REVIEW

Hematology in community medical care

Shingen Nakamura[1], Yusaku Maeda[2], Taiki Hori[3], and Masahiro Oura[2]

[1]*Department of Community Medicine and Medical Science, Tokushima University Graduate School of Biomedical Sciences, Tokushima, Japan,* [2]*Department of Hematology, Endocrinology and Metabolism, Tokushima University Graduate School of Biomedical Sciences, Tokushima, Japan,* [3]*Department of Internal Medicine, Tokushima Prefectural Kaifu Hospital, Tokushima, Japan*

Abstract : Community medical care faces challenges such as the uneven distribution of physicians, fluctuating medical demand, and the increased relative demand for physicians due to the increased specialization of medical fields. Hematologists primarily address issues, such as abnormal blood cell counts, lymphadenopathy, persistent fever, and coagulation abnormalities, which indicate hematological diseases. However, the emphasis on treating hematologic diseases within community medicine remains relatively low. Accurate and reliable differentiation and identification of hematological diseases with the cooperation of laboratory technicians and support of artificial intelligence is necessary. Significant advances have been made in the treatment of hematological diseases; however, small community hospitals often lack access to these treatments and are unable to conduct clinical trials that require specialized equipment such as for chimeric antigen receptor T-cell therapy. In the future, hematologists will need to focus on developing their careers within the community and further optimizing their practice to enhance patient care. J. Med. Invest. 72 : 21-25, February, 2025

Keywords **:** *Uneven distribution, fluctuation of medical demand, career development of hematologist*

INTRODUCTION

In Japan, a role-sharing system has been implemented for medical treatment. Patients receive primary care at local clinics, cases that require further testing are transferred to local community general hospitals, and further examinations are conducted at advanced medical institutions such as university hospitals. Although challenges, such as limited numbers and uneven regional distribution of physicians, have been reported, the problems of community medical care in hematology remain to be elucidated. We conducted a comprehensive review of regional hematology medical care in Tokushima Prefecture in Japan.

MEDICAL CARE IN TOKUSHIMA PREFECTURE

Tokushima Prefecture

Tokushima Prefecture is situated approximately 500 km southwest of Tokyo and 110 km from Osaka. It is considered a rural area. The population of Tokushima Prefecture was 719,559 people in 2020(1). Tokushima Prefecture has 338.4 doctors per 100,000 population (mean, 269.2 doctors in Japan), making it one of the top-ranking prefectures in Japan (2). On the other hand, the prefecture is relatively large (4,147 km²) and the number of doctors per 100 km² is 58.7 ; thus, it is ranked 29th out of the 47 prefectures in Japan for doctor density (2, 3). A large proportion of the population lives in the northeastern plains of Yoshino River, whereas the less populated southwestern and southern parts of Tokushima Prefecture are characterized by steep mountainous terrain and a coastal area, respectively. These geographic features contribute to specific medical demands in the western and southern regions of the prefecture.

Increase of medical demand by subdivision of specialized fields of medical doctors

In the past, medical care in the field of internal medicine was provided by a single physician who managed patients with diseases affecting multiple organ systems. However, in recent years, internal medicine has become increasingly specialized and subdivided, resulting in patients with multi-organ system diseases often being treated by multiple organ-specific specialists within the internal medicine framework. As a result, the number of doctors needed per patient is increasing. This situation is contributing to a disruption of the balance between medical demand and supply. After the new physician specialty training system started, the inequality between urban and rural areas, including those in Tokushima Prefecture, worsened (4). With the rapid advancements in treatments for hematological diseases, highly specialized therapies, such as chimeric antigen receptor T-cell (CAR-T) therapy and hematopoietic stem cell transplantation (HSCT), have been introduced into clinical practice in Japan (5, 6). When administering rapidly evolving treatments, such as CAR-T cell therapy, to patients, adaptable and appropriate collaborations between generalists and hematologists are essential. Hematologists who can additionally provide general medical care, referred to as "deep generalists," are important (7).

Uneven distribution of hematologists in Tokushima Prefecture

On 1 April 2024, there were 4,740 hematologists (8) for 124,000,000 people (3.82 hematologists per 100,000 people) in Japan (9). In comparison, there are 39 hematologists (5.7 hematologists per 100,000 people) in Tokushima, including five doctors aged over 65 years. However, only 27 out of 39 of these hematologists were working in public hospitals. Figure 1A shows the distribution of hematologists' workplaces in Tokushima as of September 2024. The distribution is concentrated in the northeastern part of the prefecture, which does not align with the overall population distribution (10) (Figure 1B). Therefore, it

Received for publication December 15, 2024 ; accepted February 4, 2025.

Address correspondence and reprint requests to Shingen Nakamura, Department of Hematology, Endocrinology and Metabolism, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15, Kuramoto-cho, Tokushima, 770-8503, Japan and E-mail : shingen@tokushima-u.ac.jp

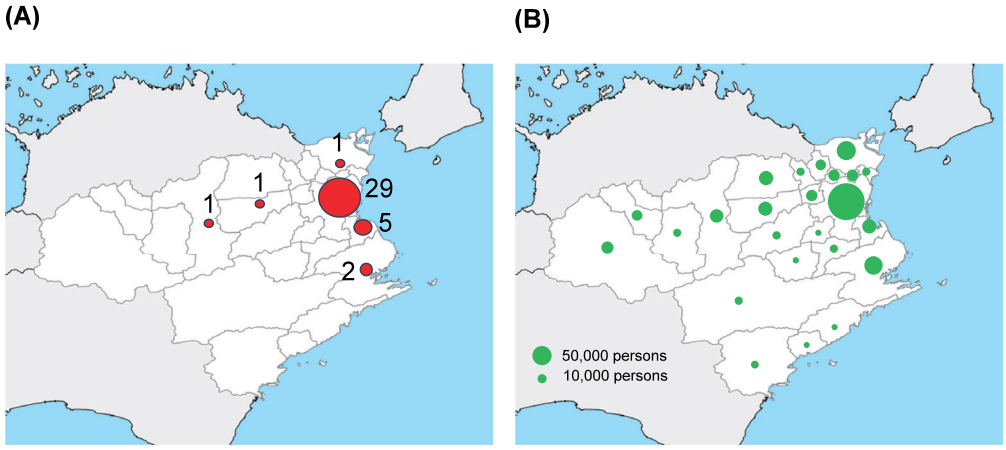

Figure 1. Distribution of hematologists and population in Tokushima prefecture. (A) The number of hematologists working in each district. (B) The population of each municipality is represented by circles. The scale is shown in the bottom left of the figure.

may be challenging for patients to receive care for hematological diseases in areas with a limited number of hematology specialists. These trends could exacerbate the imbalance between medical supply and demand, especially as local populations age and medical demand increases. The aging of physicians may further impact this balance.

Uneven or fluctuating medical demand

There is a difference in medical demand across regions due to variations in population composition and characteristics. However, methods to accurately assess true medical demand, as well as standardized estimation and statistical analysis, have not yet been established. Medical demand may fluctuate even in the same region due to outbreaks of seasonal infectious diseases and seasonal illnesses such as heat stroke. Regarding hematological disease, the development of leukemia and lymphoma has seasonal fluctuations (11-13). Fluctuations of medical demand make it challenging to estimate the number of hospital beds and staff required, predict daily workload, and optimize the number of allocated staff. Most hospitals maintain a consistent number of hospital beds ; however, the occupancy rate fluctuates over time. For example, large fluctuations were reported in many hospitals during the COVID-19 pandemic era (14). Hematological malignancies often develop without prior warning signs and can present with sudden complications. Therefore, it is difficult to predict when the patient may require hospital treatment, which becomes a barrier to utilizing medical staff effectively.

DEMAND FOR HEMATOLOGISTS AND EFFORTS IN COMMUNITY MEDICAL CARE

The true medical demand for hematology specialists remains unclear due to a lack of accurate data. However, symptoms characteristic of hematological diseases, such as cytopenia, increased blood cell counts, lymphadenopathy, fever of unknown origin, and bleeding disorders, are frequently encountered in primary care practice.

Hematology in community general hospitals

Cytopenia, increased blood cell counts, lymphadenopathy, fever of unknown origin, and bleeding tendencies are recognized as common initial symptoms of hematological diseases ; however, these symptoms can also arise from unrelated conditions. Japan does not have a family medicine system similar to the system established in the United States ; therefore, most patients exhibiting these symptoms are referred to a hematologist. Consequently, the likelihood of diagnosis with a hematological disease after thorough examination by a hematologist is relatively low. Hematologists working in community general hospitals often encounter more cases of hematological and non-hematological diseases, which limits their opportunities to treat true hematological diseases. This situation contributes to the imbalance between medical demand and the supply of hematologists. Additionally, there is no established method for non-hematologists to accurately diagnose blood diseases. The development of such methods is considered an important unmet need.

Need for accurate differentiation of complete blood count results

Abnormalities in blood cell counts are objective data that can be easily detected and shared among medical staff. Diseases characterized by an increase in blood cells, such as chronic myeloid leukemia (CML), polycythemia vera, essential thrombocythemia, and myelofibrosis, are well-known. However, cytopenia is more common than blood cell increases and is often challenging to differentiate in clinical practice. Table 1 shows our analysis of the prevalence of blood cell count abnormalities in a community general hospital over a six-month period. A total of 23,446 complete blood count (CBC) examinations were performed. Leukopenia was detected in 1,054 specimens from men (9.02%) and 1,368 specimens from women (11.6%). Regarding white blood cells (WBCs), 135 specimens (0.58%) had WBC $\leq$ 1,000 (Figure 2A). Thrombocytopenia ($\leq 15 \times 10^4/\mu L$) was detected in 3,639 specimens (15.5%), with 229 specimens (0.98%) showing platelet counts under $5 \times 10^4/\mu L$ (Figure 2B). Severe anemia (Hb < 8 g/dL) was observed in 739 specimens (3.2%) (Figure 2C). Pancytopenia, which is considered highly indicative of a blood disorder, occurred in 460 specimens (3.94%) from men and 316 specimens (2.68%) from women (Table 1). Although these data include multiple and/or follow-up measurements from the same patients, CBC abnormalities occurred frequently and routinely, making it difficult to distinguish hematological disorders. It is not feasible for hematologists to treat or differentiate all these abnormalities ; therefore, physicians or clinical laboratory technicians are required to identify cases with a high probability of hematologic disease, either manually or with the assistance of artificial intelligence (AI), and those with a high likelihood of true hematological disorders. Ideally, hematologists

Table 1. The number and abnormality rate of complete blood count results.

	Sex	Number	%
Total CBC	M	11681	100
	F	11785	100
Leukopenia	M	1054	9.02
	F	1368	11.6
Anemia	M	7304	62.5
	F	4484	38.0
Thrombocytopenia	M	2130	18.2
	F	1507	12.8
Leukopenia+anemia	M	861	7.37
	F	667	5.66
Leukopenia+thrombocytopenia	M	509	4.36
	F	521	4.42
Anemia+thrombocytopenia	M	1712	14.7
	F	842	7.14
Pancytopenia	M	460	3.94
	F	316	2.68

Abbreviations : CBC, complete blood count ; M, male ; F, female

Definition of abnormality
Leukopenia : WBC ≦ 4000/μL
Anemia: Hb Male ≦ 14, Female ≦ 11.5 g/dL
Thrombocytopenia : Plt ≦ 15×10^4×/μL

would review all cases ; however, limited human resources make this impractical. As an alternative, laboratory technicians could detect abnormalities, such as blasts in peripheral blood, and report patients with possible leukemia, myelodysplastic syndrome, or lymphoma. They could also detect increased basophils to identify possible CML cases. Furthermore, AI may be able to assist in the differentiation process. A previous study reported the effectiveness of using laboratory technicians to screen for CML based on an increased number of basophils in peripheral blood and notifying doctors of possible CML cases (15). Thus, clinical laboratory technicians are important for assisting hematologists in diagnosing and treating blood disorders.

Terminal care for hematological diseases

Despite advances in the treatment of hematological diseases, there are still cases of refractory disease and death caused by inadequate treatment due to factors such as old age or comorbidities. Unlike solid tumors, hematologic diseases often cause bleeding due to thrombocytopenia, anemic symptoms, and fever due to the presence of a tumor. As a result, supportive care with blood transfusions is often necessary, as well as treatment for persistent fever. Such care is different from terminal care in solid cancers. Furthermore, there is a lack of terminal care specialists for end-stage hematological disease in the community. This field has not yet been established as an academic discipline and there are few practitioners ; therefore, unmet needs exist.

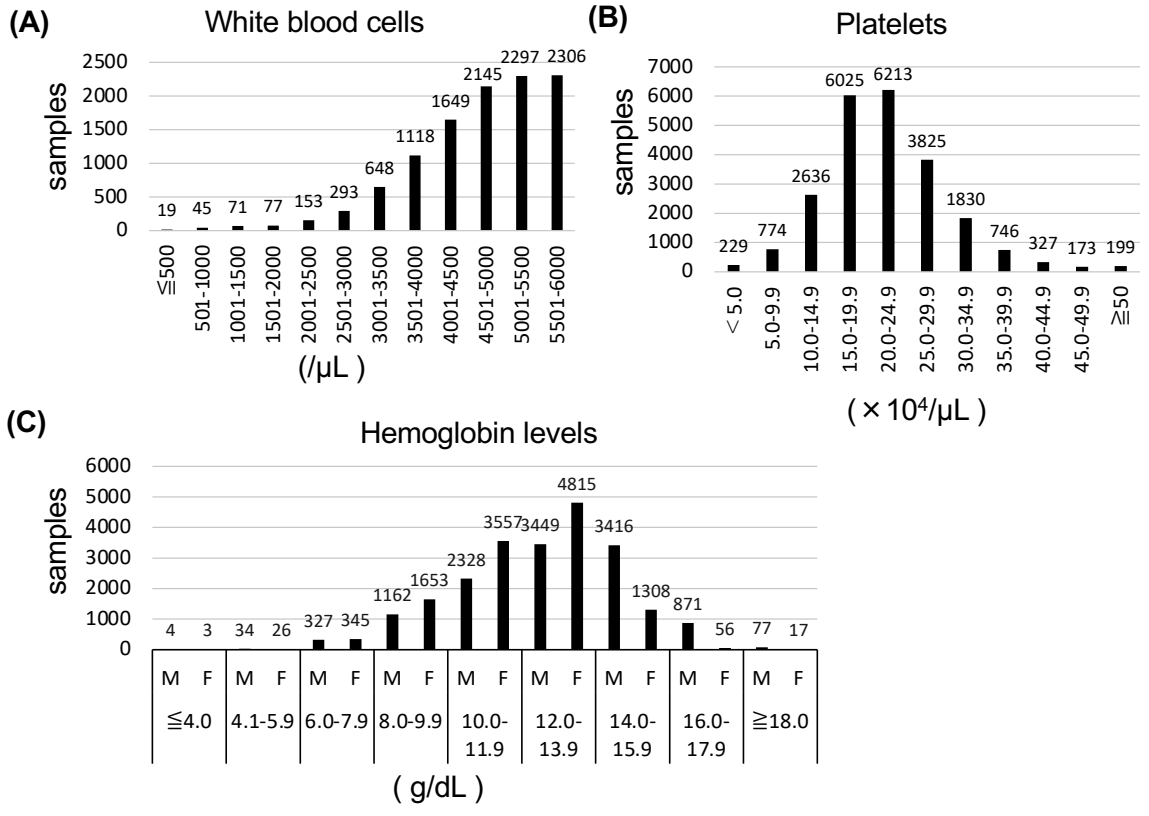

Figure 2. The distribution of complete blood count results. The number of samples in each range is shown for : (A) white blood cells (WBC) with ≤ 6000/μL, (B) platelets, and (C) hemoglobin levels. Abbreviations : M,male ; F, female

GAPS IN TREATMENT ACCESS FOR HEMATOLOGICAL DISEASES BETWEEN URBAN AND RURAL AREAS

In recent years, treatments for hematological diseases are advancing rapidly, such as CAR-T cell therapy being explored for relapsed or refractory hematological malignancies, and new therapeutic drugs are being developed. As a result, current treatments for hematological malignancies are proceeding in two stages : (1) chemotherapy and/or immunosuppressive therapy, and (2) CAR-T cell therapy and/or HSCT performed at core hospitals. These treatments are often offered at large hospitals in urban areas ; thus, in some regions, patients must travel to other prefectures to receive treatment. This issue is not limited to hematological diseases ; as medical treatments advance, they are increasingly concentrated in specialized hospitals located in urban areas. In the field of internal medicine, centralization is challenging, as primary care is required in every rural area. Moreover, in the field of surgery, surgical procedures are complex and there is a correlation between the number of surgeries and treatment outcomes ; thus, the consolidation of hospitals for specialized treatments is increasing (16, 17).

Future collaborations between urban and rural hospitals in hematology

Remote rapid consultant system

A key challenge in diagnosing hematological diseases lies in determining whether the patient has developed a hematological condition, as the initial symptoms are often non-specific. Thus, general practitioners often experience difficulties diagnosing hematological disease. To address these challenges, the installation of a remote rapid consultation system between specialists in urban hospitals and general practitioners in rural areas that utilizes a secure high-speed data communication system or smartphone-based application system is a promising solution. Healthcare applications based on 5G technology are anticipated (18). Using these systems, hematological specialists can refer to clinical, laboratory, and imaging data of the patient remotely from urban hospitals without the patient being present. This will enable more rapid diagnosis to be conducted. To execute these plans, medical staff need to acquire skills to handle fast communication computer systems.

Collaboration system using telemedicine between patients and medical staff

Despite the advancement of hematological treatments, such as CAR-T therapy and HSCT, the long-term effects and side effects remain to be elucidated. Thus, many doctors in general hospitals have concerns regarding patient follow-up. A potential solution is for experienced doctors to visit rural hospitals to provide medical care, as many issues that arise during follow-up after CAR-T and HSCT therapy can be resolved through explanations or the administration of simple treatments. To address these challenges, a bidirectional videophone communication system that connects patients, staff in rural hospitals, and staff in urban hospitals is needed.

The necessity of deep generalists

Treatment of hematological disease is rapidly evolving in many areas of internal medicine. Specialists who can provide general medical care with a deep understanding of advanced hematology care, referred to as “deep generalists”, are essential. Moreover, physicians specializing in regional cooperation and regional hematology are also increasingly needed to provide medical care in community healthcare settings.

CAREER DEVELOPMENT OF HEMATOLOGISTS IN COMMUNITY MEDICAL CARE

Currently, the number of hematologists in community general hospitals is limited. This shortage is exacerbated by the difficulty of obtaining specialist certification in hematology without prior experience at a large hospital. Furthermore, the treatment of hematological diseases is becoming increasingly sophisticated, with CAR-T cell therapy and HSCT now considered standard care and cancer gene panel tests for hematological malignancies scheduled to be implemented at some core hospitals. These advanced treatments, which require significant capital investment and specialized equipment, can only be provided at large hospitals and are difficult to integrate into community medicine. As a result, gaining experience in these treatments within the community is challenging, and obtaining specialist certification, which is now standardized by academic societies, is difficult for physicians working in the community. It is essential to establish a clear career and training path for young doctors. Educating junior doctors and creating training paths leading to a career in the field are important for stabilizing community medical care in hematology.

FUTURE PERSPECTIVE USING AI IN COMMUNITY MEDICAL CARE IN HEMATOLOGY

In rural areas, the number of specialists is relatively small ; therefore, there may be challenges diagnosing rare diseases. AI could potentially assist in overcoming this issue such as using an image recognition system to aid the differentiation of hematological diseases by analyzing images of peripheral blood or bone marrow smears (19, 20). Complete blood count data-based machine learning may help early detection of hematological disease, such as hemoglobinopathies and anemia, and solid cancer such as colorectal cancer (21-23). AI can potentially benefit patients as well as inexperienced medical staff in community general medicine.

CONCLUSION

In community hematology practice, the prompt and accurate identification of hematological diseases, including abnormal blood counts and symptoms characteristic of such conditions, is necessary. However, the number of facilities offering advanced hematological treatments is limited, which places a burden on both hematologists and patients. To improve efficiency in hematological diagnosis and treatment, greater integration of online medical care, the use of AI to detect abnormal blood cell counts, and the strengthening of cooperation and networking between large hospitals and regional hospitals is needed. These strategies could help ensure earlier diagnosis, enhance treatment options, and achieve better patient outcomes including prolonged prognosis and improved quality of life.

ACKNOWLEDGMENTS

We would like to thank Medical English Service for the English language editing.

AUTHOR DISCLOSURE STATEMENT

The authors declare that they have no relevant financial

interests related to the manuscript.

REFERENCES

1. Statistics Bureau of Japan. 2020 Population Census. 2020. Available online : https://www.stat.go.jp/english/ (last accessed on 20 November 2024).
2. Ministry of Health, Labour and Welfare of Japan. Statistics of Physicians, Dentists and Pharmacists 2020. 2020., Available online : https://www.mhlw.go.jp/english/database/db-hss/spdp.html (last accessed on 20 November 2024).
3. Geospatial Information Authority of Japan. Technical Report of the Geospatial Information Authority of Japan, E2-No.85, The Report of Statistical reports on the land area by prefectures and municipalities in Japan in 2024. 2024. Available online: https://www.gsi.go.jp/KOKUJYOHO/MENCHO/backnumber/GSI-menseki20240701.pdf (last accessed on 20 November 2024).
4. Saito H, Tanimoto T, Kami M, Suzuki Y, Morita T, Morita M, Yamamoto K, Shimada Y, Tsubokura M, Endo M : New physician specialty training system impact on distribution of trainees in Japan. Public Health 182 : 143-150, 2020
5. Therapy. HCTaCTiJARoNSTJDCfHCTTJSfTaC. Available online : http://www.jdchct.or.jp/data/report/2023/ (last accessed on 21 November 2024).
6. Goto H, Kitawaki T, Fujii N, Kato K, Onishi Y, Fukuhara N, Yamauchi T, Toratani K, Kobayashi H, Yoshida S, Shimo M, Onodera K, Senjo H, Onozawa M, Hirata K, Yokota I, Teshima T : Safety and efficacy of tisagenlecleucel in patients with relapsed or refractory B-cell lymphoma: the first real-world evidence in Japan. Int J Clin Oncol 28(6) : 816-826, 2023
7. Ferreira D, Sah RK : Who gets to the top? Generalists versus specialists in managerial organizations. The RAND Journal of Economics 43(4) : 577-601, 2012
8. Japanese society of hematology., Available online : http://www.jshem.or.jp/modules/senmoni/ (last accessed on 20 November 2024).
9. Statistics Bureau of Japan. population estimation. 2024. Available online : https://www.stat.go.jp/data/jinsui/pdf/202404.pdf (last accessed on 20 November 2024).
10. Tokushima Prefecture Planning and General Affairs Department, Statistical Information and Analysis Section. Tokushima Prefecture Estimated Population. 2024. Available online : https://www.pref.tokushima.lg.jp/statistics/month/jinkou/ (last accessed on 20 November 2024).
11. Gao F, Chia KS, Machin D : On the evidence for seasonal variation in the onset of acute lymphoblastic leukemia (ALL). Leuk Res 31(10) : 1327-1338, 2007
12. Wikén I, Andersson TM, Radkiewicz C : Seasonal effects on cancer incidence and prognosis. Acta Oncol 62(2) : 103-109, 2023
13. Chang ET, Clarke CA, Glaser SL : Making sense of seasonal fluctuations in lymphoma diagnosis. Leuk Lymphoma 48(2) : 223-224, 2007
14. Ab Rahman N, Low EV, Lim AH, Ahmad Shanizza AI, Ho SW, Kamal M, Mohamad Yahaya AH, Sivasampu S : Trends in medicine utilisation in public and private healthcare facilities before and during COVID-19 : a nationwide analysis of medicine procurement and sales data, 2018-2022. J Pharm Policy Pract 17(1) : 2401468, 2024
15. Ogasawara A, Matsushita H, Tanaka Y, Shirasugi Y, Ando K, Asai S, Miyachi H : A simple screening method for the diagnosis of chronic myeloid leukemia using the parameters of a complete blood count and differentials. Clin Chim Acta 489 : 249-253, 2019
16. Levaillant M, Marcilly R, Levaillant L, Michel P, Hamel-Broza J-F, Vallet B, Lamer A : Assessing the hospital volume-outcome relationship in surgery : a scoping review. BMC Medical Research Methodology 21(1) : 204, 2021
17. Polonski A, Izbicki JR, Uzunoglu FG : Centralization of Pancreatic Surgery in Europe. J Gastrointest Surg 23(10) : 2081-2092, 2019
18. Qureshi HN, Manalastas M, Ijaz A, Imran A, Liu Y, Al Kalaa MO : Communication Requirements in 5G-Enabled Healthcare Applications : Review and Considerations. Healthcare (Basel) 10(2), 2022
19. Wang W, Luo M, Guo P, Wei Y, Tan Y, Shi H : Artificial intelligence-assisted diagnosis of hematologic diseases based on bone marrow smears using deep neural networks. Comput Methods Programs Biomed 231 : 107343, 2023
20. Cheng W, Liu J, Wang C, Jiang R, Jiang M, Kong F : Application of image recognition technology in pathological diagnosis of blood smears. Clin Exp Med 24(1) : 181, 2024
21. Putri RD, Sujana SA, Hanifa NN, Santoso TA, Abdullah M : Efficacy of ColonFlag as a Complete Blood Count-Based Machine Learning Algorithm for Early Detection of Colorectal Cancer : A Systematic Review. Iran J Med Sci 49(10) : 610-622, 2024
22. Schipper A, Rutten M, van Gammeren A, Harteveld CL, Urrechaga E, Weerkamp F, den Besten G, Krabbe J, Slomp J, Schoonen L, Broeren M, van Wijnen M, Huijskens M, Koopmann T, van Ginneken B, Kusters R, Kurstjens S : Machine Learning-Based Prediction of Hemoglobinopathies Using Complete Blood Count Data. Clin Chem 70(8) : 1064-1075, 2024
23. Shahzad M, Shirazi SH, Yaqoob M, Khan Z, Rasheed A, Ahmed Sheikh I, Hayat A, Zhou H : AneRBC dataset : a benchmark dataset for computer-aided anemia diagnosis using RBC images. Database : the journal of biological databases and curation 2024, 2024