

Proceedings of the XX International Vitamin A Consultative Group Meeting

Recommendations for Monitoring and Evaluating Vitamin A Programs: Outcome Indicators¹

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ABSTRACT Monitoring and evaluation are essential components of vitamin A intervention programs. They enable program managers to track progress in achieving their goals. Recommendations for outcome indicators are based on suggestions from the International Vitamin A Consultative Group Meeting (IVACG) workshop in late October 2000 in Annecy, France, followed by a pre-XX IVACG meeting in Hanoi, Vietnam. In areas with detectable xerophthalmia or eye signs, a fall in the prevalence of Bitot's spots to <0.5% and a decrease in night blindness during pregnancy to <5% indicates that vitamin A deficiency (VAD) is no longer a public health problem, although it still may be responsible for excess morbidity and mortality. Pupillary dark adaptation has been proposed as an objective indicator of vitamin A status. A program is considered to have made progress when the mean pupillary threshold improves to better than $-1.24 \log \text{ cd/m}^2$. For biochemical indices, the shift of mean or median values or the frequency distribution of preschool children with serum retinol concentration below $0.70 \mu\text{mol}$ ($20 \mu\text{g/dL}$), lactating mothers with breast milk retinol values below $0.70 \mu\text{mol}$ ($6 \mu\text{g}$ per g of milk fat) or below $1.05 \mu\text{mol}$ ($8 \mu\text{g}$ per g of milk fat) are useful to monitor program progress. *J. Nutr.* 132: 2940S–2942S, 2002.

KEY WORDS: • xerophthalmia • maternal night blindness • pupillary dark adaptation • serum retinol • breast milk retinol

At the World Summit for Children in 1990 and the International Conference of Nutrition in 1992, a goal was set to “virtually eliminate vitamin A deficiency and all its consequences including blindness by the year 2000.” Currently, the World Health Organization (WHO)³ estimates that vitamin A deficiency (VAD) is a public health problem in 118 countries (1). Among children under 5 years of age, around 3 million have ocular signs of VAD, and 140 million have inadequate vitamin A status and are at increased risk of morbidity and mortality. In recent years, many countries have executed intervention programs to control and prevent VAD. Major interventions include periodic, high dose vitamin A supplementation, food fortification and dietary modification.

One of the characteristics of successful community programs was identified as “monitoring, evaluation and management information systems” (2). Monitoring activity is essential to adjust the direction of the program and frequently involves process indicators. In addition, evaluation of program effectiveness measures the impact on vitamin A status as represented by biological indicators.

This article provides recommendations for outcome indicators useful for monitoring and evaluating vitamin A programs. These recommendations are based on the suggestions provided at the International Vitamin A Consultative Group Meeting (IVACG) workshop held 30 October to 2 November 2000 in Annecy, France, and at the pre-XX IVACG meeting on 11 February 2001, in Hanoi, Vietnam.

CLINICAL INDICATORS

VAD, in its most severe stage, results in a variety of ocular manifestations known as xerophthalmia. Classification of xerophthalmia has remained unchanged throughout the years, beginning with night blindness (XN), conjunctival xerosis/Bitot's spots (X1B), corneal xerosis and corneal ulceration/keratomalacia, which ultimately leads to a corneal scar. Detailed discussions of xerophthalmia appear in earlier publications (3,4). These eye signs have been widely accepted as clinical criteria to establish the existence of a public health problem among preschool-age children (3,5) as well as to initiate vitamin A supplementation programs. In such settings, the effectiveness of the program should be demonstrated by a

¹ Presented at the XX International Vitamin A Consultative Group (IVACG) Meeting, “25 Years of Progress in Controlling Vitamin A Deficiency: Looking to the Future,” held 12–15 February 2001 in Hanoi, Vietnam. This meeting was co-hosted by IVACG and the Local Organizing Committee of the Vietnamese Ministry of Health and representatives of United Nations technical agencies, the private sector, multilateral agencies and nongovernmental organizations in Vietnam, with funding from the government of Vietnam. The Office of Health, Infectious Disease and Nutrition, Bureau for Global Health, U.S. Agency for International Development, assumed major responsibility for organizing the meeting. Conference proceedings are published as a supplement to the *Journal of Nutrition*. Guest editors for the supplement publications were Alfred Sommer, Johns Hopkins University, Baltimore, MD; Frances R. Davidson, U.S. Agency for International Development, Washington; Usha Ramakrishnan, Emory University, Atlanta, GA; and Ian Darn-ton-Hill, Columbia University, New York, NY.

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³ Abbreviations used: VAD, vitamin A deficiency; WHO, World Health Organization. X1B, Bitot's spots; XN, night blindness.

reduction in the prevalence of xerophthalmia, especially new, incident cases. Impact evaluation of vitamin A capsule distribution programs in Indonesia (6) and Nepal (7) showed a reduction in the incidence of new cases of XN and X1B after 1 year. XN tends to be unnoticed in children <2 years of age (8), and X1B tend to persist, even after improvement in vitamin A status (6). A reduction in the incidence of new cases is therefore a more meaningful indicator than a lack of change in prevalence, much of which often represents older, established, nonresponsive cases.

Evidence in several countries, particularly in southern Asia (9,10), indicates that XN is common among pregnant women, especially in their third trimester, with prevalence rates around 10%. In Nepal, night-blind pregnant women tended to be more vitamin A deficient (11) and showed an increased risk of mortality from infection (12). XN during pregnancy (within the past 3 y) also correlates well with other indicators of vitamin A inadequacy in the community such as xerophthalmia, serum retinol, breast milk vitamin A, impression cytology and dark adaptation (11). Vitamin A supplementation of pregnant women in Nepal significantly reduced XN by 67% (13). Existing data suggest that a prevalence of maternal XN of >5% can be used to identify a public health problem of VAD in a population (14). Therefore, in areas where XN occurs, maternal XN is recommended as an outcome indicator to evaluate the impact of intervention programs that target pregnant women or the whole community; they will not respond to interventions that reach only young children.

FUNCTIONAL INDICATORS

Depletion of vitamin A leads to early impairment of dark adaptation. Attempts have been made in recent years to objectively assess dark adaptation as an early means of detecting VAD. The pupillary dark adaptation test measures the pupillary response to a light stimulus as an indication of dark adaptation threshold (15). Abnormal pupillary thresholds correlated strongly in a relative dose-response relationship (15) with serum retinol concentrations (15–17). Vitamin A supplementation improved pupillary scores significantly among young children in Indonesia (15) and India (16) as well as in pregnant women in Nepal (17). Based on existing data, vitamin A programs should be initiated when the average pupillary dark adaptation score of the population is worse than $-1.11 \log \text{cd/m}^2$. The target populations should include children aged 2–6 years and pregnant women during the second or third trimester. To claim success, a vitamin A program should at least improve pupillary dark adaptation threshold to scores better than $-1.24 \log \text{cd/m}^2$ (18).

BIOCHEMICAL INDICATORS

Serum retinol concentrations have been widely used to assess vitamin A status despite the fact that the levels of retinol in the blood reflect body stores only when these are very low. In addition, serum retinol is influenced by infections, protein and zinc malnutrition and other factors, which makes this index less reliable in assessing individual vitamin A status (5). It is reliable at assessing the status of a population, and it is effective in detecting a change in population status over time. A cutoff of >15% of a preschool population with serum retinol below $0.70 \mu\text{mol}$ is recommended as indicative of VAD (19) and thus can be used as an indicator of the achievement of an intervention program. Even more sensitive and reliable is the progress in shifting serum retinol distributions. In Guatemala (20), sugar fortification with vitamin A resulted

in a shift of serum retinol distribution toward normal (Fig. 1). After the program was suspended, the prevalence of low serum retinol increased to 26%; 6 months after fortification was renewed, the prevalence dropped to 10% (21) and remained at 16% in 1995 (22). Likewise, in Honduras, fortification of sugar with vitamin A resulted in a marked reduction in the number of children with low serum retinol, from 40% in 1967 (23) to 13% in 1996 (24). A similar pattern of improvement was observed in the response to margarine fortification in the Philippines (25). For more details on food fortification, consult the article by Dary and Arroyave in this volume.

Breast milk vitamin A provides information about vitamin A status of exclusively breast-fed infants as well as of lactating mothers. Because most vitamin A in breast milk is associated with fat globules of milk, the concentration of vitamin A in casual samples should be expressed per gram of fat (5,26). Casual milk sampling concentrations of retinol, although listed as a potential criterion at an informal WHO workshop (5), is generally more difficult to analyze and is considered less reliable except under ideal laboratory conditions. Recent data from a vitamin A supplementation trial in lactating Bangladeshi women indicated that the most responsive indicator was the measurement of breast milk vitamin A per gram of fat in casual milk samples (27). Breast milk vitamin A was used as one of the evaluation indicators of sugar fortification in Guatemala (20). The median value of breast milk vitamin A increased from $0.88 \mu\text{mol}$ at baseline to a peak of $1.40 \mu\text{mol}$. Distribution of vitamin A concentrations in milk shifted significantly toward higher values during the program period. The percentage of mothers with a concentration in milk below $0.70 \mu\text{mol}$ fell from 38% at baseline to 10% after 18 mo of a sugar fortification program. Breast milk vitamin A was also used to evaluate the effect of fortification of monosodium glutamate with vitamin A in Indonesia (28). A significant increase in the average milk vitamin A concentration was observed in the program areas, whereas no change was reported in the control areas. Similar results were found elsewhere (29). Indicators are discussed in another chapter. Breast milk was not considered to be as simple and reliable an indicator as serum retinol, although in careful hands it does show a response.

In summary, the outcome indicators are important in eval-

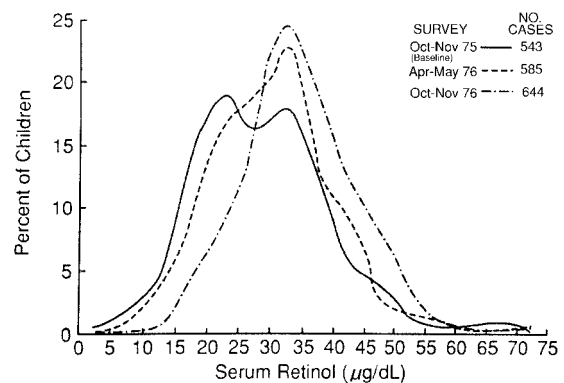


FIGURE 1 Changes in serum retinol distribution in preschool children following sugar fortification, Guatemala 1975–1976 (17). Reproduced with permission from the Pan American Health Organization (PAHO), Washington, D.C. To obtain PAHO publications, visit their website at <http://publications.paho.org> or write to PAHO Sales and Distribution Center, P.O. Box 27, Annapolis, MD 20701-0027. Fax: (301) 206-9789; E-mail: sales@paho.org.

uating vitamin A intervention programs. Such indicators include the following:

- Clinical indicators
- Incidence of X1B in preschool children
- Incidence or prevalence of XN during pregnancy
- Functional indicators
- Pupillary threshold better than $-1.24 \log \text{cd/m}^2$ in 2- to 6-year-old children and in pregnant women in the second and third trimesters
- Biochemical indicators
- Preschool children with serum retinol concentrations of $<0.70 \mu\text{mol}$ (or $20 \mu\text{g/dL}$)
- Lactating women with breast milk vitamin A concentrations of $<0.70 \mu\text{mol}$ ($6 \mu\text{g}$ per g of milk fat) or $<1.05 \mu\text{mol}$ ($<8 \mu\text{g}$ per g of milk fat)

Before the outcomes are measurable, program managers can track the progress of their interventions through the shift of mean or median values or the frequency distribution. Timing of program evaluation depends on the type of intervention (e.g., food-based strategies usually take longer than supplementation), the severity of VAD, the age of the target group and whether the programs are single or integrated.

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