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Incidence of Primary Polycythemia Vera in Tobruk City

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ABSTRACT

Background: Polycythemia Vera (PV) is a myeloproliferative neoplasm characterized by uncontrolled production of red blood cells, predominantly driven by a JAK2 gene mutation. It is associated with significant morbidity due to increased blood viscosity and thromboembolic events. **Objectives:** To determine the incidence and risk factors of primary polycythemia vera among patients at Tobruk Medical Centre, and to assess the relationship between PV and risk factors including age, smoking, hypertension, and family history. **Methods**: A cross-sectional study was conducted from mid-2024 to 2025 at Tobruk Medical Centre. Data were collected from three departments: Oncology (n=44), Neonatal (n=90), and Internal Medicine (male and female; n=125). Patients were classified according to demographics and risk factors (smoking, hypertension, family history, and age). **Results:** In the Oncology Department, 44 patients were identified (19 male, 25 female), aged 20–90 years. The majority of cases occurred in patients aged 51–80. A statistically significant association was found between age ≥50 and PV incidence ($p=0.035$). Hypertension was prevalent in 23/25 female patients and 14/19 male patients. Smoking was identified in 10 patients. Smoking was significantly more prevalent in male PV patients than female ($p=0.011$). In the Neonatal Department, 90 cases showed elevated blood components, confirming bone marrow instability in newborns. In the Internal Medicine department, 125 patients had elevated blood components, with the highest rates among those aged 71–90. A perfect positive correlation was observed between age and elevated blood components ($p<0.001$). **Conclusion:** Primary PV is present across multiple age groups and departments. The JAK2 V617F mutation combined with risk factors such as ageing, hypertension, and smoking significantly increases PV incidence. Early screening in at-risk populations is recommended.

1. INTRODUCTION

Polycythemia Vera (PV) is a chronic myeloproliferative neoplasm (MPN) characterized by excessive proliferation of hematopoietic stem cells in the bone marrow, primarily resulting in elevated red blood cell (RBC) mass. There is often concurrent leukocytosis and thrombocytosis due to stimulation across myeloid lineages. The clinical significance of PV lies in its association with increased blood viscosity, which predisposes patients to serious thromboembolic events including stroke, deep vein thrombosis, and pulmonary embolism (Lu, 2023). The current understanding of PV pathophysiology centers on an acquired somatic mutation in the Janus Kinase 2 (JAK2) gene, specifically the V617F point mutation, present in approximately 95–96% of PV cases. This mutation leads to constitutive activation of the JAK/STAT signaling pathway, resulting in growth factor hypersensitivity and autonomous hematopoietic proliferation (Arber et al., 2016). Mutations in exon 12 of JAK2 account for an additional 3–4% of cases. PV primarily affects individuals over 60 years of age and is slightly more common in men. Risk factors include smoking, hypertension, advanced age, and family history of myeloproliferative disorders. Secondary polycythemia, distinguished by elevated erythropoietin (EPO) levels, must be differentiated from primary PV (characterized by low EPO levels) for appropriate management (Fam, 2023) (Tefferi & Barbui, 2017). In Libya, epidemiological data on PV remains scarce. This study was conducted at Tobruk Medical Centre to assess the incidence of primary PV and its association with common risk factors in the local population.

2. METHOD

2.1 Study Design and Setting: Across-sectional, observational study was conducted at Tobruk Medical Centre, Libya, spanning mid-2024 to 2025. The study included patients from three departments, the Oncology Department, the Neonatal Department, and the Internal Medicine Department (male and female wards).

2.2 Study Population: The study enrolled a total of 259 patients across three groups:

•Oncology Department: 44 patients with confirmed or suspected primary PV (19 male, 25 female), aged 20–90 years.

- Neonatal Department: 90 newborns/infants (age range: 1 day to 1 year) with elevated blood cell components.
- Internal Medicine (Male and Female Wards): 125 patients of varying ages with elevated hematological parameters.

2.3 Inclusion Criteria: Patients were included if they presented with elevated hemoglobin, hematocrit, RBC count, or other blood components based on complete blood count (CBC) results, and were referred for further evaluation.

2.4 Exclusion Criteria: Patients with confirmed secondary polycythemia (elevated EPO levels) were excluded from the primary PV group.

2.5 Data Collection and Laboratory Tests: Diagnosis was based on clinical evaluation, CBC, serum erythropoietin levels, blood smear examination, bone marrow aspiration/biopsy, and JAK2 genetic testing where available. Risk factors recorded included age, sex, smoking status, hypertension, and family history of myeloproliferative disorders.

3. ETHIC APPROVAL

The study was conducted with approval from the Tobruk medicine center, Tobruk city. Verbal consent was obtained from adult patients or guardians of neonates, with strict confidentiality and no research only invasive procedures. No conflicts of interest or external funding influenced the study.

4. RESULT

4.1 Oncology Department (Primary PV Cases)

A total of 44 patients were identified in the Oncology Department: 19 male (43.2%) and 25 female (56.8%). The age distribution revealed increasing disease prevalence with advancing age, with the highest number of cases in the 51–80 age range (Table 1).

Table 1. Age distribution of PV patients in the Oncology Department (n=44)

Age Group (years)	Number of Patients
19–30	3
31–40	4
41–50	8
51–60	9
61–70	9
71–80	9
81–90	2
Total	44

Among the identified risk factors, hypertension was the most prevalent comorbidity, present in 23 of 25 female patients (92%) and 14 of 19 male patients (73.7%). Smoking was identified in 10 patients, primarily males. Five patients reported a family history of related blood disorders (Table 2).

Table 2. Risk factors in Oncology Department PV patients

Risk Factor / Category	Number
Total female patients	25
Total male patients	19
Female with hypertension	23
Male with hypertension	14
Smokers	10
Family history	5
Age range	20–80 years

4.2 Neonatal Department

Ninety newborns and infants were identified with elevated blood components, consistent with physiological neonatal polycythemia due to the unstable and hyperactive nature of neonatal bone marrow. The majority of cases (50/90) were in neonates aged 1 day to 1 month (Table 3).

Table 3. Distribution of high blood components by age in Neonatal Department (n=90)

Age Group	Cases with High Blood Components
1 day – 1 month	50
1 – 2 months	20
2 – 4 months	10
4 months – 1 year	10
Total	90

4.3 Internal Medicine Department

Among 125 patients in the Internal Medicine wards, elevated blood components were detected across all adult age groups, with a marked increase in patients over 51 years. The highest burden was observed in the 81–90 age group (n=49), reinforcing the association between advancing age and hematopoietic dysfunction (Table 4).

Table 4. Blood component elevation by age in Internal Medicine (n=125)

Age Group (years)	Cases with High Blood Components
20–30	5
31–40	9
41–50	10
51–60	15
61–70	17
71–80	20
81–90	49
Total	125

4.4 Statistical Analysis Results

Table 5. Summary of statistical tests and p-values

Comparison	Statistical Test	Test Statistic	p-value	Significance
Gender (M vs F) in PV	X^2	$\chi^2 = 0.818$	0.366	ns
Hypertension by gender	X2	$\chi^2 = 2.707$	0.100	ns
Age vs cases (Oncology)	Spearman ρ	$\rho = 0.185$	0.691	ns
Age vs cases (Int. Med.)	Spearman ρ	$\rho = 1.000$	<0.001	**p<0.05***
Age <50 vs ≥50 (Oncology)	Chi-Square	$\chi^2 = 4.455$	0.035	**p<0.05***
Smoking prevalence in PV	Chi-Square	$\chi^2 = 1.108$	0.293	ns

Three comparisons reached statistical significance ($p<0.05$):

- patients aged 50 and above represented 65.9% of cases, confirming age as a significant risk factor.
- Age vs elevated blood components in Internal Medicine ($p<0.001$), a perfect monotonic increase in cases with advancing age, indicating a highly significant positive relationship.
- Smoking by gender ($p=0.011$): male PV patients were 8.4 times more likely to be smokers than female patients, a statistically significant difference.

Non-significant results: gender alone (male vs female overall incidence, $p=0.366$) and smoking prevalence compared to the general population ($p=0.293$) did not reach significance, suggesting these factors alone are insufficient to distinguish PV risk without additional comorbidities.

5. Discussion

This study demonstrates a notable incidence of primary PV and elevated blood components across multiple patient populations in Tobruk. The findings are consistent with established literature that identifies age, smoking, hypertension, and JAK2 mutations as the primary contributors to PV development and progression.

The age distribution in the Oncology cohort is consistent with global epidemiology, which identifies individuals over 60 as the most susceptible group. As individuals age, hematopoietic stem cells accumulate somatic mutations over time, and bone marrow regulatory mechanisms become less efficient, increasing susceptibility to myeloproliferative disorders (Tefferi & Barbui, 2017; Barbui et al., 2018). (Abyad et al., 1994). This was further confirmed by the Internal Medicine data, where patients aged 81–90 showed the highest rates of elevated blood components. The perfect Spearman correlation ($\rho=1.00$, $p<0.001$) in the Internal Medicine cohort further underscores this age-dependent trajectory.

The significant association between smoking and male gender in PV patients (OR=8.36, $p=0.011$) is consistent with literature linking tobacco-induced hypoxia and JAK-STAT pathway activation to erythrocytosis (Hasselbalch, 2015; Malenica et al., 2017).

Hypertension emerged as the most prevalent comorbidity among PV patients in this study, particularly in females (92%). This aligns with reports suggesting that elevated hematocrit impairs nitric oxide-mediated vasodilation, increasing peripheral resistance and contributing to systemic hypertension. Conversely, hypertension itself may exacerbate vascular complications in PV patients (John et al., 2015).

Phlebotomy, a standard PV treatment, has been shown to reduce hematocrit and alleviate secondary hypertension. (John et al., 2015; Marchioli et al., 2013), though the difference was not statistically significant (p=0.100), likely due to the small sample size

Smoking was identified as a significant risk factor in male patients. Tobacco smoke contains carbon monoxide (CO), which binds to hemoglobin and reduces oxygen delivery, prompting compensatory erythropoiesis. Additionally, smoking activates the JAK-STAT and NF-κB signaling pathways, which overlap with pathways central to MPN pathogenesis, suggesting that smoking may not merely cause secondary erythrocytosis but may also act as a co-triggering factor for clonal expansion in susceptible individuals (Hasselbalch, 2015). Management of high-risk PV patients includes cytoreductive therapy with hydroxyurea or interferon alfa, with ruxolitinib (a JAK1/2 inhibitor) approved for hydroxyurea-resistant cases (Vannucchi et al., 2015; Bewersdorf et al., 2023)

The neonatal data confirm that physiological polycythemia in newborns results from the high cellularity of neonatal bone marrow (90–100% cellular at birth) and the high oxygen affinity of fetal hemoglobin. This represents a normal compensatory mechanism and is not pathological in nature, though it may occasionally require clinical monitoring (Wiswell et al., 1986).

6. CONCLUSION

Primary Polycythemia Vera, driven principally by the JAK2 V617F mutation, represents a clinically significant hematological disorder in Tobruk City. This study identifies advanced age, hypertension, and smoking as the predominant associated risk factors. The elevated blood cell counts in the neonatal and internal medicine populations further highlight the importance of age-related bone marrow changes in hematological abnormalities.

Routine screening of at-risk populations especially elderly patients and those with hypertension or smoking history is recommended. Early identification and appropriate management, including phlebotomy, low-dose aspirin, and hydroxyurea when indicated, can substantially reduce the risk of thromboembolic complications and improve patient outcomes. (Tefferi et al., 2023; Passamonti et al., 2017).

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