Technical Note: M65000

Improving Visual Ergonomics of Tissue Embedding

Examination of pathology lighting conditions at embedding and an embedding center innovation

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Introduction

Pathology labs are constantly asked to improve productivity even as experienced personnel become harder to find. Accordingly, new generations of instrumentation increasingly focus on issues such as workflow and automation.[1,2] Preparation of pathology samples remains, meticulous work, however, involving fine motor skills and histology expertise. Because this work requires intensive staff input, there is an increasing awareness of the importance of ergonomics.[3] Innovations that improve productivity and usability while keeping costs in line are essential for new generations of instrumentation.

The new Thermo Scientific HistoStar embedding workstation was designed especially to improve the user experience. The HistoStar embedding workstation has an innovative, uncluttered, ergonomic work surface; it has high capacity and a unique lighting system that is integrated into the paraffin dispenser. To better understand lighting conditions in the pathology laboratory and how the HistoStar embedding workstation affects histotechnologists during embedding, a national study was conducted to determine actual lighting conditions in pathology labs and on the critical work surfaces of current embedding centers. The study found that a surprising number of laboratories have inadequate lighting and helped identify ways the embedding process can be improved with new innovations.

"The new HistoStar embedding workstation utilizes every opportunity to improve the user experience."

Lighting Ergonomics

Why lighting is so important? With sufficient illumination, it is possible to see clearly and make adjustments in lighting that signficantly impacts productivity. Rigorous studies have quantified the impact of specific lighting factors[4], and even subtle differences in types of light have a significant impact on human behavior, feeling and productivity. Researchers viewing "blue-enriched" white light, for example, light showed significant improvements in alertness and performance.[5]

Comprehensive studies confirm eyestrain causes and illustrated how quickly and easily negative symptoms can emerge.[6,7] While most standards are set to provide minimal acceptable lighting, other research has demonstrated that more light may increase incrementally increase productivity. Even more valuable than the productivity gains, however, is the error reduction often seen with increased lighting. Industrial studies have shown productivity and error reduction improvements of up to 30% across a variety of tasks.[8] This work is highly relevant for performing embedding in the histology laboratory where long stretches of visually demanding tasks are the norm. For the embedding process, which deals with a variety of samples and where orientation is critical, it is not difficult to see how proper lighting is critical.[9] The popularity of lighting attachments highlights that this is a clear need.

Lighting Study Outline

Lighting measurements were taken with identical Sinometer Digital 4 illumination meters. Meters were set up and verified in working order and distributed to data collectors in the field. The meters measure luminance, the intensity of incident light on an area. This is the specific "brightness" on a specific surface. Angles of light, reflectance, shadows and other factors can affect the value. Luminance is the key measure to understand lighting effects on the user. Because different parts of the embedding center can have different luminance levels, light distribution on the work surface was a critical aspect of the study.

Forty-seven embedding centers were examined in working histopathology labs across the United States. Care was taken to get as wide a variety of makes, models, and configurations as possible as well as to visit many types of labs. Six luminance measurements were collected during each reading: the general light level within the lab, a reading taken from the working area of the embedding center and four readings taken from the surface of the embedding center as shown in Figure 1.

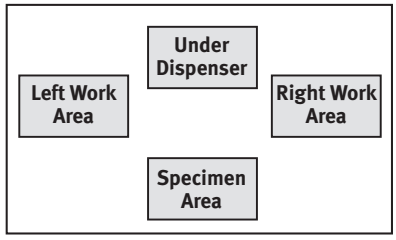

Figure 1.

Along with two ambient readings, four areas were measured at every embedding center.

General Illumination in Histopathology Laboratories

Lighting guidelines generally focus on minimum "adequate" levels and vary between countries and even standard-setting organizations within a country[10] assessing lighting guidelines for comparable work situations, however, it is clear that an absolute minimum lighting level appropriate for a histopathology laboratory is about 500 lux, with 750 lux a more generally acceptable level. Optimal levels would be comparable to "fine work" lighting standards and would be in the range of 1,000 to 2,000 lux. Industrial studies for similar tasks suggest truly optimal lighting might be even higher.[4,8,10,11,12]

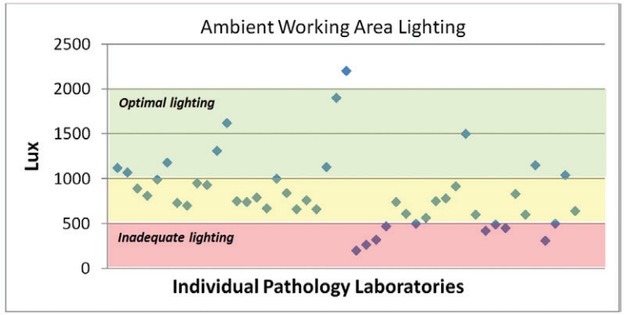

Figure 2.

Although most work areas were at an acceptable lighting level, a surprising number of observations showed lighting below 500 lux and relatively few labs were at "optimal" lighting above 1000.

Observed ambient light measurements in pathology labs support the estimated standards. The average lighting observed at the working area was 830 lux, and 23% of observations had lighting greater than 1000 lux. Nearly half were below 750 lux and, surprisingly, 17% of observations showed ambient light below 500 lux. Anecdotally, histotechnologists in the sub-optimally lit labs were very conscious of the lighting and considered it an impediment. In labs with inadequate lighting, significant bench space was often lost because it was dedicated to supplemental light sources.

Effectiveness of Lighting at Embedding Centers

The first critical finding was that more than half of embedding centers had a luminance below the ambient lighting at the actual specimen area. Although the light directly under the wax dispenser was usually much brighter than ambient, the effective luminance on the surrounding work surfaces was seldom improved.

Another consideration was how even the lighting is. Light and dark patches on a work surface can affect focus and visual effort. While contrast at the area of focus is good for visual tasks, general lighting contrast on the work surface only creates opportunities for eye strain. To measure this, the left and right work surface readings are compared. For consistency, the percentage increase of the higher value over the lower value was the chosen metric. As Figure 4 illustrates, a noticeable difference was often found.

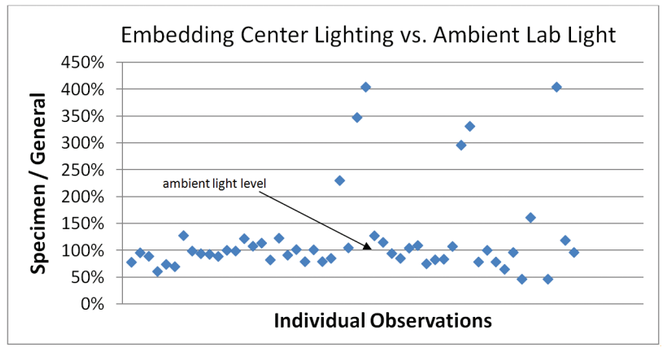

Figure 3.

Even though multiple factors could affect specimen lighting versus the lighting in the general area; in practice, few setups achieved significant improvements to the lighting at the specimen area.

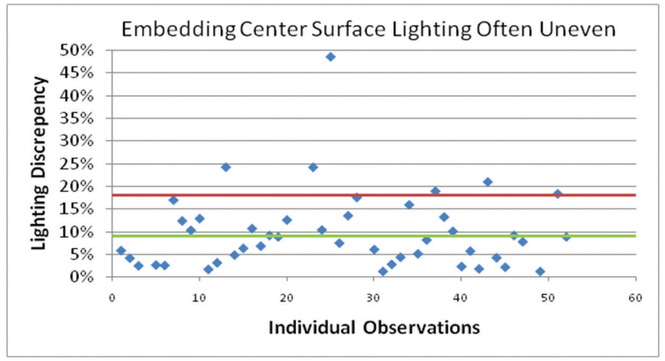

Figure 4.

Four observations greater than 50% not visible. Average is shown by red line; median by green.

Improved Lighting Ergonomics of the HistoStar Embedding Workstation

The deficiencies found by the lighting study explain why HistoStar embedding workstation was so well received. Without the clutter of additional lamps or external attachments, the integrated HistoStar embedding workstation lighting is nearly five times (470%) brighter at the specimen area working surface. Even the best lit work areas found in the study were significantly dimmer than the HistoStar embedding workstation work area. The dimmest HistoStar embedding workstation reading was still more than twice as bright as the best lit specimen area observation in the study (211%). Consistent with the specimen area, HistoStar embedding workstation side measurements were just under four times (387%) brighter. Readings directly at the specimen site under the dispenser were an overwhelming 12 times brighter (1187%). Critically, the HistoStar embedding workstation is able to deliver superior lighting while maintaining excellent side-to-side lighting variance of only 5%.

Although most literature shows that brighter is usually better, ultimately the individual user experience is the important element. Therefore, the adjustability of the HistoStar embedding workstation light level is a critical feature. Instead of either choosing no additional light, too much light or trying to modify external lighting, histotechnologists can set the illumination to their individual preference and still benefit from steady, clutter-free and even lighting. To quantify this, one additional test was performed. Specimen area lighting measurements were taken at each of the available settings. As Figure 6 shows, the HistoStar embedding workstation may be q uickly and easily adjusted to any desired lighting level.

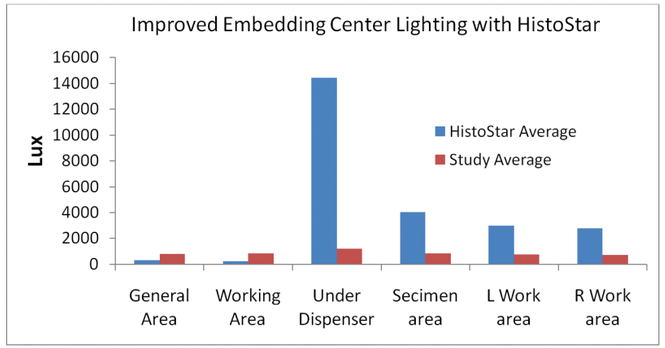

Figure 6.

Specimen area luminance at each setting.

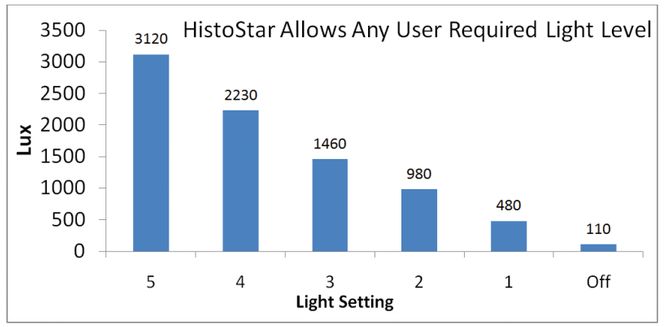

Figure 5.

Despite being tested in demonstration areas with lower lighting than most working labs, the HistoStar workstation still achieved lighting measures orders of magnitude higher than any other embedding center.

Conclusion

Collecting lighting data from a wide variety of histopathology laboratories across the U.S. has provided insight into an area that, although well studied in industrial and other medical fields, has not typically received much attention in histopathology. High levels of ambient lighting preferred by most pathology labs suggest that lighting ergonomics is as important for pathology as for other fields. The poor general lighting of some of the pathology labs and the lighting deficiencies seen in all current embedding centers can be summarized as follows:

"New perspectives and innovations like these are critical for both the comfort and well being of histotechnologists and the productivity of the laboratory."

- Almost 70% of the pathology laboratories had inadequate lighting
- Existing embedding centers do not provide adequate lighting at the specimen area
- Highly uneven lighting is common with most embedding centers

The HistoStar embedding workstation fills this need at the embedding station and improves the total user experience. Key lighting advances provided by HistoStar embedding workstation are the following:

- Dispensing area lighting was increased 12X
- A 470% increase in work surface lighting is achieved
- Uniform, consistent lighting with no shadows or dark spots is achieved

New perspectives and innovations like these are critical for both the comfort and well being of histotechnologists and the productivity of the laboratory.

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