

CHAPTER 3 – ERGONOMICS AND WORKFLOW

Lead Author: Robert Loeb, MD, Associate Professor of Anesthesiology, University of Arizona

Contributors: Ramon Berguer, MD, Clinical Professor of Surgery, UC Davis

Checklist:

Have end-users considered how patients, supplies, and equipment will move through the planned facility?

Have end-users considered the workflow of tasks they will repeatedly perform in the planned facility?

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, labs, radiology, etc.)?

Will lighting be adequate for the tasks to be performed in the facility?

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, 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 co-workers, equipment, and facilities can be studied, and that 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 (ANSI) and the Association for the Advancement of Medical Instrumentation (AAMI) 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 healthcare 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 mock-ups, 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.

Factors to consider under the heading of ergonomics include:

Medical teams in the OR

- Different needs of surgical, anesthesia, nursing (including ancillary) teams
- Patient safety, communication, shared data. Universal protocol, WHO checklist, Time Out, information displays (Xray, vitals)
- Communication into/out of the OR, case scheduling
- Simulation for OR emergencies
- Communication skills: teamwork training

Lighting

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

Noise

- ORs are noisy
- Noise is reflected and thus the localization of sounds is difficult
- High noise levels interfere with communication and alarm perception
- ASA standard requires being able to hear the pulse oximeter variable pitch tone above the background noise
- Causes of OR noise (hard surfaces; noise production from suction, room ventilation, conversations, alarms, pagers, overhead pages; 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
- Needle-sticks and sharps injuries (including exposure to blood-borne pathogens)
- Repetitive motion, static posture injuries, wrist/forearm injuries from the use of heavy or awkward instruments/devices
- Physical fatigue, OR seating
- Different user shapes and sizes (small female vs. large male). 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, instruments (in vs. out of room, 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 (setting up, supplies), writing surfaces (usually minimal)
- The “integrated OR” concept. Endosuites, integrated room/procedure video, 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 (i.e., the breathing circuit) is 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, phone

- Access to patient data in the Electronic Medical Record in real time
- Access to “help” materials (internet, etc.) 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 (touchscreens, trackballs, knobs)
- Glare, spillage, infection control considerations
- FDA Human Factors Design guidelines
- ECRI 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, as monitors, anesthesia information systems, hospital Electronic Medical Record, 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 (booms vs. carts)
 - Display locations and adjustability
 - Communication systems (video, audio, images, PACS)
 - Surgeon-controlled systems (computer interface, voice activation)
 - Management of multiple cables/tubes from multiple pieces of equipment (OR Spaghetti)
- Sharps injury prevention: Double gloving, blunt suture needles, Hands-free zone, Engineered sharps injury prevention devices
- OR documentation: paper vs computer
- Interruptions: Personal communication devices (pagers, cell phones, cameras), overhead pages, in/out room traffic.
- Workflow aids for best practices (antibiotics, DVT prophylaxis, beta blockers, etc.)
- Physical safety and comfort: Gowns, cooling systems, eye/face protection

Nursing

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

