Notes from conversation with
Jim Greenberg, Richard Lang and Robert Soler
Cincinnati Children's Hospital Neonatal unit
21 June 2021

Introductions

Dr. James 'Jim' Greenberg
Co-Director, Perinatal Institute & Director, Division of Neonatology, Cincinnati Children's Hospital, Professor University of Cincinnati Department of Pediatrics He leads one of the largest comprehensive clinical and academic programs for newborn care in the United States. He is also Professor of Pediatrics and has been an active teacher, researcher and clinician for over 30 years. He's fascinated by the way that genetic and environmental factors, including light affect NICU outcomes. Since 2016 Dr. Greenberg has also been Lead Physician overseeing construction of the Cincinnati Children's Critical Care Building. This $650 million dollar 630,000 square foot project is set to open in the Fall of 2021.

Dr. Richard Lang
Richard is a Professor within the Division of Pediatric Ophthalmology at Cincinnati Children's Hospital Medical Center. He directs the Visual Systems Group at Cincinnati Children's and has authored or co-authored more than 120 research papers, including many related to eye development and how light interacts with cells beyond the eye.

Robert Soler
Robert is Vice President of Biological Research and Technology at BIOS Lighting. Prior to his work with BIOS, he worked with NASA to help to design and build the lighting system on the International Space Station designed to synchronize circadian rhythms of astronauts.

Dr. Greenberg has been working closely with Dr. Richard Lang and Robert Soler, to develop a biologically aware, tunable lighting system so that they can look at how changes in circadian stimulus and spectral intensity affect growth and development.
This new tool for research will be running alongside the day to day patient care in the new building.

Context

Jim Greenberg

Over the course of my career practicing neonatology for more than 30 years, I've always been concerned about the environment in which we place our patients. These are very vulnerable patients, many of them born many, many weeks before term and many who have other complex medical and surgical problems.

We always focused a lot on their thermal environment, making sure that they were kept at appropriate temperature, but we never really thought very much about other inputs such as sound and light.

I had the great fortune to know Richard for many, many years now. And I have always admired his work. Not just because it focuses on neonates, but because it's extraordinarily creative and important. The biology is really profound and very special.

When we made the decision to build this new building, we recognised that there was an opportunity to do some things that would reinforce our culture of using research and discovery to care for our patients and incorporate that into the design of this building, which houses our critical care programs.

So early discussions with Richard confirmed that this was a compelling opportunity - our passions compliment each other very well. We were at the right place at the right time to make this happen, and it's been a very, very exciting journey.

New discoveries in light and neonatal health

Richard Lang

This was a remarkable coincidence. It's not very often that an institution puts up a new hospital. I learned that Jim was responsible for this just at the time that my lab was producing all these interesting new findings about opsins sense light and modulate mammalian physiology. So, we would have these conversations about how these two things might converge and realised that we had this remarkable opportunity to change this building for the better

The experimental data we have right now is all preclinical. A lot of the work has been done using the mouse model system: the mouse is a really good model system for mammals like us. So there are quite a few things I can tell you already about what we expect:

Light and growth

The data we have so far argues that violet light and blue light combined are actually going to regulate the way an infant grows. So one of the really unusual findings has been that the opsins that are sensitive to blue light and to violet light regulate our metabolism. One of them is expressed in our fat cells. One of them is expressed in the middle of our brain and they appear to combine forces to direct growth and metabolism.

And one of the things that Jim's been saying to me over many years now is that for a premature infant, for a newborn, or particularly for a premature infant, it's a crucial clinical question to get them to grow effectively.

And so one of the expectations here is that with this new lighting system and with our understanding of the way different wavelengths work to stimulate metabolism and growth, we may be able to improve that particular component of care for these newborns.

Light and neurological development

I would come back to this question of neurological development. It turns out that Opsin three is expressed throughout the developing brain. There's no solid data yet arguing that it's a light sensor, but there are a lot of neurological diseases that have this fascinating phenomenon of season of birth-dependent risk of disease. We don't know why that is, but one possibility is that neural development is partly light-dependent. That's a really interesting question to address using this new building.

Jim Greenberg

Questions about the impact of light on development are going to come up again and again. It provides a fascinating opportunity to understand human physiology. The newborn population is an ideal population because there's a huge need.

Light and susceptibility to infection

Clinical studies at the University of Pennsylvania, for example, have learned that even just cycled circadian lighting affects susceptibility to infection in newborns. And we've also appreciated that babies born early are deprived of any circadian signals that they might be receiving through their mother as well as directly from the environment.

And we know here right now, in the unit that we're about to move out of - as well as many neonatal units around the world - that the quality of the lighting is very, very low. There are basically no violet or blue wavelengths generated in any meaningful way.

So we're creating an environment that's very unnatural right now for our patients. And this is an opportunity to ask whether providing a much more realistic, natural environment where we evolved over billions of years, is going to matter. And of course we, we predict and hypothesise that it will.

We in neonatology have made wonderful progress over the last 30 years learning how to provide appropriate nutrition for babies to help them support their growth. But there are still gaps. And we we've appreciated for a while that we don't have good solutions to optimising growth and not just linear growth or weight gain, but brain growth as well. And we know that babies in those situations are more likely to have learning disabilities, psychiatric issues and other problems as they get older. And that's been a mystery of neonatology about why that happens for a long time.

So having the lights in the building allows us to ask that. And move beyond mice. So it's incredibly exciting.

The opportunity - beyond circadian lighting

Richard Lang

The architects initially asked 'Do you want circadian lighting in your building?' And of course the answer is yes, because the benefits of circadian lighting are very clear already. But then we realized we had this much larger opportunity.

When I first met Robert it became clear to me very quickly that he understood the biology and that Bios under his direction was generating lighting systems that were designed to be biologically aware.

There just aren't that many people or companies that can do this. This association is really crucially important to this project.

The budget - $650 million project, $1.5 million lighting R&D

Jim Greenberg

I preface my response by sharing a little bit about how we approach the design of this building. We started by creating a covenant and a list of guiding principles that would address how we design the building. And how we would work together to complete the building. An intrinsic part of our culture at Cincinnati Children's has to do with the direct connection between discovery-based research and patient care. We believe that one can't happen without the other. So even though this was a building that will house patient care, it's also a building that has to support our culture of research and inquiry, because that leads to the best clinical outcomes.

So with that principle in place, the idea of investing in a lighting system, like this becomes very clear. It's not an add on or something that's out of the scope of the building. It's something that's intrinsic to the guiding principles of what we're trying to accomplish. And. Therefore, because we, we really did this from the beginning of design, we were able to incorporate the design, the process and the development process for the lighting system, into the overall budget of the building.

This is a building that is on time and on budget. And when it's all done, including an upcoming renovation phase will be about $650 million.

And the fraction of that expense that's associated with the lighting is actually a little difficult to figure out because it's, it's embedded in all of the design, but we estimate that we probably invested north of a $1.5 million in developing the system from the early design work, through the specific engineering work and the software development and so on and so forth.

That's a different question than the question about how much does it cost to put lights like this in another hospital or another setting. And that's a bit mysterious. I don't mean to sound evasive. But it's probably in the neighbourhood of 10 to $50,000 a unit.

We're still trying to figure that out. At the end of the day, this ought to be a little more expensive than standard lighting systems and lighting solutions for hospitals. But not dramatically more expensive.

And I say that in part, because from the beginning, we've intended to use this as a research tool that will allow us to ask really important questions about human development that are not going to be very easily answered in other clinical settings.

There will be extra funding in the form of research grants and so on that will support that work. So it's a long-term investment.

Cost is always in the eye of the beholder.

Looking ahead - applications

Robert Soler

The reason why I'm still involved in this project is because they're asking all these hard questions and once they arrive at answers, I take that and turn it into a technology, distill it down to something that is super simple, super easy to use - that doesn't require a Dr. Lang to run it and and is cost-effective as well.

This is a very exciting development that's going to come out of Bios - the idea that we can use all this new information about biological responses to light and particularly to violet light. We can use this to design a lighting system that everybody can install in every building.

And so, one of the goals in our collaboration is to generate lighting systems that can be used in any kind of facility, whether it's, a business or a residence, or maybe a hospital that isn't a research hospital.

Schools in particular are really important for some of the biology we're talking about. So the collaboration is designed to generate lots of different types of lighting systems that are very reasonably priced and can be used by everybody depending on the specific setting.

We're very excited about that because we think we can bring a lot of health benefits to a lot of people.

Jim Greenberg

If science is done well, it will be exportable and reproducible and valuable in very general and broad ways. And our thinking always about research is that whatever new knowledge is created from that research has to be shared.

So that's been our, certainly our goal from the very beginning - that this is something that is exportable and what we're doing is creating a tool that will teach us how to do that.

And it is a tool we've designed to grow with the building. The software and other things can be modified so that we can continue to learn in the same way that the Mars Rover was supposed to last a year and it's still going.

And I would like to think that the lighting system is going to be something that will keep going for a long time.

Contact -
Dr James Greenberg: james.greenberg@cchmc.org
Dr Richard Lang: richard.lang@cchmc.org
Robert Soler: rsoler@bioslighting.com
Dr Shelley James: shelley@ageoflightinnovations.com