluation for today's program as we really value your input and want to demonstrate this to our funders.

We want to thank Steve and Glenn today for sharing their time and knowledge with us. It was a great, informative presentation.

A reminder to all of you, today's session was recorded and it will be available for viewing next week at www.adapresentations.org, go into the archive tab in the emergency management section. Our next webinar will be July 11 and we'll be joined by the Office of Civil Rights and Civil Liberties, U.S. Department of Homeland Security for a presentation of their recommendations for Offices of Emergency Management after the disasters of 2017. We hope you can join us for that. Watch your e-mail two weeks ahead of time for the announcement of the opening of registration for that webinar.

All right, everyone. Thank you so much for attending today's session. Glenn and Steve, thanks again to you all. And have a great rest of your afternoon, everyone.

Bye-bye.

>> Steve Lavender: Thank you, Lewis, for organizing.

>> Glenn Hedman: Thanks very much. Take care.