Does Assistive Technology Substitute for Personal Assistance Among the Disabled Elderly?

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Objectives. This study examined whether use of equipment (technological assistance) to cope with disability was associated with use of fewer hours of help from another person (personal assistance).

Methods. In a cross-sectional study of 2368 community dwellers older than 65 years with 1 or more limitations in basic activities of daily living (ADLs) from the 1994 National Long Term Care Survey, the relation between technological assistance and personal assistance was examined.

Results. Among people with ADL limitations, multivariate models showed a strong and consistent relation between technological assistance and personal assistance, whereby use of equipment was associated with fewer hours of help.

Conclusions. Among people with disability, use of assistive technology was associated with use of fewer hours of personal assistance. (*Am J Public Health.* 2003;93:330–337)

Personal assistance and technological assistance are the 2 basic modes of coping with limitations that interfere with the ability to complete activities of daily living (ADLs) and other tasks. Personal assistance refers to help that disabled persons receive from others, such as a spouse, child, friend, or paid caregiver. Help from another person does not enable people to function more independently, but it may reduce the difficulty experienced when attempting to perform a given task. Technological assistance refers to the use of equipment (wheelchairs, canes, walkers, raised toilet seats) to allow performance of daily activities. Equipment usually is provided to enable persons with difficulty performing their ADLs to function more independently than they would otherwise be able to do.

From a theoretical perspective, both technological and personal assistance are contextual factors that act to modify the disablement process, reducing the severity of disability.[1,2] Agree[3] and Smith[4] expanded this theoretical framework by elaborating methods for modifying disability, including reducing the task demands through environmental modification or technology, substituting another person to complete some or all of the task, and altering the performance of the given activity (e.g., going out less often, performing a bed bath instead of a tub bath). Agree and Freedman[5] suggested that the nature of the task, the characteristics of the person, the device, and the caregiver potentially influence the methods used to cope with disability. It is unknown to what extent various strategies may be interchangeable. For example, 1 potential outcome of reducing the task demands through use of technological assistance might be a decrease in the number of hours of personal assistance used for daily tasks. On the other hand, help from another person might be obtained to avoid using a piece of equipment, such as avoiding perceived stigma from a cane by leaning on the arm of a loved one.

Clearly, technological assistance or personal assistance might be used for some tasks and not for others, technological assistance or personal assistance might be used only some of the time, and use of technological assistance or personal assistance for certain tasks might vary over time. However, regardless of whether a device is used to supplement or to substitute for personal assistance and of whether it is used some of the time or all of the time, the potential for appropriate equipment to reduce use of personal assistance is apparent. For example, common sense indicates that a hydraulic lift might reduce the time required to transfer a paralyzed patient from the bed to a chair; a raised toilet seat and grab bars might eliminate the need for help from another person when using the toilet; and use of a portable oxygen tank might enable independent mobility when otherwise exertional dyspnea might necessitate assistance from another person.

Overall, use of technological assistance has increased at much higher rates than might be expected from the aging of the population alone.[6,7] Whereas the US population increased by 19.1% from 1980 to 1994, the (age-adjusted) use of leg braces increased by 52.1%, canes by 37.0%, walkers by 70.1%, and wheelchairs by 82.6%.[8] Over the same period, use of home health services increased by more than 800%.[9] We urgently need to understand the respective merits of differing approaches to coping with disability. Although caregiving has been studied extensively,[10,11] data on outcomes of any sort associated with the use of assistive technology are extremely limited.[4,12]

The goal of our study was to examine whether use of equipment to cope with disability was associated with use of fewer hours of help from another person. We chose to examine the effect of equipment use on hours of help rather than the reverse because of the potential humanitarian and financial benefits of reducing dependence on personal assistance (e.g., enabling persons without social support to maintain independence, reducing caregiver strain, lowering ongoing costs of care by reducing use of paid caregivers) and because of the relative paucity of data on the use of technological assistance as a coping strategy. We hypothesized that technological assistance might act as a buffer, reducing the number of hours of help used.

METHODS

Study Design and Population

Cases were drawn from respondents to the National Long Term Care Survey in 1994.[13] The 1994 National Long Term Care Survey used a screening procedure whereby a nationally representative group of Medicare

beneficiaries aged 65 years and older were identified and screened to select those persons with at least 1 limitation in a basic ADL or an instrumental ADL that lasted or was expected to last 3 months or more. Because persons with limitations in basic or instrumental ADLs were oversampled, our sample was more disabled than a random sample of the US population older than 65 years would be expected to be.

Persons with limitations in basic or instrumental ADLs were administered full interviews (as were 1200 persons who did not report any basic or instrumental ADL limitations during the screening procedure). Our primary analysis sample consisted of 2638 persons who had at least 1 limitation in a basic ADL. Therefore, subjects who did not report any basic or instrumental ADL limitations (i.e., subjects who did not report having basic ADL limitations [n=1712] or who had missing data on all of the basic ADL questions [n=1006]) were excluded from this analysis. In addition, 343 persons were eliminated because of missing values for explanatory variables such as race, income, or Medicaid status. The survey collected self-reported information on demographic characteristics, health, functional and cognitive status, use of technological assistance to cope with ADL limitations, hours of help used for ADLs, and health insurance. We did not use sample weights for our analyses because we controlled directly for the influence of limitations in basic ADLs, the variable on which the oversampling was conducted.

Measures: Dependent Variable

Hours of help. The survey was organized so that all subjects were asked about dependencies in basic ADLs (a problem carrying out a given activity without help from another person or equipment). In a separate section of the survey, if the subject had reported a problem with basic ADLs, the subject then was asked how many total hours of help from another person he or she received to complete the basic ADLs eating, getting in and out of bed, getting around inside, dressing, bathing, and getting to the bathroom or toilet. Subjects provided information on hours of assistance per week in the week before the survey. The key dependent variable in multivariate models was hours of help with basic ADLs per week.

For a substantial number of persons, information on hours of basic ADL support was missing (1160 of 2368; 49%). When the number of hours of basic ADL support was missing, we assigned 0 basic ADL help hours if the person had no basic ADL limitations because in such a case, they had missing basic ADL help hours because of the skip pattern of the database. If they had missing support hours but at least 1 basic ADL limitation, we imputed the basic ADL help hours received as follows. For respondents with valid responses for basic ADL hours, we estimated a linear regression model with number of basic ADL hours in the previous week as the dependent variable. The explanatory variables used were number of basic ADL limitations, male gender, and married. We then used the results of the model estimated for persons with valid responses to predict the value for number of ADL hours in the previous week for persons with missing basic ADL hours. The predicted values ranged from 2 hours to 13.5 hours per week.

Measures: Independent Variables

Technological assistance. Equipment used to cope with dependencies in ADLs was identified in a separate section from the questions on hours of help from another person. Subjects were asked whether they used technological assistance with any 1 of 7 ADLs: eating, getting in and out of bed, dressing, bathing, toileting, indoor mobility, and outdoor mobility. Specific types of assistive technological devices were identified for each basic ADL, and subjects were asked if they did or did not use those specific equipment items (equipment listed for mobility inside the home included railing, wheelchair, walker, cane, crutches, elevator or escalator, orthopedic shoes, leg or back brace, prosthesis, oxygen or respirator, furniture or [use of] walls, chairlift, other; equipment listed for bathing included shower seat or tub stool, grab bars or handle bars at sink, handheld shower, walker or cane, rubber mat, other).

To measure technological assistance use, we created 2 variables. The first was a dummy variable for any equipment use; in other words, the subject used technological assistance alone or in combination with personal assistance. This variable measured whether equipment was used at all, irrespective of the extent of ADL impairment or use of personal assistance. The second variable was used to measure the extent of technological assistance use, after control for the degree of ADL impairment. Specifically, we derived 3 mutually exclusive groups from the extent to which technological assistance was used to cope with ADL dependencies: (1) technological assistance used for no basic ADL impairments, (2) technological assistance used for some basic ADL impairments, and (3) technological assistance used for all ADL impairments, irrespective of how many basic ADL limitations the person reported.

ADL impairment. To classify subjects according to ADL limitation, the entire population was divided into 2 mutually exclusive groups: limitation in only 1 basic ADL (n=695) and limitation in 2 or more basic ADLs (n=1673). We also derived the number of basic ADL impairments. This latter variable was the measure for basic ADL limitations included in our multivariate analyses. We excluded people with missing values on all of the basic ADL questions; in the remaining sample, 34 persons had a missing value on 1 basic ADL question; 9 had 2 missing values, and 30 had 3 missing values. In these cases, we classified the person as not having a limitation for that item. We included a control variable in multivariate regressions predicting hours of personal assistance equal to the number of ADLs so assigned.

Cognitive impairment. Cognition was measured by the Short Portable Mental Status Questionnaire, a 10-item scale that measures cognitive abilities with respect to place (Where are you?), time (What day of the week is it?), and person (What is your mother's maiden name?). Persons who answered 0 to 3 items (of 10) correctly on this scale were classified as having severe cognitive impairment; persons who answered 4 to 6 items correctly were classified as having mild cognitive impairment, and persons who answered 7 to 10 items correctly were classified as having mild or no cognitive impairment. When a respondent had a missing value for a particular item on the Short Portable Mental Status Questionnaire, he or

she was assumed to have answered that question incorrectly. When a person had a proxy interview and the reason for a proxy was stated as cognitive impairment, we assigned him or her to the most severely cognitively impaired group.

Psychological impairment. We accounted for psychological impairment as a covariate separately from the other covariates because of data showing that emotional factors can be independent predictors of disability; therefore, psychological impairment might be an independent predictor of coping style.[14] We included a variable equal to 1 when a respondent self-reported that he or she "ever felt a need for the help of a doctor for a mental or emotional problem." We chose to use this variable rather than a more symptom-based question because of concern that questions based on symptoms such as loneliness might be confounded by receipt of personal assistance and thus might not truly reflect psychological constructs exacerbating disability.

Medical characteristics. Health was measured by number of self-reported conditions and by hospitalization in the preceding year. Self-reported conditions included rheumatoid arthritis, paralysis, multiple sclerosis, cerebral palsy, Parkinson's disease, diabetes, hip fracture, pneumonia, cancer, heart attack, stroke, chronic bronchitis, and emphysema. For inclusion in our models, these conditions were trichotomized as no comorbid conditions, 1 comorbid condition, and 2 or more comorbid conditions. Hospitalization during the year before the 1994 National Long Term Care Survey was ascertained by self-report and was included in the model as a binary variable equal to 1 if a person had been admitted to the hospital at least once for any reason and 0 otherwise. We included hospitalization as a covariate because hospitalized persons might have more access to equipment as a result of exposure to rehabilitation providers who might recommend equipment, better insurance reimbursement of equipment recommended during or after hospitalization, or otherwise unmeasured medical need for equipment.

Sociodemographic characteristics. Age, race, sex, marital status and living arrangements, income, education, and Medicaid eligibility were measured via self-report. In multivariate models, age was entered as 2 binary variables; the first was equal to 1 when a person was aged 85 years or older, and the second was equal to 1 when the person was between 75 and 84 years. The omitted category was persons aged 65 to 74 years. Race was defined as White vs Other, and marital status and living arrangements equaled 1 if a person was married or living with another person but 0 if he or she lived alone. Education was measured in years of completed education. Income was measured as a continuous variable but was trichotomized into terciles. The variables entered into the model were the highest tercile (top one third of income) and the middle tercile (middle one third), with the omitted category being the lowest one third of income. Medicaid eligibility was included in the model because that might affect availability of payment for either technological assistance or personal assistance.

Analytic Methods

To test the hypothesis that use of technological assistance was associated with less use of personal assistance, we estimated 2 multivariate ordinary least squares models that had the same dependent variable in each case: the total number of hours of help for all basic ADL impairments. The variables noted in preceding sections were used as explanatory variables. The only way in which the 2 equations differed was in how the use of equipment was specified. In the first equation, any use of equipment was the key explanatory variable (any vs no use of technological assistance), and in the second equation, the extent of equipment use was examined, as operationalized by 2 explanatory variables (no use of technological assistance for any basic ADL impairments and some use of technological assistance for some basic ADL impairments). In the second model, the referent group was use of technological assistance for all basic ADL impairments. Because both models had a linear (nonlogged) dependent variable, the coefficients represented an increase or a decrease in the number of hours of assistance used per week.

As noted, 1160 of the 2368 respondents had missing information on hours of basic ADL assistance, and we imputed the value of the dependent variable. We reestimated both models after eliminating these 1160 cases for which the dependent variable had been imputed to determine the sensitivity of our findings to the treatment of these missing cases. The substantive results did not change regardless of whether these cases were included.

A key problem in an analysis such as this is the potential for unmeasured sickness and frailty to affect analytic results. For example, use of equipment might be associated with less frailty, which might be the reason that fewer hours of help were reported. To account for this possiblity, we controlled for multiple factors likely to be associated with hours of help (income, marital status, medical conditions). In addition, we compared the results of bivariate analyses with the results of multivariate analyses controlling for these variables to determine to what extent our control variables were effective. That is, if the multivariate analysis adequately controlled for sickness and frailty, we hypothesized that use of equipment would be associated with fewer hours of personal assistance on multivariate analysis, compared with the original bivariate analysis showing equipment use to be associated with more hours of personal assistance owing to confounding by sickness and frailty. For example, if using equipment is associated with greater frailty, and greater frailty also is associated with use of more hours of personal assistance, then use of equipment would be associated with more hours of personal assistance on bivariate analysis. However, once the frailty is controlled for, the equipment use would be associated with fewer hours of help.

Other approaches that could be used to deal with the potential endogeneity, or reverse causation, between equipment use and hours of assistance were not used, for several reasons. First, instrumental variable regression, whereby a variable that is correlated with use of equipment but not hours, was not used because of the lack of a theoretically plausible instrumental variable in this database. Second, in a cross-sectional study such as this one, such attempts to address endogeneity can cause even more problems than the potential endogeneity. Finally, this study provides needed groundwork for future studies using longitudinal designs that link changes in coping strategy in a time-ordered

TABLE 1—Coping Style (Use of Personal and/or Technological Assistance), by Number of Basic Activity of Daily Living (ADL) Limitations

	No Personal Assistance; No Technological Assistance, n (%)	No Personal Assistance; Yes Technological Assistance, n (%)	Yes Personal Assistance; No Technological Assistance, n (%)	Yes Personal Assistance; Yes Technological Assistance, n (%)
1 basic ADL limitation (n = 695)	24 (3.4)	49 (7.1)	87 (12.5)	535 (77.0)
≥2 basic ADL limitations (n = 1673)	14 (0.8)	224 (13.4)	44 (2.6)	1391 (83.1)
Total (N = 2368)	38 (1.6)	273 (11.5)	131 (5.5)	1926 (81.3)

fashion to clarify whether changes in equipment use reduce use of assistance. The inability to address endogeneity statistically or via a longitudinal design is a study limitation, but the results remain useful in elucidating the effects of different coping strategies and in laying the groundwork for a longitudinal study to definitively address the question.

RESULTS

Table 1 shows the use of technological assistance and/or personal assistance according to the number of basic ADL limitations. Use of both technological assistance and personal assistance was the most common coping style, both among persons with only 1 basic ADL limitation (77.0% of the 695 persons with 1 basic ADL limitation) and among persons with 2 or more basic ADL limitations (83.1% of 1673 persons). Use of personal assistance alone was more common among people with only 1 basic ADL limitation than among those with 2 or more basic ADL limitations (12.5% vs 2.6%).

Table 2 shows the extent to which technological assistance was used to cope with disability among people with 1 or more basic ADL limitations, both overall and according to sociodemographic and medical characteristics: 61.3% (n = 1452) used equipment for all of their ADL impairments; 31.5% (n = 747) used equipment for some, but not all, of their basic ADL impairments; and 7.1% (n = 169) used equipment for none of their ADL impairments. For several variables on which groups were compared, persons who used technological assistance for all of their ADL impairments or for none of their ADL impairments were similar, whereas those that used technological assistance for some of their ADL limitations, as a group, differed. Examples of such variables included age, race/ethnicity, marital status, multiple medical conditions, and recent hospitalization.

TABLE 2—Proportion of Disabled Population[a] With Selected Characteristics, by Extent to Which Technological Assistance (Equipment) Is Used to Cope With Basic Activity of Daily Living (ADL) Limitations

	Total Disabled Sample (N = 2368), Mean	Mean Proportion Using Equipment for All Basic ADL Impairments (n = 1452)	Mean Proportion Using Equipment for Some Basic ADL Impairments (n = 747)	Mean Proportion Using Equipment for None of Basic ADL Impairments (n = 169)
Sociodemographic characteristics				
Age ≥85 y	0.30	0.28	0.35***	0.26
Male	0.28	0.28	0.30	0.25
Married	0.35	0.31	0.42***	0.35
White	0.88	0.89	0.85**	0.89
College graduate	0.08	0.10	0.07*	0.05*
High school graduate	0.35	0.36	0.33	0.28
Income > $15 000	0.44	0.48	0.38***	0.4*
Medicaid	0.17	0.14	0.22***	0.22**
Medical characteristics				
No. of basic ADL limitations	2.74	2.07	4.27***	1.73***
No. of hours of help	13.75	9.14	23.47***	10.43
Severe cognitive impairment	0.32	0.19	0.54***	0.53***
Moderate cognitive impairment	0.08	0.07	0.09***	0.08
Psychological impairment	0.21	0.22	0.18**	0.17*
1 condition	0.41	0.46	0.33***	0.33***
≥2 conditions	0.49	0.45	0.59***	0.43
Hospitalized	0.36	0.34	0.42***	0.31

Note. Referent for *t*-test comparisons is use of equipment for all ADL impairments.
[a]≥1 basic ADL limitation.
*$P<.05$; **$P<.01$; ***$P<.001$, for the *t* test of means.

Other factors showed a different pattern. For example, people with severe cognitive impairment were much more likely to use technological assistance for some or none of their basic ADL impairments than they were to use technological assistance for all of their basic ADL impairments (54%, 53%, and 19%, respectively; $P<.001$). With regard to physical disability, those using technological assistance for none of their basic ADL impairments were significantly less disabled than those using technological assistance for all basic ADL impairments (1.73 vs 2.07 basic ADL limitations; $P<.001$), but the number of hours of help they received each week (10.4 hours) was similar to the number of weekly hours of help received by those using techno-

TABLE 3—Multivariate Models Predicting Hours of Help Used in the Preceding Week Among People With 1 or More Basic Activity of Daily Living (ADL) Limitations (N = 2368)

	Any vs No Equipment Used for ADL Impairments			Equipment Used for None or Some vs All ADL Impairments		
	Hours	SE	*P*	Hours	SE	*P*
Use of equipment						
Use any equipment for basic ADL impairments	-3.8	1.4	.008	...	...	...
Use no equipment for basic ADL impairments[a]	...	...	...	4.1	1.4	.003
Use equipment for some basic ADL impairments[a]	...	...	...	1.4	1.0	.185
Medical characteristics						
ADL total	6.0	0.3	<.001	5.8	0.3	<.001
No. of missing ADLs[b]	5.6	1.8	.002	5.4	1.8	.003
Missing hours of help	4.7	0.6	<.001	4.9	0.6	<.001
Moderate cognitive impairment[c]	0.6	1.1	.572	0.5	1.1	.651
Severe cognitive impairment[c]	5.0	0.9	<.001	4.8	0.9	<.001
Psychological impairment	0.3	0.7	.611	0.3	0.6	.639
Hospitalized at least once in past year	0.7	0.7	.35	0.7	0.7	.317
1 medical condition[d]	-0.9	1.3	.513	-0.9	1.3	.519
≥2 medical conditions[d]	0.4	1.4	.80	0.4	1.4	.807
Sociodemographic characteristics						
Age ≥85 y	2.0	1.1	.063	2.0	1.1	.060
Age 75–84 y	0.4	0.8	.587	0.4	0.8	.604
Male	3.3	0.8	<.001	3.3	0.8	<.001
White	0.8	1.1	.466	0.8	1.1	.448
Married	-1.6	0.8	.039	-1.7	0.8	.031
High school graduate[e]	0.8	0.7	.265	0.8	0.7	.269
≥College graduate[e]	2.3	1.4	.098	2.3	1.4	.090
Income, highest tercile	2.2	1.0	.020	2.3	1.0	.018
Income, middle tercile	1.6	0.8	.040	1.6	0.8	.036
Medicaid eligible	1.4	1.1	.205	1.4	1.1	.218
Constant	-7.4	2.1	.001	-11.1	1.9	<.001
R^2	0.29					

[a]Referent is use of equipment for *all* basic ADL impairments.
[b]Represents the number of missing responses to ADL questions (the range of missing responses was 1 to 3; number with 1 missing response was 34; with 2 missing was 9; and with 3 missing was 3).
[c]Referent is no cognitive impairment.
[d]Referent is no medical conditions.
[e]Referent is less than high school education.

logical assistance for all basic ADL limitations (9.1 hours). People who used technological assistance for some basic ADLs had twice as many basic ADL limitations (4.27 vs 2.07, $P<.001$) and used about twice as many hours of help in the past week (23.5 hours, $P<.001$), on average, as did those who used technological assistance for all basic ADL limitations (9.1 hours).

Table 3 shows the results of our multivariate analyses. The multivariate models show a strong and consistent relation between equipment use and hours of help—the use of equipment was associated with fewer hours of help, after control for other factors. Disabled people who used any technological assistance, either for some or for all of their basic ADL impairments, reported 3.8 ($P=.008$) fewer hours of help per week than did those who used no technological assistance, net of other factors (columns 1–3, Table 3). We found some evidence for a dose–response relationship between the extent of reliance on technological assistance and hours of personal assistance used (columns 4–6, Table 3). People who used technological assistance for none of their basic ADL impairments reported 4.1 ($P=.003$) more hours of help per week than did those who used technological assistance for all of their impaired basic ADLs, whereas those who used technological assistance for some but not all basic ADL impairments showed a trend, which did not reach statistical significance, toward requiring more hours of help than did those who used technological assistance for all basic ADL impairments (1.4 more hours per week, $P=.19$).

We conducted sensitivity analyses for our multivariate models and reestimated the same models shown in Table 3 with only the cases that did not have missing values for the hours of personal assistance in the past week (n=

1208). The results were remarkably consistent. The signs of all variables shown in Table 3 remained the same, and no variables that were significant lost significance (or the reverse) when we used the smaller sample. The magnitude of the coefficients for the key variables increased when we used the smaller sample. For example, the coefficient for any equipment use showed a decrease of 3.8 hours per week when a respondent used any equipment (P=.008); in the smaller sample, the effect was a decrease of 6.2 hours (P=.002).

The covariates that were significantly associated with hours of help were consistent with both multivariate models (i.e., the models for any use of technological assistance and for extent of technological assistance use). Subjects with more ADL impairments and severe cognitive impairment reported more hours of help. We also found that subjects with missing data for ADLs or for hours of help reported using significantly more hours of help. In neither model was the number of medical conditions reported significant. Subjects older than 85 years and men reported significantly more hours of help, whereas married subjects reported using fewer hours of help. Whites reported using more hours of help per week in both equations, but the relation did not reach statistical significance in either. Equipment use, number of basic ADL limitations, missing data for basic ADLs or hours of help, and severe cognitive impairment all had significant differences of 4.5 or more hours of help per week.

DISCUSSION

Our findings clearly support the hypothesis that technological assistance might substitute for at least some personal assistance in coping with disability. People who do not use equipment report about 4 more hours of help per week compared with those who do use equipment. We found that a variety of sociodemographic and medical factors were associated with differences in coping style. For example, Medicaid recipients, people who were poor, and those who were either cognitively or psychologically impaired were more likely to be in the group that either used no devices for their ADL impairments or used devices for only some of their ADL impairments. Although some devices may be too difficult for cognitively impaired people to manipulate, financial and psychological factors are amenable to change, and our findings support the possibility that public health efforts could influence how people cope with disability.

Our findings are consistent with conceptual models of the disablement process and with the data available on outcomes from assistive technology. Recent models of the disablement process envision contextual factors such as assistive technology as modifying the process.[1,2] Indeed, other studies have shown that providing equipment to homebound elders reduced self-reported difficulty with ADLs and time required to perform ADLs.[15,16] Similarly, both Agree[3] and Verbrugge et al.[17] showed that persons relying on technological assistance reported less residual disability than did those relying on personal assistance, particularly those with arthritis or with mild or moderate physical impairment or dependencies in lower-extremity function. The beneficial effects of technological assistance on ADL performance in turn would be expected to reduce the number of hours of personal assistance needed to cope with ADL deficits.

Work by Allen and colleagues[18] showed that canes and crutches, but not wheelchairs and walkers, were associated with fewer hours of personal assistance. This finding may have resulted from inherent differences in the utility of different devices, but it was more likely attributable to an inability to fully control for the greater levels of disability associated with wheelchairs and walkers in the Allen et al. study. In contrast, our standard of equipment use measured equipment use relative to the amount of disability, as well as including disability and other medical characteristics as covariates, thus better controlling for the important role of comorbid disability and consistently showing fewer hours of help among equipment users.

This study had several important limitations. Our data on the relation of coping style to hours of help were cross-sectional, so this study cannot speak to causality. Moreover, the relation between personal assistance and technological assistance likely is bidirectional, and our analysis examined only 1 side of that bidirectional relationship. Nonetheless, whether direct or indirect, the relation between personal assistance and technological assistance is noteworthy. Our study relied on self-reported data, possibly allowing inaccurate reporting. The inaccuracies of self-reported data on function have been well characterized and are generally modest and unlikely to account for differences of the magnitude seen in this study.

Another limitation was the role that unmeasured sickness may have played in our findings. However, we controlled for multiple factors that are likely to be associated with hours of help, and our findings were quite consistent. Moreover, univariate analyses showed that people using technological assistance for some basic ADL limitations received 23.47 hours of help per week, compared with 9.14 hours per week for those using technological assistance for all ADLs; in our multivariate analyses, this difference declined to 1.4 hours and was no longer significant, indicating that our control variables were effective in accounting for disability- and sickness-related differences in hours of help.

In addition, change in the opposite direction occurred in our multivariate analyses for the group of people using technological assistance for none of their basic ADL limitations—univariate analyses showed that people who used technological assistance for none of their ADL limitations reported more, although not significantly more, hours of help than did those who used equipment for all of their ADL limitations; after controlling for disability and other variables, people using technological assistance for none of their ADL impairments reported substantially and significantly more hours of help than did those using technological assistance for all of their ADL impairments, again indicating that our control variables were effective in accounting for group differences in disability. Better control of unmeasured sickness would be likely to increase this difference further. However, definitive resolution of this issue will require a randomized trial or an observational study that begins studying patients well before the onset of disability.

The results of our study have several important clinical and research implications. Providers sometimes fear that prescribing equipment such as a wheelchair or walker

will promote dependency in self-care ("use it or lose it"). Our data suggest that just the opposite may occur. People who did not use technology to cope with disability reported more dependency on others. However, we can only speculate on the reasons that equipment use was associated with fewer hours of help.

Others have noted apparent induced disability with provision of personal assistance. Specifically, Avorn and Langer[19] and Penrod et al.[20] showed that exposure to greater levels of formal and informal help was associated with greater levels of subsequent disability. Use of equipment may help prevent induced disability, or it may act to preserve physical conditioning by maintaining a greater level of physical activity, or its effect may be direct through allowing self-care tasks to be performed more efficiently. There may be important differences in effects of equipment at the individual ADL level, specific comorbid conditions may have important effects on benefits from specific kinds of devices, and the benefits may vary according to the specific device in use. For example, manual wheelchairs may be more helpful for impaired mobility due to paraplegia in young adults who have good upper-body strength and good cardiopulmonary function, whereas motorized scooters or wheeled walkers may be more helpful for frail elders who may have arthritic shoulders and/or cardiopulmonary disease in addition to their impaired lower-extremity function. Answering these questions will require detailed longitudinal study. Such study is important because of the possibility raised by our findings that provision of technological assistance may reduce caregiver burden insofar as fewer hours of help were used when technological assistance was in place.

Many severely disabled people own no assistive equipment, and substantial unmet needs are reported[21,22]; this lack of equipment may play a role in the substantial disparities noted by others in use of personal assistance.[10,23,24] For example, depending on the condition, 3- to 7-fold geographic differences in use of home care services were seen in Canada.[25] Disparities in use of personal assistance have both humanitarian and financial implications. Schulz and colleagues[26,27] clearly showed that caregivers experiencing strain report poorer health status, have increased mortality, and report greater numbers of ADL dependencies in their spouses and greater amounts of time providing help.

Total expenditures in the United States for home care services amounted to more than $32 billion in 1999 and are expected to be nearly triple this amount by 2010.[9] In terms of financial costs, conservatively estimating the cost of employing a personal assistant at $6.95 per hour,[28] cost savings in our study from using technological assistance could amount to $30 per week, on average. However, the benefits from technological assistance may not be equally apparent among users of informal vs formal assistance, and the costs of providing technological assistance must be considered. Because the burden of added hours of help may not be felt by private insurers or Medicare, there may be little incentive for coverage of technology that reduces use of personal assistance, a possibility that is supported by our finding of lower device use among Medicaid recipients and poor subjects. Our study does not allow direct calculation of the cost trade-offs of different coping methods, but this clearly is an important area for future research.

The methods chosen to cope with disability, and how we as a society and as health care practitioners influence the use of specific coping strategies, will become increasingly important societal issues as the population ages, develops physical disability, and looks to technological and personal assistance to cope with that disability. ■

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Human Participant Protection

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