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Thoughts on Micronutrient Surveillance

Surveillance of micronutrient deficiencies is an essential part of their control. This process may be defined as keeping watch over micronutrient malnutrition in order to make decisions that will lead to improvements in it (Mason et al., 1984). Surveillance of micronutrient malnutrition is necessary to evaluate control efforts, and to monitor progress toward local, national, and international goals.

Surveillance requires indicators that are informative, responsive, and simple. The indicators must provide *information* about the range of nutriture that is related to the health outcomes of concern. Twenty years ago, when the primary health outcome known to be associated with vitamin A deficiency was xerophthalmia, it was logical to focus on clinical eye signs of vitamin A deficiency for surveillance purposes. However, after it became clear that subclinical vitamin A deficiency increased children's risk of dying, there was a need to choose new indicators for vitamin A surveillance that reflected subclinical as well as clinical deficiency. Prevalence of xerophthalmia no longer provided all the necessary information. To evaluate control efforts and monitor progress, surveillance indicators must also be *responsive* to changes in the status of populations. And surveillance indicators must be *simple*, or surveillance will not be carried out in the resource-limited regions where it is most needed.

Following the endorsement of international goals to eradicate iodine and vitamin A deficiency and to control iron deficiency anemia (FAO & WHO, 1992), surveillance was needed to monitor global progress. To meet this need, the WHO in collaboration with partner agencies reviewed and published core indicators for monitoring progress toward global goals for micronutrient malnutrition. These core indicators are summarized in the Table.

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Although the documents published by WHO are still relatively new, discussion is ongoing about the indicators chosen for micronutrient surveillance, especially those for iron and vitamin A deficiencies. For vitamin A, new questions were raised during the XVIII IVACG meeting held in Cairo in September 1997. I offer the following questions and comments in the hope that they will generate useful discussion amongst readers of the Bulletin.

How simple is simple enough? At the recent IVACG meeting, Dr. David Alnwick of UNICEF reported on the current state of progress toward eradication of vitamin A deficiency. He noted that most country surveys have included only serum retinol, and wondered whether the three indicators recommended by WHO are too complex. We should think carefully about the possibility of relying only on serum retinol for surveillance purposes. Certainly the simplicity of a single indicator is attractive.

The question really boils down to: What is the right balance between information and simplicity? It is apparent from the Table that the three core vitamin A indicators yield different information. Night blindness in children, the sole clinical indicator of deficiency, may be the most responsive indicator in settings where vitamin A deficiency is relatively severe. Indonesia has eliminated childhood blindness due to vitamin A deficiency and was highlighted as a vitamin A success story in UNICEF's State of World's Children 1998, even though it remains in the "severe public health problem" category based on its >50% prevalence of low serum retinol in children. By monitoring clinical deficiency over the period of its eradication, Indonesia has generated strong political will to continue to combat the problem of subclinical deficiency. (Many other factors have also contributed to this political will.)

Breast milk retinol was included in the core indicators because it reflects vitamin A deficiency in the mother-infant dyad. As reported at the IVACG meeting, use of this indicator has drawn attention to vitamin A interventions for women in Swaziland (Vilakati et al., 1997) and Oman (Shuqaidef, 1997). In Oman, documentation of low breast milk vitamin A levels provided the impetus to expand their vitamin A program to include post-partum dosing of mothers.

However, breast milk retinol has been implemented in surveys in only a few settings, and questions remain about the relative usefulness and feasibility of breast milk retinol compared to serum retinol or other indicators in women.

Iron deficiency is the only case in which we rely essentially on one indicator for surveillance. The core indicator was practically defined in the statement of the global goal, which is "reduction by one-third of 1990 levels of iron deficiency anemia among women of child-bearing age." Since the 1990 levels of *iron-deficiency* anemia were not measured directly but rather estimated from the prevalence of anemia, the goal and its measurement come down to hemoglobin concentration. I wonder whether this is not a case of sacrificing necessary information for simplicity. How accurate and reliable is our ability to make inference about iron deficiency from the prevalence of anemia? Although much can be discerned from looking at hemoglobin distributions from different age and sex groups within a population (Yip et al., 1997), how can this technique be used to interpret surveillance data? Or is an additional indicator specific to iron deficiency needed for surveillance? Recently we observed a large secular trend in hemoglobin concentration in Zanzibari school children that was not explained by change in iron status. In 1002 children who received no intervention, hemoglobin concentration increased 11 g/L and anemia prevalence decreased by 31 % in a 12-month period, while erythrocyte protoporphyrin decreased only 5.9 $\mu\text{mol/mol}$ heme, and serum ferritin increased only 2.8 $\mu\text{g/L}$ (Stoltzfus et al., 1998). If we had relied on only hemoglobin concentration to make inference about changes in the iron status of these children we would have been badly misled.

If we do simplify surveillance down to one indicator, can we maximize information across the spectrum of deficiency by examining several cutoff points of a continuous indicator? If certain parts of the indicator distribution reliably reflect risk of different health outcomes, or if certain parts of the distribution respond most quickly to intervention, then it would be useful to highlight this information by keeping watch on the prevalence of values below more than one cutoff. This is the recommended approach for urinary iodine, where cutoffs of 50 and 100 $\mu\text{g/L}$ are both used in the criteria for elimination of iodine deficiency. The definition for eradication is < 20% of samples below 20 $\mu\text{g/L}$ and < 50% of samples below 100 $\mu\text{g/L}$ (WHO, UNICEF &

ICCIDD, 1994). Another nutrition example is UNICEF's surveillance of both moderate-severe and severe malnutrition, defined as weight-for-age Z scores < -2 and < -3 , respectively (UNICEF 1998). I have previously suggested that surveillance of multiple cutoffs might be a useful approach to the interpretation of hemoglobin data (Stoltzfus 1997), and perhaps serum retinol by itself would provide more information in surveillance systems if we set prevalence criteria for two levels of severity. Although most investigators already examine the full distribution of values and not only a single recommended cutoff level, for the purposes of global monitoring and reporting, a consensus on cutoffs must be reached. It can be very difficult to access original data to analyze an additional cutoff once a final report has been written by local investigators.

Is it time to develop separate core indicators for surveillance of vitamin A deficiency in women? As noted above, the inclusion of breast milk retinol in the core indicators for vitamin A deficiency reflected our dawning awareness that vitamin A deficiency is a problem affecting women as well as their children. This awareness has taken a huge leap forward with the documentation of night blindness in women in South Asia (Katz et al., 1997, Starbuck 1993, Christian et al., 1997, Loganathan et al., 1997), and the finding that vitamin A or β -carotene supplementation to Nepalese women decreased their risk of maternal mortality by nearly 50% (West et al., 1997). We must now scramble to bring our ability to measure and interpret vitamin A deficiency in women up to date with our awareness of the importance of the problem.

Leading indicators for surveillance of women's vitamin A status are likely to be serum retinol, breast milk retinol, and night blindness. (Modified relative dose response provides useful information, but is likely to be too technically demanding for surveillance purposes in women, as in children.) Important questions remain about each of these. Cutoffs for women's serum retinol concentration and their interpretation have not been set. Cutoffs for breast milk were recommended by WHO (WHO 1996), but these were based on few data and need to be reviewed as more evidence accumulates. Preliminary evidence from two studies in our laboratory suggests that breast milk retinol is more sensitive to mild vitamin A deficiency in women (i.e. low liver stores) than is serum retinol. If this observation holds, does the high sensitivity of breast milk retinol increase or decrease its usefulness in surveillance? This

depends on what level of maternal deficiency is associated with the health outcomes that concern us, a question that may not be answerable with current data.

At the IVACG meeting we learned that night blindness of women in Nepal is a dramatic indication of a woman in poor health and in urgent need of intervention (Christian et al., 1997). But prevalence rates of night blindness in women reported at the Cairo meeting also raise concerns about its validity and reliability across populations. Rates of night blindness in women from large population surveys were reported as 11 % (incidence) in pregnant women in Sarlahi, Nepal (Christian et al., 1997), 1 % (positive history) in the Bangladesh nutritional surveillance system (Loganathan et al., 1997), and 9 % (prevalence) among a national sample of Egyptian women (Moussa et al., 1997). These rates seem illogical given what we know about the health and nutritional status of these populations. There is a large amount of work to be done to clarify vitamin A surveillance methods for women.

As with many life tasks, surveillance seems simple but in reality requires careful thought and discernment. The questions raised in Cairo and the diversity of opinions about different indicators will, in the end, help us do the work better.

Table. Core indicators for micronutrient surveillance and their relation to level of deficiency.

Micronutrient	Level of Deficiency		
	Clinical	Subclinical with adverse health risk	"At risk" but no adverse health risk
Vitamin A	night blindness in children 24-71 mo.	serum retinol < 0.70 mol/L in children 6-71 mo. breast milk retinol < 1.05 µmol/L or < 8 µg/g fat	breast milk retinol < 1.05 µmol/L or < 8 µg/g fat
Iodine	enlarged thyroid in children 6-12 yr	neonatal TSH > 5mU/L urinary iodine < 100 µg/L and < 50 µg/L	
Iron		hemoglobin (age and sex-specific cutoffs)	

Core indicators from WHO, FAO & ICCIDD, 1994; WHO 1996; and WHO 1998. For iodine, proportion of households consuming effectively iodized salt is recommended as an additional process indicator.

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