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Theoretical Knowledge Versus Clinical Readiness: Why Do Medical Graduates Struggle to Manage Common Pediatric Hemoglobinopathies?

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Abstract

Thalassemia and sickle cell disease are important inherited hemoglobin disorders that require more than theoretical knowledge for safe clinical management. Medical graduates should be able to recognize patterns of anemia, interpret basic hematological tests, identify acute complications, initiate appropriate first-line management, educate families, and arrange timely referral. However, undergraduate medical education may not adequately prepare graduates for real-world clinical decisions involving transfusion-dependent thalassemia, suspected transfusion reactions, or acute presentations of sickle cell disease. In Iran, where thalassemia remains a substantial health concern and hemoglobinopathies exhibit regional variation, this gap warrants particular attention. This letter highlights the mismatch between theoretical learning and clinical readiness and proposes competency-based, case-based, and performance-oriented educational strategies.

Key Words: Clinical readiness, Medical education, Pediatric hemoglobinopathies, Thalassemia, Sickle cell disease.

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Dear Editor,

Hemoglobinopathies, including thalassemias and sickle cell disease, are among the most common inherited disorders worldwide and impose substantial burdens on affected children, families, and health systems (1). Their management has improved through transfusion programs, iron-chelation therapy, hydroxyurea, hematopoietic stem-cell transplantation, genetic counseling, and multidisciplinary care. Nevertheless, these disorders remain clinically complex and require accurate decision-making throughout childhood and adolescence (2,3). Management extends beyond identifying anemia or confirming a diagnosis; it requires the ability to recognize acute deterioration, interpret laboratory findings, understand treatment-related complications, communicate effectively with families, and ensure appropriate referral and continuity of care.

Iran has particular relevance in this area. Thalassemia remains prevalent in several regions, especially in northern and southern parts of the country, whereas sickle cell disease and related hemoglobin variants are more clinically relevant in southern and southwestern areas, including Khuzestan and regions near the Persian Gulf (4, 5). National premarital screening and prenatal diagnosis programs have reduced the number of births affected by thalassemia major. However, children living with hemoglobinopathies require sustained care, including regular transfusions when indicated, monitoring for iron overload, surveillance for cardiac and endocrine complications, genetic counseling, and psychosocial support (2–4).

A central educational concern is that theoretical knowledge does not necessarily translate into clinical readiness. Medical students may understand the genetic basis of beta-thalassemia or sickle cell disease, the concept of autosomal-recessive inheritance, and the main laboratory characteristics of these disorders. However, they may remain uncertain when confronted with a pale child with severe anemia, a transfusion-dependent child with fever, or a child with sickle cell disease presenting with pain, dyspnea, or respiratory symptoms. Such encounters require more than factual recall. They require the ability to obtain a focused history, interpret basic laboratory findings, identify red flags, initiate safe first-line measures, communicate with caregivers, and arrange timely referral.

The management of transfusion-dependent thalassemia clearly illustrates this gap. Care involves more than raising hemoglobin concentrations. It requires awareness of transfusion safety, appropriate selection and monitoring of blood products, recognition of transfusion reactions, monitoring for iron overload, recognition of endocrine and cardiac complications, and coordination with specialist teams (2,3). The Thalassaemia International Federation emphasizes that transfusion-dependent thalassemia is a lifelong condition that should preferably be managed in specialized centers through multidisciplinary care (2). General practitioners are not expected to independently manage all aspects of chelation therapy or long-term surveillance. However, they should be able to recognize warning signs, understand the importance of adherence to care plans, identify potential adverse events, and determine when urgent specialist consultation is required.

This issue is closely related to the quality of transfusion-medicine education in Iran. Available evidence suggests that transfusion-medicine education is inconsistent and insufficiently practice-oriented in many Iranian medical training settings, creating a gap between theoretical instruction and clinical requirements (6). Medical graduates should at least understand the general indications for transfusion, essential pre-transfusion safety procedures, patient monitoring during and after transfusion, and recognition of acute transfusion reactions. In children with thalassemia, each transfusion-related decision should be informed by the child's clinical status, transfusion history, risk of alloimmunization, and individualized specialist care plan. These skills are difficult to acquire through isolated lectures and written examinations alone.

The need for clinical readiness may be even more urgent in sickle cell disease. A child may present with severe pain, fever, acute anemia, acute chest syndrome, stroke, serious infection, splenic sequestration, or other potentially life-threatening complications. Safe early management depends on prompt recognition of clinical deterioration, appropriate pain assessment and treatment, evaluation for infection, attention to respiratory symptoms, and timely involvement of specialist services (7, 8). International guidance further emphasizes preventive care, vaccination, family education, infection

prevention, regular follow-up, and coordination across primary, emergency, and specialist care settings (7, 8).

This challenge is not unique to Iran; however, it may be amplified by limitations in clinical training. In many educational settings, students encounter hemoglobinopathies primarily through lectures, brief ward rounds, or isolated clinical cases rather than through longitudinal and supervised involvement in patient care. In Iran, broader reviews of medical education have identified limited opportunities for direct observation, structured feedback, supervised clinical participation, and active skills development as barriers to effective clinical learning (9). Consequently, students may retain fragmented knowledge but lack the clinical reasoning, communication, and prioritization skills required for safe practice in real-world and time-sensitive situations.

A further concern is that written examinations may reward factual recall without demonstrating that learners can integrate knowledge into safe action. A student may correctly identify the causes of microcytic anemia or list the complications of chronic transfusion but still fail to identify a child requiring urgent referral. This limitation is particularly important in peripheral hospitals and primary-care settings, where the first physician evaluating a child may not have immediate access to pediatric hematology expertise. The ability to recognize uncertainty, seek advice early, and arrange safe transfer is therefore itself a core clinical competency.

Curriculum reform should focus on clearly defined competencies rather than knowledge acquisition alone. Before graduation, all medical students should be able to obtain a focused history from a child and caregiver, recognize common patterns of microcytic and hemolytic anemia, interpret initial laboratory results, identify emergency features, provide safe supportive care, communicate uncertainty honestly, and determine when urgent referral is needed. They are not expected to replace pediatric hematologists. Rather, they should be capable of recognizing common or high-risk presentations, avoiding unsafe delays, and participating effectively in coordinated care.

Several feasible strategies could strengthen undergraduate training in Iran. First, case-based teaching should focus on realistic presentations rather than isolated disease labels. Examples may include a child with microcytic anemia, a febrile child receiving regular transfusions, a child with sickle cell disease and severe pain, a child with respiratory symptoms suggestive of acute chest syndrome, or a suspected transfusion reaction. Such scenarios can integrate differential diagnosis, test selection, interpretation of laboratory findings, initial management, communication with parents, and referral planning. They also allow students to understand that management decisions depend on clinical context rather than laboratory values alone.

Second, brief supervised rotations in pediatric hematology clinics, thalassemia centers, and transfusion units could provide meaningful exposure to chronic disease management and multidisciplinary teamwork. Students could observe transfusion visits, discussions about treatment adherence, counseling sessions, and collaboration among pediatricians, hematologists, nurses, laboratory personnel, psychologists, social workers, and other professionals. This exposure can help students appreciate that effective care includes attention to school attendance, growth, puberty, mental health, stigma, family stress, and transition from pediatric to adult services.

Third, simulation and Objective Structured Clinical Examinations should be used to evaluate practical readiness. A structured clinical station could require a student to assess a child with chronic anemia, interpret a complete blood count and ferritin level, explain warning signs to a parent, and develop a safe referral plan. Other stations could address fever in a transfusion-dependent child, severe pain in sickle cell disease, or recognition of a transfusion reaction. These assessment methods are more likely than multiple-choice examinations alone to evaluate whether students can apply knowledge safely in clinical practice. Structured feedback after these exercises would further allow learners to identify knowledge gaps and refine their communication and clinical-reasoning skills.

Fourth, faculty development should accompany curriculum reform. Clinical teachers need support in supervising students, providing specific feedback, assessing performance, and integrating clinical reasoning with patient-centered communication. Faculty members in pediatrics, hematology,

transfusion medicine, family medicine, and emergency medicine can jointly develop shared learning objectives and teaching cases. Such collaboration would reduce fragmentation and reinforce the message that hemoglobinopathy care is not confined to a single specialty.

These interventions do not necessarily require expensive infrastructure. Medical schools can use de-identified clinical cases, Persian-language educational materials, short case-based sessions, workshops on the interpretation of complete blood counts and hemoglobin studies, low-cost simulation, and partnerships with local thalassemia centers. E-learning resources could supplement bedside teaching, particularly for students training in settings with fewer pediatric hematology services. Pilot programs could initially be implemented at selected medical schools and evaluated through learner performance, confidence, feedback from faculty and patients, and the quality of referral decisions.

Training should also consider regional differences in Iran. A national curriculum can establish core competencies for all graduates, while locally adapted teaching can reflect the greater relevance of sickle cell disease in some southern regions and the substantial burden of thalassemia in other parts of the country (4, 5). Such an approach would preserve national educational standards while ensuring that graduates are prepared for the epidemiological realities of the communities they are likely to serve.

CONCLUSION

The gap between theoretical knowledge and clinical readiness in pediatric hemoglobinopathies is an important educational concern in Iran. Fragmented teaching, limited direct patient exposure, overreliance on written examinations, and insufficient performance-based assessment may leave medical graduates uncertain in clinically important situations. Integrating case-based learning, supervised clinical exposure, transfusion-medicine education, simulation, structured feedback, faculty development, and performance-based assessment into undergraduate medical curricula could improve graduates' ability to recognize hemoglobinopathies, initiate safe first-line care, identify warning signs, communicate effectively with families, and arrange timely referral.

CONFLICT OF INTEREST: None.

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