

## BIOENGINEERING METHODS OF WHEELCHAIR EVALUATION

**EDWARD PEIZER, PHD; DONALD WRIGHT, MED; HOWARD FREIBERGER, AM**

The Veterans Administration undertakes the responsibility for evaluation of a variety of orthopedic devices such as braces, artificial limbs, wheelchairs, and patient lifts. Its primary purpose is to provide an intelligent basis for selection, procurement, and application of those devices which can be of greatest benefit to disabled veterans. This program also serves to guide the manufacturers of orthopedic devices along lines of development that are of particular interest to the Veterans Administration. The evaluation may therefore range from analysis of the design and materials to a full-scale biomechanical analysis in the laboratory, as well as a field study in several hospitals and clinics around the country. Laboratory studies are generally delegated to the VAPC Bioengineering Laboratory, and field studies are usually conducted by the Prosthetic and Sensory Aids Service.

Orthopedic braces and artificial limbs for both the upper and lower extremities have been the subject of evaluation programs for many years, and relatively useful methods and techniques have been evolved. The parameters which provide the most useful assessment of these devices are fairly well established. In addition, there exists a body of basic data on normal human locomotion from

which useful criteria for evaluating performance can be drawn.

A somewhat different situation prevails in an approach to the evaluation of such items as lift aids and wheelchairs since there is available little basic information about their performance factors. Such standards as do exist are descriptive in nature and relate primarily to dimensions and materials of the devices. A meaningful evaluation, however, depends on tests not only of hardware but also of the human factors that enter into efficient use.

To provide a basis for an adequate assessment of orthopedic lift aids and wheelchairs, there has evolved in the Bioengineering Laboratory an evaluation program that takes into account the man-machine combination that is both descriptive and functional. This program consists of specifically designed test procedures to provide information on:

1. Analysis of mechanical design, adequacy of materials, and durability.
2. Convenience and ease of operation.
3. Patient acceptability in relation to appearance, utilization in the home, and the availability of other similar devices.
4. Stability and safety.
5. Force and energy requirements.

A careful analysis of the design of an orthopedic device illustrates the extent to which the fundamen-

tal idea or purpose has been translated into appropriate mechanical features. A consideration of the mechanical design in relation to all aspects of the intended application frequently discloses serious limitations. In designing an orthopedic lift for extreme stability, for example, one developer failed to realize that the broad base of support was a grave handicap in confined areas where lifts are frequently used. Materials used in an apparatus strongly influence comfort, safety, and durability. These features are assessed in the light of good design principles and on the basis of some standards which, although not entirely adequate, can be usefully applied. Durability is frequently determined by means of cycling tests.

Convenience and ease of operation are not only important considerations for the therapist who may use the devices, but they are especially critical factors for the patients of limited strength and mobility who must operate them. Use tests are devised to assess these matters. In some cases, observation of several appropriately selected patients may suffice; in other cases, longer-term hospital use may provide the basis for judgment.

To continue reading, please visit <http://www.rehab.research.va.gov/jour/64/1/1/77.pdf>

