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Anaemia in Developing Countries: Burden and Prospects of Prevention and Control

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1. Introduction

Anaemia constitutes a public health problem in developing countries. Worldwide, about 2 billion people are estimated to suffer from anaemia and it is reported to account for three-quarters of 1 million deaths a year in Africa and South-East Asia. The underlying causes of anaemia are many, varied and largely preventable; these include nutritional deficiencies, infections and haemoglobin disorders.

Cost-effective interventions against anaemia are well documented in the literature. However, there are constraints to diagnosis, treatment and prevention in resource-poor settings of developing countries. Effective management of anaemia includes treatment of the underlying cause, restoration of the haemoglobin concentration to normal levels, and prevention and treatment of complications, among others. Suggested strategies aimed at preventing anaemia focused on the major underlying causes in developing countries.

2. Background

Anaemia is the reduction in the haemoglobin concentration of the peripheral blood below the normal range expected for age and sex of an individual.(1) The World Health Organisation (WHO) defines anaemia as a hemoglobin value below 13 g/dl in men over 15 years of age, below 12 g/dl in non pregnant women over 15 years, and below 11 g/dl in pregnant women.(2) It is a condition in which the number of red blood cells or their oxygen carrying capacity is insufficient to meet physiologic needs and this varies for age, sex, altitude and pregnancy status.(3) However, the determination of hemoglobin concentration should always take the state of hydration and altitude of residence of an individual into consideration.(1)

Anaemia is a global health problem in both developing and developed countries with major consequences on human health as well as social and economic development.(4) Anaemia is

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the world's second leading cause of disability.(3) Worldwide, the World Health Organisation (WHO) estimated the number of anaemic persons to be about 2 billion and approximately 50% of all cases can be attributed to iron deficiency.(5) Anaemia is responsible for about 1 million death a year, out of which three-quarters occur in Africa and South-East Asia.(6) Anaemia affects over half of preschool age children and pregnant women in developing countries, and at least 30-40% in industrialized countries.(3) Nevertheless, it is apparent that the prevalence of anaemia in developing countries is about four times more than developed countries.(7) In view of the above, this chapter highlights the burden of anaemia in the population and discusses its causes in developing countries. Furthermore, the chapter reviews the prospects and challenges of diagnosis of underlying causes, treatment and prevention in the developing countries.

3. Methods

We reviewed literature using key words of the thrust of the paper; hence, search terms such as prevalence, burden, causes, treatment and prevention of anaemia in developing countries were used. Cross sectional, observational and randomized control trials' literature on the subject published between 2000 and 2010 served as the main sources of information. Commonly used medical databases such as PubMed (Medline), AJOL and Google Scholar were searched as appropriate; in addition, Cochrane Library was used to source for systematic reviews on the subject matter.

4. Results

4.1 Burden of anaemia in developing countries

The most vulnerable groups in the population are children and pregnant women, while others such as the non pregnant women and the elderly are next affected. An estimated 10-20% of preschool age children in developed countries and 30-80% in developing countries are anaemic at 1 year of age.(8) The consequences of anaemia in children are inimical as it affects their cognitive performance, behaviour and physical growth. Children who suffer from anaemia have delayed psychomotor development and impaired performance of tests; in addition, they experience impaired coordination of language and motor skills, equivalent to a 5 to 10 points deficit in intelligent quotient (IQ).(5)

The World Health Organisation (WHO) estimated that 56% of all pregnant women in developing countries are anaemic.(9) In Southern Asia, the prevalence of anaemia in pregnancy is about 75% in contrast to what obtains in North America and Europe with about 17% prevalence. Furthermore, 5% of pregnant women suffer from severe anaemia in the worst affected parts of the world.(9)

The consequences of anemia in women are enormous as the condition adversely affects both their productive and reproductive capabilities. First, anaemia reduces their energy and capacity for work (10), and can therefore threaten household food security and income. Second, severe anaemia in pregnancy impairs oxygen delivery to the fetus and interferes with normal intra-uterine growth, thereby resulting in intrauterine growth retardation, still birth, low birth weight and neonatal deaths.(10-11) Therefore, anaemia is highly contributory to poor pregnancy and birth outcomes in developing countries as it predisposes to premature delivery, increased perinatal mortality and increased risk of death during delivery and postpartum (10).

Worldwide, it is estimated that about 20% of maternal deaths are caused by anaemia; in addition, anaemia contributes partly to 50% of all maternal deaths.(12) Similar situation is found in sub-Saharan Africa where anaemia is reportedly accounted for about 20% of all maternal deaths brought about through three main mechanisms.(13) First, anaemia resulting from blood loss during or after childbirth makes women more susceptible to deaths by lowering their haematological reserve. Second, severe anaemia is associated with increased susceptibility to infection due to lowered resistance to disease; and third, haemoglobin (Hb) level of less than 4 g/dl is associated with high risk of cardiac failure and death particularly during delivery or soon after, if prompt intervention is not instituted.(14-15)

In terms of lost years of healthy life, iron deficiency anemia causes 25 million cases of Disability Adjusted Life Years (DALYs); this accounts for 2.4% of the total global DALYs.(3) Physical and cognitive losses due to iron deficiency anaemia cost developing countries up to 4.05% losses in gross domestic product per annum(16), thereby stalling social and economic development. In the World Health Organisation (WHO)/World Bank rankings, Iron Deficiency Anaemia (IDA) is the third leading cause of disability-adjusted life years lost for females' aged 15–44 years.(17-18)

4.2 Common causes of anaemia in developing countries

Most often, anaemia co-exists with an underlying disease and rarely occurs on its own. The commonest causes of anaemia in developing countries, particularly among the most vulnerable groups (pregnant women and preschool age children) are nutritional disorders and infections.

4.2.1 Iron deficiency

Iron Deficiency Anaemia (IDA) is an underlying risk factor for maternal and perinatal mortality and morbidity; it is estimated to be associated with 115,000 of the 510,000 maternal deaths (i.e. 22%) and 591,000 of the 2,464,000 perinatal deaths (i.e. 24%) occurring annually around the world.(19) Iron is an essential component of haemoglobin (Hb), which is required for basic cellular function in all human tissues, particularly muscle, brain and red blood cells.(20) Therefore, deficiency of iron in the body can lead to anaemia in any age group. Iron deficiency anaemia (IDA) occurs when iron deficiency is sufficiently severe enough to diminish erythropoiesis, thereby leading to a decrease in the number of red cells in the blood and resulting in the development of anaemia.(21) However, mild-to-moderate forms of iron deficiency can occur in which the affected person is yet to become anaemic, but tissues are functionally iron deficient.(5) It is generally assumed that 50% of cases of anaemia are due to iron deficiency(5), but this may vary within population groups or environment.

The risk factors for IDA include a low intake of iron, poor absorption of iron from diets high in phytate or phenolic compounds, and early period of life when iron requirements are expectedly high. (4) Similarly, iron requirements are highest for pregnant women - 1.9 mg/1,000 kcal of dietary energy in the second trimester and 2.7 mg/1,000 kcal in the third trimester. These are followed by iron requirements in infants (1.0 mg), adolescent girls (0.8 mg), adolescent boys (0.6 mg), non pregnant women (0.6 mg), preschool and school age children (0.4mg), and adult men (0.3mg).(22)

Sources of dietary iron include meat, fish and poultry; other sources, though in less quantity, are cereals, dairy products, fruits and vegetables. About 40% of iron content of meat, fish and poultry is in the haem form, out of which about 25% is absorbed;(7) whereas

only about 2 - 5% of total iron is absorbed from cereals and legumes. Therefore, these foods have a major influence on iron status.(23) Unfortunately, intakes of these foods especially meat, fish and poultry are low among people of low socio-economic status. Furthermore, some of the foods are avoided or observed as taboos for religious or cultural reasons in certain communities of developing countries.

Inadequate absorption of dietary iron is highly contributory to the high prevalence of anaemia in the developing countries of Asia and other regions, except where it is caused by infections such as hookworm and malaria.(7) Poor absorption of dietary iron can be due to substances which interfere with its absorption such as proton pump inhibitors, calcium supplements and dairy products.(24)

4.2.2 Micronutrient deficiency

Evidence abounds that haemoglobin (Hb) concentration of persons with Vitamin A deficiency (VAD) increases by about 10 g/L when vitamin A supplements are provided.(25) Studies also suggest that vitamin A can improve hematologic indicators and enhance the efficacy of iron supplementation.(26) Thus, it is suggestive that Vitamin A deficiency (VAD) can predispose to anaemia.

It is reported that riboflavin deficiency may be quite common in developing countries where intake of animal products is low, and especially during seasons when there is less intake of vegetables.(7) Vitamin B12 is necessary for the synthesis of red blood cells and its deficiencies have been associated with megaloblastic anemia.(17) Therefore, diets with little or no animal protein, as it is often the case in the developing world, coupled with malabsorption related to parasitic infections of the small intestine, might result in Vitamin B 12 deficiency.(17)

Folic acid is also essential for the formation and maturation of red blood cells and necessary for cell growth and repair. Deficiency of folate reduces the rate of DNA synthesis with consequent impaired cell proliferation and intramedullary death of resulting abnormal cells; this shortens the lifespan of circulating red blood cells and results in anaemia.(27) There is, however, little evidence that folic acid deficiency may be a public health problem in many developing countries.

4.2.3 Infections

4.2.3.1 Malaria

It is now estimated that malaria is responsible for 1.2 million deaths annually and 2.9% of total DALYs in low and middle income countries.(28) About 35% of children with malaria in Africa have anaemia.(29) In sub-Saharan Africa, it is estimated that between 200,000 and 500,000 pregnant women develop severe anemia as a result of malaria.(9) *P. falciparum* malaria in pregnancy is the primary cause of up to 10,000 maternal anaemia related deaths in sub-Saharan Africa annually.(30)

Malaria, especially by the protozoon *Plasmodium falciparum,* causes anaemia by rupturing red blood cells and suppressing production of red blood cells.(31) However, this cannot be explained simply by the direct destruction of parasitized red blood cells at the time of release of meroziotes.(32) Decreased red cell production results from marrow hypoplasia seen in acute infection and dyerythropoiesis.(33) *Plasmodium falciparum* is the primary cause of severe malaria in regions of the world where malaria is endemic, especially sub-Sahara Africa .(7)

4.2.3.2 Parasitic infestation

Helminthes such as flukes, hookworm and whipworm cause chronic blood loss, and consequently iron loss.(34) These parasitic infestations are known to cause chronic haemorrhage and iron deficiency, resulting in the development of anaemia.(35) Blood loss caused by helminthiasis put the mother, fetus and child at risk of iron deficiency, which could lead to anaemia.(36) For example, the trematode, *Schistosomia haematobium* (fluke), predisposes to a significant urinary blood loss in severe infections and infected persons may present with terminal heamaturia, which continues for as long as it is not treated and then results in anaemia. Whereas, *Schistosomia mansoni* eggs can rupture the intestinal lining and result in the leakage of blood, other fluids and nutrients into the lumen.(34)

Hookworm infestation produces a high degree of long-term morbidity by causing iron deficiency anemia.(17) The extent to which this deficiency occurs depends on the host's iron status, the infecting parasites, and the intensity and duration of infection.(36) Blood loss is caused primarily by coagulase released by the parasite and it is responsible for continuous blood loss in the stool.(17) For example, *Ancylostoma duodenale* is estimated to cause up to 0.25 ml of blood loss per worm per day.(30)

A hookworm burden of 40–160 worms (depending on the iron status of the host) is associated with iron deficiency anemia.(37) Several studies in developing countries observed that 51% of anaemic children were iron deficient and if hookworm infection could be reduced by as much as 25%, it would reduce iron deficiency anaemia by 35% and severe anaemia by 73%.(31, 38) The nematode, *Trichuris trichiura* (whipworm) causes anaemia if the worm burden is heavy(31) and colonic lesions are associated with bleeding or there is a chronic reduction in food and micro-nutrient intake caused by anorexia-inducing effects of tumor necrosis factor-α released in response to the infection.(39-40)

4.2.3.3 Human Immuno-deficiency Virus infection (HIV)

Developing countries are the worst hit by the HIV pandemic, which accounts for 22.5 million people (68% of global total) in sub-Saharan Africa and 4.9 million people (15% of global total) in Asia living with HIV/AIDS in 2009.(41) In 2009, 1.3 million Africans died of HIV and this constituted 72% of the global total.(42) Anaemia is a frequent complication among HIV-positive individuals and it has been associated with a rapid HIV disease progression and mortality.(43) The predominant cause of anaemia in the context of HIV is anaemia of inflammation; this is also known as anemia of chronic disease, which is characterized by decreased red blood cell production through a series of mechanisms mediated, in part, by pro-inflammatory cytokines such as tumor necrosis factor-α and interleukin-6.(17)

Studies have also shown that zidovudine (AZT) causes anaemia in pregnant women as early as four weeks of commencing therapy.(44) The cause of anaemia in HIV-positive patients is, therefore, multi-factorial and includes infections, neoplasm, dietary deficiencies, blood loss, medications and antibodies to antiretroviral agents.(45-46) In addition, bone marrow suppression, especially the erythroid lines, by the AIDS virus is also known to cause anaemia in affected persons.(47)

4.3 Sickle cell diseases and thalassemia

About 5% of the world's population carries the genes responsible for haemoglobinopathies.(48) Sickle cell disease is an inherited disorder of hemogblobin and it is among the most common genetic diseases in the world.(17) Each year, about 300,000 infants are born with major haemoglobin disorders – including more than 200,000 cases of

sickle-cell anaemia in Africa.(48) It is characterized by lifelong haemolytic anaemia and many other significant morbidities largely related to painful and debilitating vaso-occlusive phenomenon.(49)

Patients present with recurrent anaemia, which sometimes require blood transfusion. *'Sicklers'*, as affected persons are often called, have worsened symptoms of low packed cell volume especially when there is a co-infection or pregnancy. It is a challenge for patients in developing countries, both old and young, in treating their ill conditions as there are usually inadequate supportive measures to restore them back to their stable states.

Thalassemia is the most common single genetic disorder worldwide, resulting from defects in genes producing hemoglobin. (50) It is highly prevalent in many Asian, Mediterranean and Middle Eastern countries.(51) The intermediate clinical forms of thalassemia result in anaemia, with occasional need for transfusions of red blood cells.(17)

5. Prospects and challenges of diagnosis of underlying causes of anaemia

Blood test for serum ferritin seems to be a sensitive and an early indicator of iron deficiency. In most developing countries, it is determined by using an immunoassay kit which is readily available, easily done and relatively inexpensive. (52) However, serum iron concentration, total iron-binding capacity and examination of blood films cannot detect the earliest stages of iron deficiency. (52) On the other hand, bone marrow examination showing absence of stainable iron is the definitive method for diagnosing IDA;(53) however, this is a painful and invasive procedure and it is therefore usually used as a last resort.(54)

The World Health Organisation (WHO) recently recommended prompt parasitologic confirmation by microscopy or alternatively, by rapid diagnostic tests (RDTs) in all patients suspected of malaria before treatment is commenced unless parasitological diagnosis is not accessible; this is with a view to reducing cases of resistance to anti malaria treatment. (55) However, many peripheral health facilities in resource-poor settings of developing countries lack the capacity to conduct quality parasitological diagnosis of malaria by microscopy.(56-57) Nonetheless, rapid diagnostic tests (RDTs) for malaria had recently been shown to offer the potential of extending accurate malaria diagnosis to areas when microscopy services are not available, especially in remote locations of the developing countries.(58-59)

In making a diagnosis of any clinical phase of schistosomiasis, the highly sensitive and specific PCR based assays have been developed for the detection of schistosome DNA in faeces or sera and plasma.(60) However, these tests are either not available or very expensive in many developing countries; thus, clinicians often use clinical acumen to make a diagnosis in majority of cases. Furthermore, fresh water bath is common among children in developing countries; thus, children with pruritic reaction or unexplained febrile illness several weeks after a fresh water bath are suspected to have contracted urinary schistosomiasis.(61) Diagnosis is made by finding parasitic eggs in urine sample, which is best taken at midday after exercise when most eggs are being shed.(61) On the other hand, eggs of hookworm are readily isolated from stool samples in developing countries.

Major challenges facing laboratory systems in HIV testing in resource-poor settings include poor infrastructure, lack of human capacity, lack of laboratory policies, and limited synergies between clinical and research laboratories; these factors compromise the quality of test results and patient management.(62) In addition, HIV stigmatization is a major barrier preventing many people from having voluntary counseling and testing done in developing countries. For instance, in the prevention of maternal to child transmission programme

(PMTCT), challenges of diagnosis in developing countries include HIV-associated stigma. This has been reported to pose a barrier to service utilization, including failure of women to return for HIV test results where rapid testing is not available, low acceptance of short-course preventive ARVs offered to HIV-positive women at antenatal clinics, difficulty in tracking and following up of mothers who deliver their infants at home and complexities of infant feeding for HIV-positive mothers in very low-resource settings.(63)

The major challenge in the diagnosis of haemoglobin disorders is detection of the disease conditions during prenatal period. At this period, laboratory confirmation is critically important to enable a couple at risk in making an informed decision about potential termination of pregnancy.(64) With DNA diagnostics, it has become possible to make definitive diagnoses of different haemoglobin disorders during the first trimester of pregnancy by analyzing foetal DNA obtained from chorionic villous biopsy. There is evidence that neonatal screening for sickle-cell anaemia, when linked to timely diagnostic testing, parental education and comprehensive care, markedly reduces morbidity and mortality from the disease condition in infancy and early childhood.(48, 65).

6. Management of anaemia

The objectives of management of anaemia include(1):

- Treatment of the underlying cause;
- Restoration of the haemoglobin concentration to normal levels; and
- Prevention and treatment of complications.

6.1 Treatment of the underlying cause of anaemia

Iron deficiency anaemia is treated with oral iron supplements as ferrous sulfate, ferrous fumerate or ferrous gluconate given as 200 mg twice or three times daily. Treatment could also be parenteral as iron dextran, especially when there is intolerance to oral iron or anaemia is diagnosed late in pregnancy.

Low birth weight infants are born with low iron stores; therefore, they demand high iron requirements for growth. Furthermore, their iron requirements cannot be readily met from breast milk and it is known that their iron stores are depleted by 2 to 3 months postpartum.(7) The global recommendation is to supply low birth weight infants with supplemental iron drops starting at 2 months of age.(38) A substantial amount of evidence confirms that iron supplementation of anaemic school children improves their school performance, verbal and other skills.(66)

Vitamin A can be given as oral supplementation doses to postpartum mothers irrespective of their breastfeeding options in doses of 200,000 I.U and to less than 5 years of age in doses between 100,000-200,000 I.U. In some countries where vitamin A deficiency is a public health problem, vitamin A supplements in capsule form are administered during National Immunization Days (NIDs) alongside oral polio and measles vaccines.(67) Though, high supplementation dose of vitamin A is of immense benefit to both mother and breast feeding infant, it should be avoided in pregnant women because it can cause miscarriage and birth defects.(68)

Vitamin B 12 is usually given intramuscularly but recent studies have shown that an oral dose is as effective as the injectable administration.(69) The daily requirement of vitamin B_{12} is approximately 2 mcg; the initial oral replacement dosage consists of a single daily dose of 1,000 to 2,000 mcg.

Folic acid supplementation can be given to patients with folate deficiency in doses between 1-5 mg daily. It is routinely given to pregnant women, particularly early in pregnancy, to prevent neural tube defect in the growing foetus in some developing countries. Malaria is treated with a wide range of anti-malaria drugs and most African countries now recommend the Artemisinin-based combination therapy (ACT), which is given to reduce cases of resistance of the parasite to other drugs.

Antihelminthic drugs such as albendazole or mebendale can be given to people infested with hookworm. In addition, iron deficiency aneamia which may co-exist can be treated with iron supplement. Praziquantel is the drug of choice for the treatment of schistosomiasis and it is shown to be effective and safe in pregnancy.(36) Praziquantel can easily be administered according to height using a "dose pole" developed to dispense the drug at 40-60 mg/kg; this is with a view to minimizing under dosage while the "dose pole" helps in identifying five height intervals corresponding to 1½, 2 ,2½, 3 and 4 tablets of praziquantel.(70)

The availability of the highly active antiretroviral therapy (HAART) at no cost has been of immense benefits to people living with HIV and AIDS, especially in developing countries where most affected persons cannot afford the drug treatment. Furthermore, WHO introduced revised treatment guidelines in 2010; these guidelines recommended early initiation of antiretroviral therapy, at a CD4 count of < 350 cells/mm3. This has, therefore, increased the total number of people medically eligible for antiretroviral therapy by about 50% i.e. from 10 million to 15 million in 2009 globally.(42) The main aspect of care for persons affected by sickle cell anaemia involves early treatment intervention of preventable health problems such as analgesics, antibiotics, vitamins, folic acid supplementation and high fluid intake are periodically used.

6.2 Restoration of the haemoglobin concentration to normal levels

Generally, blood transfusion is a very important measure in the treatment of anaemia; but it should not be used as a substitute for specific treatment of the underlying cause.(1) Blood can be given as an autologous transfusion, exchange transfusion or direct transfusion with blood products. It is recommended that blood transfusion should be given only if the dangers of failure to transfuse outweigh those of transfusion. (1) In developing countries, problems such as economic constraints may limit blood safety precautions; thus, unsafe blood which ought to have been screed for infections such as HIV, hepatitis B or C and syphilis, is inadvertently transfused.(71)

In addition, many developing countries do not have reliable testing systems because of staff shortage, lack of basic laboratory services, poor quality test kits or their irregular supply.(72) Sometimes, patients receive wrong blood type due to mismatch error and thereafter, develop blood transfusion reaction. These constraints underscore the importance of strengthening blood transfusion services in developing countries; furthermore, the process of obtaining an informed consent from patients, including discussing the risk and benefit of transfusion, except in life-threatening emergencies should be emphasised.(1)

6.3 Prevention and treatment of complications

Complications may arise as a result of the underlying disesase or anaemia itself. The overall goal is to ensure that anaemia does not re-occur or further deteriorates. Once the underlying cause can be treated, the prognosis is good in most cases. Other supportive measures include a balanced diet with adequate protein and vitamins; bed rest can also go a long way to restore blood levels in the body.

7. Strategies to prevent anaemia

Food fortification and dietary diversification with iron are important measures to prevent iron deficiency anaemia(8), especially in the vulnerable groups such as pregnant women and children. A number of strategies are used to deliver additional iron to humans, but food fortification has the greatest potential to improve the iron status of the largest number of people.(7) Ferrous fumarate, ferrous succinate and small particle size iron are suitable iron fortificants for infant cereals.(73) Infant cereals are widely fortified in developed countries and this has resulted in a definite reduction in anaemia. (74) WHO recommends that all pregnant women receive iron supplements of 60 mg daily combined in a pill, which also contains 400 µg folic acid.(75)

In view of the high prevalence of Vitamin A deficiency in developing countries and the potentially high prevalence of deficiencies of other micronutrients required for Hb synthesis and other functions, it is logical to assume that supplementation with multiple micronutrients, rather than just iron or iron plus folate, would be a rational public health strategy.(7) Currently, WHO recommends routine vitamin A supplementation during pregnancy or at any time during lactation in areas with endemic vitamin A deficiency.(76) Vitamin A can be given to children under 5 years of age in doses between 100,000-200,000 I.U as it is practised in some developing countries during national immunization days. Furthermore, absorption of iron from food can be enhanced by increasing intake of vitamin C.

Vector control remains as the most effective measure to prevent transmission of malaria in developing countries; though the methods used may vary considerably in their applicability, cost and sustainability.(77) WHO had recommended a combination of integrated vector management, indoor residual spraying, insecticide treated material and larval control.(78) Insecticide-impregnated bed nets in communities decrease the prevalence of severe anaemia in young children.(7) The home management of malaria (HMM) strategy has been introduced where early recognition, and prompt and appropriate treatment of malaria illness in children under 5 years of age in the home or community can be achieved. If *Plasmodium falciparum* malaria is endemic and transmission of infection is high, women in their first or second pregnancies should be given curative antimalarials at their first prenatal visit followed by locally recommended antimalarial prophylaxis.(7) Malaria control programme is highly necessitated among the highly susceptible group especially in the tropical regions of the world.(7)

In areas endemic with parasitic infections which affect Hb or iron status, the International Nutritional Anemia Consultative Group (INACG), WHO, and United Nations Childrens' Fund (UNICEF) recommended certain complementary control measures.(79) For example, adults and children over 5 years living in hookworm endemic areas (i.e. prevalence of 20-30% and above) are required to be treated with at least an annual dose of albendazole, mebendazole, Levamisole or Pyrantel. These drugs can be given to pregnant and lactating women, but should be avoided in the first trimester of pregnancy.(80)

Other efforts aimed at controlling hookworm infections include sanitary disposal of faeces and educational campaigns on proper use of latrines.(81) Most at risk persons are those who engage in agriculture and fishing, and those who use unsafe water for household chores particularly girls and their mothers.(36) Therefore, primary health care measures such as hand washing and wearing of shoes in hookworm endemic areas can have a major impact on the prevalence of anaemia.(7) All forms of schistosomiasis including intestinal and urinary types can be treated with praziquantel effectively. Prevention is best achieved by eliminating water dwelling snails, which serve as natural reservoirs of the disease.

Effective HIV preventive interventions include condom use, provision of clean injecting equipment, standard precautions, blood safety and post exposure prophylaxis for occupational and non-occupational exposures.(82) Sickle cell anaemia can be prevented if couples at risk of having affected children can be identified by inexpensive and reliable blood test. Periodic prophylaxis against malaria, infections and other factors which may trigger discomfort could improve quality life of affected children.(48)

8. Conclusion and recommendations

In developing countries which are usually characterized by resource-limited settings, slow progress has been made toward reducing the prevalence of anemia; this is largely due to persistent micro-nutrient deficiencies, and high prevalence of parasitic diseases, HIV, sickle cell disease and thalassemia.(17) The best approach to preventing IDA in pregnancy is to ensure adequate maternal iron status early in pregnancy or preferably in the pre-conceptional period.(83) Therefore, micronutrient supplements should be given not only to pregnant women but also to non-pregnant women of reproductive age and adolescent girls; this would reduce the prevalence of anaemia in the community and consequently, improve fertility and maternal health.

The apparent failure to reduce the prevalence of anaemia in developing countries may be partly due to existing interventions, which are usually designed with the assumption that iron deficiency is the main cause.(84) Thus, other important causes of anaemia have been underestimated and neglected, and these have been on the increase. Therefore, adequate attention should be given to the emerging causes of anemia in developing countries such as HIV/AIDS and micronutrient deficiency

The involvement of government of developing countries can effectively combine and balance the needs for programme implementation, monitoring and evaluation, research and community involvement. It is expected that the burden of anaemia will drastically reduce if adequate attention is paid to joint participation of all stakeholders in combating the burden in developing countries. Intervention programmes should address iron deficiency with the focus on both dietary quantity and quality of the micronutrient composition. Strategies which are required to improve nutrition knowledge and awareness of mothers and health workers may also be implemented.

Ultimately, treating the underlying causes of anaemia is critical in eliminating anaemia in all age groups, particularly the vulnerable ones. Therefore, it becomes imperative that all stakeholders harmonize and coordinate their efforts in ensuring that the burden and prevalence of anaemia, and its causes are reduced to the barest minimum in all developing countries.

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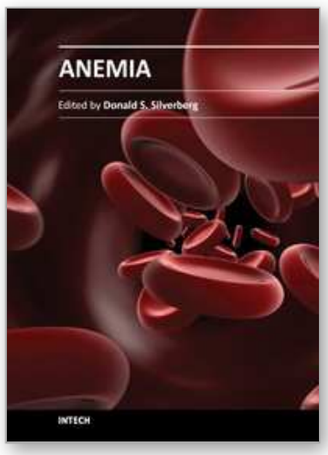

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This book provides an up- to- date summary of many advances in our understanding of anemia, including its causes and pathogenesis, methods of diagnosis, and the morbidity and mortality associated with it. Special attention is paid to the anemia of chronic disease. Nutritional causes of anemia, especially in developing countries, are discussed. Also presented are anemias related to pregnancy, the fetus and the newborn infant. Two common infections that cause anemia in developing countries, malaria and trypanosomiasis are discussed. The genetic diseases sickle cell disease and thalassemia are reviewed as are Paroxysmal Nocturnal Hemoglobinuria, Fanconi anemia and some anemias caused by toxins. Thus this book provides a wide coverage of anemia which should be useful to those involved in many fields of anemia from basic researchers to epidemiologists to clinical practitioners.

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