Effectiveness of Home- and Community-Based Rehabilitation in a Large Cohort of Patients Disabled by Cerebrovascular Accident: Evidence of a Dose-Response Relationship

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Abstract
Objectives: To (1) assess the effectiveness of home- and community-based rehabilitation (HCBR) in a large cohort of individuals with disabilities secondary to cerebrovascular accident (CVA); and (2) evaluate the responsiveness to treatment of the Mayo-Portland Adaptability Inventory (MPAI-4) to changes resulting from HCBR in this patient group.

Design: Retrospective analysis of program evaluation data for treatment completers and noncompleters.

Setting: HCBR conducted in 7 geographically distinct U.S. cities.

Participants: Individuals with CVA (n=738) who completed the prescribed course of rehabilitation (completed course of treatment [CCT]) compared with 150 individuals who were precipitously discharged (PD) before program completion.

Intervention: HCBR delivered by certified professional staff on an individualized basis.

Main Outcome Measures: Mayo-Portland Adaptability Inventory (MPAI-4) completed by professional consensus on admission and at discharge.

Results: With the use of analysis of covariance, MPAI-4 total scores at discharge for CCT participants were compared with those of PD participants, with admission MPAI-4, age, length of stay, and time since event as covariates. CCT participants showed greater improvement than PD participants (F=99.48, P<.001) with a moderate effect size (partial $\eta^2=.10$). Group differences and effect sizes were similar for the 3 index scores: Ability (F=75.96, P<.001; partial $\eta^2=.08$), Adjustment (F=99.67, P<.001; partial $\eta^2=.10$), and Participation (F=69.15, P<.001; partial $\eta^2=.07$).

Conclusions: Individuals in the CCT group who received the entire planned course of HCBR showed greater improvement on all MPAI-4 indexes than those in the PD group who were discharged before completing the prescribed program. This dose-response relationship provides evidence of a causal relationship between treatment and outcome.

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In a prior study7 of more than 600 cases with TBI, we reported superior outcomes on the Mayo-Portland Adaptability Inventory (MPAI-4) for participants who completed the entire planned program (completed course of treatment [CCT]) of home- and community-based rehabilitation (HCBR) compared with participants who were precipitously discharged (PD) before completing the prescribed rehabilitation program. Although in the prior report we did not refer to a dose-response relationship, this term appears appropriately applied since the PD group received a lower “dose” of the planned treatment than the CCT group.

This brief report describes a replication of this prior study with individuals admitted to the same national multisite rehabilitation system subsequent to cerebrovascular accident (CVA). Although the MPAI-4 has been validated with mixed groups of individuals with ABI, its responsiveness to a rehabilitation treatment effect has not been specifically evaluated with individuals with CVA. The MPAI-4 has been shown to retain good psychometric qualities when used with individuals with stroke.8 Objectives were (1) to assess the effectiveness of HCBR in a large cohort of individuals with disabilities secondary to CVA, and (2) to evaluate the responsiveness to treatment of the MPAI-4 to changes resulting from HCBR in this patient group. Our hypothesis was simply that individuals who completed a planned program of HCBR would demonstrate greater improvement at discharge on the MPAI-4 than those receiving a lesser dose. Effect size of the treatment was computed to evaluate the responsiveness of the MPAI-4 to HCBR (objective 2). This study was not designed to assess whether the MPAI-4 is more sensitive than other measures to this type of treatment.

Methods

Participants

The sample in this retrospective study consisted of consecutive admissions to HCBR after CVA with admission and discharge MPAI-4 data. Detailed diagnostic information about the CVA was recorded in the patient’s clinical record but not practically available for research. Participants were admitted to HCBR using the following admission criteria: (1) medically stable enough to participate in rehabilitation and had medical supports in place to maintain stability in the proposed living environment; (2) potential to achieve specified rehabilitation goals in the home and community setting; (3) reside in a safe and accessible environment with adequate supervision and support so that they are not at risk when therapists are not on site; (4) behaviors are manageable in the proposed treatment environment; and (5) able to consent by self or proxy to admission/treatment. A potential participant’s ability to meet the above criteria was determined through a preadmission screening assessment conducted by a qualified evaluator through a face-to-face interview and a review of available medical records. Participants or their proxies signed consent forms on admission to allow their data to be included in this study. Although consent for data use was obtained from each participant, data collection was originally planned only for program evaluation purposes; that is, this was not a prospective research study. Institutional review board (IRB) approval through an Indiana University IRB for retrospective analysis of these deidentified data was obtained subsequent to data acquisition.

At discharge, participants were classified as CCT or PD according to the following definitions:

- **CCT**: Participant received services as initially targeted toward 1 or more functional outcome goals (eg, independent living status, independence in personal activities of daily living) with at least 2 clinical disciplines other than clinical coordination.
- **PD**: Any discharge that allowed less than 1 week of preparation time before discharge or was unanticipated. This included situations in which participant, family, physician, payer, and/or program staff decided to discharge before reaching agreed-on outcome goals in the plan of treatment. However, if the discharge was planned for and goals were set accordingly, it was not considered a precipitous discharge even if goals were not met.

Demographic and injury-related variables for both groups are displayed in table 1. Statistical comparisons showed no difference between groups with regard to sex ($\chi^2 = .28, P = .59$), chronicity (time since event: $t = -1.11, P = .27$), or age ($t = -1.82, P = .07$). As expected, the CCT group ($n = 738$) had longer lengths of stay in the program ($t = -9.72, P < .001$) than the PD group ($n = 150$). Seventeen potential CCT and 8 PD subjects were not included in the study because of missing admission or discharge MPAI-4 data. This small amount of lost data appeared unsystematic (ie, random) and was not believed to bias results.

Outcome measure

The MPAI-4, a measure with well-established psychometric properties,9,10 was completed on program admission and at discharge by consensus of the rehabilitation team working with the participant. Telephone follow-up 3 and 12 months postdischarge was conducted by clinical staff using the Participation Index only.

Procedures

All study participants were actively involved in an individualized HCBR program, accredited by the Commission on Accreditation of Rehabilitation Facilities, in 1 of 7 geographically diverse states owned by a single rehabilitation corporation (Rehab Without Walls). The program, services and procedures, and quality assurance for administration of the MPAI-4 are more completely described in Altman et al.7 As in the original study, it was not possible to determine in this retrospective study precisely why individuals, their families, or their physicians decided to terminate the program precipitously. It appeared that, in most cases, discharge occurred precipitously because of factors beyond the participant’s control, such as lack of funding, transportation, changes in the living situation, or the family’s ability to provide support. As in the original study, rating clinicians were not aware that a retrospective study would be conducted to analyze differences among patient groups.

**List of abbreviations:**

- **ABI** acquired brain injury
- **ANCOVA** analysis of covariance
- **CCT** completed course of treatment
- **CVA** cerebrovascular accident
- **HCBR** home- and community-based rehabilitation
- **IRB** institutional review board
- **MPAI-4** Mayo-Portland Adaptability Inventory
- **PD** precipitously discharged
- **RCT** randomized controlled trial
- **TBI** traumatic brain injury
Results

Admission MPAI-4

Comparison of admission MPAI-4 scores revealed that the PD group had more limitations, particularly in Adjustment and Participation, on entering rehabilitation (fig 1). Groups differed on admission total MPAI-4 score \((t = 3.11, P < .002)\), the Adjustment Index \((t = 3.75, P < .001)\), and the Participation Index \((t = 3.65, P < .001)\) but not significantly on the Ability Index \((t = 1.83, P = .07)\). While group differences on admission were statistically significant because of the relatively large sample size, actual T-score differences between groups were not large. The mean T scores on admission for the Adjustment Index, Participation Index, and total score for the CCT group were 49.4, 49.4, and 49.5, respectively, compared with 52.8, 52.5, and 52.3, respectively, for the PD group.

Outcome posttreatment

Analysis of covariance (ANCOVA) was applied to total MPAI-4 and all subscale raw scores at discharge with group (CCT vs PD) as the between-subjects variable and admission MPAI-4 score, age on admission, log chronicity, and length of stay as covariates. (Chronicity was highly skewed; see mean vs quartile metrics in table 1. Consequently, a log conversion was applied to normalize the distribution.) Significant differences between the groups were present at discharge for the total MPAI-4 \((F = 99.48, P < .001)\) with a moderate effect size \((\gamma^2 = .10)\), Admission MPAI-4 score \((F = 1347.85, P < .001; \text{partial } \gamma^2 = .60)\), age \((F = 12.80, P < .001; \text{partial } \gamma^2 = .01)\), and log chronicity \((F = 107.09, P < .001; \text{partial } \gamma^2 = .11)\) also explained significant variance on the outcome measure, but length of stay did not \((F = 3.66, P = .06; \text{partial } \gamma^2 = .004)\). Group differences were similar for the Ability Index \((F = 75.96, P < .001; \text{partial } \gamma^2 = .08)\), the Adjustment Index \((F = 99.67, P < .001; \text{partial } \gamma^2 = .10)\), and the Participation Index \((F = 69.15, P < .001; \text{partial } \gamma^2 = .07)\). In each subscale analysis, admission score, age, and log chronicity accounted for significant variance on the discharge score. Length of stay contributed to explained variance only for the Ability Index \((F = 7.50, P = .006)\) with a small effect size \((\gamma^2 = .008)\).

Figure 1 illustrates changes in total MPAI-4 score from baseline to posttreatment for each group. T scores were computed using the admission mean and SD for all participants. On the MPAI-4, a lower raw score indicates less restricted performance.

### Table 1  Demographic and injury-related variables by group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Completers ((n = 738))</th>
<th>PD ((n = 150))</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men (%)</td>
<td>56</td>
<td>54</td>
<td>(\chi^2 = .28)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>51.10±11.46 (44, 52, 59)</td>
<td>52.96±10.80 (48, 52, 59)</td>
<td>(t = -1.82)</td>
</tr>
<tr>
<td>Chronicity (d)</td>
<td>108.15±319.36 (28, 46, 89)</td>
<td>140.33±344.45 (33, 57, 106)</td>
<td>(t = -1.11)</td>
</tr>
<tr>
<td>LOS (d)</td>
<td>77.88±71.19 (43, 62, 90)</td>
<td>44.29±27.56 (25, 38, 61)</td>
<td>(t = 9.72^*)</td>
</tr>
</tbody>
</table>

NOTE. Values are mean ± SD (25th, 50th, 75th percentiles), or as otherwise indicated.

Abbreviation: LOS, length of stay.

* \(P < .001\).
hence, lower T scores also indicate better outcomes. As can be seen, the CCT group, on average, changed a little over 1 SD from admission to discharge on all measures. In contrast, the change for the PD group was less than 0.5 SD.

Follow-up

Because follow-up data collection was done by clinicians during the time available, loss to follow-up was substantial. Nonetheless, although both groups improved, the advantage for program completers remained apparent. At 3-month follow-up, the Participation T score was 31.9 for 312 CCT participants compared with 38.3 for 40 PD participants ($t = -2.64, P = .009$). At 12-month follow-up, the Participation T score was 29.2 for 214 CCT participants compared with 37.0 for 26 PD participants ($t = -2.57, P = .01$).

Discussion

Results show gains from HCBR for individuals with CVA that are similar in degree to those previously reported for individuals with TBI, and demonstrate the responsiveness to treatment of the MPAI-4 to changes over the course of rehabilitation in patients with CVA. The dose-response relationship was also similar in degree to that reported previously, indicating that a “full” dose—that is, completing the entire planned rehabilitation program—results in superior outcomes to a partial dose resulting from unplanned discharge. Although the PD group does not constitute a rigorous control condition, this dose-response relationship provides some evidence of a causal relationship between the intervention and the outcome. The absence of a consistent relationship between the outcome and length of stay suggests that dosing probably represents a combination of factors, such as intensity, quality, and appropriateness of services, and not simply time in the program.

Both TBI and CVA result in heterogeneous patient groups. Detailed diagnostic information about the CVA was not available. However, while this may be of academic interest, the variable most relevant to outcome in both this and the previous study is the functional assessment (MPAI-4) on admission. As indicated by partial $\eta^2$, admission MPAI-4 accounted for 60% or more of the variance on discharge MPAI-4 in both studies. As in the prior study, chronicity also significantly affected outcome, indicating the value of early intervention. Although age affected outcome in this study, the effect size was small.

The PD group showed statistically greater disability on the Adjustment and Participation Indices and total score than the CCT group on admission. However, the actual differences between groups were not large and hovered close to the mean. These differences were statistically controlled by the use of ANCOVA. Hence, we do not believe that the small differences between groups in disability on admission can account for the more substantial differences between groups at discharge.

Although loss to follow-up was substantial, available data suggest that both groups continued to improve after discharge in community participation. This might be expected as daily schedules shift from participating in therapy to more community-oriented activities. However, as in our original study with individuals with TBI, program completers continued to show an advantage at follow-up in community participation compared with the PD group. Training family and significant others to encourage and support community integration after discharge is an essential part of the HCBR program and may have contributed to the CCT group maintaining superior community participation during the follow-up period.

Study limitations

As in the previous study, the primary limitation of this study is the absence of a randomly assigned control condition. A number of factors (eg, difficulty in offering manualized treatment in an individualized fashion, difficulty in blinding participants and providers to the experimental condition, and ethical concerns) frustrate rigorous experimental investigation (ie, RCT) of post-hospital rehabilitation.11 Large observational trials, such as this one, typically include more representative samples and yield similar conclusions to RCTs.12,13

Conclusions

Compared with a group who left the program before completing the entire planned course of treatment, individuals admitted to an HCBR program post-CVA who did complete the entire planned course of treatment showed greater improvement on total MPAI-4 score as well as on MPAI-4 subscale indexes measuring Ability, Adjustment, and Participation. Despite the lack of a rigorous control condition, this dose-response relationship provides some evidence of a causal relationship between treatment and outcome.

Keywords

Cerebrovascular accident; Rehabilitation; Stroke

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