



The readability of online leukemia materials

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Abstract

Health literacy is considered an important factor in an individual's ability to increase control over their health. With low levels of health literacy associated with a worse quality of health, more and more people have been turning to the Internet to obtain information on their health. The purpose of this study was to determine the readability of the content of the first one hundred leukemia websites on the Internet using six indices that measured reading levels, along with other leukemia-related words. This study found that the readability level of the documents was not adequate for the general population to comprehend the content. The findings underscore the need for improved health information accessibility and clarity on the Internet of leukemia-related materials, as without change, individuals would be negatively affected.

Keywords

Leukemia, Health literacy, Readability, Internet websites, Flesch-Kincaid Reading Ease, Flesch-Kincaid Grade Level, Gunning Fog Index, Simple Measure of Gobbledygook, Coleman-Liau Index, Automated Readability Index

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Introduction

Every 3 minutes, a person is diagnosed with blood cancer, with more than a third of those diagnoses being leukemia (1). In 2020, approximately 500,000 people in the United States were living with leukemia with trends showing rapid increase of cases (2, 3). Out of all patients diagnosed with leukemia, 25.2% were older adults in the age group of 65 to 74, with the median age of diagnosis being 67 years of age (2). Although the overall leukemia survival statistics rates may seem high (4), when viewed upon closer inspection, the dire reality of the impacts the cancer has on the majority of those diagnosed can be seen (5). Population-based studies have shown that while younger patients had survival rates up to 50%, older adults (over the age of sixty, who make up the majority of leukemia patients) only reported a 3-year survival rate of 9-10% and a 5-year survival rate of 3-8% (6).

Over the past few years, the Internet has become an increasingly popular source to which people turn to to learn about their health and health management (7). However, despite the availability and accessibility of information about health issues on the Internet, the general public is unable to comprehend the materials provided (8). Health literacy, defined as the “degree to which individuals can find, understand, and use information” by the Centers for Disease Control and Prevention (CDC), plays a crucial part in patients’ decisions related to disease management (9-10). However, over the past years, health literacy has been at an all-time low (11).

A 2022 multi-cohort study stressed the importance of health literacy, showing how patients who had lower health literacy were more likely to visit the emergency department than compared to patients who had adequate levels of health literacy (12). Further, individuals who had low levels of health literacy had further increased risks of chronic illnesses, incurred over 4 times the health care costs, and presented with an increased 50% risk of hospitalization (13). Specifically in the elderly, limited health literacy was associated with a nearly 2-fold increase in mortality (14).

However, Internet materials related to information on leukemia may not be accessible to the intended audience due to the high reading levels at which the websites are written (15). While the average American adult’s health literacy level is at the 7th to 8th-grade level (16), the 2003 National Assessment of Adult Literacy has estimated only 3% of older adults (+65 years of age) had a proficient level of literacy (17-18). With the majority of the demographic of leukemia being older adults (19), it is important to adhere to their level of reading comprehension, as patients would be negatively affected by further health complications as they are left at a disadvantage, unable to access the said health information (20).

Readability is defined by the Oxford Dictionary as “the fact of being clear and easy to read.” Comprehension is defined by the Oxford Dictionary as “the ability to understand.” Readability and comprehension have long been correlated with each other, with both comprehension and health literacy increasing as the readability of materials increases (23).

In this study, the health literacy levels of leukemia-related websites are assessed to measure whether or not the currently available materials online are to the readable standards for the general and elderly population.

Materials and Methods

Using a cleared Internet browser, a search was conducted for the keywords of “leukemia” and “blood cancer” along with common symptom words such as “fatigue” and “fever.” The browser used for this study was Firefox and the first 100 readable URLs in English were recorded in the data set for each keyword. The term “readable” is used here due to some of the first 100 websites in the search for keywords being either broken links or video formats. Embedded advertisements or links were not assessed in this study.

Using the collected data set, the following six tests were individually conducted: Flesch Kincaid Reading Ease (FRE), Flesch Kincaid Grade Level (FKGL), Gunning Fog Score (GFI), Simple Measure of Gobbledygook (SMOG), Coleman Liau Index (CLI), and the Automated Readability Index (ARI). The Flesch Kincaid Reading Ease (FRE) is the most widely used measure of readability. The scores are based on a 0-100 scale with a higher score indicating easier readings while lower scores suggest the text is complicated to understand. It is calculated as follows: $206.835 - 1.015 \times (\text{words/sentences}) - 85.6 \times (\text{syllables/words})$. Closely related to the Flesch Kincaid Reading Ease (FRE), the Flesch Kincaid Grade Level (FKGL) is based on the American school grade system and calculates the grade the reader would have to be in to comprehend the material. It is calculated as follows: $0.39 \times (\text{words/sentences}) + 11.9 \times (\text{syllables/words}) - 15.59$. The Gunning Fog Score (GFI) measures the years of formal education needed to comprehend the text on the first reading. Unlike the Flesch Kincaid Reading Ease (FRE) test, the Gunning Fog Score (GFI) test is not primarily focused on the American grade scale, but rather on the years of education needed. It is calculated as follows: $0.4 \times ((\text{words/sentences}) + 100 \times (\text{complexWords/words}))$. The Simple Measure of Gobbledygook (SMOG) measures the years of education a person needs to comprehend writing. It is calculated as follows: $.0430 \times \text{square root of } (30 \times \text{complexWords/sentences}) + 3.1291$. The Coleman Liau Index (CLI), like the Flesch Kincaid Grade Level (FKGL), approximates the U.S. grade level necessary to comprehend the text. However, unlike most other tests, the Coleman-Liau Index (CLI) relies on whole characters rather than specific syllables per word. It is calculated as follows: $5.89 \times (\text{characters/words}) - 0.3 \times (\text{sentences/words}) - 15.8$. Lastly, the Automated Readability Index (ARI) measures the understandability of text and calculates the American grade for which the reader would have to be to understand the text. The Automated Readability Index (ARI) relies on ratios. It is calculated as $4.71 \times (\text{characters/words}) + 0.5 \times (\text{words/sentences}) - 21.43$. The Coleman Liau and ARI rely on counting characters, words, and sentences while the other indices such as the Kincaid Reading Ease, Flesch Kincaid Grade Level, and Gunning Fog Score consider the number of syllables and complex words. Due to many professional opinions varying on which type of test is most accurate, all were used in the study to generate the widest range of data possible.

Specifically, the content/materials assessed at each website to determine the readability were only of content that were deemed relevant to health and the topic of the website. This focus was exclusively on materials directly pertinent to health and the thematic essence of each website. This encompassed diverse textual components such as headings, body paragraphs, and references to affiliated websites. Certain elements were purposefully excluded from the readability assessment. The footer of each website, containing copyright information, publication details, and sponsor information, was intentionally omitted from the evaluation process. This exclusion was predicated on the determination that such peripheral details, while important for legal and administrative purposes, were not directly relevant to the primary focus on leukemia-related content. The decision to exclude this information aimed to streamline the assessment process, ensuring a more targeted and focused analysis of the substantive material presented on each website.

Google Sheets was used for the data entry, data analysis, and to calculate the statistics. Although the average reading level in the United States of America falls between the 7th and 8th grade, the American Medical Association (AMA) currently recommends that healthcare materials be written at or below a sixth-grade reading level, equivalent to 6 years of schooling, to meet the needs of the general public (21). Using these AMA guidelines, tests were divided into three classifications: “easy” (Grade < 6), “recommended” (Grade = 6), or “difficult” (Grade > 6).

Results

All six tests showed that the reading level of the majority of the materials was above the recommended 6th-grade level (Table 1). None (0%) of the websites in the data set were considered “easy” by any of the six indices used to measure difficulty. Four out of the six indices determined that all materials were above the 6th-grade level and were “difficult” to read. Only the Flesch Kincaid Grade Level and the Automated Readability Index indices determined that 1% and 3% of the websites fell in the recommended 6th-grade reading level, respectively.

The mean and median scores of the 5 indices that measured years of education needed to comprehend the given material were calculated (FKGL, GFI, SMOG, CLI, ARI). The averages of the 5 indices showed that the audience required a mean of 12.54 years of formal education and a median of 12.12 years to comprehend the available material (Figure 1). Both data points showed that the difficulty of the materials was more than double than that recommended.

Table 1. Categorization of websites based on the results of the indices for the keyword “Leukemia”

Test	Minimum	Maximum	Easy: Grade < 6	Recommended: Grade 6	Difficult: Grade > 6	Mean	Median	SD
FRE	24.2	35.8	0	0	100	43.54	43.35	8.20
FKGL	12.9	14.8	0	1	99	11.73	11.15	1.34
GFI	15.4	17.7	0	0	100	14.04	13.60	1.63
SMOG	11.6	13.1	0	0	100	10.76	10.40	1.06
CLI	14.3	16.2	0	0	100	14.32	14.30	1.34
ARI	12.0	14.1	0	3	97	11.83	11.60	1.48

Note. FRE = Flesch-Kincaid Reading Ease; FKGL = Flesch-Kincaid Grade Level; GFI = Gunning Fog Index; SMOG = Simple Measure of Gobbledygook; CLI = Coleman-Liau Index; ARI = Automated Readability Index. FRE scoring is as follows: Easy: score > 80; recommended: score 80 to 100; difficult: score < 80.

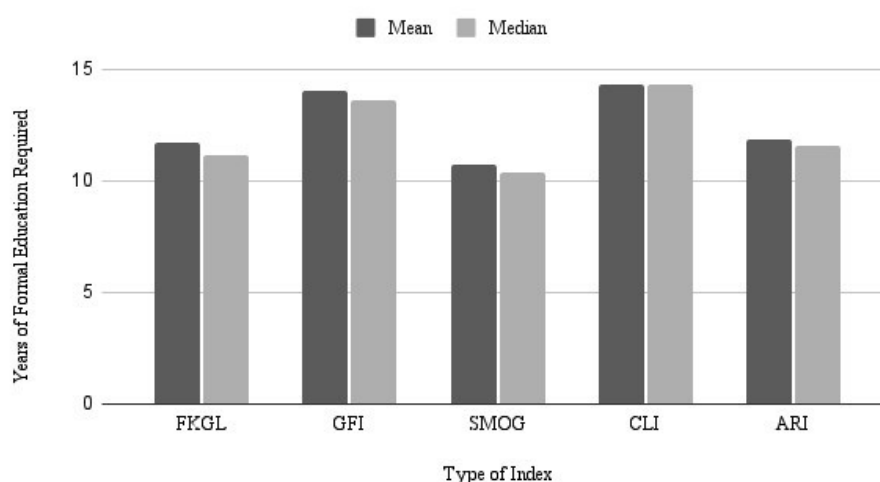


Figure 1. Mean and Median Values of Years of Education Required to Comprehend “Leukemia” Related Search Words. Abbreviations are the same as those in Table 1.

There were no significant differences between the comparison of the mean readability score and the search position in order (Table 2). The articles higher on the search order which were the most accessible by the audience needed an average of 13.17 years of education to comprehend the material while the articles which were less accessible averaged 11.08 years of education needed to comprehend the material. While there was a difference of 2.11 years, both years of education were above the recommended level and therefore the difference was considered not significant.

Table 2. Average indices score of the articles in order of the search results given for the keyword “Leukemia”

Order	FRE	FKGL	GFI	SMOG	CLI	ARI
1 - 10	36.25	12.35	15.15	11.25	15.30	11.80
11 - 20	44.70	10.60	12.80	9.80	14.80	10.30
21 - 30	37.50	13.25	14.85	11.90	14.50	13.25
31 - 40	55.30	9.90	12.00	9.10	12.75	10.2
41 - 50	40.95	11.70	14.15	10.70	14.35	11.10
51 - 60	43.05	12.05	14.35	11.00	14.05	12.15
61 - 70	43.55	12.15	15.00	11.25	14.20	12.60
71 - 80	59.15	8.15	10.70	8.00	13.10	8.05
81 - 90	45.45	11.60	13.50	10.40	14.10	12.00
91 - 100	49.80	10.40	12.45	9.65	13.05	9.85

Note. FRE = Flesch-Kincaid Reading Ease; FKGL = Flesch-Kincaid Grade Level; GFI = Gunning Fog Index; SMOG = Simple Measure of Gobbledygook; CLI = Coleman-Liau Index; ARI = Automated Readability Index. FRE scoring is as follows: Easy: score > 80; recommended: score 80 to 100; difficult: score < 80.

The six index tests were applied to the content on the NIH websites for Leukemia (Table 3). The articles presented on the NIH websites did not show significant differences with other articles, as the majority (100%) of articles were deemed to be too difficult for the average population to comprehend.

Table 3. Readability level scores for the first 7 websites on the NIH page for Leukemia.

NIH WEBSITES	FRE	FKGL	GFI	SMOG	CLI	ARI
Leukemia—Patient Version - NCI	25.7	15.1	11.5	12.7	17.2	15.9
Adult Acute Lymphoblastic Leukemia Treatment - NCI	52.7	10.1	12	9.3	13.1	10
Chronic Lymphocytic Leukemia Treatment - NCI	50.9	10.3	12.1	9.5	13.6	10.4
Chronic Myelogenous Leukemia Treatment - NCI	51.7	10	11.6	9.2	13.9	10.2
Hairy Cell Leukemia Treatment - NCI	53.8	9.7	11.6	9	13.2	9.7
Childhood Acute Lymphoblastic Leukemia Treatment - NCI	49.4	10.6	12.3	9.5	14.1	10.9
Childhood Acute Myeloid Leukemia Treatment - NCI	49.7	10.2	12	9.2	14.2	10.4

Note. FRE = Flesch-Kincaid Reading Ease; FKGL = Flesch-Kincaid Grade Level; GFI = Gunning Fog Index; SMOG = Simple Measure of Gobbledygook; CLI = Coleman-Liau Index; ARI = Automated Readability Index. FRE scoring is as follows: Easy: score > 80; recommended: score 80 to 100; difficult: score < 80.

The six indices tests were applied to other keywords associated with Leukemia by collecting the first 100 relevant online websites for each specific word (Table 4). All words for the majority of materials presented online were deemed to be too difficult for the general public to comprehend.

Table 4. Average readability score for Leukemia and keywords associated with Leukemia.

KEY WORDS	FRE	FKGL	GFI	SMOG	CLI	ARI
Leukemia	43.54	11.73	14.04	10.76	14.32	11.83
Blood Cancer	43.72	12.18	13.8	11.02	14.39	12.88
Fatigue	46.52	11.31	15.59	10.88	13.5	11.38
Fever	53.324	10.155	12.023	9.201	11.961	9.529

Note. FRE = Flesch-Kincaid Reading Ease; FKGL = Flesch-Kincaid Grade Level; GFI = Gunning Fog Index; SMOG = Simple Measure of Gobbledygook; CLI = Coleman-Liau Index; ARI = Automated Readability Index. FRE scoring is as follows: Easy: score > 80; recommended: score 80 to 100; difficult: score < 80.

Discussion

The readability of leukemia cancer health materials on the Internet found that the majority of available information was written above the high school level, with zero websites meeting adequate readability levels according to four separate indices. Despite the National Institute of Health (NIH) recommendations that health-related information should be written at the sixth to seventh grade level, the online websites were found to be, on average, over the twelfth-grade level (24). All online websites provided by the National Institute of Health were over their recommended reading level. This is consistent with previous studies that found that high-impact medical journals rarely meet their grade reading level recommendations, with only 2.1% of materials meeting the American Medical Association guidelines of sixth grade (25). With consideration of the main demographic of these leukemia-related health articles—the elderly population consisting of adults over the age of sixty—this study found that the information on the internet was inaccessible for many audiences to read and comprehend.

The order of the online websites did not influence the readability levels of the materials themselves. There was only a negligible difference of 2.11 years between the websites on the front pages of the search results and those on the last pages, with those on the front pages being harder to comprehend. Regardless of order, all materials were still considered to be above the recommended reading levels.

Other keywords such as “blood cancer,” “fever,” and “fatigue” were also assessed to measure how online materials that did not contain specific medical terminology pertaining only to leukemia would be comprehensible to the general public. These related words were also found to be too difficult for the general public to comprehend, with the average years of education to understand the material being near twice the recommended levels, per the American Medical Association guidelines. Compared to the keywords “leukemia” and “blood cancer,” general symptom words such as “fatigue” and “fever” showed higher readability scores, assessed on the Flesch-Kincaid Reading Ease index (Table 4). Although slightly easier to read, the online websites of symptom-words would not be understandable by the majority of the general population.

It is important to note that health literacy is colinear with wealth and social status, as it correlates to the access of education and reading comprehension (26, 27). It may be argued that a population with low education accessibility may be unlikely to read health information even if it is presented at the 6th grade level. However, this study followed the American Medical Association recommendation of sixth-grade reading level as a baseline for suitability and readability for the majority of the American population, regardless of possible differences in socio-economic status of the readers (21).

Further, it is important to note that if the readability level of different health-related websites is increased, the erudition and depth requirements of acceptable scientific work itself do not need to be sacrificed. As per the American Medical Association recommendation, health literacy materials are, and should be, able to be written at the sixth grade level without phrasing the work as being overly simplistic to the general public (21). These online materials that follow such guidelines should be adequate for the general public to read, comprehend, and use. From these materials written at the appropriate level, the general public should be able to make well-informed decisions about their own health (9).

Health literacy can improve a patient's health condition, control diseases, and prevent future diseases (22). Without a change in the reading level of these websites related to leukemia, people would continue to be unable to obtain relevant comprehensible information about their health and may unnecessarily jeopardize their health further.

While there are some limitations of this study, such as the exclusion of sponsored websites, the exclusion of broken links, the exclusion of video links, the use of search providers, and the use of open websites where information can be changed regularly, this research showed that the need to create leukemia-related information on the Internet that is understandable for the general public is much needed.

Conclusion

The Internet has become a popular source of information on health-related resources. However, there is a large discrepancy between the readability of the educational materials and the reading level of the targeted audience. According to the AMA guidelines, the large majority of reading content and material were considered too difficult to read for the public, requiring an average of 12 to 13 years of schooling to comprehend. In addition to the older population struggling to access information online, the current popular available materials can be concluded to not be comprehensible nor suitable for the majority of the population. These findings call for a need for change on the currently available materials to ensure greater understanding of an individual's own health and to promote a better quality of life for the public as a whole.

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Appendix: Raw data of all websites and computed readability scores for the keyword
“Leukemia”

Website	Flesch Kincaid Reading Ease	Flesch Kincaid Grade Level	Gunning Fog Score	SMOG Index	Coleman Liau Index	Automated Readability Index
https://www.ncbi.nlm.nih.gov/books/NBK560490/	24.2	14.8	17.7	13.1	16.2	14.1
https://medlineplus.gov/leukemia.html	24.8	14.9	16.6	13.3	16.1	14.4
https://www.leukaemia.org.au/blood-cancer/leukaemia/	32.3	13.3	16.7	12.3	16.4	13.4
https://www.cancer.org/cancer/types/leukemia.html	51.6	10.6	12.2	9.2	13.1	10.9
https://www.cdc.gov/nceh/radiation/phase2/mleukemi.pdf	44.4	11.2	12.9	10.5	12.8	9.9
https://www.health.ny.gov/statistics/cancer/registry/abouts/leukemia.htm	58.2	8.2	10.8	8	13	7.8
https://www.healthdirect.gov.au/leukaemia	49.1	10.9	13.4	9.9	13.4	11
https://www.canceraustralia.gov.au/cancer-types/leukaemia/overview	63.2	8.5	11.6	8.6	11.5	8.7
https://www.webmd.com/cancer/lymphoma/understanding-leukemia-basics	62.1	8.4	10.6	8.4	12	8.4
https://www.mayoclinic.org/diseases-conditions/leukemia/symptoms-causes/syc-20374373	48.3	9.9	12.6	9.4	14.4	9.5
https://my.clevelandclinic.org/health/diseases/4365-leukemia	52.9	9	11.7	8.8	13.6	8.4
https://www.lls.org/leukemia/acute-lymphoblastic-leukemia	53.1	9.9	11.8	9.2	13.8	10.4
https://www.lls.org/leukemia/acute-myeloid-leukemia	49.2	11.1	13.7	10.3	14.2	11.9
https://www.lls.org/leukemia/chronic-lymphocytic-leukemia	57.3	9	11.4	8.6	13.1	9.3
https://www.lls.org/leukemia/chronic-myeloid-leukemia	53.1	10.2	13.1	9.9	12.6	10
https://www.lls.org/leukemia/hairy-cell-leukemia	56.3	9.7	12.7	9.3	12.6	9.9
https://www.lls.org/leukemia/chronic-myelomonocytic-leukemia	51.6	10	11.8	8.8	14.4	10.6

https://www.lls.org/leukemia/juvenile-myelomonocytic-leukemia	49	10.7	12.9	10	14.4	11.2
https://www.lls.org/leukemia/large-granular-lymphocytic-leukemia	32.3	14.4	17.1	12.88	15.2	14.7
https://www.lls.org/leukemia/b-cell-prolymphocytic-leukemia-b-pll	36.5	12.2	13.9	10.8	16	12.2
https://www.lls.org/leukemia/b-cell-prolymphocytic-leukemia-b-pll	24.5	15.8	17.2	14	15.9	15.9
https://www.lls.org/leukemia/t-cell-prolymphocytic-leukemia-t-pll	36.2	14.6	17.3	13	14.3	15.6
https://www.hematology.org/education/patients/blood-cancers/leukemia	36.2	13.2	15.9	12	15.1	13.3
https://www.cancer.org.au/cancer-information/types-of-cancer/leukaemia	44.8	11.8	14.5	10.6	14.3	12.4
https://www.mdanderson.org/cancer-types/leukemia.html	41.9	11.2	13.8	10.5	15.3	11.1
https://www.fredhutch.org/en/diseases/leukemia/facts-resources.html	45.6	12.2	14.6	11	14.3	13.3
https://kidshealth.org/en/parents/cancer-leukemia.html	51.6	10.2	12.2	9.3	13.4	10.3
https://www.oncolink.org/cancers/blood-cancers/leukemia-types-and-treatment	62.3	7.4	9.6	7.5	11.8	6.3
https://www.stanfordchildrens.org/en/topic/default?id=leukemia-frequently-asked-questions-35-FAQLeukemia	63.1	7.5	9.6	7.4	12.3	7.1
https://www.roswellpark.org/cancer/leukemia/about	50.5	10.7	12.5	9.8	13.1	10.6
https://www.cincinnatichildrens.org/health/l/leukemia	59.2	8.8	10.7	8.3	12.4	8.7
https://www.moffitt.org/cancers/leukemia/diagnosis/causes/	25.7	16.5	19	14.4	15.8	17.6
https://www.moffitt.org/cancers/leukemia/diagnosis/risk-factors/	16.9	19.4	22.2	16.8	14.5	19.9
https://www.moffitt.org/cancers/leukemia/diagnosis/screening/	27.3	17	20	14.6	14.6	18
https://www.moffitt.org/cancers/leukemia/diagnosis/stages/	39.3	14.1	13.9	12.4	13.7	14.8
https://www.moffitt.org/cancers/leukemia/diagnosis/types/	30.8	15.2	17.6	13.4	15.88	16.4
https://www.childrenshospital.org/conditions/leukemia	47.7	10.3	11.4	9.2	13.5	9.5

https://together.stjude.org/en-us/about-pediatric-cancer/types/leukemia.html	55.4	9.2	10.2	8.5	13.7	9.6
https://www.cityofhope.org/clinical-program/leukemia/leukemia-facts	41.7	12.6	14.9	11.5	14.6	13.3
https://bloodcancer.org.uk/understanding-blood-cancer/leukaemia/leukaemia-symptoms-signs/	51.4	11	13.3	9.9	13.1	11.7
https://pubmed.ncbi.nlm.nih.gov/32809325/	24.3	14.7	17	12.8	15.9	13.7
https://www.ncbi.nlm.nih.gov/books/NBK459149/	21.8	14.7	16.2	12.6	17	14
https://pubmed.ncbi.nlm.nih.gov/27595359/	10.5	17.3	20.8	15	19	17.5
https://www.pennmedicine.org/cancer/types-of-cancer/leukemia	41.6	11.6	13.7	10.7	16	12.3
https://www.yalemedicine.org/conditions/leukemia-diagnosis	40.8	12.2	15.1	11.4	13.8	11.6
https://www.beaconhealthsystem.org/library/diseases-and-conditions/leukemia?content_id=CON-20374356	54.8	9	11.7	8.8	13.3	8.6
https://www.yalemedicine.org/conditions/chronic-lymphocytic-leukemia-cll	38.8	12.6	14.8	11.4	15.7	13.2
https://www.yalemedicine.org/conditions/hairy-cell-leukemia	42.2	12.4	15.3	11.3	14	12.6
https://iuhealth.org/find-medical-services/leukemia	42.5	11.8	13.9	10.8	14.9	12.2
https://www.mayoclinic.org/diseases-conditions/leukemia/diagnosis-treatment/drc-20374378	57.6	8.7	11.3	8.6	12.8	8.5
https://www.msdmanuals.com/en-kr/home/blood-disorders/leukemias/acute-lymphoblastic-leukemia-all	39	13	15.1	11.7	14.4	13.2
https://www.msdmanuals.com/en-kr/home/blood-disorders/leukemias/acute-myeloid-leukemia-aml	32.9	14	16.3	12.5	15.2	14
https://www.medicalnewstoday.com/articles/142595	49.1	10.4	13	9.7	13.7	10.1
https://www.nhs.uk/conditions/acute-myeloid-leukaemia/	40.9	13.2	15.9	11.8	14.5	14.1
https://cancer.ca/en/cancer-information/cancer-types/leukemia/what-is-leukemia	51.4	9.7	12.9	9.7	14.2	9.9

https://www.msdmanuals.com/en-kr/home/blood-disorders/leukemias/overview-of-leukemia	29.2	13.7	16.8	12.5	16.7	13.7
https://www.everydayhealth.com/leukemia/guide/	48.2	10.9	12.4	10.1	13.5	10.7
https://www.mskcc.org/cancer-care/types/leukemias	45.2	10.7	13.8	10.2	14.7	10.6
https://www.cancer.columbia.edu/cancer-types-care/types/leukemia/about-leukemia	48	11	12.6	10.3	14	11.3
https://www.medicinenet.com/leukemia/article.htm	47.1	11.1	13.6	10.3	13.7	11.1
https://cancer.osu.edu/for-patients-and-caregivers/learn-about-cancers-and-treatments/cancers-conditions-and-treatment/cancer-types/leukemia	42.1	12.4	15.5	11.5	14.6	13
https://www.merckmanuals.com/professional/hematology-and-oncology/leukemias/overview-of-leukemia	7.8	19.2	20.7	16.7	17.2	19
https://myhealth.alberta.ca/Health/Pages/conditions.aspx?hwid=tv7433	65.4	6.7	9.3	7	12.3	6.3
https://health.ucdavis.edu/cancer/cancer-types/leukemia.html	45.2	11.5	13.5	10.5	14.1	11.7
https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=34&contentid=17597-1	69.8	6.3	8.3	6.5	11.6	6.2
https://www.merckmanuals.com/professional/hematology-and-oncology/leukemias/acute-lymphoblastic-leukemia-all	13.5	17.2	19.7	14.8	17.1	16.5
https://www.physio-pedia.com/Leukemia	46.3	10.7	13.1	10	14.3	10.4
https://www.bumrungrad.com/en/conditions/leukemia	34	16.2	18.8	13.5	13.8	17.8
https://orthoinfo.aaos.org/en/diseases--conditions/leukemia/	39.8	12.3	14.8	11.3	15.7	12.9
https://www.gleneagles.com.sg/conditions-diseases/leukemia/symptoms-causes	45	11.9	14.5	11	13.8	12.2
https://www.uchealth.org/diseases-conditions/leukemia/	52.7	9.3	12	8.9	13.9	9.2
https://www.britannica.com/science/leukemia	30.6	14.1	15.5	13.4	15.2	13.6

https://www.cityofhope.org/clinical-program/leukemia	29.8	15.2	18	13.6	15.9	16.2
https://www.macmillan.org.uk/cancer-information-and-support/leukaemia	46.1	10.5	12.9	9.7	14.7	10.3
https://www.health.harvard.edu/cancer/leukemia	45.5	10.9	13.6	10.1	14.5	10.8
https://www.merriam-webster.com/dictionary/leukemia	16.1	18.7	20.2	16.1	14.4	18.3
https://www.hopkinsmedicine.org/health/conditions-and-diseases/leukemia	59.8	7.9	10.7	8.1	12	6.9
https://www.healthcentral.com/condition/leukemia	37	12.7	15.9	11.9	15	12.5
https://www.sciencedirect.com/topics/nursing-and-health-professions/leukemia	32.5	13.6	16.4	12.6	15.8	13.7
https://www.stanfordchildrens.org/en/topic/default?id=leukemia-90-P02324	65.6	7	9.4	7.1	12.3	6.9
https://stanfordhealthcare.org/medical-conditions/cancer/leukemia/types.html	46.9	10.7	12.8	9.9	14.3	10.7
https://bestpractice.bmj.com/topics/en-us/272	23.2	14.7	16.7	12.7	16.9	14
https://leukemiarf.org/	49.5	10.7	13.4	10.2	13.7	11
https://www.cancerresearchuk.org/about-cancer/leukaemia	61.9	7.6	10.6	7.9	13.4	7.9
https://medschool.cuanschutz.edu/colorado-cancer-center/for-patients-families/cancers-we-treat/leukemia	50.5	10.6	11.4	9.7	13.2	10.6
https://www.verywellhealth.com/leukemia-7255544	40.6	12.6	14.7	11.6	14.7	13.1
https://www.drugs.com/health-guide/leukemia.html	51.2	9.5	11.9	9.2	14	9.3
https://www.chp.edu/our-services/cancer/conditions/leukemia/types	39.8	11.8	13.6	11.1	15.6	11.9
https://www.dkms.org/learn-more/blood-cancer/leukemia	40.4	11.9	14.7	10.9	15.7	12.4
https://www.mercy.com/health-care-services/cancer-care-oncology/specialties/blood-cancer-hematology/conditions/leukemia	44	12.5	14.2	10.9	13.9	13.3
https://www.cancer.net/cancer-types/leukemia-acute-lymphocytic-all/introduction	63.8	7.9	9.5	7.7	11.8	7.7

https://www.aafp.org/pubs/afp/issues/2023/0400/patient-information-leukemia.html	52	9.4	11.2	8.7	13.4	8.8
https://www.ohsu.edu/knight-cancer-institute/understanding-leukemia	46.8	10.1	12.9	9.7	14.8	9.8
https://www.ucsfbenioffchildrens.org/conditions/leukemia	49.5	10.7	13.2	10	13.8	11
https://www.healthhub.sg/a-z/diseases-and-conditions/382/leukemia_ncis	51.2	10.6	13	10	13.5	11
https://winshipcancer.emory.edu/patient-care/cancer-types/leukemia.html	32.3	13.1	15.3	11.6	16.1	12.9
https://www.wakehealth.edu/condition/l/leukemia	47.5	11	11.9	9.8	14.5	11.6
https://www.fredhutch.org/en/research/diseases/cancers/leukemia.html	34.2	13	14.8	11.6	16.5	13.5
https://www.leukaemiacare.org.uk/support-and-information/information-about-blood-cancer/blood-cancer-information/leukaemia/	60.5	9.5	12.2	9.3	12.6	10.7
https://en.wikipedia.org/wiki/Leukemia	35.8	12.9	15.4	11.6	14.3	12