Role of Vitamin A in Iron Deficiency Anemia

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In recent years, the relationship between vitamin A deficiency, iron, and anemia has been the subject of several investigations. Although the early literature already suggested a potential association between vitamin A and iron (1), its importance was not recognized until the mid-1970s by Hodges et al. (2), who described an iron type anemia in vitamin-A-depleted adult subjects. Follow-up studied by Mejía et al. (3) showed that anemia also occurs in the vitamin-A-deficient rat. Furthermore, it was found that in the deficient animals the levels of serum iron are lower than normal and that iron accumulates in storage depots, such as the liver and the spleen (3,4).

In support of the animal data, epidemiological studies in Central American (5) and Indian children (6) indicated an association between serum retinol and biochemical indicators of iron nutrition. More recently, hematological values have been positively associated with vitamin A deficiency, as assessed by conjunctival impression cytology (CIC), in Micronesian children (7). In this study, children with abnormal CIC had significantly lower hematocrit than did children with normal cytology. Hematocrit for 53% of CIC-abnormal children and for only 17% of the CIC-normal children was below a normal age-adjusted hematocrit threshold of 34%.

All this information has suggested the importance of vitamin A in hematology and iron nutrition and that in vitamin A deficiency there is a failure in the mobilization of iron from body stores into the circulation and consequently into hematopoietic tissues.

EFFECT OF VITAMIN A INTERVENTIONS

Vitamin A Fortification of Sugar

In Central America hypovitaminosis A is an endemic condition. In order to overcome this nutritional problem, the Institute of Nutrition of Central America and Panama (INCAP) in conjunction with the Guatemala Government began in late 1975 a vitamin A fortification program at the national level using table sugar as the dietary vehicle. The design and evaluation of this program have been reported (8).
mary, preschool children and lactating mothers from 12 small rural communities were studied for 2 years in five consecutive surveys, one prior to vitamin A fortification (survey I) and four additional ones (surveys II–V) at 6-month intervals after the intervention began. The dietary data revealed that in comparison with the prefortification survey, the implementation of sugar fortification resulted in a significant threefold increase in the average daily intake of retinol equivalents. As a result, there was a significant reduction in the prevalence of low and deficient levels of serum retinol in children and in the levels of breast milk of lactating women. The average intake of iron, however, did not change throughout the 2-year period of evaluation. This program thus provided a unique opportunity to evaluate the effect of this single intervention on iron nutrition and metabolism at the population level. The results showed that vitamin A fortification had a positive impact on iron nutrition (9).

Figure 1 shows the changes observed in serum retinol in relation to changes in iron biochemical indicators in a group of preschool children sampled in the initial survey and at 6 months after fortification began.

There were significant positive correlations between the experienced change in serum retinol and changes in serum iron, total iron-binding capacity (TIBC), and percent transferrin saturation (%TS). In contrast, stored iron, as defined by serum ferritin levels, correlated negatively, suggesting the mobilization of stored iron when the vitamin A status became improved. It is interesting to note in the figure that in these children, despite the increase in serum iron and %TS, there was an increase in TIBC suggesting an increased concentration of the iron carrier glycoprotein, transferrin.

After a more prolonged intervention, the effect of vitamin A on iron nutrition was different, particularly in relation to iron stores. When comparing children between the initial and last survey (after 2 years), there was an overall improvement of all iron indicators. This favorable effect was more marked in relation to stored iron. There was a lower prevalence of children with low serum ferritin levels (<10 ng/ml) in survey V than in survey I prior to vitamin A fortification. Most probably, this increase in iron stores observed in the long run was due to an enhancement of dietary iron absorption triggered as a response to the initial depletion of iron reserves experienced in the early phase of vitamin A fortification. Because this was a retrospective study performed using stored serum samples, it was not possible to assess the hematological impact of the program.

Vitamin A Fortification of Monosodium Glutamate (MSG)

Vitamin A deficiency is a major nutritional problem in Indonesia. In an attempt to overcome this condition, Muhilal et al. (10) conducted a controlled field trial using vitamin-A-fortified MSG which was distributed through normal market channels in five Indonesian villages. Another five nearby villages served as the control area. The program was evaluated by examining children and lactating mothers at baseline, 5 and 11 months after the introduction of fortified MSG. In order to determine any
FIG. 1. Correlation between changes in serum vitamin A and changes in serum levels of iron indices in Guatemalan children after 6 months of vitamin A fortification of sugar. TIBC, total iron-binding capacity. (From ref. 9, with permission.)
TABLE 1. Mean hemoglobin levels in Indonesian children during the program of vitamin A fortification of MSG*  

<table>
<thead>
<tr>
<th>Group</th>
<th>Duration of marketing MSG (months)</th>
<th>Number of children</th>
<th>Hemoglobin levels* (g/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>0</td>
<td>205</td>
<td>11.3 ± 1.6</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>258</td>
<td>12.3 ± 1.6</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>217</td>
<td>12.1 ± 1.3</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>240</td>
<td>11.4 ± 1.6</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>289</td>
<td>11.2 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>290</td>
<td>11.4 ± 1.4</td>
</tr>
</tbody>
</table>

* From ref. 10, with permission.

b X ± SD.

c p < 0.001 compared with baseline for program children.

impact of the program on the hematological status, hemoglobin levels were measured on 6% of the children (a systematic subsample of one of every three children undergoing anthropometry). This program had a significant positive impact on vitamin A nutrition in the villages receiving fortified MSG. Serum vitamin A levels of children and vitamin A content of breast milk became improved. Furthermore, the prevalence of Bitot’s spot among children in program villages fell progressively from 1% to 2% at baseline to 0.2% at 11 months after fortification began.

It was also found that the program had a significant impact on the hematological condition of children living in the program villages. These results are presented in Table 1. Hemoglobin values of children from the program and control villages were virtually identical at baseline: 11.3 and 11.4 g/dl, respectively. However, they rose significantly from 11.3 to 12.3 g/dl in the program subjects after 5 months of intervention. This increase remained significantly higher than baseline, even at 11 months. There were no changes in hemoglobin values in the children from the control area. This study showed that in this population, vitamin A was a limiting factor for hemoglobin formation. No other indices of iron nutrition were determined to infer about the possible mechanism of the observed phenomenon.

Effect of a Single Oral Massive Dose of Vitamin A

Periodic single massive oral doses of vitamin A (200,000 IU) is a standard procedure to combat hypovitaminosis A in children in developing countries. The question then arises whether improving vitamin A status by this intervention could have any impact on iron nutrition.

In Thailand, where vitamin A deficiency and anemia are major health problems, single massive doses of vitamin A have been used to overcome hypovitaminosis A. A study conducted in northeast Thailand in 1060 children revealed a significant as-
A retrospective study was undertaken by Bloem et al. (11) to assess the impact of a single oral dose of vitamin A in children aged 3–9 years living in three villages in the northern part of the Sakorn province in northeast Thailand. One hundred thirty-four children were randomly selected for the study on the basis of signs of conjunctival xerosis. Blood was drawn for laboratory analysis of vitamin A and iron indices (baseline data). A massive vitamin A dose (standard capsule containing 110 mg of vitamin A) was then given to a random selection of 65 of the 134 children under study. After 2 weeks, all children were reevaluated by the same procedure.

Table 2 shows the results obtained in this study on biochemical indicators of vitamin A and iron nutrition before and after 2 weeks of the massive dose intervention. As expected, blood retinol and retinol-binding protein levels increased significantly, indicating the children's improvement in vitamin A nutrition. Furthermore, with the exception of blood ferritin and transferrin, all other iron indices improved significantly after 2 weeks of the vitamin A intervention. Although there was only a small change in blood hemoglobin levels of 0.3 g/dl ($p < 0.05$), changes in serum iron and %TS were marked, indicating a significantly greater iron availability in the circulation. The small change in hemoglobin was probably due to the short period of evaluation. These data then indicate that, even when using single doses of vitamin A, iron status can also be improved.

### Effect of Supplementing Vitamin A and Iron

In order to assess the effect of vitamin A on hematologic and iron status under more controlled conditions, a randomized supplementation trial was conducted by
ROLE OF VITAMIN A IN ANEMIA

Mejia and Chew (12) in Guatemalan children. With the purpose of evaluating and controlling the role of both vitamin A and iron intakes, the objective of this particular study was to investigate the effect of supplementing anemic children with vitamin A, with or without additional iron therapy.

In this investigation, 99 anemic children (hematocrit >1.5 SD below normal value) aged 1–8 years were randomly assigned to four different treatment groups to be supplemented orally and daily for 2 months as follows: Group I—supplemented with 10,000 IU (3.0 mg) of vitamin A in the form of a water-soluble preparation; Group II—supplemented with iron, as ferrous sulfate in the form of a syrup, at a level of 3 mg of elemental iron per kilogram body weight; Group III—supplemented with both vitamin A and iron (in the doses used for Groups I and II); Group IV—this was the control group which received a placebo.

At the beginning of the supplementation trial (t0, baseline) and at 1 (t1) and 2 (t2) months of treatment, the children underwent clinical and anthropometric evaluations. To evaluate the effect of the various treatments on hematology and on levels of biochemical indicators of iron nutrition, blood samples were obtained for laboratory analyses at t0 and at the end of the 2-month supplementation (t2). The following blood analyses were performed: hemoglobin, hematocrit, red cell count, leukocyte count, serum retinol, serum iron, TIBC, %TS, serum ferritin, and erythrocyte sedimentation rate (ESR).

In addition to the clinical information obtained by the pediatrician at the time of examining the children, a record was kept by nurses of the morbidity observed throughout the study period. The results showed that vitamin A supplementation had a significant positive effect on the levels of serum retinol (Groups I and II). Iron supplementation did not change serum retinol levels (Group II).

Table 3 shows the effect of the different treatments on hemoglobin values after two months of vitamin A and iron supplementation. As expected, iron treatment caused an increase in hemoglobin levels. Vitamin A supplementation also had a significant effect: The group receiving only vitamin A had a rise in hemoglobin of 0.93 g/dl ($p = 0.0481$) at the end of the study.

The factorial model of data analysis used in the study also showed that the hemoglobin response was related only to the basal hemoglobin value ($p < 0.0001$) and not to the basal retinol level ($p = 0.4813$) or the basal level of ferritin ($p = 0.4813$). There was no significant effect of treatment on leukocyte counts or ESR. At baseline, ESR values were similar among the groups and correlated significantly with serum ferritin levels ($p < 0.02$), suggesting that the high ferritin values were probably due to inflammation. At the end of the trial, there was an overall decrease in the ESR values in all groups; however, neither vitamin A nor iron had any specific effect on this variable.

The effect of the various treatments on serum iron and %TS is presented in Table 4. The baseline levels of these two variables did not differ significantly among the groups. With treatment, there were increases in serum iron ($p = 0.181$) and in %TS ($p = 0.0089$). The specific effect of vitamin A supplementation on iron levels was highly significant, both when the data were analyzed as actual values ($p = 0.0070$)
### TABLE 3. Effect of treatments on hemoglobin levels after 2 months of supplementation (g/dl) in Guatemalan children

<table>
<thead>
<tr>
<th>Treatments</th>
<th>n</th>
<th>t0 (basal)</th>
<th>t2 (2 months)</th>
<th>t2−t0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>25</td>
<td>10.3 ± 0.8</td>
<td>11.2 ± 0.8</td>
<td>0.93 ± 0.5</td>
</tr>
<tr>
<td>Group II</td>
<td>30</td>
<td>10.5 ± 0.6</td>
<td>11.9 ± 0.9</td>
<td>1.4 ± 0.9</td>
</tr>
<tr>
<td>Group III</td>
<td>24</td>
<td>10.6 ± 0.6</td>
<td>12.0 ± 0.7</td>
<td>1.4 ± 0.9</td>
</tr>
<tr>
<td>Group IV</td>
<td>20</td>
<td>10.4 ± 0.7</td>
<td>10.7 ± 0.6</td>
<td>0.3 ± 0.6</td>
</tr>
</tbody>
</table>

#### Analysis of variance

<table>
<thead>
<tr>
<th>Effect of</th>
<th>p</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Time</td>
<td>0.0000</td>
<td>—</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>0.0594</td>
<td>0.0481</td>
</tr>
<tr>
<td>Fe</td>
<td>0.0028</td>
<td>0.0000</td>
</tr>
<tr>
<td>Vitamin A × basal retinol</td>
<td>0.4813</td>
<td>—</td>
</tr>
<tr>
<td>Vitamin A × basal ferritin</td>
<td>0.2966</td>
<td>—</td>
</tr>
<tr>
<td>Vitamin A × basal hemoglobin</td>
<td>0.0001</td>
<td>—</td>
</tr>
</tbody>
</table>

* X ± SD.

* From ref. 12, with permission.

* Group I = vitamin A; Group II = Fe; Group III = vitamin A + Fe; Group IV = placebo.

### TABLE 4. Effect of treatments on serum Fe levels and percent transferrin saturation (%TS) in Guatemalan children

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n</th>
<th>t0 (basal)</th>
<th>t2 (2 months)</th>
<th>t2−t0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>25</td>
<td>39.3 ± 17.4</td>
<td>49.9 ± 27.5</td>
<td>10.6 ± 24.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7 ± 3)</td>
<td>(9 ± 5)</td>
<td>(2 ± 4)</td>
</tr>
<tr>
<td>Group II</td>
<td>30</td>
<td>43.5 ± 18.2</td>
<td>51.4 ± 21.8</td>
<td>7.9 ± 26.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8 ± 3)</td>
<td>(9 ± 4)</td>
<td>(1 ± 5)</td>
</tr>
<tr>
<td>Group III</td>
<td>24</td>
<td>44.6 ± 17.0</td>
<td>65.6 ± 39.0</td>
<td>21.0 ± 40.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8 ± 3)</td>
<td>(12 ± 7)</td>
<td>(4 ± 7)</td>
</tr>
<tr>
<td>Group IV</td>
<td>20</td>
<td>43.8 ± 16.5</td>
<td>38.6 ± 26.4</td>
<td>−5.3 ± 25.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8 ± 3)</td>
<td>(7 ± 5)</td>
<td>(−1 ± 5)</td>
</tr>
</tbody>
</table>

#### Analysis of variance

<table>
<thead>
<tr>
<th>Effect of</th>
<th>p</th>
<th>p</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Time</td>
<td>0.0181</td>
<td>—</td>
<td>0.0089</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>0.0070</td>
<td>0.0187</td>
<td>0.0500</td>
</tr>
<tr>
<td>Fe</td>
<td>0.1461</td>
<td>0.0556</td>
<td>0.3097</td>
</tr>
</tbody>
</table>

* X ± SD.

* From ref. 12, with permission.

* Group I = vitamin A; Group II = Fe; Group III = vitamin A + Fe; Group IV = placebo.
and when they were analyzed as the change between the basal and the 2-month evaluation. Interestingly, the average change in serum iron in the group receiving vitamin A and iron simultaneously was much greater than that in the group receiving vitamin A or iron alone.

The vitamin-A- and iron-treated groups (Groups I, II, and III) experienced an increase in %TS, whereas there was a slight decrease in %TS in the group receiving the placebo (Group IV). Again, the group receiving vitamin A plus iron (Group III) showed the greatest increase.

Vitamin A treatment did not have the expected lowering effect on the levels of TIBC \( (p = 0.8445) \) as did iron alone. TIBC levels in Group I were 395.4 ± 70.7 μg/dl (mean ± SD) in the basal evaluation and 388.1 ± 52.6 μg/dl after the trial, whereas Group II changed from 380.9 ± 54.4 to 345.2 ± 54.0 μg/dl.

Only iron supplementation had a positive effect on serum ferritin values \( (p = 0.0324) \). There was no significant effect of vitamin A on this variable.

The most commonly observed infections during the study were respiratory diseases, diarrhea, dermal infections, and conjunctivitis. Respiratory infections had the highest incidence in the four groups. Diarrhea was most commonly found in the groups supplemented with iron. The iron-treated groups (Groups II and III) also had a higher incidence of dermal infections than did the groups treated only with vitamin A or placebo. However, as already indicated, this higher incidence of clinical dermal infections was not reflected in changes in ESR.

CONCLUSION

The data available strongly suggest that there is an interrelationship between vitamin A and iron nutrition. Animal and human studies conducted in different parts of the world by independent investigators support such a concept. It is also evident that improving vitamin A nutrition of underprivileged children living in the developing world has a positive impact on their iron and hematological status. Different types of vitamin A interventions such as fortification, supplementation, or massive doses can improve hemoglobin levels and biochemical indicators of iron nutrition. Thus in regions where vitamin A supply is limited, this vitamin may play an important role in the etiology of iron deficiency anemia.

The mechanism by which vitamin A exerts its action on iron utilization is, however, still unclear. Some data suggest that in vitamin A deficiency, iron accumulates in storage depots, making this mineral less available for red cell formation \((3,4)\). On the other hand, iron absorption does not seem to be affected \((4)\). However, a common finding in hypovitaminosis A is low levels of serum iron; when vitamin A is given, serum iron and %TS become increased \((9,12)\). All this information suggests an impairment of iron transport and release from the liver. However, the studies conducted so far have failed to confirm this hypothesis \((12)\). There are several confounding factors. One is the role of infections, the effect of which on iron metabolism and hematopoiesis is similar to that observed in vitamin A deficiency—that is, low serum
iron and accumulation of iron in storage tissues (13). The other factor is general undernutrition, particularly protein-energy malnutrition (PEM) in which iron transport and the synthesis of iron carrier proteins are impaired (14). Both of these conditions, infections and PEM, also prevail in regions where vitamin A deficiency and anemia are endemic. Specific studies are therefore needed to investigate the role of infections and undernutrition in relation to the anemia observed in hypovitaminosis A. Nevertheless, regardless of the mechanism, this direct or indirect interaction of vitamin A and iron is an important phenomenon to be taken into consideration when combating iron deficiency anemia in populations.

REFERENCES


DISCUSSION

Dr. Viteri: When you give vitamin A to vitamin-A-deficient rats or humans, what is the interval between giving the vitamin and the increase in serum iron? Possibly the effect is related to the interaction between vitamin A and glycoprotein synthesis. This is supported by your finding that vitamin A treatment, but not iron, resulted in an increase in transferrin levels. It would be interesting to know what is the relationship between the increase in transferrin and the increase in serum iron.

Has anyone studied the effect of vitamin A deficiency on iron absorption in humans? And have there been any studies looking at carotene and iron—in other words, is there the same response to carotene as there is to preformed vitamin A?
Dr. Mejia: We have not looked at the time sequence of iron increase after vitamin A ourselves, but some of our data suggest that there is an increase in serum iron within 2 weeks. With regard to the effect of vitamin A on iron absorption, we have found no effect in rats, but we have not done the experiment in humans. I think Dr. Cook may have some data. With regard to carotene, Hodges' studies from Iowa and later from the University of California showed that the effects on hemoglobin in vitamin-A-depleted men were the same whether they were given retinyl palmitate or β-carotene.

Dr. Cook: Some years ago we looked at the effect of a large dose of vitamin A on iron absorption in normal subjects and could find no effect.

Dr. Valyasevi: In Thailand, about 20% of children living in rural areas have subclinical vitamin A deficiency because of their low fat intakes. When we give them iron supplements without vitamin A we get a good hemoglobin response. My question is, What degree of vitamin A deficiency will prevent or interfere with the correction of anemia? And have there been studies in other parts of the world showing that vitamin A can reduce infection morbidity? Perhaps the reduction in infection is a confounding factor.

Dr. Mejia: I am not saying that the solution to anemia is vitamin A—iron is still, and will continue to be, the most important factor. To what degree vitamin A deficiency may be affecting the prevalence of anemia may be gauged from the Indonesian work of Muhilal, who showed that when vitamin A is not a limiting factor there is an increase in hemoglobin of about 1 g/dl. With regard to infection and morbidity, I have no answer to this at present and this is certainly an area for further research.

Dr. Brabin: You have shown that there is a change in iron status when vitamin A is given, and several other studies support this conclusion. What about the reverse situation? When iron deficiency anemia is corrected with iron, is there any change in vitamin A status or absorption? My second question is in relation to infection. There is evidence from studies from South Africa, India, and Indonesia that the incidence of diarrheal disease is reduced in communities where vitamin A supplementation programs have been introduced. There is currently a trial going on in Ghana with a study population of about 20,000 children which should provide confirmatory evidence of a clear link between the risk of diarrheal disease and vitamin A deficiency. If this is indeed the case, then it is likely that in those children who received vitamin A supplementation the incidence of diarrheal disease would have been reduced and this would have affected iron absorption.

Dr. Mejia: With regard to your first question, in the supplementation study we did in Guatemala we found that children receiving only iron had no change in their serum retinol levels, indicating that improved iron nutrition had no effect on vitamin A status. As to your second point, I would agree that if diarrheal disease is reduced there may well be improved iron absorption.

Dr. Hershko: In your rat studies there is a tremendous increase in radioactivity in the spleen in vitamin-A-deficient animals. This is not a result of increased absorption but of an internal redistribution of iron which could only come about through hemolysis. If you consider together the reduction in serum iron and hemoglobin, followed by the improvement in serum iron and the internal redistribution of iron when vitamin A deficiency is corrected, this is exactly what you find when iron homeostasis is disturbed in inflammation. This could mean that vitamin A deficiency increases the severity or incidence of infection or, more likely, that it has a biological effect which is similar to the inflammatory reaction. In either case it could explain all your data: The improved response to iron, the improvement in hemoglobin in your field studies, and the internal redistribution of iron in your animal studies are all very similar to the mechanism of iron reshuffling within the body during an inflammatory reaction.
Dr. Mejia: In the Guatemala study we found that the groups receiving iron had a higher rate of dermal infection, but in the group receiving vitamin A and iron, despite the same type and degree of infection, the iron levels were not as depressed as in the other groups. This led us to believe that the metabolic changes taking place in infection are less severe when vitamin A is present.

Dr. Adelekan: It was reported many years ago that subjects deficient in riboflavin also developed anemia. We published some data some years ago where we showed that feeding rats for 8 weeks on a riboflavin-deficient diet resulted in a low serum iron and that after as little as 3 weeks of riboflavin deficiency the concentration of iron in the liver was significantly less than in control rats. We also showed, both in vivo and in vitro, that iron absorption was impaired in riboflavin-deficient rats and that when radioactive iron was given intravenously there was massive deposition in the liver. So the problem with riboflavin deficiency is that there is impaired absorption as well as failure of mobilization of iron from reticuloendothelial stores, which would explain the anemia. My question is, How severe must vitamin A deficiency be to affect iron? What you did not show in the data of Bloem and his colleagues was the vitamin A status of their subjects. The mean serum retinol concentration in the test subjects before supplementation was 1.6 μmol/l, which is higher than the cut-off of 0.35 μmol/l. So we cannot say that these subjects were vitamin-A-deficient, and their mean hemoglobin of 11.5 g/dl is certainly not indicative of anemia.

Dr. Mejia: The deficiency does not have to be severe, perhaps not even what would normally be regarded as deficiency. For example, in Central America we see children with lowish vitamin A levels but with no clinical signs of deficiency. Thus the vitamin A deficiency may only need to be marginal for there to be a beneficial effect of giving vitamin A.

Dr. Adelekan: Is it reasonable to suggest that the effect of a low vitamin A is that it impairs iron mobilization, because you showed massive deposition in the liver and spleen and no effect on absorption? Could it be that iron is entering the body but is not mobilized from reticuloendothelial stores?

Dr. Mejia: It is clear that there is a redistribution of iron in the body. Whether this accumulation of iron in liver and spleen is due to a failure of release and transport or because of impaired utilization I don’t know. This is a challenge for future research.

Dr. Daza: A brief comment regarding micronutrient interaction. The World Summit for Children Declaration signed in New York in 1990 focused international attention on the need for concerted action to improve the health of the world’s children. A key component of this effort will be to work towards the elimination of micronutrient deficiencies, particularly those of vitamin A, iodine, and iron. As a follow up to this meeting, the Task Force for Child Survival and Development has been designated on behalf of WHO and UNICEF to organize an international conference on “Ending Hidden Hunger” and to also organize a meeting of several international and national agencies in Ecuador to address vitamin A issues and to review successful community programs of vitamin A intervention. The views on iron–vitamin A interactions of the participants of this workshop will greatly assist PAHO/WHO in developing action programs for reducing iron deficiency anemia.

Dr. Vatyasevi: In other words, in areas where there is vitamin A deficiency together with iron deficiency anemia, you might kill two birds with one stone by giving vitamin A?

Dr. Mejia: I concur with this to some extent, but I still believe that lack of iron is the main reason for the widespread prevalence of anemia. I don’t want to give the impression that by giving vitamin A the iron problem will be solved.

Dr. Viteri: We must remember that when vitamin A deficiency is treated, serum ferritin
decreases as serum iron increases. These changes are also seen in inflammation. Infection/inflammation may still be a confounding factor. It would appear that giving vitamin A alone affects iron mobilization rather than resulting in improvement in iron nutrition.

*Dr. Adelekan:* Our recommendation is to give iron as well as riboflavin, as several studies have shown that this results in a better hematologic response than if either iron or riboflavin is given alone. I’m sure the same applies to vitamin A.