

Dissecting Age-Based Survival Patterns in Acute Lymphoblastic Leukemia: A Landmark Analysis of Early Mortality and Conditional Survival

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INTRODUCTION

Acute lymphoblastic leukemia (ALL) demonstrates significant age-related survival disparities; however, the relative contributions of early mortality and post landmark survival across the age spectrum remain unclear. This study characterizes age dependent survival patterns using a landmark-based and conditional survival framework, with emphasis on age extremes.

METHODS

A population-based analysis was performed using Surveillance, Epidemiology and End Results (SEER) program derived relative survival estimates. Twelve-month and sixty-month relative survival across predefined age groups were evaluated. Analyses included absolute survival decline, conditional survival (60-month survival conditional on 12-month survival), and proportion of mortality occurring within the first year. Age trends were assessed using midpoint stratification. Focused analyses were performed for age extremes, defined as pediatric (0-14 years) and older adult (≥65 years) groups.

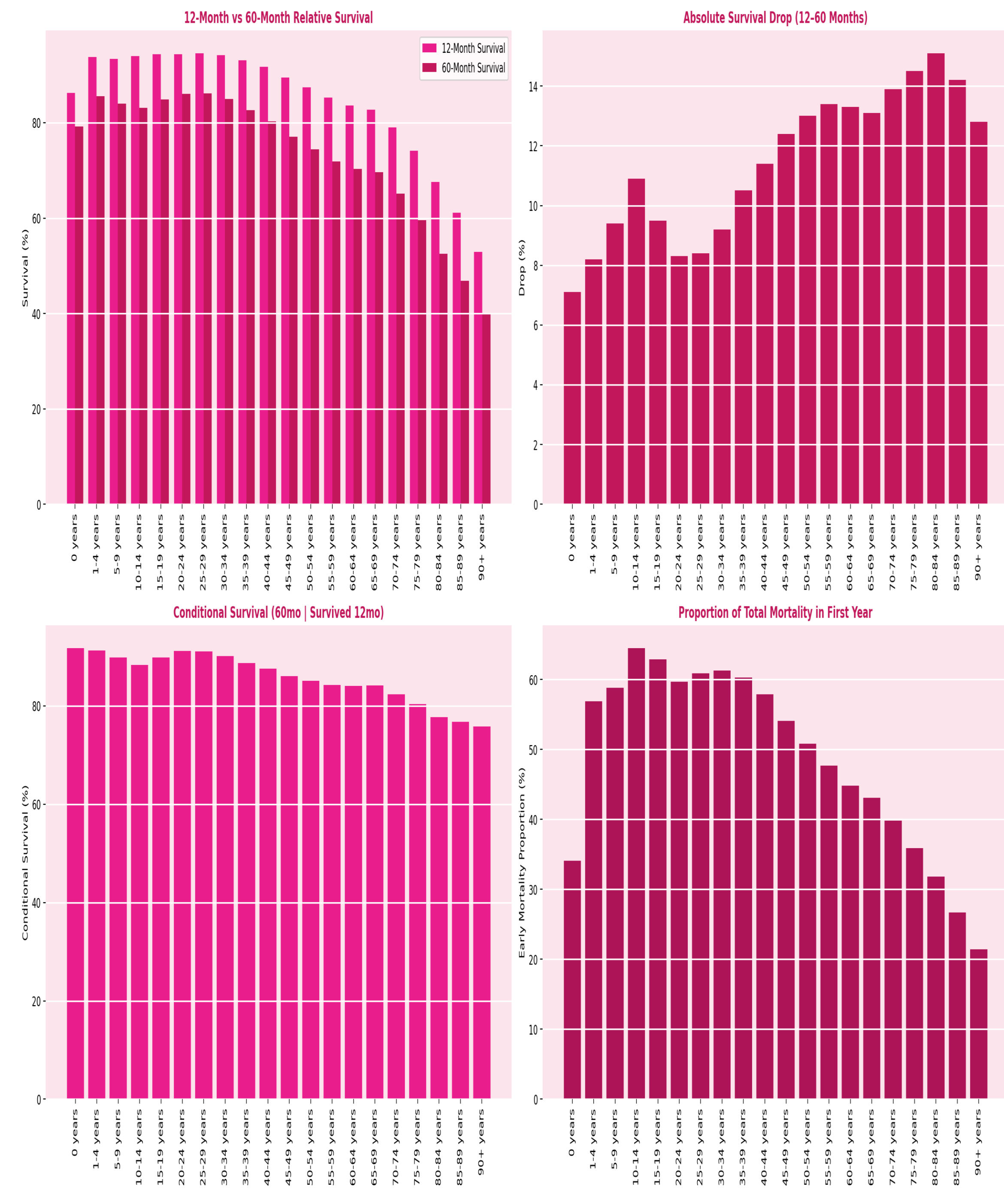
RESULTS

Twelve-month survival decreased from 86.3% in infants to 52.9% in patients aged ≥90 years, while sixty-month survival declined from 79.2% to 40.1%. The interval specific survival loss between 12 and 60 months (reflecting post first year mortality) increased with age from 7.1% in infants to a peak of 15.1% in patients aged 80–84 years, followed by a modest decrease to 12.8% in those aged ≥90 years. Conditional survival decreased from 91.8% in infants to 75.8% in the oldest group. The proportion of total mortality occurring within the first year was highest in pediatric patients, reaching 64.5% in those aged 10–14 years, and decreased progressively with age to 21.4% in patients aged ≥90 years. Across intermediate adult age groups, early mortality remained relatively stable at 55-62%.

CONCLUSION

Age related survival disparities in ALL reflect distinct temporal patterns of mortality across the age spectrum.

Early mortality constitutes a larger proportion of total deaths in pediatric patients, whereas mortality beyond the first year contributes more substantially in older adults. Despite a lower contribution of early mortality at advanced age, overall survival remains poorest in the oldest cohorts, reflecting a greater burden of late mortality. These findings highlight the need for age-adapted therapeutic strategies targeting early mortality in younger patients and improving durability of response in older populations.



Age Group	12-Month Survival (%)	60-Month Survival (%)	Absolute Drop (%)	Conditional Survival (%)	Age Midpoint	Relative Decline (%)	Early Mortality Proportion (%)
0 years	86.3	79.2	7.1	91.8	0	0.0	34.1
1-4 years	93.8	85.6	8.2	91.3	2.5	0.0	56.9
5-9 years	93.4	84.0	9.4	89.9	7	0.0	58.8
10-14 years	94.0	83.1	10.9	88.4	12	1.7	64.5
15-19 years	94.4	84.9	9.5	89.9	17	0.0	62.9
20-24 years	94.4	86.1	8.3	91.2	22	0.0	59.7
25-29 years	94.6	86.2	8.4	91.1	27	0.0	60.9
30-34 years	94.2	85.0	9.2	90.2	32	0.0	61.3
35-39 years	93.1	82.6	10.5	88.7	37	1.3	60.3
40-44 years	91.7	80.3	11.4	87.6	42	2.6	57.9
45-49 years	89.5	77.1	12.4	86.1	47	4.2	54.1
50-54 years	87.4	74.4	13.0	85.1	52	5.3	50.8
55-59 years	85.3	71.9	13.4	84.3	57	6.2	47.7
60-64 years	83.6	70.3	13.3	84.1	62	6.5	44.8
65-69 years	82.7	69.6	13.1	84.2	67	6.4	43.1
70-74 years	79.0	65.1	13.9	82.4	72	8.3	39.8
75-79 years	74.1	59.6	14.5	80.4	77	10.5	35.9
80-84 years	67.6	52.5	15.1	77.7	82	13.6	31.8
85-89 years	61.1	46.9	14.2	76.8	87	14.6	26.7
90+ years	52.9	40.1	12.8	75.8	92	15.7	21.4