Post hoc Analysis of Edaravone Study 19: Efficacy in Bulbar Onset ALS Patients With and Without Reduced Pulmonary Function

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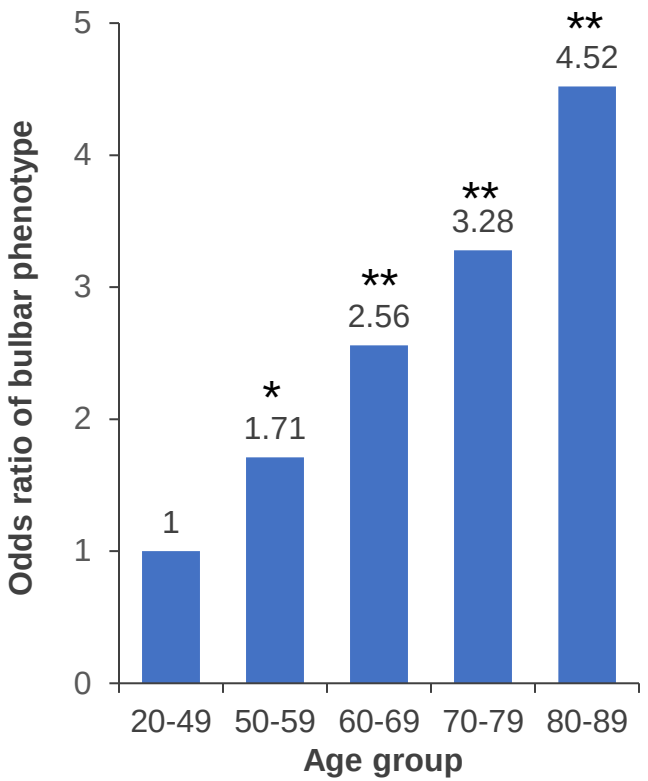
Background

- Amyotrophic lateral sclerosis (ALS) is a progressive and fatal neuromuscular disease, with most patients succumbing to respiratory failure[1-3]
- ALS typically begins in the limbs, but about one third of cases are bulbar, characterized by difficulty chewing, speaking, or swallowing[1]
- A recent study indicates that bulbar phenotype may be correlated with older age[4]
- Bulbar dysfunction in ALS has a significant impact on quality of life and is currently the focus of the development of best practice guidelines[5]

Correlation between bulbar phenotype and older age[4]



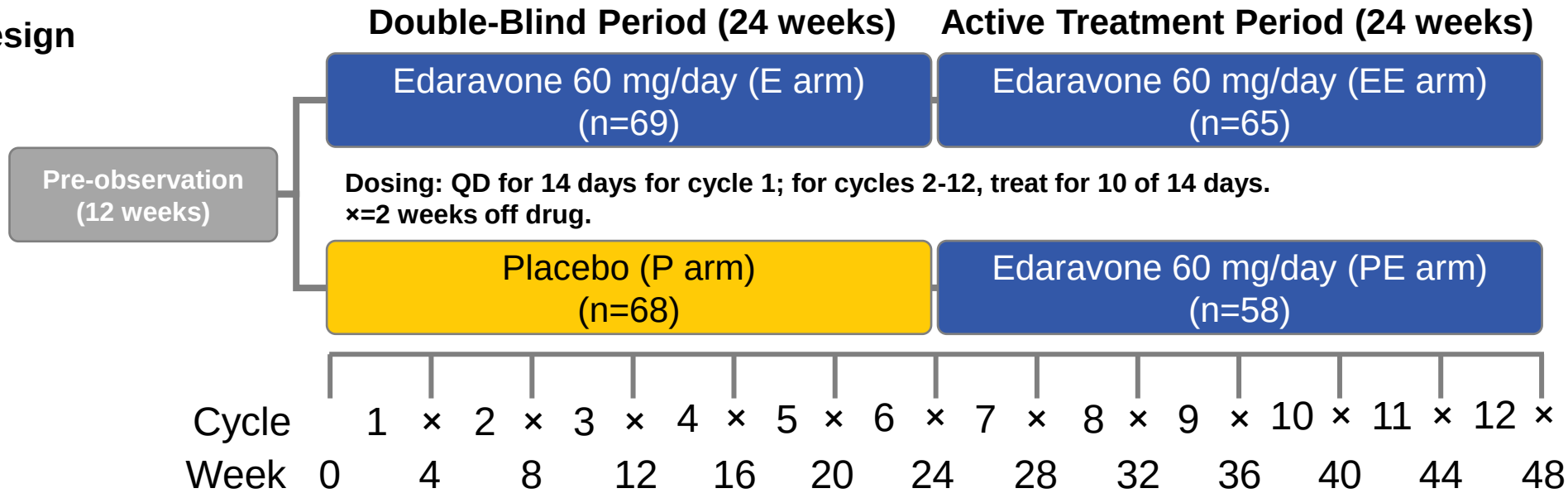
*P=.020; **P=.0001.

1. Brown RH, Al-Chalabi A. *N Engl J Med.* 2017;377(2):162-172.
2. Lechtzin N, et al. *Amyotroph Lateral Scler Frontotemporal Degener.* 2018;19(5-6):321-330.
3. Niedermeyer S, et al. *Chest.* 2019;155(2):401-408.
4. Chio A, et al. *Neurology*. 2020 [Epub ahead of print].
5. Pattee GL, et al. *Muscle Nerve.* 2019;59(5):531-536.

Edaravone Study 19 Overview

- Edaravone study MCI186-19 (Study 19), was a Phase 3, randomized, double-blind, parallel-group study
  - The study consisted of a 24-week (cycles 1-6) double-blind, placebo-controlled treatment period, followed by a 24-week (cycles 7-12) uncontrolled, open-label, active treatment extension period
- As the 24-week study extension was uncontrolled, multiple linear regression analysis was used to develop a model to project the placebo arm through week 48 (cycle 12) to assess the long-term efficacy and safety of edaravone

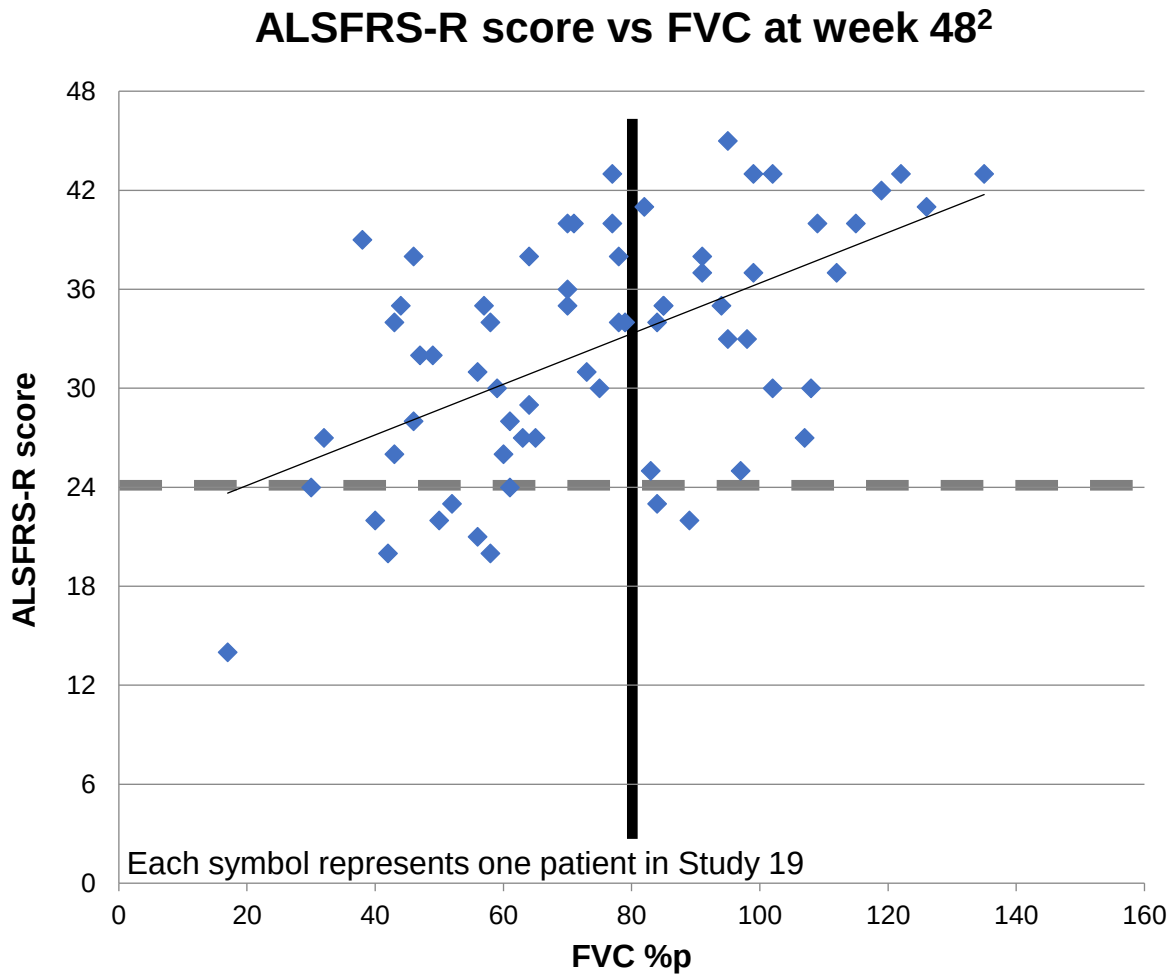
Study design



Writing Group; Edaravone (MCI-186) ALS 19 Study Group. *Lancet Neurol.* 2017;16(7):505-512.

Edaravone Study 19 (cont.)

- In Study 19, patients with ALS experienced significantly less functional decline with edaravone vs placebo, as measured by the ALS Functional Rating Scale-Revised (ALSFRS-R)[1]
  - At 24 weeks, the difference between groups in change from baseline in ALSFRS-R score = 2.49 (33% difference; *P*=.0013)
- Post-hoc analysis of the ALSFRS-R score vs forced vital capacity (FVC) at week 48[2]
  - Most patients had ALSFRS-R scores >24, including those with FVC <80%
  - Thus, these patients appeared to have functionality in other domains of the ALSFRS-R that would benefit from a treatment that slows the loss of physical function



1. Writing Group; Edaravone (MCI-186) ALS 19 Study Group. *Lancet Neurol.* 2017;16(7):505-512.
2. Brooks BR, et al. unpublished.

Edaravone Study 19 (cont.)

- A previous post hoc analysis of Study 19 revealed that ALS patients with reduced FVC of <80% prior to starting open-label edaravone, experienced a slower reduction in ALSFRS-R score after initiating edaravone treatment (33% difference, *P*=.006; n=25)[1,2]
  - This study included both limb- and bulbar-onset patients, therefore, it was thought to be important to compare these groups regarding their response to edaravone treatment, and to assess bulbar patients with FVC ≥80% vs <80% at the time of treatment initiation

1. Agnese W, et al. European Network to Cure ALS (ENCALS) 2018 Meeting; 20-22 June 2018; Oxford, UK. Abstract D31.
2. Brooks BR, et al. unpublished.

Objectives

- To address the efficacy of edaravone in patients with bulbar-onset ALS and bulbar patients with FVC of either ≥80% or <80%

Methods: Post Hoc Analysis

- A post hoc analysis of Study 19 was conducted to examine the change from baseline ALSFRS-R at week 24 and week 48, with subjects divided into subgroups based on bulbar- vs limb-onset disease[a]
- Multiple linear regression analyses
  - Multiple linear regression analyses were performed to estimate the slopes of the scores for the treatment arms for the edaravone, placebo, edaravone-edaravone, and placebo-edaravone patients in each subgroup
- Analysis of disease progression in bulbar patients with FVC ≥80% vs <80%
  - Study 19 subjects were divided into subgroups based on their FVC values at week 24 (end of cycle 6): FVC <80% and FVC ≥80%
  - The change from baseline ALSFRS-R at week 24 and week 48 was analyzed in the two subgroups of patients
- As a post-hoc, subgroup analysis of Study 19, this study is subject to the limitations inherent in post-hoc analyses (eg, analyses were not prespecified in Study 19, smaller sample sizes in each subgroup, lack of control for type 1 error)

[a]Bulbar-onset patients were identified based on whether the patient's initial symptoms were bulbar symptoms or limb symptoms, which was determined by study investigators when they enrolled patients in Study 19.

Results: Baseline Characteristics of the Analysis Populations

- The bulbar- and limb-onset patient populations were comparable at baseline in terms of age, duration of disease, and ALSFRS-R score
- Bulbar-onset patients had a higher proportion of women and may have had more severe disease than limb-onset patients

Table 1. Baseline characteristics of analysis populations

	Limb (n=107)	Bulbar (n=30)	*P* value
Gender, n (%) Men Women	 68 (64) 39 (36)	 11 (37) 19 (63)	.0084
Age, mean (SD)	59.6 (10)	62.7 (8)	.1229
Duration of disease, mean years (SD)	1.10 (0.5)	1.08 (0.4)	.7859
ALS diagnostic criteria, n (%) Definite Probable	 39 (36) 68 (64)	 16 (53) 14 (47)	.0955
ALS severity, n (%) Grade 1 Grade 2	 25 (23) 82 (77)	 13 (43) 17 (57)	.0955
ALSFRS-R score, mean (SD) Before preregistration Baseline in cycle 1	 43.4 (2.2) 41.8 (2.4)	 44.0 (2.1) 42.0 (2.1)	 .2464 .5824

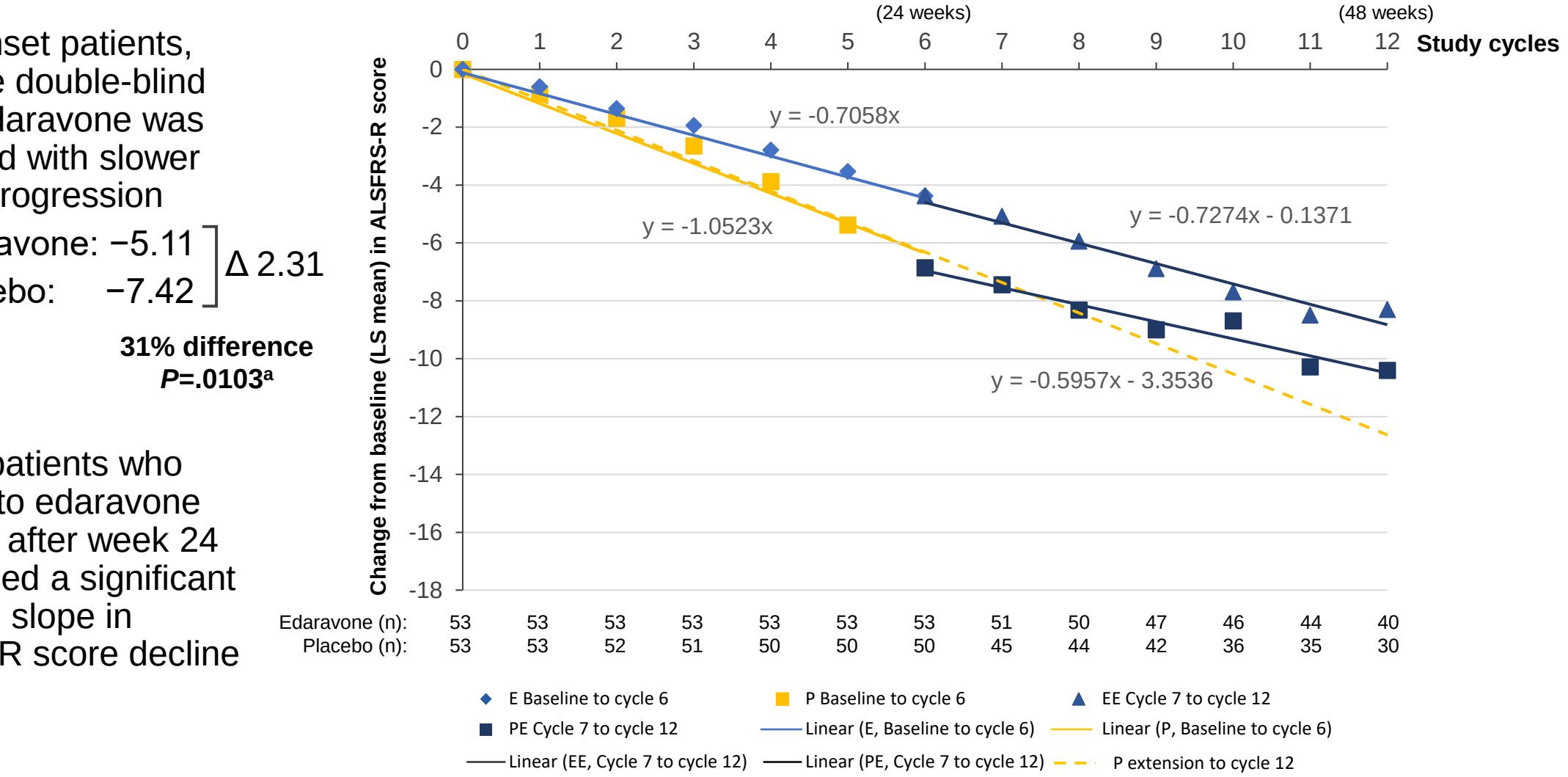
ALSFRS-R in Study 19 Limb-Onset Patients

- In limb-onset patients, during the double-blind period, edaravone was associated with slower disease progression
  - Edaravone: −5.11
  - Placebo: −7.42

  ] Δ 2.31

31% difference
***P*=.0103[a]**

- Placebo patients who switched to edaravone treatment after week 24 experienced a significant change in slope in ALSFRS-R score decline (*P*<.001)



[a]ANOVA, LOCF analysis.

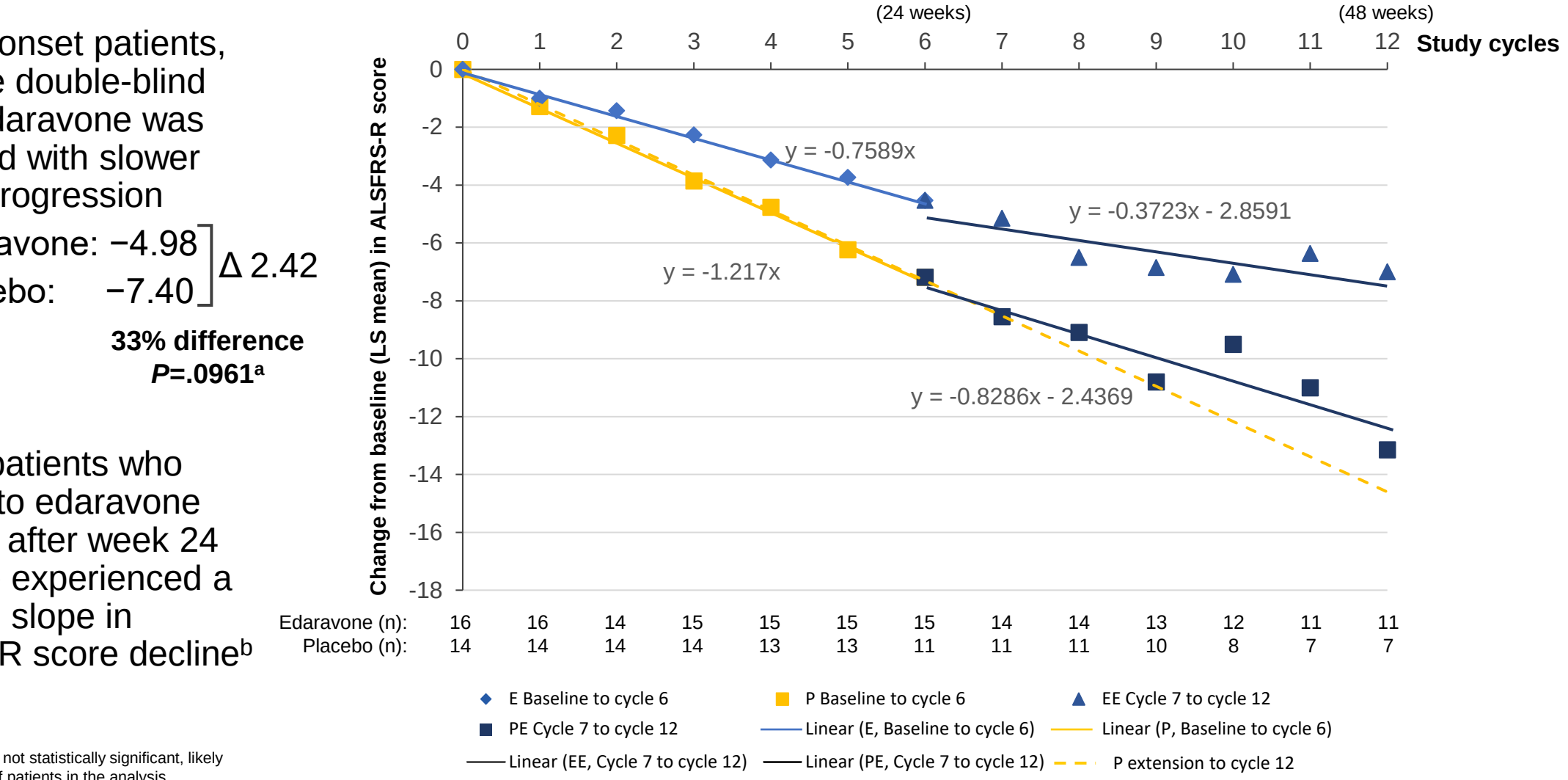
ALSFRS-R in Study 19 Bulbar-Onset Patients

- In bulbar-onset patients, during the double-blind period, edaravone was associated with slower disease progression
  - Edaravone: −4.98
  - Placebo: −7.40

  Δ 2.42

33% difference
***P*=.0961[a]**

- Placebo patients who switched to edaravone treatment after week 24 may have experienced a change in slope in ALSFRS-R score decline[b]



[a]ANOVA, LOCF analysis.
[b]This change in slope was not statistically significant, likely due to the small number of patients in the analysis.

Baseline Characteristics of Bulbar Patients With FVC <80% vs ≥80% at Week 24

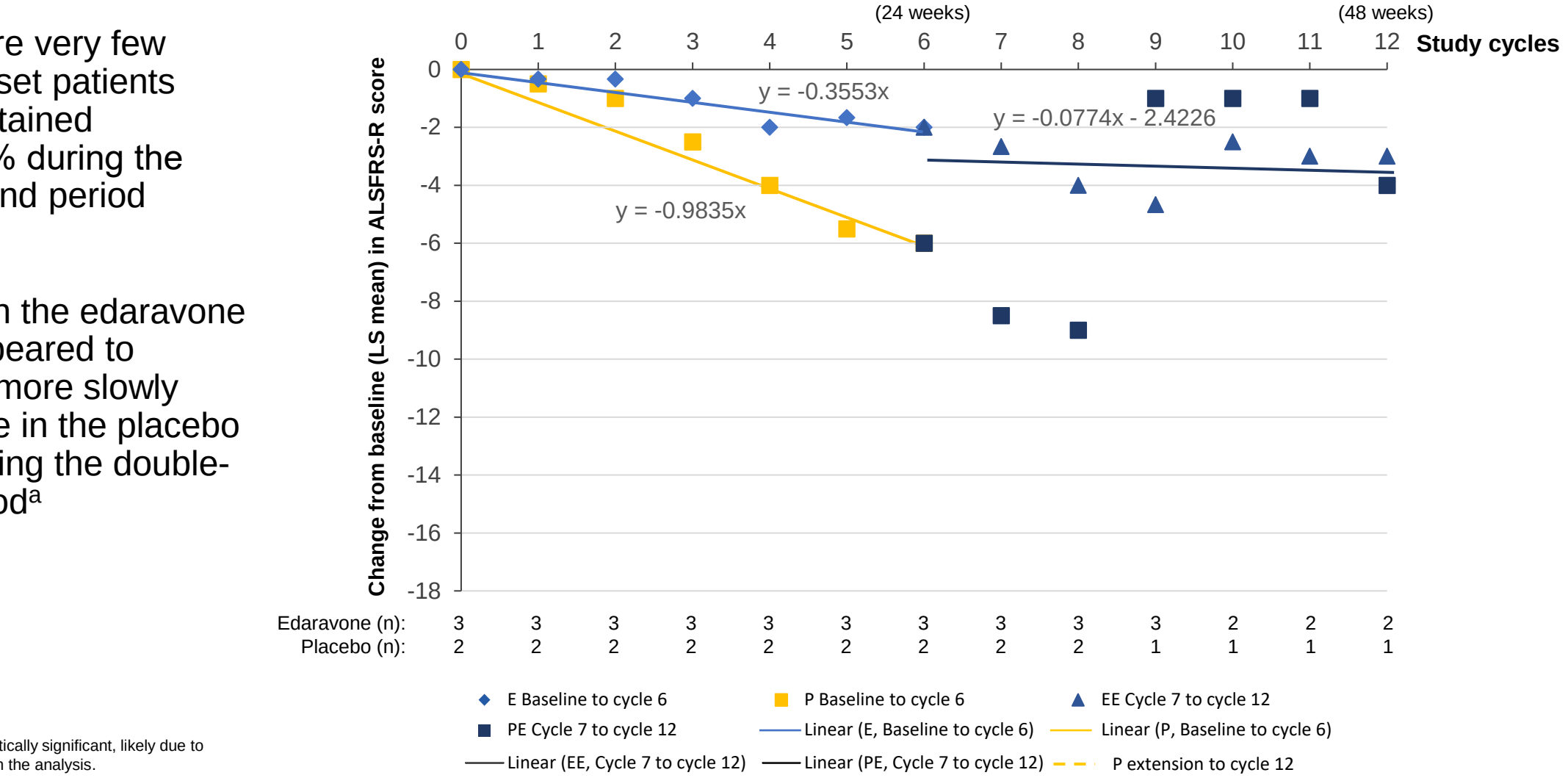
- Bulbar-onset patients were divided into 2 groups based on having FVC <80% vs ≥80% at the end of the double-blind period (cycle 6)
- At the end of the double-blind period, there were more bulbar patients with FVC <80% vs ≥80%
- The baseline characteristics of the 2 groups were comparable, although patients with FVC <80% may have had more severe disease

Table 2. Baseline characteristics of FVC ≥80% vs <80%

	FVC <80% (n=21)	FVC ≥80% (n=5)	*P* value
Gender, n (%) Men Women	 6 (29) 15 (71)	 4 (80) 1 (20)	.0336
Age, mean (SD)	63.6 (7)	58.2 (12)	.1782
Duration of disease, mean years (SD)	1.07 (0.4)	1.18 (0.4)	.5751
ALS diagnostic criteria, n (%) Definite Probable	 10 (48) 11 (52)	 4 (80) 1 (20)	.1918
ALS severity, n (%) Grade 1 Grade 2	 8 (38) 13 (62)	 4 (80) 1 (20)	.1918
ALSFRS-R score, mean (SD) Before preregistration Baseline in cycle 1	 43.7 (2.2) 41.6 (2.0)	 44.2 (2.2) 42.6 (2.3)	 .6235 .3534

ALSFRS-R in Bulbar Patients With FVC ≥80% at Week 24

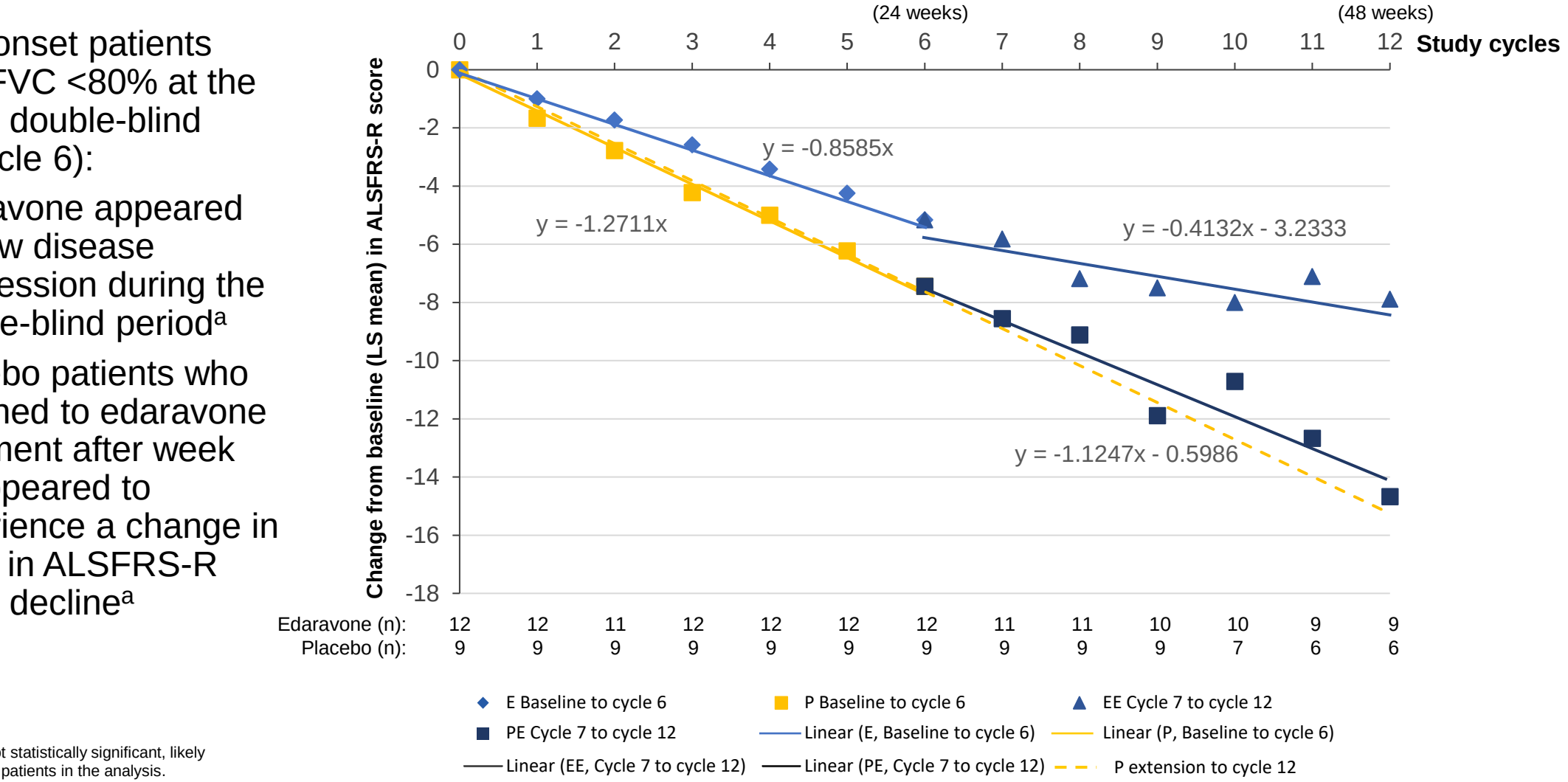
- There were very few bulbar-onset patients who maintained FVC ≥80% during the double-blind period
- Patients in the edaravone group appeared to progress more slowly than those in the placebo group during the double-blind period[a]



[a]This difference was not statistically significant, likely due to the small number of patients in the analysis.

ALSFRS-R in Bulbar Patients With FVC <80% at Week 24

- In bulbar-onset patients who had FVC <80% at the end of the double-blind period (cycle 6):
  - Edaravone appeared to slow disease progression during the double-blind period[a]
  - Placebo patients who switched to edaravone treatment after week 24 appeared to experience a change in slope in ALSFRS-R score decline[a]



[a]These differences were not statistically significant, likely due to the small number of patients in the analysis.

Summary

- A previous post hoc analysis of the full Study 19 population revealed that ALS patients with FVC <80% experienced a slower reduction in ALSFRS-R score after initiating edaravone open-label treatment
- In the Study 19 placebo arm, bulbar-onset patients experienced a more rapid decline in ALSFRS-R score over time compared with limb-onset patients
- Patients in both the bulbar- and limb-onset groups experienced a slower reduction in ALSFRS-R score with edaravone treatment vs placebo through week 48
- In addition, after starting open-label treatment with edaravone, former placebo patients with either bulbar- or limb-onset disease seemed to demonstrate a slower reduction in ALSFRS-R score from baseline to week 48, and a notable change in the slope of the ALSFRS-R score-vs-time graph
- Analysis of bulbar-onset patients with either FVC <80% or ≥80% seemed to indicate that both populations experienced a slower reduction in ALSFRS-R score with edaravone vs placebo
- The limitations inherent with post hoc analyses should be considered when interpreting these results
- Further studies to assess bulbar function with edaravone are under consideration

Acknowledgments and Disclosures

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Disclosures

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Thank you