Owing to a rapidly growing and active older population, adults aged 65 years or older will comprise 40% of all trauma patients by 2050.\(^1,2\) Traumatic injury is a sentinel life event that can precipitate a trajectory of functional decline in older patients.\(^3,4\) In comparison with younger patients, older trauma patients experience greater morbidity and mortality,\(^5-11\) and their prolonged and complicated hospital course results in poorer recovery of functional abilities.\(^12-15\)

Functional recovery after traumatic injury is a meaningful outcome, particularly in the elderly population. While a few studies have defined long-term recovery as a general return to independent living,\(^16-22\) activities of daily living (ADLs) are understudied as an outcome.\(^23\)

Moreover, understanding an older trauma survivor’s ADL difficulties can directly inform caregiving needs, treatment decisions such as life support and cardiopulmonary resuscitation, and health care costs both during and after hospitalization.\(^24-26\) In a retrospective study of older trauma patients, we previously used the Short Functional Status (SFS) survey,\(^27\) a 5-point ADL scale, to document a persistent ADL decline at 12 months postinjury.\(^28\)

Little is known about the preventability of posttraumatic functional decline in older trauma patients. Geriatric consul-
Geriatric Consultation (GC), which addresses inpatient issues such as delirium and immobility, has improved outcomes of hip fracture patients but has not been studied in older patients with other types of injuries. We implemented a routine GC for all elderly trauma patients and prospectively compared preinjury with 1-year postinjury functional status to measure functional recovery.

**Methods**

**Setting and Participants**

This study was approved by the University of California, Los Angeles Office of Protection of Human Subjects. Informed consent was obtained from participants at enrollment (written for GC group and by telephone for control group). The GC group consisted of all adults aged 65 years and older who triggered trauma activation and were admitted to our academic tertiary care level 1 trauma center between December 1, 2007, and June 30, 2010 (Figure 1). Patients who died, were discharged, or were transferred within 24 hours were excluded. As a comparison group, we used previously published data from 37 trauma patients of similar age and length of stay admitted in 2006. We completed follow-up data collection in June 2011 (Figure 1).

In a clinical partnership between trauma surgery and geriatric medicine, we aimed to request a formal GC for all trauma patients aged 65 years and older in the GC group. The hospital GC service consists of geriatric faculty and a rotating geriatric medicine fellow, with a typical practice of daily visits until resolution of geriatric medical and disposition issues. The goal of our usual consultation is to identify risks early in the hospital course including preexisting cognitive and functional impairment, early detection of delirium, medication review for harm, review of advanced directives and care preferences, and psychosocial history to identify issues that might complicate safe and timely discharge. We provided guidance to reduce risks identified, as well as care for general medical issues, if requested by the primary team. The control group received our medical center's usual care, which included the option of requesting a general medical consultation or GC. We analyzed our results according to intention to treat, even if patients crossed over their original group assignments, a method that allows for more generalizable results than per-protocol designs.
Measures of Functional Outcome

We measured functional status using the SFS, a community-based screen for sentinel functional impairment. The SFS measures the ability to perform 5 ADLs independently, without help from another person: shopping (eg, obtaining personal items from a store), bathing, walking across the room, using the toilet, and managing finances. Higher SFS scores indicate greater independence. The SFS can be completed in less than 4 minutes via personal or telephone interview by non-clinical administrative personnel and was validated as a measure of functional change in uninjured community-dwelling elder individuals, where the mean decline in SFS was 0 over 9 to 14 months. A decline of 1 point is considered to be clinically significant.

For the GC group, we first administered the SFS in person on admission (reflecting preinjury function), and at 3, 6, and 12 months after the injury by telephone interview. We defined change in function as follow-up minus preinjury SFS score, with a higher (less-negative) value indicating better recovery of baseline function.

In addition, we asked both control and GC patients to compare their current with preinjury function using a 5-point ordinal rating of their self-rated degree of global recovery: 0% or none, 25% or somewhat, 50% or partial, 75% or almost full, and 100% or full. We used the global recovery question, as well as age, sex, race/ethnicity, comorbidity, marital status, and pre-injury living situation to model the GC group’s preinjury score, then applied the model to the control group to predict each control patient’s most likely baseline SFS score.

We obtained covariables (age, sex, race/ethnicity, comorbidity, Injury Severity Score [ISS], discharge to nursing or other facility for physical rehabilitation, any surgical procedure, and hospital complication) from the institutional trauma registry. Hospital complications were prespecified according to the Trauma Quality Improvement Program.

Statistical Analysis

To quantify functional recovery for the GC group only, we compared SFS scores at 3, 6, and 12 months with preinjury scores using unadjusted paired 2-tailed t tests. We used correlation (r) in the GC group only to internally validate the new self-reported global assessment of recovery item against the change in SFS score. We compared the other clinical characteristics using χ² and 1-way analysis of variance.

Our primary outcome measure of functional recovery was change in SFS score (follow-up minus baseline, with a higher [less-negative] value indicating better recovery of preinjury function) at 3, 6, and 12-month points as 3 separate models. We controlled for sex, race/ethnicity, living situation, age, ISS, comorbidity, length of stay, nursing home or rehabilitation center discharge, any surgical procedure, any complication, and the baseline ADL score. Last, we performed a longitudinal analysis using multilevel random-effects regression, which allowed for testing for differences in recovery at all 3 follow-up points, as well as whether functional recovery differed in their slopes across time.

To analyze secondary functional outcomes, we used logistic regression to predict each of the 5 ADL impairments and ordinal logistic regression to predict improved self-rated global recovery. All secondary outcome models used the same covariables as the main analysis. We performed all analyses using Stata version 12.0. P < .05 was considered significant.

Results

Of 136 patients eligible for the GC group, we enrolled 106 patients (78%) to participate in this functional outcomes study (Figure 1). Of these, 85 (80%) survived and participated in at least 1 follow-up telephone interview (n = 74, 70, and 57 at 3, 6, and 12 months, respectively). Patients who refused enrollment were more likely to be of nonwhite ethnicity than those who enrolled (33% vs 14%, P < .04) but were otherwise similar with respect to age, sex, comorbidity, and ISS (P > .70). Patients lost to follow-up had a higher mean ISS (18 vs 13, P < .03) but were otherwise similar in age, race/ethnicity, comorbidity, and sex (P > .20). We provided GC for 59 of the enrolled GC-group patients (69%) compared with 6 (17%) in the control group. The GC-group patients without a GC were short-stay patients with less-severe injury than GC patients with consult (mean length of stay, 6 vs 12, P < .05; mean ISS, 9 vs 15, P < .01); most with a planned uncomplicated discharge left before a consult could be requested. Combining the GC with the control-group interviews, we collected 488 total observations for 122 patients for statistical analysis. We compared GC-group with control-group characteristics (Table 1). The GC group was more likely to be male, but the groups were otherwise similar.

Comparing Functional Status Outcomes Between GC and Control Groups

The GC group reported having 0.79 fewer ADL abilities by 1 year compared with preinjury baseline (SD, 1.48; range, <5 to >2 ADLs) on the SFS score compared with 1.36 fewer ADLs (SD, 1.34; range, <5 to >1 ADLs) for the control group, a difference that was not statistically significant on unadjusted analysis (P > .08, Table 2). In the multivariable model predicting ADL decline, there were no differences between the groups at 3 and 6 months; however, by 12 months, the GC group had recovery of 0.67 ADLs more compared with the control group (P < .03, Table 3). In the hierarchical linear model using all 488 observations for 122 patients and independent trajectories between the GC and control groups over time, both groups had downsloping trajectories over time, but the GC group had less decline (difference in slope of 0.11 fewer ADLs below baseline per month, P < .01) than the control group (Figure 2). In this final model, we found that those in the GC group had recovered more of their function (0.76 ADLs below baseline; 95% CI, 1.0-0.4) than the control group (1.4 ADLs below baseline; 95% CI, 1.8-1.1) by the 12-month follow-up.

Among the clinical covariables tested, the sole predictors of functional outcome in the final hierarchical model were longer hospitalization (β = 0.08 fewer ADLs recovered per additional hospital day, P < .001) and white ethnicity (β = 0.9 more ADLs compared with nonwhite, P < .03) (Table 3).
Secondary Outcomes (Specific ADLs and 5-Item Global Recovery)

Of the 5 specific ADLs, the most common new impairment after injury was shopping disability for both groups at all points. Geriatric consult patients were also more likely than the control group to regain shopping ability at 3 and 12 months (Table 4). The 5-item global recovery item was well-correlated with change in SFS score ($r = 0.39$, $0.32$, and $0.43$ at 3, 6, and 12 months, respectively; $P < .05$ for all points). The most common self-perceived global recovery rating for both groups at months 3 and 6 was “recovery of 75%” and “fully recovered” at 12 months, with no difference between the GC and control groups at any point for unadjusted and multivariable analyses.

Discussion

Compared with their younger counterparts, older adults require substantial health care resources after traumatic injury.5–8 Long-term data measuring meaningful recovery in geriatric populations following an acute hospitalization after traumatic injury is lacking. In this study, we demonstrated that a routine geriatric medicine consultation can feasibly be added to the hospital care of older patients admitted for acute injury without affecting hospital course. Consistent with our prior retrospectively identified cohort,28 we also found a substantial decline in functional status among our new cohort of GC-group patients enrolled after implementation of a routine GC. However, these patients exhibited a lesser degree of ADL decline when compared with patients in the preimplementation control group. Furthermore, after discharge, injured elders in the GC group exhibited fewer total ADL dependencies, mostly in the area of shopping for personal items.

Measurement of functional trajectory for older adults is increasingly recognized as an important benchmark in geriatric surgical care.36 In the present study, the GC group had few functional impairments prior to injury (mean SFS score of 4.7), consistent with prior studies of SFS in the general geriatric population.27,32 These results suggest that the injured elder individuals examined in this study were in good health prior to injury. The mean 0.6-ADL decrement that our GC group sustained after the injury and up to 1 year after the injury is substantial. Longitudinal community-dwelling elder individuals report no decline in ADLs over time.32 Any measureable ADL impairment predicts substantial increased risk (approximately 30% absolute-risk increase) of further functional decline and death in an injured community-dwelling individual.27,33 These findings imply that injured elder individuals are at a particularly increased risk for detrimental postinjury decline.

When analyzing specific functional activities, the ability to shop independently was the most notable postinjury decline for both groups. Geriatric consultation patients were also more likely than the control group to regain shopping ability at 3 and 12 months (Table 4). The 5-item global recovery item was well-correlated with change in SFS score ($r = 0.39$, $0.32$, and $0.43$ at 3, 6, and 12 months, respectively; $P < .05$ for all points). The most common self-perceived global recovery rating for both groups at months 3 and 6 was “recovery of 75%” and “fully recovered” at 12 months, with no difference between the GC and control groups at any point for unadjusted and multivariable analyses.

### Table 1. Comparison of Group Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Geriatric Consultation Group (n = 85)</th>
<th>Control Group (n = 37)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>78 (8.0)</td>
<td>77 (7.8)</td>
<td>.56</td>
</tr>
<tr>
<td>Male, %</td>
<td>65</td>
<td>46</td>
<td>.05</td>
</tr>
<tr>
<td>Comorbidity (Charlson Comorbidity index score$^{a}$), mean (SD)</td>
<td>4.6 (2.3)</td>
<td>4.1 (1.4)</td>
<td>.18</td>
</tr>
<tr>
<td>Injury Severity Score, mean (SD)</td>
<td>13 (9.3)</td>
<td>12 (7.6)</td>
<td>.42</td>
</tr>
<tr>
<td>White, %</td>
<td>86</td>
<td>86</td>
<td>.93</td>
</tr>
<tr>
<td>Living alone, %</td>
<td>18</td>
<td>16</td>
<td>.73</td>
</tr>
<tr>
<td>Living with spouse, %</td>
<td>26</td>
<td>32</td>
<td>.46</td>
</tr>
<tr>
<td>Any complication, %</td>
<td>26</td>
<td>22</td>
<td>.38</td>
</tr>
<tr>
<td>Any surgery, %</td>
<td>41</td>
<td>30</td>
<td>.23</td>
</tr>
<tr>
<td>Length of stay, mo</td>
<td>10.5</td>
<td>7.1</td>
<td>.17</td>
</tr>
<tr>
<td>Discharge to rehabilitation at a nursing home or other facility, %</td>
<td>37</td>
<td>30</td>
<td>.48</td>
</tr>
</tbody>
</table>

*Unadjusted $t$ tests for continuous variables (age, comorbidity, and Injury Severity Score) and $\chi^2$ tests for dichotomous variables (sex, race/ethnicity, living alone, living with spouse, any complication, and any surgery).

### Table 2. Preinjury and Postinjury Mean Short Functional Status Survey Scores

<table>
<thead>
<tr>
<th>Postinjury Point, mo</th>
<th>Geriatric Consultation Group (n = 85)</th>
<th>Control Group (n = 37)</th>
<th>Unadjusted Difference in Decline$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preinjury</td>
<td>Postinjury</td>
<td>Preinjury</td>
</tr>
<tr>
<td>3</td>
<td>74</td>
<td>4.7</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>70</td>
<td>4.7</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>57</td>
<td>4.6</td>
<td>3.9</td>
</tr>
</tbody>
</table>

$^a$ Interpretation of the difference between geriatric consultation group decline (follow-up minus preinjury Short Functional Status score) and control group decline (follow-up minus preinjury Short Functional Status score): a negative result indicates that the geriatric consultation group outcome had less decline, expressed in units of count of activities of daily living abilities.

$^b$ Baseline activities of daily living count for the control group was predicted using age, sex, race/ethnicity, comorbidity, marital status, preinjury living situation, and self-reported degree of recovery (using Poisson regression of activities of daily living count).
functional decrement in our study. Shopping for personal items requires physical and cognitive reserve to obtain goods outside of the home, differing from the other ADLs in the SFS that are performed in the home. Of the 5 SFS items, shopping is also considered to be the most difficult functional status activity when arranged on a hierarchical scale. With respect to shopping disability, our cohort of geriatric trauma patients was healthier prior to injury than the average Medicare patient (15.6% need help with shopping) but much worse after injury. These results underscore the loss of independence and functional decline continuing in the year following injury for the injured elderly patient.

Our study of a health care intervention targeted to older trauma patients joins a handful of similar studies. Demetriadou et al demonstrated better survival in 76 older patients admitted after implementation of a systemwide policy of early trauma activation for patients aged older than 70 years compared with 260 older patients admitted prior to the new policy. Fallon and colleagues used multidisciplinary geriatric team consultation to study hospital care in an uncontrolled study of older trauma patients. The team was more likely to provide consultation to patients who survived the hospitalization and provided geriatric care such as pain management and delirium evaluation. Further studies of targeted geriatric services with concurrent control individuals aimed at improving immediate and long-term outcomes are needed. Functional status outcomes have also been proposed as a target for future comparison of hospital quality of care that identifies different high- and low-performing medical centers rather than survival outcomes.

To date, studies of routine inpatient GC alone for older patients undergoing nontrauma surgery have shown minimal or no improvement of long-term functional status. However, geriatrics involvement in combination with postacute care, such as geriatric rehabilitation, does improve long-term functional outcomes, particularly in patients with hip fracture repair. One multicomponent inpatient consultation intervention prevented delirium in hip fracture patients. Because delirium itself is cause of prolonged functional impairment in older surgery patients, future GC studies that include early delirium detection for trauma and nontrauma surgery patients are much needed.

Although our new GC cohort had better functional recovery than our retrospective cohort, it is likely too early to directly attribute the improvement to our routine GC intervention. Our GC was a complex intervention including comprehensive evaluation and recommended care tailored to
the needs of the individual patient. A more detailed secondary data analysis of specific care provided by the geriatricians in collaboration with the primary surgery team is under way. However, this study was not powered to study whether specific consultative services were linked to improved long-term function. Similarly, although only the shopping ability ADL reached statistical significance, this study was not powered to isolate ADLs responsive to GC. Future research to improve postinjury geriatric health will likely require a stronger intervention on the most effective types of care. A larger study will be needed to answer questions about specific care processes and differences in ADL recovery.

Our results are also limited by the temporal nature of our study. First, as in any pre-post study, secular time trends could explain some of the differences observed. During GC group enrollment, economic downturn occurred, which is associated with less traumatic injury. It is possible that fewer or less-severe trauma injuries were the underlying reason we found less functional decline; however, the similar ISS for both groups would suggest otherwise. Second, because our control group was retrospectively identified, we expected greater survivor bias and poorer retention than the prospective group. However, we would expect that this bias would result in a healthier control group with less functional decline, which we expect would have lessened the effect of our quality-improvement intervention.

Because one-third of older persons experience functional decline following acute hospitalization, identification of older individuals most at risk will be paramount for targeting future interventions. We identified prolonged hospital stay, a marker of more-severe injury and complicated hospital course, as a potential future target for increased efforts to improve long-term function. Other studies among older hospital patients have identified other patient-level variables that might also predict functional outcomes: preinjury cognitive and mobility impairment, malnutrition, and nursing home status. Future refinement of geriatric consultation for acute injury should consider targeting for the most high-risk patients.

**Conclusions**

In summary, we present evidence suggesting that geriatric-specific interventions in the acute setting may contribute to improved functional recovery after traumatic injury in the elderly. To achieve substantial and lasting functionality in this vulnerable population, it will be critical to identify effective hospital services targeted to the clinical and rehabilitative needs of older injured patients during complex and prolonged hospitalizations.

**References**


