Feasibility Study of Problem-Solving Training for Care Partners of Adults With Traumatic Brain Injury, Spinal Cord Injury, Burn Injury, or Stroke During the Inpatient Hospital Stay

Shannon B. Juengst, PhD, CRC
Candice L. Osborne, PhD, OTR
Radha Holavanahalli, PhD
Valeria Silva, BS
Chung Lin Kew, BA
Andrew Nabasny, MS
Kathleen R. Bell, MD

Department of Physical Medicine and Rehabilitation, University of Texas Southwestern Medical Center, Dallas, Texas
Department of Rehabilitation Counseling, University of Texas Southwestern Medical Center, Dallas, Texas

Abstract
Objective: To determine the feasibility of delivering an evidence-based self-management intervention, problem-solving training (PST), to care partners of individuals with traumatic brain injury (TBI), spinal cord injury (SCI), burn injury, or stroke during the inpatient hospital stay.

Design: In this single group pre-post intervention pilot feasibility study.

Setting: Inpatient rehabilitation or acute care and community.

Participants: Care partners (spouse or partner, family member, friend who is in any way responsible for the health or well-being of the care recipient) of individuals with TBI, SCI, burn injury, or stroke (N=39).

Intervention: PST is a metacognitive self-management intervention that teaches individuals a global strategy for addressing self-selected problems. Participants received up to 6 sessions of PST in person or via telephone during their care recipient’s inpatient stay.

List of abbreviations: CaPPS, Care Partner Problem Solving; CSQ, Client Satisfaction Questionnaire; PRPS, Pittsburgh Rehabilitation Participation Scale; PST, problem-solving training; SCI, spinal cord injury; TBI, traumatic brain injury; WAI, Working Alliance Inventory.

Supported by the Foundation for PM&R Midcareer Investigator Research Grant Award (PI: S.B.J.), the Agency for Healthcare Research and Quality (grant no. HS022418), and Clinical and Translational Science Awards National Institutes of Health (grant no. UL1TR001105).

Disclosures: none.

To be presented at the American Congress of Rehabilitation Medicine Annual Conference, November 2019, Chicago, IL.

Cite this article as: Arch Rehabil Res Clin Transl. 2019;1:100009.
The United States Census Bureau estimates that nearly 58 million people currently live in the United States with a disability,1 and more than 65 million people in the United States provide informal care to an individual with a chronic illness or disability.2 Knowledge about the experiences of these informal caregivers, or care partners, predominantly comes from dementia literature. Data from the National Health and Aging Caregivers Study and the National Study of Caregiving revealed that care partners of older adults who provide substantial help with health care are significantly more likely to experience emotional, physical, and financial difficulty than care partners providing no help.3 They are 5 times more likely to experience participation restrictions in valued activities and 3 times more likely to experience work productivity loss.4 They also have a higher risk for problematic alcohol use if they experience social and emotional burden related to caregiving.4 A systematic review concluded that interventions to reduce care partner stress may reverse the negative effect of caregiver burden.5

Care partners supporting individuals with sudden onset medical conditions like traumatic brain injury (TBI), spinal cord injury (SCI), burn injury, or stroke share many of the same experiences as care partners of those with dementia. However, unlike care partners of adults with dementia, they have no warning or preparation for their new caregiving roles. The unpredictable and sudden onset of these conditions introduces unique considerations regarding the timing and setting of intervention delivery, but little research focuses on these care partners, despite the high prevalence of these conditions.

Currently in the United States, more than 5 million (~2% of the US population) are living with TBI-related disability,6 ~282,000 have SCI-related disability,7 up to 50% of individuals with burn injury experience associated disability,8 and ~7 million people have stroke-related disability.7 Individuals with disability related to traumatic injury or stroke experience numerous and often lifelong changes that require ongoing support, including changes in mobility, cognition, emotion, and sensation,2,8,10-22 but access to rehabilitation and mental health services in the community for individuals with these chronic conditions is limited.5,20,22-24 As a result, it often falls to care partners to provide the support required, despite limited or no caregiver training. Care partners must also manage their own lives and their complex relationships with their care recipients.25,26

Care partners of adults with traumatic injuries and stroke frequently report high levels of caregiver burden, which may lead to depression, anxiety, and physical symptoms, as well as reduced quality of life.17,24,25,27-33 Caregiver burden is largely predicted by caregivers’ unmet needs.29,30,34,36 Because the effects of traumatic injury and stroke continue to change over time, so do the perceived needs of care partners.17,23,24,28,35,37 Over time, care partners report increasing difficulty meeting their needs, particularly as problems occur in the absence of any professional support. Interventions should therefore address not only current care partner needs, but also needs that may arise over time, particularly as individuals transition out of formal care settings.23,38 Care partners of adults with burn injury specifically indicated that family adjustment after injury is a long-term issue that should be addressed early in the inpatient hospital stay.17,23 However, care partner self-management interventions to date tend to occur in an outpatient setting.39

Self-management interventions may address care partner needs over time by providing care partners with the skills necessary to manage and adapt to challenges over time. Self-management refers to the skills collectively applied to achieve a physically and emotionally healthy life, including a sense of autonomy and perceived control, the ability to engage in healthy behaviors, employing a problem-solving approach to address needs, readiness to change, and self-efficacy.40-42 Self-management skills are essential for translating knowledge into action. Problem-solving theories, especially D’Zurilla’s social problem-solving model, emphasize how critical problem solving is for effective self-management.43 Formal problem-solving training (PST) could provide the requisite skills for care partners to independently translate the health education they receive into realistic and effective action after hospital discharge.

Problem-solving training (PST)44 is a self-management intervention that teaches individuals a simple, systematic method for evaluating problems, generating and selecting solutions, developing specific goals and action plans, and
Feasibility study of PST

We conducted a single-group feasibility study of PST for care partners of adults with TBI, SCI, burn injury, or stroke delivered during the care recipient’s inpatient rehabilitation or acute care stay. A research coordinator administered baseline assessments in person prior to the study intervention. A trained interventionist delivered up to 6 sessions of PST to care partners during the care recipient’s inpatient hospital stay. After discharge, participants were given the opportunity to download the CaPPS app, which provided booster sessions once per week for 8 weeks (app content was hosted by ilumivu). During the final intervention session, the interventionist assessed the participant’s confidence using the PST strategy. Participant satisfaction and perceived working alliance were assessed at 1-month postdischarge via electronic survey through REDCap. The University of Texas Southwestern Medical Center Institutional Review Board approved all research procedures, and we obtained written informed consent from all participants.

Participants

Participants were care partners of individuals with TBI, SCI, burn injury, or stroke admitted to an Academic Medical Center hospital. Care partners were defined as individuals involved in assisting the care recipient with activities of daily living and/or medical tasks or responsible in any way for the care recipient’s well-being after hospital discharge. Recruitment occurred through flyers, physician referrals, or by approaching care partners of patients recruited for the North Texas TBI Model Systems at UT Southwestern or the UT Southwestern Burn Model Systems studies. Inclusion criteria were (1) care partner (spouse, partner, family member, friend) of an individual admitted to the hospital with a new onset TBI, SCI, burn injury, or stroke; (2) ≥1-year relation with the care recipient; (3) fluent in English; (4) ≥18 years old; (5) capacity to self-consent; and (6) owned a smartphone. Exclusion criterion was as follows: (1) legal dispute over care partner’s role in the care of the care recipient.

Measures

We collected demographic (age, sex, race, ethnicity, education) data and care partner relation information (nature, duration, living status, relation quality) at baseline to characterize the sample. Feasibility data included all of the following measures: (1) number and percentage of recruited participants; (2) reasons for ineligibility; (3) reasons for refusal; (4) number of sessions completed; (5) length of sessions; and (6) Pittsburgh Rehabilitation Participation Scale (PRPS) rated by interventionists after each PST session to measure participant engagement in the intervention. The PRPS is a 6-point scale validated for completion by a rehabilitation therapist to measure engaging, with ratings ranging from 1 (No engagement) to 6 (Excellent engagement); (7) intervention uptake (participant confidence applying the PST strategy rated from 0 to 10; number of sessions it took for the participant to feel confident that they could use the PST strategy) assessed by the interventionist during the final PST session; (8) Client Satisfaction Questionnaire-8 (CSQ-8) at 1 month postdischarge to measure participant satisfaction with PST. The CSQ-8 is a validated self-reported measure of satisfaction with health-related services received. It includes 8 questions rated on a 4-point scale, yielding a single summed score; and (9) Working Alliance Inventory (WAI) at 1-month postdischarge to measure the participant’s perceived working alliance with the interventionist. The WAI is a validated self-reported 12-item measure of how the participant feels about the interventionist, with...
individual items measured on a 7-point scale and summed for a total score.

PST intervention

PST is a global or metacognitive strategy training approach (i.e., a strategy for how to problem solve rather than a strategy for solving a specific problem), grounded in self-management theory, that teaches a global problem-solving strategy linked to an simple mnemonic: ABCDEF (A = assess the problem, B = brainstorm, C = consider and choose, D = develop and do, E = evaluate, F = flex). PST intervention consisted of up to 6 sessions (~30-45min each) following a structured format, previously described. Participants apply this strategy to whatever problems they choose to address, under the guidance of the interventionist. The PST intervention consisted of up to 6 sessions (~30-45min each) following a structured format, previously described.59,60 Participants received these sessions either in person or via telephone during the care recipient’s inpatient hospital stay, with a target of 2-3 sessions per week. The final session consisted of PST strategy review, review of progress made, and discussion of applying the PST strategy to problems that may arise in the future; this final session could be completed after discharge, if not completed before. Use of the PST strategy within and between sessions occurred through structured PST worksheets provided to the participants. The 2 study interventionists were students in a Clinical Masters in Rehabilitation Counseling program. They were trained and supervised in PST delivery by the study PI (a PhD-trained certified rehabilitation counselor), after a training protocol previously described.60

CaPPS app development and content

Two consumer focus groups conducted in October 2017 elicited 5 consistent preferences regarding app design and content for mobile health apps in general. Notable to CaPPS design were the following: (1) ability to communicate with health care providers; (2) cognitive strategies, including a notification system; and (3) app accessibility and privacy. Based on this consumer feedback and structured around the content of the PST intervention, we developed the initial CaPPS app (fig 1) using ilumivu’s mobile app platform.55 CaPPS sent notifications to participants to complete weekly booster sessions consisting of the following: Goal Attainment Scaling to evaluate goal attainment each week, Patient Health Questionnaire-2,62 Alcohol Use Disorders Identification Test-Concise,63 Zarit Burden Interview-4,64 and 2 subscales from the Brief Coping Orientation to Problems Experienced (Brief COPE) Inventory.65 Participants also had the opportunity through free text in the app to describe the problem(s) they applied the PST strategy to over the past week, and were given the option to review the steps of PST through the app.

In July 2018, we conducted 2 focus groups, one with clinicians and the other with individuals with acquired brain injuries and their family members to beta test the CaPPS app. Five themes emerged through these groups: (1) the app is easy to use; (2) notifications are a helpful memory aid; (3) participants liked the ability to track and share data with health care providers; (4) the wording in some of the assessments could be clearer; (5) participants desired the ability to track their responses and monitor progress over

![Fig 1](CaPPS smartphone app design.)
time; and (6) clinicians felt that data from the app could be used to inform inpatient rehabilitation services.

We also created instruction sheets that detailed step-by-step instructions for downloading and using the app, specific to Android or iOS operating system, including screenshots for each step and a trouble-shooting guide for common problems experienced when using the app. Participants downloaded the illumivu app for free from the mobile app store, then entered a unique mobile code (assigned by investigators) linking the app to the research study. Participants were then sent notifications weekly for 8 weeks prompting them to use the CaPPS app.

Statistical analysis plan

For our first aim, we descriptively report the number and percentage of recruited participants, reasons for ineligibility, reasons for refusal, and number of PST sessions completed. We present summary statistics (means, standard deviations) of participant satisfaction with PST, perceived working alliance with the interventionist, and participant confidence using PST. For our second aim, to assess initial feasibility of using a smartphone app to boost a behavioral intervention for care partners, we present number of participants who downloaded and used CaPPS.

Results

Feasibility of recruitment and intervention delivery

Between July and October 2018, we approached 39 care partners for potential participation in this study, of which 12 consented to participate. Figure 2 provides further detail on reasons for ineligibility or refusal. Table 1 presents demographics characterizing the study sample. All consented participants had known their care recipient for more than 10 years, though only 41% were living with the care recipient. Compared to all approached participants, those who consented were less often women and more often white and non-Hispanic. Of those who consented, 10 participants completed at least 1 PST session, with 8 completing 3 or more sessions (see fig 2). One participant withdrew after starting the intervention; all others completed their 1-month follow-up assessment.

Participants (n=11) were generally very satisfied with the intervention (CSQ mean = 3.35, SD = 0.60, 1- to 4-point scale). Interventionists rated participants who completed at least 1 PST session (n=10) as having very good engagement, on average, across all sessions (PRPS mean = 4.75, SD = 1.41, 1- to 6-point scale). Seven participants rated their level of confidence in their ability to apply the PST strategy after completion of the intervention as 9 (SD = 1.5) on a 10-point scale, with higher scores indicating greater confidence. On average, they felt confident using the PST strategy after only 2.6 (SD = 1.3, range = 1-4) sessions. Participants reported a strong working alliance with interventionists (WAI mean = 6.8, SD = 3.1, 0- to 7-point scale).

CaPPS

Mobile app profiles were created for 9 participants. This included a profile for a participant who did not complete any PST sessions, but who was sent the instructions for
Discussion

The feasibility and efficacy of early PST for care partners during the care recipient’s inpatient hospital stay are unknown. As a first step in addressing this gap in knowledge, we examined the feasibility of delivering PST to care partners of adults with new onset traumatic injuries or stroke during the care recipient’s inpatient rehabilitation or acute care stay.

Of all eligible care partners we approached, about two-fifths consented to participate. The most common reason for refusal was not perceiving any likely benefit. Participation rates could potentially be improved by providing a brief, plain language summary of the evidence for the benefits of PST for care partners or providing quotes or brief testimonials of individuals who went through the intervention. Notably, all participants who consented had a high school diploma or college degree, which may suggest an education-related volunteer bias, though we do not have education information for unconsented individuals. A small number was not interested in any research; they may have been more interested in PST if it was available as an intervention embedded in existing clinical programs (as opposed to a research study). Despite the acute-care period often being an overwhelming and busy time for care partners, only 3 potential participants refused because they felt overwhelmed or had no time. The most common reason for ineligibility was lack of English language fluency (all fluent in Spanish), supporting the need for translation and adaptation of PST into Spanish. The next most common reason for ineligibility was the care recipient having a scheduled discharge within 48 hours, leaving no time to start the study. For this study, we focused on completing PST sessions prior to the care recipient’s discharge. Future work should examine starting the intervention prior to discharge and continuing across the transition of care, which would allow for more care partners to participate despite short lengths of stay.

Once enrolled in the PST study, our data supported the general feasibility of intervention delivery; that is, we were mostly able to deliver the intervention as planned. Failure to complete 6 sessions was due predominantly to short lengths of the stay. One participant did elect to discontinue the intervention, stating only that he no longer wished to participate. Continuing the intervention across the transition of care from the hospital to home would circumvent the problem of short lengths of stay, while still initiating the intervention earlier for care partners. Previous work supports the efficacy and feasibility of delivering PST via telephone to care partners of individuals with disabilities shortly after care recipient discharge. In our study, participants found the intervention to be very satisfactory, demonstrated through their direct reports of satisfaction and through their high level of engagement during the PST sessions. Participants also reported a high level of confidence using PST, even after receiving only 2-3 sessions. A strong working alliance, a participant-reported measure of the strength of the working relationship between the interventionist and participant, indicated that interventionists built the necessary rapport and conveyed respect to participants. To quote 1 participant: “I saw the relevance after the initial meeting...It was helpful for me to break down my goals as I was stressed and having trouble with critical thinking. Really enjoyed my sessions and the interviewer!”

Use of the CaPPS smartphone app to boost the PST intervention was less successful, with very few participants initiating CaPPS use. The only participant who completed booster sessions in response to push notifications was...
trained on the app during the second to last (rather than last) PST session, suggesting that introducing the app earlier with more time to provide support for app use could improve compliance. Additional reminders to use the app and check-ins via phone with those not properly using the app, especially early on in the study, could help promote app use, as demonstrated in a prior feasibility study on app use in chronic TBI.\(^{66}\) Furthermore, other past studies using similar apps have trained participants to use the app for the first 2-4 weeks after download, closely monitoring compliance and assisting with any issues participants experienced.\(^{47,66-69}\) Overall, although app use compliance in our study was very limited, implementation of the proposed changes above may resolve many of the issues and encourage more consistent app use in future studies.

**Study limitations**

This was a small pilot feasibility study, and as such, we cannot make definitive conclusions about efficacy or feasibility across all settings. Though we had strong indicators of feasibility of intervention delivery, recruitment was more challenging. However, we identified multiple strategies to improve recruitment success, including translating and adapting PST for Spanish-speaking individuals, providing consumer-friendly summaries of the benefits of PST, and continuing intervention delivery after care recipient discharge. In addition to volunteer bias that can positively skew study results, we may have also had an education-related volunteer bias, because all our consenting participants had at least a high school education. Furthermore, more than half of our care partners did not live with the care recipient, suggesting that they may not be providing day to day support. Therefore, future studies should develop strategies to ensure representativeness in consenting participants and examine differences in care partner characteristics and outcomes based on whether or not they live with the care recipient after discharge. CaPPS was originally developed for adults with acquired brain injuries and their care partners, so initial development did not include the perspectives of individuals with SCI or burn injuries and their care partners. This may be one reason participant initiation of CaPPS was a problem in our study. We did identify several strategies to address this problem, and future work to find effective ways to leverage smartphone ownership to promote generalization of PST is warranted. Outside of apps, internet-based sites are increasingly smartphone optimized and emailing or text messaging links to web-based electronic boosters may be an alternative less prone to some of the barriers encountered using apps.

**Conclusions**

Recruiting care partners of adults with traumatic injuries and stroke into a problem-solving based self-management intervention delivered during the care recipient’s inpatient rehabilitation stay is feasible for a subset of care partners, so initial development did not include the perspectives of individuals with SCI or burn injuries and their care partners. This may be one reason participant initiation of CaPPS was a problem in our study. We did identify several strategies to address this problem, and future work to find effective ways to leverage smartphone ownership to promote generalization of PST is warranted. Outside of apps, internet-based sites are increasingly smartphone optimized and emailing or text messaging links to web-based electronic boosters may be an alternative less prone to some of the barriers encountered using apps.

**References**

1. United States Census Bureau Public Information Office. Nearly 1 in 5 people have a disability in the U.S., Census Bureau reports - miscellaneous - newsroom - U.S. Census Bureau. Available at: https://www.census.gov/newsroom/releases/archives/miscellaneous/cb12-134.html. Accessed March 17, 2017.
2. National Alliance for Caregiving in collaboration with AARP. Caregiving in the U.S. 2009. Available at: http://www.caregiving.org/data/Caregiving_in_the_US_2009_full_report.pdf. Accessed March 17, 2017.
3. Wolff JL, Spillman BC, Freedman VA, Kasper JD. A national profile of family and unpaid caregivers who assist older adults with health care activities. JAMA Intern Med 2016;176:372-9.
4. Rospenda KM, Minich LA, Milner LA, Richman JA. Caregiver burden and alcohol use in a community sample. J Addict Dis 2010;29:314-24.
5. Allen AP, Curran EA, Duggan A, et al. A systematic review of the psychobiological burden of informal caregiving for patients with dementia: focus on cognitive and biological markers of chronic stress. Neurosci Biobehav Rev 2016;73:123-64.
6. Centers for Disease Control and Prevention. Report to Congress on traumatic brain injury in the United States: epidemiology and rehabilitation. Atlanta: National Center for Injury Prevention and Control; Division of Unintentional Injury Prevention; 2015.
7. NSCSC. Spinal cord injury (SCI) facts and figures at a glance. Available at: https://www.nscisc.uab.edu/Public/Facts%20016.pdf. Accessed June 19, 2019.
8. van Baar ME, Essink-Bot ML, Oen IM, Dokter J, Boxma H, van Beeck EF. Functional outcome after burns: a review. Burns 2006;32:1-9.
9. Heidenreich PA, Albert NM, Allen LA, et al. Forecasting the impact of heart failure in the United States: a policy statement from the American Heart Association. Circ Heart Fail 2013;6:606-19.
10. Centers for Disease Control and Prevention (CDC). CDC grand rounds: reducing severe traumatic brain injury in the United States. MMWR Morb Mortal Wkly Rep 2013;62:549-52.
11. Carroll LJ, Cassidy JD, Cancellerie C, et al. Systematic review of the prognosis after mild traumatic brain injury in adults:

**Corresponding author**

Shannon B. Juengst, PhD, CRC, Department of Physical Medicine and Rehabilitation, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd., Dallas, TX 75390-9055. E-mail address: Shannon.Juengst@UTSouthwestern.edu.
cognitive, psychiatric, and mortality outcomes: results of the international collaboration on mild traumatic brain injury prognosis. Arch Phys Med Rehabil 2014;95(5S):S152-73.

12. Bhalerao SU, Geurtjens C, Thomas GR, Kitamura CR, Zhou C, Marlborough M. Understanding the neuropsychiatric consequences associated with significant traumatic brain injury. Brain Inj 2013;27:767-74.

13. Reeves RR, Panguluri RL. Neuropsychiatric complications of traumatic brain injury. J Psychosoc Nurs Ment Health Serv 2011;49:42-50.

14. Gordon WA, Zafonte R, Cicerone K, et al. Traumatic brain injury rehabilitation: state of the science. Am J Phys Med Rehabil 2006;85:343-82.

15. Ryan CM, Parry I, Richard R. Functional outcomes following burn injury. J Burn Care Res 2017;38:e614-7.

16. Dalal PK, Saha R, Agarwal M. Psychiatric aspects of burn. Indian J Plast Surg 2010;43:136.

17. Wiechman S, Saxe G, Fauerbach JA. Psychological outcomes following burn injuries. J Burn Care Res 2017;38:e629-31.

18. Gadidi V, Katz-Leurer M, Carmeli E, Bornstein NM. Long-term outcome poststroke: predictors of activity limitation and participation restriction. Arch Phys Med Rehabil 2011;92: 1802-8.

19. McClure JA, Salter K, Foley N, Mahon H, Teasell R. Adherence to Canadian best practice recommendations for stroke care: vascular cognitive impairment screening and assessment practices in an Ontario inpatient stroke rehabilitation facility. Top Stroke Rehabil 2012;19:141-8.

20. Graven C, Brock K, Hill K, Joubert L. Are rehabilitation and/or care co-ordination interventions delivered in the community effective in reducing depression, facilitating participation and improving quality of life after stroke? Disabil Rehabil 2011;33: 1501-20.

21. Patel MD, Coshall C, Rudd AG, Wolfe CD. Cognitive impairment after stroke: clinical determinants and its associations with long-term stroke outcomes. J Am Geriatr Soc 2002;50: 700-6.

22. Boschen KA, Tonack M, Gargaro J. Long-term adjustment and community reintegration following spinal cord injury. Int J Rehabil Res 2003;26:157-64.

23. Holavanahalli RK, Badger K, Acton A. Community reintegration. J Burn Care Res 2017;38:e632-4.

24. Wiechman S, Holavanahalli R. Burn Survivor Focus Group. J Burn Care Res 2017;38:e593-5.

25. Guillick JG, Taggart SB, Johnston RA, Ko N. The trauma bubble: patient and family experience of serious burn injury. J Burn Care Res 2014;35:e413-27.

26. Olson DM. Caregiver or care-partner. J Neurosci Nursing 2017;49:136.

27. Kreutzer JS, Vergusio AH, Camplair PS. Primary caregivers’ psychological status and family functioning after traumatic brain injury. Brain Inj 1994;8:197-210.

28. Kolakowsky-Hayner SA, Miner KD, Kreutzer JS. Long-term life quality and family needs after traumatic brain injury. J Head Trauma Rehabil 2001;16:374-85.

29. Manskow US, Sigurardottir S, Roe C, et al. Factors affecting caregiver burden 1 year after severe traumatic brain injury: a prospective nationwide multicenter study. J Head Trauma Rehabil 2015;30:411-23.

30. Lutz BJ, Young ME, Cox KJ, Martz C, Creasy KR. The crisis of stroke: experiences of patients and their family caregivers. Top Stroke Rehabil 2011;18:786-97.

31. Em S, Bozkurt M, Caglayan M, et al. Psychological health of caregivers and association with functional status of stroke patients. Top Stroke Rehabil 2017;24:323-9.

32. Dankner R, Bachner YG, Ginsberg G, et al. Correlates of well-being among caregivers of long-term community-dwelling stroke survivors. Int J Rehabil Res 2016;39:326-30.
53. Berry JW, Elliott TR, Grant JS, Edwards G, Fine PR. Does problem-solving training for family caregivers benefit their care recipients with severe disabilities? A latent growth model of the Project CLUES randomized clinical trial. Rehabil Psychol 2012;57:98-112.

54. Pew Research Center. Mobile fact sheet. Available at: http://www.pewinternet.org/fact-sheet/mobile/. Accessed February 2, 2017.

55. Ilumivu. Ecological momentary assessment. November 2015. Available at: https://ilumivu.com/about/science/. Accessed June 17, 2016.

56. Lenze EJ, Munin MC, Quear T, et al. The Pittsburgh Rehabilitation Participation Scale: reliability and validity of a clinician-rated measure of participation in acute rehabilitation. Arch Phys Med Rehabil 2004;85:380-4.

57. Clifford C, Greenfield TK. The UCSF client satisfaction scales: I. The Client Satisfaction Questionnaire-8. In: Mauis ME, editor. The use of psychological testing for treatment planning and outcomes assessment. 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates Publishers; 1999. p 1333-46.

58. Hatcher RL, Gillaspy JA. Development and validation of a revised short version of the Working Alliance Inventory. Psychother Res 2006;16:12-25.

59. Bell KR, Brockway JA, Fann JR, et al. Concussion treatment after combat trauma: development of a telephone based, problem solving intervention for service members. Contemp Clin Trials 2014;40C:54-62.

60. Juengst SB, Silva V, Goldin Y, et al. Care partner problem solving training (CP-PST) for care partners of adults with traumatic brain injury during inpatient rehabilitation: study protocol for a multisite, randomized, single-blind clinical feasibility trial. Contemp Clin Trials 2019;80:9-15.

61. Malec JF. Goal attainment scaling in rehabilitation. Neuropsychol Rehabil 1999;9:253-75.

62. Kroenke K, Spitzer RL, Williams JB, Löwe B. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 2009;50:613-21.

63. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. Arch Intern Med 1998;158:1789-95.

64. Bedard M, Molloy DW, Squire L, Dubois S, Lever JA, O’Donnell M. The Zarit Burden interview: a new short version and screening version. Gerontologist 2001;41:652-7.

65. Carver CS. You want to measure coping but your protocol’s too long: consider the brief COPE. Int J Behav Med 1997;4:92-100.

66. Juengst SB, Graham KM, Pulantara IW, et al. Pilot feasibility of an mHealth system for conducting ecological momentary assessment of mood-related symptoms following traumatic brain injury. Brain Inj 2015;29:1351-61.

67. Evald L. Prospective memory rehabilitation using smartphones in patients with TBI. Disabil Rehabil 2018;40:2250-9.

68. Groussard P-Y, Pigot H, Giroux S. From conception to evaluation of mobile services for people with head injury: a participatory design perspective. Neuropsychol Rehabil 2018;28:667-88.

69. Nussbaum R, Kelly C, Quinby E, Mac A, Parmanto B, Dicianno BE. Systematic review of mobile health applications in rehabilitation. Arch Phys Med Rehabil 2019;100:115-27.