SURVEY OF UPPER- AND LOWER-EXTREMITY BRACE COMPONENTS

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INTRODUCTION

In an effort to improve orthopedic services for our disabled beneficiaries, a survey was conducted to determine the types of components VA Orthopedic Shops are using for the fabrication of upper- and lower-extremity orthotic devices. A questionnaire form was forwarded to 28 VA Orthopedic Shops requesting the following information: a. the numbers of each component used during fiscal year 1967 (July 1, 1966 through June 30, 1967), b. the costs of the prefabricated items, and c. the basic materials of each design used. Other information solicited was the use of custom fabricated items in lieu of prefabricated components and the reasons for their preference. Suggestions and comments as to future emphasis in research and development of orthotic devices were also encouraged.

Responses to the survey were quite informative. Almost all of the stations suggested that more emphasis should be devoted to research and development, especially in the field of upper-extremity orthotics. It was brought to our attention that the recently developed quadrilateral ischial weight-bearing socket and the patellar-tendon-bearing braces were developments that contributed substantially to solutions of lower-extremity orthotics problems. One respondent suggested that *adjustable* appliances be made available to determine the optimum function and fit of lower- and upper-extremity appliances. In principle almost all of the shops were in favor of utilizing standard, mass-produced prefabricated parts including those now making certain components because of physicians' preferences or because they are "set up" to custom make certain parts in fairly large quantities. The majority of the shops are utilizing noncorrosive, lightweight metals such as aluminum or stainless steel; in our opinion this is favorable. Hopefully carbon steel can be slowly phased out especially when one considers the availability of the special alloys of aluminum and stainless steel as well as the synthetics that are available. The data reveal another favorable trend in the purchasing of kits and assemblies rather than individual components. Purchasing in

this manner will reduce costs and required stock levels and insure interchangeability of component parts.

RESULTS OF SURVEY

We encountered some difficulty in analyzing the data submitted in some cases because of the manner in which the shops purchase individual parts. A broad general breakdown of our findings by disability level is as follows (see Table 1.—*Results of Survey on Lower-Extremity Brace Components* and Table 2.—*Results of Survey on Upper-Extremity Brace Components*):

TABLE 1.—*Results of Survey on Lower-Extremity Brace Components*

Item no.	Item	Annual use								
		Custom made			Prefabricated					Total prefabricated and custom made (prs./sets)
		None reported (shops)	No. used (shops)	Prs./sets	None reported (shops)	No. used (shops)	Prs./sets	Cost		
								High	Low	
	HIP JOINTS									
1	Hyperextension control	27	1	15 prs.	20	8	45 prs.	$15.70	$4.95	60 prs.
2	Hyperextension control w/ lateral motion	28	—	—	27	1	5 prs.	7.40	7.40	5 prs.
3	Drop-ring lock	27	1	2 prs.	16	12	61 prs.	14.85	7.70	63 prs.
	Total			17 prs.			111 prs.			128 prs.
	KNEE JOINTS									
4	Hyperextension control	22	6	56 prs.	14	14	105 prs.	$13.75	8.08	161 prs.
5	Drop-ring lock	25	3	41 prs.	7	21	476½ prs.	15.25	7.95	517½ prs.
6	Lever lock	23	5	10 prs.	14	14	102 prs.	20.75	12.25	112 prs.
7	Spring-loaded lever with spring adjustment	28	—	—	22	6	66 prs.	19.95	14.44	66 prs.
	Total			107 prs.			749½ prs.			856½ prs.

	ANKLE JOINTS									
8	Free motion or equino-calcaneus control	24	4	45 sets	6	22	227 sets	$10. 50	$4. 00	272 sets
9	Free motion or equino-calcaneus control w/detachable caliper	27	1	12 sets	15	13	235 sets	11. 43	2. 63	247 sets
10	Equinus'control, spring loaded w/spring adjustment	27	1	20 sets	13	15	885 sets	9. 63	4. 70	905 sets
11	Equinus control, spring loaded w/spring adjustment w/detachable caliper	2	—	—	6	22	765½ sets	11. 64	4. 17	765½ sets
12	Equino-calcaneus control, spring actuated w/spring adjustment	28	—	—	18	10	51 sets	10. 82	8. 25	51 sets
	Total			77 sets			2163½ sets			2240½ sets
	JOINTS BELOW THE ANKLE									
13	Unlimited or free motion	27	1	6 sets	28	—	—	—	—	6 sets
14	Unlimited or free motion	21	7	56 sets	23	5	14 sets	2. 40	1. 18	70 sets
15	Equinus control	27	1	7 sets	28	—	—	—	—	7 sets
16	Equinus control spring-loaded, alloy (spring) steel	21	7	208 sets	19	9	57 sets	16. 35	2. 25	265 sets
	Total			227 sets			71 sets			348 sets

TABLE 1.—*Results of Survey on Lower-Extremity Brace Components*—Continued

Item no.	Item	Annual use								
		Custom made			Prefabricated					Total prefabricated and custom made (prs./sets)
		None reported (shops)	No. used (shops)	Prs./sets	None reported (shops)	No. used (shops)	Prs./sets	Cost		
								High	Low	
	ARCH SUPPORTS									
17	Combination support, high flange (Schaeffer type)	19	9	367 prs.	17	11	252 prs.	$10. 78	$1. 75	619 prs.
18	Combination support, low flange (Schaeffer type)	21	7	398 prs.	22	6	56 prs.	10. 00	1. 95	454 prs.
19	Combination support with heel (Whitman type)	22	6	16 prs.	24	4	18 prs.	12. 50	6. 50	34 prs.
20	Combination support without heel (Whitman type)	28	—	—	27	1	2 prs.	12. 00	7. 50	2 prs.
21	Combination support (insole type)	20	8	239 prs.	18	10	407 prs.	9. 00	1. 95	646 prs.
22	Metatarsal support (insole type)	20	8	156 prs.	22	6	56 prs.	8. 00	1. 00	212 prs.
	Total			1176 prs.			791 prs.			1967 prs.

TABLE 2.—*Results of Survey-on Upper-Exremity Brace Components*

Item no.	Item	Annual use								
		Custom made			Prefabricated					Total prefabricated and custom made (each)
		None reported (shops)	No. used (shops)	Each	None reported (shops)	No. used (shops)	Each	Cost		
								High	Low	
	UPPER-EXTREMITY BRACES									
23	Finger extension splint (Bunnell)	21	7	60	24	4	36	$3. 50	$1. 00	96
24	Interphalangeal joint flexion brace (Bunnell)	24	4	15	21	7	45	4. 75	1. 75	60
25	Metacarpophalangeal joint flexion-extension brace (Bunnell)	19	9	51	19	9	102	8. 14	6. 50	153
26	Basic opponens splint (UCLA)	16	12	51	22	6	76	4. 00	1. 50	127
27	Wrist stabilization brace	12	16	254	24	4	25	13. 50	2. 90	279
28	Wrist extension assist brace (Oppenheimer)	18	10	56	20	8	75	30. 00	7. 00	131
29	Long opponens hand splint (UCLA)	19	9	101	19	9	147	5. 25	2. 00	248
	Total			588			506			

Hip Joints (Fig. 1)

Comparatively speaking, fewer hip joints are being used now as were several years ago. More than likely this is due to more frequent surgery, intensive physical therapy, and utilization of such lightweight leather and fabric hip control components as Silesian belts. Approximately 60 percent of the hip joints used were made of either stainless steel or aluminum and the ratio of prefabricated parts to custom-made parts was approximately 6 : 1.

HIP JOINTS

HYPEREXTENSION CONTROL

HYPEREXTENSION CONTROL WITH LATERAL MOTION

DROP-RING LOCK

FIGURE 1

Knee Joints (Fig. 2)

Approximately 60 percent of the prefabricated knee joints used by the Orthopedic Shops were made of either aluminum or stainless steel. Those braces that were fabricated of carbon steel were made especially for patients who would subject a brace to very rough use. The drop-ring lock brace joints were used most frequently; for every lever lock used, nearly three drop-ring lock knee joints were used. The ratio of prefabricated parts to custom-made parts was approximately 7: 1.

KNEE JOINTS

HYPEREXTENSION CONTROL

DROP-RING LOCK

LEVER LOCK

SPRING-LOADED LEVER WITH SPRING ADJUSTMENT

FIGURE 2

Ankle Joints (Fig. 3)

Most of the shops are purchasing these items in kits or sets with approximately 90 percent in stainless steel and/or aluminum; the remainder are heavy-duty carbon steel components. However, carbon steel, rectangular, detachable caliper plates were used in almost all instances for Items 9 and 11 (see Table 1) mainly because these items are not supplied in stainless steel by manufacturers. The ratio of prefabricated parts to custom-made parts was approximately 28:1.

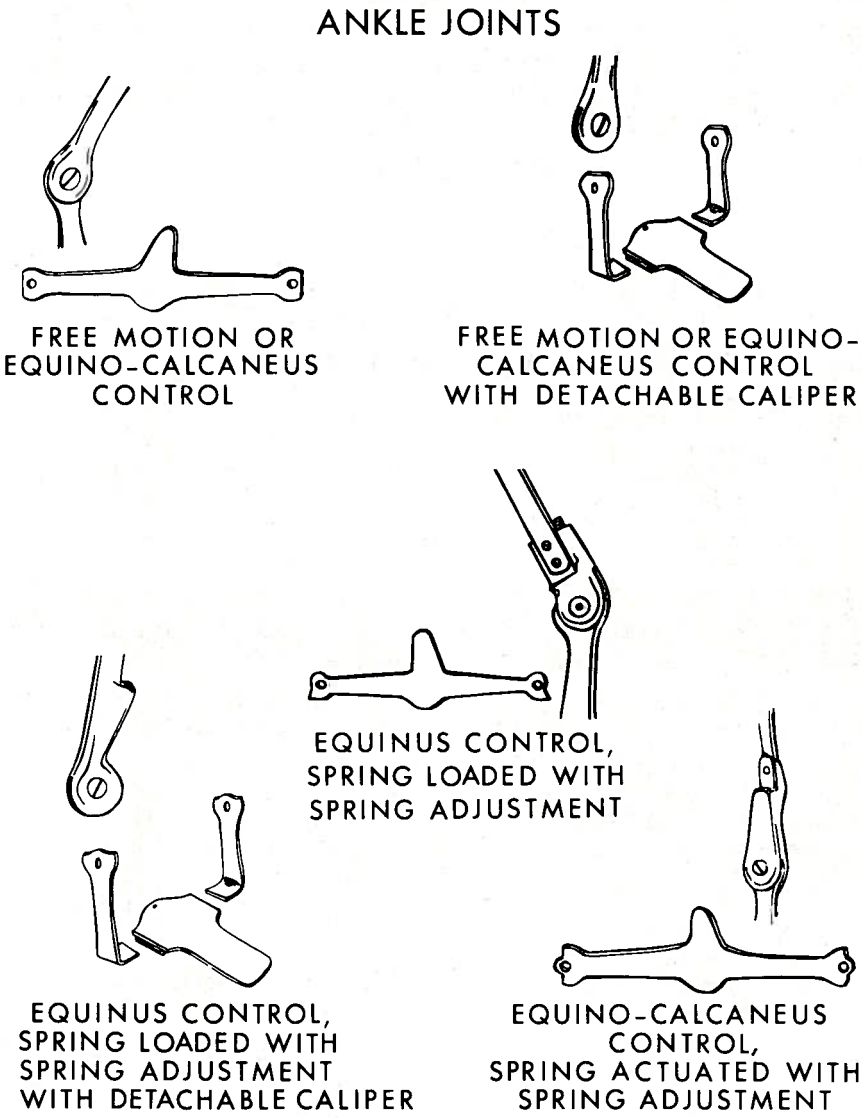


FIGURE 3

Joints Below the Ankle (Fig. 4)

Very few caliper plates were used as compared to stirrups (Items 13, 14, and 15 in Table 1). Only 83 (both prefabricated and custom made) calipers were used during Fiscal Year 1967 and of that number 69 were custom made. This low number of 83 in our opinion is desirable. Except in rare cases, mechanical ankle joints should be located as close to the anatomical ankle axis as possible. The caliper plates were for the most part made of carbon steel. Most of the shops make Item 16 (Table 1) either of stainless steel wire or of carbon steel music wire. From the descriptions given, there is a great variance of design. Even among the manufacturers of these items the materials and appliances vary. The ratio of prefabricated appliances to custom-made appliances was 1 : 4. Without a doubt there is a need for standardization of design of this item.

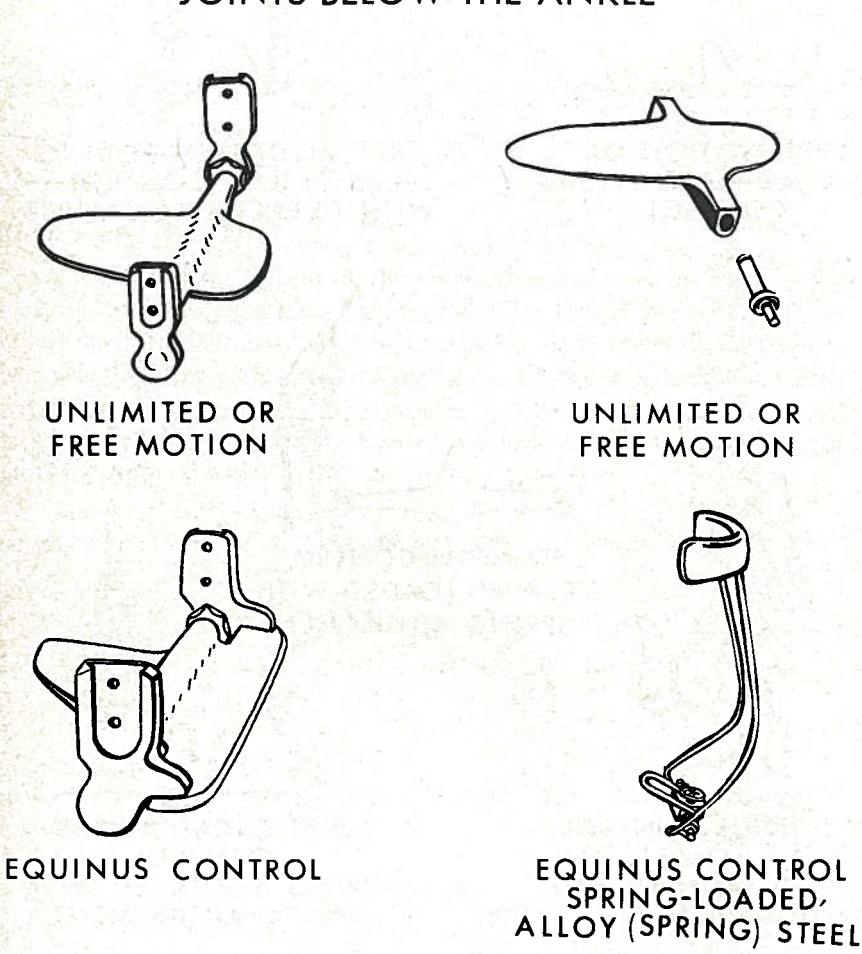


FIGURE 4

Arch Supports (Fig. 5)

Approximately 75 percent of the prefabricated arch supports used were made of leather, fabric, and were with or without springs; the balance were made of stainless steel. Very few supports of the Whitman type (Items 19 and 20, Table 1) are being used. Except for Item 21 (Table 1, *Combination Support, Insole Type*) the greater portion of the other arch supports (Items 17, 18, and 22, Table 1) were custom made as opposed to purchased. However, we assume that many of the custom-made items are in reality purchased from manufacturers in a semi-finished state and then modified and finished by the shops. In our opinion the purchasing of semi-finished supports is a desirable method of providing arch supports. Because of the versatility in the design of such items, the orthotist can easily make minute changes, build-ups, or modifications. The ratio of prefabricated arch supports to custom-made arch supports was approximately 1 : 1.5.

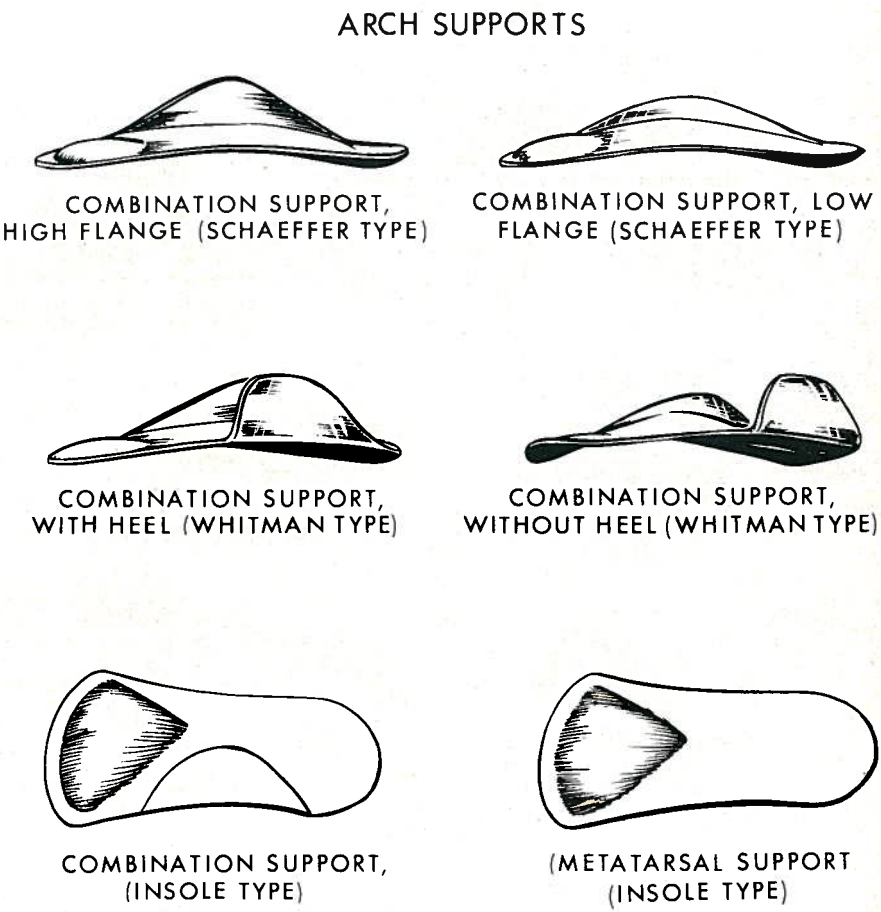
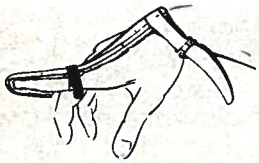


FIGURE 5

Upper-Extremity Braces (Fig. 6)

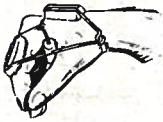
Approximately 50 percent of the prefabricated appliances were made of aluminum, 45 percent were made of carbon and/or stainless steel spring wire, and 5 percent were made of plastic materials. The ratio of prefabricated items to custom-made items was approximately 1:1. We assume that many of the custom-made items were identical in design to items that are commercially available. The great variances in cost on several of the prefabricated items can be attributed to the manner in which the items were purchased: for example, Items 27 and 28 (Table 2) were purchased as entire kits, which included not only wrist components but also components that could be utilized for metacarpal, phalangeal, and thumb function. This naturally would bring the cost up considerably. In our opinion, more emphasis should be placed on the purchasing of the plastic and aluminum components now commercially available.

UPPER-EXTREMITY BRACES



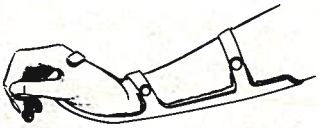
FINGER EXTENSION SPLINT (BUNNELL)

INTERPHALANGEAL JOINT FLEXION BRACE (BUNNELL)

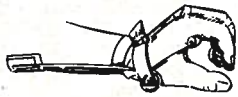


METACARPO-PHALANGEAL JOINT FLEXION-EXTENSION BRACE (BUNNELL)

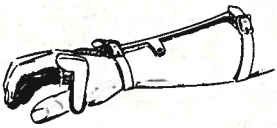
BASIC OPPONENS SPLINT (UCLA)



WRIST STABILIZATION BRACE



WRIST EXTENSION ASSIST BRACE (OPPENHEIMER)



LONG OPPENENS HAND SPLINT (UCLA)

FIGURE 6

DISCUSSION AND CONCLUSION

Generally, the custom forming of major lower-extremity components is on the wane; moreover, the upper-extremity picture is not totally unsatisfactory. There is also a noticeable reduction in the multitude of designs of both lower-extremity and upper-extremity prefabricated components. To a large extent standardization and uniformity do exist among prefabricated components used by the VA Orthopedic Shops. Therefore it should make our job much easier if a national brace contract is contemplated.

Almost 700 pairs of knee-lock joints of various designs were used for leg-thigh braces during Fiscal Year 1967. Undoubtedly some of these patients were, in fact, in need of joints of this type. But one wonders if many of the knee-lock braces, especially for the unilateral patient, could not have been of a more functional design. In our opinion there is a definite need for a lower-extremity *functional* knee lock to augment the armamentarium of lower-extremity orthotic components. We would recommend that an effort be made to stimulate a design and development project on a functional knee lock. We might establish functional specifications for such a knee lock and negotiate a contract with one of the manufacturers to develop such a device.

Several of the shops indicated that they do not use the detachable, prefabricated caliper stirrups because they develop play after short periods of wear, thus causing noise. We concur with this observation. We therefore suggest that the design of caliper stirrups be investigated to try to minimize the aforementioned shortcomings. Basically, the caliper stirrup idea is desirable because it makes the interchangeability of shoes much easier; costs are reduced in some cases since one pair of uprights can be used with several pairs of shoes. Furthermore, prefabricated caliper stirrups made of carbon steel are subject to early corrosion since they are attached to the bottom of the shoe and are therefore close to the ground. We suggest that stainless steel, even though slightly higher in cost, be considered for detachable caliper stirrups.

There are several designs of the equinus control wire drop-foot brace (Item 16, Table 1) commercially available. This item in our opinion should be of one standardized design. We might eventually consider the "pre-preg" epoxy-Fiberglas material that we are evaluating for AMBRL or the "pre-preg" materials made by a fishing rod manufacturer, DePew Company, Hicksville, Long Island, New York.

The concept of using adjustable appliances is a good one. In fact, we have a design for leg braces that could easily be modified by a clinic team and thus used as a diagnostic tool for determining the function most suitable for a given disability. Moreover, a related suggestion was made by A. Bennett Wilson of the National Academy of Sciences several years ago. But, his sug-

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gestion as we recall had to do with permanent-type leg braces having a series of adjustable features that would be "locked" into position.

The preponderance of arch supports used are of the non-rigid, leather, fabric, and/or spring type as opposed to metal arch supports. In our opinion, the non-rigid flexible support is superior to the rigid metal support inasmuch as the former provides a certain amount of dynamic function. The non-rigid type may be purchased completely finished or semi-finished and it would be desirable for the Orthopedic Brace Shops to stock both types of supports but utilize more of the semi-finished supports for the severely disabled foot.

Approximately 45 percent of the upper-extremity braces were custom made and from the descriptions given in our survey, many of these items are identical to appliances that can be purchased at minimum cost from manufacturers of prefabricated upper-extremity appliances. We also recommend that many of the appliances be purchased as complete items or in kits, *for specific disability levels,* thereby reducing costs.

Several of the VA Orthopedic Shops intimated that orthotic components should be considered for centralized distribution; four Shops made positive statements to this effect. We certainly agree with the Orthopedic Shops' recommendations that there is a need for more research and development in the orthotic field; many of the Orthopedic Shops volunteered to participate in such research and development. In the meantime, VA Orthopedic Shops should be made aware either by Newsletter or other media of those developments that have proven their worth by satisfactory clinical experience.