Assess and interpret Advanced practitioners 11: interpretation of haematology results

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1. **Standfirst:**

[max 150 characters. Explains what the article is about – expanding on the headline]

Interpretation of haematology results in adults, focusing on red cell indices, platelet count, and white cell indices.

2. **Headline**

[70 characters – Title of your article. Try to make active. Avoid "to improve care"]

Interpretation of Haematology Results

3. **Author/s**

[include **full name**, **job title/s, place of work** (no qualifications and use lower case for job titles)]

Clare Butler, Vicky MacArthur

4. **Abstract**

[50-100 words for most articles; up to 150 for research (broken into main sections of the study). The abstract is a summary of what is in the article. No references, no abbreviations unless a long phrase is repeated a few times]

Interpreting a full blood count (FBC) is a fundamental aspect of clinical practice. FBC abnormalities can signify diverse underlying conditions, therefore advanced practitioners must meticulously analyse FBC results alongside patient history, clinical presentation, and examination findings. This will enable them to use clinical reasoning to formulate an accurate understanding of the patient's condition, guide further diagnostic investigations and develop management strategies. Ultimately, the accurate interpretation of an FBC serves as a cornerstone in diagnostic decision-making, empowering advanced practitioners to deliver informed and holistic patient care.

Meta description

Citation

Quick fact

Pull quote

Advanced practitioners

This series is aimed at nurses and midwives working at or towards advanced practice. Advanced practitioners are educated at masters level and are assessed as competent to make autonomous decisions in assessing, diagnosing and treating patients. Advanced assessment and interpretation is based on a medical model and the role of advanced practitioners is to integrate this into a holistic package of care.

Interpretation of haematology results

This article will consider the interpretation of haematology results in adults, focusing on red cell indices, platelet count, and white cell indices. Conducting a comprehensive health history and clinical examination is essential to contextualise and understand the clinical significance of the results to inform decision-making regarding further investigations or referrals that may be necessary.

The full blood count

The full blood count (FBC) checks the types and numbers of cells in the blood including red blood cells (erythrocytes), white blood cells (leukocytes) and platelets (thrombocytes). It is requested for many different reasons and is often part of a general health screen or to aid the diagnosis of underlying pathology. What comprises a full blood count can be seen in Table 1. The reference ranges are also shown here but it should be noted that reference ranges are lab-specific and you should check local information.

Table 1 Full blood count and reference ranges

Red blood cells

Red blood cells, about 40% of blood volume, carry oxygen to tissues and some carbon dioxide to lungs. Haemoglobin, within RBCs, gives blood its red colour, with iron as a vital component (Butler and MacArthur 2024).

All blood cells stem from hematopoietic stem cells, differentiating via hematopoiesis regulated by substances like erythropoietin. Produced mainly by kidneys, erythropoietin regulates RBC production in response to tissue hypoxia (Hoffbrand and Steensma 2019).

Reticulocytes, precursors to RBCs, are larger with a nucleus. After maturing in bone marrow, they lose their nucleus, becoming RBCs. Without a nucleus, RBCs can't reproduce or repair themselves. With a 120-day lifespan, RBCs are broken down in the spleen by phagocytic cells (Butler and MacArthur 2024).

Evaluating the results of the red cell indices

The **first step** in identifying problems with the red blood cell is to look at the haemoglobin, haematocrit and red cell count.

Haemoglobin Estimation (Hb)

This shows the amount of haemoglobin in the blood and reflects the blood's oxygen-carrying capacity. A low Hb indicates anaemia and a high Hb indicates polycythaemia.

Haematocrit (Hct)

This is also known as the packed cell volume (PCV) and is a measurement of the proportion (percentage) of the blood made up of red blood cells. Hct is also related to the size of the RBCs (MCV) so a decreased RBC size will result in a low Hct and vice versa.

Red blood cell count (RBCC)

This relates to the number of red blood cells in the blood and is helpful as a quick snapshot of a person's overall red blood cell status and is used to diagnose specific types of anaemia (Doig and Zhang 2017).

Reduced Hb, Hct and RBCC

Anaemia is the most common red blood cell disorder with iron deficiency anaemia being the most common type of anaemia worldwide (Provan and Booth 2018). Anaemia is defined by the World Health Organisation (WHO 2021) as a condition in which the number of red cells or the haemoglobin concentration within them is lower than normal. The Hb result is the most reliable indicator of anaemia as most instances will have an associated decrease in haemoglobin.

To rapidly narrow down the causes of anaemia, the **second step** is to consider the red cell size and colour using the mean corpuscular volume and mean corpuscular haemoglobin. A reticulocyte count may also be provided as part of a full blood count.

Mean Corpuscular (or cell) Volume (MCV)

This provides information about the average size and volume of the red blood cells. Anaemias are often classified by the size of the RBC; microcytic refers to small RBCs, normocytic refers to normal-sized RBCs and macrocytic refers to large RBCs.

Mean Corpuscular Haemoglobin (MCH)

This provides information about the average amount of haemoglobin per red blood cell. MCH decreases when haemoglobin synthesis is reduced or when red blood cells are smaller than normal.

Mean Corpuscular Haemoglobin Concentration (MCHC)

This shows the average concentration of haemoglobin in a given unit of blood and unlike MCH measures the proportion of the RBC taken up by Hb. It can be used alongside MCV and MCH to classify anaemias.

Reticulocyte count
This is used to measure the percentage of reticulocytes, which are immature red blood cells, in the bloodstream and provides information about the rate of red blood cell production (erythropoiesis). A low reticulocyte count indicates decreased red blood cell production, while a high reticulocyte count suggests increased red blood cell production.

Anaemias classified by cell size

Microcytic anaemia is a type of anaemia in which the RBCs are smaller (microcytic) and paler (hypochromic) than normal. The FBC will show a low Hb, a low Hct, a low MCV, and a low MCHC.

The most common cause of microcytic anaemia is **iron deficiency**. Iron is one of the nutrients required for erythropoiesis so a deficiency will result in a reduced production of RBCs. RBCs that are produced will lack sufficient haemoglobin and so will appear paler (as Hb gives the erythrocyte its colour) and smaller (because they contain less Hb) than normal.

Iron deficiency is most commonly caused by malabsorption but can also result from low dietary intake, blood loss or chronic disease. The most common cause of blood loss in premenopausal women is menorrhagia and in post-menopausal women and men is gastrointestinal loss (NICE 2023a). Although less common, a defect in Hb can also cause microcytic anaemia (see Table 2).

Table 2. Causes of Microcytic anaemia

Normocytic anaemia is when the Hb and Hct will be decreased but the MCV and MCHC will be within normal limits as the RBC size is not affected. Normocytic anaemia is due to a drop in the number of red blood cells in the circulation for example:

- chronic disease
- bone marrow disorders
- nutritional deficiencies
- blood loss (Hoffbrand and Steensma 2019).

Elevated reticulocyte count (reticulocytosis) indicates increased erythropoiesis in response to anaemia, aiding in diagnosis.

Macrocytic anaemia is when the RBCs are larger (macrocytic) than normal. It is further divided into megaloblastic anaemia and non-megaloblastic anaemia.

In **megaloblastic anaemia** immature red blood cells with megaloblastic features such as a large immature nucleus as a result of impaired DNA synthesis are found. Because Hb production is not affected, while the MCV will be raised, the MCHC will be normal. The main cause is vitamin B12 deficiency due to poor diet, nitrous oxide abuse, deficiency of intrinsic factor (pernicious anaemia).

Non-megaloblastic anaemia presents with macrocytes without megaloblastic features, resulting in elevated MCV, normal MCHC, and low Hb levels. A raised MCV may also stem from reticulocytosis as reticulocytes are larger than RBCs. Causes of non-megaloblastic anaemia include excessive alcohol intake (due to alcohol's toxic effects on the bone marrow), antimetabolite drugs, liver disease, and pregnancy (NICE, 2024).

History, examination and management

Important areas to cover in the history include dietary history, causes of potential blood loss (menorrhagia, melena), issues with malabsorption (e.g IBD), family history of haematological disorders, symptoms of chronic disease (cardiac, renal, hepatic) (NICE 2023a). Symptoms common to all types of anaemia can be seen in Table 3, although these may be absent and depend on how quickly the anaemia develops (NICE 2023a).

Table 3. Signs and symptoms common to all types of anaemia (Butler and Macarthur 2024)

The physical examination may reveal pallor, koilonychia (spoon shaped nails), angular stomatitis (cracked skin at the corner of the mouth), glossitis (smooth sore tongue), an irregular heart rate, an elevated respiratory rate, an enlarged liver or spleen.

Further blood tests may be required such as ferritin levels, a blood smear to visualise the cell morphology, and an assessment of B_{12} and folate levels. Premenopausal and pregnant women with suspected iron deficiency anaemia may be started on a diagnostic trial of iron therapy such as daily ferrous sulphate. This should not be done in post-menopausal women and men due to the higher risk of occult gastrointestinal bleeding or malignancy as a cause of the anaemia which should first be investigated (NICE 2023a).

Raised red cell count, haemoglobin and Hct

Polycythaemia

Above normal levels of Hb indicates polycythaemia (or erythrocytosis), an increase in red blood cells. As red blood cells contain Hb, this causes an elevated Hb estimation (Hoffbrand and Steensma 2019). When severe it can cause increased viscosity of the blood which puts the patient at risk of thrombotic events (Butler and Macarthur 2024). Relative polycythaemia occurs as a result of dehydration and is not a true increase in the number of RBCs but a reduced amount of plasma in relation to the number of RBCs. This can be a result of reduced intake, diuretic use or plasma loss in burns for example (Brown 2012). Absolute polycythaemia, on the other hand, is a true increase in the number of RBCs in the blood, it can have a primary cause such as Polycythaemia vera (PV) which is a haematological cancer that causes excessive production of RBCs, or secondary causes such as the appropriately increased production of erythropoietin in response to hypoxia (at altitude or in respiratory disease for example) or inappropriate excess erythropoietin production due to renal disease (Butler and MacArthur 2024). It is important to distinguish between relative and absolute polycythemia, as the underlying causes and thus treatments differ between the two. The diagnostic criteria for polycythemia vera are hypercellularity of the bone marrow, the presence of JAK2 mutation in blood cells or low levels of erythropoietin (Tefferi and Barbui 2023).

History, examination and management

A history should include asking about family history, BMI, smoking and alcohol. Common symptoms relate to hyperviscosity of the blood and include chest/abdominal pain, fatigue, headache, tinnitus, blurred or loss of vision, and paresthesia. PV will also show signs such as bruising, itching, night sweats and painful/burning extremities. The physical examination may reveal a ruddy complexion, red conjunctiva, enlarged spleen, or abdominal masses that are causing the condition. Management will require a referral to a haematologist (NICE 2023b).

Platelets

Platelets are tiny cell fragments without nuclei, derived from megakaryocytes in the bone marrow, through a process known as thrombopoiesis (Hoffbrand and Steenama 2019).

The main function of platelets is their crucial role in haemostasis (arrest of bleeding). When blood vessels are damaged, platelets adhere to the site and aggregate together to form a platelet plug. Platelets provide a surface for coagulation, leading to the formation of a fibrin clot, stabilising the clot and sealing the wound (Butler and Macarthur 2024).

Platelets have a short lifespan, typically lasting 7-10 days in the bloodstream. They play roles in haemostasis and are cleared from circulation, mainly in the spleen and liver (Oetjen and Dunbar, 2019).

Evaluating the results of the platelet count

The platelet count is performed as part of a full blood count but might also be specifically used if there are symptoms of a bleeding or clotting disorder, to diagnose or monitor diseases that affect the bone marrow, or to monitor the effects of drugs known to affect platelets.

The use of automated counters means that low platelet counts are a common incidental finding and the practitioner needs to be able to differentiate the benign from the life-threatening causes through a comprehensive history, clinical examination and consideration of other blood results. A low platelet count might result from collection errors. If an unexpected result occurs, repeating the test using coagulation vials (citrated) is advised (Baccini et al 2020; Provan et al 2015). This is because using EDTA in vials for an FBC can lead to platelet clumping and inaccurate results. Notably, about 1–2% of people have an EDTA-dependent antibody in their blood, which can also cause false results, despite the absence of bleeding symptoms (NICE 2021a).

Platelets

The platelet count measures the number of platelets (thrombocytes) in the blood and is reported as the number of platelets per microliter (shown as 10^9/L). For example, a platelet count of 350 x 10^9/L means there are 350,000 to 450,000 platelets per microlitre of blood. The normal platelet count can be seen in Table 1. Having less than 143,000 platelets is known as thrombocytopenia and having more than 400,000 is a condition called thrombocytosis (Moore et al 2021).

Reduced Platelet Count

Thrombocytopenia is a low platelet count that can be inherited or acquired. Causes are broadly grouped into four categories (see table 4).

Table 4. Causes of acquired thrombocytopenia

History, examination and management

Thrombocytopenia is a symptom, not a diagnosis, and requires tests to confirm its presence, with management tailored to its underlying cause. A comprehensive history, including bruising, bleeding tendencies, recent infections, travel, and heparin exposure, is crucial. Physical examination should include checking for petechiae, purpura, lymphadenopathy, and splenomegaly. If no clear cause is identified, bone marrow examination and additional investigations for primary hematologic disease may be necessary (Rogers and Lehman 2019). Severe cases may require platelet transfusion (Provan et al 2015).

Raised Platelet Count

Thrombocytosis is a high platelet count and is more common than thrombocythemia. It is classified as either primary (or essential) or secondary (or reactive).

Primary Thrombocytosis

Causes of primary (essential) thrombocytosis:

- chronic myeloid leukaemia (CML),
- polycythaemia vera (PV), primary myelofibrosis (PMF),
- myelodysplastic syndromes (MDS)
- hereditary thrombocytosis (HT)
  (Rogers and Means 2019)

It is caused by an abnormality in bone marrow function, where mutated blood stem cells or precursor cells called myeloid progenitors grow too much, leading to an increase in megakaryocytes. (NICE 2021b).

Rare cases may be hereditary or familial, where there is a history of lifelong asymptomatic thrombocytosis. The course of the disease is milder and risk of thrombotic events low, likewise the progression to leukemic or myelofibrosis is rare (Rogers and Means 2019).

History, examination and management

Routine screening can help identify these individuals, so a comprehensive health history, including family history, and physical examination are essential. Not all patients show symptoms, but those that do may be fatigued, have dizziness, insomnia or migraines (Accurso et al 2020), some may first present with symptoms of a thrombotic event such as stroke or myocardial infarction or exhibit an enlarged spleen.

Following a blood count, a bone marrow biopsy and genetic testing for gene mutations may be requested to aid diagnosis with the WHO diagnostic criteria (Putti et al 2021). Management is primarily the prevention of a thrombotic event, as this is the most common cause of morbidity and mortality (Besses and Alvarez-Larrán 2016), and health promotion about smoking and diabetes.

Primary thrombocytosis may require platelet-lowering medications but is not always indicated (Rogers and Means 2019).

Secondary thrombocytosis

Secondary (reactive) thrombocytosis is in response to an underlying condition or stimulus:

- Inflammation
- Malignancy
- Infection
- Haemorrhage
- Surgery
- Trauma
- Iron deficiency anaemia
- Drug therapy (for example steroids)
  (NICE 2021b)

Secondary thrombocytosis is more common compared to primary thrombocytosis, accounting for over 80% of cases (NICE 2021b). Secondary thrombocytosis is driven by the overproduction of cytokines, including thrombopoietin, in response to inflammation, infection, or neoplasm.

History, examination and management

Like primary thrombocytosis, patients are often asymptomatic, so the health history and physical examination is key to exploring the presentation or condition that brought about the thrombocytosis. Specific attention should be given to any symptoms relating to infection and examination for lymphadenopathy. Patients normally present with symptoms of the underlying condition, not the thrombocytosis itself.

There is not normally an indication for platelet-lowering medication, as the risk of thrombosis is low (Alberio 2016), it is the diagnosis and management of the underlying condition that is a priority.

White Blood Cell

White blood cells (leukocytes) are made in the bone marrow, then enter the bloodstream to safeguard against infections by seeking out and destroying pathogens. They can also move into the lymphatic system to produce antibodies, enhancing the body's immune response.

Leukocytes are divided into 2 main groups, phagocytes and lymphocytes. Phagocytes are also subdivided into granulocytes (neutrophils, eosinophils, basophils) and monocytes), each is expressed as a percentage of the total white blood cell count and has its own characteristic and function (see table 5).

Table 5. Characteristics and function of the white cells

Evaluating the results of the White cell indices

The white cell indices quantify the total number of white blood cells (WBCs) cells present and information about the body's ability to respond to infections and other immune system challenges. However, all should be interpreted in the context of the other white cell indices.

Total white cell count

This represents the total amount of all kinds of white cells in the blood. All white cells play an important role in phagocytosis and the production of antibodies and defence against infection. Broadly speaking, having a low white blood cell count (leukopenia) increases the risk of infections, while a high white blood cell count (leukocytosis) may indicate infection or an underlying medical condition such as leukaemia, lymphoma, or an immune disorder.

Reduced White Cell Count

Leukopenia

Leukopenia is an abnormal reduction in the number of circulating WBCs, especially granulocytes and in particular neutrophils and lymphocytes and the term neutropenia is often used interchangeably with leukopenia (referring to a reduction in neutrophils) as monocytes, eosinophils, and basophils comprise a relatively small proportion of the total WBC pool (Jacobson and Berliner 2019).

On its own, low WBCs may not be significant but typically arise from diminished bone marrow production resulting from various factors such as damage or dysfunction of the bone marrow (Solomou et al 2021). While decreased bone marrow production is the predominant cause of leukopenia, increased destruction of white blood cells can also contribute to this condition, although less commonly observed (see Table 6 for causes).

Table 6. Causes of Leukopenia

History, examination and management

To manage leukopenia you need to identify and treat the underlying cause, so a comprehensive health history including drug history, recent weight loss and fever, and physical examination including for evidence of infection, lymphadenopathy and splenomegaly.

Management is mostly supportive, dependent on the cause and the severity. If the cause can be identified, this should be treated, for example, febrile neutropenia is normally treated with antibiotics and fluids (Jacobson and Berliner 2019). Patients with severe chronic disease may benefit from medication to stimulate the production of white blood cells in the bone marrow (Dale 2016).

Raised White Cell Count

Leukocytosis

Leukocytosis is the broad term for an elevated white cell count (WCC) and is a common abnormal blood result in the acute setting (Thachil and Bates 2017). Leukocytosis can be subcategorised by the type of WBC that is increased in number. Leukocytosis in which neutrophils are elevated is neutrophilia (the most common type of leukocytosis); leukocytosis in which lymphocyte count is elevated is lymphocytosis; leukocytosis in which monocyte count is elevated is monocytosis; and leukocytosis in which eosinophil count is elevated is eosinophilia (Hoffbrand and Steenama 2019).

The most common cause is a healthy bone marrow reacting to inflammation or infection, which can increase leukocyte release, decrease margination, or decrease extravasation from the blood vessels into the tissues. Or it can be as a result of underlying bone marrow disorders (see Table 7).

Table 7. Causes of Leukocytosis

History, examination and management

Leukocytosis is often acute and transient secondary to a physiological response so in the health history it is important to look for any trends in the FBC. In the acute setting stress and infection are common presentations.

Significant and/or persistent WBC elevation should prompt a history and examinations for leukaemia or myeloproliferative disorders. Both of these are malignancies that affect the bone marrow and cause the overproduction of non-functioning WBCs (de Vos et al 2018). Typical symptoms to ask about in the health history include fever, night sweats, weight loss, and fatigue. Social history is important to review as smoking and some chemical exposures have been associated with bone marrow disorders (Mank et al 2024)

Conclusion

Interpreting an FBC involves analysing the individual parameters in the context of the patient's health history, clinical presentation and examination findings. This comprehensive approach is crucial as abnormalities detected in the FBC can indicate a wide range of underlying conditions, including but not limited to anaemia, infection, inflammation, or even leukaemia. As a crucial step in the diagnostic process, accurate interpretation of an FBC serves as a vital tool for advanced practitioners to make informed decisions regarding patient care and formulate a comprehensive management plan.

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Table 1 Full blood count and reference ranges

	Male	Female
Red cells		
Haemoglobin (Hb)	133-167 g/L	118-148 g/L

Red Blood Cell Count (RBCC)	4.3-5.7 x 10^{12}/L	3.9-5.0 x 10^{12}/L
Haematocrit (Hct)	0.35-0.53 L/L	0.33-0.47 L/L
Mean cell volume (MCV)	77-98 fL	
Mean cell haemoglobin (MCH)	26-33 pg	
Mean cell haemoglobin (MCHC)	330-370 pg/L	
White blood cells		
Total white cell count	4.0-10.0 x 10^9/L	
Neutrophils	2.0-7.0 x 10^9/L	
Lymphocytes	1.0-3.0 x 10^9/L	
Monocytes	0.2-1.0 10^9/L	
Eosinophils	0.02-0.1 x 10^9/L	
Basophils	0.02-0.1 x 10^9/L	
Platelets	143-400 x 10^9/L	

(Moore et al 2021)

Table 2. Causes of Microcytic anaemia

Cause	**Condition**
Iron deficiency due to: Malabsorption Blood loss Chronic disease	Inflammatory Bowel Disease Ulcers Menorrhagia Infections Autoimmune diseases Malignancy Chronic kidney disease

Destruction of RBCs due to: Defect in Hb	Thalassemia

(Provan et al 2015)

Table 3. Signs and symptoms common to all types of anaemia (Butler and Macarthur 2024) [change into a box]

Dyspnoea
Fatigue
Headache
Palpitations
Tachycardia
Dizziness, fainting
Lack of concentration
Angina, intermittent claudication

Table 4. Causes of acquired thrombocytopenia

	Condition
Reduced production of platelets in the bone marrow	Conditions affecting bone marrow: ● Bone marrow metastases ● Myelofibrosis ● Sarcoidosis ● Aplastic anaemia ● Bone marrow failure (inherited or acquired due to malignancy, drugs, autoimmune or viral causes) ● Nutritional deficiencies (Vitamin B12 or folate deficiencies)
Increased platelet destruction/consumption	Can be immune and non-immune causes. ● Immune thrombocytopenic purpura (destruction) ● Disseminated intravascular coagulation (consumption) ● Drug-induced platelet destruction (eg. quinidine, quinine, NSAIDs, penicillin, and anticonvulsants)
Sequestering of platelets in the spleen	Abnormal accumulation of platelets in the spleen: ● Liver disease, such as cirrhosis, liver cancer, or hepatitis ● Infections, such as malaria, tuberculosis, or HIV ● Hematologic disorders, such as leukaemia, lymphoma, or myeloproliferative disorders ● Inflammatory conditions such as rheumatoid arthritis, systemic lupus erythematosus, or inflammatory bowel disease

Dilution	Occurs when platelets in the blood are diluted by fluids lowering platelet concentration and raising bleeding risk. ● Blood transfusion ● Crystalloid infusion

(NICE 2021a; Warkentin et al 2019)

Table 5. Characteristics and function of the white cells

White blood cell	**Key characteristics**	**Function**
Lymphocytes	● Second most abundant WBC ● Fundamental immune cells for cellular and humoral immunity ● Belong to B system (production of antibodies) or T system (destruction of harmful pathogens)	Mainly target viral infections
Neutrophils	● Most abundant WBC and first responders at infection site ● Highly mobile ● Engulf and destroy bacteria	Mainly target bacterial and fungal infections
Monocyte	● Largest WBC ● Highly mobile ● Participate in inflammation ● Release cytokines	Mainly target bacterial infections
Eosinophils	● Release of histamine in allergic responses/inflammation ● Regulate hypersensitivity reactions ● Found in high concentrations in gastrointestinal tract, skin, and lungs	Mainly target parasitic infections
Basophils	● Least abundant type of WBC ● Regulate hypersensitivity reactions ● Release of histamine ● Involved in acute and chronic allergic diseases (e.g., anaphylaxis, asthma, hay fever)	Main action is response to allergens

(Butler and MacArthur 2024)

Table 6. Causes of Leukopenia

	Condition
Infections	Some viral infections, or certain types of bacterial infections, can suppress the bone marrow's ability to produce white blood cells. ● HIV ● Hepatitis

	● Influenza
Medications	Some medications, or some antipsychotic medications, can cause bone marrow suppression. ● Chemotherapy drugs ● Antibiotics ● Antiepileptic drugs ● Immunosuppressants
Immune-Mediated	Autoimmune disorders where auto-antibodies cause the destruction of WBCs. ● Systemic lupus erythematosus ● Rheumatoid arthritis (Felty syndrome)
Bone Marrow Disorders	Conditions that affect the bone marrow's ability to produce white blood cells ● Aplastic anaemia ● Myelodysplastic syndromes (MDS) ● Leukaemia
Idiopathic	In some cases, the cause of leukopenia may not be identified, and it is referred to as idiopathic leukopenia.

(Jacobson and Berliner 2019; Provan et al 2015)

Table 7. Causes of Leukocytosis

	Cause	**Conditions**
Physiological Response	Infection: Stimulate the body to produce more white blood cells as part of the immune response	● Pneumonia ● Urinary tract infections ● Cellulitis ● Bacterial meningitis. ● Influenza
	Inflammation: Triggers an increase in white blood cell production	● Rheumatoid arthritis ● Inflammatory bowel disease ● Vasculitis
	Tissue necrosis: Lead to the release of inflammatory mediators, stimulating white blood cell production	● Trauma ● Surgery ● Burns ● Tissue damage
	Medications: Can cause leukocytosis as a side effect	● Corticosteroids ● Lithium ● Epinephrine,
Bone Marrow Disorders	Certain bone marrow disorders can lead to an overproduction of white blood cells	● Myeloproliferative neoplasms (e.g., polycythemia vera,

		essential thrombocythemia)
	Blood cancers can cause abnormal proliferation of white blood cells, leading to leukocytosis	● Acute or chronic leukemias

(Cashen and Van Tine 2012)