

# KLARO™: Bringing Surgical Lighting Out of the Dark Ages

An innovative in vivo LED lighting device has been developed to overcome the shortcomings of surgical lighting, illuminating cavities from the inside to avoid shadows and provide wide-angle illumination.

Professor N Gopalakrishna Iyer, Head of the Department of Head and Neck Surgery at the National Cancer Centre Singapore and Singapore General Hospital, discusses the collaborative project between surgeons and engineers that led to this innovation.

Dr Gopal Iyer graduated top of his medical school class at the National University of Singapore (NUS) in 1998, with Honours. He subsequently went on to complete a PhD in molecular carcinogenesis at the University of Cambridge under Prof Carlos Caldas. Trained as a General Surgeon at Singapore General Hospital he went on to complete two separate head and neck surgical fellowships at Sydney Head and Neck Cancer Institute at Royal Prince Alfred Hospital, Australia and Memorial Sloan-Kettering Cancer Centre (MSKCC), New York, USA. At the end of his fellowship at MSKCC, he was awarded the Michael Burt award for being the best fellow in the surgical division both in terms of operative skill and research output.

Currently, Dr Gopal Iyer works as a Head and Neck Surgeon in National Cancer Centre and Singapore General Hospital. He is also Senior Consultant of the SingHealth Duke-NUS Head and Neck Centre. Dr Gopal has extensive experience in the surgical management of head and neck cancers, as well as surgery for benign diseases in the head and neck (including thyroid, salivary gland and skin lesions). He performs complex resections and reconstructions of cancers involving the oral cavity, oropharynx, larynx, hypopharynx, nasopharynx, paranasal sinuses and neck. He is also involved in the robotic and endoscopic head and neck surgical program at his current place of practice, having performed a number of these procedures locally and mentored the first ever robotic thyroidectomy in Australia in Feb 2012.



**Professor N Gopalakrishna Iyer**  
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Surgeons need sufficient illumination to perform operations to the best of their abilities, but inadequate lighting has been identified as one of the largest shortcomings in operating theatres<sup>1</sup>. Lighting is more than just brightness, surgeons require a solution that reduces glare and shadows, offering uninterrupted vision to allow them to concentrate for long periods without fatigue or eye strain. Vivo Surgical embarked on a mission with SingHealth and Panasonic Lighting (Europe) to develop the KLARO™ in vivo lighting system, a flexible LED light strip designed to give an optimal view of the surgical cavity by illuminating it from within.

Dr Gopal, a key contributor to the project, outlined its origins: “The limitations of popular surgical lighting options are not often thought about, as the same methods have been used for many years, and surgeons are simply forced to work around these shortcomings. Instead, it took an

outside view to highlight this issue. A multidisciplinary engineering team visited our hospital, and followed the activities of surgical teams to identify when novel technological solutions could be used to overcome the routine challenges we face every day. This team identified 111 areas where innovation could benefit workflows, and determined surgical lighting to be the most important area to improve on.”

## Shining a light on the limitations of surgical lighting

“The majority of my work is comprised of cancer surgery in the oral cavity,” Dr Gopal commented. “As you can imagine, it’s like trying to operate in a small, dark cave. The traditional boom-mounted surgical lights hanging from the ceiling do very little to illuminate this cavity and can cast shadows that create uneven spots of darkness. In addition, surgeons never operate alone and – in a busy teaching hospital – are often surrounded by fellow consultants, registrar or medical students, making for a busy

operating suite. Sadly, the downside of this is that there are usually a lot of bodies blocking the major source of light. In the few instances where light is plentiful, the abundance of polished metal and other reflective surfaces in an operating theatre can cause constant and uncontrolled glare, increasing eye strain and fatigue.”

“Wearable headlights were introduced to overcome this, as they allow the surgeon to focus the light on the site of interest, but these often cause as many problems as they solve,” Dr Gopal added. “Usually, the primary surgeon is the only person that wears a headlight, which means that as soon as the surgeon changes focus, the main light source is taken away. This may be a good solution for the person that wears the headlight, but not for the rest of the team who will have interrupted vision. The headlight also sits just above the eyes, which is uncomfortable for any surgeon, and can make it difficult

to concentrate. This becomes a particular hindrance in situations requiring surgical loupes, for example, as having multiple pieces of equipment on your head for long procedures can be exhausting. Too many surgeons are still relying on 20th century lighting systems of ceiling lamps and headlights for 21st century surgeries, and it's time we make the most of modern technology."



### Breaking the status quo

"Optimal surgical lighting should offer sufficient illumination without going as far to cause uncomfortable glare or strain, and this is where the idea for the KLARO™ in vivo lighting system came from," Dr Gopal continued. "This device is a sterile, single-use LED strip, offering four hours of constant illumination from inside the surgical cavity<sup>2</sup>. The concept is simple – it makes far more sense to illuminate a cave from the inside, rather than trying to get light in from the outside – but the design was far more complex. We worked closely with the engineering team to create a product that would meet the needs of a busy, but varied, operating theatre for a range of different procedures, from head and neck to pelvic surgeries. Each team brought something to the table; the engineers shared their

wisdom on what technologies are available, and we were able to give first-hand information about the limitations of surgical lighting, ensuring that the system would be tailored to address these pain points."

"The design process was very iterative as, with each prototype, we realised more of the challenges of surgical lighting, then looked at how these could be overcome. Very early on, we moved away from spotlighting towards floodlighting, which would light up an entire area rather than a particular focal point. Flooding a surgical cavity with light provides wide-angle illumination and minimises shadowing, and a flexible LED strip was the best and most efficient hands-free approach to achieve this."

### Safety first

"Safety is paramount with any piece of surgical equipment," Dr Gopal explained. "It is often assumed that the brightest light provides the most clarity, but this is rarely true. In fact, for long and extended procedures, bright lights can be tiresome, and lower light intensities can help the surgeon to focus. For example, it can be challenging to distinguish the margins between normal and tumour tissue when they are brightly lit but dialing the light down slightly can show the interface much more clearly. Similarly, a warm, white colour light was determined to be the best choice for distinguishing between anatomical features, as this shows the surgical site in the most natural colour possible. KLARO™ therefore offers varying light intensities, which allows the surgeon to choose the optimal light intensity based on their own preferences and

the size of the space that they are illuminating. In addition, the advanced LED technology maintains a safe operating temperature of below 38 °C – regardless of light intensity<sup>2</sup> – making the system ideal for in vivo use."

### Creating surgical lighting equality

"Another key requirement of surgical lighting solution is flexibility, as we not only need the device to be suitable for the different procedures, but to also address inequalities in operating theatre resources. A rigid light could not account for the varying shapes and configurations on a human body, but a flexible strip can mould to different openings, and be used across various surgeries. The system is also self-contained; its four-hour battery pack can be easily attached to surgical drapes or placed next to the patient, meaning that the surgeon is free to move without having to traipse a lighting source around the theatre. This also means that surgeons can take KLARO™ into any operating suite, regardless of the resources that are already there, and know that they will be equipped with sufficient and safe illumination, bringing equality to surgical lighting everywhere," Dr Gopal concluded.

#### References:

1. Knulst AJ, Mooijweer R, Jansen FW et al. Indicating shortcomings in surgical lighting systems. *Minim Invasive Ther Allied Technol.* 2011;20(5):267-275. doi:10.3109/13645706.2010.534169
2. KLARO-18-027-09 IFU English



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