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Outcome of Childhood Langerhans Cell Histiocytosis: Experience from a Lower- Middle Income Country

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ABSTRACT

Background: Langerhans cell histiocytosis (LCH) is an uncommon myeloid neoplasm, presenting with a wide spectrum of clinical manifestations. Prognosis varies widely based on disease extent and risk-organ (RO) involvement. This study aimed to assess treatment outcomes and prognostic indicators in pediatric LCH.

Methods: A retrospective study was conducted at the Pediatric Hematology/Oncology Department, Combined Military Hospital (CMH) Rawalpindi. Twenty-nine children aged 0–18 years, diagnosed and treated from June 2013 to June 2023, were enrolled through non-probability consecutive sampling. Data were extracted retrospectively from medical records of patients and analyzed using SPSS version 25.0. Kaplan-Meier survival curves were generated for event-free survival (EFS) and overall survival (OS), and compared using the log-rank test. Prognostic factors were evaluated through the Cox regression analysis. A p-value of <0.05 was considered statistically significant.

Results: Among the 29 patients, 22 (75.86%) had multi-system disease, with 12 (54.54%) showing RO-positivity. The median age at diagnosis was 18 months. Relapse occurred in 6 (20.68%) patients; all were successfully re-treated. Eleven (37.93%) patients expired, all with multi-system disease, and 9 (81.81%) had RO involvement. With a median follow-up of 80 months, the rates of 5-year EFS and OS stood at 32% and 60%, respectively. Patients with RO involvement had significantly lower EFS and OS rates (p=0.001 and p=0.00, respectively).

Conclusion: Multi-system and RO-positive cases have poor short-term outcomes, but long-term prognosis improves with survival beyond the initial 2-3 years. RO involvement remains the most powerful predictor of mortality and morbidity in LCH.

Keywords: Langerhans cell histiocytosis, Lower-middle income country, Pakistan, Pediatric oncology, Resource-limited setting, Risk organ, Survival.

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INTRODUCTION

Langerhans cell histiocytosis (LCH) is a rare neoplasm of myeloid origin, marked by the abnormal build-up of Langerhans-type dendritic cells, eosinophils, and histiocytes that destroy affected tissues[1,2]. The estimated incidence is around 5 to 10 cases per million children annually, and 1 to 2 per million adults, with a slight male predominance[3]. LCH can affect a single organ (single-system LCH, SS-LCH) or multiple organs (multi-system LCH, MS-LCH)[4]. Bone involvement is most frequent, seen in approximately 80% of cases[4]. Some organs, when affected—namely the liver, spleen, and hematopoietic system—are considered "risk-organs" due to their association with increased disease-related mortality[5]. Similarly, certain craniofacial bone lesions, excluding the skull vault, are classified as central nervous system (CNS)-risk lesions due to their potential for neurodegenerative complications[5].

LCH exhibits a range of manifestations ranging from solitary, self-limiting lesions to disseminated, life-threatening disease[6]. Some patients experience spontaneous regression of lesions, while others have a chronic disease that requires prolonged therapy[7]. Although localized forms may resolve without therapy, risk-organ involvement correlates with poor prognosis[8]. Radiologically, LCH is typically characterized by punched-out lytic bone lesions. Diagnosis is confirmed by biopsy. The disease is characterized by MAPK pathway genetic alteration leading to pathway activation[9]. *BRAFV600E* mutation is the most commonly seen alteration, occurring in approximately 50% of cases, followed by *MAP2KA* alteration[9].

Despite growing understanding of its biology, LCH remains a clinical challenge due to its diverse presentation and unpredictable course. Treatment strategies have evolved empirically, and current recommendations are still largely based on older clinical experience[10]. Given the rarity of the disease, this study was conducted to evaluate the outcomes of current treatment protocols and to identify prognostic factors associated with LCH.

METHODS

This retrospective observational study was conducted at the Pediatric Hematology/Oncology Department, Combined Military Hospital (CMH) Rawalpindi, after obtaining ethical approval from the Institutional Review Board (letter#729/dated 20-11-2024). Children aged 0 to 18 years with histologically confirmed LCH, diagnosed and treated between June 2013 and June 2023, were enrolled. Exclusion criteria included patients over 18 years of age, those with uncertain diagnoses, those who presented with reactivation/relapse after initial treatment prior to the study period, and those who abandoned treatment within the first month.

A total of **29** patients fulfilled the inclusion criteria, and were enrolled using non-probability consecutive sampling. Based on diagnosis era, patients were treated according to either the LCH-III or LCH-IV protocol. Supportive care was provided as per institutional guidelines.

Data on demographics, clinical presentation, duration of illness, nutritional status, disease extent, RO and CNS risk lesion status, laboratory and imaging findings, pathology, therapeutic details, disease progression and reactivation/relapse details, and final outcomes were collected retrospectively from medical records of patients. No standardized data abstraction tools were used; clinical documentation served as the data source.

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive statistics were used to present demographic and clinical data. Frequencies and percentages were reported for categorical variables, while medians with interquartile ranges (IQR) were used for continuous ones. The primary endpoints were the incidence of permanent consequences (PC), relapse rate, mortality rate, event-free survival (EFS), and overall survival (OS). Survival curves were compared using the log-rank test across pre-defined subgroups, including age (<1, 1–5, >5 years), sex (male vs female), illness duration (<3, 3-6, >6 months), nutritional status (not malnourished vs. malnourished), skeletal involvement (negative vs. positive), disease extent (SS vs. MS), risk-organ involvement (negative vs. positive), and number of chemotherapy strata administered (single stratum vs. multiple strata).

Multivariate analysis using Cox proportional hazards regression analysis was conducted to identify significant predictors for EFS and OS. Hazard ratios (HRs) with 95% confidence intervals (CI) were reported, and a p-value of <0.05 was considered statistically significant.

EFS was defined as the time from initiation of therapy to the first adverse event—progression, reactivation/relapse, secondary malignancy, or death. OS referred to the time from diagnosis to death from any cause. Follow-up was completed on November 30, 2024. Patients without events were censored on that date.

RESULTS

Table 1. Mortality Analysis

Parameter	n (%)
Sex	
Female	6 (54.54)

Male	5 (45.46)
Age Group	
≤12 months	5 (45.46)
13–36 months	4 (36.36)
>36 months	2 (18.18)
Risk-Organ Involvement	
Positive	9 (81.82)
Negative	2 (18.18)
Chemotherapy Strata Received	
Stratum I	7 (63.64)
Stratum II	2 (18.18)
Stratum III	2 (18.18)
Timing of Death	
Initial course	4 (36.37)
Continuation therapy	2 (18.18)
Stratum II chemotherapy	2 (18.18)
Stratum III chemotherapy	1 (9.09)
After EOT	1 (9.09)
Palliative phase	1 (9.09)
Category of Death	
Treatment-related	7 (63.63)
Disease-related	4 (36.37)
Grouped Cause of Death	

Pneumonia	3 (27.28)
Neutropenic sepsis	2 (18.18)
Refractory disease	2 (18.18)
Failure to thrive	2 (18.18)
Invasive aspergillosis	1 (9.09)
Procedure-related collapse	1 (9.09)

Abbreviation: EOT, End of Treatment.

Of the 29 patients, 18 (62.10%) were male and 11 (37.90%) female. Multi-system (MS) disease was diagnosed in 22 (75.86%) patients, while 7 (24.14%) had single-system (SS) disease. Of the patients with MS disease, 12 (54.54%) were risk-organ (RO)-positive. Patients were diagnosed at a median age of 18 months (IQR: 2-120 months). Age distribution showed that 10 (34.48%) patients were younger than 1 year, 16 (55.17%) fell within the 1 to 5-year age range, and 3 (10.35%) were older than 5 years. None were over 10 years old. The median time from symptom onset to diagnosis was 6 months (IQR: 1-60 months). The most frequent complaints at presentation were fever (n=12, 41.37%), skin lesions (n=10, 34.48%), and ear discharge (n=8, 27.58%). The most frequent findings on examination were skin lesions and lymphadenopathy, each seen in 9 (31.03%) patients, followed by swellings in craniofacial region in 5 (17.24%), and unilateral proptosis in 4 (13.79%) patients. Lytic bone lesions were present in 18 (62.07%) patients, while CNS-risk lesions were identified in 5 (17.24%). Fourteen (48.27%) patients were malnourished, with weight-for-age and sex below the 3rd centile.

Regarding treatment, 4 (13.79%) patients were managed according to the LCH-III protocol, while 25 (86.21%) received the LCH-IV protocol. Nineteen (65.51%) were managed with stratum I chemotherapy only; 5 (17.24%) escalated to stratum II; 3 (10.34%) escalated to stratum III; and 2 (6.91%) were managed with stratum VI (observation). Of the latter, one eventually required stratum I chemotherapy. No patients underwent surgery (curettage), radiotherapy, targeted therapy, or hematopoietic stem cell transplantation. Febrile neutropenia (FN) was the most frequent complication of treatment, occurring in 13 (44.82%) patients.

Six (20.68%) patients experienced disease progression during treatment, 5 (83.33%) of whom had multi-system risk-organ-positive (MS-RO+) disease; all five eventually expired. The one SS-LCH patient with progression was successfully treated.

Reactivation/relapse occurred in 6 (20.68%) patients; in 5 (83.33%) it occurred after end of treatment (EOT), and in one (16.67%) during continuation therapy. Four (66.66%) patients with relapse had SS disease. All six were successfully re-treated with chemotherapy alone.

No cases of neurodegeneration (ND-CNS-LCH) or transformation to secondary malignancy or hemophagocytic lymphohistiocytosis (HLH) were observed. Six (20.69%) patients experienced permanent consequences (PC) which included diabetes insipidus (DI) in 3 (10.34%) patients, vertebra plana in 2 (6.90%), and unilateral vision loss in 1 (3.44%).

In total, 11 (37.93%) patients expired, all of whom had MS disease; 9 (81.81%) were RO-positive **(Table I).** Approximately one-third (36.37%) of all deaths occurred during the initial treatment course. Nearly two-thirds (63.63%) of all deaths were treatment-related. Three (27.28%) patients died due to pneumonia, making it the predominant cause of death.

With a median follow-up of 80 months, event-free survival (EFS) rates at 1, 3, 5, and 10 years were 57%, 41%, 32%, and 32%, respectively **(Figure 1)**.

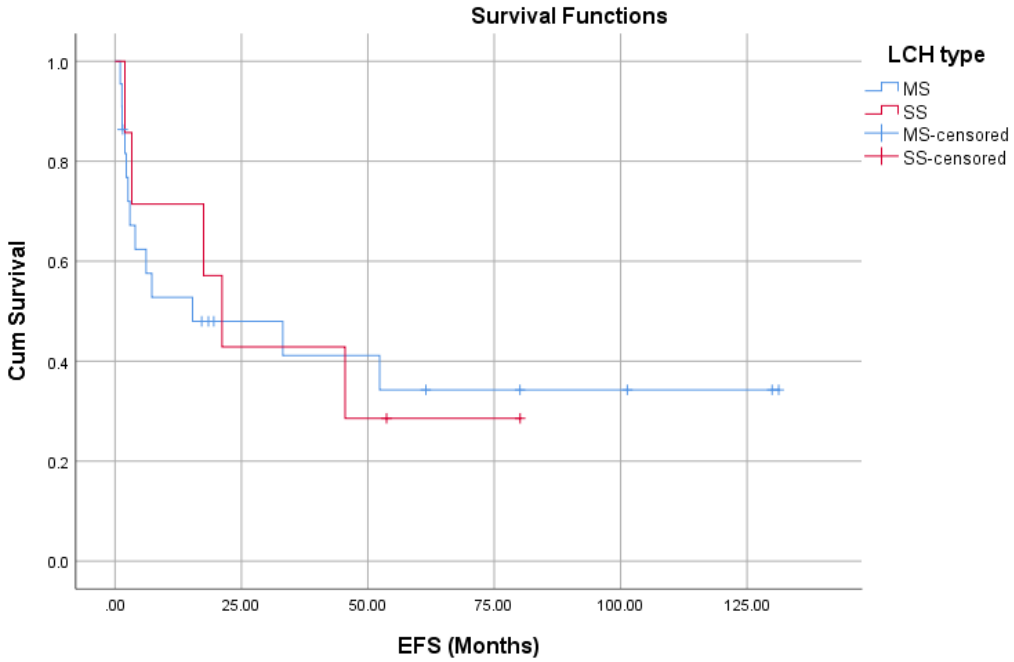

Figure 1. Event-free survival (EFS). MS, Multi-system; SS, Single-system.

Corresponding overall survival (OS) rates were 64%, 60%, 60%, and 60% **(Figure 2)**.

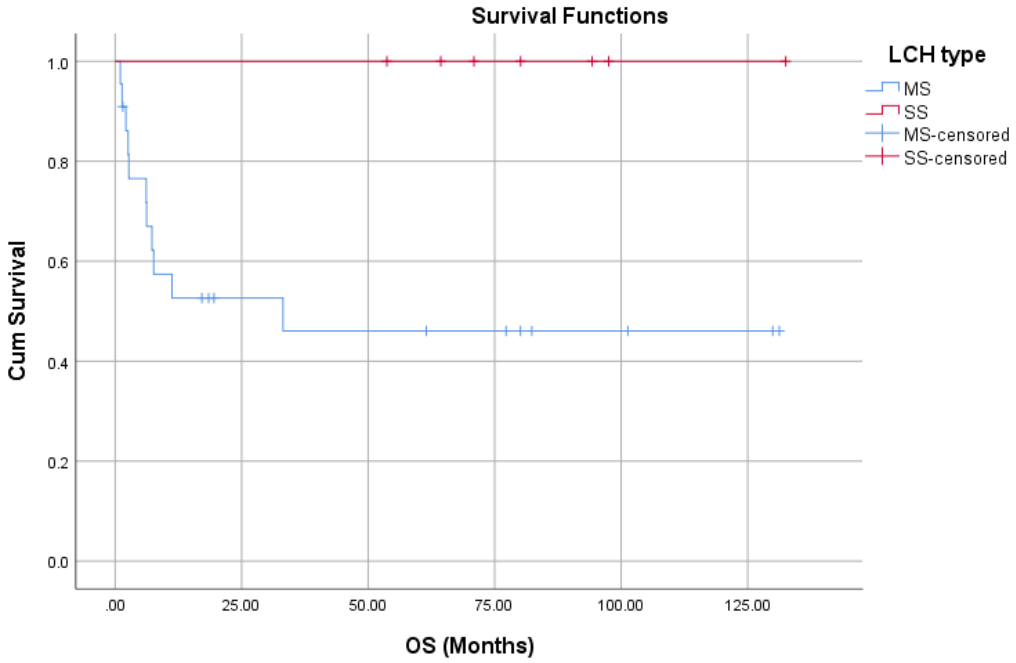

Figure 2. Overall survival (OS). MS, Multi-system; SS, Single-system.

Patients with RO involvement had significantly lower 5-year EFS and OS survival rates (p = 0.001 and p = 0.00, respectively) **(Table II)**. Likewise, female gender was associated with a significantly lower 5-year EFS rate (p = 0.005), but OS did not differ significantly between genders (p = 0.15).

Table 2. Log-rank test

Subgroups	5-Year EFS (%)	p-value	5-Year OS (%)	p-value
Age group (Years)				
<1 1-5 >5	18 40 33	0.37	42 69 67	0.42
Gender				
Male Female	48 09	0.005	69.5 46	0.15
Illness duration (Months)				

<3 3-6 >6	38 20 42	0.32	86 21.5 66.5	0.10
Malnutrition				
No Yes	39 21	0.96	66 52	0.58
Skeletal involvement				
No Yes	25 36	0.60	59 61	0.98
Disease extent				
SS-LCH MS-LCH	29 35	0.92	100 46	0.02
Risk-organ involvement				
No Yes	67 19	0.001	80 14	0.00
No. of chemotherapy strata received				
1 >1	44 12	0.13	61.5 56	0.83

Abbreviations: EFS, Event-free survival; OS, Overall survival.

Table 3. Multivariate Cox regression analysis

Predictor	Event-free survival (EFS)			Overall survival (OS)		
	p-value	HR	95% CI	*p*-value	HR	95% CI
Age	0.552	1.009	0.980-1.038	0.187	0.974	0.938-1.013
Female gender	0.155	2.590	0.697-9.619	0.396	1.892	0.435-8.235
Malnutrition	0.321	0.579	0.196-1.707	0.398	1.751	0.478-6.416

Illness duration	0.556	0.980	0.916-1.048	0.987	1.001	0.902-1.110
Skeletal involvement	0.155	7.266	0.473-111.57	0.485	1.710	0.379-7.708
Multi-system disease	0.123	0.055	0.001-2.19	0.184	38.118[@]	0.178-8173
Risk-organ involvement	0.019	51.112	1.927-1355.40	0.002	11.930[@]	2.518-56.52
>1 chemotherapy stratum	0.217	0.169	0.010-2.841	0.519	1.684	0.346-8.20

Abbreviations: CI, Confidence interval; HR, Hazard ratio.

[@]Hazard ratios for "Multi-system disease" and "Risk-organ involvement" were reported from univariate Cox regression, as near-complete separation in the multivariate model of overall survival precluded reliable estimation.

RO positivity was the sole significant predictor of EFS and OS in Cox regression analysis (p = 0.019 and p = 0.002, respectively) **(Table 3)**.

DISCUSSION

The study sheds light on outcomes and prognostic factors of pediatric LCH in a resource-limited setting. Our findings of male predominance and a low median age at diagnosis are consistent with previous literature[11,12]. However, our observation that MS-LCH was the more prevalent subtype—and that SS-LCH had a relatively higher reactivation/relapse rate—differs from most published reports. This discrepancy may be attributable to our small sample size. Nonetheless, a few other studies also reported MS-LCH as the more prevalent subtype[13,14]. The 54.54% risk-organ positivity rate in MS-LCH in our cohort is comparable to international data[15].

Our survival outcomes are significantly worse than those reported from upper-middle[16-19] and high income countries[12,15,20-22]. These differences likely stem from disparities in healthcare infrastructure,

availability of diagnostic tools, access to timely and effective therapy, and socioeconomic constraints in lower-middle income countries like Pakistan.

When compared with national data, our reactivation and mortality rates align with those from the Indus Hospital, Karachi[23]. However, compared with findings from the Children's Hospital, Lahore, our reactivation rate is lower, but mortality is higher[13]. Similarly, while our reactivation rate matches that observed in a study from the Shaukat Khanum Memorial Cancer Hospital, Lahore, our mortality rate again exceeds theirs[14].

Our survival outcomes are also worse than those reported in a similar study from India[24]. Following a steep decline in the first 2 to 3 years after diagnosis, our survival curves plateaued for the remainder of the follow-up period. This emphasizes the need for improved supportive care during this early high-risk phase.

Consistent with international literature, risk-organ positivity was found to be the most significant predictor of poor prognosis. The incidence of permanent consequences in our cohort was 20.69%. While this is lower than the 33% incidence reported in a study from Japan, the difference may be explained by their longer follow-up period of 12 years[25]. The incidence of diabetes insipidus in our cohort is comparable to existing literature[26].

With currently available therapies, the outcome of MS-LCH is poor, especially when there is risk-organ involvement. Although newly-emerged targeted therapy with BRAF/MEK inhibitors is very promising, ongoing research is needed to address safety concerns, therapy duration, and resistance mechanisms, with potential future therapies including newer generation of inhibitors and combination approaches[9].

Unfortunately, access to molecular diagnostics and targeted therapy remains limited in Pakistan due to cost and availability issues. These systemic barriers must be addressed at the national health policy level if we aim to bring our survival rates at par with those seen in high income countries.

CONCLUSION

LCH presents significant treatment challenges, particularly in multi-system and risk-organ positive disease. Our study underscores that the most critical period for patient survival appears to be the first 2 to 3 years following diagnosis, during which intensive monitoring and optimal supportive care are essential. If patients survive this high-risk phase, long-term outcomes are generally favorable. Risk-organ involvement remains the most powerful predictor of mortality and morbidity in LCH.

LIST OF ABBREVIATION

CMH Combined Military Hospital

LCH Langerhans Cell Histiocytosis

SS Single-system

MS Multi-system

RO Risk-Organ

MAPK Mitogen-activated Protein Kinase

CNS Central Nervous System

ND Neurodegeneration

DI Diabetes Insipidus

PC Permanent Consequences

SPSS Statistical Package for Social Sciences

EFS Event-free Survival

OS Overall Survival

FUNDING

None.

CONFLICT OF INTEREST

None.

ETHICAL APPROVAL

This study was conducted after approval from the Institutional Review Board (IRB) of CMH, Rawalpindi via letter#729/dated 20-11-2024.

AUTHORS' CONTRIBUTION

AA & TG: Responsible for the conceptualization, writing, design, data collection, analysis, and interpretation, as well as the drafting and revision of the manuscript, **RM & FSR:** Provided valuable guidance, contributed to manuscript drafting, and assisted in study design and methodology, while also providing critical feedback on the manuscript, **AL & SA: R**esponsible for study design, data analysis, interpretation, and feedback on the manuscript

REFERENCES

1. Bielamowicz K, Dimitrion P, Abla O, Bomken S, Campbell P, Collin M, et al. Langerhans cell histiocytosis: NACHO update on progress, chaos, and opportunity on the path to rational cures. Cancer. 2024 Jul 15;130(14):2416-2439. https://doi.org/10.1002/cncr.35301

2. Pavan VH, de Preliasco VF, Ienco M, Benchuya C. Langerhans cell histiocytosis oral lesions in pediatric patients. Acta Odontol Latinoam. 2023 Dec 31;36(3):156. https://doi.org/10.54589/aol.36/3/156

3. Gulati N, Allen CE. Langerhans cell histiocytosis: Version 2021. Hematol Oncol. 2021 Jun;39:15-23. https://doi.org/10.1002/hon.2857

4. Fu Z, Li H, Arslan ME, Ells PF, Lee H. Hepatic Langerhans cell histiocytosis: A review. World J Clin Oncol. 2021 May 24;12(5):335. https://doi.org/10.5306/wjco.v12.i5.335

5. Haupt R, Minkov M, Astigarraga I, Schäfer E, Nanduri V, Jubran R, et al. Langerhans cell histiocytosis (LCH): guidelines for diagnosis, clinical work-up, and treatment for patients till the age of 18 years. Pediatr Blood Cancer. 2013 Feb;60(2):175-184. https://doi.org/10.1002/pbc.24367

6. Yu J, Gao L, Li X, Liu T. Risk factors for the mortality of patients with Langerhans cell histiocytosis: a systematic review and meta-analysis. https://doi.org/10.22541/au.173286029.91246983/v1

7. Talasila S, Teichner EM, Subtirelu RC, Talasila NC, Mannam S, Werner T, et al. Comprehensive considerations for dermatologists: the application of FDG-PET in evaluating cutaneous lesions in pediatric Langerhans cell histiocytosis. Front Med (Lausanne). 2024 Jul 10;11:1378638. https://doi.org/10.3389/fmed.2024.1378638

8. Evseev D, Osipova D, Kalinina I, Raykina E, Ignatova A, Lyudovskikh E, et al. Vemurafenib combined with cladribine and cytarabine results in durable remission of pediatric BRAF V600E–positive LCH. Blood Adv. 2023 Sep 26;7(18):5246-5257. https://doi.org/10.1182/bloodadvances.2022009067

9. Bahabri A, Abla O. Advances in our understanding of genetic markers and targeted therapies for pediatric LCH. Expert Rev Hematol. 2024 Jun 2;17(6):223-231. https://doi.org/10.1080/17474086.2024.2353772

10. Minkov M. Langerhans cell histiocytosis: pragmatic empirism on the road to rational cure.

Expert Opin Pharmacother. 2012 Aug 1;13(12):1671-1673. https://doi.org/10.1517/14656566.2012.698612

11. Morimoto A, Oh Y, Shioda Y, Kudo K, Imamura T. Recent advances in Langerhans cell histiocytosis. Pediatr Int. 2014 Aug;56(4):451-461. https://doi.org/10.1111/ped.12380

12. Lu Y, Liu L, Wang Q, Liu B, Zhao P, Guan G, et al. Clinical features and prognostic factors of pediatric Langerhans cell histiocytosis: a single-center retrospective study. Front Med (Lausanne). 2025 Jan 15;11:1452003. https://doi.org/10.3389/fmed.2024.1452003

13. Ahmad A, Hussain M, Yaseen S, Mushtaq A, Bibi A, Dogar IH, et al. Overview of Langerhans cell histiocytosis among children. Pak J Med Health Sci. 2021 May 30;15(5):1054-1058. https://doi.org/10.53350/pjmhs211551054

14. Noor N, Wali RM, Bakar MA. CLINICAL FEATURES AND OUTCOME IN CHILDREN WITH LANGERHANS CELL HISTIOCYTOSIS. A SINGLE INSTITUTION EXPERIENCE FROM PAKISTAN. Pak Armed Forces Med J. 2021 Dec 1;71(6). https://doi.org/10.51253/pafmj.v71i6.4022

15. Tang X, Gao J, Ma ZG, Guo X, Li Q, Wan Z, et al. Clinical and prognostic characteristics of 95 cases of Langerhans cell histiocytosis in children: a single-institute experience from 2013 to 2020. Ann Med. 2021 Jan 1;53(1):1537-1546. https://doi.org/10.1080/07853890.2021.1966085

16. Nejad JS, Ahmadi AE, Tashvighi M, Mehrvar N, Mehrvar A. A Report of Pediatric Langerhans Cell Histiocytosis in a Hospital-Based Study. Int J Cancer Manag. 2024 Dec 1;17(1). https://doi.org/10.5812/ijcm-146126

17. İnce D, Kundak S, Yaman Y, Kamer S, Oymak Y, Ortaç R, et al. Pediatric langerhans cell histiocytosis: single center experience over a 17-year period. Turk J Pediatr. 2016 Aug 25;58(4):349-355. https://doi.org/10.24953/turkjped.2016.04.001

18. Monsereenusorn C, Suwannaying K, Techavichit P, Sathitsamitphong L, Komvilaisak P, Rujkijyanont P, et al. Clinical outcomes and screening for organ involvement in pediatric Langerhans cell histiocytosis in Thailand: multicenter study on behalf of the Thai Pediatric Oncology Group. Int J Hematol. 2022 Apr;115(4):563-574. https://doi.org/10.1007/s12185-022-03293-0

19. Hlatywayo L. Outcomes of children with biopsy-proven Langerhans cell histiocytosis (LCH)

treated at the Red Cross War Memorial Children's Hospital from 1998–2017. http://hdl.handle.net/11427/40977

20. Cui L, Wang CJ, Lian HY, Zhang L, Ma HH, Wang D, et al. Clinical outcomes and prognostic risk factors of Langerhans cell histiocytosis in children: results from the BCH-LCH 2014 protocol study. Am J Hematol. 2023 Apr;98(4):598-607. https://doi.org/10.1002/ajh.26829

21. Goyal G, Parikh R, Richman J, Abeykoon JP, Morlote D, Go RS, et al. Spectrum of second primary malignancies and cause-specific mortality in pediatric and adult Langerhans cell histiocytosis. Leuk Res. 2023 Mar 1;126:107032. https://doi.org/10.1016/j.leukres.2023.107032

22. Golpanian S, Tashiro J, Gerth DJ, Thaller SR. Pediatric histiocytoses in the United States: incidence and outcomes. J Surg Res. 2014 Jul 1;190(1):221-229. https://doi.org/10.1016/j.jss.2014.03.063

23. Baig N, Raza MR, Zia N, Maqsood S, Yaqoob N, Ashraf MS. Childhood Langerhans cell histiocytosis: a ten-year study from Pakistan. Pediatr Hematol Oncol J. 2022 Dec 1;7(4):177-181. https://doi.org/10.1016/j.phoj.2022.10.001

24. Narula G, Pradhan ND, Arora B, Banavali SD. Treatment of Langerhans cell histiocytosis with a modified risk-adapted protocol—experience from a tertiary cancer institute in India. Pediatric Blood & Cancer. 2018 Aug;65(8):e27028. https://doi.org/10.1002/pbc.27028

25. Sakamoto K, Morimoto A, Shioda Y, Imamura T, Imashuku S, Japan LCH Study Group (JLSG). Long-term complications in uniformly treated paediatric Langerhans histiocytosis patients disclosed by 12 years of follow-up of the JLSG-96/02 studies. Br J Haematol. 2021 Feb;192(3):615-620. https://doi.org/10.1111/bjh.17243

26. Vaiani E, Felizzia G, Lubieniecki F, Braier J, Belgorosky A. Paediatric Langerhans cell histiocytosis disease: long-term sequelae in the hypothalamic endocrine system. Horm Res Paediatr. 2021 Jun 24;94(1-2):9-17. https://doi.org/10.1159/000517040

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