

COMPLEX REHAB INNOVATION: LAUREN'S POWER WHEELCHAIR GETS SMART

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I'm always amazed and encouraged when I see ongoing innovation in complex rehab technologies, especially given limitations such as restricted funding, policies and legislation. These limitations can easily squelch product innovation – to the detriment of the end user. I believe our field needs to 'make room.' Make room for new thoughts, new designs and new interventions. Funding isn't our only limitation. When I'm overloaded with work, it is harder to stay up to date with the latest and greatest, it is easier to fall back on the familiar, the true and tried. It is easy to rush through an evaluation and my documentation. Sometimes 'making room' simply lets us step back and take the time to ensure optimal product and intervention recommendations.

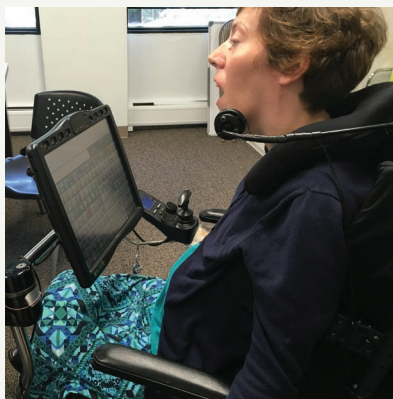


FIGURE 1

LAUREN

Lauren is a 38-year-old woman with the diagnosis of cerebral palsy. She has used a power wheelchair from a young age. Her most recent power wheelchair was a mid-wheel drive configuration with power tilt and seat elevate functions (see Figure 1). She drives using a right mounted joystick with a T shaped handle. Lauren is also able to activate small mechanical switches by her joystick for power and

mode and controls her power seating functions through the joystick. She uses a contoured back and a pressure relieving cushion. Lauren is also very proficient with a speech generating device (SGD) that she accesses using a switch mounted at the left side of her head. She uses the power wheelchair joystick via Bluetooth to emulate a mouse on her computer. Although she could access her SGD using mouse emulation, as well, she prefers switch scanning. Lauren lives with her roommate in a house with paid caregivers and her parents live close by.

THE PROBLEM

Lauren is a good driver, however, struggles in certain environments as she cannot see approximately the 180 degrees behind her or see items that are low in relation to her wheelchair. She collides with obstacles in her environment a number of times each day and this has damaged walls and doorways, as well as caused injury to Lauren (i.e. scrapes on her hands). As it is difficult for her to distinguish a curb

from the sidewalk and gutter, she has gone over these drop-offs before, and this very heavy power wheelchair has tipped over. This led to both injury to Lauren and damage to the wheelchair – as you can imagine. As a result, Lauren typically only drives when a caregiver is in the vicinity to supervise. Lauren is very anxious when driving secondary to these experiences. She tends to drive very slowly and primarily in familiar environments. She is also anxious when caregivers drive her wheelchair using the attendant control in the back – the caregivers have caused their fair share of collisions, as well!

Too many times, an otherwise proficient driver is not provided with a power wheelchair or does not drive their current power wheelchair to their full potential. Lauren could use the joystick with good control and certainly understood the task. We added tracking technologies and programmed the power wheelchair with little functional improvement. We desperately needed a better solution.

THE SOLUTION

And along came LUCI, a system that can be retrofitted to a compatible power wheelchair for the purpose of increasing safety and efficiency in driving for someone like Lauren who has motor and sensory limitations. LUCI is a combination of sensors, which are integrated with the power wheelchair electronics to specifically prevent collisions, drop-offs and modify speed as required by the driving conditions. This is not automated driving. Lauren would be in full control but would not be able to drive into detected obstacles, over an unsafe curb or into a person.

LUCI is the brainchild of two brothers, Barry and Jered Dean. Barry's daughter Katherine is a power wheelchair user and, although she is a good driver, this father was rather dismayed that such a very heavy machine could tip over, cause damage and, most alarmingly, result in injury to his daughter. His younger brother, Jered, is an engineer with a background in product development who made Barry's vision a reality in the creation of a new SMART wheelchair technology.

We were very excited about the potential advantages of LUCI for Lauren. This could dramatically reduce collisions and avoid drop-offs, as well as compensate for motor impairments, processing delays and visual field limitations. We hoped that this technology would reduce Lauren's anxiety and improve her functional driving both in familiar environments, but also beyond and into the community.

PRE-INTERVENTION

As mentioned above, Lauren had been driving a power wheelchair for a number of years. A pre-intervention questionnaire was given to Lauren and her caregivers to complete to compare current driving with future driving using SMART technologies. Here are the results:

LUCI Driving Performance Questionnaire (pre-questionnaire)

1. When using the power wheelchair, how many times a day do you (the driver) collide with obstacles in the environment?
 - a. None
 - b. 1 - 5
 - c. 5 - 10**
 - d. More than 10
 2. Has a collision with an obstacle ever led to damage of the obstacle itself (i.e. a wall)?
 - a. Yes**
 - b. No
 3. Has a collision with an obstacle ever led to damage of the power wheelchair?
 - a. Yes**
If yes, what part of the wheelchair was damaged?
armrests, tires
 - b. No
 4. Has a collision with an obstacle ever led to injury of the driver?
 - a. Yes**
If yes, please describe the injuries: **scrapes on her hands**
 - b. No
 - c. N/A, I have never collided with an obstacle
Lauren added that she has sustained injuries when her caregivers were driving the power wheelchair, including a broken toe that required an ER visit.
 5. Has the power wheelchair ever tipped over due to a drop-off (i.e. curb) or steep slope?
 - a. Yes**
 - b. No
 6. If the power wheelchair has tipped over in the past, did this result in:
 - a. Injury to the driver? No **Yes**
If yes, please list any injuries: **bump on head, scrapes**
 - b. Damage to the power wheelchair No **Yes**
If yes, what part of the wheelchair was damaged? **joystick bent, right arm pad torn**
 7. What level of supervision is required during power wheelchair driving?
 - a. None
 - b. A caregiver is in the vicinity**
 - c. A caregiver must be right by the power wheelchair at all times
 - d. I am not driving my power wheelchair at this time
 8. How do you feel about driving your power wheelchair (the driver's personal feelings)?
 - a. I feel confident
 - b. I am anxious when driving**
 - c. I am afraid to drive my wheelchair
 - d. N/A, I am not driving my wheelchair at this time
 9. How do you, as the caregiver, feel about the driver using the power wheelchair?
 - a. I feel confident when they are driving
 - b. I am anxious when they are driving**
 - c. I am afraid when they are driving
 - d. N/A, they are not driving at this time
- Comments:
- Do you have any other comments about your power wheelchair driving before trialing LUCI?
- Just a general overall feeling of unease especially near objects. When out in public, I do not drive my chair due to unknown surroundings and objects. I have my caregivers drive me.**

CONTINUED ON PAGE 40

COMPLEX REHAB INNOVATION... (CONTINUED FROM PAGE 39)

To summarize, Lauren was certainly able to drive her power wheelchair and understood the task well. However, she had a history of colliding with obstacles and even tipping over, which had resulted in injury to herself, property and the power wheelchair. Some of these issues were also a problem when caregivers were driving. Finally, these issues had led to a great deal of anxiety and hesitation when driving.

EVALUATION, RECOMMENDATIONS, AND ... FUNDING

Lauren came to the evaluation with her mom, Christy. Her supplier was Bert Lindholm, ATP, and I was the evaluating occupational therapist. During this evaluation, the team assessed Lauren's needs and ultimately recommended a new power wheelchair with power tilt and seat elevate functions, as well as new seating. Part of our recommendations included LUCI. Now, I've written a few letters of medical necessity over the years, but I knew that this one needed to include some critical information:

1. The need.
2. The recommendation.
3. How this would meet the need

Describing the need was a bit tricky. I needed the funding source to understand that this technology would help Lauren drive better, but I didn't want them to assume she couldn't drive at all and deny the power wheelchair. I needed the funding source to know what LUCI was, as this was a new and unfamiliar technology. Finally, I needed the funding source to understand that the anticipated functional benefit wasn't just bells and whistles – it was safety, and it was going to expand her world.

So, letters were written, quotes were submitted and we received an approval through Colorado Medicaid! The celebration did involve some chocolate! Eventually, everything was ordered, received, and delivered (see Figure 2). The delivery took some time, as this was so new, but everyone was quite excited!

I NEEDED THE FUNDING SOURCE TO UNDERSTAND THAT THE ANTICIPATED FUNCTIONAL BENEFIT WASN'T JUST BELLS AND WHISTLES – IT WAS SAFETY, AND IT WAS GOING TO EXPAND HER WORLD.



FIGURE 2

POST-INTERVENTION

A few issues came up during and immediately following the delivery. First, the new base clamp for her communication device mount protruded far beyond the width of the base, leading this to collide with doorways, despite LUCI, as this hardware sat above the sensors. A new base clamp was ordered, and this corrected that issue. Second, the lateral edge of each arm pad was wider than the drive wheels and so these occasionally rubbed the doorways. This was also adjusted with good results. Third, Lauren had a very unusual corner leading from the hallway into a room of the house. She was able to contact this corner with the power base as it was between the 'view' of some of the sensors. Jered actually created this corner in his design space and created a solution that benefited not only Lauren, but other drivers who may encounter unusual obstacles. It is important to note that each of these issues would have been a significant concern without LUCI and led to numerous collisions. LUCI has eliminated these collisions.

After Lauren had time to adjust to her new power wheelchair (approximately two months), I asked her to complete a post-intervention questionnaire. Here are the results:

LUCI Driving Performance Questionnaire (post-questionnaire)

1. When using the power wheelchair with LUCI, how many times a day do you (the driver) collide with obstacles in the environment?
 - a. None
 - b. 1 – 5**
 - c. 5 - 10
 - d. More than 10
2. If you experienced any collisions, was the override activated at the time?
 - a. Yes**
 - b.No

Override is a feature that allows the driver to temporarily disable LUCI. For example, to use the footplates to intentionally push open a door.
3. When using the power wheelchair with LUCI, has the power wheelchair ever tipped over due to a drop-off (i.e. curb) or steep slope?
 - a. Yes
 - b. No**
4. If the power wheelchair has tipped over, was the override activated at the time?
 - a. Yes
 - b. No
 - c. N/A**
5. Did you need to use the override feature to successfully maneuver through the environment?
 - a. Yes**

If yes, under what circumstances was override required?
Lauren sometimes used the override to maneuver around the unusually angled corner before this was addressed

 - b. No
6. If you used override, approximately how many times a day was this required?
 - a. 1 - 5
 - b. 5 - 10
 - c. More than 10** *this occurred before the updates to address the unusually shaped corner*
 - d. N/A, I didn't use override
7. What level of supervision was required during power wheelchair driving with LUCI?
 - a. None
 - b. A caregiver is in the vicinity**
 - c. A caregiver must be right by the power wheelchair at all times
 - d. I am not driving my power wheelchair at this time
8. How do you feel about driving your power wheelchair with LUCI (the driver's personal feelings)?
 - a. I feel confident
 - b. I am anxious when driving** *Lauren's anxiety persisted for a number of months post-delivery, but has been steadily decreasing*
 - c. I am afraid to drive my wheelchair
 - d. N/A, I am not driving my wheelchair at this time
9. How do you, as the caregiver, feel about the driver using the power wheelchair with LUCI?
 - a. I feel confident when they are driving**
 - b. I am anxious when they are driving
 - c. I am afraid when they are driving
 - d. N/A, they are not driving at this time

Caregiver comments:

Mom: **"I feel better with her driving now with LUCI. She is able to independently drive up and down the ramp into her van – she has never been able to do that before!"**

Caregiver 1: **"I have never seen an issue while we were out."**

Caregiver 2: **"So long as there is a caregiver with her, I am confident in her driving using LUCI. In close corners or tight turns, the sensors sometimes leave her 'stuck.' But the benefits of LUCI outweigh those sporadic occasions."**

CONTINUED ON PAGE 42

LET'S NOT GET TOO BUSY, TOO BURNT OUT, OR TOO TIRED TO MAKE ROOM FOR PRODUCT INNOVATIONS WHICH IMPACT THE PEOPLE WE HAVE THE PRIVILEGE TO WORK WITH!

COMPLEX REHAB INNOVATION... (CONTINUED FROM PAGE 41)

After receiving and adjusting to LUCI, Lauren now drives with increased confidence and is willing to drive outside of her familiar environments (Visit <https://vimeo.com/623813170> for the video of Lauren driving). She can drive in areas that she never was before, such as driving up and down her van's rear-entry ramp. Lauren has not sustained any injuries or tipped over since receiving this intervention. She initially was still colliding with obstacles, but with changes to the communication device base clamp, bringing in the arm pads and further programming to address an unusually angled corner, Lauren very rarely contacts anything with her power wheelchair – unless she chooses to use Override. I think she likes this option.

The LUCI system also tracks data if the client provides permission. In a one-month period recently, LUCI recorded 571 collision interventions, 17 drop-off interventions, 0 tip warnings, and 190 overrides. That is an average of 19 collisions avoided per day – and Lauren is a good and very careful driver! I believe Lauren has had more potential drop-offs than before receiving LUCI, as she now regularly drives up and down her van ramp. She didn't do this before for fear of going over the edge of the ramp, however LUCI allows her to do so safely. Finally, as the data indicates, Lauren loves using the override feature. She likes to 'take over' at times, even when the system is intervening to prevent a potential collision, and that is entirely up to her – as it should be.

CONCLUSION

Without new technologies, Lauren would have still received a new power wheelchair. She would have been able to drive around familiar environments, albeit with some anxiety. I would have had a straight forward letter of medical necessity to write. But we made room ... room for a Dad and Uncle to dream and invent something better,

room to consider a new innovative technology that made Lauren's new power wheelchair smarter, room to facilitate a new driving experience for Lauren that is expanding her world beyond the four walls of her home. Let's not get too busy, too burnt out, or too tired to make room for product innovations which impact the people we have the privilege to work with!

Dream on.

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Michelle Lange is an occupational therapist with more than 30 years of experience and has been in private practice, Access to Independence, for over 10 years. She is a well-respected lecturer, both nationally and internationally and has written numerous texts, chapters, and articles. She is the co-editor of "Seating and Wheeled Mobility: A Clinical Resource Guide," editor of "Fundamentals in Assistive Technology, Fourth Edition," NRRTS continuing education curriculum coordinator and clinical editor of DIRECTIONS. Lange is a RESNA Fellow and member of the Clinician Task Force. Lange is a certified ATP, certified SMS and is a senior disability analyst of the ABDA.