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Original Research Article

Study on the Prevalence of Acute and Chronic Leukemia at a Tertiary Care Teaching Hospital

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Abstract:

Introduction: Acute and chronic leukemia have different progression rates and cell types. It starts with genetics and radiation. Incidence is greater in certain locations and among men. Disease knowledge in specialized healthcare improves resource allocation and patient care. Blood tests, marrow aspirations, and genetic studies are needed to diagnose leukemia. Molecular abnormality-specific therapy is promising yet difficult. In a complex healthcare system, leukemia research improves therapy, diagnosis, and patient outcomes.

Aim and Objectives: To evaluate the prevalence of acute and chronic leukemia in a tertiary teaching hospital.

Method: The retrospective research, conducted at pathology department in the medical college and hospital, during the period of one year, involved 120 recently diagnosed leukemia patients. Exclusion criteria excluded those undergoing cancer therapy or with other hematological cancers. Detailed medical history, hemodynamic parameters, and diagnostic procedures were meticulously documented. Inclusion criteria covered all age groups recently diagnosed with acute or chronic leukemia using FAB classification.

Result: The study showed that the gender distribution among leukemia subtypes, highlighting notable disparities. Acute Lymphoblastic Leukemia (ALL) demonstrates a higher prevalence among males (75.00%), while Acute Myeloid Leukemia (AML) has a more balanced gender distribution (60% males, 40% females). Similarly, Chronic Lymphocytic Leukemia (CLL) and Chronic Myeloid Leukemia (CML) both exhibit a 60% male and 40% female distribution. Overall, males account for 66.66% of leukemia cases across subtypes, emphasizing gender-based variations in leukemia prevalence. The study also found that within ALL, the L1 subtype dominates (50%), followed by L2 and L3 (25% each). In AML, the M0 subtype is the most prevalent (40%), with M1 and M2 contributing 15% and 10%, respectively. The diverse distribution of subtypes underscores the complexity of leukemia. Notably, the M0 subtype stands out among AML cases. This detailed subtype analysis provides crucial insights for tailored treatment approaches. The study has shown that the age group 41 to 50 stands out with 13 cases, reflecting a balanced representation of leukemia types. This comprehensive age-wise breakdown informs understanding of leukemia prevalence across different life stages.

Conclusion: The study has concluded that the prevalence of Acute Lymphoblastic Leukemia (ALL) being the most prominent (44.45%) and a higher prevalence among males across different leukemia subtypes.

Keywords: Leukemia, Blood Cancer, Malignancy, Blood Analysis, Blood Disorder.

Introduction

Leukemia, a formidable blood cell malignancy originating within the bone marrow, instigates an aberrant surge in immature white blood cells, impeding their vital functions. Its presentation spans acute or chronic trajectories, reflective of distinct progression rates, alongside lymphocytic or myelogenous classifications, dictating the implicated white blood cell variant. This multifaceted disease manifests primarily as acute lymphoblastic, acute myelogenous, chronic lymphocytic, or chronic myelogenous leukemia, each imposing ambiguous symptoms: fever, fatigue, weight loss, bone discomfort, and propensity for bruising or bleeding. Underlying genetic predispositions and exposure to ionizing radiation serve as noteworthy risk factors in its onset [1,2].

Acute and chronic leukemia, two distinct types of blood cell cancers, delineate their essence through disparate progression rates, cell maturity, and treatment paradigms. Acute leukemia escalates swiftly, prompting rapid multiplication of immature cells that besiege the bone marrow, disrupting its healthy function. Conversely, chronic leukemiaadvances gradually, amassing abnormal

cells over an extended duration without the urgency seen in acute forms. Acute leukemia features predominantly undeveloped, dysfunctional cells known as blasts, while chronic variants entail relatively more mature yet aberrant cells. The symptomatology contrasts starkly; acute leukemia often manifests with pronounced indicators like fatigue, infections, bleeding, and weight loss, whereas chronic forms may initially exhibit milder or no symptoms, often detected serendipitously in routine tests. Therapeutic strategies also diverge: acute leukemia necessitates immediate, aggressive interventions like chemotherapy, radiation, and stem cell transplants, whereas the management of chronic leukemia might entail vigilant monitoring, targeted therapies, or chemotherapy tailored to the subtype and progression stage [2,3].

Leukemia, constituting a fraction of new cancer cases globally, comprises about 2.5% of total cancer incidence and contributes to approximately 3.1% of cancer-related deaths. Over time, while the number of newly diagnosed cases increased between 1990 and 2017, the age-standardized incidence rate (ASIR) showed a slight decline of 0.43% annually. Incidence varies significantly among regions, with higher rates observed in Australia, New Zealand, Northern America, and Western Europe, while notably lower rates are reported in Western Africa. Interestingly, male populations tend to experience higher incidence rates compared to females, with an overall male to female ratio of 1.4. Specific types of leukemia, like acute lymphoblastic leukemia (ALL) and chronic lymphocytic leukemia (CLL), have seen fluctuations in case numbers and ASIR over time, with distinct increases noted in CLL cases from 1990 to 2017. Moreover, distinct racial disparities are evident, with East Asians, Asian Indians, and Amerindians exhibiting significantly lower age-adjusted incidence rates (AAIR) of CLL compared to individuals of predominantly European descent. Additionally, variations in incidence rates are observed between white and black populations, with slightly higher rates recorded in men than in women [4-8].

Understanding the prevalence of diseases within a specific healthcare setting, like a tertiary care teaching hospital, is a vital compass for healthcare provision. It serves as a navigational tool, guiding resource allocation, staffing, and patient care planning. This comprehension aids in recognizing healthcare demands, channeling efforts to improve diagnostics, treatments, and professional training where needed. Furthermore, it fuels research initiatives and quality enhancements, forming the basis for epidemiological studies and interventions that elevate care standards and patient outcomes. Ultimately, this grasp of disease prevalence in such a specialized setting steers the course towards optimized healthcare delivery and overall improvement in patient well-being [9,10].

Diagnosing leukemia presents a complex puzzle due to its diverse subtypes and the imperative need for precision and timeliness. This form of blood cancer encompasses distinct variations like acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), and chronic myeloid leukemia (CML), each bearing its own distinct traits and necessitating tailored diagnostic pathways. A precise diagnosis stands as the cornerstone for effective treatment strategies. Various diagnostic avenues, including blood tests, bone marrow aspiration, and genetic assessments, form the compass in unraveling the leukemia subtype, determining its stage, and pinpointing specific genetic irregularities that hold significance in steering treatment approaches [11,12].

Treating acute and chronic leukemia presents a multifaceted challenge stemming from various fronts. Diverse genetic and molecular aberrations, individualized to each patient, dictate Leukemia's course. These anomalies significantly influence treatment responses and prognostic outcomes. Tailored therapies that pinpoint and address these molecular irregularities offer a promising avenue for improving patient results. The inherent immunosuppression associated with leukemia and its treatments elevate the risk of infections, impacting patient well-being and mortality. Collaborative efforts with infectious disease specialists play a pivotal role in effectively managing infections, thereby enhancing patient outcomes. Advances in diagnostic technologies have refined our understanding of leukemia, with molecular insights paving the way for updated classification systems and risk assessments. However, incorporating precise molecular information into treatment decisions remains a subject of debate. Leukemia operates within intricate cytokine networks that influence disease initiation and progression. While targeting these networks holds therapeutic promise, comprehending their exact roles in leukemia's pathogenesis remains a challenge, adding layers of complexity to treatment approaches [13-16].

Research on leukemia is indispensable due to its multifaceted impact on healthcare. It drives advancements in understanding the disease's molecular intricacies, facilitating the development of targeted treatments and precision medicine approaches. Additionally, ongoing research continually refines diagnostic methods, aiding in early detection and prognostication, thus enhancing patient outcomes. Beyond treatment, this research illuminates the complex disease mechanisms, opening doors to innovative therapeutic avenues. Moreover, it plays a pivotal role in shaping clinical

practices, fostering collaborations, and improving patient care standards through evidence-based approaches and advancements in leukemia management.

Method

Research Design: This retrospective research was conducted from during the period of one year. There, 90 patients were included from 120 patients with either acute or chronic leukemia. Patients undergoing cancer therapy were not considered for inclusion in this research; it only covered instances that were recently diagnosed. We also ruled out other primary hematological cancers, such as lymphomas, diseases affecting plasma cells, and bone marrow metastases. A thorough evaluation was conducted after collecting patients medical history. Every hemodynamic parameter was meticulously recorded. For a definitive diagnosis, blood counts were taken using an automated hematologyanalyzer. Peripheral blood smear examinations and bone marrow aspirations double-checked these readings. Bone marrow and peripheral blood smears were stained with Giemsa and Leishman's stain, respectively. Both peripheral blood smears and marrow aspirates were stained with specific chemicals. Interpretation of peripheral blood and bone marrow aspiration results was based on the patient's history and physical examination. Subtyping was performed using the FAB classification of acute leukemia.

Inclusion and Exclusion Criteria

Inclusion

- Recently diagnosed acute or chronic leukemia patients were included.
- All the age groups were considered who underwent cancer treatment at our hospital.
- Blood counts, peripheral blood smears, and bone marrow aspirations were performed on patients.
- FAB-classified acute leukemia cases were included.

Exclusion

- To concentrate on newly diagnosed cases, those receiving cancer treatment were eliminated.
- Besides acute or chronic leukaemia, lymphomas, plasma cell disorders, and bone marrow metastases were eliminated.
- Incomplete medical histories or hemodynamic parameter records were eliminated.

Statistical Analysis: The study has used SPSS 27 software for effective analysis. The study used the statistical analysis used descriptive statistics. The incidence of both acute and chronic leukemia was ascertained by frequency analysis. Blood counts and cytological tests were evaluated for their reliability using diagnostic accuracy measures, such as sensitivity and specificity. For subtyping purposes, the FAB classification was used. Clinical parameters and leukemia subtype associations were investigated by correlation analysis. The authors used MS Excel for creating graphs and other calculations. the continuous data were expressed as mean±standard deviation while the discrete data were expressed as frequency and its respective percentage. The study used ANOVA as the statistical tool for comparing the variables. The level of significance was considered to be $p<0.05$.

Result

Figure 1 outlines the distribution of leukemia cases based on the distinction between acute and chronic leukemia types. Acute leukemia is predominant, comprising 66.67% of the total observed cases, with a total of 60 cases. This category includes Acute Lymphoblastic Leukemia (ALL) and Acute Myeloid Leukemia (AML). On the other hand, chronic leukemia accounts for 33.34% of the cases, totaling 30 instances. This category encompasses Chronic Lymphocytic Leukemia (CLL) and Chronic Myeloid Leukemia (CML). The data underscores the higher prevalence of acute leukemia compared to chronic leukemia in the studied population. This distinction between acute and chronic forms is essential as it carries implications for treatment approaches and prognosis. The figure provides a concise overview of the broader categorization of leukemia types, facilitating a quick understanding of the distribution and proportionality of acute and chronic cases within the observed dataset. Such insights are valuable for healthcare planning and research efforts focused on differentiating and addressing the distinct challenges posed by acute and chronic forms of leukemia.

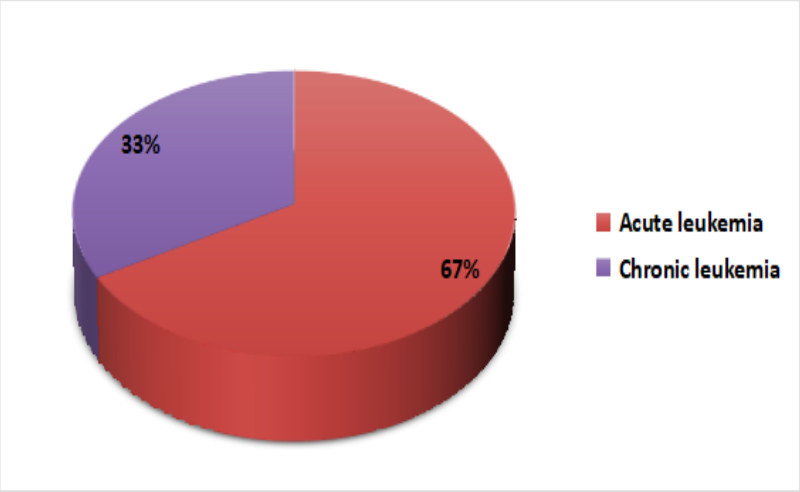


Figure 1: Distribution of acute and chronic cases

Table 1 provides a comprehensive overview of the prevalence of different types of acute and chronic leukemias based on the total number of cases and the corresponding percentages. Among the observed cases, Acute Lymphoblastic Leukemia (ALL) constitutes the largest proportion, with 40 cases, representing 44.45% of the total. Acute Myeloid Leukemia (AML) and Chronic Lymphocytic Leukemia (CLL) share an equal percentage, each accounting for 22.23% of the cases, with 20 cases each. Chronic Myeloid Leukemia (CML) represents a smaller but significant portion, with 10 cases, contributing 11.12% to the total. In summary, the table illustrates the distribution of different types of leukemias within the observed cases, highlighting the prominence of Acute Lymphoblastic Leukemia (ALL) in the studied population. The balanced representation of Acute Myeloid Leukemia (AML) and Chronic Lymphocytic Leukemia (CLL) emphasizes the diversity of leukemia types present. This information is valuable for understanding the overall landscape of leukemia prevalence and can inform healthcare strategies and research efforts in addressing these distinct types of blood cancers.

Table 1: Prevalence of different types of acute/ chronic leukemias

Type of leukemia	Total no. of cases	Percentage
ALL	40	44.45%
AML	20	22.23%
CLL	20	22.23%
CML	10	11.12%
Total	90	100.00%

Table 2 presents the gender distribution within different subtypes of leukemia, providing insights into the prevalence of these conditions among males and females. For Acute Lymphoblastic Leukemia (ALL), the table indicates a higher incidence among males, with 30 cases (75.00%), while females account for 10 cases (25.00%). In the case of Acute Myeloid Leukemia (AML), 60% of the cases are observed in males (12 cases), and 40% in females (8 cases). Similarly, Chronic Lymphocytic Leukemia (CLL) and Chronic Myeloid Leukemia (CML) both exhibit a gender distribution of 60% in males and 40% in females, with 12 cases for each type.Considering the overall gender distribution acrossTable 2 presents the gender distribution within different subtypes of leukemia, providing insights into the prevalence of these conditions among males and females. For Acute Lymphoblastic Leukemia (ALL), the table indicates a higher incidence among males, with 30 cases (75.00%), while females account for 10 cases (25.00%). In the case of Acute Myeloid Leukemia (AML), 60% of the cases are observed in males (12 cases), and 40% in females (8 cases). Similarly, Chronic Lymphocytic Leukemia (CLL) and Chronic Myeloid Leukemia (CML) both exhibit a gender distribution of 60% in males and 40% in females, with 12 cases for each type.Considering the overall gender distribution across all leukemia types, the table shows a total of 60 cases (66.66%) in males and 30 cases (33.33%) in females out of the 90 cases observed. This data suggests a higher prevalence of leukemia among males across the different subtypes.In summary, the table underscores gender-based variations in the occurrence of different leukemia subtypes, with males consistently showing a higher prevalence in the cases examined. This information is crucial for understanding the gender-specific impact of leukemia and may have implications for healthcare interventions and research in the field

Table 2: Gender distribution in various leukemia sub-types

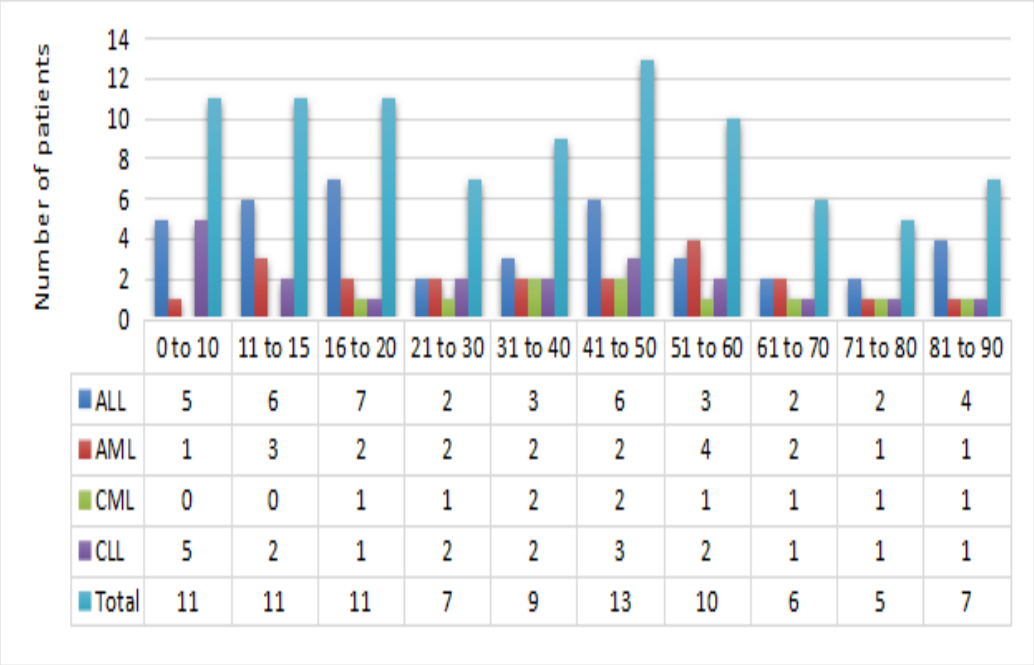
Type of leukemia	Male	Female	Total
ALL	30 (75.00%)	10 (25.00%)	40
AML	12 (60%)	8 (40%)	20
CLL	12 (60%)	8 (40%)	20
CML	6 (60%)	4 (40%)	10
Total	60 (66.66%)	30 (33.33%)	90 (100%)

Table 3 presents the prevalence of subtypes within Acute Lymphoblastic Leukemia (ALL) and Acute Myeloid Leukemia (AML), delineating the distribution of cases across various subcategories. In the context of ALL subtypes, a total of 40 cases were observed, with the majority belonging to the L1 subtype, constituting 50% of the cases. The L2 and L3 subtypes each accounted for 25% of the total ALL cases. This distribution underscores the diversity of ALL subtypes, with a significant representation of the L1 subtype. Shifting the focus to AML subtypes, the table indicates a total of 20 cases. Among these, the M0 subtype was the most prevalent, comprising 40% of the cases. The M1 and M2 subtypes contributed 15% and 10%, respectively, to the overall AML cases. This distribution suggests variability in the prevalence of AML subtypes, with the M0 subtype standing out as the most common among the observed cases. In summary, the table provides valuable insights into the prevalence of specific subtypes within the broader categories of ALL and AML, offering a detailed perspective on the distribution of cases across distinct subcategories for these two types of leukemia

Table 3: Prevalence of subtypes of ALL and AML

Subtypes	Total no. of cases	Percentage
ALL subtypes		
L1	20	50.00%
L2	10	25.00%
L3	10	25.00%
Total	40	100%
AML subtypes		
M0	8	40%
M1	3	15%
M2	2	10%
M3	2	10%
M4	2	10%
M5	1	5%
M6	1	5%
M7	1	5%
Total	20	100%

The distribution of leukemia cases across different age groups is comprehensively shown in Figure 2. The data on the distribution of leukemia cases across various age groups provides a comprehensive insight into the prevalence of different types of leukemia in distinct demographic segments. In the age group of 0 to 10, a total of 11 cases were reported, with Acute Lymphoblastic Leukemia (ALL) and Chronic Lymphocytic Leukemia (CLL) each accounting for 5 cases. In the subsequent age group of 11 to 15, there were 11 cases as well, with a higher representation of Acute Lymphoblastic Leukemia (ALL) at 6 cases and Acute Myeloid Leukemia (AML) at 3 cases. Moving to the 16 to 20 age group, the total number of cases remains at 11. Acute Lymphoblastic Leukemia (ALL) takes prominence with 7 cases, while Acute Myeloid Leukemia (AML), Chronic Myeloid Leukemia (CML), and Chronic Lymphocytic Leukemia (CLL) contribute 2, 1, and 1 case, respectively. The following age groups, up to 90 years, exhibit varying patterns in the distribution of leukemia types. Notably, the age group of 41 to 50 stands out with the highest total of 13 cases, featuring a balanced representation of different leukemia types. Acute Lymphoblastic Leukemia (ALL) peaks in the 16 to 20 age group, while Acute Myeloid Leukemia (AML) shows notable occurrences in the 11 to 15 and 51 to 60 age groups. Chronic Myeloid Leukemia (CML) reaches its highest count in the 16 to 20 age group, and Chronic Lymphocytic Leukemia (CLL) maintains a relatively consistent distribution across age groups.



	0 to 10	11 to 15	16 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90
ALL	5	6	7	2	3	6	3	2	2	4
AML	1	3	2	2	2	2	4	2	1	1
CML	0	0	1	1	2	2	1	1	1	1
CLL	5	2	1	2	2	3	2	1	1	1
Total	11	11	11	7	9	13	10	6	5	7

Figure 2: Distribution of cases of leukemia in various age groups

Discussion

In the realm of global cancer burden, developing countries shoulder over half the load, and within this context, leukemia stands at 3% of all malignancies, clocking in at 300,500 yearly incidences. A study by Ghartimagar et al. (2012) delves into the landscape of hematological and non-hematological malignancies within Nepal's Western region, tracing a retrospective journey from January 2000 to June 2011. This comprehensive analysis encompasses bone marrow malignancies, embracing leukemias, multiple myeloma, and marrow infiltration/metastasis, totaling 155 reported cases. Spanning a wide age range of 1 to 82 years, the findings spotlight acute myeloid leukemia (AML) as the dominant player, accounting for 80 cases, trailed by chronic myeloid leukemia (CML) with 20 cases, acute lymphoid leukemia (ALL) exhibiting 16 cases, and chronic lymphoid leukemia (CLL) manifesting in 7 cases. Among childhood leukemia below 15 years, AML took precedence, with subsequent subtypes of AML and ALL identified as M2 and L2, respectively. Notably, the incidence of CML in this region presented a relatively lower frequency, where females were more prominently affected. Furthermore, 23 cases of multiple myeloma and 9 cases of marrow infiltration/metastasis were recorded, with males emerging as the more affected gender in the realm of multiple myeloma [17].

From January 1997 to December 2002, a retrospective study by Kulshrestha et al. (2009) was conducted in Nepal investigating 196 cases of leukemia. The leukemia patterns were analyzed based on morphological subtypes, gender distribution, age at diagnosis, seasonal occurrence, and geographic prevalence. It was found that chronic myeloid leukemia constituted the largest group, accounting for 35.2% of all cases, followed by acute myeloid leukemia at 28.57%, and acute lymphoid leukemia at 19.9%. The highest number of cases was observed in the lowlands, while the mountain districts showed the least number of cases. The study, marking the second investigation into leukemia in Nepal, revealed a leukemia spectrum unique to the eastern region, with similarities in AML, CML, and ALL patterns resembling those in developed western countries. In contrast, the lesser frequency of CLL echoed trends observed in Southeast Asian regions [18].

During a 5-year period from 1999 to 2003, a hospital-based epidemiological study on leukemia was conducted in the northern part of Tunisia by Haouas et al. (2011). Among 402 Tunisians diagnosed with leukemia, 344 cases (85.6%) were identified as acute leukemia, while chronic leukemia accounted for 58 cases (14.4%). Incidence rates specific to age were documented for acute lymphoid leukemia (ALL), acute myeloid leukemia (AML), chronic lymphoid leukemia (CLL), and chronic myeloid leukemia (CML). The distribution of leukemia in the governorate of Nabeul was established. These findings are deemed valuable for the organization and monitoring of medical care in the region [19].

Upon completion of intensive induction or re-induction chemotherapy for acute myeloid leukemia (AML), patients typically encounter prolonged cytopenias, necessitating an extended hospital stay for approximately 30 days due to infection and bleeding risks, alongside significant transfusion and supportive care requirements. Rising AML care costs have led to reconsideration of this practice.

Some small-scale studies have proposed outpatient supportive care post-intense AML therapy, indicating potential benefits like reduced healthcare expenses, enhanced quality of life, and lowered susceptibility to hospital-acquired infections. Though outpatient management seems safe for selected AML patients, adequate planning is crucial to provide requisite support, education, and prompt management of severe complications among this vulnerable patient cohort. However, comprehensive leukemia care mandates specialized attention, often involving frequent hospitalizations for treatments such as chemotherapy, radiation, or stem celltransplants. This places significant strain on hospital resources, impacting bed availability, specialized oncology staff, and medical supplies, exacerbated by the need for isolation rooms for low white blood cell count patients [20].

Clinical relevance lies in understanding the prevalence of acute and chronic leukemia for effective diagnosis and management. In one study, delayed presentation to a doctor correlated with a higher risk of waiting more than three months from symptom onset to initial presentation in patients with acute leukemia, underscoring the importance of early diagnosis and swift treatment to enhance outcomes. Moreover, in chronic myeloid leukemia (CML), distinct BCR-ABL1 fusion gene transcripts varied among patients, potentially influencing treatment response and outcomes. This variation aids in treatment decisions and predicts treatment-free remission rates. Additionally, the course of neutrophil count during infection significantly impacted perianal lesion outcomes, treatment choices, and prognosis in leukemia patients with perianal infection. Bone marrow examination emerged as a pivotal diagnostic tool, primarily used to confirm and manage acute leukemia in the study. Furthermore, bleeding episodes, a common complication in Philadelphia-negative myeloproliferative neoplasms (Ph-negative MPN), including select chronic leukemia types, necessitate a comprehensive understanding of optimal patient care in MPN, encompassing causes, prevention, and management strategies [21-23].

Studies indicate that multiple factors, including age, race, genetic characteristics, and specific medication use, can significantly influence treatment approaches and outcomes in leukemia. For instance, diverse induction regimens exhibit varying impacts on survival outcomes among acute myeloid leukemia (AML) patients. Age has emerged as a prognostic element in pediatric acute lymphoblastic leukemia (ALL), showcasing differing survival rates within distinct age brackets. Furthermore, factors like socioeconomic status and healthcare access potentially affect treatment outcomes [24-26].

Based on the prevalence findings in acute and chronic leukemia, potential avenues for further investigation emerge. Future inquiries should focus on delineating the nuanced characteristics, prognosis, and treatment responses within distinct subtypes of acute and chronic leukemia. This could involve an in-depth exploration of rare subtypes or subdivisions within these broader disease classifications. Research endeavors could seek to unearth and validate additional molecular signposts linked to acute and chronic leukemia. This includes delving into genetic, epigenetic, and protein biomarkers that assist in predicting risk, diagnosing the condition, understanding prognostic implications, and monitoring disease progress. There's potential for further exploration into the effectiveness of pioneering treatment modalities tailored for acute and chronic leukemia. Investigating targeted therapies, immunotherapies, or amalgamated treatment strategies designed to specifically address the molecular aberrations and pathways contributing to leukemia genesis could be promising. Ongoing research could focus on refining methodologies to detect and track minimal residual disease in leukemia patients. Advanced technologies like high-throughput sequencing and ultra-sensitive techniques offer opportunities to assess treatment response, anticipate relapse, and guide treatment protocols. Investigating the role of epigenetic alterations in shaping the onset and progression of leukemia presents a promising avenue. Exploring the epigenetic profiles of diverse leukemia subtypes could shed light on their impact on disease trajectory, responsiveness to treatments, and eventual patient outcomes [27-33].

Conclusion

The study has concluded that the prevalence of Acute Lymphoblastic Leukemia (ALL) being the most prominent (44.45%) and a higher prevalence among males across different leukemia subtypes. This study has brought forward the valuable insights for healthcare strategies and leukemiaresearch. When it comes to the timely diagnosis of hematological malignancies, it is helpful to identify symptoms and manifestations that are especially diagnostic of leukemia in a timely manner. For the purpose of rapidly and properly detecting hematological malignancies (leukemia) and successfully treating them, it is necessary to conduct a comprehensive hematological examination. This examination should involve the analysis of samples of bone marrow aspiration smears and peripheral blood, as well as cytogenetic analysis. Developing leukemia diagnosis methods is a research gap. Both bone marrow aspiration and cytogenetic analysis have sensitivity and specificity issues. To improve early detection, molecular approaches and bi-omarkers should be developed in the future. Non-in-vasive diagnostic methods and artificial intelligence for data interpretation might increase hematological

test efficiency and accuracy, speeding leukemia diagnosis and therapy.

The study effectively explored acute and chronic leukemia, identifying gender-based and subtype disparities. However, avenues for further investigation include in-depth analyses of genetic, environmental, and socio-economic factors influencing leukemia incidence. The study's focus on prevalence and distribution calls for a deeper exploration of molecular and genetic characteristics for personalized therapeutic interventions. Future research should assess long-term outcomes, survival rates, and the impact of emerging therapies in real-world settings. A broader geographic scope in prospective studies could uncover regional variations, while a multicenter approach would enhance findings' generalizability, collectively contributing to a more comprehensive understanding of leukemia and informing advanced treatment strategies.

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