RELATIVE INCIDENCES OF NEW AMPUTATIONS
Statistical Comparisons of 6,000 New Amputees

Hector W. Kay and June D. Newman

Because of the methods employed in the delivery of health services in the United States, it has not been practical to conduct accurate census studies of the amputee population; and, except for data on Veterans Administration beneficiaries, little is known generally about the characteristics of individuals who have lost their limbs.

In 1964 Dr. Harold W. Glattly published the results of a survey of new amputees (1) he conducted with the assistance of members of the American Orthotic and Prosthetic Association (AOPA) during the period October 1, 1961–January 31, 1963. Data were obtained on more than 12,000 amputees who presented themselves for fitting of an artificial limb for the first time. The study was the first of its kind, and the results have been of interest and use to many practitioners, research workers, and administrators.

In 1973-74, the Committees on Prosthetics Research and Development and Prosthetic-Orthotic Education (CPRD-CPOE) conducted an identical study to determine whether the characteristics of the current amputee population were any different from those recorded by Glattly.

Procedures identical to those used in the first study were employed so that valid comparisons could be made.

In his study Glattly found that there was no change in the ratios obtained when data from the first 5,000 cases were compared with those obtained from the total sample of 12,000. In the 1973-74 study, data from the first 1,654 cases were analyzed (2) and compared later with data from 5,830 cases. Because there were no practical differences in the ratios obtained, the study was concluded.

Thus, it is felt that the data presented accurately reflect current incidences of amputation practice. However, it should be emphasized that neither this study nor the one reported by Glattly was conducted in conformance with scientific sampling techniques.

A comparison of the new reading with Glattly's final report reveals some apparently significant changes in amputation statistics, as well as some situations where very little change seems to have occurred during the past 12 years.

METHOD

One hundred and forty-three prosthetics facilities, all members of AOPA, in 39 states and the District of Columbia, participated (Fig. 1). Two simple data-collection forms were devised by Dr. Glattly. To gather the same type of information, similar forms, updated for computer programming, were used in the current study (Figs. 2 and 3). The participating facilities were provided packets of the forms, which contained original data slips to be retained by them for future reference, as well as carbon copies in the form of addressed and stamped postcards for mailing to CPRD-CPOE. Participants were instructed to complete a card on each new amputee for whom an original prosthetic device was provided. Amputees furnished with a replacement prosthesis were not recorded in either study. Card No. 1 was used for single amputations or multiple amputations done simultaneously for a single cause. Card No. 2 was prepared for cases in which more than one amputation was done at separate times for either the same or different causes—for

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example, an individual who had a below-knee amputation revised at a later date to the above-knee level. This type of patient represents a "new" case in the sense that his above-knee limb remnant had never been fitted previously. To indicate sex, site, and causes of amputation, numbers adjacent to the appropriate information were circled.

Causes of amputation were grouped under four categories:

- **Trauma.** Amputations due to physical and thermal injuries, and to infection following injury.
- **Disease.** Amputations due to vascular diseases and infections.
- **Tumor.** All types of growths for which an amputation is performed.
- **Congenital.** Only cases in which prostheses were fitted were included. The type of prosthesis was used to determine the "amputation" level.

### FINDINGS

#### SEX

Glattly found that, in the total survey population, the ratio of males to females undergoing amputation (Table I) was better than 3 to 1 (77 to 23 percent). In the present study the proportion of males had dropped slightly, with a corresponding proportional increase in females (72 to 28 percent).

Glattly concluded that the disparity in amputation rates for males and females was attributable largely to the fact that amputations by reason of injury occurred nine times as frequently in males as they did in females (Table 2). In the current study males still predominated, but the trauma ratio had dropped to 7.2 to 1. The proportion of males to females coming to amputation because of disease had dropped slightly—2.6 to 1 versus 2.1 to 1, but it is somewhat doubtful whether this change is of any significance.
Fig. 2. Amputee Survey Card No. 1. Data form for single amputations and multiple amputations resulting from a single cause at the same time.

Fig. 3. Amputee Survey Card No. 2. Data form for multiple amputations of the same limb, occurring serially at different times from the same or different causes.
Table 2. Ratios Of Males To Females In Relation To Cause Of Amputation.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Current Study</th>
<th>Glattly Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>7.2 to 1</td>
<td>9.2 to 1</td>
</tr>
<tr>
<td>Disease</td>
<td>2.1 to 1</td>
<td>2.6 to 1</td>
</tr>
<tr>
<td>Tumor</td>
<td>1.3 to 1</td>
<td>1.2 to 1</td>
</tr>
<tr>
<td>Congenital</td>
<td>1.5 to 1</td>
<td>1.2 to 1</td>
</tr>
</tbody>
</table>

Distribution of new amputations by cause and sex is considered in somewhat more detail in Table 3. Here, some significant changes have occurred. In the total population (male and female) the percentage of amputations deriving from trauma dropped from Glattly’s 33.2 percent to 22.4 percent in the present study, and substan-

Table 3.

**DISTRIBUTION by CAUSE and SEX**

<table>
<thead>
<tr>
<th></th>
<th>TRAUMA</th>
<th>DISEASE</th>
<th>TUMOR</th>
<th>CONGENITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MALE</td>
<td>FEMALE</td>
<td>MALE</td>
<td>FEMALE</td>
</tr>
<tr>
<td>Male</td>
<td>392</td>
<td>124</td>
<td>666</td>
<td>547</td>
</tr>
<tr>
<td>Female</td>
<td>9.6</td>
<td>13.2</td>
<td>1307</td>
<td>1244</td>
</tr>
</tbody>
</table>

|            | MALE   | FEMALE | MALE  | FEMALE     | MALE  | FEMALE | MALE  | FEMALE   |
|-----------|--------|--------|-------|------------|
| Present Survey | 392    | 124    | 666   | 547        | 797   | 699    | 703   | 580       |
| Glattly Study  | 124    | 13.2   | 1244  | 1244       | 1297  | 1320   | 1320  | 1244      |
tial decreases in trauma-related amputations in both males and females are apparent. The reverse situation is evident in figures for disease-related amputation. In the total sample the percentage increased from Glattly's 58 percent to 70.3 percent in the present study, percentage increases occurring in both male and female populations. Other cause-of-amputation categories did not appear to show significant changes.

In the 1961-63 study the proportion of lower- to upper-limb amputations in the total sample was roughly 6 to 1 (Table 4). In the present survey the ratio had increased to approximately 11 to 1. This ratio increase was apparent for both males and females. It could be caused by an increase in the number of older patients fitted with lower-limb prostheses rather than a decrease in the incidence of upper-limb amputations.

 sidel and Site of Amputation

- Side. Glattly found no significant difference in the incidence of left- and right-sided amputations in either the upper or lower limbs. These proportions remained essentially unchanged in the present data (Table 5).

<table>
<thead>
<tr>
<th>Table 5.</th>
<th>Distribution By Side Of Amputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Limb</td>
<td>Percent Present Study</td>
</tr>
<tr>
<td>Left</td>
<td>51.3</td>
</tr>
<tr>
<td>Right</td>
<td>48.7</td>
</tr>
<tr>
<td>Lower Limb</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>50.1</td>
</tr>
<tr>
<td>Right</td>
<td>49.9</td>
</tr>
</tbody>
</table>
The data presented in Table 6 show significant changes in the percentages of above- and below-knee amputations. The present survey shows a decrease to 32.6 percent from Glattly's 44.1 percent in above-knee amputations, and a proportionate increase in below-knee amputations from 36.8 percent to 53.8 percent.

AGE AND CAUSE

Glattly was surprised by the large number of amputees over 70 years of age who were being fitted with prostheses. They numbered 1,749, or 15.4 percent of all reported cases. In the present report the amputees in this category numbered 1,271, or 22 percent of the total number of cases, a significantly higher proportion (Table 7). Moreover, the later data show four more amputees over the age of 91 in a one-year period than there were in the Glattly two-year study (12 versus 8). Both studies revealed that the largest
The number of “new” amputees fitted with prostheses were in the 61-70 age group.

- **Tumor.** A relatively high incidence of amputation for malignancy in the second decade of life was noted by Glattly. This common finding was confirmed by the present data (Table 8A).

- **Trauma.** In the Glattly report the largest number of amputations due to trauma occurred in the 41-50 age group. In the current survey the largest number of trauma-related amputations occurred in the 21-30 age group (Table 8B). One might speculate that injuries occurring during the Vietnam war could be largely responsible for trauma-related amputations in the younger age group. However, it seems unlikely that a significant number of such patients could be receiving their first limbs in 1973-74.

- **Disease.** In both studies the largest number of amputations for disease occurred in the 61-70 age group (Table 8C). Ninety-three percent of all amputations in this age group were performed for disease. The figure rises with advancing age — 96.5 percent of amputations for persons over age 71 were for disease.

### MULTIPLE AMPUTATIONS

Amputations involving more than one limb that are done at the same time for the same cause are infrequent (Table 9). They represent only 3.3 percent of all amputations in the current study. In Glattly's survey they represented 2.6 percent of all reported cases.

<table>
<thead>
<tr>
<th>Table 8. RELATIVE INCIDENCE by AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. AMPUTATIONS DUE TO TUMOR</strong></td>
</tr>
<tr>
<td>YEARS</td>
</tr>
<tr>
<td>0-10</td>
</tr>
<tr>
<td>11-20</td>
</tr>
<tr>
<td>21-30</td>
</tr>
<tr>
<td>31-40</td>
</tr>
<tr>
<td>41-50</td>
</tr>
<tr>
<td>51-60</td>
</tr>
<tr>
<td>61-70</td>
</tr>
<tr>
<td>71-80</td>
</tr>
<tr>
<td>81-90</td>
</tr>
<tr>
<td>91+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>B. AMPUTATIONS DUE TO TRAUMA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>YEARS</td>
</tr>
<tr>
<td>0-10</td>
</tr>
<tr>
<td>11-20</td>
</tr>
<tr>
<td>21-30</td>
</tr>
<tr>
<td>31-40</td>
</tr>
<tr>
<td>41-50</td>
</tr>
<tr>
<td>51-60</td>
</tr>
<tr>
<td>61-70</td>
</tr>
<tr>
<td>71-80</td>
</tr>
<tr>
<td>81-90</td>
</tr>
<tr>
<td>91+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>C. AMPUTATIONS DUE TO DISEASE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>YEARS</td>
</tr>
<tr>
<td>0-10</td>
</tr>
<tr>
<td>11-20</td>
</tr>
<tr>
<td>21-30</td>
</tr>
<tr>
<td>31-40</td>
</tr>
<tr>
<td>41-50</td>
</tr>
<tr>
<td>51-60</td>
</tr>
<tr>
<td>61-70</td>
</tr>
<tr>
<td>71-80</td>
</tr>
<tr>
<td>81-90</td>
</tr>
<tr>
<td>91+</td>
</tr>
</tbody>
</table>

**Table 8. RELATIVE INCIDENCE by AGE**

**Table 9. Multiple Amputations**

<table>
<thead>
<tr>
<th>Occurring At Same Time From Same Cause</th>
<th>Cases Present Study</th>
<th>Cases Glattly Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Limb — Same Level</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Upper Limb — Two Levels</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Lower Limb — Same Level</td>
<td>131</td>
<td>96</td>
</tr>
<tr>
<td>Lower Limb — Two Levels</td>
<td>38</td>
<td>55</td>
</tr>
<tr>
<td>One Upper and One Lower Limb</td>
<td>19</td>
<td>106</td>
</tr>
</tbody>
</table>
POLICY CONSIDERATIONS

The Glattly data provided two items which might influence the policies of State Bureaus of Vocational Rehabilitation:

- **Amputees over 65 years of age who are fitted.** Glattly noted that in six states amputees in this age group exceeded 30 percent of all amputees reported as being fitted in these states. The current study reveals that the 30 percent figure for this group was exceeded in 29 states. In four states the number exceeds 50 percent (Table 10). These data suggest that funds to provide prostheses for the elderly have become more readily available. One could speculate that more are below-knee cases with better chances of success.

- **The percentage of new amputees fitted who are females.** During the period of the Glattly study housewives were not accepted as beneficiaries by certain State Bureaus of Vocational Rehabilitation. In one state females represented only 8 percent of the fitted amputees, but in another they accounted for 36 percent of all new cases. The current study shows that in only two states did females represent fewer than 20 percent of all new amputees fitted (Table 11). Moreover, in 14 states females represented 29 percent or more of the total amputee population, as opposed to only 3 states in this category in the Glattly report. Again, the implication is that funds for fitting female amputees are now available in more states than they were 12 years ago.

Below vs. Above-Knee Amputations

In his discussion of below- and above-knee amputations in patients over 40 years of age, Glattly reported that the vast majority of these individuals had peripheral vascular disease, with or without diabetes. He found "no significant difference in the age distribution of below- and above-knee amputees." No breakdown of his figures showing this distribution is available. Table 12 indicates that in the present CPRD-CPOE-AOPA survey below-knee amputations outnumbered above-knee amputations by a ratio of nearly 2 to 1 for the over-40 age category. However, in the above- and below-knee subsamples, the percentages for each decade were remarkably similar. For instance, of all those pa-

Table 10.

THE FITTING OF ELDERLY AMPUTEEES
(BY STATES)

<table>
<thead>
<tr>
<th>Number of States Fitting</th>
<th>Present Survey</th>
<th>Glattly Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>11-20</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>21-30</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>31-40</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>41-50</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>51-60</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 10.

percentage of amputees over age 65 who are fitted

PERCENTAGE OF AMPUTEES OVER AGE 65 WHO ARE FITTED
tients receiving above-knee amputations, 9.9 percent fell in the 41-50 year age group; while of all those receiving below-knee amputations, 10.3 percent were in the same age group. This finding suggests that age is not a factor in the decision as to whether the amputation should be above or below the knee.

Glattly cited the then-current textbook warnings against below-knee amputation in cases of gangrene due to vascular disease by reason of the likelihood of a second amputation. However, he reasoned that the relatively large percentage of such amputees who were being successfully fitted at the below-knee level threw doubt upon the validity of this principle. He urged preservation of the knee joint in older individuals, and the current study indicates that more decisions are being made in favor of below- rather than above-knee amputations.

In Table 13 percentages of above- versus below-knee amputations for disease in ten metropolitan areas are shown. Glattly pointed out that, while the patients operated upon were quite similar, 66 percent were amputated at the above-knee level in one area, while in another area only 42 percent were amputated at this level. In the present study, significant changes were found in below- and above-knee rates for the same areas previously reported. In all cities except one (Baltimore), percentages of below-knee amputations for disease increased, with a corresponding decrease in above-knee amputations. Some cities showed quite striking reversals in level selection. San Francisco, for example, showed a 36 to 64 below- to above-knee ratio in the earlier study, but present figures indicate a 74 to 26 below- to above-knee ratio. All cities except one (Philadelphia) showed a higher percentage of below- than above-knee amputations. In four cities (San Francisco, Los Angeles, New York, and Atlanta) below-knee amputations are more than double the reported above-knee amputations. In the Glattly study all but three cities (New York, Atlanta, and Baltimore) reported greater numbers of above- than below-knee amputations for disease.
Multiple amputations occurring serially in time, reported on data card No. 2 (Fig. 3), made up less than 1 percent of the cases in this study; in Glattly's they represented 1.6 percent of all reported cases. As indicated in the earlier study, the figures do not accurately represent the relative numbers of persons who have had a second or third amputation. Unless such persons were fitted with a prosthesis, they were not included in either study.
For the 56 cases reported on data card No. 2 in this study, the following facts appear significant:

Forty-seven (84 percent) were male amputees.
Forty-one (73 percent) were 50 years of age or over.
Disease was the cause of reamputation in 41 (73 percent) of the cases.
In the 50-and-over age group, disease was the cause of reamputation in 93 percent of the cases.
Trauma accounted for 16 percent; tumor for only 2 percent; and congenital cases, 4 percent.
All but two amputations were of the lower limb. Fifty percent of all lower-limb amputations were at the above-knee level, 30 percent were at the below-knee level.

LITERATURE CITED


ACKNOWLEDGMENTS

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ALABAMA

ALASKA
Alaska Orthopedics, Inc., Anchorage: Eugene C. Fleishauer

ARIZONA
Phoenix Limb Shop, Phoenix: Dale E. Jenkins

ARKANSAS
Adams Artificial Limb Company, Little Rock: Cooper C. Collins
Snell Limb & Brace Company, Little Rock: George E. Snell

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Alpha Orthopedic Appliance Co., Los Angeles: Fred Quisenberry
A-1 Orthopedic Appliances, Inglewood: Patrick Roberts
Blaylock Orthotic and Prosthetic Service, Anaheim: Paul D. McCullough, J. Michael Young
Child Amputee Prosthetics Project, UCLA Rehabilitation Center, Los Angeles: Susan Clarke, Ruth Rosenfelder
Colwell-Snelson Orthotic & Prosthetic Service, Panorama City: Lennart Rosenqvist
Fresno Orthopedic Co., Inc., Fresno: John Bird
C. H. Hittenberger Company, San Francisco: Herman Hittenberger, Margaret O'Neil
Laurence's Orthopedic Appliance Co., Inc., Oakland: Matthew G. Laurence
Long Beach Artificial Limb Co., Inc., Long Beach: Charles L. Jones
Navy Prosthetic Research Laboratory, Oakland: Charles Asbelle, Ruth Shibley
Orthotic-Prosthetic Service of San Diego: Randy Mason
Peerless Prosthetics Co., Los Angeles: James C. Hennessy
Progressive Orthopedic Mfg., Sacramento: William Earl Cummings
Rancho Los Amigos Hospital, Inc., Amputee Center, Downey: Richard T. Voner
RGP Prosthetics, San Diego: Walter Caleson
Robin-Aids, Inc., Vallejo: George B. Robinson, Esther L. Pettit
Snelson Orthotic and Prosthetic Service, Downey: David L. Porter
Snelson-Irons Orthotic & Prosthetic Service, Inglewood: George P. Irons, Donald F. Colwell, Jr.
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Robert B. Reid, C.P.O., Miami: Robert B. Reid

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Augusta: Aron Eugene Hair; Savannah: J. D. Rosser

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J. E. Hanger, Inc., Peoria: Ralph W. Polley
Merrick-Hopkins Co., Chicago: Alfred Denison

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IOWA
American Prosthetics, Inc., Des Moines: Ronald Cheney

KANSAS
Petro’s Surgical Appliances, Topeka: Gerald Stickler

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Massachusetts Limb & Brace Co., Inc., Boston: Rene Robillard
Starkey Artificial Limb Co., West Springfield: Robert F. Hayes
The United Limb & Brace Co., Inc., Dorchester: Josephine Doyle, Claire Gabriel

MICHIGAN
Orthotic-Prosthetic Facility, The University of Michigan Medical Center, Ann Arbor: Joseph P. Giacinto
Polega Prosthetics, Inc., Grand Rapids: James A. and Thomas Polega, Thomas Szczysykko
E. H. Rowley Co. of Detroit, Inc., Detroit: Edward Schmitt
E. H. Rowley Co. of Grand Rapids, Inc.: John Dubinshak
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Kroll’s, Inc., St. Paul: Robert H. Lawrence
Northwestern Artificial Limb Co., Duluth: Marvin R. Heide
The Winkley Company, Minneapolis: Robert C. Gruman

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W. E. Isle Company, Inc., Kansas City: Elmer C. Nichols
Shriners Hospitals for Crippled Children, St. Louis: Leo V. Tippy

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Butte Orthopedic Appliance Co., Butte: Pearl G. DuBois
Clark’s Orthopedic Supply, Great Falls: Ralph W. Clark

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Eschen Prosthetic & Orthotic Laboratories, Inc., New York: John E. Eschen
Finger Lakes Orthopedic Supplies, Inc., Clifton Springs: Robert N. Brown
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NORTH DAKOTA
Fredrickson Orthopedics, Inc., Fargo: Gary Skavlem

OHIO
American Prosthetic Lab., Inc., Columbus: Peter A. Ockenfels
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J. E. Hanger Co., Columbus: Denise Mannion
J. E. Hanger, Inc., Cincinnati: Floyd J. Keeton
J. F. Rowley Co., Cincinnati: Paul G. Lund
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Shamp Prosthetic Center, Inc., Maple Heights: Elmer Konya
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Minneapolis Artificial Limb Co. of Oklahoma, Oklahoma City: Gordon Johnson
Sabolich, Inc., Oklahoma City: Lester J. Sabolich, B. Ray Buddin

OREGON
Coast Orthopedic Co., Portland: Ray Moore

PENNSYLVANIA
Boas Surgical, Inc., Allentown: Ernest S. Boas
J. C. Lloyd Artificial Limb Company, York: Kathleen Lloyd
U.S. Navy Hospital, Prosthetics & Orthotics, Philadelphia: F. J. Cremona
Scranton Artificial Limb Company, Scranton: Herbert E. Niehuus
Eugene Teufel & Son Orthotics & Prosthetics, Inc., Elizabethtown: Robert G. Florschutz
Union Artificial Limb & Brace Co., Inc., Pittsburgh: Leonard A. Svetz, Catherine Keane
Zielke Orthotics & Prosthetics, Inc., Lancaster: Donald G. Zielke, Barbara Falk

TEXAS
Austin Prosthetics Center, Austin: Dennis Cole
Galveston Brace & Limb Co., Galveston: Dan Morgan
J. E. Hanger, Inc. of Texas, Dallas: Robert F. Reich
Rupley Artificial Limb Co., Fort Worth: Alvin E. Rupley

UTAH
University of Utah Medical Center, Arthritis Project, Salt Lake City: Earl V. Shields, Ronald L. Webb

VIRGINIA
J. E. Hanger, Inc. of Virginia, Richmond: Arthur R. Collins; Roanoke: Ralph T. Coffman
Tidewater Prosthetic Center, Inc., Norfolk: Raymond Francis
University of Virginia Medical Center, Division of Prosthetics & Orthotics, Orthopedics & Rehabilitation, Charlottesville: Virgil Faulkner

WASHINGTON
American Artificial Limb Co., Seattle: Joseph H. Zettl, Ilse Kunkel
Prosthetics Research Study, Seattle: Shirley M. Forsgren, Anne G. Alexander
Schindler's, Inc., Spokane: Alton W. Christenson
Tacoma Brace & Limb Co., Tacoma: Loren R. Ceder
University of Washington, Department of Rehabilitation Medicine, Seattle: Bernard C. Simons

WISCONSIN
Acme Surgical Appliance, Inc., Milwaukee: David C. Schultz