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Patterns of Acceptance and Rejection of Upper Limb Prostheses

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INTRODUCTION

Many individuals are faced with a disability caused by an upper limb deficiency (due to some congenital problem) or limb loss (due to trauma or surgery). The common practice in rehabilitation is to fit these people with prostheses ranging from simple cosmetic attachments through mechanically powered units to complex myoelectric units, the purpose of which is to compensate in some way for the limb deficiency. Given the wide range of options and technical expertise available, it is important to find out how recipients react to their prostheses, the purposes for which they use their prostheses, and the extent of such use. This knowledge will permit the available technology to be used to the best advantage.

This study addresses questions of prosthesis acceptance and rejection with the help of a sample of disabled persons living in the lower part of the North Island of New Zealand, where there are a number of services available to clients requiring an upper limb prosthesis. The usual procedure is for such a person to be referred to the Artificial Limb Centre in the metropolitan area by their orthopedic surgeon. Following this, a series of visits to the Centre would accommoderate the measurement for, and fitting of, the prosthesis. Training of the recipient in the use of the prosthesis would normally occur during these visits. In some cases, where the necessary services are available, follow up rehabilitation is exercised through a rehabilitation unit attached to a hospital in the person's home district. The study examined the extent to which the sample of recipients accepted or rejected their upper limb prostheses and variables related to level of prosthesis use. This involved the development of measures of rejection that could be used in a quantitative way and administered by means of a postal questionnaire.

Previous research on this topic has taken rejection to mean the non-use or minimal use of a prosthesis which has been fitted to the individual and has examined the question of whether or not rejection of prosthesis is a serious problem among recipients. Wilson[7] noted that there is no doubt that the acceptance rate of prostheses is "woefully low." The factors that Wilson sees as causing this low acceptance are the functional capabilities of the prosthesis and technical difficulties, such as malfunctioning joints and poor fitting to the residual limb.

McKenzie[6] is another author who has alluded to rejection, stating that, "The rejection rate by unilateral arm amputees is much too high for complacency." He also states that it is much worse than for the bilateral amputee. His views on the causes of the high rejection rate amongst unilaterals include: development of one handedness which removes the functional need for the prosthesis, lack of sufficient training or skill in using the prosthesis, poor comfort of the prosthesis, the unnatural look or profile of the prosthesis, and the reactions

which the wearer gets from other people. Neither of these writers provided figures demonstrating the extent of rejection.

Herberts, Korner, Caine and Wensby[2] did provide such a measure. In their study they were not directly concerned with the problem of rejection but were evaluating a clinical rehabilitation program for amputees. Their measure of rejection was a simple count of the number of individuals using different kinds of prostheses, and one of their categories happened to be, "None," (prosthesis not used at all). Of the sample of 38 individuals surveyed, between one and twelve years after receiving a prosthesis, 26.3 percent indicated that they did not use it. This response demonstrated the existence of a problem, but overall there has been a dearth of research into rejection and particularly into the factors behind failure to use a prosthesis.

One of the reasons for this lack of research into recipients' attitudes may stem from the emphasis on the technical aspects of prosthetics. When approached from such a perspective, the way to overcome problems of rejection or non-use is seen to be by improving the function and design of the tool. Earlier fitting, better cosmetics, or more training are also seen as possible answers.

After examining these previous research interests, the following questions were formulated for the present study:

1. Is there a rejection problem in the population under study and, if so, what is the extent of this problem? This question involves defining a measure of rejection, identifying levels of use among the sample, according to this measure, and identifying high and low users of upper limb prostheses.
2. What are some of the variables related to the level of use of upper limb prostheses?

METHOD

Certain constraints were placed on the sampling procedure in order to contain the study within reasonable boundaries. First, it included only those individuals who had received a primary prosthesis between January, 1975 and May, 1982. Second, any person who, at May, 1982, was less than five years of age was excluded. Third, the sample was restricted geographically to the lower part of the North Island which was serviced by the Artificial Limb Centre in the capital city. Within these limitations there was a population of seventy recipients. Considering the limited size of the population under study it was decided to send questionnaires to all seventy recipients.

The questionnaire contained six questions designed to operationalize and measure the concept of prosthesis rejection. The steps involved in the development of this questionnaire consisted of generating, from the literature, a pool of questions which were then validated by a group of ten expert judges. The judges chosen, in this case, were all health professionals attached to a rehabilitation unit at a large provincial hospital (see Table 1 for the distribution of expert judges by professions). Health professionals closely associated with the treatment and care of prosthesis recipients were chosen, rather than amputees themselves, so as not to deplete the experimental sample by extracting a subsample of recipients for the purpose of questionnaire development.

The health professionals were asked to make a series of judgments on a pool of nine questions, six referring to quantitative and three to qualitative measures of prosthesis use, including two measures of satisfaction. The latter two items used five-point "Faces" scales.[4] First, each of the nine items was rated on how important the judges considered it to be in measuring

Professions of Expert Judges	
Charge Nurse	1
Clinical Psychologist	1
Medical Officer	2
Occupational Therapist	3
Physiotherapist	3
Total	10

Table 1.

prosthesis use. Items would be included in the questionnaire only if there was a high level of consensus among the ten judges. Level of consensus was calculated using a statistical procedure based on Lawshe's Content Validity Ratio (C.V.R.). Second, the ten judges rated a series of seventeen specified tasks according to how essential they considered the prosthesis to be in performing that task. Third, they rated the frequency with which, in their opinion, amputees would be expected to wear their prostheses in each of eight specified situations. Finally, they were given the opportunity to make additional comments and suggestions. As a result of the analysis of these data, six questions were included in the final questionnaire.

In addition to this, there were six items relating to prosthesis type and services used by the recipients. Information on age, sex, ethnic group, occupation, education, length of time since prosthesis was fitted, and dominant hand was collected.

The seventy upper limb prosthesis recipients were initially contacted through the staff of the Artificial Limb Centre, who mailed out the questionnaire together with a cover letter to members of the population. Each posting included a return, stamped, addressed envelope. A reminder and replacement questionnaire were sent to subjects who did not respond to the first request.

RESULTS

Thirty-four completed questionnaires were returned. This represents a response rate of 48.6 percent which, while low, is similar to other studies using postal questionnaires with disabled people, where the return rate for postal questionnaires has ranged from 10 to 50 percent (Croxon, Clarke and Burrough,[1] Kidder[3]). In comparison with these figures, the present study seems to have achieved a reasonable response rate. Moreover, when respondents and non-respondents were compared using previously recorded data on age, sex, cause of limb loss, and site of amputation, no significant differences were found. Thus we can conclude that while the numbers were not large, the sample was representative of the recipient population.

The questionnaire contained six measures of prosthesis acceptance/rejection. These included number of hours worn per day, time of day when prosthesis was worn, activities performed with the prosthesis, places where prosthesis was worn, satisfaction with the number of activities that could be performed with the prosthesis, and satisfaction with how well they could perform these activities.

In addressing the first research question, "Is there a rejection problem?", the following measures were considered:

Number of hours per day

The percentage of responses to these questions are shown in Table 2. This table indicates that 38.2 percent of respondents never wore their prosthesis on a regular basis and that another 26.7 percent wore it for less than nine hours a day.

Number of Hours a Day that Prosthesis is Usually Used

Hours a Day	Number Using	Percentage
None	13	38.2
Up to 3	4	11.8
3 to 6	4	11.8
6 to 9	1	2.9
9 to 12	5	14.7
12 to 15	2	5.9
over 15	5	14.7
Total	34	100

Table 2.

Times of day

Of the 61.8 percent of respondents (21 subjects) who did wear their prosthesis regularly, 14 said that they wore it between 9 a.m. and noon. This represents 41.2 percent of the total sample of 34 respondents. Thus, more people (41.2 percent) made use

Times of Day When Prosthesis Usually Worn		
Times of Day	Number Using	Percentage of Total Sample
6 a.m. to 9 a.m.	10	29.4
9 a.m. to noon	14	41.2
noon to 3 p.m.	10	29.4
3 p.m. to 6 p.m.	11	32.4
6 p.m. to 9 p.m.	10	29.4
after 9 p.m.	6	17.6

Table 3.

of the prosthesis from 9 a.m. to noon than during other time periods of the day (Table 3). To obtain a single measure of times a day, a simple summing procedure was used, with each respondent receiving a score equal to the number of time periods in which they indicated use of the prosthesis.

Activities performed

There was a wide range of responses to the question pertaining to type of activities performed with the prosthesis. Of the total sample, 55.9 percent (19 out of 34 subjects) said that they did not use the prosthesis for any of the activities mentioned. The activity, 'Using tools' was the most frequently chosen (38.2 percent) while 'Picking up a coin' was chosen by only 2.9 percent of the total sample (Table 4). The activities performed were combined into a summary measure by summing the number of activities for which each recipient used the prosthesis. This gave a single index of "Activities performed" with a range from a minimum of 0 to a maximum of 9 points.

Places to which a Prosthesis is Worn		
Place	Number Wearing	Percentage of Total Sample
Meals	10	29.4
Work	14	41.2
Movies	13	38.2
Travelling	13	38.2

Table 5.

Places worn

Apart from the 13 subjects who did not use their prosthesis at all, responses ranged from 41.2 percent, wearing the prosthesis to work, to 29.4 percent, wearing it at meals. Table 5 shows the percentages of responses given to the various options. A summary "Places worn" index was calculated for each respondent by summing the number of situations in which the recipient wore the prosthesis.

Satisfaction with the prosthesis

The first question referred to recipients' satisfaction with the number of things they could do with the prosthesis (satisfaction—1), while the second question re-

Activities Performed with the Prosthesis		
Activity	Number Using	Percentage of Total Sample
Eat with knife & fork	4	11.8
Hang out clothes	7	20.6
Hold a cup & saucer	3	8.8
Make a bed	4	11.8
Pick up a coin	1	2.9
Take notes out of a wallet	6	17.6
Using tools	13	38.2
Washing Dishes	7	20.6
Writing	5	14.7

Table 4.

Satisfaction with Number of Things Able to be Performed with Prosthesis

Level of Satisfaction		Number	Percentage
very unhappy	1	8	23.5
	2	5	14.7
	3	8	23.5
	4	5	14.7
very happy	5	2	5.9
no response		6	17.7
Total		34	100

Table 6.

Satisfaction with How Well Things Can be Done with the Prosthesis

Level of Satisfaction		Number	Percentage
very unhappy	1	6	17.6
	2	4	11.8
	3	7	20.6
	4	7	20.6
very happy	5	4	11.8
no response		6	17.6
Total		34	100

Table 7.

Frequences of Level of Acceptance/Rejection

Value	Frequency
below -5.0	6
-4.9 to -4.0	4
-3.9 to -3.0	2
-2.9 to -2.0	1
-1.9 to -1.0	5
-0.9 to 0.0	1
0.0 to 0.9	3
1.0 to 1.9	2
2.0 to 2.9	2
3.0 to 3.9	0
4.0 to 4.9	3
5.0 to 5.9	1
6.0 to 6.9	0
7.0 to 7.9	3
above 8	1
Total	34

Table 8.

ferred to how well they could do them (satisfaction—2). These measures used five-point "Faces" scales (Kunin[4]) which present a series of faces having different degrees of happy and unhappy expressions. These are later translated into a numerical scale for scoring purposes. The results obtained from the two questions pertaining to recipients' satisfaction with their prostheses are shown in Tables 6 and 7. Only 28 of the respondents answered these questions. It can be seen that 38.2 percent (ratings 1 and 2 combined in Table 6) of respondents indicated that they were, to some extent, unhappy with the number of things they could do with the prosthesis, and 29.4 percent (ratings 1 and 2 combined in Table 7) indicated unhappiness with how well they could do them.

Composite "level of acceptance/rejection" variable

A composite "level of acceptance/rejection" variable was calculated from the six measures described above. Each of the original measures was first converted to standard score form. This meant that those individuals who scored below the mean would receive a negative score. The formula for calculating the composite "level of acceptance/rejection" variable was:

$$\text{Level of acceptance/rejection} = Td(0.6) + Hd(0.8) + Ap(0.8) + Pw(0.99) + S\text{-}1(0.99) + S\text{-}2(0.99)$$

where Td = Times of day; Hd = Hours per day; Ap = Activities performed; Pw = Places worn; S-1 = Satisfaction with the number of things; S-2 = Satisfaction with how well things can be done. The weightings in this formula represent the agreement of the expert judges about the appropriateness of that measure to the concept of "level of acceptance/rejection." It was based on the C.V.R. score obtained in the validation study.

The frequencies of scores for the "level of acceptance/rejection measure," as shown in Table 8, had a number of interesting features. The distribution of scores was heavily skewed towards the 'low use' end of the scale with a mode at -5.0 and another between -1.9 and -1.0. Half of the respon-

Types of Prosthesis Worn	
Type	**Frequency**
Myoelectric	4
Mechanical	18
Cosmetic	7
Unknown	5
Total	34

Table 9.

Levels of Prostheses Worn	
Level	**Frequency**
Full Arm	6
Above Elbow	4
Below Elbow	15
Wrist	4
Unknown	5
Total	34

Table 10.

dents scored below -1.0 while the other half were spread over a scoring range of -1.0 to more than 8.0.

In order to address the second research question relating to the variables associated with the rejection of the prosthesis, a regression analysis was performed using the composite "level of acceptance/rejection" measure as the dependent variable. The following independent variables were used in the analysis: type of prosthesis; level of prosthesis; type of terminal unit; time since prosthesis was first fitted; dominant hand; referring hospital board; sex; age; occupation; and educational level. Rehabilitation services used and ethnic origin were not included in the analysis because a lack of variance within the variables made their predictive ability minimal. Only two variables were stepped into the regression equation before the probability of further variables causing significant changes reached the termination value of $p < 0.05$. The two variables were type of prosthesis and level of prosthesis. The analysis showed that the myoelectric and mechanically powered prostheses were owned, in the main, by higher users who also tended to have more distal prostheses, usually below elbow level. Lower users tended to own cosmetic prostheses and to have either full arm or above elbow units. These two variables together accounted for 46.3 percent of the variance in the "level of acceptance/rejection" measure. Of course, we cannot determine from these results the direction of causality. It may be that those people who need or intend to make the most use of their prosthesis choose functional rather than cosmetic types of prostheses. The frequencies of these variables in the sample are shown in Tables 9 and 10.

Further regression analyses were performed using the composite "level of acceptance/rejection" measure recalculated without the C.V.R. weights and without the 'Time of day' measure (which had the lowest C.V.R. score of any of the measures used). Both of these regression analyses extracted the same significant variables (prosthesis type and level of prosthesis). In each case the level of variance accounted for was in the range of 42 percent to 46 percent. This suggests that the statistic relating level of acceptance/rejection to prosthesis type and level is relatively robust and largely independent of the agreement between expert judges.

DISCUSSION

The first issue that the questionnaire examined was whether or not rejection occurred. Rejection was initially taken to mean the non-use or minimal use of the prosthesis. From the answers obtained from specific questions, there was strong evidence for a high level of prosthesis rejection. For example, 38.2 percent of respondents said that they did not make regular use of their prosthesis (Table 2), 55.9 percent said that they did not utilize their prosthesis in the performance of any of the activities listed, and 38.2 percent indicated that they did not wear their prosthesis to any of the places mentioned. Added to this are the large number of people who said that they made only minimal use of their prosthesis on these

measures. These quantitative measures are supplemented by the qualitative measures of satisfaction, which indicated that 38.2 percent of respondents felt some lack of satisfaction with the number of things they could do with their prosthesis, and 29.4 percent were dissatisfied with how well they could do them. When we consider the composite measure of acceptance/rejection calculated in this study, we see that the majority of respondents were concentrated towards the lower end of the scale. Thus, the answer to the first question concerning the existence and extent of a rejection problem seems to be that there is a considerable amount of rejection by recipients of upper limb prostheses. These findings support the earlier speculations of Wilson[7] and McKenzie,[6] both of whom recognized the existence of a rejection problem. Moreover, the extent of rejection in our sample appears to be greater than the 26.3 percent obtained by Herberts, et al.,[2] and may be as high as 38.2 percent.

The second issue to be addressed through the questionnaire was whether any of the prosthesis characteristics or demographic variables could explain the variance in levels of use. Using a stepwise regression procedure, it was found that only two variables contributed a significant amount to the variance in the "level of acceptance/rejection" measure. These two variables were prosthesis type and prosthesis level, which together accounted for 46.3 percent of the total variance. None of the demographic variables accounted for any significant amounts of variance.

In order to relate patterns of use to these two characteristics of prostheses, we must examine them in terms of their contribution to the functioning of the prosthesis. In general terms it can be said that a cosmetic unit has very low functionality, as does a full arm prosthesis. In fact, given the weight of the prosthesis, in the absence of a residual limb it is extremely difficult to fit a full arm prosthesis that is anything other than cosmetic. Myoelectric prostheses are the most functional form of motive power, but they can only be fitted effectively to those people with below elbow or above wrist amputations. A person with a residual limb extending at least two inches below the elbow can be given a unit that will provide relatively full function of the arm. The results of this study seem to indicate that the response of the recipients to the prosthesis may be related to how much it can improve their ability to function in their daily lives. Some of the comments made by low users tend to support this statement, i.e.:

- "Never found it any help"
- "It is much easier to do things without it"

Examples of comments from high users included:

- "I use it for every day use—I am dependent on it"
- "Using the hook, I am able to do all my household chores"

Closely related to functionality is the matter of training in the use of the prosthesis. McKenzie[6] says, "Learning to use an arm prosthesis never comes instinctively and its effective use is an acquired skill, so much so that no worthwhile return in the way of function is apparent to the user, and rejection may result."

The importance of training is related to the fact that training can increase the capability of the recipient to make use of the prosthesis. This, in turn, increases the functionality of the prosthesis as a tool for living. This was illustrated in Herberts, et al.'s[2] research, which concentrated on training in the use of below elbow myoelectric prostheses. Their training program involved intensive training in generating myoelectric impulses in the residual limb. This was followed by a one week training course after the fitting of the prosthesis, the purpose being to master the use of the grip function over the full range of orientations of the prosthesis. The Herberts, et al.'s[2] study evaluated the usefulness of the program. It was found that more trained than untrained recipients continued to use some form of prosthesis one to 12 years after the fitting of a primary prosthesis.

Finally, part of the question of functionality revolves around the way in which the recipient views the prosthesis. If a person has an exaggerated expectation about the usefulness of the prosthesis as a replace-

ment arm, then it would be expected that the person would be dissatisfied with the ultimate functioning of the prosthesis and may even reject it all together. On the other hand, if the expectations of recipients are more realistic from the start, then the ultimate judgments will be based on the ability of the prosthesis to improve the recipients' performance. Some comments from low users illustrate the possibility that unrealistically high expectations may have resulted in dissatisfaction and ultimately rejection:

- "There is great scope for improvement"
- "I thought it would be good till I got it, I found it didn't work—I've no complaints about the way it's built, just that it doesn't work"

CONCLUSIONS

The results suggest that the type of prosthesis fitted is closely related to the ultimate use made of the prosthesis. It is therefore important that each recipient receive the type of prosthesis which will give him or her the greatest functional capability for the particular needs and lifestyle required. The myoelectric and mechanical units have the greatest functional capability, but these cannot always be fitted. While the site of amputation is often predetermined, especially in trauma and congenital cases, there is some room for choice of site in those cases where the arm is to be surgically removed. The optimal level of amputation for the fitting of the most functional type of prosthesis available should receive careful consideration in cases where some choice is feasible. There is evidence of some degree of dissatisfaction both with the number of activities that can be performed with the prosthesis and with the standards of performance that can be reached. This may also contribute to the high rejection rate. Counselling to help the recipient develop realistic expectations about the capabilities of their prosthesis and adequate training in the use of their prosthesis after it has been fitted seem to be priorities for upper limb amputees if the unacceptably high rejection rate is to be reduced. Of the respondents to the present questionnaire, only one indicated the use of any rehabilitation service other than the Artificial Limb Centre.

The full rehabilitation process for an amputee is necessarily a long one. It starts at the loss of the limb and the acceptance of the loss, and continues through to the receiving of a prosthesis and learning to use it. It is not completed until a stable, independent lifestyle has been achieved and the recipient's social and occupational niches have been re-established. Rehabilitation involves both adopting appropriate behaviors in the use of the prosthesis and a favorable emotional response in the form of satisfaction with the prosthesis as an aid to a fuller and more normal way of life.

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