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Publication Ethics

Publication ethics of Greater Mekong Subregion Medical Journal (GMSMJ)

Greater Mekong Subregion Medical Journal presents articles in the field of basic and advanced clinical research in medicine and related health sciences, medical education as well as community medicine in Thailand and international, especially in countries of Greater Mekong Subregion.

The journal publishes 3 issues a year: Issue 1 (January - April), Issue 2 (May - August) and Issue 3 (September -December). All submitted research articles and review articles will be evaluated by a single blinded peer-review process and reviewed by 2 experts who have knowledge, expertise, and experience in the field of medicine and related health sciences prior to publication. The journal encloses the information of authors and reviewers. In case of a difference of evaluation, the article evaluation will be considered and given a final decision.

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Original Article

GMSMJ Greater Mekong Subregion Medical Journal

Community-Based Screening for Heterozygous α^0-Thalassemia (--SEA and --THAI Deletions) Using Multiplex Gap-PCR in Pathum Thani Province

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Abstract:

Introduction: Alpha-thalassemia is a significant public health problem in Thailand, particularly the Southeast Asian (--SEA) deletion and the THAI deletion (--THAI), which are major causes of heterozygous α^0-thalassemia and may lead to hemoglobin Bart's hydrops fetalis, a life-threatening condition in fetuses.

Objectives: This study aimed to determine the prevalence of heterozygous α^0-thalassemia due to --SEA and --THAI deletions in a community population and to evaluate its association with hematological parameters.

Materials and Method: A cross-sectional study was conducted on 95 individuals (aged ≥18 years) residing in Pathum Thani Province. Leftover EDTA blood samples from routine health check-ups were tested for α^0-thalassemia (--SEA and --THAI deletions) using multiplex gap-PCR. Hemoglobin (Hb) levels and red blood cell indices were obtained from complete blood counts. Anemia was defined by World Health Organization (WHO) criteria (Hb < 13 g/dL in males, Hb < 12 g/dL in females). Statistical analysis used Fisher's exact test to compare proportions.

Results: Of the 95 participants, 90 (94.7%) had a normal genotype ($\alpha\alpha/\alpha\alpha$), and five (5.3%) were carriers of the --SEA deletion. No --THAI deletion carriers were detected. All individuals carrying the --SEA deletion exhibited anemia with microcytosis, whereas 30% of those with normal genotype were anemic. The association between --SEA carrier status and both anemia and microcytosis was statistically significant ($p < 0.01$).

Conclusion: The heterozygous α^0-thalassemia (--SEA deletion) carrier rate was 5.3% in this community sample. Multiplex gap-PCR proved to be an effective tool for community-based thalassemia carrier screening. These findings provide essential

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baseline data for planning premarital screening programs and allocating resources for genetic counseling in Pathum Thani.

Keywords: Alpha-Thalassemia; Gene Deletion; Multiplex Polymerase Chain Reaction; Genetic Carrier Screening; Prevalence

Introduction

Thalassemia is one of the most common inherited anemias worldwide and represents a major public health challenge in many regions. The World Health Organization (WHO) estimates that approximately 7% of the global population are carriers of thalassemia genes, with around 300,000 infants born each year with severe forms of the disease.[1] Thalassemia not only affects patients' quality of life but also poses a significant barrier to achieving the United Nations Sustainable Development Goals (SDGs), particularly Goal 3: Good Health and Well-being. Prevention and control of genetic disorders such as thalassemia are directly linked to reducing infant mortality, improving maternal health, and alleviating the economic burden on families and healthcare systems.

Thailand is located within the global "thalassemia belt," resulting in a high carrier prevalence, with approximately 30–40% of the Thai population carrying at least one thalassemia gene. Combinations of these abnormal genes give rise to more than 60 thalassemia syndromes with varying clinical severity, ranging from asymptomatic conditions to fatal diseases.[2] Consequently, the Thai government has incorporated thalassemia into the National Thalassemia Prevention and Control Program, aiming to reduce the incidence of three severe forms: homozygous β-thalassemia, β-thalassemia/Hb E disease, and hemoglobin Bart's hydrops fetalis.[3] The core strategy of this program involves carrier screening in pregnant women and their partners using preliminary hematological tests such as mean corpuscular volume (MCV) and the dichlorophenolindophenol (DCIP) test for hemoglobin E (Hb E).[4]

Alpha-thalassemia is the most prevalent form of thalassemia in Thailand, with an average carrier frequency of 20.1%, one of the highest in Southeast Asia.[5] The disease results from deletions or mutations of the α-globin genes located on chromosome 16, leading to reduced or absent α-globin chain production.[6] The most severe condition, homozygous α^0-thalassemia, occurs when both parents are α^0-thalassemia carriers, resulting in a 25% chance of having a fetus with hemoglobin Bart's hydrops fetalis (––/––), which is usually fatal in utero or shortly after birth. This condition also increases the risk of serious maternal complications such as preeclampsia and postpartum hemorrhage.[7]

Reported frequencies of α^0-thalassemia deletions in Thailand vary by region and study population but consistently show that the Southeast Asian deletion (--SEA) is the predominant α^0-thalassemia determinant, whereas the Thai deletion (--THAI) is distinctly uncommon. In a 7-year screening study from Ramathibodi Hospital, Bangkok, involving 31,632 blood samples, the overall α-thal-1 carrier rate was 14.40%, comprising --SEA 14.21% and --THAI 0.18%.[6] Similarly, a large referral-center study from northeast Thailand analyzing 12,525 specimens found α^0-thalassemia alleles in 15.0% of samples, including 14.8% with the --SEA deletion and 0.2% with the --THAI deletion.[8] In northern Thailand, heterozygous --SEA was reported in 12.23% of 638 pregnant women, while a

population-based ethnic survey found --SEA in 3.5% and no --THAI carriers.[9]

Although national data on thalassemia prevalence in Thailand are well documented, particularly in northern regions with high prevalence[10], community-level data from metropolitan provinces such as Pathum Thani remain limited. Pathum Thani is a semi-urban province within the Bangkok metropolitan area, characterized by population migration from all regions of the country, resulting in high genetic diversity. Thus, this area may better reflect the genetic structure of modern Thai society compared with more genetically homogeneous rural areas. Previous community health screening in Sam Khok District, conducted by the Faculty of Allied Health Sciences, Pathum Thani University, reported an anemia prevalence of up to 20% (unpublished data, 2024), indicating the need for further investigation, particularly regarding thalassemia carrier status.

Preliminary screening using red blood cell indices is sensitive but lacks specificity and may yield false-positive results due to conditions such as iron deficiency.[4] Therefore, molecular confirmation is essential. This study employed the multiplex gap-PCR technique because of its high efficiency in simultaneously detecting --SEA and --THAI deletions in a single reaction, with high sensitivity and specificity (>95%), simple procedures, and relatively low cost compared with other molecular methods, making it particularly suitable for large-scale community screening.[11]

Objectives

1. To determine the prevalence and 95% confidence interval of heterozygous α^0-thalassemia caused by --SEA and --THAI deletions in a sample population from Pathum Thani Province.

2. To analyze the association between α^0-thalassemia carrier status and hematological parameters, particularly anemia and microcytosis.

3. To provide baseline data to support public health policy planning, population-specific genetic counseling services, and the development of effective community-based thalassemia prevention strategies in Pathum Thani Province.

Materials and Method

Study Design and Ethical Approval

This study was a cross-sectional descriptive study. The research protocol was reviewed and approved by the Human Research Ethics Committee of Pathum Thani University (Approval No. PTU-IRB-CERT-CL-2025-030; approved on 11 August 2025). Only leftover blood samples from routine health check-ups were used, and all personal identifiers were removed.

Study Population and Sample Size

The study population consisted of individuals aged 18 years and older residing in Sam Khok District, Pathum Thani Province, who participated in an annual health check-up program. Inclusion criteria were consent to use leftover EDTA blood samples and no history of blood transfusion within three months prior to testing. Exclusion criteria included hematological disorders affecting erythropoiesis (e.g., aplastic anemia, myelodysplastic syndrome) and insufficient or poor-quality DNA samples.

Sample size was calculated using a prevalence estimation formula based on a reported α-thalassemia carrier prevalence of 22.6% in Southeast Asia (Goh et al., 2020), with a 95% confidence level ($\alpha = 0.05$) and an allowable error (d) of 0.08. The minimum required sample size was approximately 90 participants. Blood samples were stored at 4°C until DNA extraction.

Study Area

Sam Khok District, Pathum Thani Province, was selected due to its semi-urban characteristics and ethnically diverse population, reflecting the overall demographic structure of the province. Previous community health screening reported a high anemia prevalence of 20% (unpublished data, 2024), underscoring the importance of genetic disease surveillance in this area.

Hematological Analysis

Hematological parameters, including hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH), were obtained from routine complete blood count analysis using an automated hematology analyzer. Anemia was defined according to WHO criteria (Hb < 13 g/dL in males and < 12 g/dL in females), and microcytosis was defined as MCV < 80 fL.[12]

DNA Extraction

Genomic DNA was extracted from 300 μL of EDTA blood using a commercial DNA extraction kit (Favorgen Biotech Corp., Taipei, Taiwan). DNA concentration and purity were measured using a spectrophotometer (PerkinElmer, MA, USA) at 260 nm. DNA samples with concentrations of 25–50 ng/μL were stored at –20°C until analysis.

Detection of α^0-Thalassemia (--SEA and --THAI Deletions) by Multiplex Gap-PCR

Multiplex gap-PCR was performed using KAPA 2G Fast HotStart ReadyMix with dye (Kapa Biosystems, USA). Primer sequences were based on.[13] PCR amplification was conducted using a PCRmax thermal cycler under standard cycling conditions. PCR products were analyzed by 2% agarose gel electrophoresis and interpreted according to band size.

Quality Control and Interpretation

Each PCR run included positive controls for --SEA/αα, --THAI/αα, a normal genotype (αα/αα), and a no-template negative control. Band sizes were interpreted as follows: normal genotype (1010 bp), --SEA deletion (660 bp), and --THAI deletion (410 bp).

Statistical Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize demographic data and carrier prevalence with 95% confidence intervals. Fisher's exact test was applied to compare categorical variables (e.g., proportions of anemia and microcytosis between groups). A p-value < 0.05 was considered statistically significant.

Results

A total of 95 participants were included in the study, comprising 73 females (76.8%) and 22 males (23.2%), with a mean age of 45.9 years. The demographic characteristics and hematological indices of the participants stratified by genotype. Carriers of the --SEA deletion had markedly lower mean hemoglobin (10.6 g/dL vs 12.9 g/dL) and hematocrit (34.6% vs 40.1%) compared to those with a normal genotype, reflecting anemia. The mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were also substantially lower in --SEA carriers (58.8 fL and 19.8 pg, respectively) than in individuals with normal genotype (87.5 fL and 28.1 pg), indicating pronounced microcytosis in the carrier group (Table 1). Genotypic analysis by multiplex gap-PCR identified 90 individuals (94.7%) with the normal genotype (αα/αα) and five individuals (5.3%) as heterozygous --SEA deletion carriers (--SEA/αα). No carriers of the --THAI deletion were detected in this population (Table 2). Figure 1 illustrates

the multiplex gap-PCR results: all samples from --SEA deletion carriers exhibited the expected 660 bp deletion band in addition to the normal 1010 bp band, whereas samples with the normal genotype showed only the 1010 bp band.

Table 1 Demographic and hematological characteristics of participants by α-thalassemia genotype (normal vs. --SEA deletion carrier).

Characteristics	Normal Genotype (αα/αα) (n = 90)	--SEA Deletion Carrier (--SEA/αα) (n = 5)
Sex (Male/Female)	21/69	1/4
Mean age (years)	45.8	47.6
Mean Hb (g/dL)	12.9	10.6
Mean Hct (%)	40.1	34.6
Mean MCV (fL)	87.5	58.8
Mean MCH (pg)	28.1	19.8

Table 2 Frequency distribution of α^0-thalassemia genotypes in the study population (N = 95).

Genotype	Number of individuals	Percentage (%)
αα/αα	90	94.7
--SEA/αα	5	5.3
--THAI/αα	0	0
Total	**95**	**100**

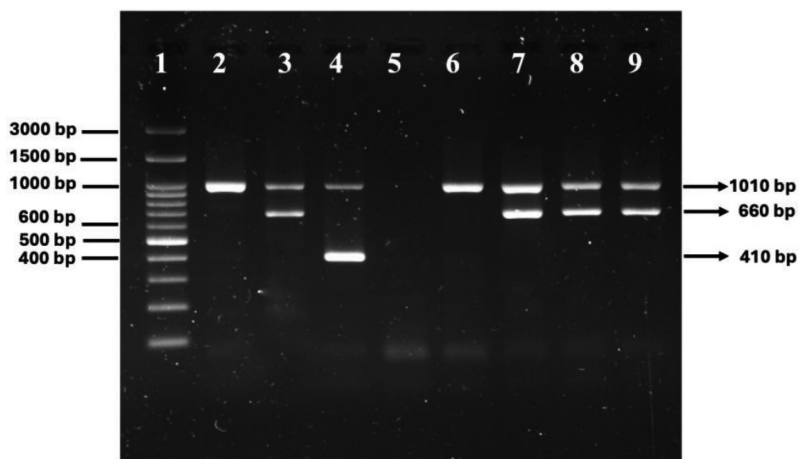


Figure 1 Multiplex gap-PCR results for detection of α^0-thalassemia (--SEA and --THAI deletions). Lane 1: 100 bp DNA ladder; Lane 2: normal genotype (αα/αα), showing a 1010 bp band; Lane 3: heterozygous --SEA deletion carrier (--SEA/αα, positive control), showing 1010 bp and 660 bp bands; Lane 4: heterozygous --THAI deletion carrier (--THAI/αα, positive control), showing 1010 bp and 410 bp bands; Lane 5: negative control (no DNA template); Lane 6: study sample with normal genotype (αα/αα); Lanes 7–9: study samples identified as heterozygous --SEA deletion carriers (--SEA/αα).

In this study, all five --SEA deletion carriers were anemic (100%), whereas among the 90 individuals with normal genotype, 27 (30.0%) had anemia and 63 (70.0%) were non-anemic (Table 3). This difference in anemia prevalence between carriers and non-carriers was statistically significant ($p = 0.0035$). Similarly, all --SEA carriers (100%) had microcytic red blood cells (MCV < 80 fL), compared to 21 (23.3%) of the normal-genotype group (Table 4). The association between --SEA carrier status and microcytosis was also significant ($p = 0.0011$). Overall, the presence of a heterozygous --SEA deletion was strongly correlated with increased risk of anemia and microcytosis in this population ($p < 0.01$).

Table 3 Anemia status of participants by α-thalassemia genotype.

Genotype	Anemic n (%)	Non-anemic n (%)	Total (N)
αα/αα	27 (30.0)	63 (70.0)	90
--SEA/αα	5 (100)	0 (0)	5
Total	**32 (33.7)**	**63 (66.3)**	**95**

Note: Anemia defined as Hb < 13 g/dL in males and Hb < 12 g/dL in females (WHO criteria). *p*-value (Fisher's exact test) = 0.0035 for difference in anemia prevalence between genotypes.

Table 4 Prevalence of microcytosis (MCV < 80 fL) among participants by α-thalassemia genotype.

Genotype	Microcytic RBC n (%)	Non-microcytic RBC n (%)	Total (N)
--SEA/αα	5 (100)	0 (0)	5
αα/αα	21 (23.3)	69 (76.7)	90
Total	**26 (27.4)**	**69 (72.6)**	**95**

Note: Microcytosis defined as MCV < 80 fL. *p*-value (Fisher's exact test) = 0.0011 for difference in microcytosis between genotypes.

Discussion

In this community-based study in Pathum Thani, the prevalence of heterozygous α^0-thalassemia (--SEA deletion) carriers was 5.3%, and no --THAI deletion carriers were identified. This finding reflects the genetic distribution in central Thailand, where the --SEA deletion is known to be the predominant α-thalassemia mutation.[11] All carriers in our study had anemia and microcytosis, highlighting the clear hematological impact of losing one pair of α-globin genes. The differences in hemoglobin level and red cell indices between carriers and non-carriers were statistically significant, consistent with reports that even a single α^0-thalassemia deletion can cause notable hematologic changes.[1,14]

The absence of --THAI deletion carriers in this sample may be explained by the limited geographic distribution of the --THAI mutation, which is restricted to certain areas of central and southern Thailand.[3,15] Additionally, the sample size and the fact that participants were drawn

from a single district could limit the detection of such a rare mutation. Regional variations in α-thalassemia prevalence have been documented; while the average α-thalas semia carrier rate in Thailand is about 20%[5], the rate can vary widely between different provinces and ethnic groups. The carrier rate of 5.3% observed in Pathum Thani is lower than the national average, potentially due to the province's diverse population and the presence of other genetic factors. Notably, all --SEA carriers in our study had only mild-to-moderate anemia. This raises the possibility of concurrent factors such as iron deficiency or co-inheritance of other hemoglobinopathies (e.g., Hb E trait), which are common in the Thai population and could influence the hematological presentation.[2,16]

The application of multiplex gap-PCR proved to be practical and effective for community screening. This technique can simultaneously detect multiple α-globin gene deletions (--SEA, --THAI, and others) in a single test, with high sensitivity and specificity (over 95%) [11]. Our findings support previous studies[11,17] that demonstrated multiplex PCR as a reliable method comparable to conventional PCR for thalassemia mutation detection, yet more efficient for screening purposes. The ability to use standard laboratory equipment without requiring advanced technology makes multiplex gap-PCR especially suitable for widespread screening in resource-limited settings.

The limitation of this study is relatively small sample size and the focus on only two deletional mutations, which may not capture all forms of α-thalassemia carriers in the community. Nevertheless, the data provide a valuable snapshot of carrier prevalence in a semi-urban Thai population and underscore the importance of proactive screening. Our results are in line with current recommendations that community-level carrier screening and genetic counseling are crucial for preventing new cases of severe thalassemia.[18] Identifying carrier couples before or during early pregnancy can effectively prevent the birth of infants with hemoglobin Bart's hydrops fetalis, a condition that is incompatible with life and poses serious risks to maternal health.[7,18] These findings reinforce the need to integrate molecular thalassemia screening into existing public health programs, such as premarital check-ups and antenatal care, as advocated by the National Thalassemia Prevention and Control Program.[2,19]

From a broader public health perspective, implementing community-based thalassemia carrier screening using multiplex PCR is a cost-effective approach to reduce the burden of severe thalassemia. Such screening can be expanded province-wide or nationally, for example, by incorporating it into routine premarital or preconception health screening programs supported by the Ministry of Public Health. Further studies on the cost-effectiveness of this strategy are warranted to confirm the long-term benefits, including reduced healthcare expenditures for thalassemia patient care and improved quality of life for at-risk populations.[4]

Conclusion

In this community sample, the carrier frequency of heterozygous α^0-thalassemia due to the --SEA deletion was 5.3%, while no --THAI carriers were detected. Multiplex gap-PCR was feasible for community-based screening in this setting. Integration of this molecular screening into public health initiatives could help prevent severe thalassemia cases and inform targeted genetic counseling strategies.

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References

1. Tuo Y, Li Y, Li Y, Ma J, Yang X, Wu S, et al. Global, regional, and national burden of thalassemia, 1990–2021: a systematic analysis for the global burden of disease study 2021. eClinical Medicine. 2024;72: 102619. https://doi.org/10.1016/j.eclinm.2024. 102619.
2. Paiboonsukwong K, Jopang Y, Winichagoon P, Fucharoen S. Thalassemia in Thailand. Hemoglobin. 2022; 46: 53–7. https://doi:10.1080/03630269.2022.2025824.
3. Leckngam P. Thalassemia and Hemoglobinopathies in Thailand: A Systematic Review. Journal of Health Science and Alternative Medicine, 5 (03), 104–13. https://doi.org/10.14456/jhsam.2023.24.
4. Jindatanmanusan P, Riolueang S, Glomglao W, Sukontharangsri Y, Chamnanvanakij S, Torcharus K, et al. Diagnostic applications of newborn screening for α-thalassaemias, haemoglobins E and H disorders using isoelectric focusing on dry blood spots. Ann Clin Biochem. 2014; 51 (Pt 2): 237-47. https://doi: 10.1177/0004563213491078.
5. Goh LPW, Chong ETJ, Lee PC. Prevalence of alpha (α)-thalassemia in Southeast Asia (2010–2020): A meta-analysis involving 83,674 subjects. Int J Environ Res Public Health. 2020; 17 (20): 7354. https://doi: 10.3390/ijerph17207354.
6. Musallam KM, Barella S, Origa R, Ferrero GB, Lisi R, Pasanisi A, et al. Revisiting iron overload status and change thresholds as predictors of mortality in transfusion-dependent β-thalassemia: A 10-year cohort study. Ann Hematol. 2024; 103 (7): 2283-97. https://doi: 10.1007/s00277-024-05715-x.
7. Srisupundit K, Wanapirak C, Sirichotiyakul S, Tongprasert F, Luewan S, Traisrisilp K, et al. Fetal red blood cell hematology at mid-pregnancy among fetuses at risk of homozygous β-thalassemia disease. J Pediatr Hematol Oncol. 2013; 35 (8): 628-30. https://doi: 10.1097/MPH.0b013e3182a2717a.
8. Chaibunruang A, Prommetta S, Yamsri S, Fucharoen G, Sae-Ung N, Sanchaisuriya K, et al. Molecular and hematological studies in a large cohort of α^0-thalassemia in northeast Thailand: data from a single referral center. Blood Cells, Molecules, and Diseases. 2013; 51 (2): 89–93. https://doi.org/10.1016/j.bcmd.2013.04.003.
9. Pharephan S, Sirivatanapa P, Makonkawkeyoon S, Tuntiwechapikul W, Makonkawkeyoon L. Prevalence of α-thalassaemia genotypes in pregnant women in northern Thailand. Indian J Med Res. 2016; 143 (3): 315–22. https://doi: 10.4103/0971-5916.182622.
10. Lithanatudom P, Khampan P, Smith DR, Svasti S, Fucharoen S, Kang wanpong D, et al. The prevalence of alpha-thalassemia amongst Tai and Mon-Khmer ethnic groups residing in northern Thailand: A population-based study. Hematology. 2016; 21 (8): 480-5. https://doi: 10.1080/10245332.2016.1148374.
11. Jomoui W, Panyasai S, Sripornsawan P, Tepakhan W. Revisiting and

updating molecular epidemiology of α-thalassemia mutations in Thailand using MLPA and new multiplex gap-PCR for nine α-thalassemia deletion. Sci Rep. 2023; 13 (1): 9850. https://doi: 10.1038/s41598-023-36840-8.

12. World Health Organization. Guideline on haemoglobin cutoffs to define anaemia in individuals and populations. Geneva: World Health Organization; 2024. ISBN-13: 978-92-4-008854-2ISBN-13: 978-92-4-008855-9.
13. Old J, Harteveld CL, Traeger-Synodinos J, Petrou M, Angastiniotis M, Galanello R. Prevention of thalassaemias and other haemoglobin disorders: volume 2: laboratory protocols. 2014. Thalassaemia International Federation, Nicosia 2083, Cyprus.
14. Meri MA, Al-Hakeem AH, Al-Abeadi RS. An overview on thalassemia: A review article. Medical Science Journal for Advance Research. 2022; 3 (1): 26–32. https://doi.org/10.46966/msjar.v3i1.36.
15. Laosombat V, Viprakasit V, Chotsampancharoen T, Wongchanchailert M, Khodchawan S, Chinchang W, et al. Clinical features and molecular analysis in Thai patients with HbH disease. Ann Hematol. 2009; 88 (12): 1185-92. https://doi: 10.1007/s00277-009-0743-5.
16. Fucharoen S, Weatherall DJ. The hemoglobin E thalassemias. Cold Spring Harb Perspect Med. 2012; 2 (8): a011734. https://doi: 10.1101/cshperspect. a011734.
17. Wichian P, Yamsri S, Sanchaisuriya K, Fucharoen S. Direct amplification of whole blood and amniotic fluid specimens for prenatal and postnatal diagnosis of Hb E-β^0-Thalassemia diseases. Lab Med. 2021; 52 (5): 460-8. https://doi:10.1093/labmed/lmaa117.
18. Songdej D, Fucharoen S. Alpha-thalassemia: diversity of clinical phenotypes and update on the treatment. Thalass. Rep. 2022, 12 (4), 157-72; https://doi.org/10.3390/thalassrep12040020.
19. Buakhao J. Guidelines for the care of thalassemia patients in general practice. Bangkok: The War Veterans Organization of Thailand printing. 2017.


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Special Article

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Violence in Healthcare Settings: A Scoping Review of Theoretical Foundations and Implications for Violence Prevention in Healthcare Systems

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Abstract:

Background: Workplace violence in healthcare settings is a growing occupational health concern affecting healthcare workers worldwide. Exposure to aggression and threats can negatively impact staff wellbeing and the quality of patient care.

Objectives: This scoping review aimed to synthesize theoretical perspectives and empirical evidence related to workplace violence in healthcare settings and to examine implications for violence prevention strategies in healthcare systems.

Materials and Method: The review followed the methodological framework proposed by Arksey and O'Malley and further refined by Levac and colleagues. Literature searches were conducted in PubMed, CINAHL, PsycINFO, and the Thai-Journal Citation Index for studies published between 2014 and 2024. Titles and abstracts were screened independently by two reviewers, followed by full-text assessment based on predefined inclusion criteria.

Results: The search identified 1,847 records. After screening and eligibility assessment, 16 studies were included in the final synthesis. The literature highlighted several relevant theoretical perspectives, including emotional intelligence, ecological systems theory, and communication-based approaches to conflict management. Empirical findings indicate that workplace violence is shaped by interactions among patient characteristics, staff communication practices, and organizational factors.

Conclusion: Effective violence prevention requires integrated strategies addressing individual competencies, organizational policies, and systemic conditions within healthcare systems.

Keywords: Workplace violence; Healthcare workers; Violence prevention; Healthcare settings; Scoping review; Occupational health

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Introduction

Workplace violence directed toward healthcare workers has become a significant concern within healthcare systems around the world.[1,2] Healthcare professionals frequently encounter aggressive behavior in the form of verbal abuse, threats, and physical assault while performing their clinical duties.[3,4] Research conducted across different countries consistently demonstrates that healthcare workers experience higher rates of workplace violence than employees in most other occupational sectors.[1,2]

The impact of workplace violence extends beyond immediate physical harm. Exposure to aggression can lead to psychological distress, reduced job satisfaction, and increased burnout among healthcare workers.[5] These consequences may contribute to staff turnover and workforce instability, which in turn can affect the quality and continuity of patient care.[5] Environments characterized by frequent violence may also disrupt communication among healthcare teams and undermine patient safety.

Despite the growing body of research addressing workplace violence in healthcare settings, the existing literature remains fragmented across multiple academic disciplines. Studies addressing this issue have emerged from fields such as nursing science, occupational health, psychology, and healthcare management.[2,5] While these contributions provide valuable insights, they often focus on specific aspects of violence rather than integrating theoretical and empirical perspectives into a comprehensive framework.

Another important limitation of the existing literature concerns geographical representation. Many studies on healthcare workplace violence originate from North America and Europe. Although these studies provide important evidence, their findings may not fully reflect the cultural and organizational contexts of healthcare systems in other regions, particularly in Asia.

Healthcare interactions are influenced by cultural norms related to communication, authority, and social relationships. In many Asian healthcare systems, communication styles tend to emphasize respect for hierarchy and the maintenance of interpersonal harmony. These cultural characteristics may influence how conflicts emerge and how healthcare professionals respond to potentially aggressive situations.

Historically, institutional responses to workplace violence have often focused on security measures such as surveillance systems and the presence of security personne[1,6] While these measures are important components of workplace safety, they do not address the interpersonal dynamics that frequently precede violent incidents. Communication breakdowns, unmet expectations, and emotional distress among patients or their family members can contribute to the escalation of conflict in healthcare settings.

A broader understanding of workplace violence therefore requires conceptual frameworks that consider individual behavior, interpersonal communication, and organizational context simultaneously. Scoping reviews provide a useful methodological approach for synthesizing diverse forms of evidence and identifying conceptual patterns within complex research fields. The present review was conducted to examine theoretical and empirical literature related to workplace violence in healthcare settings and to identify key concepts relevant to violence prevention strategies.

Method

This study employed a scoping review methodology to explore the range of research addressing workplace violence in healthcare environments. The review

followed the methodological framework proposed by Arksey and O'Malley[7] and later refined by Levac.[8] Scoping reviews are particularly suitable for mapping interdisciplinary evidence and identifying conceptual gaps in the literature.

A comprehensive literature search was conducted using four electronic databases: PubMed, CINAHL Complete, PsycINFO, and the Thai-Journal Citation Index. Search terms were developed to capture three main concepts: workplace violence, healthcare settings, and prevention strategies. Keywords included combinations of terms such as "workplace violence," "aggression," "healthcare workers," "hospital," "communication," and "violence prevention." The search included studies published between January 2014 and December 2024.

Two reviewers independently screened titles and abstracts to identify potentially relevant articles. Publications that appeared to meet the inclusion criteria were retrieved for full-text review. Disagreements between reviewers were resolved through discussion.

The initial search identified 1,847 records. After removing duplicate entries, titles and abstracts were screened to assess relevance. A total of 312 articles were considered potentially relevant and were retrieved for full-text review. Following the application of inclusion and exclusion criteria, 16 studies were retained for inclusion in the final synthesis.

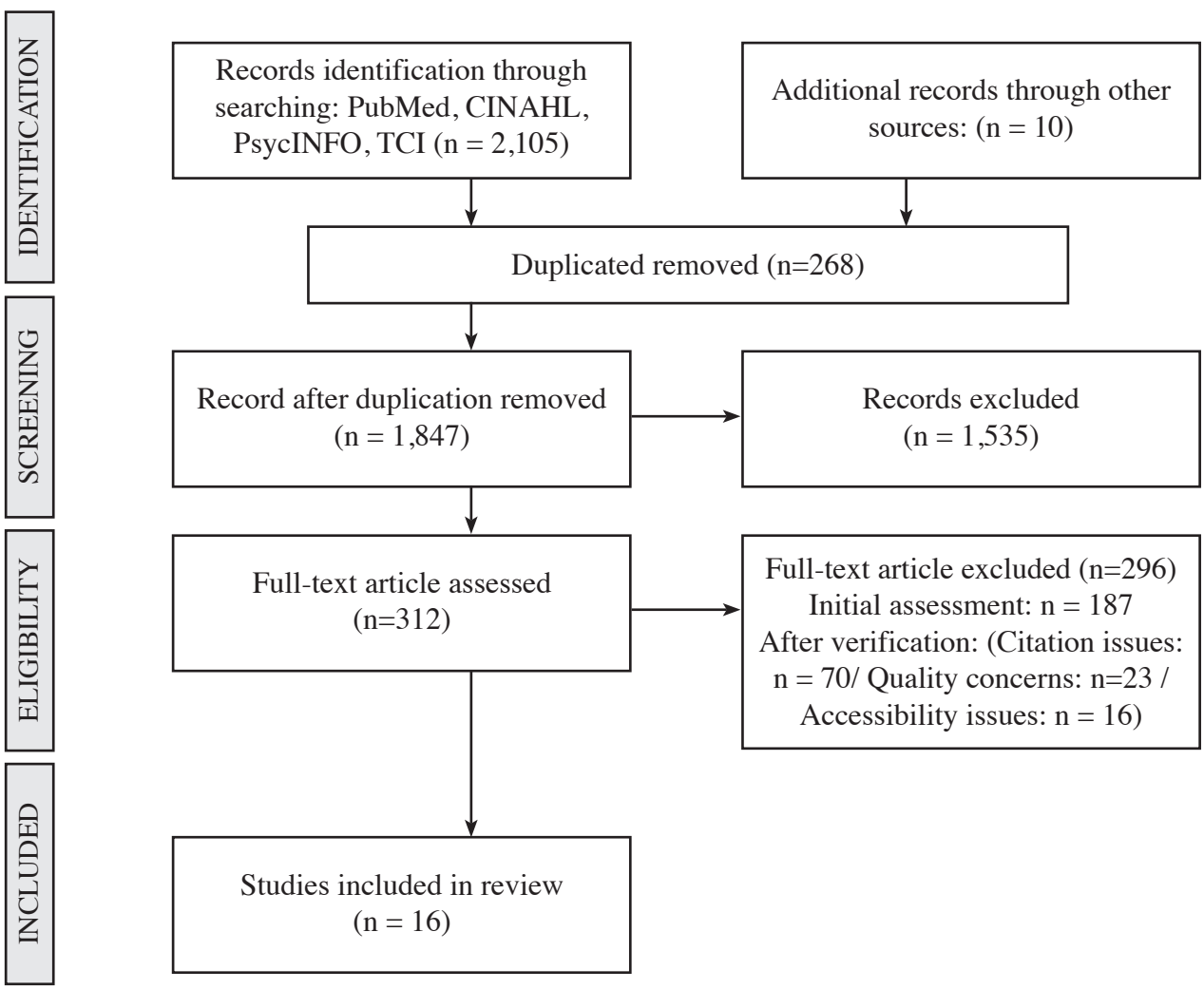


Figure 1 PRISMA flow diagram of the study selection process

Data extracted from each study included information on publication year, study location, research design, setting, and key findings. Because the included studies varied in design and objectives, the findings were synthesized using narrative thematic analysis.

This scoping review constitutes a component of a broader research initiative previously published elsewhere, which received ethics approval from the Ministry of Public Health Institutional Review Board (IRB No. EC 033-2568, issued 21 October 2025).

Results

The characteristics of the studies included in the final synthesis are summarized in Table 1. The selected publications represent a combination of empirical investigations, theoretical contributions, and methodological discussions related to workplace violence in healthcare settings. Most empirical studies were conducted in hospital environments, particularly emergency departments, psychiatric units, and inpatient wards, where healthcare workers are frequently exposed to aggressive behaviors from patients or visitors.[3,9,10]

Across the included studies, research designs varied considerably. Several investigations employed cross-sectional survey methods to assess the prevalence and correlates of workplace violence among healthcare workers. Other studies adopted qualitative approaches to explore healthcare professionals' experiences and perceptions of violent incidents. In addition, a number of publications provided theoretical frameworks or conceptual models relevant to violence prevention, including perspectives from psychology, communication theory, and organizational behavior.

The geographical distribution of the studies reflects the global nature of workplace violence in healthcare, with research conducted across North America, Europe, and Asia. Despite differences in healthcare systems and cultural contexts, the studies consistently highlight similar risk factors, including high patient volumes, inadequate staffing, communication breakdowns, and insufficient organizational support for incident reporting and prevention.

Table 1 Characteristics of Studies Included in the Scoping Review

Author	Year	Country	Study Design	Sample/Setting	Key Findings
Arnetz et al.[11]	2015	USA	Cross-sectional	Hospital staff	Workplace violence frequently underreported
Spector et al.[1]	2014	International	Meta-analysis	Nurses worldwide	High prevalence of workplace violence
Lanctôt & Guay[5]	2014	Canada	Literature review	Healthcare workers	Violence linked to psychological distress
Peek-Asa et al.[6]	2009	USA	Intervention study	Psychiatric facilities	Prevention programs reduce incidents
Liu et al.[2]	2019	China	Systematic review	Healthcare workers	Violence prevalent across clinical settings

Table 1 Characteristics of Studies Included in the Scoping Review (con.)

Author	Year	Country	Study Design	Sample/Setting	Key Findings
Shi et al.[4]	2020	China	Cross-sectional	Hospital staff	Organizational factors linked to violence
Aljohani et al.[9]	2021	Saudi Arabia	Cross-sectional	Emergency departments	High exposure to verbal aggression
Hassankhani et al.[10]	2018	Iran	Qualitative	Nurses	Staff perceive violence as routine
Chapman et al.[3]	2009	UK	Cross-sectional	Nurses	Patient aggression common
Barrera & Castro[12]	2006	USA	Conceptual	Intervention science	Cultural adaptation framework
Fredrickson[13]	2001	USA	Theory	Psychology	Positive emotions build resilience
Fredrickson[14]	2013	USA	Theory	Psychology	Broaden-and-build theory
Goleman[15]	1995	USA	Theory	Organizational behavior	Emotional intelligence framework
Bronfenbrenner[16]	1979	USA	Theory	Developmental systems	Ecological systems theory
Levac et al.[8]	2010	Canada	Methodological	Research synthesis	Improved scoping review methods
Arksey & O'Malley[7]	2005	UK	Methodological	Research synthesis	Scoping review framew

The studies included in this review represented a combination of theoretical contributions, methodological discussions, and empirical investigations of workplace violence in healthcare settings. Theoretical works provided conceptual perspectives on communication, emotional regulation, and conflict management, while empirical studies examined patterns of violence within specific healthcare environments.

Research across different healthcare systems consistently indicates that healthcare workers frequently encounter verbal aggression and threatening behavior.[1,2,4] Although physical violence occurs less often, it remains a significant occupational risk. Studies conducted in emergency departments and psychiatric facilities report particularly high exposure rates due to the intensity and unpredictability of patient interactions in these settings.

Several studies also highlight the problem of underreporting.[11] Healthcare workers may perceive aggression as an unavoidable aspect of clinical work or may believe that reporting incidents will not lead to meaningful organizational change. As a result, official incident records often underestimate the true prevalence of workplace violence.

The literature identifies multiple factors that contribute to the occurrence of violence in healthcare environments. Patient-related factors include psychological distress,

cognitive impairment, substance intoxication, and frustration associated with illness or healthcare access. Staff-related factors may involve limited experience in conflict management or communication difficulties during stressful situations. Organizational factors, including staffing shortages, high patient volumes, and inadequate reporting systems, also play a critical role in shaping the risk of violent incidents.

Research examining prevention strategies suggests that effective interventions typically involve multiple components. Communication training programs designed to enhance empathy and de-escalation skills are frequently cited as key elements of prevention. However, studies also emphasize the importance of organizational support, clear reporting procedures, and leadership commitment to staff safety.

Discussion

The findings of this review indicate that workplace violence in healthcare settings is a complex phenomenon influenced by multiple interacting factors. Empirical studies consistently show that healthcare workers experience high levels of verbal aggression, particularly in high-intensity clinical environments such as emergency departments and psychiatric services. Although physical violence occurs less frequently, it remains a serious occupational risk.

Theoretical frameworks identified in the literature provide important insights into the mechanisms underlying violent incidents. Emotional intelligence theory emphasizes the role of emotional awareness and regulation in managing difficult interactions.[15] Similarly, the broaden-and-build theory of positive emotions suggests that positive emotional states may enhance resilience and adaptive coping in stressful situations.[13,14]

Ecological systems theory highlights the influence of organizational and environmental conditions on individual behavior.[16] From this perspective, workplace violence should be understood not only as an interpersonal problem but also as an outcome of structural conditions within healthcare systems.

The literature also highlights the importance of communication practices in preventing the escalation of conflict. Healthcare workers who receive training in communication and de-escalation techniques may be better equipped to manage emotionally charged interactions with patients or family members. However, training alone is unlikely to eliminate workplace violence without broader organizational support.

Organizational interventions and structured prevention programs have been shown to reduce workplace violence incidents in healthcare environments.[6] In environments where aggression is perceived as an inevitable aspect of clinical work, incidents may go unreported and preventive measures may be limited. In contrast, institutions that recognize workplace violence as a significant occupational health issue are more likely to implement effective reporting systems and prevention strategies.

Conclusion

Workplace violence remains a significant challenge for healthcare systems worldwide. The evidence synthesized in this review suggests that effective prevention strategies must address individual competencies, interpersonal communication processes, and organizational structures simultaneously. By integrating theoretical and empirical perspectives, this study provides a conceptual foundation for the development of comprehensive violence prevention initiatives in healthcare settings.

AI-Assisted Writing Disclosure

Artificial intelligence–assisted writing tools were used to support language editing and improve clarity during manuscript preparation. The authors were responsible for all intellectual content, interpretation of findings, and final approval of the manuscript.

References

1. Spector P E, Zhou ZE, Che XX. Nurse exposure to physical and nonphysical violence, bullying, and sexual harassment: A quantitative review. International Journal of Nursing Studies. 2014; 51 (1): 72–84. https://doi.org/10.1016/j.ijnurstu.2013.01.010
2. Liu J, Gan Y, Jiang H, Li L, Dwyer R, Lu K, et al. Prevalence of workplace violence against healthcare workers: A systematic review and meta-analysis. Occupational and Environmental Medicine. 2019; 76 (12): 927–37. https://doi.org/10.1136/oemed-2019-105849
3. Chapman R, Perry L, Styles I, Combs S. Predicting patient aggression against nurses in all clinical settings. British Journal of Nursing. 2009; 18 (8): 476–83. https://doi.org/10.12968/bjon.2009.18.8.42435
4. Shi L, Zhang D, Zhou C, Yang L, Sun T, Hao T, et al. A cross-sectional study on the prevalence and risk factors for workplace violence against healthcare workers in China. BMJ Open. 2020; 10 (6): e036456. https://doi.org/10.1136/bmjopen-2019-036456
5. Lanctôt N, Guay S. The aftermath of workplace violence among healthcare workers: A systematic literature review of the consequences. Aggression and Violent Behavior. 2014; 19 (5): 492–501. https://doi.org/10.1016/j.avb.2014.07.010
6. Peek-Asa C, Casteel C, Allareddy V, Nocera M, Goldmacher S, O'Hagan E. Workplace violence prevention programs in psychiatric units and facilities. Archives of Psychiatric Nursing. 2009; 23 (2): 166–76. https://doi.org/10.1016/j.apnu.2008.05.008
7. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology. 2005; 8 (1): 19–32. https://doi.org/10.1080/1364557032000119616
8. Levac D, Colquhoun H, O'Brien KK. Scoping studies: Advancing the methodology. Implementation Science. 2010; 5: 69. https://doi.org/10.1186/1748-5908-5-69
9. Aljohani B, Burkholder J, Tran QK, Chen C, Beisenova K, Pourmand A. Workplace violence in the emergency department: A systematic review and meta-analysis. Public Health. 2021; 196: 186–97. https://doi.org/10.1016/j.puhe.2021.02.009
10. Hassankhani H, Parizad N, Gacki-Smith J, Rahmani A, Mohammadi E, Hassankhani H. Workplace violence against nurses in emergency departments: A qualitative study. International Emergency Nursing. 2018; 39: 9–14. https://doi.org/10.1016/j.ienj.2017.07.007
11. Arnetz JE, Hamblin L, Ager J, Luborsky M, Upfal MJ, Russell J, et al. Underreporting of workplace violence: Comparison of self-report and actual documentation of hospital incidents. Workplace Health & Safety. 2015; 63 (5): 200–10. https://doi.org/10.1177/2165079915574684
12. Barrera M, Castro FG. A heuristic framework for the cultural adaptation of interventions. Clinical Psychology: Science and Practice. 2006; 13 (4): 311–6. https://doi.org/10.1111/j.1468-

2850.2006.00043.x
13. Fredrickson BL. The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. American Psychologist. 2001; 56 (3): 218–26. https://doi.org/10.1037/0003-066X.56.3.218
14. Fredrickson BL. Positive emotions broaden and build. Advances in Experimental Social Psychology. 2013; 47: 1–53. https://doi.org/10.1016/B978-0-12-407236-7.00001-2
15. Goleman DP. Emotional intelligence: Why it can matter more than IQ for character, health and lifelong achievement. 1995, New York: Bantam Books.
16. Bronfenbrenner U. The ecology of human development: Experiments by nature and design. 1979. Harvard University Press.

Causal Factors Influencing the Performance of General Administration Personnel in Maha Sarakham Provincial Hospital Organizational Determinants of Work Performance among General Administration Personnel in a Provincial Hospital

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Abstract:

Background: Provincial hospitals are key components of Thailand's public health system. The performance of general administration personnel is essential for supporting clinical services and ensuring organizational efficiency; however, empirical evidence regarding organizational factors influencing their performance remains limited.

Objective: To examine the effects of organizational culture, work motivation, and Total Quality Management (TQM) on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

Method: A quantitative cross-sectional survey was conducted among general administration personnel at Maha Sarakham Provincial Hospital. Data were collected using a structured questionnaire with acceptable reliability. Descriptive statistics were used to summarize participant characteristics, and multiple linear regression analysis was applied to identify factors associated with work performance.

Results: Work motivation demonstrated a statistically significant positive effect on work performance ($p < 0.01$). Organizational culture and TQM showed positive but non-significant associations with work performance ($p > 0.05$). The overall regression model was statistically significant and explained a substantial proportion of variance in work performance.

Conclusion: Work motivation was identified as the most influential determinant of work performance among general administration personnel in a provincial hospital setting. Strengthening motivational strategies, alongside fostering supportive organizational culture and context-appropriate quality management practices, may enhance administrative performance and contribute to overall hospital effectiveness.

Keywords: Organizational culture; Work motivation; Total Quality Management; Work performance; Provincial hospital

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Introduction

Provincial hospitals play a critical role in Thailand's public health system as secondary and tertiary healthcare institutions.[1] In addition to providing comprehensive medical services, they function as regional centers for specialized treatment, referral systems, professional training, and the implementation of national health policies.[2,3] Amid ongoing social and demographic changes particularly population aging, the increasing prevalence of non-communicable diseases, and rising public expectations regarding healthcare quality provincial hospitals face growing challenges in achieving effective and sustainable organizational management.[4]

While physicians and nursing staff are central to clinical care delivery,[5] general administration personnel constitute an essential support system that enables hospitals to function efficiently.[6] Their responsibilities include administrative documentation, human resource management, finance and accounting, procurement, planning, policy coordination, and internal and external organizational communication.[7] The effectiveness of general administration personnel directly influences resource utilization, policy implementation, regulatory compliance, and adherence to public-sector quality standards.[8,9] Suboptimal performance among this group may therefore undermine organizational efficiency and indirectly affect healthcare service quality.[10]

In practice, general administration personnel in provincial hospitals often operate under complex bureaucratic structures, heavy workloads, frequent policy changes, and limited incentives or career advancement opportunities.[11,12] These conditions may negatively affect job satisfaction, work motivation, and ultimately work performance.[13] Understanding the organizational factors that influence administrative performance is therefore essential for improving hospital management and service delivery in public healthcare institutions.[14]

Previous studies in public-sector and healthcare settings indicate that organizational culture is a key determinant of employee performance.[15] A culture characterized by shared values, effective communication, managerial support, and collaboration has been associated with higher employee engagement and improved performance, particularly in hierarchical organizations such as public hospitals.[3,16] However, existing research has largely focused on clinical personnel,[17] with limited attention given to general administration personnel whose work involves policy implementation and cross-departmental coordination.[18]

Work motivation is another critical factor influencing employee performance across organizational contexts.[7] Both intrinsic motivation such as job meaningfulness,[19] responsibility, and pride in work and extrinsic motivation including compensation, job security, and recognition have been shown to affect work outcomes in public organizations.[20,21] In hospital settings, appropriate reward systems and managerial recognition are associated with improved performance among administrative staff; however, empirical evidence specific to general administration personnel in provincial hospitals remains limited.[22]

Total Quality Management (TQM) has also been widely adopted in public hospitals as a strategy to enhance organizational efficiency, service quality, and accountability.[23] Studies suggest that TQM practices emphasizing continuous improvement, employee participation, and process standardization may positively influence

employee performance.[11,12] Nevertheless, the effectiveness of TQM in public-sector organizations may vary depending on how well quality management practices are integrated into daily administrative work, particularly among non-clinical personnel.[15]

Despite extensive research on medical and nursing staff, empirical studies examining organizational factors influencing the performance of general administration personnel in provincial hospitals remain scarce.[16] This gap is particularly evident in non-metropolitan contexts,[24] where hospital management structures are complex and subject to distinctive administrative constraints.

Objectives

1. To examine the effect of organizational culture on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

2. To examine the effect of work motivation on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

3. To examine the effect of Total Quality Management (TQM) on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

Research Hypotheses

H1: Organizational culture has a statistically significant effect on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

H2: Work motivation has a statistically significant effect on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

H3: Total Quality Management (TQM) has a statistically significant effect on the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

Conceptual Framework

This study is guided by theories of human resource management and organizational behavior in public-sector organizations. The conceptual framework proposes that organizational factors influence the work performance of general administration personnel in provincial hospitals, where administrative work is characterized by complex procedures and policy-driven operations.

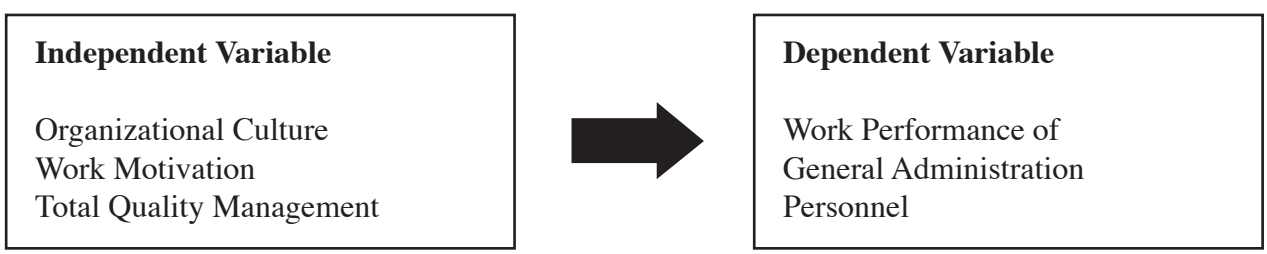


Figure 1 Conceptual framework illustrating the effects of organizational culture, work motivation, and Total Quality Management on work performance.

Research Methodology

Study Design

This study employed a quantitative, cross-sectional survey design to examine organizational factors influencing the work performance of general administration personnel at Maha Sarakham Provincial Hospital.

Population and Sample

The study population consisted of all general administration personnel employed at Maha Sarakham Provincial Hospital during the data collection period. This group included personnel responsible for administrative and support functions, such as general administration, human resource management, finance and accounting, procurement, planning, and policy coordination.

Given that the total number of general administration personnel was finite and manageable, a census sampling approach was adopted. All eligible personnel were invited to participate in the study to ensure comprehensive coverage of the target population and to minimize sampling error. A total of 385 completed questionnaires were returned and deemed valid for analysis, representing the full census of administrative personnel and providing an adequate sample size for multiple regression analysis.

Research Variables and Measurement

The independent variables in this study were organizational culture, work motivation, and Total Quality Management (TQM). Organizational culture reflected shared values, communication, teamwork, leadership support, and overall work climate. Work motivation encompassed both intrinsic factors (e.g., job satisfaction, responsibility, and professional pride) and extrinsic factors (e.g., compensation, job security, recognition, and career advancement). Total Quality Management focused on the implementation of Hospital Accreditation (HA) standards, process standardization, continuous improvement, and staff participation in quality management activities.

The dependent variable was work performance of general administration personnel, defined as the effectiveness and efficiency of administrative work. This included accuracy and timeliness of task completion, compliance with organizational policies and procedures, efficiency of work processes and interdepartmental coordination, and contribution to overall organizational effectiveness.

Research Instrument and Quality Assessment

Data were collected using a structured questionnaire consisting of four sections corresponding to organizational culture, work motivation, Total Quality Management, and work performance. All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Content validity of the instrument was assessed by three experts in public administration and health services management using the Item–Objective Congruence (IOC) index. Items with IOC values of 0.50 or higher were retained. Reliability was evaluated using Cronbach's alpha coefficient, with values of 0.70 or above considered acceptable for internal consistency.

Data Collection Procedures

Approval to conduct the study was obtained from Maha Sarakham Provincial Hospital prior to data collection. Questionnaires were distributed to participants using both online (Google Forms) and paper-based formats to maximize response rates. Data collection was conducted over a one- to two-week period. Returned questionnaires were checked for completeness and accuracy before analysis.

Data Analysis

Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic characteristics and overall response levels. Inferential analysis was conducted using multiple linear regression analysis to examine the effects of organizational culture, work motivation, and Total Quality Management on work performance.

All independent variables were entered simultaneously into the regression model. Statistical significance was determined at the 0.05 and 0.01 levels. Assumptions for regression analysis, including adequacy of sample size, were considered appropriate given the census approach and number of observations.

Results

Descriptive Statistics

General administration personnel at Maha Sarakham Provincial Hospital reported high perceptions across all study variables. Organizational culture was rated at the highest level ($\overline{X}$ = 4.52, S.D. = 0.41), while work performance also demonstrated a high level ($\overline{X}$ = 4.70, S.D. = 0.34). Mean scores for work motivation ($\overline{X}$ = 4.56, S.D. = 0.38) and Total Quality Management (TQM) ($\overline{X}$ = 4.60, S.D. = 0.36) were similarly high, as shown in Table 1.

Effect of Organizational Culture on Work Performance

Multiple linear regression analysis indicated that organizational culture had a positive association with the work performance of general administration personnel; however, this relationship did not reach statistical significance at the 0.05 level ($\beta = 0.158$, $p = 0.083$).

When organizational culture was examined at the dimensional level, consistency/shared values and organizational mission demonstrated statistically significant positive effects on work performance at the 0.01 level. In contrast, the involvement and adaptability dimensions were not significantly associated with work performance. These findings suggest that clarity of organizational values and mission may be more influential in enhancing administrative performance than participatory or adaptive cultural elements in the provincial hospital context.

Table 1 Means and Standard Deviations of Research Variables

Variable	Mean ($\overline{X}$)	S.D.	Level
Organizational Culture	4.52	0.41	Highest
Work Motivation	4.56	0.38	Highest
Total Quality Management (TQM)	4.60	0.36	Highest
Work Performance	4.70	0.34	Highest

Effect of Work Motivation on Work Performance

General administration personnel reported a high level of work motivation ($\overline{X}$ = 4.56, S.D. = 0.38). Multiple linear regression analysis demonstrated that work motivation had a statistically significant positive effect on work performance ($\beta = 0.414$, $p < 0.01$) and emerged as the strongest predictor among the examined organizational factors (Table 2).

The overall regression model was statistically significant ($F = 101.756, p < 0.01$) and explained 53.2% of the variance in work performance ($R^2 = 0.532$). In contrast, organizational culture ($\beta = 0.158, p = 0.083$) and Total Quality Management (TQM) ($\beta = 0.152$, $p = 0.082$) showed positive but non-significant associations with work performance.

Further dimensional analysis revealed that both motivational factors and hygiene/supportive factors were significantly associated with work performance at the 0.01 level, indicating that intrinsic and extrinsic motivational elements jointly contribute to administrative performance.

Table 2 Multiple Linear Regression Analysis of Factors Influencing Work Performance

Independent Variables	B	S.E.	Beta	t	Sig.	VIF
Constant	2.803	0.107	–	22.902	0.000	–
Organizational Culture	0.072	0.038	0.158	1.672	0.083	5.766
Work Motivation	0.224	0.044	0.414	4.245	0.000**	5.706
Total Quality Management (TQM)	0.086	0.046	0.152	1.676	0.082	5.354

$R = 0.729$, $R^2 = 0.532$, Adjusted $R^2 = 0.526$
$F = 101.756$, $p < 0.01$
Durbin–Watson = 1.970 Note: $p < 0.01$

Table 3 Multiple Linear Regression Analysis of Organizational Culture Dimensions Affecting Work Performance

Variables	B	S.E.	Beta	t	Sig.	VIF
Constant	2.835	0.103	–	24.875	0.000	–
Involvement	0.026	0.027	0.076	0.974	0.314	4.317
Consistency / Shared Values	0.175	0.040	0.378	3.613	0.000**	6.363
Adaptability	-0.035	0.027	-0.103	-1.212	0.211	4.777
Organizational Mission	0.203	0.048	0.358	3.444	0.001**	6.304

Note: $p < 0.01$

Results

Regression analysis of organizational culture dimensions indicated that consistency/shared values ($\beta = 0.378$, $p < 0.01$) and organizational mission ($\beta = 0.358, p < 0.01$) were significantly associated with work performance. In contrast, involvement ($\beta = 0.076$, $p = 0.314$) and adaptability ($\beta = -0.103, p = 0.211$) were not statistically significant predictors.

Dimensional Analysis of Work Motivation

Regression analysis of work motivation dimensions demonstrated that both motivational factors ($\beta = 0.381$, $p < 0.01$) and hygiene/supportive factors ($\beta = 0.338$, $p < 0.01$) were significantly associated with work performance (Table 4).

Table 4 Multiple Linear Regression Analysis of Work Motivation Dimensions Affecting Work Performance

Variables	B	S.E.	Beta	t	Sig.	VIF
Constant	2.882	0.107	–	25.782	0.000	–
Motivational Factors	0.207	0.037	0.381	4.372	0.000**	4.388
Hygiene / Supportive Factors	0.177	0.037	0.338	3.911	0.000**	4.388

Note: $p < 0.01$

Effect of Total Quality Management on Work Performance

Total Quality Management (TQM) was perceived at a high level among general administration personnel ($\overline{X} = 4.60$, S.D. = 0.36). Regression analysis indicated that overall TQM had a positive but non-significant association with work performance ($\beta = 0.152$, $p = 0.082$).

When examined at the dimensional level, internal customer focus and employee participation demonstrated statistically significant positive associations with work performance at the 0.01 level, whereas continuous improvement was not significantly associated with work performance.

Table 5 Multiple Linear Regression Analysis of Total Quality Management (TQM) Dimensions Affecting Work Performance

Variables	B	S.E.	Beta	t	Sig.	VIF
Constant	2.731	0.120	–	20.826	0.000	–
Internal Customer Focus	0.152	0.030	0.303	3.930	0.000**	3.243
Continuous Improvement	0.048	0.030	0.111	1.461	0.132	3.400
Employee Participation	0.202	0.030	0.315	5.072	0.000**	2.102

Note: $p < 0.01$

Regression analysis of TQM dimensions indicated that internal customer focus ($\beta = 0.303$, $p < 0.01$) and employee participation ($\beta = 0.315$, $p < 0.01$) were significantly associated with work performance. In contrast, continuous improvement was not a statistically significant predictor of work performance ($\beta = 0.111$, $p = 0.132$).

Discussion

Objective 1: Influence of Organizational Culture on Work Performance. The findings indicate that organizational culture is positively associated with the work performance of general administration personnel, with organizational mission and shared values/consistency emerging as significant predictors. This suggests that personnel who clearly understand the hospital's mission and internalize shared organizational values are more likely to perform administrative tasks effectively and consistently. In a provincial referral hospital, where administrative personnel support complex clinical and non-clinical operations, a strong mission-driven culture provides a shared sense of purpose that

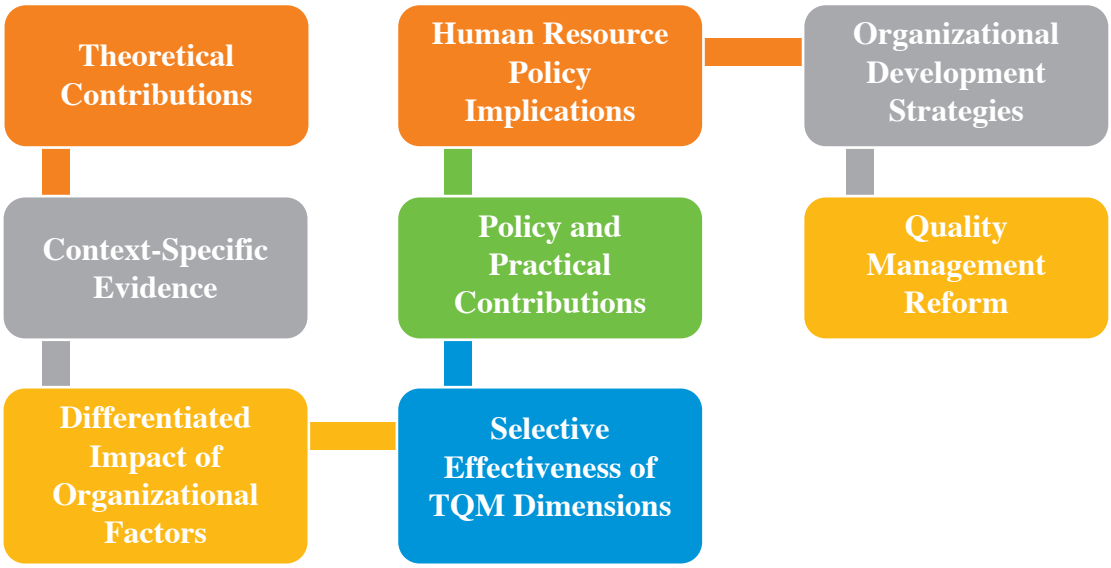
aligns daily administrative functions such as documentation, budgeting, and coordination with strategic organizational goals. These results reinforce the notion that, in highly structured healthcare organizations, cultural clarity functions as a stabilizing mechanism that enhances efficiency and accountability. The non-significant effects of involvement and adaptability may reflect hierarchical decision-making structures and limited autonomy commonly observed in public hospitals, where participation and flexibility are constrained by regulations and standardized procedures.[25] Consistent with prior studies,[26,27] the present findings underscore the importance of shared values and mission clarity in enhancing performance within public-sector healthcare institutions.

Objective 2: Influence of Work Motivation on Work Performance. Work motivation was found to be the most influential factor affecting work performance, with both motivational and hygiene-related dimensions demonstrating significant positive effects. This highlights the central role of motivation in sustaining performance among general administration personnel, who often operate under heavy workloads, strict regulatory requirements, and limited recognition compared with clinical staff. When personnel perceive their work as meaningful and experience organizational support, they are more likely to demonstrate higher levels of responsibility, accuracy, punctuality, and commitment to service standards. These findings align with Herzberg's Two-Factor Theory, which emphasizes the combined importance of motivators and hygiene factors in enhancing performance, as well as Self-Determination Theory which posits that perceived value and support strengthen work engagement and productivity.[8] In line with the results confirm that motivation plays a decisive role in driving performance in complex public-sector organizations, particularly within healthcare settings where administrative work directly supports service delivery quality.[27]

Objective 3: Influence of Total Quality Management (TQM) on Work Performance. The analysis revealed that TQM practices contribute positively to work performance, particularly through internal customer focus and employee participation, while continuous improvement did not exhibit a statistically significant effect. This suggests that quality management practices emphasizing collaboration, responsiveness, and staff involvement are more immediately impactful for general administration personnel in provincial hospitals. By improving coordination with clinical departments and internal service recipients, these practices facilitate smoother workflows and reduce operational inefficiencies. The non-significant effect of continuous improvement may reflect contextual constraints, such as high administrative workloads, limited time for reflective practices, and insufficient resources for sustained quality initiatives.[28] Continuous improvement often requires long-term investment in training and process evaluation, which may be difficult to maintain in resource-constrained public hospitals. Similar findings have been reported by who emphasized that employee participation and customer focus are foundational to effective TQM implementation in large healthcare organizations.[29]

New Knowledge contributed by the study

This study contributes new theoretical and policy-relevant insights to the fields of public sector human resource management and healthcare administration, particularly within the context of provincial referral hospitals.



The study provides empirical evidence demonstrating that organizational culture, work motivation, and Total Quality Management (TQM) influence the work performance of general administration personnel. This group has been relatively underrepresented in prior healthcare performance research, which has predominantly focused on clinical staff. By shifting attention to administrative personnel, the study broadens the scope of performance-related research in public healthcare organizations.

Differentiated Impact of Organizational Factors

The findings reveal that work motivation exerts the strongest influence on work performance, followed by organizational culture and TQM. This hierarchy of influence advances organizational behavior theory by highlighting the central role of motivational mechanisms in large, bureaucratic healthcare institutions, where formal structures and regulations may limit the effectiveness of cultural and procedural interventions alone.

Selective Effectiveness of TQM Dimensions

The study extends TQM theory by demonstrating that not all quality management dimensions exert equal effects on performance. While internal customer focus and employee participation significantly enhance work performance, continuous improvement does not show a significant effect. This finding suggests that continuous improvement initiatives may be constrained by workload pressures, limited resources, and structural rigidity in tertiary-level public hospitals, emphasizing the importance of contextual factors in TQM implementation.

Recommendations

Human Resource Policy Implications

The results underscore the importance of prioritizing motivational strategies for general administration personnel. Hospital administrators and policymakers should emphasize recognition systems, supportive supervision, job security, and non-monetary incentives to strengthen job satisfaction, commitment, and sustained performance.

Organizational Development Strategies

Strengthening mission clarity and reinforcing shared organizational values emerge as cost-effective strategies for enhancing administrative performance. Such cultural alignment is particularly valuable in resource-constrained public hospitals, where financial incentives may be limited.

Quality Management Reform

The findings suggest that quality management initiatives in provincial hospitals should focus first on participatory practices and internal service quality. Emphasizing employee involvement and responsiveness to internal clients may yield more immediate performance gains than prematurely expanding continuous improvement programs that require substantial time and resource investment.

Integrative Interpretation

Overall, this study advances understanding of how organizational factors operate within the administrative functions of provincial hospitals. It highlights that improving the performance of general administration personnel requires a balanced and context-sensitive approach that integrates motivational support, cultural alignment, and pragmatic quality management practices. These insights provide a valuable foundation for future research and evidence-based policy development in public healthcare administration.

References

1. Jing G, Worapongpat N, Wongkumchai T. Developing a competitive strategy for an alternative energy power company: A case study of Taizhou Sanxin Co., Ltd. Journal of Administration Management and Sustainable Development. 2024; 2 (1): 231–46. https://so15.tci-thaijo.org/index.php/jamsd/article/view/522
2. Worapongpat N. ESG best practices for OEM dietary supplement businesses. Chiang Mai University Journal of Economics. 2025; 29 (1): 1–14. https://so01.tci-thaijo.org/index.php/CMJE/article/view/279192
3. Soetomo CT, Gunawan MFB, Fernaldi K, Hasan H. The effect of organizational culture, team collaboration, and work motivation on the performance of health workers in a maternal and child hospital. Indonesian Interdisciplinary Journal of Sharia Economics. 2025; 8 (2): 3608–21.
4. Qi T, Wongkumchai T, Worapongpat N. Factors affecting customers' purchase intentions toward organic food products in Chengdu. Art and Science Great Mekong Subregion Research Journal. 2024; 31 (2): 70–85. https://li01.tci-thaijo.org/index.php/oasjournal/article/view/261549
5. Worapongpat N, Jodkum E, Limlertrid T, Srichun P. Guidelines for plant design and layout systems in applied industries. Journal of Academic for Eastern Institute of Technology Suvarnabhumi. 2024; 3 (1): 41–7. https://so09.tci-thaijo.org/index.php/JEITS/article/view/2208
6. Sophon T, Worapongpat N. Service quality affecting the reuse of internal medicine clinic services at Vajira Hospital, Navamindradhiraj University. Journal of Education and Learning Reviews. 2025; 2 (1): 59–68. https://doi.org/10.60027/jelr.2025.96
7. Mas'ud M, Alam R, Hamid S, Saleh M. Performance and service optimization: The role of organizational culture, leadership and motivation. Zhongguo Kuangye Daxue Xuebao. 2024; 29 (3): 400–8.
8. Worapongpat N. The impact of production management on competitiveness in full-service supplement manufacturing. Journal of Public and Private Issues. 2024; 1 (3): 159–71. https://so17.tci-thaijo.org/index.php/jppi/article/view/577
9. Sukpum M, Sattayasomboon Y, Sillabutra J,Yodmai K. Quality of working life among public health personnel in sub-district health-promoting hospitals, Nakhon Pathom

Province. Thai Journal of Public Health. 2025; 55 (2): 1246–60.
10. Qoyimah DL, Yuhelmis Y. The effect of work discipline, work motivation, and organizational culture on employee performance improvement strategies at Bogor City Hospital. International Journal of Social and Management Studies. 2024; 5 (6): 14–23.
11. Tumkosit U, Punnitamai W, Phromphan S. An evaluation of human resource management and development in sub-district health promotion hospitals transferred to Thai provincial administrative organizations. Journal of Public Administration, Public Affairs, and Management. 2024; 22 (1): 19–29.
12. Wang Y, Worapongpat N, Wongkumchai T. College graduates' employment city selection and its impact on housing prices in the Yangtze River Delta region. Journal of Administration Management and Sustainable Development. 2024; 2 (1): 195–218. https://so15.tci-thaijo.org/index.php/jamsd/article/view/521
13. Nugraha BA. The significance of work motivation: The impact of organizational culture and work environment on employee performance. MANAZHIM: Jurnal Manajemen dan Ilmu Pendidikan. 2024: 6 (1): 265–89.
14. Raharjo R, Pasinringi SA, Rivai F, Sari N. The influence of leadership and organizational culture on employee performance through work motivation at Beriman Balikpapan Regional Hospital. Frontiers in Health Informatics. 2024: 13 (8): 3821-33.
15. Whitehead D, Hamidi Y, Ebrahimi H, Hazavehei SMM, Kharghani Moghadam SM. Relationships between lifestyle, quality of life, organizational culture, and job satisfaction among nurses related to health-promoting hospital standards. Health Services Insights. 2023; 16: 11786329231193792.https://doi.org/10.1177/11786329231193792
16. Worapongpat N. Digital leadership and productivity in the health and beauty supplement manufacturing industry. Journal of Public and Private Issues. 2025; 2 (3): 116–30. https://so17.tci-thaijo.org/index.php/jppi/article/view/871
17. Worapongpat N, Jodkum E, Limlertrid T, Srichun P, Passabutr P. Design development of multipurpose car seat products. Journal of Administration Management and Sustainable Development. 2023; 1 (4): 396–405. https://so15.tci-thaijo.org/index.php/jamsd/article/view/193
18. Rumengan J, Suhardis A, Gunawan D. The influence of job promotion, work culture, work facilities, and job satisfaction on employee performance at Hj Bunda Halimah Hospital, Batam. In IAIC International Conference Series. 2021; 3 (2): 8–15.
19. Worapongpat N, Chaoluang J. Spare part management in manufacturing: A case study of SMT Co., Ltd. Journal of Academic for Eastern Institute of Technology Suvarnabhumi. 2023; 2 (1): 129–37. https://so09.tci-thaijo.org/index.php/JEITS/article/view/1538
20. Sriyasak A, Sridawruang C, Sriring P, Nitkhamhan B, Chatchumni M, Khaonuan B, Sarakshetrin A. Factors affecting hospital provision of health-promoting services transferred to provincial administration in Thailand. International Journal of Environmental Research and Public Health. 2024; 21 (8): 1053. https://doi.org/10.3390/ijerph21081053.
21. Worapongpat N. Developing a competitive alternative energy strategy: A case study of Taizhou Sanxin Co., Ltd. Journal of Value Chain Management and Business Strategy. 2025; 4 (1):

1–19. https://so08.tci-thaijo.org/index.php/VCMBS/article/view/2894
22. Worapongpat N. Improving the efficiency of chemical transport drivers. Journal of Interdisciplinary Management. 2022; 6 (1): 45–78. https://so02.tci-thaijo.org/index.php/journalfms-thaijo/article/view/260277
23. Purwaningsari RT, Juniarti AT, Affandi A, Sunarsi D. Strategy for strengthening work culture in an effort to improve the quality of health services: A case study at a community health center in Tasikmalaya City. Jurnal Ilmiah Ilmu Administrasi Publik. 2022; 12 (2): 613–20.
24. Worapongpat N, Wongkumchai T, Muangmee C. Factors influencing production order decisions for health supplement branding through digital media. Journal of Social Innovation and Mass Communication Technology. 2023; 6 (1): 33–43. https://doi.org/10.14456/jsmt.2023.4
25. Worapongpat N. Employee satisfaction toward welfare in a consumer goods company. Journal of Social Sciences and Humanities, Kasetsart University. 2023; 49 (1): 103–14. https://so04.tci-thaijo.org/index.php/socku/article/view/258412
26. Abrori I, Rizki VL, Muttaqien F. Human resource management in improving employee performance through work motivation, quality of work life, and work discipline. In Proceedings of the Conference on SDGs Transformation through the Creative Economy: Encouraging Innovation and Sustainability (TCEEIS 2023) (pp. 178–83). Atlantis Press.
27. Worapongpat N, Banyen R. Waste reduction in airbag sewing processes. Journal of Administration Management and Sustainable Development. 2023; 1 (4): 360–76. https://so15.tci-thaijo.org/index.php/jamsd/article/view/303
28. Worapongpat N. Enhancing production efficiency through organizational support and workforce competence. Liberal Arts and Social Studies International Journal. 2025; 1 (3): 1–16. https://so18.tci-thaijo.org/index.php/laassij/article/view/1185
29. Masinde CA, Manyasi J, Otsyula JO, Onyango RO. Moderating effect of organizational culture on the relationship between quality of work life and organizational commitment amongst nurses in public hospitals in Bungoma County. African Journal of Empirical Research. 2023; 4 (2): 745–53.

Evaluation of Leukocyte-Depleted Blood Components from Citrate Phosphate Dextrose / Saline Adenine Glucose–Mannitol Quadruple Blood Bag with an Integrated Leukocyte Filter

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Abstract:

Background: Leukocyte-depleted blood components are widely used to reduce transfusion-related adverse reactions associated with residual leukocytes. When a new blood bag system is introduced into routine practice, evaluation of the quality of the resulting blood components is necessary to ensure compliance with the National Standards Criteria.

Objectives: This study aimed to evaluate leukocyte-depleted blood components, including leukocyte-depleted packed red cells in additive solution (LDPRC) and leukocyte-depleted fresh frozen plasma (LDFFP), prepared using a citrate phosphate dextrose/saline adenine glucose- mannitol (CPD/SAG-M) quadruple blood bag with an integrated leukocyte filter, and to evaluate the blood components quality according to the National Standards Criteria.

Materials and Method: This descriptive evaluation study was conducted at the Blood Bank, Division of Clinical Pathology Mae Fah Luang University Medical Center Hospital. Whole blood was collected using CPD/SAG-M quadruple blood bags with an integrated leukocyte filter and processed into LDPRC and LDFFP. Evaluation was done in accordance with the National Standards Criteria for approval of validation of blood component characteristic, including component volume, hemoglobin content, residual white blood cell (rWBC) count, and hemolysis during storage. Residual WBC enumeration was performed using an automated hematology analyzer in body fluid mode based on flow cytometric principles.

Results: All LDPRC units met the criteria for residual leukocyte content and other parameters throughout the storage period. Hemolysis remained within specified limits up to 42 days of storage. LDFFP units also complied with the criteria. Analysis of factor VIII activity is currently in progress.

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Conclusion: Leukocyte-depleted blood components prepared using the evaluated CPD/SAG-M quadruple blood bag with an integrated leukocyte filter met the National Standards Criteria, supporting the suitability of this system for routine blood component preparation in a hospital-based blood bank.

Keywords: Leukocyte-depleted blood components; Leukocyte-depleted packed red cells; Leukocyte-depleted fresh frozen plasma; Residual white blood cells; Quality control of blood components

Introduction

Leukocyte-depleted blood components are routinely used in transfusion practice to reduce febrile non-hemolytic transfusion reactions, HLA alloimmunization, and other adverse effects associated with residual leukocytes. These benefits result improvement of transfusion safety and clinical outcomes for patients who require repeated or high-risk transfusions, particularly those with chronic blood transfusions such as patients with thalassemia, as well as patients with hematologic malignancies or solid tumors undergoing intensive chemotherapy.[1-3] Various methods have been developed to reduce leukocyte content in blood components, including pre-storage whole blood leukocyte filtration.

In Thailand, the preparation and quality control of blood components must comply with National Standards for Blood Banks and Transfusion Services developed by the National Blood Centre, Thai Red Cross Society (NBC, TRCS)[1] and guidelines issued by relevant authorities. These standards specify acceptance criteria for residual leukocyte content, hemoglobin content, hemolysis during storage, and other key quality parameters. When a new blood bag system is introduced into routine use, evaluation of the resulting blood components is required to confirm compliance with these standards.

The objective of this study was to evaluate leukocyte-depleted blood components prepared using a CPD/SAG-M quadruple blood bag with an integrated whole blood leukocyte filter by assessing residual leukocyte counts and selected quality parameters of the final products in accordance with national standards and international guidelines.[4,5]

Materials and Method

Study Design and Blood Collection

This descriptive evaluation study was conducted at the Blood Bank, Department of Clinical Pathology Mae Fah Luang University Medical Center Hospital as a process-oriented evaluation. Whole blood was collected from voluntary non-remunerated donors in accordance with NBC, TRCS blood donation criteria1, using a CPD/SAG-M quadruple blood bag with an integrated whole blood leukocyte filter. The structure of the blood bag system is illustrated in Figure 1.

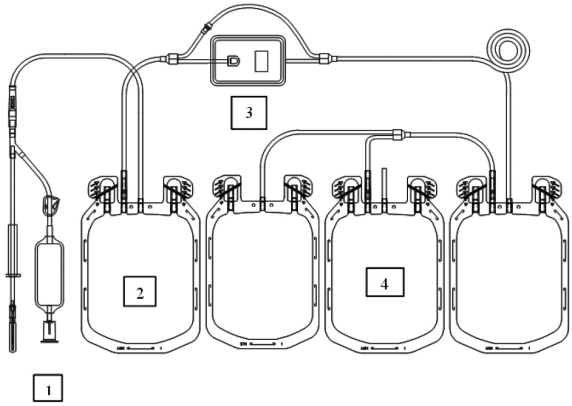


Figure 1 TRCS CPD/SAG-M quadruple blood bag 350 mL with whole blood leukocyte filter and sample diversion pouch
1 = Sample diversion pouch
2 = CPD blood bag
3 = Whole blood leukocyte filter
4 = SAG-M solution bag

Preparation of Leukocyte-Depleted Blood Components

A total of 17 whole blood units were collected from March 2025 to August 2025. During the initial implementation and process optimization phase, the first five units were excluded from analysis. The remaining 12 units were included for final evaluation. Whole blood units were filtered through the integrated leukocyte filter by gravity filtration to produce leukocyte-depleted whole blood according to the manufacturer's instructions. Following filtration, these units were centrifuged and separated into leukocyte-depleted packed red cells (LDPRC) and leukocyte-depleted fresh frozen plasma (LDFFP).

LDPRC units were supplemented with SAG-M additive solution and stored at 2–6 °C for up to 42 days and assessed for hemolysis, therefore they were not issued for clinical transfusions. LDFFP units were frozen within the specified time after collection and stored under appropriate freezing conditions. The overall study workflow is illustrated in Table 1.

Table 1 Study process

Step	Process	Method/Equipment	Out put
1	On Day 0: WB collection	CPD/SAG-M quadruple blood bag 350 mL with whole blood filter and sample pouch	WB
2	Measure WB weight, collection one sample segment.	Digital balance by OHAUS: RANGER2000	WB: weight(g), volume (mL)
3	Measure Hb and Hct of WB	Automatic blood cell counter by Mindray CAL6000: BC6200	WB: Hb (g/dL, g/unit), Hct (%)
4	Store WB at room temperature for at least 2 hours.		

Table 1 Study process (con.)

Step	Process	Method/Equipment	Output
5	Filter WB to obtain LDWB	As in step 1: Gravity filtration	LDWB
6	Measure LDWB weight, collection two sample segments.	As in step 2	LDWB: weight (g), volume (mL)
7	Measure Hb, Hct, cell count	As in step 3: Cell count use BF mode	LDWB: Hb (g/dL, g/unit), Hct (%), WBC (10^9/uL), residual leukocyte (10^9/unit)
8	Centrifuge LDWB Heavy spin at 5,102 g for 10 min.	Refrigerated centrifuge THERMO FISHER SCIENTIFIC: SORVALL LEGEND XTR	
9	Extract to separate red cell and plasma and store	Extractor, blood bank freezer	LDPRC in CPD and LDFFP keep -20°c
10	Add SAG-M to LDPRC	As in step 1	LDPRC in CPD/SAG-M
11	Measure LDPRC in CPD/SAG-M weight	As in step 2	LDPRC: weight (g), volume (mL)
12	Aseptic transfer LDPRC 15 mL into transfer bag	Transfer bag and sterile connecting device process*	15 mL LDPRC samples
13	Keep LDPRC at 4C (2 – 6 °C) to Day 14 and Day 42	Blood bank refrigerator 2-6 °C	
14	Transfer LDPRC sample to test tube 5 mL, 3 tubes	Polyethylene tube 12x75 mm.	
15	Tube 1: Measure Hb, Hct, cell count	As in step 7	LDPRC: Hb (g/dL, g/unit), Hct (%), WBC (10^9/uL), residual leukocyte (10^9/unit)
16	Tube 2 and 3 closes with parafilm centrifuge at 4200 rpm, 15 min at 4 °C	Centrifuge: THERMO FISHER SCIENTIFIC; HERAEUS CRYOFUGE 16 CENTRIFUGE	
17	Collect supernatant plasma and measure Hb	As in step 3	plasma Hb
18	Calculate % Hemolysis	%Hemolysis = [(100-Hct)/ Total Hb]x Plasma Hb	%Hemolysis on Day 0
19	On Day 14: Repeat step 12	As in step 18	%Hemolysis on Day 14
20	On Day 42: Repeat step 12	As in step 18	%Hemolysis on Day 42

WB = Whole blood, Hb = Hemoglobin, Hct = Hematocrit, LD = Leukocyte depleted, PRC = Packed red cell, FFP = Fresh frozen plasma, BF= Body fluid, * Transfer bag (JMS Transfer Pack; Sterile nonpyrogenic non-toxic 300 mL capacity), Automatic benchtop tube sealer blood bag tube welder; TSCD®-II Terumo

Table 2 Criteria for approval of blood component quality and characteristics[1]

Criteria for Blood Component Quality and Characteristics

Blood components	Test items	Specification	% Passed criteria
Whole blood (WB)	Volume	364 – 434 mL	100%
	Hemoglobin	≥ 35 g/unit	100%
	Hematocrit*	-	-
Leukocyte depleted whole blood (LDWB)	Volume*	-	-
	Hemoglobin*	-	-
	Hematocrit*	-	-
	Residual leukocytes	< 1 x 10^6 /unit by count	90%
Leukocyte depleted packed red cell (LDPRC)	Volume	180 – 270 mL	100%
	Hemoglobin	≥ 32 g/unit	100%
	Hematocrit	50 -70 % (in additive solution)	100%
	Residual leukocytes	< 1 x 10^6 /unit by count	90%
	Hemolysis (day 0, 42)	< 0.8 % (at initial, end)	100%
Leukocyte depleted fresh frozen plasma (LDFFP)	Volume	≥ 150 mL	100%
	Factor VIII	≥ 0.7 IU/mL	100%
	Appearance	No abnormal color, No visible clots	100%
	Leakage	No leakage in any part of container	100%

*Measured for information only.

According to the National Standards[1], the criteria for blood component quality and characteristics are presented in Table 2.

Evaluation of leukocyte-depleted blood components included component volume, hemoglobin content, hematocrit, residual white blood cell count (rWBC), and percentage hemolysis during storage. Component volume was determined by weight measurement. Hemoglobin content and hematocrit were measured using Mindray BC-6200 automated hematology analyzer. Residual white blood cell counts (rWBC) was determined using the mentioned automated hematology analyzer in body fluid (BF) mode, which utilizes flow cytometric principles for cell detection and counting.[6] Hemolysis was assessed on Day 0, Day 14, and Day 42 of storage. The percentage hemolysis was calculated using the standard formula.[7,8] :

$$\%\text{Hemolysis} = [(100 - \text{Hct}) / \text{Total Hb}] \times \text{Plasma Hb}$$

LDFFP characteristics were preliminarily evaluated based on volume, visual appearance, and evidence of leakage. Factor VIII activity analysis is currently ongoing.

Results

A total of 17 whole blood units were collected during the study period. Of these,

12 units proceeded to final quality evaluation after exclusion of 5 units used during the initial implementation and process optimization phase.

Evaluation results of WB: All 12 units of WB prior to filtration met the criteria at 100% pass in both volume and hemoglobin content. The mean volume was 394.31 mL (range: 387.24–400.38 mL) and the mean hemoglobin content was 46.16 g/unit (range: 41.42–50.73 g/unit). The results are summarized in Table 3.

Table 3 Evaluation results of whole blood (WB) prior to leukocyte filtration (n = 12 units)

		WB				
		Weight (g)	**Volume (mL)**	**Hb (g/dL)**	**Hb (g/unit)**	**Hct (%)**
Specification			**364-434 mL**		**=>35 g/unit**	
Criteria pass			**100%**		**100%**	
		Results				
No. unit	397	449.5	392.86	12.6	49.5	38.6
No. unit	398	449.5	392.86	10.6	41.6	33.2
No. unit	417	447.3	390.76	10.6	41.4	33.4
No. unit	418	445.1	388.67	11.2	43.5	34.1
No. unit	419	443.6	387.24	12.4	48.0	38.5
No. unit	420	457.4	400.38	10.6	42.4	32.6
No. unit	421	455.6	398.67	11.6	46.2	37.2
No. unit	768	456.5	399.52	11.6	46.3	36.0
No. unit	769	449.9	393.24	12.9	50.7	38.9
No. unit	770	449.2	392.57	12.8	50.2	39.6
No. unit	771	454.5	397.62	12.2	48.5	38.3
No. unit	772	454.2	397.33	11.4	45.3	36.3
			100%		100%	
			pass		pass	

Evaluation results of LDWB: Fifty percent of LDWB met the specification; therefore, the acceptance criteria were not fully achieved. The mean rWBC was 1.144×10^6 cells/unit (range: 0–3.200×10^6 cells/unit). Detailed results are presented in Table 4.

Table 4 Evaluation results of leukocyte-depleted whole blood (LDWB) after filtration (n = 12 units)

LDWB								
		Weight (g)	Volume (mL)	Hb (g/dL)	Hb (g/Unit)	Hct (%)	WBC BF mode (10^3/uL)	rWBC BF mode (10^6/unit)
Specification								**<1x10^6 /unit**
Criteria pass								**90%**
Results								
No. unit	397	406.8	352.19	13.0	45.8	40.4	0.004	1.4088
No. unit	398	399.9	345.62	11.1	38.4	35.1	0.001	0.3456
No. unit	417	403.1	348.67	12.1	42.2	37.5	0.008	2.7893
No. unit	418	408.4	353.71	11.6	41.0	35.4	0.000	0.0000
No. unit	419	403.8	349.33	13.0	45.4	40.4	0.006	2.0960
No. unit	420	409.2	354.48	11.3	40.1	35.0	0.006	2.1269
No. unit	421	410.3	355.52	12.4	44.1	40.0	0.009	3.1997
No. unit	768	407.7	353.05	11.2	39.5	35.3	0.002	0.7061
No. unit	769	407.9	353.24	12.6	44.5	38.2	0.003	1.0597
No. unit	770	411.4	356.57	12.4	44.2	38.3	0.000	0.0000
No. unit	771	414.2	359.24	10.9	39.2	34.2	0.000	0.0000
No. unit	772	414.9	359.90	11.2	40.3	35.9	0.000	0.0000
								50%
								not pass

Evaluation results of LDPRC: All 12 units of LDPRC, which was added SAG-M to each unit, met the criteria at 100% pass in volume, hemoglobin content and rWBC. The mean volume was 210.53 mL (range: 197.81–224.76 mL). The mean hemoglobin content was 41.46 g/unit (range: 38.2–46.1 g/unit). The mean rWBC count was 0.00 × 10^6 cells/unit (range: 0.00–0.00 × 10^6 cells/unit). Component characteristics are shown in Table 5

Table 5 Evaluation results of Leukocyte-depleted packed red cell in SAG-M (LDPRC) (n = 12 units)

LDPRC Residual leukocyte (rWBC)								
		Weight (g)	**Volume (mL)**	**Hb (g/dL)**	**Hb (g/Unit)**	**Hct (%)**	**WBC BF mode (10^3/uL)**	**rWBC BF mode (10^6/unit)**
Specification			**180-270 mL**		**=>32 g/unit**			**<1x10^6/unit**
Criteria pass			**100%**		**100%**			**100%**
Results								
No. unit	397	273.0	224.76	20.5	46.1	63.7	0.000	0.0000
No. unit	398	249.4	202.29	18.9	38.2	59.5	0.000	0.0000
No. unit	417	256.6	209.14	19.3	40.4	60.0	0.000	0.0000
No. unit	418	251.7	204.48	19.8	40.5	60.9	0.000	0.0000
No. unit	419	268.9	220.86	20.8	45.9	65.3	0.000	0.0000
No. unit	420	244.7	197.81	20.4	40.4	63.5	0.000	0.0000
No. unit	421	271.6	223.43	19.1	42.7	61.5	0.000	0.0000
No. unit	768	251.3	204.10	19.0	38.8	60.6	0.000	0.0000
No. unit	769	258.2	210.67	20.6	43.4	62.5	0.000	0.0000
No. unit	770	262.3	214.57	20.2	43.3	63.1	0.000	0.0000
No. unit	771	252.0	204.76	18.7	38.3	59.1	0.000	0.0000
No. unit	772	257.0	209.52	18.9	39.6	60.7	0.000	0.0000
			100%		100%			100%
			pass		pass			pass

Percentage of hemolysis: LDPRC units were evaluated for %hemolysis on Day 0, 14 and 42 after blood collection. On Day 0, there was an error occurred on measuring process, therefore 10 units were evaluated and showed 0% hemolysis in all units. On Day 14, twelve LDPRC units showed mean percentage hemolysis at 0.08% (range: 0.00–0.31%) then on Day 42 showed slightly increasing of mean percentage hemolysis at 0.15% (range: 0.00–0.35%). The results are presented in Table 6,7, and 8

Table 6 Percentage hemolysis in LDPRC on Day 0 (n = 10 units)

LDPRC % Hemolysis Day 0					
		Total Hb (g/dL)	**Hct (%)**	**Plasma Hb (g/dL)**	**day 0**
Specification					**<0.8%**
Criteria					**100%**
Result					
No. unit	397	20.5	63.7	Error	Error
No. unit	398	18.9	59.5	Error	Error
No. unit	417	19.3	60.0	0.0	0.00
No. unit	418	19.8	60.9	0.0	0.00
No. unit	419	20.8	65.3	0.0	0.00
No. unit	420	20.4	63.5	0.0	0.00
No. unit	421	19.1	61.5	0.0	0.00
No. unit	768	19.0	60.6	0.0	0.00
No. unit	769	20.6	62.5	0.0	0.00
No. unit	770	20.2	63.1	0.0	0.00
No. unit	771	18.7	59.1	0.0	0.00
No. unit	772	18.9	60.7	0.0	0.00
					100%
					pass

Table 7 Percentage hemolysis in LDPRC on Day 14 (n = 12 units)

LDPRC % Hemolysis Day14					
		Total Hb (g/dL)	**Hct (%)**	**Plasma Hb (g/dL)**	**day 14**
Specification					**<0.8%**
Criteria					**100%**
Result					
No. unit	397	20.3	64.4	0.0	0.00
No. unit	398	19.1	60.9	0.1	0.20
No. unit	417	19.4	62.3	0.0	0.00
No. unit	418	19.9	62.3	0.0	0.00
No. unit	419	20.8	67.7	0.2	0.31
No. unit	420	20.3	64.1	0.1	0.18
No. unit	421	19.1	63.1	0.1	0.19
No. unit	768	19.1	61.8	0.0	0.00
No. unit	769	20.7	63.5	0.1	0.18
No. unit	770	20.2	64.4	0.0	0.00
No. unit	771	18.7	60.1	0.0	0.00
No. unit	772	18.9	62.0	0.0	0.00
					100%
					pass

Table 8 Percentage hemolysis in LDPRC on Day 42 (n = 12 units)

LDPRC % Hemolysis Day42					
		Total Hb (g/dL)	**Hct (%)**	**Plasma Hb (g/dL)**	**day 42 (end)**
Specification					**<0.8%**
Criteria					**100%**
Result					
No. unit	397	20.5	69.0	0.1	0.15
No. unit	398	19.0	63.9	0.0	0.00
No. unit	417	19.5	65.0	0.0	0.00
No. unit	418	19.9	64.7	0.0	0.00
No. unit	419	20.7	70.1	0.2	0.29
No. unit	420	20.5	66.4	0.0	0.00
No. unit	421	19.2	66.6	0.2	0.35

Table 8 Percentage hemolysis in LDPRC on Day 42 (n = 12 units) (con.)

LDPRC % Hemolysis Day42					
		Total Hb (g/dL)	**Hct (%)**	**Plasma Hb (g/dL)**	**day 42 (end)**
Result					
No. unit	768	19.4	67.4	0.2	0.34
No. unit	769	20.9	68.7	0.1	0.15
No. unit	770	20.3	70.3	0.1	0.15
No. unit	771	18.8	64.1	0.1	0.19
No. unit	772	19.0	66.7	0.1	0.18
					100%
					pass

Table 9 Evaluation results of leukocyte-depleted fresh frozen plasma (LDFFP) (n = 12 units)

LDFFP					
		Volume (mL)	**Factor VIII (IU/mL)**	**Appearance**	**Leakage**
Specification		=> 150 mL	=>0.7 IU/mL	no abnormal color, no visible clot	no
Criteria pass		100%	100%	100%	100%
Result					
No. unit	397	182.32	NA	PASS	PASS
No. unit	398	207.77	NA	PASS	PASS
No. unit	417	201.00	NA	PASS	PASS
No. unit	418	208.00	NA	PASS	PASS
No. unit	419	200.00	NA	PASS	PASS
No. unit	420	218.00	NA	PASS	PASS
No. unit	421	191.00	NA	PASS	PASS
No. unit	768	222.00	NA	PASS	PASS
No. unit	769	216.00	NA	PASS	PASS
No. unit	770	214.00	NA	PASS	PASS
No. unit	771	225.00	NA	PASS	PASS
No. unit	772	220.00	NA	PASS	PASS
		100%	On going	100%	100%
		pass		pass	pass

Evaluation results of LDFFP: All 12 LDFFP units met the criteria preliminary at 100% pass in volume, appearance and leakage observation. The mean volume of LDFFP was 208.76 mL/unit (range: 182.32–225.00 mL). No abnormal color or visible clots observed, and no leakage detected. Analysis of factor VIII activity is ongoing process. Detailed results are presented in Table 9.

Discussion

The present study demonstrated that leukocyte-depleted blood components prepared using a CPD/SAG-M quadruple blood bag with an integrated leukocyte filter consistently met National Quality Standards, particularly for leukocyte-depleted packed red cells (LDPRC), which achieved full compliance in terms of volume, hemoglobin content, and residual white blood cell (rWBC) levels. These findings indicate that the overall blood component production process is robust and effective under routine operational conditions.

This study was designed as a process-oriented evaluation rather than a formal blood bag system validation, which is typically conducted by manufacturers or reference institutions in accordance with international guidelines. According to the Joint United Kingdom Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC), data supporting the evaluation of blood pack systems may be derived from the manufacturer, and blood establishments are not required to repeat full validation but are expected to perform local installation and process validation under routine operational conditions to confirm that blood components produced using this system meet established quality standards within our institution.

In addition, the blood bag system evaluated in this study is produced by the National Blood Centre, Thai Red Cross Society and has been approved as a medical device by the Thai Food and Drug Administration (approval date: 29 July 2025; valid until 31 December 2029). This indicates that its safety and performance, including the intrinsic characteristics and leukocyte filter, have been previously assessed through regulatory processes. The sample size decided in this study is consistent with routine quality control practices in blood banks, where representative sampling is performed to ensure compliance with quality specifications, as recommended by international standards such as AABB and EDQM.4,5 The recommended number is about 1% of blood component production or not less than 10 units. Therefore, the number of units in this study is appropriate for its intended purpose as a process-oriented quality assessment under routine operational conditions.

All whole blood prior to filtration (WB) met acceptance criteria, reflecting the effectiveness of donor selection, blood collection procedures, and process control during blood donation and collection. However, 50% of leukocyte-depleted whole blood (LDWB), met acceptance criteria on residual white blood cell (rWBC). This observation suggests variability in leukocyte removal efficiency during the whole blood filtration step. Potential contributing factors include leukocyte filter performance, filtration technique, time interval between collection and filtration, and environmental conditions during processing. These findings indicate the need for ongoing monitoring and process review at the LDWB filtration stage to improve consistency in routine practice.

The leukocyte reduction performance observed in this study is consistent with previous reports demonstrating that modern leukocyte filtration systems can achieve residual white blood cell levels of $\leq 1 \times 10^6$ cells/unit, which is widely

accepted as the international standard.[4,5] In the present study, all LDPRC units showed undetectable or extremely low rWBC levels, indicating effective leukocyte removal comparable to established leukocyte filtration technologies.

Similarly, the percentage hemolysis observed throughout storage remained well below the acceptable threshold (<0.8%), with a gradual increase over time, which is consistent with expected storage-related changes in red blood cells. These findings agree with previously published studies reporting low hemolysis levels during storage of packed red cells under appropriate conditions[7,8], supporting the adequacy of the additive solution, storage conditions, and product handling in this study.

For leukocyte-depleted fresh frozen plasma (LDFFP), all evaluated parameters met the specified criteria, indicating that the plasma component derived from this system is preliminary acceptable for routine use. The analysis of factor VIII activity is ongoing and will provide additional information regarding the functional quality of the plasma component.

Residual white blood cell enumeration is conventionally performed using a Nageotte chamber or flow cytometer, which are considered reference methods. In this study, rWBC measurements were performed using an automated blood cell counter (Mindray CAL-6000: BC-6200), routinely used in the central laboratory for hematology and body fluid cell analysis. This analyzer applies flow cytometric principles combined with fluorescence detection and includes a body fluid (BF) mode designed for low cell count analysis. According to manufacturer specifications[6], the background/blank count for WBC in BF mode is $\leq 0.001 \times 10^9$/L, approximately 100-fold lower than that of the complete blood count (CBC) mode ($\leq 0.1 \times 10^9$/L). Therefore, BF mode was selected for preliminary rWBC assessment in this evaluation.

Based on the manufacturer's Clinical Performance Evaluation Report (CE) for the Mindray BC-6000 series, the limit of detection (LoD) for WBC measurement in BF mode is 0.003×10^9/L. Using the allowable maximum LDPRC volume specified by national criteria (180–270 mL), a worst-case scenario calculation based on a volume of 270 mL (0.27 L) yields an LoD of 0.81×10^6 cells per unit. When compared with the criterion for LDPRC (rWBC $\leq 1 \times 10^6$ cells per unit), the calculated LoD remains below the specified threshold. These findings indicate that the BC-6200 analyzer operated in BF mode provides sufficient analytical sensitivity for preliminary confirmation of LDPRC quality and is suitable for use in routine quality control.

Nevertheless, to ensure full compliance with national and international standards[4,5], the blood bank plans to conduct a comparative evaluation of rWBC measurements obtained using the BC-6200 analyzer and a reference flow cytometry method in the future. This comparison will further validate the accuracy and reliability of automated cell counting for quality assessment of leukocyte-reduced blood components, including leukocyte-poor packed red cells, leukocyte-depleted packed red cells, and single-donor platelets, to support routine blood bank operations.

In addition to technical performance, the evaluated blood bag system offers practical advantages in routine blood donation settings, particularly its 350 mL collection volume, which is suitable for donors with lower body weight such as 45-50 kg. who constitute a significant proportion of the donor population in our setting. This feature may enhance donor safety and expand donor eligibility while maintaining product quality.

Overall, the findings of this study support the use of this system for routine blood collection and blood component

preparation, resulting in leukocyte-depleted blood components that meet established quality standards.

Conclusion

Leukocyte-depleted blood components prepared using a CPD/SAG-M quadruple blood bag with an integrated leukocyte filter met National Standards for residual leukocyte content and other key component parameters. The use of this system supports the provision of safer blood components for patients by minimizing leukocyte-related transfusion reactions while maintaining acceptable component quality. This is particularly relevant for patient groups who are vulnerable to transfusion-related complications, such as chronically transfused patients with thalassemia and patients with oncologic diseases, indicating the suitability of this system for routine preparation of leukocyte-depleted blood components in a hospital-based blood bank.

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Conflict of Interest

The authors declare no conflicts of interest. The blood bags used in this study were provided at no cost by the National Blood Centre, Thai Red Cross Society, which had no role in the study design, data analysis, interpretation of results, or manuscript preparation.

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References

1. National Blood Centre, Thai Red Cross Society. Standards for Blood Banks and Transfusion Services. 5th ed. Bangkok: National Blood Centre, Thai Red Cross Society; 2024. ISBN: 978-616-8345-02-3.
2. National Blood Centre, Thai Red Cross Society. Physician's Manual for Rational Use of Blood and Blood Components. 2nd ed. Bangkok: National Blood Centre, Thai Red Cross Society; 2023. ISBN: 978-616-8212-84-4.
3. World Health Organization. Educational modules on clinical use of blood. Geneva: World Health Organization; 2021. ISBN: 978-92-4-003373-3 (electronic), 978-92-4-003374-0 (print).
4. Cohn CS, Delaney M, Johnson ST, Katz LM, editors. Technical manual. 21st ed. Bethesda (MD): AABB; 2023.
5. European Directorate for the Quality of Medicines & HealthCare (EDQM). Guide to the preparation, use and quality assurance of blood components: appendix to Recommendation No. R (95) 15. 22nd ed. Strasbourg: Council of Europe; 2025.
6. Henzhen Mindray Bio-Medical Electronics Co.,Ltd. BC-6200 automated hematology analyzer: operator's manual. Shenzhen: Shenzhen Mindray Bio-Medical Electronics Co., Ltd.; 2018.
7. Arif SH, Yadav N, Rehman S, et al. Study of hemolysis during storage of blood in the blood bank of a tertiary health care centre. Indian J Hematol Blood Transfus. 2017; 33 (4): 598–602. doi:10.1007/s12288-016-0769-5.
8. Makroo RN, Raina V, Bhatia A, et al. Evaluation of the red cell hemolysis in packed red cells during processing and storage. Asian J Transfus Sci. 2011; 5 (1): 15–9.

Nutritional Status of Lung Cancer Patients Receiving Chemotherapy

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Abstract:

Introduction: Malnutrition is common among lung cancer patients and adversely affects treatment outcome, quality of life, and survival. Data on nutritional status in this population, particularly during chemotherapy, remain limited in Myanmar.

Objectives: This study aimed to assess the nutritional status of lung cancer patients using the Subjective Global Assessment score (SGA) and Body Mass Index (BMI).

Materials and Method: This study evaluated the nutritional status of 70 patients with lung cancer at Yangon General Hospital, Myanmar using the SGA score and BMI. Changes in nutritional status were evaluated before and after chemotherapy.

Results: At baseline, 66% of patients were malnourished according to SGA, increasing to 68% after chemotherapy. Most patients experienced significant weight loss, as evidenced by a decline in BMI following chemotherapy. Although the overall change in SGA categories before and after chemotherapy was not statistically significant, individual-level analysis showed that a greater proportion of patients experienced deterioration than improvement, particularly in those with metastatic disease.

Conclusion: Malnutrition is highly prevalent among lung cancer patients in Myanmar. Routine nutritional assessment and early nutritional intervention should be integrated into cancer care to mitigate weight loss and improve treatment outcomes.

Keywords: Lung cancer; Malnutrition; Chemotherapy; SGA; BMI

Introduction

Lung cancer is the most common cancer worldwide and a leading cause of cancer-related mortality.[1] In Myanmar, the burden of lung cancer is substantial, reflecting the high prevalence of tobacco smoking.[2] Malnutrition is a frequent and serious problem among cancer patients, and its prevalence varies according to tumor site, disease stage, and treatment setting. The highest rates are reported in pancreatic cancer (80–85%), gastroesophageal cancer (65–85%), and head and neck cancer

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(65–75%), while in lung cancer, the prevalence ranges from 45–60%.[3]

In lung cancer patients, malnutrition is strongly associated with cancer cachexia, driven by inflammatory cytokines, anorexia, hyper catabolism, and progressive skeletal muscle loss.[4] In contrast, in upper gastrointestinal tumors, malnutrition is related to impaired oral intake due to dysphagia or obstruction. Patients with breast cancer often have normal or increased body weight and are generally considered at lower risk of malnutrition.[9] In liver cancers, malnutrition is also common but is driven by distinct metabolic and nutritional mechanisms.[10] These differences highlight the importance of tumor-specific nutritional assessment, particularly in lung cancer, where systemic cachexia plays a central role independent of mechanical limitations to oral intake.[3-4,9]

Cancer-related malnutrition has been associated with poor treatment tolerance, increased complications, prolonged hospital stay, reduced quality of life, and decreased survival.[5] Chemotherapy can further exacerbate nutritional deterioration through adverse effects such as nausea, vomiting, anorexia, mucositis, and fatigue. Early identification of nutritional risk is therefore essential to optimize treatment outcomes in lung cancer patients.[6]

The Subjective Global Assessment (SGA) is a validated clinical tool widely used to assess nutritional status in oncology patients.[7] It is a standardized, noninvasive, and cost-effective method that incorporates information from medical history (weight loss, dietary intake, gastrointestinal symptoms, and functional capacity) and physical examination (loss of subcutaneous fat, muscle wasting, and the presence of edema or ascites).[7]

In resource-limited settings, routine nutritional assessment is often overlooked due to limited manpower and facilities, and local data on the nutritional status of lung cancer patients undergoing chemotherapy remain scarce.[6] Therefore, this study aimed to evaluate the nutritional status of lung cancer patients before and after chemotherapy using BMI and SGA, and to identify associated clinical factors.

Method

Study design and setting

This was a hospital-based observational study conducted at the Medical Oncology Department, Yangon General Hospital, Myanmar, between February 2019 and January 2020.

Study population

A total of 70 patients with histologically confirmed lung cancer were enrolled. Patients of both sexes aged ≥18 years, with any histological subtype, who were scheduled to receive chemotherapy were included. Patients who were terminally ill or unable to complete at least three cycles of chemotherapy were excluded.

Data collection and clinical variables

Demographic and relevant clinical variables were collected, including age, sex, smoking status, histological subtype, disease stage, treatment modalities (surgery and radiotherapy), and chemotherapy regimens. These variables were predefined and included in the analysis to evaluate their association with changes in nutritional status.

Nutritional assessment

Baseline nutritional status was assessed prior to the initiation of chemotherapy using BMI and SGA score. Follow-up assessment was performed after completion of three cycles of chemotherapy. Chemotherapy consisted predominantly of platinum-based combination regimens administered every

three weeks; therefore, the interval between assessments was approximately nine weeks. However, the exact duration may have varied depending on individual patient condition and treatment delays related to chemotherapy toxicity.

Body weight and height were measured, and BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Patients were classified according to BMI categories: underweight (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30 kg/m^2).

The SGA score is a validated clinical tool originally developed by Detsky et al.[7] for the evaluation of nutritional status in adult patients. It incorporates information from medical history and physical examination (in Supplementary material). Based on these components, patients were classified into three categories: well nourished (SGA-A), moderately malnourished (SGA-B), or severely malnourished (SGA-C). All SGA assessments were performed by a single investigator who had received appropriate training, using a standardized assessment protocol.

Assessment of SGA changes

Individual changes in SGA classification before and after chemotherapy were assessed. Changes were categorized into three groups: "Worse," "No change," and "Improved." No change in SGA classification was recorded as "No change." Changes from SGA-A to B, A to C, or B to C were classified as "Worse." Changes from SGA-C to B, C to A, or B to A were classified as "Improved."

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 16. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean ± standard deviation. Paired t-tests were used to compare mean BMI values before and after chemotherapy. Associations between categorical variables were analyzed using Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Limitations

Multivariable analysis to adjust for potential confounders (e.g., disease stage, treatment type, and baseline nutritional status) was not performed due to the relatively small sample size and limited number of events, which may reduce the reliability of such models.

In addition, due to resource limitations, formal nutritional interventions such as oral nutritional supplements or enteral/parenteral nutrition were not routinely provided. Patients mainly received general nutritional counseling as part of standard care; however, detailed data regarding the extent and consistency of counseling were not systematically recorded, and its impact on nutritional outcomes could not be evaluated.

Ethical considerations

Ethical approval for the study was obtained from the Research and Ethics Committee of the University of Medicine - 1 Yangon. Written informed consent was obtained from all participants prior to enrollment, and confidentiality of participant data was strictly maintained.

Results

Baseline demographic and clinical characteristics

The baseline characteristics of the study population are summarized in Table 1. A total of 70 patients were included. Most patients were aged 51–60 years (40%), followed by 61–70 years (28%). The majority were male (83%) and smokers

(71%). The most common histological subtype was squamous cell carcinoma (53%), followed by adenocarcinoma (28%). A large proportion of patients presented with advanced-stage and metastatic disease (63% and 36%, respectively). Only 1% were stage II, and no patients were stage I. Regarding treatment modalities, 13% of patients received radiotherapy and 6% underwent surgical intervention. The majority were treated with palliative chemotherapy (61%). Platinum plus etoposide was the most frequently used chemotherapy regimen (72.8%). The distribution of chemotherapy regimens among lung cancer patients is summarized in Table 2.

Baseline nutritional status

At baseline, 30% of patients were underweight according to BMI, while 50% had a normal BMI. Based on SGA classification, 34% of patients were well nourished (SGA-A), 47% were moderately malnourished (SGA-B), and 19% were severely malnourished (SGA-C) (Table 3). Overall, 66% of patients were malnourished prior to chemotherapy.

Baseline BMI was significantly associated with baseline SGA classification ($p = 0.010$) (Table 4). Patients with normal BMI were more likely to be classified as SGA-A, whereas

Table 1 Baseline demographic and clinical characteristics of lung cancer patients (n = 70)

Characteristics	Number (%)
Age ≤50	9 (13)
Age 51–60	28 (40)
Age 61–70	20 (28)
Age >70	13 (19)
Male	58 (83)
Female	12 (17)
Smoker	50 (71)
Non-smoker	20 (29)
Squamous cell carcinoma	37 (53)
Adenocarcinoma	20 (28)
Large cell carcinoma	9 (13)
Small cell carcinoma	4 (6)
Stage I	- (-)
Stage II	1 (1%)
Stage III	25 (36)
Stage IV	44 (63)
Radiotherapy – Yes	9 (13)
Radiotherapy – No	61 (87)
Surgery – Yes	4 (6)
Surgery – No	66 (94)
Adjuvant Chemotherapy	4 (6)
Chemoradiotherapy	23 (33)
Palliative Chemotherapy	43 (61)

Table 2 Distribution of chemotherapy regimens among lung cancer patients

Regimen	Number	Percentage
Platinum + etoposide	51	72.8%
Platinum + gemcitabine	10	14.2%
Platinum + paclitaxel	6	8.5%
Platinum + pemetrexed	2	2.8%
MVP	1	1.4%
Total	70	100%

underweight patients were more frequently classified as SGA-B or SGA-C. No other demographic or clinical variables showed a significant association with baseline SGA status.

Table 3 Distribution of Subjective Global Assessment (SGA) categories before and after chemotherapy (n=70)

SGA category	Before chemotherapy n (%)	After chemotherapy n (%)
SGA-A	24 (34.3)	22 (31.4)
SGA-B	33 (47.1)	31 (44.3)
SGA-C	13 (18.6)	17 (24.3)

Table 4 Association between baseline BMI and baseline SGA classification (n=70) Changes in BMI after chemotherapy

Baseline BMI (kg/m²)	SGA-A n (%)	SGA-B n (%)	SGA-C n (%)
<18.5	1 (4.2)	14 (42.4)	6 (46.2)
18.5–24.9	17 (70.8)	12 (36.4)	6 (46.2)
25–29.9	5 (20.8)	6 (18.2)	1 (7.7)
≥30	1 (4.2)	1 (3.0)	0 (0.0)

After completion of the third cycle of chemotherapy, the proportion of underweight patients increased to 37%, while the proportion of overweight and obese patients decreased. Mean BMI significantly declined from 21.3 ± 4.2 kg/m² before chemotherapy to 20.2 ± 3.2 kg/m² after chemotherapy ($p < 0.001$) (Table 5).

Table 5 Comparison of mean body mass index (BMI) before and after chemotherapy

BMI (kg/m²)	Mean ± SD	Paired t statistic	p value
Before chemotherapy	21.3 ± 4.2		
After chemotherapy	20.2 ± 3.2	4.813	<0.001

Table 6 Changes in SGA score after chemotherapy (n = 70)

Change in SGA score	Number of patients	Percentage (%)
No change	52	74
Worse	11	16
Improved	7	10
Total	70	100

Changes in SGA after chemotherapy

Following chemotherapy, 31% of patients were classified as SGA-A, 44% as SGA-B, and 24% as SGA-C (Table 3). The overall distribution of SGA categories before and after chemotherapy did not differ significantly (p = 0.446). However, individual-level analysis demonstrated meaningful changes in nutritional status.

Most patients (74%) showed no change in SGA classification. Nutritional deterioration was observed in 16% of patients, while 10% demonstrated improvement (Table 6).

Factors associated with individual changes in nutritional status

Disease stage was significantly associated with individual changes in SGA status (p = 0.043). Patients with advanced disease were more likely to experience deterioration in nutritional status. Other factors, including age, sex, histological type, surgery, radiotherapy, and chemotherapy type, were not significantly associated with changes in SGA status.

Discussion

This study provides important local data on the nutritional status of lung cancer patients in Myanmar, where structured nutritional assessment is not routinely integrated into oncology care. A significant proportion of patients presented at an advanced stage. Approximately two-thirds of patients (66%) were malnourished at baseline, with further deterioration observed during chemotherapy. The prevalence of malnutrition observed in this study is consistent with reports from other oncology populations, where rates ranging from 40–80% have been documented.[3] The predominance of advanced-stage disease in our cohort may partly explain the high baseline prevalence of malnutrition.

A significant decline in mean BMI was observed following chemotherapy, indicating deterioration in objective nutritional status during treatment. There was also a significant association between baseline BMI and SGA classification, suggesting that lower BMI is correlated with poorer nutritional status. Although BMI is a simple and objective measure that allows precise

monitoring of changes in body weight over time, it may underestimate malnutrition, particularly in patients with normal or higher body weight.[8] In contrast, SGA provides a more comprehensive clinical assessment by incorporating weight loss, dietary intake, functional status, and physical examination findings.[7] Moreover, weight loss is a key parameter in the assessment of malnutrition in cancer patients and is included within the SGA tool.[5] Therefore, the combined use of BMI and SGA enables a more complete evaluation of nutritional status by capturing both objective and clinical dimensions of malnutrition.

The overall change in SGA categories before and after chemotherapy was not statistically significant. Although most patients did not show a change in their individual SGA classification, a greater proportion experienced deterioration than improvement, particularly in patients with metastatic disease, underscoring the vulnerability of this group. The absence of a statistically significant change in SGA categories may reflect heterogeneity in treatment response, disease characteristics, and individual patient factors, resulting in both improvement and deterioration across patients. In addition, this finding may be explained by the multidimensional nature of the SGA tool, whereby changes in individual components may not be sufficient to alter the overall classification over a relatively short follow-up period.

In lung cancer, particularly in advanced stages, deterioration in nutritional status during chemotherapy is frequently observed and is multifactorial. Contributing factors include treatment-related toxicities, reduced oral intake, increased metabolic demand, systemic inflammation, and cancer-related cachexia.[4] A large proportion of patients in our study had advanced-stage disease, which may have contributed to the greater likelihood of deterioration in nutritional status at the individual level.

SGA is a simple, inexpensive, and clinically applicable tool for assessing nutritional status in lung cancer patients and can be readily implemented in routine clinical practice, particularly in resource-limited settings. In Myanmar, where the burden of lung cancer–related mortality is high, the implementation of structured nutritional assessment and management is particularly important, as it may improve treatment tolerance, reduce complications, and enhance overall clinical outcomes. These findings highlight the importance of early nutritional assessment and timely intervention throughout treatment, particularly during chemotherapy.

This study has several limitations. It was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. Several potential confounding factors may have influenced the observed changes in nutritional status, including treatment-related factors such as chemotherapy regimens and associated toxicities, as well as patient-related factors such as age, sex, smoking status, and histologic subtype. Furthermore, the lack of structured nutritional interventions in our setting may represent an additional confounding factor. Due to the limited sample size and number of events, multivariable analysis was not performed to adjust for these confounders, and the findings should be interpreted with caution.

Despite these limitations, this study provides valuable insight into the nutritional challenges faced by lung cancer patients undergoing chemotherapy in routine clinical practice. Further studies with larger sample sizes, longer follow-up, and incorporation of objective body composition measurements are warranted to provide additional insight. In addition, the use of more cancer-specific

tools, such as PG-SGA, may facilitate earlier identification of patients at nutritional risk by capturing patient-reported symptoms relevant to cancer-related malnutrition.[9,12]

Conclusion

Malnutrition is highly prevalent among lung cancer patients receiving chemotherapy, both at baseline and during treatment. Most patients experienced significant weight loss, as evidenced by a decline in BMI after chemotherapy. Although most patients did not show a change in SGA classification, a greater proportion experienced deterioration than improvement, particularly in those with metastatic disease, underscoring the vulnerability of this patient group.

This single-center study with a small sample size is subject to potential confounding factors and should be interpreted with caution. Despite these limitations, it highlights important nutritional challenges in lung cancer patients undergoing chemotherapy. Larger studies with longer follow-up, along with the use of cancer-specific tools such as PG-SGA, are needed to improve early identification and management of nutritional risk, enabling timely intervention and potentially improving treatment tolerance and overall patient care. Incorporating structured nutritional screening and assessment into routine oncology practice should be encouraged, particularly for patients with advanced lung cancer.

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Conflict of Interest

The author declares no conflict of interest.

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References

1. Sung H, Ferlay J, Siegel RL, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021; 71 (3): 209–49. doi:10.3322/caac.21660.
2. International Agency for Research on Cancer. Myanmar: Global Cancer Observatory (GLOBOCAN 2020). Lyon: IARC; 2020.
3. Arends J, Bachmann P, Baracos V, et al. ESPEN guidelines on nutrition in cancer patients. Clin Nutr. 2017; 36 (1): 11–48. doi:10.1016/j.clnu.2016.07.015.
4. Baracos VE, Martin L, Korc M, et al. Cancer-associated cachexia. Nat Rev Dis Primers. 2018; 4:17105. doi: 10.1038/nrdp.2017.105.
5. Dewys WD, Begg C, Lavin PT, et al. Prognostic effect of weight loss prior to chemotherapy in cancer patients. Am J Med. 1980; 69 (4): 491–7.
6. Arends J, Baracos V, Bertz H, et al. ESPEN expert group recommendations for action against cancer-related malnutrition. Clin Nutr. 2017; 36 (5): 1187–96. doi:10.1016/j.clnu.2017.06.017.
7. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? JPEN J Parenter Enteral Nutr. 1987; 11 (1): 8–13. doi:10.1177/014860718701100108.
8. Kyle UG, Pirlich M, Schuetz T, et al. Is nutritional status assessed by body mass index? Clin Nutr. 2003; 22 (6): 545–50. doi:10.1016/S0261-5614(03)00096-0.

9. Arends J, Strasser F, Gonella S, et al. ESPEN practical guideline: Clinical nutrition in cancer. Clin Nutr. 2021; 40 (5): 2898–913. doi:10.1016/j.clnu.2021.02.005.
10. Prado CM, Purcell SA, Laviano A. Nutrition interventions to treat low muscle mass in cancer. Lancet Oncol. 2020; 21 (3): e136–e147. doi:10.1016/S1470-2045(19)30890-2.
11. Vittinghoff E, Glidden DV, Shiboski SC, et al. Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models. 2nd ed. New York: Springer; 2012.
12. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. Eur J Clin Nutr. 2002; 56 (8):779–785. doi:10.1038/sj.ejcn.1601412.

Supplementary material

Subjective Global Assessment (SGA) form used for nutritional assessment

1. Nutrient Intake

☐ No change; adequate

☐ Inadequate; duration of inadequate intake: _____

- ☐ Suboptimal solid diet
- ☐ Full fluids or oral nutrition supplements only
- ☐ Minimal intake, clear fluids, or starvation

Nutrient intake in the past 2 weeks:

- ☐ Adequate ☐ Improved but not adequate
- ☐ No improvement or inadequate

2. Weight

Usual weight: ____ kg Current weight: ____ kg

Non-fluid weight change in the past 6 months:

- ☐ <5% loss or weight stability
- ☐ 5–10% loss without stabilization or increase
- ☐ >10% loss and ongoing

If above not known, subjective weight loss over past 6 months:

- ☐ Non/mild ☐ Moderate ☐ Severe

Weight change in the past 2 weeks:

- ☐ Increased ☐ No change ☐ Decreased

3. Symptoms

- ☐ Anorexia ☐ Vomiting ☐ Dysphagia ☐ Diarrhea
- ☐ Constipation ☐ Dental problems ☐ Early satiety
- ☐ Nausea ☐ Pain on eating

Severity of symptoms:

☐ Intermittent/mild/few

☐ Constant/severe/multiple

Symptoms in the past 2 weeks:

☐ Resolved ☐ Improving ☐ No change or worsened

4. Functional Capacity

☐ No dysfunction

☐ Reduced capacity; duration: ____

☐ Difficulty with ambulation or normal activities

☐ Bed- or chair-ridden

Functional capacity in the past 2 weeks:

☐ Improved ☐ No change ☐ Decreased

5. Metabolic Requirement

☐ High metabolic requirement ☐ No ☐ Yes

6. Physical Examination

Loss of subcutaneous fat:

☐ No ☐ Mild/Moderate ☐ Severe

Loss of muscle mass:

☐ No ☐ Mild/Moderate ☐ Severe

Presence of edema or ascites:

☐ No ☐ Mild/Moderate ☐ Severe

7. Global SGA Rating

☐ SGA-A: Well-nourished

☐ SGA-B: Moderately malnourished

☐ SGA-C: Severely malnourished

Case Report

GMSMJ

Greater Mekong Subregion Medical Journal

Acquired Perforating Dermatosis Associated with Hodgkin Lymphoma: Rare Associated Manifestation

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Abstract:

Acquired reactive perforating collagenosis (ARPC) is a rare subtype of acquired perforating dermatosis (APD) that typically occurs in adults, often associated with diabetes mellitus or chronic renal failure. However, ARPC has also been reported in association with malignancies and other systemic disorders. We presented the case of a 21-year-old Thai woman presented with multiple erythematous, pruritic papules with central keratotic plugs on the trunk, back, and extremities for five months. With history of chronic cough and significant weight loss of 10 kg over three months. Punch biopsy consistent with ARPC. Further investigations revealed an anterior mediastinal mass, multiple enlarged cervical and intra-abdominal lymph nodes, and tiny pulmonary nodules with peribronchovascular consolidations at anterior segment of RUL; concerning for lymphatic or lung involvement. EBUS-guided biopsy showed atypical cells compatible with Classic Hodgkin lymphoma. The patient was diagnosed with ARPC with Hodgkin lymphoma stage IIIB with bulky disease, IPS 0. This case highlights the importance of recognizing ARPC as a potential cutaneous manifestation of underlying malignancy.

Keywords: acquired perforating dermatosis, central keratotic plug, significant weight loss, Hodgkin lymphoma

Introduction

Acquired reactive perforating collagenosis (ARPC) is a subtype of acquired perforating dermatosis (APD) that typically occurs in adulthood, often associated with diabetes mellitus (DM) or chronic renal failure (CRF).[1,2] Recently, ARPC has also been reported in patients with malignancies,[3] hepatic and endocrine disorders, acquired immunodeficiency syndrome, often including retiform purpura.[4] In severe cases, ischemic necrosis and purpura fulminans tuberculosis, pulmonary aspergillosis, neurodermatitis, atopic dermatitis, and scabies.[4] ARPC presents as umbilicated necrotic papules or nodules with central keratotic plugs.[5] Lesions can be localized or generalized,[6] commonly affecting the extensor surfaces of the limbs, while involvement of the trunk, face, and back is less frequent.[7]

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Case presentation

A 21-year-old Thai female presented with multiple erythematous pruritic papules with central keratotic plugs on trunk, back, and both extremities for five months. (Figure 1A, 1B, 1C) Three months before presentation, she developed a chronic cough accompanied by significant weight loss of 10 kilograms over a three-month period. Symptoms progressed, so she came to visit Dermatology department.



Figure 1A



Figure 1B

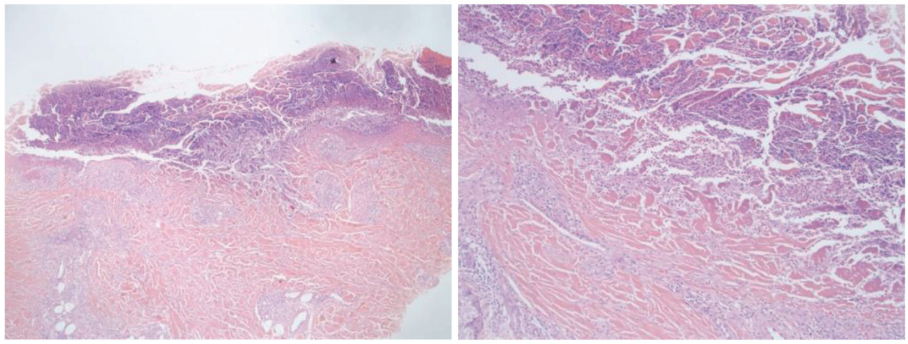


Figure 1C

Figure 1A, 1B, 1C Multiple well-defined border erythematous and hyperpigmented papules with central keratotic plug on trunk, back, and both extremities

Physical examination revealed multiple well-defined erythematous and hyper pigmented papules with central keratotic plugs distributed over the trunk, back, and both extremities. Bilateral cervical lymphadenopathy was noted, with multiple enlarged lymph nodes measuring up to 1.5 cm in diameter.

Punch biopsy from her left leg showed perforation of the epidermis forming a tunnel filled with cellular debris and was covered with scale-crust (Figure 2A). Thick collagen fibers perforated through this tunnel. The area of perforation was not connected to the hair follicle (Figure 2B). The dermis showed proliferation of small blood vessels and mid perivascular mixed inflammatory cell infiltration, comprised of lymphocytes and few neutrophils. There was no granuloma infiltration. The histopathological findings were consistent with acquired reactive perforating collagenosis.



H&E, x40
Figure 2A

H&E, x100
Figure 2B

Figure 2A(x40) Perforation of the epidermis forming a tunnel filled with cellular debris and was covered with scale-crust. **Figure 2B(x100)** Thick collagen fibers perforated through this tunnel. The area of perforation was not connected to the hair follicle.

Further investigations were performed to identify the underlying etiology of acquired reactive perforating collagenosis. Chest radiography revealed widening of the mediastinum. Computed tomography (CT) of the chest demonstrated a large anterior mediastinal mass, approximately 8x10x8 cm. The mass encased the SVC with bilateral brachiocephalic veins and right superior lobar pulmonary artery without significant compression. There were multiple bilateral cervical and right cardiophrenic lymphadenopathies. Perilymphatic distribution of multiple tiny pulmonary nodules with peribronchovascular and interlobar-septal at RUL and peribronchovascular consolidations at anterior segment of RUL; concerning for lymphatic or lung involvement from mediastinal mass, especially lymphoma. CT of the whole abdomen revealed several subcentimeter and enlarged nodes at right cardiophrenic, gastrohepatic, retrocaval, and paraaortic regions, size 0.9-1.3 cm; could be lymphomatous involvement. Endobronchial ultrasound-guided biopsy (EBUS) showed atypical lymphoproliferative lesion : rare large B cell proliferative for PAX5, MUM1(focal), and CD45 (focal), negative for CD3, CD15, CD20, CD23, AE1/AE3. ALK-1 and EBER. The lymphoid cells were mixture of predominant small T cell (CD3+) and few small B cells (CD20+). B cell: T cell around 1:5. The suspicious rare large bizarre cells were positive for CD30. The diagnosis was Classic Hodgkin lymphoma. Bone marrow aspiration and biopsy revealed normal cellular trilineage marrow with maturation. Flow cytometry findings were within normal limits. Laboratory investigations showed hemoglobin 13.6 g/dL, hematocrit 41.7%, white blood cell count 12,950/μL (68% neutrophils, 20% lymphocytes), and platelet count 496,000/μL. Renal function tests were normal (BUN 7.4 mg/dL, creatinine 0.9 mg/dL), and liver enzymes were within normal limits. Serologic tests for HIV, HBsAg, anti-HBc, anti-HCV, and Quantiferon-TB were negative. Thyroid function and HbA1c were also within normal range.

Based on the clinical presentation and the results of laboratory and imaging investigations, the patient was diagnosed with acquired perforating dermatosis in association with Classic Hodgkin lymphoma Ann Arbor stage IIIB with bulky disease, International Prognostic Score (IPS) of 0.

Discussion

Perforating dermatoses are a group of papulonodular skin disorders characterized by transepidermal elimination of dermal material, they are divided into primary and secondary forms.[1] Primary perforating dermatoses are subdivided into Kyrle disease (KD), reactive perforating collagenosis (RPC), perforating serpiginous elastosis (PSE), and perforating folliculitis (PF).[1] The secondary form of the disease is known as acquired perforating dermatosis (APD).[1]

Clinically, ARPC presents as umbilicated necrotic papules or nodules with central keratotic plugs which are characteristic skin lesions of the condition. The papules gradually develop from pinpoint size to 5 to 6 mm in diameter, with a central concavity resembling a navel. The skin lesions would relieve spontaneously, with temporary hypochromic areas and atrophic scars left.[5] Lesions may be localized or generalized[6], usually distributing on the extremities and back, sometimes face and neck. Pruritus is common but Koebner phenomenon is rarely reported.[7]

Faver et al proposed the following diagnostic criteria for ARPC:

1. Transepidermal material elimination of dermal connective tissue
2. Keratotic plug at the center of umbilicated papules or nodules; and
3. The age of onset after 18 years old.[7]

Dermoscopy is a useful and rapid tool for diagnosing ARPC, characterized by a homogeneous yellowish-brown structureless area at the center of the lesion corresponding to the scale-crust; a whitish ring-shaped rim to the epidermal invagination (EI), the thickness of which varied; and the pink-white halo seemed to correspond to a combination of small blood vessels surrounding the lesion.[8]

Histopathological examination is diagnostic. Early lesions show epidermal hyperplasia, thickening of epidermis and widening of papillary dermis, with degenerated collagen bundles. Later lesions exhibit cup-shaped invagination filled with keratotic plug consisting of degenerated collagen, parakeratotic cells and cellular fragments can be seen. Necrotic basophilic collagen fibers are eliminated to the epidermis.[5] Collagen bundles can be highlighted by Masson's trichrome staining.[9]

Cases of Hodgkin lymphoma associated with ARPC have been reported in 1987, and 2016 encompassing three cases where manifestations of cancer and dermatosis were concurrent or where cancer preceded dermatosis.[3,10] Other hematologic malignancies reported in association with ARPC include non-Hodgkin lymphoma, mixed histiocytic lymphocytic lymphoma, myelodysplastic syndrome (MDS), acute myeloid leukemia (AML), and chronic lymphocytic leukemia (CLL).[11,12,13,6] Additional reported malignancies include hepatocellular carcinoma, prostate cancer, pancreatic cancer, undifferentiated adenocarcinoma, and renal cell carcinoma with liver metastasis.[14-18]

Several therapeutic options have been reported as first-line therapy in ARPC, including topical corticosteroids, local and systemic retinoids, and UVB phototherapy with variable outcomes. Photodynamic treatment, amitriptyline, and doxycycline have also been utilized.[19-21]

In this case, the patient received multimodal treatment. For the acquired perforating dermatosis, therapy included topical corticosteroids, oral prednisolone 15 mg/day for five days, antihistamines, acitretin 25 mg once daily for sixteen months, and anti-pruritic therapy with gabapentin 300 mg/day for one month, followed by pregabalin 150 mg/day for two months. Narrowband UVB (NBUVB) phototherapy was administered twice weekly for six months. The underlying Hodgkin lymphoma was treated with the ABVD (Adriamycin,

Bleomycin, Vinblastine, Dacarbazine) chemotherapy regimen. The patient demonstrated marked symptomatic improvement following treatment for Hodgkin lymphoma. Adjunctive and supportive dermatologic care resulted in reduced pruritus, with overall clinical improvement of the skin lesions observed within twelve months.

Conclusion

Acquired perforating diseases can be associated with malignancies. Early detected and prompt, thorough diagnostic workup is essential for identifying the underlying causes of these conditions.

Conflict of interest

The authors have no relevant conflicts of interest to disclose.

References

1. Fernandes KA, Lima LA, Guedes JC, et al. Acquired perforating dermatosis in a patient with chronic renal failure. An Bras Dermatol. 2016;91(5 Suppl 1): 10–3.
2. Rapini RP. Perforating disorders. In: Arndt KA, LeBoit PE, Robinson JK, Wintroub BU, editors. Cutaneous Medicine and Surgery. 1st ed. Philadelphia: W.B. Saunders; 1996. p.407–11.
3. Pedragosa R, Knobel HJ, Huguet P, et al. Reactive perforating collagenosis in Hodgkin's disease. Am J Dermatopathol. 1987; 9: 41–4.
4. Saray Y, Seckin D, Bilezikci B, et al. Acquired perforating dermatosis: clinicopathological features in twenty-two cases. J Eur Acad Dermatol Venereol. 2006; 20 (6): 679–88.
5. Fei C, Wang Y, Gong Y, et al. Acquired reactive perforating collagenosis: a report of a typical case. Medicine (Baltimore). 2016; 95: e4305.
6. Huseynova L, Akdogan N, Gököz Ö, et al. Acquired reactive perforating collagenosis in association with prostate adenocarcinoma, chronic lymphocytic leukemia, and Graves' disease. An Bras Dermatol. 2020; 95 (3): 336–9.
7. Faver IR, Daoud MS, Su WP, et al. Acquired reactive perforating collagenosis. J Am Acad Dermatol. 1994; 30: 575–80.
8. Kittisak P, Tanaka M, et al. Dermoscopic findings in a case of reactive perforating collagenosis. Dermatol Pract Concept. 2015; 5 (2):75–7.
9. Eljazouly M, Alj M, Chahboun F, et al. Acquired reactive perforating collagenosis: a case report. Cureus. 2021; 13 (2): e13583.
10. Rivera-Rodríguez A, Prieto-Torres L, Felipo-Berlanga F, et al. Acquired reactive perforating collagenosis associated with Hodgkin disease. Clin Exp Dermatol. 2017; 42 (8): 934–6.
11. Sankesara KR, Shihora MK, Joshi KN, et al. Acquired reactive perforating collagenosis in association with non-Hodgkin lymphoma: two case reports of a rare association. Int J Res Dermatol. 2025; 11 (3): 263–5.
12. Henry JC, Jorizzo JL, Apisarnthanarax P, et al. Reactive perforating collagenosis in the setting of prurigo nodularis. Int J Dermatol. 1983; 22 (6): 386–7.
13. Karpouzis A, Tsatalas C, Sivridis E, et al. Acquired reactive perforating collagenosis associated with myelodysplastic syndrome evolving to acute myelogenous leukaemia. Australas J Dermatol. 2004; 45 (1): 78–9.
14. Kilic A, Gönül M, Cakmak SK, et al. Acquired reactive perforating collagenosis as a presenting sign of hepatocellular carcinoma. Eur J Dermatol. 2006; 16 (4): 447.

15. Boeck K, Mempel M, Hein R, et al. Acquired perforating collagenosis in a patient with carcinoma of the prostate. Acta Derm Venereol. 1997; 77 (6): 486–7.
16. Chae KS, Park YM, Cho SH, et al. Reactive perforating collagenosis associated with periampullary carcinoma. Br J Dermatol. 1998; 139 (3): 548–50.
17. Bong JL, Fleming CJ, Kemmett D, et al. Reactive perforating collagenosis associated with underlying malignancy. Br J Dermatol. 2000; 142 (2): 390–1.
18. Kurban M, Uthman I, Kibbi AG, et al. Acquired perforating dermatosis heralding metastatic renal cell carcinoma to the liver. Int J Dermatol. 2008; 47 (10): 1038–40.
19. Brinkmeier T, Schaller J, Herbst R, et al. Successful treatment of acquired reactive perforating collagenosis with doxycycline. Acta Derm Venereol. 2002; 82 (5): 393–5.
20. Yong A, Chong WS, Tey HL, et al. Effective treatment of uremic pruritus and acquired perforating dermatosis with amitriptyline. Australas J Dermatol. 2014; 55 (3): e54–7.
21. Sezer E, Erkek E, et al. Acquired perforating dermatosis successfully treated with photodynamic therapy. Photodermatol Photoimmunol Photomed. 2012; 28 (1): 50–2.