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Analysis of the Screening Efficacy of the Konsung Hemoglobin Analyzer in Anemia Patients

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Abstract: Anemia, a highly prevalent disease worldwide, severely impacts the health and quality of life for hundreds of millions of people. Early screening is of great significance for improving the prognosis of patients and reducing the burden of disease. With medical resources sinking to the grassroots level, it is urgent to develop precise and convenient screening tools. This article takes the Konsung Hemoglobin Analyzer (H7 series) as the research object and delves into the application value of its spectrophotometric detection principle in anemia screening. Through systematic analysis of instrument performance parameters, multicenter clinical validation data, and comparison with traditional laboratory testing methods, it was found that the device demonstrated high precision (± 2% error range) and high efficiency (3 seconds/sample) in hemoglobin quantitative detection. Its portable design and simple operation process greatly lowered the threshold for primary medical staff to use it. It is particularly suitable for large-scale screening in primary medical institutions. The study also pointed out that the device has an initial screening accuracy rate of 92.3% for iron deficiency anemia, can effectively identify high-risk groups, provide a reliable basis for subsequent precise diagnosis and treatment, and has important clinical and social value in promoting the forward shift of anemia prevention and treatment and achieving early diagnosis and treatment.
Keywords: Hemoglobin analyzer; Anemia screening; Spectrophotometry; Konsung H7; Diagnostic accuracy

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1. Introduction

Anemia is a clinical syndrome of hemoglobin (HB) levels below normal, with a global prevalence of about 24.8%, of which iron deficiency anemia accounts for 50%. Long-term anemia not only leads to weakened immunity and impaired cognitive function, but may also cause cardiovascular and cerebrovascular diseases, especially posing a significant threat to special groups such as pregnant women and children. However, traditional screening, which relies on routine blood tests and requires large automated instruments, has problems such as high equipment costs, complex operation, and long testing cycles, making it difficult to meet the demand for rapid diagnosis in primary medical care [1]. The Konsung hemoglobin analyzer (H7 series) has gradually gained popularity in anemia screening in primary medical institutions thanks to its portability and rapid detection feature (detection time ≤ 3 seconds). The device uses advanced spectrophotometry to break through the technical bottleneck of traditional detection. It can achieve precise detection with a small amount of blood collected from the fingertip, significantly improving screening efficiency and patient compliance. This article systematically assesses the detection efficiency of the device and its clinical application value, aiming to provide a scientific basis for optimizing anemia screening programs and promoting hierarchical medical treatment, and to help address the reality of the shortage of medical resources at the primary level.

2. Technical characteristics of Konsung hemoglobin analyzer

2.1. Detection principle and core parameters

The device, based on the principle of a spectrophotometer, measures the hemoglobin concentration in whole blood samples by the SLS-Hb method, with a detection range of 0–250g/L and a resolution of 1g/L [2]. Its core components include a microfluidic chip, a 532nm wavelength light source and photoelectric sensors, which calculate the HB content by measuring the light absorption value of the solution after hemolysis. Clinical validation showed a correlation of 0.98 ($P < 0.001$) with the results of a fully automatic blood analyzer, such as Sysmex XT-1800i.

2.2. Operational advantages and limitations

2.2.1. Advantages

(1) Fast and convenient: No need for complex sample pretreatment, only 7μL of fingertip blood is needed to complete the test, saving 90% of the sample collection time compared to traditional blood routine tests. The instrument has a simple and intuitive interface, and after standardized training, non-professional medical staff can complete the sample test in one minute, greatly improving the screening efficiency [3]. For example, in the physical examination of elderly people in the community, the daily test volume can reach three times that of traditional equipment.

(2) Cost-effectiveness: The cost of consumables for a single test is 30% lower than that of a conventional blood routine test, and the equipment is easy to maintain and does not require frequent calibration.

(3) Application scenarios: The device is compact and portable, especially suitable for scenarios with limited resources such as physical examination centers, blood banks, blood donation vehicles, and community hospitals [4]. In free medical consultations in remote areas or health screenings for enterprise employees, its feature of not requiring an external power supply (with an internal battery lasting over 8 hours) effectively solves the problem of traditional equipment relying on laboratory environments and promotes the extension of anemia screening services to grassroots and mobile terminals.

2.2.2. Data connect

Equipped with Bluetooth transmission capability, it integrates with regional medical databases for real-time data sharing. Primary healthcare providers can rapidly upload results to higher-level hospitals or public health platforms, facilitating patient health record creation and dynamic monitoring. Big data analytics further aid health authorities in identifying regional anemia patterns to inform targeted prevention strategies [5].

2.2.3. Limitations

(1) Morphological information missing: Inability to provide key parameters such as mean cell volume (MCV) and red cell distribution width (RDW), which affect the identification of anemia types;

(2) Interfering factors: Hyperbilirubinemia (> 20mg/dL) or chylous blood samples may lead to biased results.

3. New breakthrough in portable hemoglobin monitoring

3.1. Innovative technology for precise detection

Hemoglobin is a protein molecule found in red blood cells that transports oxygen from the lungs to other parts of the body. It is essential to human life. Low hemoglobin levels may indicate that a person has certain diseases, including aplastic anemia, cancer, chronic kidney disease, and cirrhosis, so real-time hemoglobin monitoring is necessary. The Konsung H7 series portable hemoglobin analyzer uses microfluidic, spectrophotometry, and scattering compensation technology to ensure clinical standard accuracy (CV ≤ 1.5%) [6–8]. Only 7μL of fingertip blood needs to be collected, and the test results will be displayed on the TFT color screen within 3 seconds. The storage of 2,000 test results provides great convenience for monitoring hemoglobin levels in daily life.

Using reliable hemoglobin methods and more operable sampling techniques, Hb and HCT can be detected quickly and accurately to diagnose and monitor diseases such as anemia, polycythemia, sickle cell disease, etc. [9–11]. It is widely used in blood stations and can also be used in clinical, bedside testing, medical laboratories, hospitals, etc.

3.2. Analysis of clinical application scenarios

(1) Large-scale screening: Among 5,000 physical examinations conducted in primary medical institutions, the device detected a positive rate of 12.3% (616 cases) of anemia, which was in agreement with 91.8% of subsequent blood routine reexamination results;

(2) Dynamic monitoring: Follow-up of iron supplementation treatment in patients with iron deficiency anemia showed that the trend of changes in HB detected was consistent with the improvement of clinical symptoms ($r = 0.79$, $P < 0.01$);

(3) Suitability for specific populations: For children patients (3–12 years old), no age-related bias was observed in the test error ($P = 0.45$), but attention should be paid to the influence of children's cooperation at the time of blood collection.

3.3. Sensitivity and specificity

Select 800 clinical blood samples (including 220 male samples, 300 female samples, and 280 children samples) [12]. Tests are conducted now on the BC-5140 automatic blood cell analyzer produced by Mindray Bio-Medical Electronics Co., LTD. (hereinafter referred to as "BC-5140") and then on the Konsung H7-3 hemoglobin analyzer (hereinafter referred to as "H7-3"), and the results of both tests were statistically analyzed and the sensitivity and specificity of the H7-3 hemoglobin analyzer was calculated [13]. Table 1 shows the results of the test conducted on the male samples. Using these data, the sensitivity and specificity were calculated, which are 96.70% and 94.74%, respectively.

Table 1. Male test data

		BC-5140		
		Positive (+)	**Negative (-)**	**Total**
H7-3	Positive (+)	176	2	178
	Negative (-)	6	36	42
	Total	182	38	220

Sensitivity = 176 / (176 + 6) × 100% = 96.70%

Specificity = 36 / (36 + 2) × 100% = 94.74%

Table 2 shows the results of the test conducted on the female samples. Using these data, the sensitivity and specificity were calculated, which are 96.80% and 92.00%, respectively.

Table 2. Female test data

		BC-5140		
		Positive (+)	**Negative (-)**	**Total**
H7-3	Positive (+)	242	4	246
	Negative (-)	8	46	54
	Total	250	50	300

Sensitivity = 242 / (242 + 8) × 100% = 96.80%

Specificity = 46 / (46 + 4) × 100% = 92.00%

Table 3 shows the results of the test conducted on the samples taken from children. Using these data, the sensitivity and specificity were calculated, which are 98.33% and 85.00%, respectively.

Table 3. Children test data

		BC-5140		
		Positive (+)	**Negative (-)**	**Total**
H7-3	Positive (+)	236	6	242
	Negative (-)	4	34	38
	Total	240	40	280

Sensitivity = 236 / (236+4) × 100% = 98.33%
Specificity = 34 / (34 + 6) × 100% = 85.00%

Table 4 shows the results of the total test data. The sensitivity and specificity of Konsung H7-3 hemoglobin analyzer was 97.32% , and the specificity was 90.63%.

Table 4. Total test data

		BC-5140		
		Positive (+)	**Negative (-)**	**Total**
H7-3	Positive (+)	654	12	666
	Negative (-)	18	116	134
	Total	672	128	800

Sensitivity = 654 / (654+18) × 100% = 97.32%
Specificity = 116 / (116+12) × 100% = 90.63%

3.4. Quality control solutions

Konsung offers a comprehensive quality control program designed to monitor and verify the accuracy of test results produced by the H7 hemoglobin analyzer. This program includes:
(1) Hemoglobin quality control solution: HBC-3A (Level L, M, H)
(2) Hemoglobin analyzer quality control chip: HBQC-3C (Chip-high, Chip-middle, Chip-low).

4. Comparison with Other Detection Methods

4.1. Microscopic method

The microscopic method allows for the identification of abnormal red blood cell morphology, such as target cells. However, it is time-consuming, typically requiring more than 15 minutes per sample, and its accuracy is highly dependent on the operator's expertise and experience.

4.2. Fully automatic analyzer

Fully automatic hematology analyzers offer comprehensive blood cell parameter analysis with high precision. Nevertheless, their high cost, ranging from 20 to 50 times more than that of Konsung instruments, can be a limiting factor for widespread use.

4.3. Portable photoelectric colorimetric device

These portable devices demonstrate performance comparable to the Konsung H7 hemoglobin analyzer. However, as of 2025, they lack certification from the National Medical Products Administration (NMPA), which may restrict their clinical adoption and regulatory approval.

5. Optimization suggestions and future prospects

5.1. Technology upgrade

Integrated AI image recognition module for semi-quantitative analysis of red blood cell morphology by connecting to an external microscope [14]. Currently, AI has shown great potential in the field of medical image analysis. Introducing it into hemoglobin analyzers can automatically identify abnormal size and shape of red blood cells, assisting doctors in quickly identifying disease characteristics such as iron deficiency anemia and megaloblastic anemia. Compared with traditional microscopic examination, AI can significantly reduce subjective errors, improve diagnostic efficiency and accuracy, and is particularly suitable for scenarios where primary medical experience is insufficient.

5.2. Multi-index tests

Tests such as serum ferritin and transferrin saturation provide valuable insights into iron storage and transport status, enabling more precise differentiation between various types of anemia. Relying solely on a hemoglobin test is often insufficient, as it does not distinguish among causes such as iron deficiency, chronic disease, or other hematologic conditions [15]. By expanding the test indicators, multi-dimensional data support for anemia diagnosis can be formed, helping doctors quickly identify the cause and develop personalized treatment plans. This will not only improve the level of primary care, but also reduce the rate of patient referrals and optimize the allocation of medical resources.

6. Conclusion

The Konsung hemoglobin analyzer shows efficient and economical advantages in the initial screening of anemia and can be the preferred tool for primary care. There is a general shortage of testing equipment and professional technicians in primary medical institutions. Traditional anemia testing equipment is not only complex to operate, but also has high requirements for the environment and personnel, making it difficult to carry out screening work quickly. The Konsung hemoglobin analyzer, however, uses a convenient fingertip blood collection method, does not require complex sample pretreatment, and can be quickly operated by medical staff after simple training, greatly shortening the testing process and significantly improving the screening efficiency. Economically, the cost of the equipment and consumables is much lower than that of traditional testing devices, which can effectively reduce the financial burden on primary medical institutions. In addition, the device is compact and portable, and can be flexibly adapted to daily outpatient services, mobile screening in remote areas, and community health check-ups, providing a practical solution for large-scale initial screening of anemia at the grassroots level and helping to improve the level of anemia prevention and treatment at the grassroots level.

Disclosure statement

The author declares no conflict of interest.

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