



Original Article

Prevalence of anemia in pediatric patients of traumatic brain injury and problems associated with management in a developing country: Unfolding of an underrated comorbidity

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Received : 25 December 2020

Accepted : 05 February 2021

Published : 23 February 2021

DOI

10.25259/SNI_944_2020

Quick Response Code:



ABSTRACT

Background: Pediatric anemia has a high prevalence in developing countries such as Pakistan. It is common knowledge among hospital specialties but little is done to manage this condition by hospitalists. The issue is compounded with a poor primary care infrastructure nationally. The aim of this study is to bring to light the high prevalence of anemic children in neurosurgery and to describe the difficulties in managing their anemia in a tertiary hospital setting. A literature review is presented highlighting the socioeconomic difficulties that contribute to this widespread comorbidity and the difficulty in managing it from a hospital specialty point of view.

Methods: A prospective descriptive case series was carried out between March 2020 and September 2020. All patients under the age of 13 who presented to our department for traumatic brain injury (TBI) meeting our inclusion and exclusion criteria were enrolled and assessed for the presence and severity of anemia. Demographic data were collected. Following discharge, patients were referred to our hospital's pediatrics' anemia clinic which was before their first neurosurgery follow-up 2 weeks following discharge and attendance to follow up was documented.

Results: The prevalence of anemia was 78.9%. Over 95% of patients attended their neurosurgery follow-up but only 28% of patients attended their referral to the anemia clinic.

Conclusion: Anemia is highly prevalent in children presenting to neurosurgery for TBI and its longitudinal management has difficulties with lost to follow up in a tertiary hospital setting. There is a need for national initiatives to reduce the prevalence of anemia but concurrently better strategies need to be devised to manage anemic children in a hospital setting.

Keywords: Anemia and traumatic brain injury, Anemia in children in a developing country, Anemia in children with traumatic brain injury, Anemia in pediatric neurosurgery patients, Pediatric anemia in a developing country

INTRODUCTION

The primary health-care systems of developing countries are hard pressed and suffer from chronic disorganization, and a lack of consumer needs being adequately met by providers.^[10]

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Pakistan specifically has suffered numerous problems with its health infrastructure which amalgamated into a primary healthcare system that is virtually nonexistent with structural fragmentation, sparsity of resources, inaccessibility, and lack of gender sensitivity being contributing factors.^[31] Nearly two-thirds of the population live rural and are beleaguered by poverty, high illiteracy rates which along with the poor organization to the overall health-care structure have slowed down general health progress indicators.^[31] Within the first decade of the 21st century, a modest 0.6–1.19% of gross domestic product and 5.1–11.6% of the development budget have been spent on health and nearly a majority of this is gulped by large academic tertiary hospitals for curative services.^[19]

One of the public health crises as a result of poor public and primary health-care systems along with general poverty in developing countries such as Pakistan is that of anemia, specifically in children, with a prevalence as high as 61% to nearly 80%.^[2] While world over, 50% of anemic cases can be assumed to be due to iron deficiency,^[32] in Pakistan, an overwhelming majority of childhood anemias is due to iron deficiency.^[2] The contributing factors here have been identified as poverty, low dietary iron, poor personal hygiene and lack of sanitation, and a low maternal education.^[1,3] The fragmentations within the health-care system, poor national prevention strategies, and lack of robust public health initiatives, particularly with regard to primary care, resulted in us as neurosurgeons finding ourselves caring for an unusually high number of anemic children. Where in developed countries, anemia in children would be picked up by primary care, the tremendous prevalence of anemia in developing countries such as Pakistan with the effectively nonexistent primary health-care system has laid the burden of this widespread condition on tertiary hospital-based specialties including neurosurgery. Specific to neurosurgery, we have observed in our department a large proportion of children found to be anemic, who were admitted for traumatic brain injury (TBI) which has a very high incidence in Pakistan.

The aim of this study was to present the burden of anemia in pediatric patients who presented with TBI at our neurosurgery department and to discuss the peculiarities and hurdles faced from a health-care structural point of view in our efforts to treat their anemia.

MATERIALS AND METHODS

In this prospective descriptive case series, following ethical review board approval, we followed all pediatric patients who presented to our Neurocritical Care department following head injury and met our inclusion and exclusion criteria. The study duration was between March 2020 and September 2020. During this period, eligible patients were

enrolled within the study and assessed for the presence of anemia. Blood was drawn on admission following informed consent and anemic patients were graded for anemia severity according to the World Health Organization (WHO) anemia grading severity scale which is adjusted for difference age ranges.^[33] Those who were anemic, while admitted were started on an oral syrup containing ferrous sulfate 131 mg as its main ingredient and referred to pediatrics' anemia clinic at our hospital. Patients were then followed up to see if they attended their outpatient appointment to pediatrics' that we arranged for them, for the management of their anemia.

These appointments were before the patient's neurosurgery outpatient follow-up which was 2 weeks following discharge. All information was entered and analyzed in Statistical Package for the Social Sciences version 27. The primary outcome was to describe the prevalence of anemia in pediatric patients presenting to neurosurgery for TBI. The secondary outcome was to provide an overview of the difficulties of treating anemia in children in a tertiary hospital setting.

Inclusion criteria

1. All TBI patients aged 12 years or less, of both sexes, who presented within the study duration.
2. Patients of whom TBI were managed conservatively.
3. Parental consent to have blood drawn to assess for the presence of anemia in their child after informing them of the study rationale, importance of managing anemia, and the possibility of having their child referred to an anemia clinic.

Exclusion criteria

The following criteria were excluded from the study:

1. All patients of polytrauma.
2. Patients who underwent neurosurgical intervention.
3. Patients with significant subgaleal hematoma requiring transfusion.
4. Patients with any significant blood loss that could be a cause of anemia (no more than 300–400 ml)
5. Patients of chronic anemia due to any underlying hemopathy whether known at the time of enrolment or at subsequent follow-up.

RESULTS

A total of 120 children aged 12 or less presented to our Neurocritical Care department within the duration of the study. One hundred patients met our inclusion and exclusion criteria. Of these 100 patients, 10 did not participate in the study due to refusal of consent from their parents. Of the remaining 90, 71 patients had anemia. [Table 1] summarizes the important demographic and baseline characteristics, etiology of trauma, injury severity by Glasgow Coma Score,

Table 1: Demographic and baseline characteristics of anemic children in study cohort.

	Count	Percentage
Sex		
Male	46	64.8
Female	25	35.2
Mechanism of injury		
Road traffic accident	23	32.4
Fall from height	47	66.2
Sporting injury	1	1.4
Glasgow Coma Score		
Mild	44	62.0
Moderate	22	31.0
Severe	5	7.0
CT scan findings		
Extra dural hematoma	9	12.7
Subgaleal hematoma	2	2.8
Skull fracture	26	36.6
Contusion	7	9.9
Diffuse axonal injury	2	2.8
Unremarkable	25	35.2
World Health Organization anemia grade		
Normal	0	0.0
Grade 1	38	53.5
Grade 2	25	35.2
Grade 3	8	11.3
Number of transfusions		
None	63	88.7
1	6	8.4
2	2	2.8
Duration of stay		
2 days	30	42.3
2–7 days	32	45.1
Greater than 7 days	9	12.7
Age range		
1–4	34	47.9
5–8	30	42.2
9–12	7	9.9
Attended neurosurgery outpatient follow-up appointment		
Yes	68	95.8
No	3	4.2
Attended pediatrics' follow-up outpatient appointment		
Yes	20	28.2
No	51	71.8

duration of time patients were admitted, anemia severity, and attendance of outpatient follow-up appointments for patients who were anemic. The mean age of these patients was 4.89 years, with a standard deviation \pm 2.72 years. The minimum age was 1 year and maximum 12 years. Nearly 65% of anemic children were male and 35% were female.

Patients who were admitted from the emergency department, to our Neurocritical Care Unit for head injury could have their injury classified into three groups. The majority had suffered a fall from a height (66.2%) followed by road traffic

accidents (32.4%) with one patient suffering a cricket ball to the head injury. The majority of patients, 62%, had a mild TBI. The majority of the patients, 38 (53.5%), were mildly anemic but a substantial minority, 25 (35.2%), had moderate anemia. There were 8 patients (11.3%) with severe anemia. The prevalence of anemia was 78.9%.

Blood transfusions were only required by those who had severe anemia (8 patients). Of these, most patients required one transfusion except two patients, who required two transfusions each. About 96% of patients attended their follow-up appointment for neurosurgery but only 28% of patients attended their pediatrics outpatient follow-up appointment for the management of their anemia.

DISCUSSION

Anemia can be thought of as the reduction in mass of red blood cells leading them to be inefficient to meet the physiological needs of the body. It is a global problem which is a major public health concern, particularly in developing countries with Southeast Asia and Africa having the highest incidence worldwide.^[34] Our study provides evidence that caring for anemic children is a widely prevalent problem faced by the neurosurgical community, and one that is inexorable by hospitalists. The burden is being faced by all hospital-based specialties, particularly at tertiary hospitals because of the peculiar conditions in Pakistan, a developing country, that have fostered an environment where anemia as an entity is so prevalent, being as high as between 61% and nearly 80% in large national studies,^[2,14] and 78.9% in our small cohort. Studies have revealed that the majority of childhood anemias in Pakistan are by far as a result of iron deficiency.^[2] Pakistan's National Health Survey indicated that the prevalence of anemia was significantly associated with a child's age thus younger children were more likely to develop anemia.^[14] [Figure 1] illustrates the age range distribution with anemia severity in our cohort. A study from India, a country that shares similar cultural and socioeconomic challenges showed that the highest prevalence of anemia was children aged <5 years.^[5] In general, a younger age has had a higher prevalence anemia supported by studies conducted in Brazil, Nepal, Bangladesh, Iran, India, the Philippines, and Ethiopia.^[11,12,16,27,28,36] We cannot establish an association between gender and anemia due to nature of our sampling and there remains a conflict in the literature where some studies in Pakistan show no association between gender and anemia in children and other studies reporting a higher incidence in males or females.^[18]

We know that in developing countries, major risk factors for anemia include poverty, poor personal hygiene, lack of sanitation, lack of awareness of anemia, poor nutritional intake, and unhealthy dietary choices, and poor maternal education.^[1,11,16] However, the societal and cultural problems

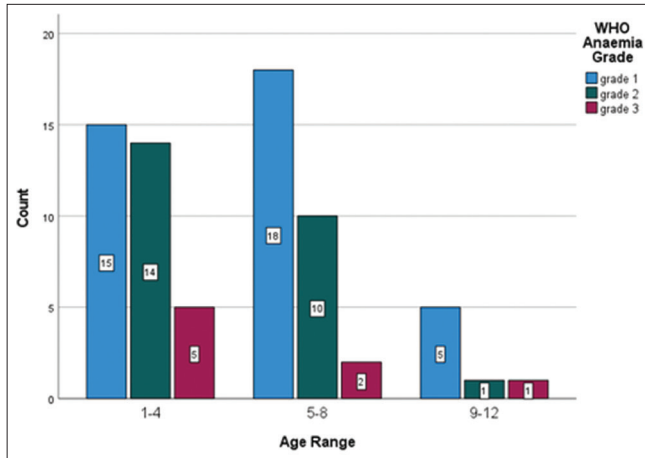


Figure 1: Age range of anemic patients in our series and severity of anemia per age group.

that give rise to these aforementioned risk factors may be different between countries. For Pakistan, reasons to be considered include lack of a robust and comprehensive primary health-care infrastructure and an archaic tribal culture in rural/village populations that have persistently had an active opposition to education, particularly for females, and is a cause of the high illiteracy rate in these communities.^[21]

The problems with primary health care in Pakistan shed light on not only why anemia is so prevalent but also help in part to explain why the burden of this condition is lying with tertiary care hospital specialties such as neurosurgery and the difficulties associated with treating anemia from the point of view of a hospitalist who is not working in the community.

Primary health-care units exist as dispensaries and basic health units (BHU) in rural and peri-urban areas of Pakistan, but the services that they are able to provide are far from what would be considered a comprehensive primary health center.^[17] Most primary care centers have lost credibility and are at the whims of corrupt administration, misgovernance, and a lack of accountability^[17] and as previously mentioned the vast majority of the health budget is consumed by tertiary care centers.^[19] While there is a need to allot more money to healthcare overall and within that to primary health care, it is critical to scrutinize and improve the current infrastructure.^[8,13] The major problem recognized in our BHUs is the absenteeism which is a result of virtually no regulation on practitioners and poor availability of essential equipment. This is a recognized issue within the BHUs of rural, tribal, and village areas.^[17] The butterfly effect of these nonfunctioning BHUs has caused a detrimental imbalance where widely prevalent issues which are appropriately suited to being managed in primary care are going to tertiary centers.^[17] For a condition like childhood anemia, it is the BHUs that are in a position to provide the most

appropriate setting to treat and manage the anemia as they are in the position to provide longitudinal care. They are situated within villages and districts and thus the patients of these areas would not have to come to tertiary centers in major cities. The WHO recognizes that a primary care is an essential service that is needed to improve public health.^[30] Neurosurgery being within a tertiary center in a major city is not able to provide longitudinal care as the majority of the population lives rural and a considerable distance away from tertiary hospitals in major cities. Our own department is located within the heart of the city but a large proportion of our TBI patients come from areas further afield.

The problems with lost to follow up generally within longitudinal research are recognized in Pakistan.^[4] Over 95% of patients attended their neurosurgery follow-up appointment, however, there was a disheartening attendance to anemia clinic with only 28% of patients attending. We believe the reason for this low turnout can be a result of low maternal education and poverty, which are risk factors for anemia in children and the fact that many of our patients stay a considerable distance away from the hospital. This distance coupled with low literacy rates, particularly an issue in villages/rural and tribal areas,^[21] may be why the parents of our patients did not appreciate or accept why it is so crucial to address their child's anemia, despite thorough information at enrolment in the study during the child stay in our department. Whereas with the physical, tangible, and visible nature of TBI, the children's parents are more concerned for the well-being of their child and attended follow-up due to the obvious nature of injury. The poor attendance of the anemia clinic may be compounded by the fact that the majority of our patients, 38 or 53.5%, had mild anemia which may not have had a dramatic apparent manifestation on children in their day-to-day lives so it can be argued that these parents may feel sceptical to travel distances for a condition such as anemia that is in many cases, asymptomatic.^[15] In developed countries, the gateway to secondary and tertiary care is BHUs where family physicians are locally accessible and where problems with the developing child and nutritional advice should be addressed. Thus, a good and accessible primary health-care center in proximity to the family's catchment area would be invaluable in managing anemia. Further research is, however, needed to establish the exact reasons for the poor of attendance to the anemia clinic and only then can they be addressed.

Most of the families in our cohort were from rural, villages, or tribal areas with poverty and low literacy rates, especially for females. At our own outpatient follow-up when probed about why parents did not choose to attend their child's anemia appointment, the vast majority said that they did not feel a need to attend or did not believe it was of importance to treating their child's anemia as per documented on the patient notes. This was despite being advised comprehensively of

the long-term implications. Our assessment was that these parents did not feel that anemia was even affecting their child due to its' asymptomatic nature. This is a cause of grave concern as chronic anemia has negative effects on linear growth during all stages of life from infancy to adolescence and infants are likely to develop delayed cognitive, motor, and affective development.^[26] When uncorrected, it is a cause of concern for a developing country as such a high prevalence would mean that the effected children are at risk of permanent developmental problems and can reduce future productivity which in already impoverished countries with poor economic opportunity puts them at a risk of a cycle of absolute poverty. Studies have shown that nutritional deficits are detrimental to a child's ability to capitalize on educational opportunities and negatively impacts their employment prospects as adults.^[9] Anemia particularly as a result iron deficiency is quick, cheap, and easy to correct.^[26] However, it needs the right structural system of healthcare in place if it is to occur nationally.

The rationale for studying TBI patients was 2-fold. First, the high incidence of TBI in Pakistan and at our center made it convenient a way to enroll children who would be eligible for the purpose of this study in a prospective manner. Our neurosurgery department is one of the referral centers for TBI that caters to the more than 12 million population of Lahore and surrounding rural villages and is referred a large volume due to the well equipped and advanced neuro-monitoring and critical care available. We are the only neurosurgery department in Pakistan, at the time of writing, to carry out Brain Micro-dialysis, and monitor ICP, ICPa and brain parenchymal oxygen and temperature. As a developing country, Pakistan with a population of 220 million has one of the highest incidences of TBI globally, 184/100,000, with a survey ($n > 100,000$) showing nearly one-third of patients suffered from TBI with about 10% having moderate-to-severe TBI.^[25]

Second, TBI would serve as one example that would demonstrate in the literature how a national issue of widespread anemia prevalence in children should be recognized in neurosurgery as a cause of concern not only from a holistic point of view of child development but from the view of neurosurgical outcomes. There is evidence to say that anemia and correction with blood transfusions are associated with a poorer outcomes in adults with TBI.^[23,24] However, these results are not generalizable to the pediatric population as there exists significant difference between pediatric and adult cerebral blood flow in the physiological state and states of traumatic injury,^[29] and there is evidence to suggest that correction of anemia with blood transfusions is not associated with poor outcomes in the pediatric population as is the case in adults.^[35] Thus, the high prevalence of anemia has implications for not only

cares for our patients from a holistic point of view but it is also a cause of concern as it may influence immediate neurosurgical outcomes.

It is certain that national programs for iron supplementation and food fortification are required to bring the prevalence of iron deficiency anemia down nationally.^[2,7,14] Wheat and flour fortification with iron supplementation have been shown to be effective strategies being used worldwide.^[20] Studies from Asian countries have shown that wheat flour fortification can significantly improve iron status on a population level.^[6,20,22] The long-term the burden of anemia must be address nationally and at a grass root level to have longitudinal and meaningful effects.

We hope the data in our study bring to light the prevalence of anemia and highlight problems faced in addressing it from a neurosurgical/hospital-based specialty limelight which could serve as a foundation for future cohort studies to elucidate cause and effect between reasons for not attending anemia clinics. Then, we may be in a position to make guidelines on how to promote compliance, at tertiary hospital center level, of parents in treating their child's anemia and giving the condition its due attention. However, these initiatives should not be a substitute for the long-term strategies to improve the nutrition status nationally.

Our study was a descriptive case series and a temporal and formal relationship between anemia, its risk factors, and reasons for not attending pediatric anemia clinic cannot be established. We lacked a detailed and systematic investigation into the reasons patients did not attend their anemia clinic as assessment of poverty, rural living, and illiteracy was made subjectively by asking the parents regarding their education status, income, and their location of residence. Further studies should be done to see how neurosurgery, at a hospital-based specialty and cross-sectional level could play a role in reducing the burden of anemia in their patients as it is fundamental to a child's development, can impact neurosurgical outcomes, and improve the socioeconomic outlook for these children.

CONCLUSION

Anemia has a high prevalence in children who present to neurosurgery for TBI. Parents are not giving due emphasis to the treatment of their child's anemia and this needs to be improved. Food fortification programs and public health awareness measures need to be introduced nationally to reduce the prevalence of anemia.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Ashraf M, Kamboh UA, Zubair M, Sultan KA, Raza MA, Hussain SS, *et al.* Prevalence of anemia in pediatric patients of traumatic brain injury and problems associated with management in a developing country: Unfolding of an underrated comorbidity. *Surg Neurol Int* 2021;12:75.