The majority of the iron in a third trimester fetus is stored as hemoglobin in the red cell mass, with a lesser amount in the tissues as storage iron (or ferritin). Hemoglobin production in the red blood cells is signalled when iron supply does not meet iron demand. This means that fetal tissues such as skeletal, muscle, heart, and brain will become iron-deficient before signs of IDA emerge in the mother (Rao and Georgieff 2002). Bruner and colleagues (1996) found that iron-deficient (non-anemic) adolescent girls performed better on tests after they were treated for their iron deficiency. The implications for iron deficiency and IDA for infants has not been studied, but the potential implications are interesting.

What can happen as a result of IDA?
Some potential consequences of untreated iron deficiency and IDA during pregnancy and during the postpartum period include low-birthweight infants, preterm delivery, decreased infant iron status, and cognitive deficits for the infant (Cogswell 2004). Published literature suggests that IDA diagnosed early in pregnancy is associated with an increased risk of preterm delivery compared to IDA diagnosed during the third trimester. It has been proposed that third trimester IDA is not associated with poor outcomes because of normal third trimester expanded plasma volume (Scholl and Hediger 1994). This makes it difficult in the third trimester to determine whether an individual has true IDA or if their iron is now diluted because of expanded blood volume. Many health care practitioners err on the side of caution and provide an iron supplement along with close monitoring of hemoglobin levels.

There is an association between maternal iron status in pregnancy and the iron status of the infant postpartum (Mungen 2003). We know that in the third trimester of pregnancy the mother transfers iron from her stores to her baby’s in order to establish a good iron supply for the first months of life. Conditions in pregnancy that lower newborn iron stores include severe maternal iron deficiency, maternal hypertension with intrauterine growth retardation, and maternal diabetes mellitus. Premature babies are also at risk of early postnatal iron deficiency because they collect less iron during the pregnancy and grow more rapidly postnatally (Rao and Georgieff 2002). The need for prophylactic iron during pregnancy is uncertain. A study conducted by Cogswell and colleagues (2003) found that, compared to placebo, iron supplementation from twenty-eight weeks of gestation on did...
not significantly affect overall prevalence of anemia or the incidence of preterm births. The same study also concluded that iron supplementation led to significantly higher mean birthweight, a significantly lower incidence of low-birthweight infants, and a significantly lower incidence of preterm low-birthweight infants. The Centers for Disease Control and Prevention (CDC) recommends a low-dose (30 mg/day) supplement of iron for all pregnant women at the first prenatal visit, and counselling on iron-rich foods and foods that enhance iron absorption (Chicago Dietetics Association 2000).

IDA treatment and prevention with nutrition. In many situations, IDA is caused by a diet low in iron-containing foods. A diet that is low in iron may also be low in other nutrients, including protein and zinc. Prescribing an iron supplement may correct the problem of IDA in the short-term, but it does not address the poor diet. Women who are diagnosed with IDA need to be counselled on how to improve their general diet and lifestyle, selecting foods that are high in iron, and selecting foods that help in the absorption of iron (Scholl and Hediger 1994).

There are two forms of iron derived from food: heme and non-heme iron. We absorb a high amount of iron from heme sources in comparison to non-heme iron. Absorption of dietary iron is influenced by body stores, the amount and form of iron, and by dietary factors that enhance or inhibit availability of iron for absorption.

Heme iron is highly available and absorbable and is found in meats, fish, and poultry. Non-heme iron is less available and absorption varies depending on composition of the meal. Non-heme iron is found in grains, fruits, and vegetables. The absorption of non-heme iron is improved when a source of heme iron, such as meat, fish, or poultry, or an iron absorption-enhancing food, such as foods rich in Vitamin C (e.g., orange juice) is included at the same meal.

continued on page 14

<table>
<thead>
<tr>
<th>Excellent Source of Iron</th>
<th>Good Source of Iron</th>
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<tbody>
<tr>
<td><strong>Heme Iron</strong></td>
<td></td>
<td></td>
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<tr>
<td>beef</td>
<td>chicken, ham, lamb, pork, veal, eggs, halibut, canned or fresh salmon, haddock, perch, tuna, shrimp</td>
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<tr>
<td>cooked beans — white beans, soybeans, lentils, chick peas, clams, oysters pumpkin, sesame, and squash seeds breakfast cereal enriched with iron tofu</td>
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<tr>
<td><strong>Non-Heme Iron</strong></td>
<td>canned lima, red kidney beans, chick and split peas dried apricots</td>
<td></td>
</tr>
<tr>
<td>peanuts, pecans, sunflower seeds cooked pasta bread bran muffin cooked oatmeal, wheat germ dried seedless raisins, peaches, prunes, apricots</td>
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</tr>
</tbody>
</table>

(Health Canada 1999)

Some foods that interfere with non-heme iron absorption

<table>
<thead>
<tr>
<th>Polyphenols: tea, coffee Phytate: legumes, soybeans, whole grains Oxalate: spinach, chard, beet greens, rhubarb, sweet potatoes Calcium: food and supplements</th>
</tr>
</thead>
</table>

(Health Canada 1999)

These foods should be consumed at separate times from iron-containing foods when trying to improve iron status. Calcium has also been reported to inhibit both heme and non-heme iron absorption when calcium-containing foods or supplements are consumed with iron-containing foods or supplements (Reddy & Cook, 1997; Whiting, 1995).
IDA treatment and prevention with vitamin/mineral supplements and IDA:
The major problem with iron supplementation during pregnancy is compliance (Mungen 2003). Health care providers need to discuss any barriers that may exist for each woman in taking her supplement. Individuals with IDA need to take their iron supplement in addition to taking their prenatal vitamin. Iron absorption from prenatal vitamins is affected by the other nutrients within the vitamin that the iron is bound to. Due to this effect, the amount of iron in the prenatal vitamin is not considered when determining the amount of iron to prescribe for those with IDA. A prenatal vitamin is often continued along with iron therapy since it contains many other nutrients which are important during pregnancy.

Women are encouraged to take their iron supplement with vitamin C-containing fluids such as orange juice rather than milk, which can inhibit iron absorption. Some women experience constipation when taking an iron supplement. It is important to include high-fiber foods as well as extra fluids to prevent or alleviate this problem. Some women also experience heartburn during their pregnancy and take antacids for some relief. Antacids can inhibit iron absorption, so it is recommended that antacids be taken at separate times from both the iron supplement and prenatal vitamin. Women need to be aware of the dangers that prenatal vitamins can pose to a child. As few as 10 ferrous sulphate tablets (total of 600 mg elemental iron) can kill a small child (Juurlink et al. 2003). Vitamins need to be treated as cautiously as other medications and stored away from children.

Should we be concerned with high iron concentrations?
Attention is now also being focused on the effects of high hemoglobin levels on pregnancy outcomes. A high maternal hemoglobin concentration is fairly strongly associated with hypertension and pregnancy-induced hypertension. Like IDA, high hemoglobin concentrations are associated with an increased risk of poor pregnancy outcomes. Goldenberg and colleagues (1996) found that high serum ferritin (a form of stored iron) levels, rather than low, especially at twenty-six weeks of pregnancy were strongly associated with subsequent preterm delivery and birthweight. High hemoglobin concentrations may also reflect failure of the maternal plasma volume to expand (Scholl and Hediger 1994).

Conclusion
IDA is a nutritional issue that can have serious consequences if not diagnosed and treated early enough. Educating women about the proper use of iron supplements, why iron is important to baby, and providing counselling on good food sources of iron is essential. In reality, however, it is difficult to always eat properly and remember to take supplements. Social and economic barriers need to be discussed in order to improve outcomes for women and their infants.

References

Congratulations to Jane Grassley
The ICEA Board of Directors has chosen Jane Grassley to be the recipient of the 2005 Virginia Larsen Research Grant. The title of her project is A Study to Develop an Intervention to Facilitate Grandmother's Knowledge and Support of Breastfeeding.