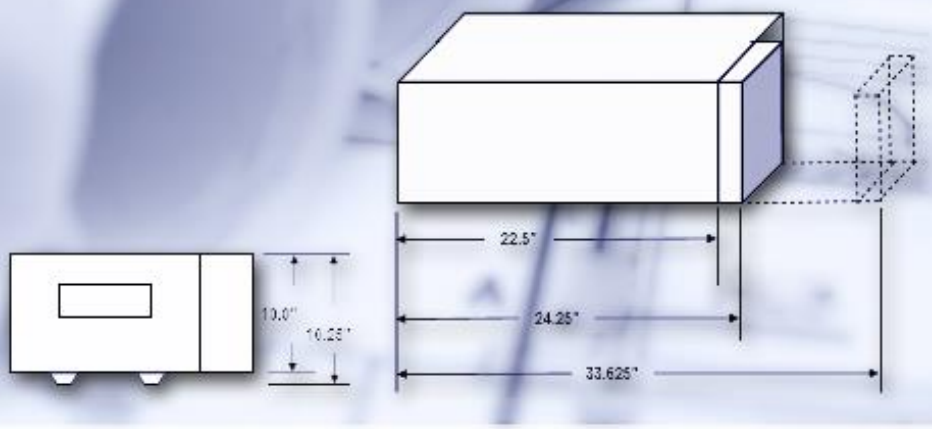
Never Lose Your Cool Again

a White Paper Outlining Careful Considerations for Hospital Grade Refrigeration



Introduction

The patient experience is a notable measurement of healthcare performance in the hospital setting. It is sometimes, mistakenly perceived as solely being a business definition by which metrics are employed to increase hospital revenue and profitability. This aspect cannot be overlooked because a profitable healthcare venture is, in fact, a valuable means to a healthy outcome for the patient. Consider the high probability that all of us will be a patient at some point. As a patient, it is reassuring to know that the facility providing medical care is highly rated with regard to patient satisfaction. The measure of satisfaction along with its impact on profitability is a purposeful tool which the hospital can use to justify expenditures to fund new research, acquire the latest and greatest instruments, as well as hire and retain talented staff. However, the patient experience metric also means that the hospital is diligently and actively involved with providing an environment in which patients and staff feel safe, comfortable, and confident in care provided and received. It's a practical measurement to improve and ensure that all the operational dynamics work well together and that the facilities are designed well to promote positive outcomes. It is also a key indicator for the identification and resolution of improvement initiatives. Most importantly, it is the right thing to do.

Every detail matters in the endeavor to provide a successful patient experience. This paper looks at the various considerations for just one piece of equipment, patient room refrigerators. To most of us, installing a refrigerator is a simple, plug-and-play thing. However, for targeting and achieving a positive patient and staff experience, multiple perspectives need to be examined and addressed.

Applicable considerations include efficacy and efficiency of technology and design, safety and infection control, and confluence with patient-centered medical treatment. Additionally, efficient, convenient, and cost effective dynamics must be included as forethoughts to support hospital staff in their tireless efforts to battle disease.

Healthy Designs

"How many times do I have to ask you to shut the refrigerator door?" At some point in time we've either been on the receiving or giving end of the sarcastic question. The reason for the admonishment is clear. It's not cost efficient to cool a room with a refrigerator, the contents of the refrigerator will spoil as cold air is lost and warm air enters, and the refrigerator will have to work much harder to regain appropriate temperature if left open; consequently shortening its lifespan.

Conceptually, one of the major flaws of a refrigerator's efficiency is its door design. The swing-out, front door or doors allow cool air to escape and warm air to enter every time they are opened. This is due to simple physics. Cold air is heavier than warm air. With an open refrigerator door, cold air falls out of the bottom. To compensate, thusly achieving equilibrium, warm air is actively pulled into the refrigerator.

An improved design is one which compensates for such a shortfall. Knowing that cold air is heavier than warm air, the question becomes one of understanding how to keep the cold air in place. If the cold air is not displaced when the door is opened, then there simply is no room for warm air to enter. There would be no need to balance the equilibrium equation.

Such a solution can be achieved by using a drawer instead of a door. The cold air sinks into the drawer rather than falling out.

By conserving cold air and consequently preventing warm air from entering, the refrigerator's efficiency is vastly improved. The enhanced temperature stability not only protects the refrigerator contents from becoming spoiled, it significantly minimizes out-of-range temperature fluctuations. This tighter control of temperature maintenance decreases the equipment's operational burden for temperature recovery. In turn, the equipment has a longer lifespan. This aspect of operational efficiency is an obvious cost savings in the long term. The less obvious measure of cost savings is the time spent by nurses, facility management, and biomedical engineers to address out-of-range, temperature alarms. Additionally, an efficient refrigerator with Energy Star certification and faster temperature recovery time doesn't just decrease the cost of the electrical bill; it's a broad improvement for decreasing the environmental burden or footprint. "Green" efforts are a responsible practice and a highly appropriate pursuit by hospitals promoting healthy living.

A second and vitally important consideration of design is infection control. Because of the cycling of warm and cold air, most refrigerators require a condensation or drip tray to catch condensate. The collected condensate evaporates into the environment over time and is reliant on heat displaced by the compressor's motor. Typically, this is not a problem for healthy individuals. Healthy bodies can battle microbes and reasonable exposure is known to boost immunity. In the hospital however, patients' immune systems are compromised. Their bodies are already fighting a battle against disease severe enough to necessitate clinical intervention. The refrigerator drip tray unfortunately facilitates a wet

environment which is ideal for bacterial proliferation. For health compromised patients, additional, undesired microbial challenges are a problem.

The solution is elimination of moisture or condensate. Therefore, the drip tray must be eliminated. Certain refrigerators address this issue with improved technology. Positioning of the cooling plate and motor housing are details of the intellectual property within the design of such refrigerators. Disposable desiccants which absorb and eliminate moisture are also employed to remove the threat of microbial agent exposure to patients.

Healthy Acoustics

It seems intuitive that healing from an illness requires rest. After all, has anyone who's been sick not been told "be sure to get plenty of rest and drink lots of fluids"? It makes sense to allow the body to use cellular energy for healing post-trauma and for fighting infection by not exerting energy elsewhere, hence resting. This is especially pertinent for hospital inpatients. Hospitalized patients are hospitalized because the acuteness of their condition requires risk intervention beyond what is achievable outside of the clinical setting.

Inpatient sleep disturbance and noise levels are an expanding topic of study. Historical focus has been placed on evaluating ICU patient populations' response to noise level associated stress. ICU patients with poor sleep quality have demonstrated greater risk for infection, complications, and mortality. Noise level in patient rooms outside of the ICU has the same clinical significance regarding recovery. The physiologic correlation of the sleep cycle has been well studied. Sleep is simply essential for helping the body recover from "normal" daily activity, stress, and anxiety. This need is greatly increased when the body experiences more than "normal" events, like illness. As such, sleep quality is a critical consideration for patient care. Studies have shown that disruption of the sleep cycle impacts neurological and cardiovascular outcomes. Noise levels in patient rooms are considerably higher than generally recommended, account for significantly measurable sleep loss, and have been shown to directly and significantly affect clinical outcomes. In the hospital, the primary factor reported as the cause of sleep interruption is noise in the patient room. Additionally and in support of study conclusions, higher levels of ambient noise in the patient room were found to directly correlate with a longer hospital stay.[1]

> ***"Higher levels of ambient noise in the patient room were found to directly correlate with a longer hospital stay."***

Studies suggest that noise levels of 50 dBA during the day and 40 dBA during the night represent appropriate limit values to sufficiently minimize disturbance of patients' quality of rest. Specifically, 49.3

dBA during the day and 34.24 dBA during the night were found to essentially eliminate all sleep disturbance.[2] Night-time hours for the purpose of addressing patient sleep efficiency are defined as the period between midnight (24.00) and 5:00 AM (05.00). Most studies however, agree within the range of 23.00 – 07.00 for the purpose of defining nighttime, sleeping hours. Accordingly, results from IRB approved studies show that although noise levels are typically lower between 23.00 – 07.00, nighttime levels of noise inside patient rooms range from 38.2 dB – 82.6 dB; which as expected, causes frequent sleep disruption as reported by study participants. [4] [Figure 1].

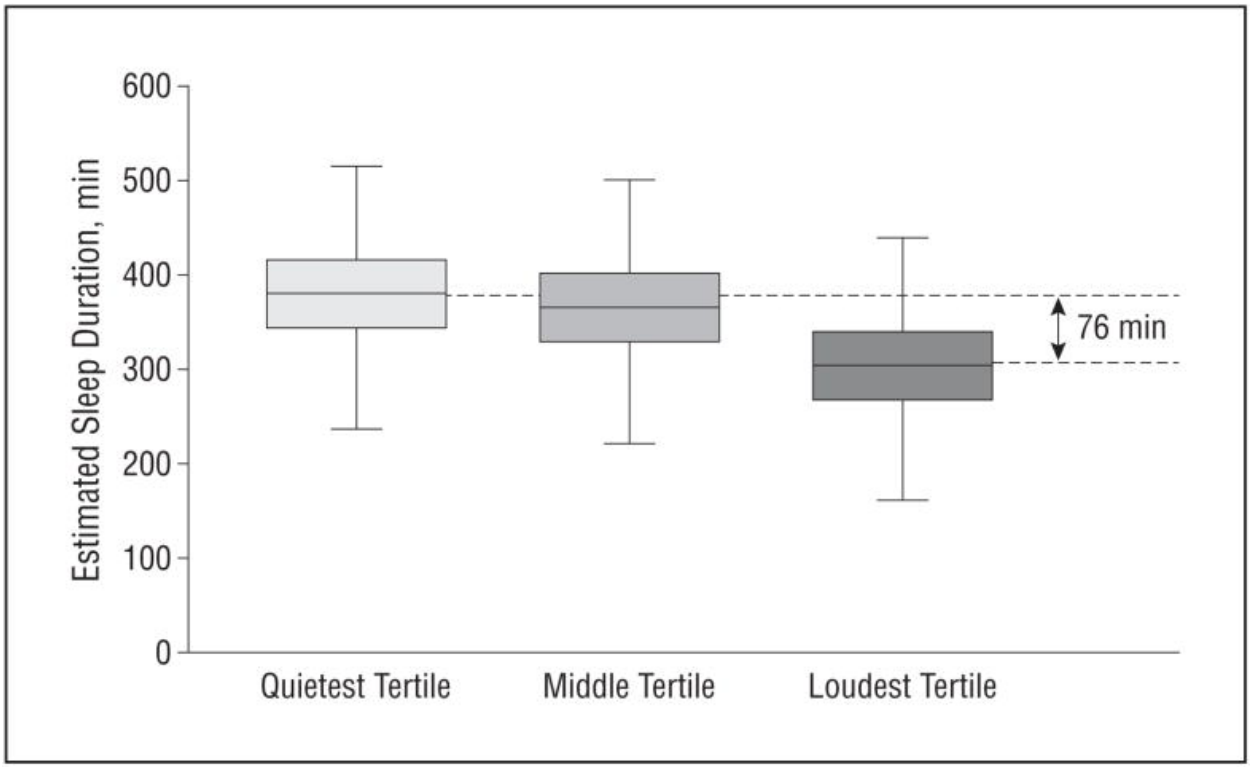


Figure 1: Sleep duration values based on average, nighttime noise levels ranging from 41.1 dB (mean Leq 43.3 dB) to 52.0 dB (mean L_{eq} 50dB) show a 76 minute difference in sleep duration between the quietest and loudest levels.

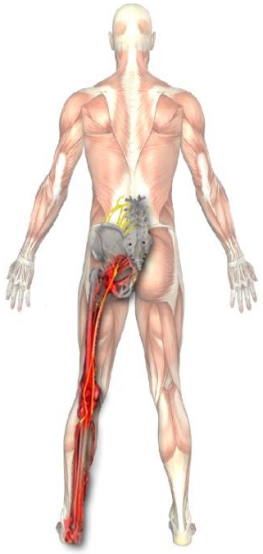
While studies based on current, general populations to understand continuous improvements in healthcare are undeniably important, addressing near-future and future patient population trends are important for prioritization and specificity of potential corrective actions to target maximized benefits of healthcare improvement initiatives. Specifically, the current global trend of an aging population requires attention. For the sake of simplification, as the body ages, cellular repair capabilities continue to degrade. The point in time or the individual's age when the balance is shifted and cellular repair mechanisms can no longer keep up with the rate of cellular damage is different for every individual; the basis of which is both genetic and environmental. Studying the effects of current practices to understand and uncover potential initiatives and benefits for the wellbeing of elderly patients must be a

critical, current consideration. Because of health vulnerability in the elderly, stemming from the slowing of the body's ability to repair itself, hospitalization occurs more frequently in this population. With the escalating number of aging individuals globally and the overall increased age of human expiration, it can be reasonably expected, as evidenced historically, that a growth demand for hospitalized care will occur. With regard to noise levels on hospital wards, one qualitative design, clinical study demonstrated that elderly inpatients experienced dynamic changes to their sleep cycles and these changes resulted in sleep disruption and depravation.[3] When correlated to the results of the multitude of studies assessing inpatients' ability or inability to rest with subsequent impact to health outcomes, the implications are disconcerting. The clinical evidence clearly supports the reduction of the noise level within patient rooms and justifies the old adage for getting plenty of rest to get better.

Patient room refrigerators are not exempt from ambient noise determination. Compressor cycling noise is typically 50dB and higher for standard, medical-grade, patient room refrigerators. Compressor cycling also occurs frequently on refrigerators with design inefficiencies such as those with front doors or open compartments necessitating condensation trays. 50dB is well above the recommended noise level for achieving restful healing and a satisfied inpatient experience. Interestingly, higher ambient noise causes a cascade of escalating decibel levels simply from staff, patients, and visitors needing to overcome ambient noise for communication purposes.

Technological and design advancements have significantly improved upon compressor noise levels. Efficient refrigerators with integrated compressor housing operate below 40dB. This equates to more than a 20% improvement over standard, medical-grade refrigerators and is appropriately within recommended levels of ambient noise to facilitate a healing and restful environment for patients and staff.

Healthy Ergonomics



"Bend with your legs" is sage advice. The reason for heeding the advice is to protect the lower back from injury. The lower back is a complex and interrelated network of bones, nerves, muscles, ligaments and tendons. Overexertion of this network by frequent bending, bending and lifting, twisting, or hereditary causes can lead to pain which ranges from mild discomfort to debilitation. The pain can be localized or can radiate distally due to the nerves which extend to the legs. Sciatica for example, is caused by nerve root compression in the lumbosacral spine. Symptoms of discomfort and severe pain can radiate along the large sciatic nerve from the lower back to the feet.

Causes of lower back pain generally stem from muscle or soft tissue strain and from compression of lumbar disc space. However, typical causes are different for younger and older adults. Younger adults aged ~30 to 60 years, typically exhibit symptoms caused by muscle strain or lumbar disc herniation. Older adults over the age of ~60, typically exhibit symptoms caused by osteoarthritis, spinal stenosis, or compression fractures which are all related to deterioration

of the joints. Both groups can be affected by degenerative disc disease. Degenerative disc disease is caused by the breakdown of the lumbar discs between the vertebrae. The breakdown of these cushions between vertebrae results in a cascade of painful symptoms ranging from inflammation to instability.

Lower back pain is typically treated with rest, heat and ice packs, and a variety of medications. The medications may be OTC or prescribed by physician to target specific causes such as inflammation. Physical therapy may be included to strengthen, stretch, and condition muscles for improved support of the spine. In extreme cases, surgical intervention may be required. Procedures include laminectomy, microdisectomy, and fusion of vertebrae.

By design, hospitals are intentional settings for the professional practice of healing arts. As such, ergonomic architecture is essential for promoting the very purpose of hospital based medical care. Both patients and staff benefit from an ergonomically functional environment. Consider the irony of workers compensation claims originating in a hospital. Consider the cost of such claims and how the funds could be used to further medical research and quality of care.

Refrigerators that require bending pose a risk to both patients and staff. Candidly, even one less flexion in this regard decreases the risk for a lower back injury. The point is that accessing refrigerators in multiple patient rooms and multiple times per day increases the risk of injury. For staff, such consideration is important; especially for nurses and dieticians who must access multiple patient refrigerators several times per shift; per week, per month, etc. For patients, especially elderly patients, it's an important consideration because their core strength, muscle and tendon flexion, and bone mass may be deficient from either disease state or age. For facility management, the sheer scale or volume of equipment requiring preventative maintenance, annual calibration, etc. can be overwhelming. The strain of contorted flexion to service equipment can be extremely physically demanding. Considering these aspects, it becomes undeniable that both architectural design and equipment design must address such challenges to the extent possible in order to ease the potential for harm.

The appropriate solution is architectural in nature. Refrigerators should be mounted at counter height. Drawer refrigerators provide a substantial advantage for such utility. A drawer refrigerator can be mounted beneath a counter or placed on a counter to allow patients and staff access without the burden of bending. Added advantages include flexibility for strategic placement within the patient room, with convenience for the patient and for staff workflow. For example, a drawer refrigerator can be built into the bedside nightstand. Unlike a door refrigerator, the patient does not have to get out of bed to retrieve items from a drawer refrigerator.

Healthy Hygienics

"Cleanliness is next to godliness". Of the multitude of challenges facing healthcare, infection control is primary in the hospital setting. Medscape, among other sources, estimates that hospital acquired infections cost upward of $10 billion per year. This enormous cost persists in spite of continuous improvements and well executed quality assurance efforts. It does stand to reason that the hospital setting is a localized concentration for pathogenic exposure. It is, after all, the place where sick people go for treatment when disease has surpassed the competence of home care. Therefore, hospital staff and administration diligently pursue ways and means to contain the spread of evolving disease causing agents. Hospitals are partitioned according to risk based exposure to pathogens. For example, surgical suites are maintained aseptic while the lobby or reception area is not. That does not however imply that the reception area is not cleaned regularly with germicides, which disrupt the DNA chain of bacteria and viruses, to contain and eradicate the spread of germs. It simply means that there is greater probability of exposure to germs in an area where more people, who have not aseptically scrubbed down, can congregate.

Inpatient wards also have measures and procedures in place to minimize exposure to germs. The stringency of each ward's policy is based on the measured risk of exposure to the type of patient receiving care. Post-surgical patients, for example, are at an increased risk because pathogens have a direct route of infection. The skin is a formidable barrier to microbial invasion. Once penetrated for surgical purposes, the skin requires time to heal for that barrier to be reformed. Immunocompromised patients, whether by natural or therapeutic causes, are also at increased risk because their immune systems cannot fight infections.

To properly sustain infection control, materials used for hospital construction and for equipment must be such that they do not harbor or cause the proliferation of germs. They must be such that they can be sanitized with germicidal cleaning, disinfection and sterilization agents.

The principles of equipment sanitation can be broken down into three actions, cleaning, disinfecting, and sterilizing.

> ***Cleaning*** *can be defined as the general removal of visible debris like dirt or blood. Cleaning serves as a means to reduce organic matter which can support the growth of germs.*
>
> ***Disinfection*** *is the action of eliminating most germs. Disinfection is generally performed on surfaces with the intent of removing organisms that can cause disease.*
>
> ***Sterilization*** *is the total elimination of organisms.*

Sanitation of equipment utilized in the hospital setting is categorized according to levels of infection risk. For example, surgical equipment which penetrates the vascular system is designated as critical. Critical equipment must be sterilized. Equipment that comes into contact with mucous membranes or open skin is classified as semi-critical. This equipment, such as respiratory therapy equipment, requires a high level disinfection. Non-critical equipment is defined as equipment which only makes contact with intact skin. This type of equipment, such as patient room refrigerators, minimally requires low-level disinfection. An additional category is environmental cleaning. Environmental cleaning is categorized as intermediate or low-level disinfection after removal of visible debris.

Sanitation practices are complicated by the usage burden of a piece of equipment. With regard to patient room refrigerators, low-level or intermediate cleaning with disinfecting wipes is adequate most of the time. However, if a spill occurs on or within the refrigerator, a higher level of cleaning and disinfection may be required to stop the potential for bacterial growth. Also, once a patient is discharged, the room and its contents require a higher level of disinfection prior to admission of a new patient into the room. Plentiful, hospital-based studies have identified multiple surfaces within patient environments which demonstrate an escalated risk for pathogenic exposure. Within a patient room, bed rails, monitors, countertops, the sink area, drawer and door handles, the paper hand-towel bin, and equipment handles are among the common surfaces proliferating germ biospheres. These microbes, if not contained, for example by changing gloves and disinfecting hands, can readily spread to other patient rooms or areas. A 2001 study that stemmed from a positive culture of Vancomycin-resistant Enterococci (VRE) on all of the sites noted above facilitated guidance for the sanitation of “high touch surfaces”.[5]

Figure 2 consolidates the results of 6 different studies which demonstrate the risk of microbial infection within a patient room from the prior room occupant.

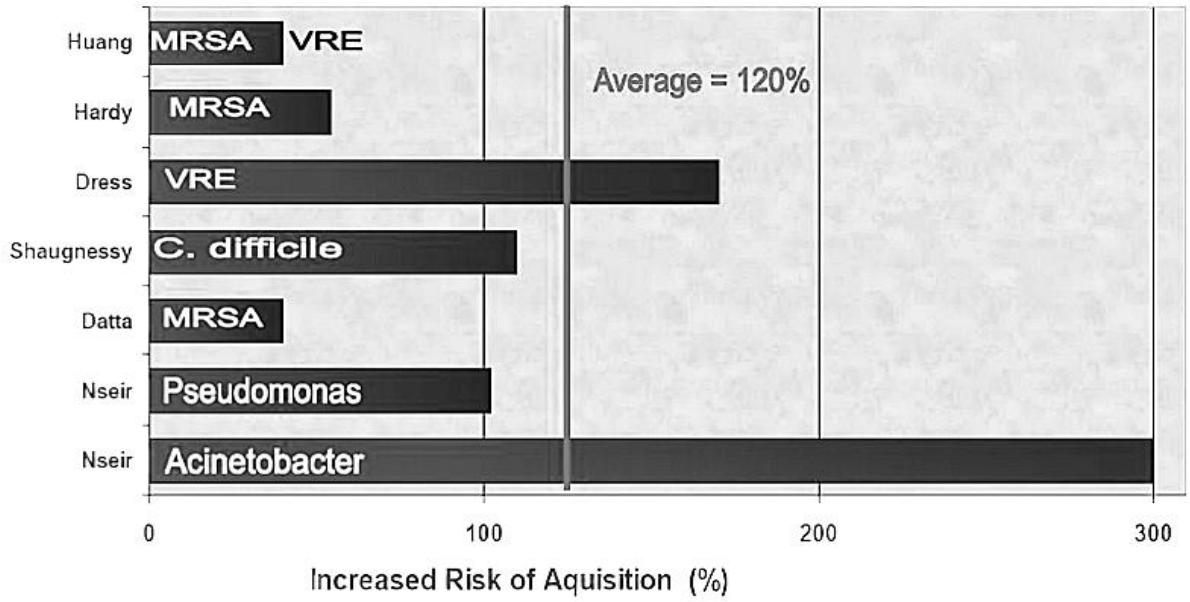


Figure 2: Six studies demonstrate the increased risk of acquisition (%) from prior room occupant.[6]

To achieve sanitation protocol requirements, devices and equipment like patient room refrigerators should be constructed of solid and nonporous material with the ability to withstand disinfecting agents.

In addition, both design and architectural considerations should include convenient and ergonomic accessibility for the facilitation of appropriate sanitation practices. Disinfection cannot typically be achieved without an initial cleaning. The bioburden of organic material must be reduced by an initial cleaning so that disinfectants are not diluted by organic material beyond their capability to achieve the desired result. For example, to adequately clean and disinfect door-type refrigerators the person assigned to the task has to uncomfortably contort into unnatural positions to reach all interior surfaces. This task is especially demanding if the refrigerator is housed low to the ground or on the ground. It should again be noted that sanitation is not limited to a single refrigerator in a hospital setting. The repetitive process of sanitizing multiple refrigerators throughout the hospital can create a miserable working environment. Since completion of the sanitation procedure as outlined by SOP is subject to human performance, a difficult or inconvenient process introduces increased risk for performance lapse and human error.

The solution is to implement equipment which is easy and convenient to operate and sanitize. A drawer refrigerator is markedly more accessible and convenient to operate but is also superior for the purpose of sanitation. The drawer can be removed which allows for comfortable and comprehensive cleaning and disinfection.

Healthy Aesthetics

"Looking good and feeling good" is a fun statement to express one's confidence. It is also a highly applicable sentiment for healthcare. Imagine a patient's reaction to a nervous surgeon. Confident care providers are recognized as talented experts in their field of practice. This confidence radiates positivity and hope of recovery to patients. The same idea is equally applicable to patient surroundings. A chaotic, unorganized, or mismatched facility's appearance is not recognized as conducive to convalescence.

To achieve a balance of clinical care functionality with congruent aesthetics aimed to bolster a healing environment, architects meticulously apply multi-disciplinary design principles into hospital construction plans. Several considerations taken into account are described in the previous sections of this paper. Ultimately, completed construction is expected to be harmonious.

A significant challenge faced by architects is maximizing space while staying within a limited budget. New or renovated construction must provide for an efficient and safe work flow with the ability to remain clean and tidy. Thusly, equipment which can be integrated into the design is particularly helpful for achieving a clean look, maximizing space, and ensuring a safe work flow. In this regard, door refrigerators are poor space maximizers and complicate the architectural design. The arc of the swinging door requires extra, unusable space to allow for its span and to ensure that a fully opened door does not obstruct a walking, work flow, or exit path.

However, drawer refrigerators can be integrated into the cohesive aesthetics of any design. They allow flexibility within the design because they can be mounted strategically within a room. They also maximize space availability within the architectural design as well as in their content utility. The drawer requires significantly less space which allows for ample, non-obstructed walkway and work flow space. Floor space is saved too because the efficient design of a drawer refrigerator does not require a bulky footprint which must be set on the floor. These advantages offer space maximizing utility for architectural plans which in turn free up tight budgetary constraints for use in other aspects of the architectural design plan.

Healthy Conclusions

“Never lose your cool” is a great motto for a stress free experience and an appropriate synopsis of the contents within this paper. Every piece of equipment installed and used in a hospital is subject to and in turn, creates multiple issues which are intertwined with a slew of complex dynamics. These dynamics span from architectural design to patient satisfaction and wellbeing. They touch numerous stake holders: architects, facility management, infection control, biomedical engineering, nurses, physicians, administration, and patients, among others. Fortunately, advancements in technology and design have delivered a suitable solution with regard to medical-grade refrigerators. Counter height mountable, ergonomic, efficient, convenient, flexible, quiet, and easy to disinfect, drawer refrigerators which seamlessly fit into any architectural design are undeniably the most cost effective and space maximizing option for hospitals.

References:

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