Kate Turley, Chroma Lighting

and

Lynne Green, Kirk House Care Home, Belfast

Innovators in Healthcare Presentation

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Transcript

Kate Turley:

Good afternoon everyone and thank you very much for having us here today to present at Innovators in Healthcare. Lynne and I are here at Kirk House Care Home in East Belfast and will give a two-part presentation today.

So I will talk from Chroma Lighting's point of view regarding the design of the Daylight Simulator Luminaire and Sensor, how we trialled this and some of our preliminary results and then we'll go on to introduce Kirk House Care Home and her experience with piloting the technology, both from the aspect of care staff and from the residents themselves.

I'm sure all of us here are familiar with the benefits that daylight has on human health and well-being. In terms of well-being for people living with dementia, particularly in the context of light and studies, when we talk about well-being, we refer to aspects of well-being that light impacts, so agitation, mood and depression, sleep-wake cycles, and rest-activity.

Often these will be measured with tools such as the Cohen Mansfield Agitation Index, the Pittsburgh Sleep Quality Index, and various other quality-of-life

scales. But in the last decade, there has been a rise in the use of sensing technologies. Commonly worn will be wrist-worn accelerometers, which can monitor rest-activity cycles and cameras, which monitor fall detection. However, there's a privacy issue with passive infrared and technology for mobility and activities of daily living. Also, we have pressure sensors to monitor sleep, wake cycles and falls. But with people who are living with dementia, because they are a vulnerable cohort, they sometimes have issues with having a piece of equipment on their person.

So, we need to find ways to monitor their well-being without increasing levels of agitation. In terms of the gold standard I'm monitoring well-being in terms of light. Melatonin suppression is the gold standard measure, but this comes from saliva samples, so it's not always feasible to collect.

With Chroma Lighting's help, we wanted to be able to test daylight-simulating luminaires, but also to be able to monitor well-being in terms of sensing technologies that are going to be unobtrusive. So we decided to use ceiling-deployed sensing devices and luminaires to monitor this.

Here you can see our prototype technology. We have quadrant LED boards that are both dimmable and tunable white, so they have both cool and warm channel outlets so that you can change the colour temperature and the lighting intensity throughout the day. In the centre of the device is a central armature with a millimetre wave radar sensor.

So, we're able to monitor the 3D positional coordinates of a person over time in relation to each luminaire. On board is a Bluetooth low-energy module, which allows all of the luminaires and sensors to talk to each other in a mesh network. Then, we place a Bluetooth low-energy gateway within the care home to harvest all of the lighting information, as well as all of the sensor information.

At any time, we can see what the lighting output is and what the resident behaviour is and analyse it on a local server. So we programmed the daylight-simulating cycle as the same for every resident from the hours of 7 in the morning until 6 in the evening, and we had higher-intensity, cooler lighting during the day with lower intensity, warmer lighting at night in terms of the sensor component.

We had a 3D depth penetrating sensor, which shows the positional coordinates of a person over time. We can see their X, and Y translations, but we also have insight into depth. For future iterations, we will be able to monitor fall

detections. As an example, in the grid here, you can see when a person is sitting or when they're pacing in a circle.

And because it's just following a point coordinate, it's privacy-friendly. When talking about sensing technologies and previous light and studies, as I mentioned before, there are wrist-worn accelerometers that are typically employed to monitor rest-activity, and some of the metrics that they pick up are inter-daily stability, inter-daily variation and relative amplitude.

What we did was create algorithms that basically can create the same metrics so we can compare the studies. So we have algorithms that monitor the rest-activity of the residents. There are time in bed metrics: How much time they spent in bed during nighttime hours, how many disturbance kinds they had, and how long these disturbance points would have lasted alongside location trajectories.

So again, if we know the output of the light in terms of its intensity and colour temperature, and we know the location of the resident with respect to the light fitting, and whether or not light switches are turned on or off, we can get information on the relationship between light and well-being for each resident.

In terms of the Chroma Lighting side of things, this was our lighting design concept. So we have that integrated device, luminaire and sensor. And then we wanted to be able to test it in a care home so we could see how this works in a real-life environment, which is where we came on to the collaboration with Lynne and Kirk House.

I'll pass on to Lynne to talk a little bit about this.

Lynne Green:

Over the years, Kirk House has participated in a few studies with Ulster University, all of which have to do with innovation in care. In 2019, Chroma Lighting and Kate contacted Kirk House and myself about a study to do with lighting design for people with dementia.

And we were immediately intrigued. After meeting with Lloyd from Chroma and Kate and seeing what they could do and how it would benefit people in our residence with dementia, we agreed to go forward with the study. We delivered a group discussion with staff and relatives and Lloyd and Kate delivered a fantastic presentation to explain the benefits and what was expected from all involved.

Kirk House is part of BCA Belfast Central Mission, which is an agency of the Methodist Church. Belfast Central Mission was founded in 1889 as a response to problems from inner Belfast and all to do with inner city life. Today, BCM continues to meet the needs of the whole person, spiritually, emotionally, socially, and physically, regardless of class, creed or religion.

Its current services include community services, housing support for young adults, housing support for young people aged 16 to 25, housing support for older people, which is us here at Kirk House and also in Copelands, therapeutic counselling, accommodation for older people, parent support projects, and we do Christmas programs and volunteer programs throughout.

Kirk House itself opened in 1993. Specially designed so that residents felt that they were in their own homes and not just a bedroom. Our values are excellence, respect, integrity, and people, and people-centered. We have 42 flatlets which house up to 46 residents. In 2014, we opened Memory Lane, a nine-bed dementia unit delivering person-centered care.

When designing Memory Lane, we consulted with Stirling University's recommendations in dementia design, and we received the gold standard award for dementia design that year. We also developed the Buttons model of care, delivering person-centered care in a household setting.

We are also the first dementia care unit in Northern Ireland to use music and memory therapy. All our staff have been trained in best practice in dementia care through Stirling University.

Kate Turley:

In order to trial our technology within a care home, we had to go through OREC NI, so the Office for Research Ethics Northern Ireland. We recruited via Lynne, who was the gatekeeper, who then recruited the participants and family members. We also gave them information sheets and consent forms. Finally, in the end, we had 13 people who expressed consent, but 11 participants were included in the analysis.

We did a 16-week trial. So, the first four weeks were a baseline study in which we kept the pre-existing lighting levels the same. So we kept the same colour temperature and illuminance as well as the preexisting light fittings for 4 weeks. For the following 12 weeks, we introduced daylight-simulating lighting. For each of these weeks, we asked care staff to fill out a quality report, which is the quality-of-life scale for people living with dementia, so that we could have a

comparison of static lighting versus dynamic lighting. Here you can see the floor plan, as Lynne described earlier: each of the flatlets have a living area, a bedroom, and a bathroom. In each of these, we placed one of our devices with both the sensor and the luminaire and a Bluetooth gateway close by the luminaire to access all of this information over the air.

Here is an example of what the installation looked like. So if you look on the left-hand side, these were the old fixtures in each of the flatlets in Kirk House. So I think the colour temperature here was about 3000 kelvins. We matched this with our light fittings at the beginning of the study. We had to do this instead of keeping the original light fittings because we needed the sensor component in order to collect that data.

In the image on the right, you can see the difference between different times of the day and the phase of the cycle the lighting is outputting. So at noon, you can see that it's at a cooler colour temperature with higher intensities. Similar to the midday blue sky and both at dusk and dawn, you would have had these warmer colour temperatures with lower illuminances.

The sensor was able to collect the nighttime metrics so we could get an insight into the total time that was spent in bed during the nighttime or any kind of disturbance - any times they left the bed and the total amount of time that these disturbances occurred for. And again, this is from the sensor algorithms that we created. So we could identify the bed location and then identify times of exits and entry points and count for how long those lasted.

In terms of activity, from our radar sensor, we were able to create a knowledge domain, we were able to create algorithms to get these inter-daily stability, inter-daily variation and relative amplitude metrics.

Again, these give us an insight into wrist-worn accelerometers and similar metrics that we could publish. It also gives us an idea of how well-aligned your circadian rhythm is with the light-dark cycle. And then, finally, we have the well-being scales that I mentioned earlier.

They were collected once a week for 16 weeks, both during baseline and intervention weeks, to understand aspects of well-being that we couldn't get from the sensor. For example, care relationship, positive affect, negative affect, low mood, restless behaviour and social isolation.

What we were able to find from our preliminary findings was that the median number of nighttime disturbances decreased, the median by length of nighttime

disturbances also decreased and median total amount of sleep in hours. But it should say the total amount of time spent in bed because we can't assume they were asleep. That increased by 45 minutes from baseline to weeks 5 to 10 and increased by 27 minutes from baseline to weeks 10 to 16 in terms of rest-activity patterns.

These patterns were very heterogeneous between individuals, but we can see that there was a statistically significant improvement in all three of these aspects from baseline to weeks 5 to 10 and from baseline to 10 to 16. There was also a statistically significant improvement in the inter-daily stability.

In terms of the Qualiderm results, so the well-being scales that we asked our staff to fill out, we find a statistically significant improvement from baseline to weeks 5 to 10 of three of the parameters. So these were positive affect, so positive mood, and was social isolation - there was a reduction in this, which we can also see from the location trajectories of each individual who were spending more time in the common areas and also H, which is a sense of feeling at home.

So there was an improvement in that as well.

So our initial analysis from this 16 week trial was that dynamic lighting in this context does have the potential to support wellbeing and dementia with seemingly stronger influence in earlier weeks, where the dynamic lighting initially follows the static lighting and then it continues to aggregate as marginal gains over time.

So we seem to see this biggest contrast as soon as we put the dynamic light in and the biggest improvement, and then it continues to improve at a slower rate.

I'll pass on to Lynne to talk a little bit about effects on residents.

Lynnee Green:

So our positive effects were our residents were more settled during sundown in ours, which previously we had great issue with. We're having less residents up through the night distressed. Our staff feel that they have a better relationship with the residents.

And residents are more focused during activities. Any negative effects could be because the lighting is temporary. There have been a few issues with light switches as they’re Bluetooth, which can cause a delay in transmission. Two of

the light fittings were further away in the building, so the signal wasn't that great.

The idea of this kind of lighting is amazing and the explanation and delivery have been outstanding, ensuring that everyone from staff, Residents and relatives fully understood the aspects of it and what we were hoping to achieve.

One point I would like to make is that I feel this lighting needs to be in place when a care facility is being built and not just as a temporary measure.

There are no limitations, as time was built in at the start of the study to resolve any issues with the lighting. I would recommend the use of daylight-simulating lighting to assist sundowning and the natural flow of the day. Our experience with the collaboration? Very positive one. We felt very well supported from the start and it's still going on.

Kate Turley:

In terms of the future for lighting design for dementia, I believe that we need to include people living with dementia in aspects relating to their lighting. There's a 2024 position statement from the CIE, which states that we need to do a lot more research on integrative lighting, particularly for the aging generations.

So I'm looking to do a study that includes people living with dementia and interviews to talk about their interaction and their perspective of lighting so that we can better inform lighten policy for their future.

Lynne Green:

And I would love to see this kind of lighting in all care homes. I don't feel it needs to be just based on dementia care I feel even from this study, I myself have made changes in my own home.

Kate Turley:

Thank you very much for your time and attention.

John Bullock:

It's just it just warms the cockles, doesn't it? It's absolutely wonderful, just fantastic experience out there. It's a shame that it's a temporary one and we just want it to be there forever!

Shelley:

So Sarah has kindly asked whether this was just a one-off or if it's going to be there for a while.

Kate Turley:

So initially, we had put our ethics through for the 16-week study, that four-week baseline and 12-week intervention.

But after the study, we went back to Lynne and had many more ideas about extending it over the season so we would have summer and winter data as well: when we initially put it in, it was from March to July. So we wanted to do a longitudinal study and see if what we saw initially, like marginal gains over time would continue into the winter season.

So we put an amendment in for the ethics with Lynne's permission because she was happy enough with the technology, and we've extended it now for a 3-year period. So now, I have permission to be in there both from ethics and from Lynne's point of view until July 2026.

Shelley:

Perhaps you could just share a little bit more about where you see that going and maybe how the collaboration with Lloyd is going?

Kate Turley:

Yeah, for sure. So what I probably didn't show you behind all that architecture is how the light and the sensor actually connect together.

So we have a light and API. There's a lot that we need to learn about different parameters and how they affect lighting. So we have the existing infrastructure there and architecture where, when we know more about it, we're able to, based off sensor responses and being, so rest-activity and sleep-wake cycles, we can push demands or rules out to the lighting, so that we can change different aspects of its intensity or its colour temperature.

So we have that infrastructure in place. It's just we haven't implemented any of the changes yet because initially, this was a 16-week project, and we don't know enough at the minute until we gather that sort of baseline data on the long-term. I think if we have it until July 2026 and we have maybe over a year's worth of information and we see we can cluster information based on say, rise times or sleep times and we see common patterns, then possibly we can implement by that architecture, these outputs in the lighting.

But the difficulty is again that this study is based on 11 residents within one care home. It comes back to funding and making these larger-scale trials so we get more information so we know what we're doing when we're making changes to the lighting because at this point it's ‘okay, I have an inference, but is it actually evidence-based yet?’

Lloyd Crawford:

Basically I started up Skyjoy as a separate company to develop this technology. Skyjoy was started by Dr. Pamela Topping and I, and the idea is to bring it to market worldwide. So the data we gather from the sensor will feed into our understanding of human response to light. Then, we can use the system that we've got using reliable Bluetooth technology and feed that information back to the luminaires. And hopefully, improve our our luminaire's performance for people living with dementia.