Rehabilitation Practice and Science

Volume 2023 | Issue 1 Article 2

6-1-2023

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Recommended Citation

Chiu, Ru-Huang; Tsai, Kang-Ting; Wang, Yu-Lin; and Cheng, Hsin-Han (2023) "Early Rehabilitation during Hospitalization Might Decrease the Risk of 3-month Mortality in Older Patients: A Retrospective Cohort Study," *Rehabilitation Practice and Science*: Vol. 2023: Iss. 1, Article 2.
DOI: https://doi.org/10.6315/TJPMR.202306_2023(1).0002
Available at: https://rps.researchcommons.org/journal/vol2023/iss1/2

Original Article

Early Rehabilitation during Hospitalization Might Decrease the Risk of 3-month Mortality in Older Patients: A Retrospective Cohort Study

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Purpose: The prevalence of hospital-associated disability is high among older individuals; early rehabilitation may mitigate subsequent physical function decline. However, information regarding the short-term survival of hospitalized older individuals receiving inpatient rehabilitation is limited. We evaluated the relationship of early rehabilitation on the post-discharge 3-month mortality of older patients. Moreover, the association between various age groups and 3-month mortality with or without early rehabilitation was explored.

Methods: A retrospective cohort study, patients aged ≥65 years admitted to the geriatrics ward for acute medical illness were recruited. Differences in age, sex, Barthel index and comorbidities between patients with and without early rehabilitation were compared. A multivariate logistic regression analysis was performed to determine the interrelation of relevant variables with 3-month mortality.

Results: A total of 199 patients were included in the early rehabilitation group and 268 in the non-early rehabilitation groups. The total 3-month mortality after discharge was 22.91%, with a lower mortality rate in the early rehabilitation group than that in the non-early rehabilitation (20.60% vs. 24.63%). Multivariate logistic regression analysis indicated that early rehabilitation, and high Barthel scores on admission were significantly associated with reduced adjusted odds ratio (AOR) of 3-month mortality (AOR: 0.974, 95% CI: 0.965-0.982, $p<0.001$ and AOR: 0.567, 95% CI: 0.351-0.916, $p<0.02$, respectively). Besides, those aged ≥85 years receiving early rehabilitation had a significantly lower AOR of 3-month mortality (AOR: 0.378, 95% CI: 0.179-0.796) than that in other age groups.

Conclusions: Early rehabilitation might be a crucial and modifiable factor to reduce the odds of post-discharge 3-month mortality among hospitalized older individuals. The benefit is more significant in older adults aged ≥ 85 years than in other age groups. (Rehabil Pract Sci 2023; 2023(1): 11 - 19)

Key Words: geriatrics, inpatient rehabilitation, mortality, disability

Submitted date: 23 August 2022 Revised date: 4 October 2022 Accepted date: 3 January 2023

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INTRODUCTION

Aging is a demographic trend globally and is already seen in developed countries. The pace of population aging is expected to increase dramatically in developing countries. The World Health Organization reported that the proportion of the world's population aged >60 years was 1 billion in 2019, and is expected to nearly double by 2050. Due to this demographic change, life expectancy has increased, but the quality of life will be disturbed in the presence of a disability. More attention is required to prevent the development of disability in older individuals. During the process of aging, pathophysiologic changes, chronic diseases, muscular weakness, and cognitive deterioration are observed. Geriatric syndromes are complex, and multifactorial disorders can occur due to the effects of disease-related and age-related changes on body systems. The common characteristics of geriatric syndromes are cognitive impairment, frailty, falls, malnutrition, and incontinence. These conditions are highly prevalent among older adults but usually underestimated. Hence, these individuals can present with lower physiological reserves, physical function, and quality of life, and their life span can also decrease.[1]

Disabilities associated with hospitalization due to acute medical diseases, including acceleration of physical function decline, increased dependency on activities of daily living (ADL) and new impairment in instrumental ADL, are defined as hospital-associated disability (HAD).[2,3] HAD is more common in older adults than in young adults,[4] and the prevalence of HAD after discharge is approximately30% in older adults.[5] The greatest risk factors of adverse functional outcomes are older age, preadmission instrumental ADL disabilities, and lower mental status on admission.[2] Only 30% of patients with HAD recover to their preadmission functional level after 1 year.[6] Notably, many older patients do not recover from functional loss during hospitalization and may even develop new post-discharge disabilities. HAD and new post-discharge functional impairment in older adults can increase the risk of readmission, institutionalization, and mortality.[7]

To reverse the detrimental effect of nosocomial deconditioning, a comprehensive early inpatient rehabilitation program is recommended. To improve aerobic capacity, substantial muscle loss, and extremity strength and to promote balance, agility, and proprioception, exercise training in older individuals should include strengthening, endurance, flexibility, and neuromotor training.[8] According to the "American College of Sports Medicine's guideline for exercise testing and prescription", it supports that the benefits of physical activity can optimize age-related changes in body composition, promote psychological and cognitive function, manage chronic diseases, reduce the risks of physical disability, and increase longevity.[8,9]

Both hospitalization and acute illness induced neuromuscular weakness, functional decline, disability development, and even mortality in older patients. Early rehabilitation might inhibit subsequent functional deterioration, and might be crucial in improving poor outcomes. Present data about short-term outcomes of hospitalized and deconditioned older individuals receiving early inpatient rehabilitation are inconclusive and limited. Whether early rehabilitation intervention could reduce the subsequent deconditioning due to disease or hospitalization and reduce the risk of death after discharge, we think that this idea can be examined in older patients hospitalized for acute illness. The association of the relative variables and different age groups with early rehabilitation in hospitalized older patients will analyze. Besides, we would verify that this benefit of early rehabilitation intervention does not limit to specific disease-diagnosed older adults, but could be extrapolated to any underlying diseased older adults. So, we would recruit all older adults admitted to the geriatric ward, and the purpose is to show the diversity of the older group.

METHODS

Participants

This was a retrospective cohort study and data were collected from one medical center in Southern Taiwan. From June 1, 2020, to December 31, 2020, the older individuals aged ≥65 years who were hospitalized in the geriatrics ward for acute medical illness were included.

However, some patients were excluded due to the following reasons: transfer to another unit, in-hospital

mortality, missing relative medical data, unavailable date of mortality, or loss to follow-up within 3 months after discharge. After discharge, patients were followed up for 3 months via assessment of outpatient medical records or telephone interviews to confirm their survival status. The remaining individuals were divided into two groups based on whether they received inpatient rehabilitation intervention or not: the early inpatient rehabilitation and non-early rehabilitation group (Figure 1). Geriatric physicians professionally clinical assessments to determine whether older patients are deconditioning and needed early inpatient rehabilitation intervention based on the rehabilitation potential including basic ADL abilities, state of consciousness, cooperation, motivation, emotion, and hemodynamics status of older patients. The early rehabilitation program will initiate only if these patients meet the rehabilitation potential. Older adults in the geriatric ward mostly have multiple comorbidities and deconditioning due to acute illness, and those with decreased basic physical activity function, poor hand grip strength, poor walking endurance, and walking speed compared with pre-admission functional status will be thought frail tendency.

The survival time and clinical characteristics significantly differ among older individuals based on age. Therefore, older individuals would be divided into several subgroups based on age to separately explore the association with 3-month survival with or without early rehabilitation. As some studies classification, [10,11] we stratified our individuals into three age groups, which were as follows: the young-old group, 65-74 years; the old-old (middle-old) group, 75-84 years; and the oldest-old group, ≥85 years. The study was conducted in compliance with the Declaration of Helsinki and was approved by the ethics committee of our institution (IRB: 11007-004). Due to the retrospective design of this study, the consent form was not required.

Data Collection

Medical data about age, sex, serum creatinine, Barthel index (BI)on admission, and multiple comorbidities including hypertension, diabetes mellitus, chronic obstructive pulmonary disease, osteoarthritis, cancer, and pressure sore, were collected. We used BI to evaluate the level of assistance needed to perform self-care and the mobility of people with disability. The total BI score ranges from 0 to 100, with a higher score indicating lower disability and better independence in performing ADL.[12] The inter-rater reliability of the BI score showed good agreement for older people aged ≥65 years, but was less reliable in patients with cognitive impairment. [13,14]

Early rehabilitation was defined as a therapeutic strategy arranged during hospitalization. The early rehabilitation program was based on the patient's clinical physical ability and may contain limbs range of motion, mobilization, core muscle and lower extremity strengthening, balance, mobility, endurance, flexibility, and resistance training for a total duration of 30 minutes per day executed by the professional therapists. Sub maximal moderate-intensity aerobic and resistance training can promote muscle strength, balance, endurance and cardiopulmonary function, and flexibility training can improve stiffness and avoid falling down. Exercise training can assist in recovery pre-admission activity daily life function.

Statistical Analysis

Statistical analyses were conducted using the Statistical Analysis System software. Categorical variables including sex, comorbidities and mortality were presented as frequency with percentage (%). Continuous variables including age, serum creatinine, and BI were expressed as median plus ranges. Ranges refer to the difference between the maximum and minimum values, represented by "R". The difference in the distribution of univariables was evaluated using the chi-square test for categorical variables and the Mann-Whitney U test for continuous variables. To control multiple variables, multivariate logistic regression analysis was used to investigate the association of various variables on 3-month mortality among older individuals, and results were presented as adjusted odds ratio (AOR) with 95% confidence intervals (CI). In the age-stratified analysis, univariate and multivariable logistic regression models explored the influence of early inpatient rehabilitation on 3-month mortality in different age groups, and results were presented as odds ratio (OR) and AOR, with 95% CI, respectively. A p-value of <0.05 was considered statistically significant.

RESULTS

In total, 467 individuals aged ≥65 years who were hospitalized in the geriatrics ward were enrolled. Patients were treated in accordance with the medical guidelines and were discharged smoothly. They were divided into two groups: the early rehabilitation intervention group (n = 199, 42.6%) and the non-early rehabilitation group (n = 268, 57.4%). Table 1 depicts demographic characteristics, underlying disease, BI on admission, and 3-month survival after discharge between two groups. The proportion of participants in both groups was predominantly female. The median age of the early rehabilitation group was relatively older than that of the non-early rehabilitation group (83 vs. 81 years, p = 0.07). The median score of BI in the early rehabilitation group was significantly lower than that in the non-early rehabilitation group (15 vs. 25 points, p < 0.001). The early rehabilitation group had a higher incidence of comorbidities, including hypertension, diabetes mellitus, osteoarthritis, and cancer, than the non-early rehabilitation group. However, there is no statistically significant difference in terms of age, sex, serum creatinine, and presence of multiple comorbidities between the two groups. Among all older individuals, the number of the deaths at 3-month post discharge was 107 and the 3-month mortality rate was 22.9%. The mortality ratio was lower in the early rehabilitation group than in the non-early rehabilitation group although no statistically significant 3-month mortality was observed between the two groups (20.6% vs. 24.6%, p = 0.31).

Table 2 shows the relevant variables among older patients that may affect the 3-month mortality after discharge. After controlling relevant confounding factors, the result showed early rehabilitation during hospitalization could significantly reduce the odds of 3-month mortality among older adults (AOR: 0.567, 95% CI: 0.351-0.916, p = 0.02). The early rehabilitation could significantly reduce the odds of post-discharge 3-month mortality by 43%. In addition, BI scores on the initial were significantly associated with 3-month mortality, that is higher scores of the BI indicated a lower odd of 3-month mortality (AOR: 0.974, 95% CI: 0.965-0.982, p < 0.001). Older individuals with a cancer history had a higher odd of 3-month mortality after acute hospitalization (AOR: 2.506, 95% CI: 1.422-4.415, p = 0.002). Osteoarthritis was not significantly related with 3-month mortality (AOR: 1.571, 95% CI: 0.971-2.542, p = 0.07). Age did not seem to have a significance on 3-month mortality in the hospitalized older adults (AOR: 1.010, 95% CI: 0.982-1.039, p = 0.47).

Early inpatient rehabilitation can positively affect the risk of 3-month survival among older individuals with acute illness as shown in the results above. We further explored the benefit of inpatient rehabilitation on different age subgroups, the young-old group (n = 125); the old-old (middle-old) group (n = 160); and the oldest-old group (n = 182), as shown in Table 3. In the age-stratified analysis, early rehabilitation had significantly reduced OR of 3-month mortality (OR: 0.416, 95% CI: 0.207-0.835) and strength of effect was more increased after adjusting potential variables (AOR: 0.378, 95% CI: 0.179-0.796) in the oldest-old groups.

DISCUSSION

Previous studies have reported that exercise interventions for geriatric patients can decrease nosocomial disability associated with bed rest-based care or diseases, length of hospital stay, and discharge to a nursing home and also improve functional outcomes at discharge at up to 1 year follow-up. Adverse effects and healthcare cost correlated with early rehabilitation intervention did not differ between the exercise and usual care groups. Notably, exercise significantly decreased the risk of falls, injurious falls, and possibly fractures.[15] The effects of geriatric inpatient rehabilitation programs decreased the 1-year mortality among older adults.[7,16] For hospital mortality during orthopedic ward hospitalization, some studies have reported no effect of exercise intervention among older people, whereas other studies have reported a significant effect on reducing hospital mortality; a possible reason for this difference is progression in medical and surgical care to prevent complications, and not the intervention *per se*.[17] A few studies have analyzed the effects of exercise during a stay in a geriatric ward on 3-month mortality. Two studies reported no significance of intervention on reducing 3-month mortality after acute hospitalization. One study suggested that the intervention lacked any substantial beneficial effects, and the other stated that the included participants were very elderly with a theoretically short life expectancy

after hospitalization.[18,19] Before controlling for relevant variables, our study found a statistically insignificant mortality rate between the two groups at a 3-month follow-up. However, after controlling for relevant variables, the older patients who received early rehabilitation could significantly decrease the odds of post-discharge 3-month mortality by 43%.

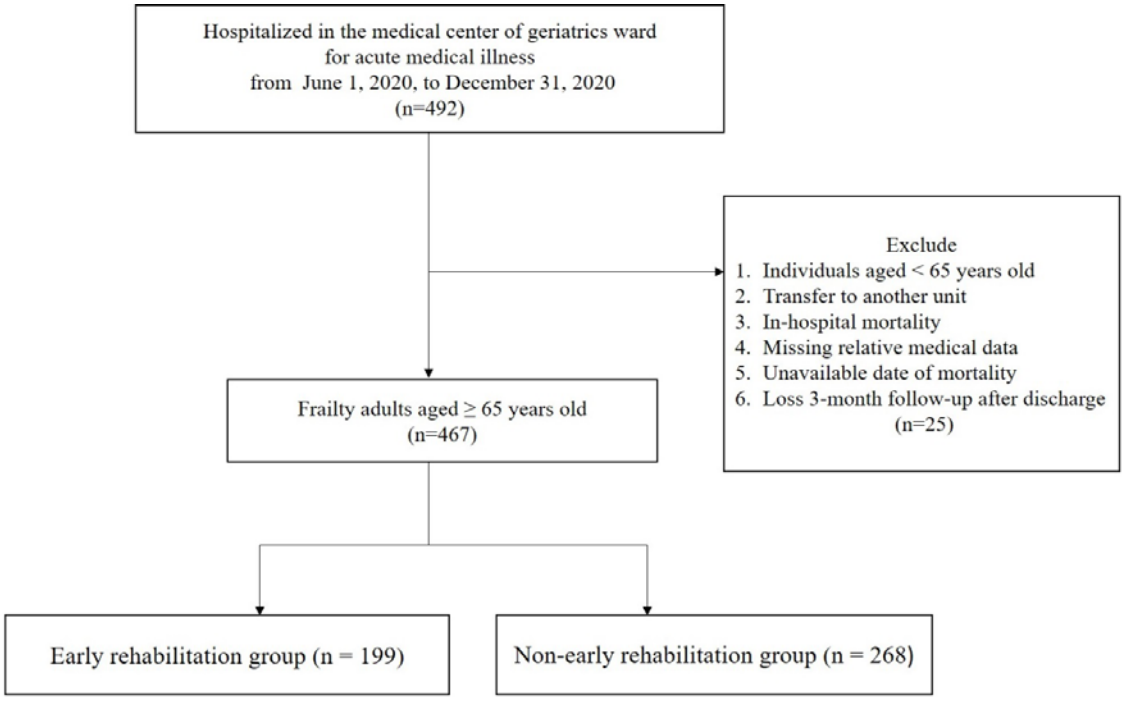

Figure1. The flow chart of selected participants

Table 1. Demographic characteristics, Barthel index, comorbidities, and 3-month mortality between patients with and without early rehabilitation

Variables	Early rehabilitation group (n = 199)	Non-early rehabilitation group (n = 268)	p-value
Sex (%)			0.40†
Male	94 (47.2)	116 (43.3)	
Female	105 (52.8)	152 (56.7)	
Age (median + R)	83 (38)	81 (38)	0.07‡
Serum creatinine (median + R)	1.00 (9.6)	0.95 (11.9)	0.072‡
Barthel index (median)	15	25	<0.001‡*
Hypertension (%)	157 (78.9)	197 (73.5)	0.18†
Diabetes mellitus (%)	98 (49.3)	127 (47.4)	0.69†
Chronic obstruction pulmonary disease (%)	28 (14.1)	52 (19.4)	0.13†
Osteoarthritis (%)	81 (40.7)	88 (32.8)	0.08†
Cancer (%)	44 (22.1)	43 (16.1)	0.10†
Pressure sore (%)	56 (28.1)	74 (27.6)	0.90†
3-month mortality rate (%)	41 (20.6)	66 (24.6)	0.31†

† Chi-square test

‡ Mann-Whitney U test

* $p < 0.05$

Table 2. The odds ratio of relevant variables on 3-month mortality in older patients after discharge was assessed via a multivariate logistic regression analysis

Variables	B	SE†	AOR‡	95% CI§	p-value
Age	0.010	0.014	1.010	0.982-1.039	0.47
Barthel index	−0.027	0.005	0.974	0.965-0.982	<0.001*
Osteoarthritis	0.452	0.246	1.571	0.971-2.542	0.07
Cancer	0.919	0.289	2.506	1.422-4.415	0.002*
Early rehabilitation	−0.567	0.245	0.567	0.351-0.916	0.02*

†SE: standard error

‡AOR: adjusted odds ratio

§95% CI: 95% confidence interval

* $p < 0.05$

Table 3. The age-stratified analysis for three-month mortality in older adults receiving rehabilitation compared to the non-early rehabilitation group was assessed via univariate and multivariate logistic regression analysis.

Age subgroup	Crude OR†	95% CI§	AOR‡	95% CI§
Young-old group¶	1.587	0.584-4.312	1.116	0.357-3.490
Old-old group¶	0.927	0.448-1.919	0.536	0.234-1.228
Oldest-old group¶	0.416	0.207-0.835	0.378	0.179-0.796

† OR: odds ratio

‡AOR: adjusted odds ratio

§95% CI: 95% confidence interval

¶ Young-old group, 65-74 years; old-old group, 75-84 years; and oldest-old group, ≥85 years.

Our study found that hospitalized patients with better functional ability preserved at admission had a lower AOR of 3-month mortality. Previous studies have reported that functional loss on admission is a relevant prognostic indicator for short-term survival and that functional loss at discharge is an important risk factor for long-term survival in older individuals after hospitalization.[20,21] Furthermore, ADL function may serve as a predictor of poor response to inpatient exercise program. The prevalence of poor response to exercise was 52% among hospitalized older individuals. Some studies have reported that poor functional status on admission likely indicates adverse responders, whereas other studies found that impaired ADL function upon admission was associated with greater responsiveness to an exercise program.[22,23] As there is still no clear conclusion, further studies are warranted. Functional status on admission may serve not only as a predictor of post-discharge outcome but also as a prognostic factor for responses to exercise interventions in hospitalized older individuals. Hence, hospital care should include a comprehensive assessment of physical function on admission and at discharge, as this can predict the outcomes of deconditioned older individuals.

Chronic diseases, such as chronic obstructive pulmonary disease, hypertension, diabetes mellitus, osteoarthritis, cancer, and pressure sore, were risk factors for adverse outcomes among older individuals.[20,24] Our study showed that osteoarthritis and cancer increased the AOR of mortality among older individuals, but only the AOR of cancer significantly differ for short-term mortality. One possible reason may be the different deteriorating timelines of two diseases. Osteoarthritis is a slowly progressive disease and slowly affects the physical activity among older individuals. Inactivity and bed-rest mode further increase the risk of cardiovascular diseases and diabetes mellitus, and these adverse outcomes are observed in long-term follow-ups.[25] Advancing age is a predominant risk for cancer and its correlated mortality compared with age younger than 65 years.[26] Cancer can

destroy the normal cell life cycle and may rapidly progress and invade several vital organs, which regulate the living center, particularly in older adults who mostly choose palliative treatment. In any case, these comorbidities induced health deterioration and physical activity decline associated with poor prognosis. Thus, exercise programs had an important role to maintain physical function in hospitalized older individuals with comorbidities.

Generally, aging is synonymous with poorer health and increased disability, thereby resulting in a higher risk of poor outcomes. ADL function deterioration caused by acute hospitalization events significantly varied with age. That is, it decreased to >50% in individuals aged ≥85 years.[27] However, this does not mean that the older you are, the less potential you have for rehabilitation. Our results showed that age was the insignificance on post-discharge 3-month mortality in the hospitalized older. Besides, the oldest-old group was better responders to early inpatient exercise intervention, and the outcome was more significant in the oldest-old group, who had significantly reduced crude OR and AOR of 3-month mortality. Meanwhile, the significant association was not similar in the young-old group. One probable reason was that individuals in the young-old group who may reserve higher functional level had a better capability to cope with HAD regardless of exercise intervention. Thus, more older people should participate in rehabilitation programs to regain or maintain physical functions and reduce further mortality after discharge.

Limitation and strength

The indication of receiving early rehabilitation is determined by specialist geriatricians' assessment of the rehabilitation potential, but there inevitably exists some selection bias between inter-rater evaluations. Other underestimated factors such as caregiver assistance and patient's motivation will influence on the clinical program execution. This retrospective study had contacted many limitations in recruiting relevant data. The number of inclusive cases was relatively small, and data were recruited from a single medical center. Unmeasured confounding variables might influence the post-discharge 3-month mortality such as the nature of life expectancy, and irreversibly severity of disease course. The primary diagnosis of the admitted older patients is not completely recorded and categorized. We wanted to present the older in diversity and generalizability but did not prudentially take into account the impact of the primary diagnosis that tends to have an influence on the subsequent survival outcomes. Other major organ comorbidities, such as coronary heart disease, cerebrovascular disease, and renal disease, unrecorded will also interfere with subsequent mortality. Besides, the etiology of subsequent post-discharge death did not enroll, and it might provide more information to analyze the influence of early rehabilitation. The loss of follow-up population effect might have influence on the 3-month mortality. However, we had no complete data of the survival time of all patients, the Cox regression model can't use to correct the loss follow-up effect on mortality. In addition, the post-discharge factors, including discharge destination, post-discharge level of care, continuous outpatient rehabilitation and family support status, might interfere with outcomes, but are not totally collected and analyzed in the study. The long-term influence of early inpatient rehabilitation must be monitored after discharge. Further, prospective large-scale random distribution studies, more comprehensive statistical analysis and study design may be able to eliminate the influence of potential confounding factors on post-discharge mortality and have more information on the early rehabilitation effect.

This study had some advantages. We recruit all older patients in a geriatric ward with multiple underlying diseases and comorbidities, and this population possesses diversity and generality. With intervention of early inpatient rehabilitation, the odds of post-discharge 3-momths mortality had significant decline. In age-stratified analysis, we found that the greater response to early inpatient rehabilitation in promoting post-discharge survival is significant in the oldest-old people aged more than 85 years. Therefore, rehabilitation potential is not limited by older age. In addition, the external validity of our results may be extrapolated to any underlying diseased older adults because of the diversity in our participants with the non-selective specific diagnosis.

CONCLUSION

Early inpatient rehabilitation might be a crucial and modifiable factor for short-term survival among older individuals with acute illness and significantly decreased the odds of 3-month mortality by 43%. Moreover, the positive influence of early rehabilitation is more significant in the oldest-old group aged ≥85 years; therefore, rehabilitation potential is not restricted by older age. Besides, the BI score on admission is a relevant factor for post-discharge short-term outcomes in acutely hospitalized older individuals. Hospitalized geriatrics care plans must incorporate early rehabilitation programs to optimize health status and to promote a better prognosis among older individuals.

ACKNOWLEDGEMENTS

We would like to thank the Chi Mei Medical Center that provided the database for this study, and we are grateful to all the patients and staff who participated in this study.

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