CHAPTER 3
ERGONOMICS AND WORKFLOW

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Checklist

1. Have end users considered how patients, supplies, and equipment will move through the planned facility?
2. Have end users considered the workflow of tasks they will repeatedly perform in the planned facility?
3. Will there be adequate technology and access to technology for communication within the facility and to the outside (considering telephony, intercoms, information displays for schedule, laboratories, radiology, etc.)?
4. Will lighting be adequate for the tasks to be performed in the facility?
5. Has the facility been optimized to control noise pollution, provide different temperature zones, and distribute electrical power and compressed gases?

Introduction

Ergonomics is the field of study of the physical and psychological relationships between working humans and their tools and environments. The purpose of ergonomics is to promote efficiency of operation and decrease human error and stress and strain on the user. Ergonomics should be an early consideration in the design of any new or retrofitted surgical facility so that the interactions of workers with their coworkers, equipment, and facilities can be studied and the resulting data can guide the design of better policies, procedures, equipment, and facilities.

Early attention to ergonomics is increasingly applied to the design of medical instrumentation. In 2001, the American National Standards Institute and the Association for the Advancement of Medical Instrumentation published the *Human Factors Design Process for Medical Devices*, which describes how ergonomics and human factors should be applied to the design of medical devices. The intention is to help equipment manufacturers develop safe and effective medical devices. However, no such document describes the application of ergonomics and human factors to the design of operating suites and other health care environments, even though these facilities greatly influence the safety and efficiency of the processes within.

The process of facility design has already been covered in Chapter 1, “The Design Process,” but the key ergonomic considerations will be highlighted here. Facility design begins with an analysis of needs and a clearly defined objective. From this, an overall concept for the facility is formulated. This leads to the development of the functional criteria and requirements for

specific areas of the facility. Thereafter, a schematic design of the facility is produced. Finally, construction of the facility begins. But, ergonomic-guided design is an iterative and cyclical process wherein the steps from overall concept to schematic design are repeated and refined based on the feedback of owners, end users, consultants, and customers until all the major design flaws have been fixed. Techniques such as task and workflow analysis, site visits to similar facilities, building mockups, cognitive or computer-based walkthroughs, and interviews and surveys are used to obtain feedback on the proposed designs. Such a design approach requires the early involvement of experienced users who have time allotted to help with the design process. As stated in Chapter 1, the design team must include people who will actually work in the facility.

Ergonomics

Factors to consider under the heading of ergonomics include medical teams in the operating room (OR), lighting, noise, temperature, work-related injuries, and workflow and task analysis.

Medical Teams in the OR

- Different needs of surgical, anesthesia, and nursing (including ancillary) teams
- Patient safety, communication, and shared data: Universal Protocol, World Health Organization checklist, time out, and information displays (e.g., x-ray, vitals, etc.)
- Communication into and out of the OR and case scheduling
- Simulation for OR emergencies
- Communication skills: teamwork training

Lighting

- Sufficient light is needed for works-specific tasks
- Surgeons need the brightest light
- Anesthesiologists and nurses need bright light
- Hazards of colored lenses (e.g., need for laser safety goggles)
- Interference of ceiling-mounted light booms with other equipment (e.g., video monitors, drop down gas sources, and intravenous poles)
- Local-field lighting: headlights

Noise

- ORs are noisy
- Noise is reflected; thus, the localization of sounds is difficult
- High noise levels interfere with communication and alarm perception
- American Society of Anesthesiologists standard requires being able to hear the pulse oximeter variable pitch tone above the background noise
- Causes of OR noise (e.g., hard surfaces, suction, room ventilation, conversations, alarms, pagers, overhead pages, and music)
- Room and furniture design to decrease noise levels

Temperature

- Comfortable temperature increases efficiency and safety
- Patient and staff are insulated to various degrees
- Patients tend to become hypothermic
- Surgeons tend to become uncomfortably warm
- Personal cooling and warming devices
- Need for rapid changes in room temperatures

Work-Related Injuries

- Lifting
- Needlesticks and sharps injuries (including exposure to blood-borne pathogens)
- Repetitive motion injuries, static posture injuries, and wrist/forearm injuries from the use of heavy or awkward instruments/devices
- Physical fatigue and OR seating
- Different user shapes and sizes (e.g., small female vs. large male) and the effect of sizes and shapes of medical device handles and controls.

Workflow and Task Analysis

- Use of simulation in the design phase
- Location of supplies, medication, and instruments (e.g., in vs. out of room and free access to supplies vs. electronic inventory control systems)
- Planning for sequential vs. parallel patient flow (e.g., block rooms and induction rooms)
- Equipment storage, work surfaces (e.g., setting up and supplies), and writing surfaces (usually minimal)
- The "integrated OR" concept: Endosuite®, integrated room/procedure video, and telemedicine/telementoring systems

Team-Specific Issues

Anesthesia: The Anesthesia Cockpit

- Machine size and orientation:
  - Typical anesthesia workstation and medication cart dimensions
  - Anesthesia machines are generally configured so the patient attachments (e.g., the breathing circuit) are located on the left-hand side of the machine
  - The anesthesia machine is best positioned to the right side at the head of the OR table or in a less desirable location behind the anesthesia provider
  - In some surgical procedures, the anesthesia machine may be located at the patient's side or at the patient's feet
- Suction:
  - Suction canister and controls should be located in the anesthesia cockpit within reach and view of the anesthesia provider
  - Height of suction canister should be below the level of the surgical table (to decrease effect of hydrostatic pressure)
- Monitor, computer, and phone:

  - Access to patient data in the Electronic Medical Record (EMR) in real time
  - Access to "help" materials (e.g., internet) in real time
  - Wired and/or wireless access
  - Portable vs. fixed computers with keyboards and mice; where will the mouse be located?
  - Use of alternate screen-pointing devices (e.g., touch screens, trackballs, and knobs)
  - Glare, spillage, and infection control considerations
  - Food and Drug Administration Human Factors Design guidelines
  - ECRI Institute resources
- Power management:
  - Electrical, phone, network, and compressed gas outlets should be located near the anesthesia cockpit and not across major pathways into and out of the room
  - Multiple network ports may be needed because monitors, anesthesia information systems, hospital EMRs, and general intranet and internet usage may require separate networks
  - Can be located on the ceiling or on ceiling-mounted "booms"
- Hose cord and cable management:
  - Hoses, cord, and cables on the floor can be a trip hazard and can interfere with positioning of wheeled equipment.
  - Wheel protectors can be used to push cables away

Surgery

- Cleaning and sterility
- Patient support and positioning systems: adequate table height adjustments during surgery
- Video-endoscopic surgery:
  - Integrated equipment towers (e.g., booms vs. carts)
  - Display locations and adjustability
  - Communication systems (e.g., video, audio, images, picture archiving and communication system, etc.)
  - Surgeon-controlled systems (e.g., computer interface and voice activation)
  - Management of multiple cables/tubes from multiple pieces of equipment (e.g., "OR spaghetti")
- Sharps injury prevention: double gloving, blunt suture needles, hands-free zone, and engineered sharps injury prevention devices
- OR documentation: paper vs. computer
- Interruptions: personal communication devices (e.g., pagers, cell phones, and cameras), overhead pages, and in/out room traffic
- Workflow aids for best practices (e.g., antibiotics, deep vein thrombosis prophylaxis, beta blockers, etc.)
- Physical safety and comfort: gowns, cooling systems, and eye/face protection

Nursing

- Preference cards or the electronic equivalent and their use and location
- Standardization of supplies