Electrical Receptacles in Patient Care Areas:

Determining Quantities, Location, and Code Compliance for Operationalizing Patient Care

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The Facility Guidelines Institute (FGI) is a not-for-profit corporation founded in 1998 to provide leadership and continuity to the revision process for the *Guidelines for Design and Construction* series of documents. FGI functions as the coordinating entity for development of the *Guidelines* documents using an interdisciplinary, consensus-based process and for provision of ancillary services that encourage and improve their application and use. FGI invests revenue from sales of the *Guidelines* documents to fund the activities of the next revision cycle as well as research that can inform the *Guidelines* development process.

FGI seeks to gather perspectives on challenges facing patients and clinicians in clinical spaces with the intent of gleaning ideas for research and supporting efforts to keep FGI's *Guidelines for Design and Construction* documents current with operations in the field. The process of collecting this information also provides an avenue to explore the implications of current *Guidelines* requirements and to assess the need for potential changes in future editions.

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Emerging technology and a consistently changing model of care often complicate efforts to design and construct hospitals and outpatient facilities. Planning and design of engineering systems for a health care facility present unique challenges that require an understanding of how to address code compliance, flexibility, redundancy, resiliency, project budget, and future-proofing—all while meeting patient and staff needs. In this context, designers are often asked to provide a "code minimum" design to meet budget constraints with little consideration of how such a design will affect patient care once it has been implemented. At the same time, how a health care organization plans to use a particular room may require a design that exceeds the minimum standards established by codes and guidelines. Minimum means, after all, the least possible, which does not always support organizational, staff, and patient needs.

This white paper provides information to help designers, owners, regulators, and other users of the *Guidelines* determine the quantities and configuration of electrical receptacles needed to operationalize patient care areas. This is not meant to be a prescriptive method for design, though. As codes and standards allow more flexibility in designing for safe delivery of care, it is important for the design team, owner, regulators, and other stakeholders to collaborate as they determine the quantity of receptacles needed for patient care and identify where code minimums may not meet the functional requirements of a health care space, that is, when “code sensible” is a better option than “code minimum.” This paper will help readers identify essential points of discussion, reinforce the importance of validating requirements in current codes and guidelines, and provide a foundation for understanding concepts and design criteria that affect the quantity and location of electrical receptacles. It also provides a needs assessment tool for use in matching a final project design with care delivery demands.

The Challenge of Minimum Requirements

To assure critical architectural and engineering systems provide a functional environment as well as basic (minimum) life and fire safety, electrical service, ventilation, and patient safety, national codes and standards are developed to coordinate with federal and state regulations for reimbursement and occupancy compliance. With very few exceptions, these codes and standards are written as minimum requirements to establish a threshold that must be achieved for compliance. For the unwary owner or designer, these minimum standards may become the benchmark for design, an approach that often results in completed construction that is less than optimal—and sometimes inadequate—for the clinical end user and the patient population.

Relevant Codes and Standards

National organizations such as the National Fire Protection Association (NFPA), International Code Council (ICC), Facility Guidelines Institute (FGI), ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers), and many others have committees comprised of industry experts who write, substantiate, and update codes and standards. These committees are typically multidisciplinary and include engineers, architects, clinicians, facility managers, administrators, regulators, manufacturers, installers, and other industry experts.[1] Their charge is to write an enforceable minimum standard that applies to any size facility from a 20-bed critical access hospital to a 1,000-bed teaching institution to an outpatient facility. Best practice or guidance language is often highlighted in an appendix or annex to assist the user in applying the code to a design (this language is not intended to be enforced as a minimum requirement).

The primary documents used to regulate receptacles in a health care facility are NFPA 70: *National Electrical Code* and NFPA 99: *Health Care Facilities Code*. These two documents work hand-in-hand, in theory, to provide performance requirements (NFPA 99) and installation requirements (NFPA 70). An additional layer of compliance in most states comes from the FGI *Guidelines for Design and Construction* documents, which are informed by the NFPA requirements and provide additional context and guidance. Local and/or state

NFPA 99: *Health Care Facilities Code*

1.1 Scope.

1.1.1 The scope of this document is to establish criteria to minimize the hazards of fire, explosion, and electricity in health care facilities providing services to human beings.

NFPA 70: *National Electrical Code*

90.1 Purpose.

90.1(A) Practical Safeguarding.

The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

90.1(B) Adequacy.

This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

Informational Note: Hazards often occur because of overloading of wiring systems by methods or usage not in conformity with this *Code*. This occurs because initial wiring did not provide for increases in the use of electricity. An initial adequate installation and reasonable provisions for system changes provide for future increases in the use of electricity.

2022 FGI *Guidelines for Design and Construction of Hospitals*

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FGI endeavors to develop performance-oriented and evidence-based minimum requirements for design of U.S. health care facilities without prescribing design solutions. Those using this document should rely on their own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstance.

[1] FGI's Health Guidelines Revision Committee does not include manufacturers or installers.

jurisdictions may have other codes that should also be reviewed but, in general, these documents are the source for electrical receptacle requirements in health care facilities.

To support a thoughtful discussion around making electrical system decisions that will yield a health care facility functional for the future, an understanding of some definitions and basic codes and standards information is useful.

Definitions

What exactly is a receptacle? The answer to this question is not as obvious as one might think. NFPA 70 Part I Definitions identifies a receptacle as a "contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designated to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke or strap. A multiple receptacle is two or more contact devices on the same yoke or strap." An informative note indicates that a "duplex receptacle is an example of a multiple receptacle that has two receptacles on the same yoke or strap." This explanatory material is referenced in NFPA 99.

So, what does the definition actually mean? It means that each plug-in point is considered a receptacle. If you have a duplex receptacle, you have a total of two plug-in points or two receptacles. This is an important distinction.

What is a patient bed location? NFPA 99 defines a patient bed location as the "location of a patient sleeping bed, or the bed or procedure table of a Category 1 space.[2]"

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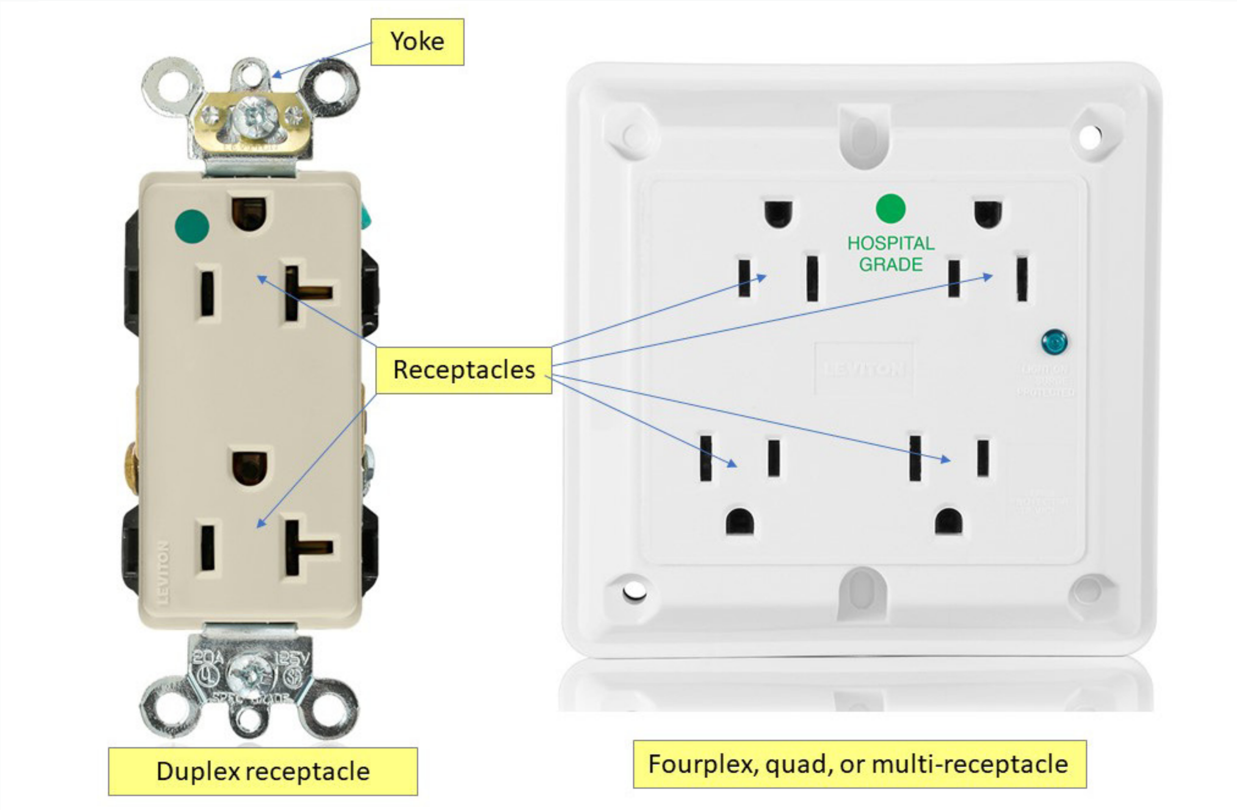
[2]Risk categories 1 and 2 are defined as follows in the 2021 edition of NFPA 99: *Health Care Facilities Code.*

- Category 1—Activities, systems, or equipment whose failure is likely to cause major injury or death to patients, staff, or visitors.
- Category 2— Activities, systems, or equipment whose failure is likely to cause minor injury to patients, staff, or visitors.

Figure 1: Receptacles



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Basic Code Information

Code cycles and adoption of codes vary state to state. How should this be handled? Confirm which codes are used in the jurisdiction where a project is located and validate what is applicable for occupancy, licensing, and reimbursement. These are often not in alignment so—as when comparing multiple references—always follow the more stringent requirements and confirm compliance with the authority having jurisdiction and/or reimbursement agency.

Where can receptacle quantity requirements be found? NFPA 99 is the primary source regarding device quantities and branch of power for receptacles. NFPA 70 references the NFPA 99 requirements, and FGI aggregates this information and enhances details as appropriate for patient care. So, what happens when all of these documents are adopted and enforced but different editions are accepted by a particular jurisdiction or are in conflict? Again, the rule of thumb is that the most stringent requirements should be applied.

How are device quantities determined in NFPA documents? Two key pieces of information must be defined to determine receptacle quantities.

The first is the category of the space (i.e., the type of care area). Per NFPA 99 Chapter 6 (2021), Category 1 spaces are defined as spaces "in which failure of equipment or a system is likely to cause major injury or death of patients, staff, or visitors" (e.g., an intensive care unit or operating room). Category 2 spaces are defined as spaces "in which failure of equipment or a system is likely to cause minor injury to patients, staff, or visitors" (e.g., a medical/surgical patient room). It is best to validate the category for a particular space with the health care organization because other factors may cause risks that also need to be considered.

The second key piece of information required in determining electrical receptacle quantities is how the area or space will be used and how its design will affect the number of receptacles needed.

Specific receptacle quantities can be calculated from both NFPA 99 Chapter 6 and NFPA 70 Article 517 as summarized in the list below. Receptacle requirements can be met with single, duplex, or fourplex receptacles.

- *Patient bed locations in Category 1 spaces:* Minimum of 14 receptacles of which at least 7 shall be connected to either the normal branch circuit or a critical branch circuit supplied by a different transfer switch than that supplying the other critical branch power source at the same location.
- *Patient bed locations in Category 2 spaces:* Minimum of 8 receptacles of which at least 4 shall be connected to either the normal branch circuit or a critical branch circuit supplied by a different transfer switch than that supplying the other critical branch power source at the same location.
- *Operating rooms*: Minimum of 36 receptacles of which at least 12 shall be connected to either the normal branch circuit or a

critical branch circuit supplied by a different transfer switch than that supplying the other critical branch power source at the same location.

Does NFPA 70 provide any other criteria regarding these locations? NFPA 70 focuses on installation criteria, so requirements cover circuiting, bonding, and distribution. The information in these sections does not clarify device counts but is imperative to assure a safe and compliant electrical installation.

Does NFPA 99 provide any other criteria? The basic electrical requirements in NFPA 99 reside in Chapter 6, "Electrical Systems," but another chapter has a significant impact on electrical design as well. This is Chapter 12, "Emergency Management," which requires the health care organization to create an emergency operations plan (EOP) that includes a strategy for managing the critical functions of a facility during an emergency. Power distribution and utilization of patient care spaces (and, in turn, electrical device utilization) must be addressed in this plan.

Because the EOP is required by code, its development and implementation are also required by code. Depending on how a health care organization plans to function in an emergency, additional receptacles (along with other electrical provisions) may be required. Thus, it is very important to have a discussion with the health care organization (i.e., the governing body) early in the project design phase about how the facility will be used in an emergency.

How is NFPA code information used in the FGI *Guidelines*? In Table 2.1-1 (Electrical Receptacles for Patient Care Areas in Hospitals) in the 2022 FGI Hospital *Guidelines* and Table 2.1-1 (Electrical Receptacles for Patient Care Areas in Outpatient Facilities) in the 2022 FGI Outpatient *Guidelines*, the framework from NFPA has been applied to different modalities and program spaces. Included are receptacle requirements for areas such as a procedure room (NFPA Category 1 or 2 space) and post-anesthetic care unit (NFPA Category 1 or 2 space). The tables also provide guidance on locations for devices in patient care spaces. Designers should be mindful that the NFPA receptacle counts are the base (minimum) requirements and the FGI

Guidelines overlays additional requirements for some of these spaces. The full *Guidelines* electrical receptacle table for hospitals appears in Appendix 1 of this white paper.

Figure 2: Excerpt from Table 2.1-1 (Electrical Receptacles for Patient Care Areas in Hospitals) in the 2022 FGI Hospital *Guidelines*

Table 2.1-1

Electrical Receptacles for Patient Care Areas in Hospitals

Section	Location	Minimum Number of Single Receptacles[1]	Receptacle Locations[2]
PATIENT BED LOCATIONS			
2.1-2	All room[3]	12	Devices shall be located to support clinical functions and patient and visitor needs.[4]
2.2-2.2.2	Medical/surgical unit patient room[3]		
2.2-2.2.4.4	Protective environment room[3]		
2.2-2.5.2	Intermediate care unit patient room		
2.2-2.9.2.2	Postpartum unit patient room[3]		
2.2-2.11.2	Pediatric and adolescent unit patient room[3]		
2.6-2.2.2	Rehabilitation unit patient room		
2.2-2.6.2	Intensive care unit (ICU) patient room	16	Devices shall be located to support clinical functions and patient and visitor needs.[4]
2.2-2.7.2	Pediatric intensive care unit patient room		

With this knowledge of the receptacle requirements in NFPA 99, NFPA 70, and the FGI *Guidelines*, why would a number of receptacles beyond the minimum prescriptive quantity be needed? Continue reading to understand that health care design is not just a prescriptive exercise but a patient-focused effort that—in addition to design professionals—engages clinical and facility staff and other key decision-makers to assure a safe and functional healing environment is created.

A Typical Installation—the Patient Room

The computer age, technology advancements, staffing challenges, and ergonomic considerations have changed how electrical receptacle installations are designed for patient care spaces. The enhanced use of patient-side diagnostic and monitoring equipment, in addition to the personal electronics patients and visitors bring into a health care environment, compounds the need to rethink how power is provided to these spaces and where receptacles are located. This shift also complicates device placement and the circuiting required to support the devices in a code-compliant manner that does not add risk to patient care.

The inpatient care room is used in this paper to demonstrate how to determine receptacle numbers and placement for a project. The patient room was chosen as an example because this room type typically has the most variability in design criteria. The variables described here may be applied to other room types as well and can help in developing questions that can be used to determine appropriate electrical receptacle solutions for any health care space.

Design Considerations for Receptacles in Patient Rooms

Planning a patient room for today requires thinking about future needs as well as today's requirements. In 2019 the average length of stay for an inpatient was 6.2 days according to the Centers for Disease Control and Prevention.[3] The acuity of inpatients this reflects is likely to continue, accompanied by a greater reliance on technology to care for such patients. As well, the importance of planning for surge capacity has become increasingly evident. In response to these realities, designers and users must carefully consider the electrical system needs (including receptacles) for patient rooms so these spaces can accommodate the needs of patients, staff, and families.

[3] Centers for Disease Control and Prevention/National Center for Health Statistics/Division of Analysis and Epidemiology. Data retrieved in fall 2022 from https://www.cdc.gov/nchs/hus/topics/hospitalization.htm#featuredcharts.

Patient Acuity

As the model of care evolves, so too will patient care spaces. An example of this evolution is the emergence of acuity-adaptable rooms that can flex to support changing needs. Implementing the acuity-adaptable design concept requires an assessment of receptacle quantities and locations so a health care space will have the functionality needed to meet planned uses.

A thoughtful design process is important to achieving a space with electrical equipment that is appropriate and functional as well as compliant. More equipment does not always mean better; therefore, understanding the function of a space and the medical equipment used in it is a vital part of designing patient rooms. For example, rooms used for higher acuity patients will require additional life support equipment and the code-required minimum quantity of circuits serving the patient bed may not be sufficient.

Surge Capacity

Recent events such as the COVID-19 pandemic have demonstrated the value of having surge capacity (doubling the number of patients in a space). When planning for surge events, it's important to consider the need for additional receptacles in patient rooms. Other public health or incident-based emergencies can also trigger a critical need for receptacles to support additional medical equipment, increasing the demand for power to patient care areas.

How receptacles are circuited to the normal branch and critical branch will be affected when a surge plan is implemented. Therefore, consideration should be given to the design of circuit assignments to assure that one patient bed location will not put the second patient at risk if a breaker trips. Utilizing dedicated circuits for each patient bed will improve resiliency and mitigate the effects of local power failures.

Patient Care Equipment

Patient beds. Patient beds come with a wide variety of options. Some do not require power and some require minimal power input, while others must have a dedicated circuit. If a bed mattress will deflate upon loss of power, it should be circuited to the critical branch. Patient lifts may be planned to assist in moving a patient from the bed to a chair, commode, or toilet room. Often these lifts plug into a receptacle that is mounted on either the ceiling or headwall.

Designing for the requirements of the types of equipment the health care organization plans to use is the minimum goal. However, a health care organization may want to consider going beyond the minimum so the room is equipped to provide flexibility for future uses, including accommodation of new technologies and equipment.

Patient monitoring. Monitoring vital signs and other patient data becomes a more critical component of care delivery as patient acuity increases. Patient monitoring technology, like other evolving technologies, is trending toward a future that embraces artificial intelligence (AI). In addition to understanding current patient status, monitoring signals should be expected to play an important role in the health care industry's use of AI and its ability to predict best practices for each patient. AI-assisted patient monitoring can be used to help create individual patient care plans and to provide more precise staff alerts when intervention is needed.

As technology continues to evolve, monitoring functions will likely be consolidated into a single integrated device. In this case, the quantities and locations of these monitors will inform decisions about placement of additional electrical receptacles.

Medical equipment locations. Depending on the quantity of equipment in a patient room, the space on just one side of a patient bed may be insufficient to accommodate all the medical equipment needed for patient care. To address this deficiency, it may be necessary to locate additional devices on the opposite side of the bed from the nurse's work-side or even at the footwall.

The frequency with which equipment is plugged in and unplugged should be taken into consideration when determining the height and location for an electrical receptacle. Whenever possible, consider placing receptacles 48 inches above the finished floor to eliminate the need for staff bending to plug and unplug devices.

Technology. Technology and diagnostics go hand-in-hand and, as the medical world is able to diagnose more, technology will be needed to prevent, treat, and—when possible—cure these ailments. For example, the world has risen to the challenge of COVID-19 with temperature-screening gateways and AI air detection systems. Technology will also be developed to meet the demands for care of patients and clients who present with increased acuity. Most of this technology will require access to receptacles.

Security. Increasing violence against health care staff[4] is likely to require security screening at all entries to health care facilities. The electrical systems and equipment, including receptacles, needed to support these services should be determined during the project planning phase.

Accommodations for Patient and Visitor Communications

Visual boards and patient entertainment and education systems. Visual boards in health care settings can be used to identify caregivers as they enter a patient room, validating a staff member's identity and letting patients know who is providing their care. Current types of devices providing this service use line voltage power, but low-voltage (power over Ethernet, or PoE) health care-listed pieces of equipment to serve these functions are becoming available.

Patient room television/monitor displays serve many purposes in health care. Access to television shows, movies, and newscasts

[4] Wallace Stephens, "Violence Against Healthcare Workers: A Rising Epidemic," AJMC.com (May 12, 2019). https://www.ajmc.com/view/violence-against-healthcare-workers-a-rising-epidemic

Figure 3: A Patient Room Rendering

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provide a distraction and help normalize a patient's stay. In addition, monitors can provide access to meditation and guided or non-guided visual imagery of nature—all of which offer the potential to reduce patient stress and even the need for pain medication.[5]

Patient education platforms can also be used to prepare patients for discharge or simply to provide more information about an illness or diagnosis.

Personal electronic equipment. Today many patients and their visitors are bringing laptops, phones, tablets, and other devices into the inpatient setting. In response, it is imperative to provide receptacles convenient to the lounge chair, family zone, and outside the patient care space for visitors' and patients' personal electrical devices. In designing patient care circuits, it is useful to understand the types of chargers required for this personal equipment. As well, separation of non-patient care receptacles from receptacles used for

[5] D. Krau, "The Multiple Uses of Guided Imagery,' *Nursing Clinics of North America* 55, no. 4 (December 2020): 467–74. https://doi.org/10.1016/j.cnur.2020.06.013

patient care should be considered so the patient care circuits are not compromised, adding risk to the patient.

Equipment for Imaging and Dialysis Services

Imaging. Frequent use of bedside diagnostic equipment has increased the need for supportive power at the bedside. Such equipment may include portable X-ray and ultrasound equipment, scopes, and more. The ability to store charged portable units is essential in high-volume areas, so provision of backup power in patient care units and in individual patient rooms should be considered. Understanding the power requirements of the diagnostic equipment to be used will allow the designer to plan for the appropriate National Electrical Manufacturers Association configuration in the patient room or to provide appropriate power in an alcove or equipment storage room for charging mobile imaging equipment.

Dialysis. Health care organizations typically select patient floors, wings, or rooms for inpatient dialysis, although some are starting to create infrastructure that will support dialysis in all patient rooms in the future. When rooms are designed for this flexibility, it is necessary to plan for the power needs to accommodate the dialysis and/or deionized water machines. Dialysis equipment often requires a dedicated circuit because of its power demand, which typically necessitates more than the minimum circuits for a patient bed location. If the receptacles to be used for dialysis are counted as part of the code-minimum count for receptacles and circuits, the functional flexibility of the patient care space could be restricted.

Other Electrical Equipment Considerations

Branch of power and circuit loading. Codes and standards require and recommend a minimum receptacle count and minimum number of circuits for various health care areas. For the space around the patient bed, it is prudent to evaluate how many devices will be plugged in concurrently to determine whether a patient can be sustained if some of the devices become unavailable due to failure of one circuit or power branch.

A good rule of thumb for loading circuits in a health care facility is a maximum of eight duplex receptacles per 120V 20A circuit. Circuit loading should be taken into consideration when determining what may be plugged in at the patient headwall today and in the future. A high-acuity room may have more equipment that draws more power, which could overload circuits sized using the rule of thumb. On the flip side, if a design trends toward use of PoE devices, the line voltage power needed may be less. Understanding the diversity of patient care loads, how the health care organization intends to use a space, and what the organization's risk tolerance is will provide guidance for determining how many devices will be located at the headwall and how they should be circuited.

Coordination with other systems and equipment. Receptacle count, location, and available functionality depend on other engineering systems and the actual equipment located or used at the headwall and in other parts of a patient room. Some issues to consider are these:

- *Receptacles by the patient bed.* If the electrical branch that feeds receptacles on each side of the bed is insufficient for the number of devices to be plugged in, power cords may end up draped across the patient or located behind the bed, where they may be damaged or hard to reach.
- *Monitor size.* Since the monitor size may not be known at the time of design, procured equipment may block or restrict access to additional devices.
- *Use of charging bricks and AC adapters.* These items, which transform 120V electricity for use by electronic equipment, often occupy more than a single receptacle space, rendering the adjacent receptacle unusable on a duplex or fourplex receptacle.

Exterior wall construction. Where electrical receptacles are placed on an exterior wall, their installation should not compromise the vapor barrier or other aspects of the wall construction. Location of these devices should be coordinated with the design team responsible for the exterior wall design.

Figure 4: Medical-Grade Power Strip

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Medical-grade power strips. Although power strips are commonplace in residential and commercial buildings, codes and standards limit their use in health care facilities. The Centers for Medicare & Medicaid Services (CMS) prohibits their use in patient care vicinities. Even power strips with hospital-grade outlets may be used only outside patient care areas.

Early development of a thoughtful plan for locating electrical receptacles will help prevent health care organizations from needing to rely on power strips once a space has been occupied. Although CMS has issued a categorial waiver for power strip use where an unreasonable hardship may result,[6] planning ahead will avoid the need to request a waiver.

Telehealth Considerations

Telehealth access, which connects patients and clients to doctors and other care providers remotely, skyrocketed during the COVID-19 pandemic, and its continued use in health care delivery is predicted going forward. This technology alone will change the delivery of care and the built environment in all health care settings, transforming the face of the continuum of care.

Telehealth will occur in patient rooms, exam rooms, and perhaps even in operating rooms as physicians can now consult together on an as-needed basis. This technology integration affects not only the quantity of electrical receptacles required in a room but also the use of alternate, low-voltage power distribution technologies such as PoE, or plastic optical fiber. Migrating to this type of power distribution completely changes the profile of the electrical distribution system, including electrical receptacle and data outlet needs.

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[6] For further guidance, see survey and certification letter 14-46-LSC: CMS Center for Clinical Standards and Quality/Survey & Certification Group, "Categorical Waiver for Power Strips Use in Patient Care Areas Various" (September 26, 2014), www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Policy-and-Memos-to-States-and-Regions-Items/Survey-and-Cert-Letter-14-46.

Planning

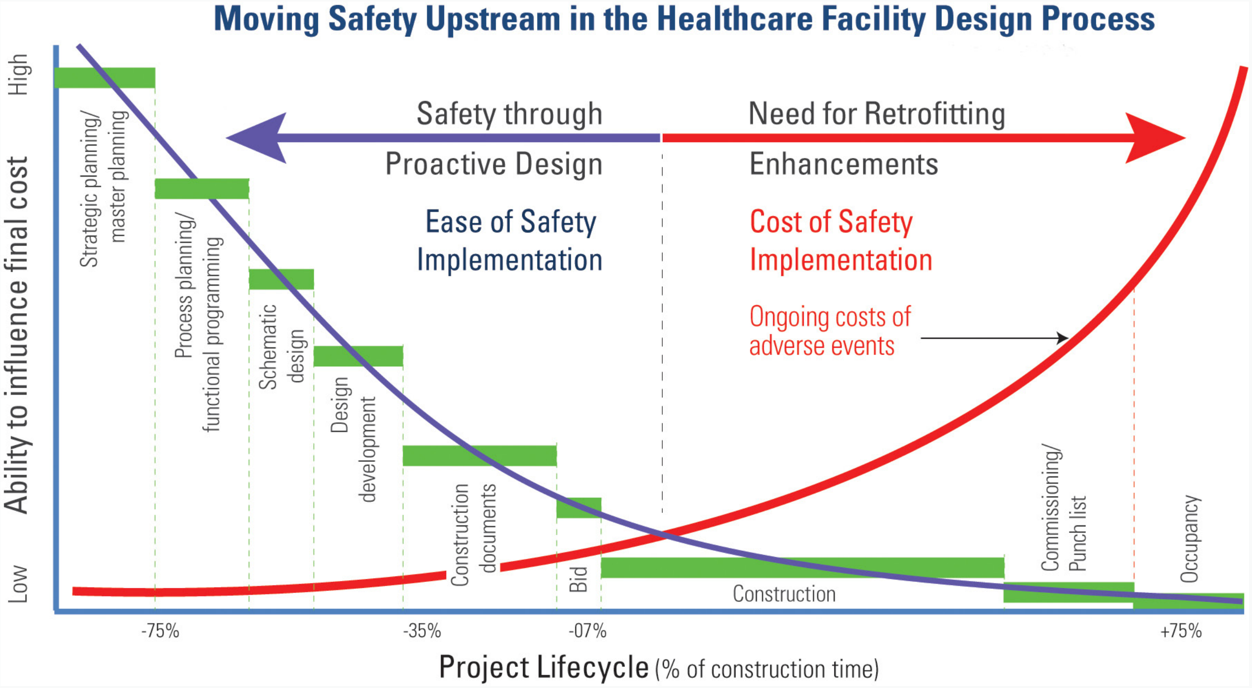
When a new construction or major renovation project begins, organizational leadership should identify a multidisciplinary team that is affected by and integral to the design of the project. The participation of these team members is crucial in several processes, including development of a scope of work, budget, functional program, and safety risk assessment. Planning the electrical infrastructure and access to power is central to achieving health care delivery goals in the present and future.

Project Budget

A code-sensible design that meets the minimum requirements as well as any additional needs for patients, visitors, and staff offers the highest long-term return on investment. Too often, provision of basic code-required minimums is dictated for budgetary reasons. Although such a design may be appropriate in some applications, the best way to confirm what is required for a particular project is to acknowledge the minimum requirements but empower key decision-makers to make an informed decision. Understanding when additional receptacles are needed for a particular situation is paramount.

When design elements or future considerations are not explored in the beginning of project planning, the result can be patient rooms that do not function as desired. Addressing operational needs using the change order process or after occupancy is an expensive way to achieve the physical environment needed for safe, effective patient care. A robust design including electrical receptacles beyond the minimum requirements may have a higher first cost, but such a flexible and code-sensible design enables a greater return on investment over the life of the project and future use of the space. Thoughtful planning of the electrical system, receptacles, and associated circuiting supports the ability of the health care organization to meet its care delivery mission into the future.

Figure 5: Timing is Everything



The Center for Health Design (excerpted from *Online Safety Risk Assessment Toolkit | A Process to Mitigate Risk* [CHD Tools], www.healthdesign.org/sra)

Figure 5 illustrates the impact timing has on design decisions in the project life cycle, and the short- and long-term costs show why a proactive, thoughtful design improves the delivered health care environment.

Staffing and Functional Considerations

Consistent headwall design. Often there is efficiency in designing the same provisions on each side of the headwall in a patient room, allowing nursing staff to care for a patient consistently from either side of the bed. This design approach also works for mirrored rooms, which may necessitate slight modification of device locations to accommodate patient needs.

Research[7] informs us that providing standardized gases and outlets at the patient bedside, where some of the most critical work occurs in a hospital, will improve staff response time and reduce overall stress for staff. Similarly, the physical location and elevation of electrical receptacles should support easy access and use for staff.

Figure 6: Location, Location, Location

Access to receptacles may be blocked or limited where they are located below suction outlets and canisters. Spills onto the receptacles can be a hazard.

Krista McDonald Biason

Proximity of equipment. Equipment location is often determined by the side of the bed from which staff will primarily provide care and the patient's diagnosis. The location of equipment for a patient with a head injury may differ from that for a patient with a foot injury, and

[7] R. Collins, "Clinician Cognitive Overload and Its Implications for Nurse Leaders," *Nurse Leader* 18, no. 1 (February 1, 2020): 44–47. https://doi.org/10.1016/j.mnl.2019.11.007

the electrical receptacles should be located to address the needs of the unit (if beds are segregated by program) or to allow flexibility to serve all patients.

Provision of receptacles to support all equipment needed at the bedside becomes more difficult as patient acuity increases. For example, in an intensive care unit (ICU), a patient may be connected to three intravenous pumps (each with their own plug), a dialysis machine, a ventilator, a heart and lung machine (for extracorporeal membrane oxygenation), and a cardiac monitor. All this equipment is attached to the patient and must be located directly adjacent to the patient bed; therefore, it is critical to determine the appropriate number and placement of electrical receptacles for an ICU.

In considering equipment location and needed receptacles, keep in mind that the future of health care is largely unknown. One certainty, however, is that health care facilities will need to be able to accommodate an increasing number of high-acuity patients, who will require an increasing amount of equipment to sustain and optimize their quality of life.

Receptacles for adjacent patient support rooms. In this paper, the patient room is used to illustrate strategies for designing the appropriate quantities, types, and locations of receptacles for a particular health care space. Proper attention should also be given to receptacles and circuit assignments for the adjacent toilet room; anteroom, where present; and nurse stations if these spaces are included in the project design.

Emergency Operations Plan

It is crucial for designers to understand a health care organization's EOP and how the organization's staff intends to operationalize the facility during an emergency event. This information may add constraints or demands that require more receptacles than the code-required, defend-in-place minimum requirements. A traditional hospital may require additional power at the patient bed for ventilators or other life-sustaining equipment. Medical/surgical rooms may be double-loaded to accommodate additional inpatients during an epidemic or after a catastrophic event. A hospital may even partner with another facility and shift high-acuity patients to another location. All of these factors should be considered when designing electrical systems, including receptacles, for patient care spaces.

Work Group Recommendations

There is no single recommendation for quantity, branch of power, location, or circuiting of electrical receptacles in patient care areas. The codes and guidelines provide minimum requirements and guidance but do not address functionality or ever-evolving demands for technology and diagnostic equipment. It is a disservice to patient care to blindly locate code-minimum devices in a space without understanding the specific conditions of care to be provided there. Rather, designers should strive for a code-sensible design that meets patient care needs (as well as staff and family needs) and can adapt to future opportunities.

Understanding the basic codes and standards requirements and then evaluating all of these parameters enables the designer and client to determine whether a code-minimum design is adequate or if the minimums should be enhanced to provide a facility design that meets the health care organization's operational needs. This knowledge also should validate that the final design is aligned with the budget and the desire to address future needs while still fulfilling the requirements of the organization's emergency operations strategy.

Process for Determining Electrical Receptacle Requirements

The FGI Electrical Receptacle Work Group suggests the following process for determining the operational requirements for electrical receptacles in patient care areas:

- Review NFPA 70, NFPA 99, and the FGI *Guidelines* documents for minimum requirements.

- Confirm facility and/or health care organization standards and whether they should be considered minimum requirements or a starting point for discussion.
- Conduct an assessment in collaboration with the health care organization to understand the proposed use of each space.
- Communicate with facility stakeholders:
  - Request clinical input.
  - Request input from on-site biomedical equipment staff.
  - Request input from the safety and security director.
  - Request facility management input.
  - Open and maintain a dialogue with the facility-side project team.
- Ask questions:
  - Appendix 2 of this paper shares some recommended questions to ask during planning.
  - Don't assume the minimum requirements are sufficient—ask the questions.
- If the area under consideration is an existing space:
  - Conduct a site visit to understand the existing installation and evaluate its ability to handle future needs.
  - Determine if the current electrical system up to the source, not just the local panelboard, can accommodate additional load.
  - Address infrastructure needs in conjunction with the receptacle design.
- Consider future technologies, including alternate power technologies, and alternate uses of the space.
- Discuss design solutions with the client and assure there is alignment in expectations and clinical outcomes.
- Obtain approval for the design solution from affected stakeholders and regulatory entities, as required.
- Finalize the design solution and generate the required construction documentation.

Needs Assessment Tool

A significant revision in Table 2.1-1 (Electrical Receptacles for Patient Care Areas in Hospitals) in the 2022 FGI Hospital *Guidelines* requires that additional devices "be located to support clinical functions and patient and visitor needs" over and above the NFPA minimum number of receptacles. Planners and designers generally prefer a hard number, but every project is unique. Thus, it is not assured that provision of the minimum number of receptacles will support clinical functions and patient and visitor needs if these have not been clearly defined. Moreover, some patient rooms are now being designed with more walls than the original assumption of four. For these reasons, the *Guidelines* no longer dictates exact locations beyond NFPA requirements.

In this more fluid environment, an assessment tool can be useful to provide structure and a decision-making process for determining a hospital's need for power access. The sample assessment provided in Appendix 2 of this paper demonstrates how to document current and future needs for medical/surgical patient rooms. This example can be applied to many types of patient care, diagnostic, and treatment rooms and can be used to inform emergency planning efforts.

This assessment tool enables the design team to frame questions for the client and to record their responses. Use of such a tool is intended to help identify the true minimum number of electrical receptacles and power requirements for a particular space and can be modified for different room types.

The questions posed for a medical/surgical patient room in Appendix 2 illustrate the questions that should be asked for most patient care spaces. The primary differences between rooms would be the functional use of each space and how those decisions affect the requirement for electrical receptacles and associated power requirements.

Appendix 1

2022 FGI Hospital *Guidelines*
Table 2.1-1: Electrical Receptacles for Patient Care Areas in Hospitals*

Section	Location	Minimum Number of Single Receptacles[1]	Receptacle Locations[2]
PATIENT BED LOCATIONS			
2.1-2.4.2	Airborne infection isolation (AII) room[3]	12	Devices shall be located to support clinical functions and patient and visitor needs.[4]
2.2-2.2.2	Medical/surgical unit patient room[3]		
2.2-2.2.4.4	Protective environment room[3]		
2.2-2.5.2	Intermediate care unit patient room		
2.2-2.10.2.2	Postpartum unit patient room[3]		
2.2-2.12.2	Pediatric and adolescent unit patient room[3]		
2.6-2.2.2	Rehabilitation unit patient room		

2022 FGI Hospital Guidelines Table 2.1-1: Electrical Receptacles for Patient Care Areas in Hospitals *(continued)*

Section	Location	Minimum Number of Single Receptacles[1]	Receptacle Locations[2]
2.2-2.6.2.2	Intensive care unit (ICU) patient care station	16	Devices shall be located to support clinical functions and patient and visitor needs.[4]
2.2-2.7.2	Pediatric intensive care unit (PICU) patient room		
2.2-2.9.2	Neonatal intensive care unit (NICU) infant care station		
2.2-2.10.3	Labor/delivery/recovery (LDR) and Labor/delivery/recovery/postpartum (LDRP) room		8 convenient to head of mother's bed 4 convenient to each bassinet with one on each wall
2.2-2.16.2	Hospice and/or palliative care room		Convenient to head of bed with one on each wall
2.2-2.11.3.1	Newborn nursery infant care station	4	Convenient to each bassinet
2.2-2.11.3.2	Continuing care nursery infant care station	5	Convenient to head of each bed, crib, or bassinet (At least 50% of these outlets shall be connected to emergency system power and be so labeled.)
2.5-2.2.2	Behavioral and mental health patient care unit patient bedroom	No minimum	
DIAGNOSTIC AND TREATMENT AREAS			
2.1-3.2 2.2-3.5.2.1 (2)	Exam room Class 1 imaging room	8	4 convenient to head of gurney or bed or on each lateral side of the imaging gantry
2.2-2.10.11.1	Cesarean delivery room	30[5]	16 convenient to table placement 2 on each wall 6 in the infant care area
2.2-3.1.2.6	Treatment room for basic emergency services	12	Convenient to head of gurney or bed

2022 FGI Hospital *Guidelines* Table 2.1-1: Electrical Receptacles for Patient Care Areas in Hospitals *(continued)*

Section	Location	Minimum Number of Single Receptacles[1]	Receptacle Locations[2]
2.2-3.1.3.3 (2)	Triage room or area in the emergency department	6	Convenient to head of gurney or bed (At least 50% of these receptacles shall be connected to emergency system power and be so labeled.)
2.2-3.1.3.6 (1)	Emergency department treatment room	12	Convenient to head of gurney or bed
2.2-3.1.3.6 (2)	Trauma/resuscitation room	16	Convenient to head of gurney or bed
2.2-3.1.3.6 (6)	Low-acuity patient treatment station	4	Convenient to patient chair
2.2-3.1.3.6 (7) (a)	Interior human decontamination room	4	—
2.2-3.3.2	Observation unit patient care station	8	4 convenient to head of gurney or bed
2.2-3.4.2 2.2-3.5.2.1 (2)	Procedure room (including endoscopy) Class 2 imaging room	12[5]	8 convenient to table placement with at least one on each wall
2.2-3.4.3 2.2-3.5.2.1 (3)	Operating room Class 3 imaging room	36[5]	16 convenient to table placement 2 on each wall
2.2-3.10.2	Hemodialysis patient care stations	8	4 on each side of a patient bed or lounge chair. (Two on each side of the bed shall be connected to emergency power.)
POST-ANESTHESIA CARE LOCATIONS			
2.1-3.4.4	Phase I post-anesthetic care unit (PACU) patient care station	8	Convenient to head of gurney or bed
2.1-3.4.5	Phase II recovery patient care station	4	Convenient to gurney, lounge chair, or bed

[1]Permanently installed single, duplex, or fourplex receptacles or a combination of these shall be permitted. Receptacles in relocatable power taps or mounted on portable equipment shall not be counted as part of the total minimum requirement.

[2]"Convenient" in this table means the cords from the equipment to be used in the room can reach the receptacles without causing a trip hazard.

[3]Omission of receptacles from exterior walls in patient rooms shall be permitted where construction or room configuration makes installation impractical.

[4]The number of receptacles at the patient bed location for these spaces is intended to agree with the number required in the governing edition of NFPA 99: *Health Care Facilities Code* and NFPA 70: *National Electric Code*. Additional receptacles shall be provided to support clinical functions and the personal needs of the patient and visitors.

[5]The number of receptacles for these spaces is intended to agree with the number required in the governing edition of NFPA 99: *Health Care Facilities Code*.

Notes

1. In case of a single transfer switch failure, consideration shall be given to providing some receptacles on critical branch power and some on normal power or to providing two separate sources of critical branch power originating from two different transfer switches at the head of patient beds and in operating rooms, cesarean delivery rooms, and trauma/resuscitation rooms. The number of circuits provided shall comply with NFPA 70 and NFPA 99 requirements.
2. Each patient bed location or procedure room shall be supplied by at least two branch circuits, one from the critical branch system and one or more from the normal system. Critical care locations served from two separate transfer switches on the essential electrical system shall not be required to have separate circuits from the normal system.
3. Branch circuits serving only special purpose receptacles or equipment in critical care areas shall be permitted to be served by other panelboards.
4. An additional receptacle shall be provided for a television if one is furnished in the room.
5. A minimum of one dedicated circuit shall be provided to each critical care patient location.
6. Open heart post-anesthesia recovery spaces require more receptacles than those specified in this table; the number should be determined during the planning phase.
7. Receptacles shall be located so they are not in conflict with suction slides and canisters.

Appendix 2

Sample Electrical Receptacle Needs Assessment*

Medical/Surgical Patient Room

Department: ______________________________ **Date:** ____________________________________

Patient acuity: ____________________________ **Date(s) revisions made to the assessment:** ___________________________

Patient types or range of diagnoses: ____

Patient room function(s): ____

Room number(s): ____

Patient Room Design Criteria	Y/N	Comments
1. Design for surge capacity?		
2. Design for multiple functions/ modalities?		
3. Will telehealth service occur in this room?		

*The needs assessment for a medical/surgical patient room shown here is intended as an example of how to apply this form for any patient care area.

Patient Room Design Criteria	Y/N	Comments
4. Will dialysis occur in this room?		
5. Will imaging equipment be used in this room?		
6. If this is a pediatric space, will tamper-resistant receptacles be needed?		
7. Will the following staffing and functional considerations be included in the design?		
a. Same hand or mirrored design		
b. Consistent headwall design		
c. Ergonomic requirements		
d. Proximity of equipment		
8. Has the emergency operations plan been evaluated or incorporated into the design?		
9. Will patients also have acute behavioral health needs?		
10. Will patient lifts be used in the room?		
a. Installed patient lifts		
b. Mobile patient lifts		

General Zone Criteria	Y/N	Comments (include vendor if known)
1. Do patient beds require receptacles?		
2. Patient bed requirements		
3. Do patient lifts require receptacles?		
4. Additional receptacle needs for areas supporting the patient room?		
5. General technology criteria		
a. Patient-monitoring equipment?		
b. Patient entertainment, education, and visual boards?		
c. Personal electronic equipment receptacles and ports?		
d. Net new technology goals?		

Patient Room Equipment Criteria			
Patient zone equipment—list items below.	Location	Power requirements	Additional requirements (life-supporting, tamper-resistant, dedicated circuit, etc.)

Staff zone equipment—list items below.	Location	Power requirements	Additional requirements (life-supporting, tamper-resistant, dedicated circuit, etc.)

Family zone equipment—list items below.	Location	Power requirements	Additional requirements (tamper-resistant, dedicated circuit, furniture connections, USB devices, etc.)

Notes

1. Refer to NFPA 70, NFPA 99, and the FGI *Guidelines* documents for minimum quantity of receptacles.
2. NFPA Category 2 spaces require a minimum of 8 receptacles at the patient bed, while Category 1 spaces require a minimum of 14 receptacles at the patient bed. These requirements indicate the number of receptacles for the patient bed location only (not for the patient room overall).
3. Refer to Table 2.1-1 (Electrical Receptacles for Patient Care Areas in Hospitals) in the 2022 FGI Hospital *Guidelines* (and in Appendix 2 of this white paper), with associated notes, for total minimum FGI *Guidelines* requirements.
4. The minimum number of receptacles required in a patient room is the highest quantity of receptacles indicated from all mandated codes and standards and is not additive.
5. Toilet room, anteroom, and nursing station needs are not included in this sample assessment.

FGI ELECTRICAL RECEPTACLE WORK GROUP

Krista McDonald Biason, PE, vice president and senior electrical project engineer at HGA in Minneapolis, served as **chair** of this work group. She is a licensed electrical engineer with 30 years' experience in health care electrical design and has extensive experience with infrastructure upgrades and facility assessments. Krista currently serves on the NFPA 70 National Technical Committee-Code-Making Panel 13. She is a special expert for the NFPA 99 Health Care Facilities Code Technical Committee on Electrical Systems (HEA-ELS) and serves on NFPA task forces that evaluate implementation of microgrids and alternate energy sources. She serves as co-chair of the American Society for Health Care Engineering's Equity, Diversity, and Inclusion task force. Krista has served on the FGI Health Guidelines Revision Committee since 2018, contributing to the Hospital Document Group and the alternate care facility task force. She was also a member of the alternate care facility task group, part of FGI's Emergency Conditions Committee.

Udo Ammon, AIA, served for eight years as bureau director for architecture and engineering review with the New York State Department of Health. In this role, he developed regulations and served on several committees related to a wide range of health care issues, including facility resiliency, Ebola planning and preparation, and COVID response. In 2022 Udo joined St. Peters Health Partners, affiliated with Trinity Health, as senior director of facilities, construction, and design. At St. Peters he works with planning, design, and regulatory affairs and oversees numerous hospitals, nursing homes, and medical office facilities. His 34 years of practicing architecture also include a senior position at the Dormitory Authority of the State of New York conducting reviews for certificates of need. Udo has served on the FGI Health Guidelines Revision Committee since 2015, participating on the Hospital Document Group and various topic and task groups, including a work group of authorities having jurisdiction.

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