Case 4

Reducing Child Mortality With Vitamin A in Nepal

Geographic area: Nepal

Health condition: In the 1990s, 2–8 percent of preschool-aged Nepali children experienced severe vitamin A deficiency, or xerophthalmia, associated with blindness and risk of child death.

Global importance of the health condition today: Vitamin A deficiency affects approximately 21 percent of the developing world's preschool-aged children and leads to the deaths of over 800,000 women and children each year. Because it compromises the immune system, vitamin A deficiency is estimated to be responsible for nearly one fourth of global child mortality from measles, diarrhea, and malaria and for a fifth of all-cause maternal mortality.

Intervention or program: In 1993, the government of Nepal initiated the National Vitamin A Programme (NVAP) with the support of UNICEF, USAID, and local researchers and nongovernmental organizations. The NVAP aimed to reduce child mortality and morbidity related to vitamin A deficiency by providing twice-yearly supplements of vitamin A capsules to children in priority districts; treating xerophthalmia, severe malnutrition, prolonged diarrhea and measles; and encouraging dietary intake of vitamin A and breast-feeding. A large cadre of women who served as community-based volunteers was integral to the rapid expansion of the program to Nepal's 75 districts.

Cost and cost-effectiveness: The cost of delivering two rounds of vitamin A per year was approximately $1.25 per child covered. With an estimated cost of $327–$397 per death averted and $11–$12 per disability adjusted life-year (DALY) gained, the NVAP is considered highly cost-effective.

Impact: The NVAP prevents blindness in approximately 2,000 children each year and was found to reduce by about half the mortality rate for children under 5 years of age in Nepal between 1995 and 2000.

Enveloped in poverty and burdened by its onerous topography, Nepal is hardly an obvious birthplace for a public health success story. And yet, the marriage of scientific and operational innovations provided the foundation for a national program that saves hundreds of thousands of children's lives.

In the early 1980s, a series of studies demonstrated that vitamin A supplementation could reduce child mortality; two of them were carried out in Nepal.[1,2] Following this discovery, Nepal conceived of the National Vitamin A Program to distribute small, red vitamin A capsules to millions of children each year. Its creative design overcame the country's economic and geographic hurdles by harnessing local capacity and relying on new channels of public health delivery—bridging the once insurmountable gap between where the formal health sector

Case drafted by Jessica Gottlieb.

ended and the needs of the poor began. The reduction in child mortality demonstrated by this program and the sustained high levels of coverage would make this innovation in service delivery a model for future attempts to combat vitamin A deficiency and other childhood illnesses.

Carrots for the Eyes

Improved eyesight is perhaps the most familiar benefit of vitamin A. Without sufficient intake of this micronutrient, a condition called xerophthalmia or a dryness of the eyes ensues. Manifesting first as night blindness, severe vitamin A deficiency will eventually cause softening of the corneas and total blindness. Vitamin A deficiency is, however, not only associated with eye problems; it is also an underlying determinant of child mortality. Because of vitamin A's role in epithelial defenses and the immune system, deficiency puts children at greater risk of respiratory, measles, and diarrheal morbidity.[3]

Vitamin A deficiency affects approximately 21 percent of the developing world's preschool-aged children[4] and leads to the deaths of over 800,000 women and children each year. Furthermore, vitamin A deficiency is responsible for 20–24 percent of global child mortality from measles, diarrhea, and malaria and for 20 percent of all-cause maternal mortality.[5] It also increases the severity and fatality of measles.[3]

Carrots, spinach, and other green leafy vegetables; ripe yellow fruit; and animal products such as eggs, milk, and liver contain vitamin A. Regularly eating recommended amounts of these foods prevent vitamin A deficiency. In their absence, vitamin A deficiency can also be prevented by consuming dietary supplements. Where vitamin A deficiency is a public health problem, children under five years of age are recommended to periodically take preventive vitamin A in high doses. More specifically, children 6–11 months of age are recommended to receive an oral dose of 100,000 International Units (IU), and children 12–59 months of age should receive a 200,000 IU dose every four to six months.[6] For adults in the United States, the daily recommended dose of vitamin A is 4,000–5,000 IU.

Another target group for vitamin A interventions is pregnant and breast-feeding women. Night blindness, an early symptom of clinical vitamin A deficiency, can be highly prevalent during pregnancy, affecting 10 percent to 20 percent of expecting mothers in rural South Asia. Night blind mothers have their own health risks[7] and are more likely to have vitamin A deficient children.[8] Night blindness can be avoided by eating a nutritious diet that is plentiful in foods rich in vitamin A, and it can be treated by taking low doses of vitamin A on a weekly basis. Also, while high doses of vitamin A should be generally avoided in pregnancy due to concerns about risks of birth defects, a high dose of vitamin A can be given to mothers within six weeks after delivery to prevent maternal health problems from vitamin A deficiency and to increase breast milk vitamin A content for breast-feeding infants.[6]

Evidence of the positive health impact of vitamin A supplementation is clear. In a meta-analysis of multiple trials, vitamin A supplementation was shown to be an important way to reduce child mortality.[9] By aggregating similar findings of individual studies, the meta-analysis helped motivate the decision to pursue a sustained national program of vitamin A supplementation in Nepal and elsewhere.

Vitamin A Deficiency in Nepal

In the years before the national program, vitamin A deficiency was an important health problem in Nepal with 2–8 percent of preschool-aged children experiencing xerophthalmia or severe vitamin A deficiency.[2,13] Several contextual factors can help to explain this high prevalence rate. Difficult terrain makes it hard to grow or access the types of food that supply vitamin A naturally. Beyond geography, 28 percent of Nepal's 23 million inhabitants live in absolute poverty and nutritious foods are more difficult to come by.[14] Even when proper foods may be available, unequal access to them within families can lead to young children and pregnant mothers not getting their fair share.[15] These are the root problems of malnutrition, including vitamin A deficiency, and will take many years to solve. However, in the shorter run, national vitamin A supplementation programs can stave off deficiency and prevent blindness and mortality.

From Community Trial to National Program

Before the 1980s, the role that vitamin A deficiency played in placing children at risk of death was not widely appreciated. By the early 1980s, however, medical researcher Dr. Alfred Sommer had observed in Indonesia that an exceptional number of children with mild eye signs of xerophthalmia, such as night blindness and Bitot's spots, were dying.[10] Such findings were in line with observations of nutritionists and health scientists in the early part of the 1900s who associated severe xerophalthmia with blindness and risk of child death. However, Sommer's attempt to link vitamin A and child mortality was not immediately accepted by critics.[16]

Sommer, his colleague Dr. Keith West, and their Indonesian colleagues carried out a 30,000-child trial in northern Sumatra in the early 1980s (see Box 4–1). The trial supported Sommer's theory that vitamin A deficiency lead to child deaths and that when given to children vitamin A prevented deaths. Their second trial, among 30,000 children in the southern Nepal plains district of Sarlahi in the early 1990s echoed the results from Indonesia: Periodic vitamin A delivery could reduce mortality in children aged 6–60 months by about 30 percent.[1] Around the same time, another field trial in Jumla, in the western hills of Nepal, further strengthened the case by reporting an approximate 30 percent difference in child mortality of children who took vitamin A compared to those who did not.[2]

Aware of these new and dramatic findings and cognizant of the nation's high child mortality rate, the Nepalese Ministry of Health began planning a national vitamin A program with the help of the research community, other ministries, the National Planning Commission, NGOs, and the international agencies UNICEF, WHO, and USAID. In February 1992, the government of Nepal, along with national and international agencies, discussed the data generated during the vitamin A trials and developed an implementation strategy and objectives for a national program. Vitamin A supplementation was made part of His Majesty's Government's Eighth Five-Year Development Plan (1992–1997) with a 10-year goal to reduce the prevalence of xerophthalmia from 1.9 percent to 0.1 percent by the year 2001.[17]

With financial and technical assistance from USAID and UNICEF, Nepal's National Vitamin A Programme (NVAP) began in 1993 with the following objectives:

- Reduce child mortality and morbidity through prophylactic supplementation of children 6–60 months with high-dose (200,000 IU) vitamin A capsules twice yearly in 32 priority districts.
- Treat xerophthalmia, severe malnutrition, prolonged diarrhea, and measles in all 75 districts.
- Bring about behavior change to increase dietary intake of vitamin A and improve breast-feeding in the 32 priority districts.

The Nepali Technical Assistance Group (TAG) was an NGO created specifically to assist the health ministry in implementing the program, especially with training, monitoring, motivation, mobilization, and supervision. Since 1999, the Micronutrient Initiative through support from the Canadian International Development Agency (CIDA) has provided vitamin A capsules for the NVAP, and the Australian international aid agency (AusAID) has financially contributed to the training component.

The Campaign

As in many poor countries, Nepal's public health system was faced with severe problems from low utilization rates of local health posts (less than 20 percent for treatment of child illnesses), to absenteeism among health workers, to poor quality health care. This was not a setting in which the large-scale NVAP could be successfully launched. Rather than undertake the mammoth task of vastly extending the reach of health post workers, a semiannual campaign approach was adopted to enable vitamin A to reach Nepalese children in a nationally visible, coordinated, focused way. Mass distribution of vitamin A would be carried out in April before the beginning of the high-risk season of xerophthalmia, and in October to boost vitamin A stores to support accelerated child growth that often follows fall harvest season. To achieve high coverage rates, each distribution date would be preceded by training, promotion, and ensuring the availability of vitamin A capsules in each district.[18]

Harnessing Local Resources to Save Lives

Based on an existing network of unpaid female community health volunteers (FCHVs) who helped to deliver primary health care and family planning to villages, NVAP decided to engage this underutilized and underresourced workforce in vitamin A delivery. In 1993, there were 36,000 FCHVs in 75 Nepalese districts. These mostly illiterate women were not always given respect by their communities, and their credibility was further challenged by oft-lacking medical supplies. With the help of NVAP, this network of volunteers was transformed into 49,000 public health agents who were able to reach 3.7 million children with vitamin A capsules twice per year (Ram Shrestha, Nepal Technical Assistance Group, personal communication, July 2006).

This transformation would have been impossible without the insight and dedication of TAG's leader, Mr. Ram Shrestha. Shrestha noticed that the network of FCHVs, nominated from women's organizations to promote health messages, fell into disuse after the first year of existence. The reason: money. During year one, all FCHVs were given a monthly stipend of 100 rupees (about US$2) as an incentive.[a] After one year, the Nepalese government realized that it was impossible to continue to offer a monthly stipend of 100 rupees; when the incentive ceased, so did the work of the volunteers. Shrestha realized that to motivate community volunteers, he would have to come up with a renewable incentive that would adapt over time to reflect the changing needs of the volunteers. Through a profound knowledge of the community and a wealth of creativity, Shrestha achieved this aim. He relied on a few basic principles—opportunity, respect, recognition, and ownership—knowing that the FCHVs could be motivated without monetary incentives.

Through tactics such as inviting volunteers to speak at meetings, allowing them to pass to the front of the line when awaiting social services, and giving them preference in participating in other government programs, NVAP brought FCHVs newfound respect in their communities and motivated them to carry out public health activities. As one FCHV said, "This [vitamin A] program has made us more active. We undergo training every six months and people come to visit so often for advice."[17] In a culture where women are not often given prominence in society, this program had the added effect of challenging deeply rooted gender biases, giving women responsibilities valued by their families and communities.

The FCHVs did not function in isolation; rather they served as a critical bridge between the public health sector and the community. Although they were engaged in the most direct contact with beneficiaries, the public health system still played a major role. The newly expanded cadre of 49,000 FCHVs was made possible by a method of training the trainers, adopted to enable staff at the district health office to train the chief of the health post in a village, who would then train village health workers, FCHVs, and others. The government supported other key activities such as the provision of supplies and monitoring. Sectors outside of health, such as agriculture and education, also pitched in by integrating messages about the importance of vitamin A into their programs.

The NVAP helped communities take the health of their children into their own hands. The prominence of FCHVs raised the profile of public health, and their integration within the communities they served greatly increased accessibility. The existence of a retrained and invigorated cadre of FCHVs produced a new awareness of and demand for health care, as did the public outreach and health education undertaken by them and other NGO partners. This demand is evidenced by the families that brought their children each distribution day to a central village site or health post—sometimes a long walk from home. While FCHVs did not often go door to door, children missed during the first day of distribution were usually traced the next day.

Promoting community ownership over the care of children created a natural constituency that helped to ensure the sustainability and success. When supplies weren't delivered or when FCHVs didn't receive training, beneficiaries in the communities noticed and held the government accountable.

a Initially, FCHVs were also given a small amount of supplies that were intended to be sold for a small profit, the funds from which could be used to buy more. This did not work well and was eventually stopped.

Expanding to a National Strategy

A critical factor in the success of the national vitamin A program was its phased expansion. In a predetermined sequence, Nepal's 32 priority districts were incrementally phased in to the program at a rate of 8 to 10 districts per year to allow the government time to build local capacity and ownership, and to apply lessons from earlier experience.

By 1997, vitamin A capsule supplementation had been introduced into all 32 districts as mandated in the Eighth Plan. Based upon the high coverage and initial success of the program, the government of Nepal decided to extend vitamin A supplementation to all its 75 districts. Expansion into new districts was facilitated through National Immunization Day activities whereby children would receive one capsule of vitamin A as a temporary measure until NVAP reached those districts with its twice-yearly supplementation.

Skeptics of the program asserted that supplementation was unnecessary because vitamin A deficiency could be averted simply through changing dietary practices.[17] Although one cannot dispute this claim and long-term goal, advocates of the NVAP were able to show by projection the numbers of child lives saved each round; this motivated and moved the program forward. Along with supplementation, education and outreach activities in the villages were introduced to emphasize the importance of healthy dietary practices. Though it took nearly eight years to achieve nationwide distribution, coverage in ongoing program areas remained above 80 percent to 90 percent.

Cost and Cost-Effectiveness of a National Program

In 1997 and again in 2000, cost analyses of the NVAP were undertaken—in part to guide the decision about whether or not to expand the program. Using TAG coverage estimates, the cost of the program per child covered was approximately US$1.25 to deliver two rounds of vitamin A per year (not including volunteer time of the female community health workers).[19] This appears very low-cost, compared with other child survival and nutrition interventions such as breast-feeding promotion, growth monitoring, and micronutrient supplementation, which can cost up to four times as much per child.[20]

The NVAP was found to be highly cost-effective with an estimated cost of US$327–US$397 per death averted and $11–$12 per disability adjusted life-year (DALY) gained. The NVAP also was estimated to produce cost savings for the Ministry of Health by averting severe episodes of diarrheal disease and measles.[19]

Program Impact

According to a national coverage estimate of 81 percent of all children 6 to 59 months of age, the NVAP currently prevents approximately 2,000 children from going blind each year.[21] A quasi-experimental evaluation of the program in Nepal demonstrated significant impact on child mortality as well. The study was facilitated by the fact that districts were incorporated into the program at 6-month intervals so the impacts on health in program areas could be compared to the health indicators in nonprogram areas. A demographic and health survey in 2001 provided the child mortality estimates in Nepal necessary to determine the impacts of the Nepal vitamin A program. After controlling for potentially confounding factors such as poverty, disease prevalence, and mother's education, the effect of 100 percent community-level vitamin A coverage between 1995 and 2000, relative to no coverage, was found to reduce the mortality of children under 5 years old by about half.[22]

Current Challenges

Can the national vitamin A delivery program be sustained, especially under resource-scarce conditions and amid civil conflict like the one that currently grips Nepal? Now that the nation is covered by the NVAP, a new challenge is to facilitate a longer-term solution to vitamin A deficiency. Such strategies, including strengthening home gardening, small animal husbandry, food markets, and dietary changes, within households can complement supplementation efforts until children receive ample vitamin A through their diet.

In the meantime, attention must also be paid to the sustainability of the NVAP. As occurred with monetary incentives at the outset, the effects of the personal incentives to the FCHVs appear to be waning. A new

Box 4–1

Changing Minds, Saving Lives

In 1983, when Al Sommer published his findings in *The Lancet* showing mild vitamin A deficiency was associated with an increased risk of child death,[10] he was largely ignored. Three years later, he and colleague Dr. Keith West met skepticism when they reported that mortality of young children could be reduced by one third just by giving them a dose of vitamin A every six months, based on data from a community trial in Indonesia.[11] Critics thought such a simple solution to a major global health problem "too good to be true." Finding fault with the fact that the Indonesian study had not used a placebo group, they claimed that chance could have explained the findings.

Sommer decided to challenge the skeptics by "burying them in data." He and his colleagues, as well as other research groups, repeatedly carried out vitamin A supplementation trials using a range of designs in different countries and in populations of varying nutritional and mortality risks to all establish a clear causal link between vitamin A supplementation and reduced child mortality. The trials confirmed the results of Sommer's initial observation and showed reductions in mortality as high as 55 percent. Through persistent research and spreading the word in scientific papers and meetings, commentaries, and media exposure, the potential of vitamin A supplementation was eventually recognized and brought into the mainstream of child survival activities.[12]

incentive called the FCHV Endowment Fund is being developed and tested. The Endowment Fund is established by Village Development Committees (VDCs), which place the equivalent of a little more than $1,000 in local currency into an account. The capital remains untouched, and the interest is placed into another savings account controlled by local FCHVs; the earned interest can be used for their welfare. Twenty percent of VDCs currently have this sustainable fund at their disposal and early evidence suggests it helps to increase the job satisfaction of the volunteers, according to Ram Shrestha. In VDCs that cannot afford to put aside funds for this purpose, the NVAP is working to involve local industry to contribute to the endowment funds.

Learning from Nepal's Success

Innovative technical and operational planning can result in a major population impact. Well-designed, nonmonetary incentives to community volunteers have been an efficient and cost-effective way of reaching poor families with primary health care services. The use of FCHVs has been so successful in combating vitamin A deficiency that they are now helping to address deworming, treat pneumonia, and distribute iron supplements to pregnant women. Attention to communities by local health workers and NGOs engendered local ownership of the program and spurred demand for health services, adding to program sustainability.

The success of NVAP reinforces lessons common to other health successes: the importance of local leadership, evidenced by Ram Shrestha's key role in the design and implementation; monitoring of quality, which allowed for the program to make midcourse corrections to improve service delivery; and of partnership, demonstrated by the support system among the district health workers, the NGOs and the health volunteers.

According to Keith West:

> This case is an exceptional example of how a poor country undertook the required research to demonstrate impact (not in one but two sites in different corners of the country, both of which showed a 30 percent reduction [in child mortality]), garnered the required political constituencies and funding partners, initiated and learned from mistakes along the way as it scaled up to a national program, undertook periodic and independent evaluations of impact and cost, and has managed to sustain its achievement over time. All of

this in the midst of a Maoist insurgency that has otherwise stripped parts of the country of its rural infrastructure; but the vitamin A program continues perhaps because of its known impact by the populace (instilled by its designer, Ram Shrestha) and maybe also by the realization that children need to survive, no matter who rules a country.

References

1. West KP Jr. Efficacy of vitamin A in reducing preschool child mortality in Nepal. *Lancet.* 1991;338(8759):67–71.

2. Daulaire N, Starbuck ES, Houston RM, et al. Childhood mortality after a high dose of vitamin A in a high-risk population. *BMJ.* 1992;304:207–210.

3. Sommer A, West KP Jr. *Vitamin A Deficiency: Health, Survival and Vision.* New York, NY: Oxford University Press; 1996.

4. West KP Jr. Extent of vitamin A deficiency among preschool children and women of reproductive age. *J Nutr.* 2002;132:2857S–2866S.

5. Rice AL, West KP, Black RE. Vitamin A deficiency. In: Ezzati M, Lopez AD, Rodgers A, Murray C, eds. *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors.* Vol. 1. Geneva, Switzerland: World Health Organization; 2004:211–256.

6. Ross DA. Recommendations for Vitamin A supplementation. *J Nutr.* 2002;132(9 suppl):2902s–2906s.

7. Christian P, West KP, Khatry SK, et al. Night blindness of pregnancy in rural Nepal—nutritional and health risks. *Int J Epidemiol.* 1998;27:231–237.

8. Semba RD, de Pee S, Panagides D, Poly O, Bloem MW. Risk factors for xerophthalmia among mothers and their children and for mother-child pairs with xerophthalmia in Cambodia. *Arch Ophthalmol.* 2004;122:517–523.

9. Fawzi WW, Chalmers TC, Herrera MG, Mosteller F. Vitamin A supplementation and child mortality: a meta-analysis. *JAMA.* 1993;269(7):898–903.

10. Upadhyay M. Xerophthalmia among Nepalese children. *Am J Epidemiol.* 1985;121(1):71–77.

11. Khatry SK, West KP, Katz J, et al. Epidemiology of xerophthalmia in Nepal: a pattern of household poverty, childhood illness, and mortality. *Arch Ophthalmol.* 1995;113(4):425–429.

12. Shankar AV, West Jr KP, Gittelsohn J, Katz J, Pradhan R. Chronic low intakes of vitamin A–rich foods in households with xerophthalmic children: a case-control study in Nepal. *Am J Clin Nutr.* 1996;64:242–248.

13. Sommer A, et al. Increased mortality in children with mild vitamin A deficiency. *Lancet.* 1983;2(8350):585–588.

14. Hilts PJ. *Rx for Survival: Why We Must Rise to the Global Health Challenge.* New York, NY: Penguin Press; 2005.

15. Sommer A, Tarwotjo I, Djunaedi E, et al. Impact of vitamin A supplementation on childhood mortality. A randomized controlled community trial. *Lancet.* 1986;1(8491):1169–1173.

16. McCarthy M. Alfred Sommer: a life in the field and in the data. *Lancet.* 2005;365(9460):649.

17. United Nations Children's Fund, Regional Office for South Asia. *Getting to the Roots: Mobilizing Community Volunteers to Combat Vitamin A Deficiency Disorders in Nepal.* Kathmandu, Nepal: United Nations Children's Fund; 2003.

18. Houston R. *Elements of Success: National Vitamin A Program—Nepal.* Ministry of Health, HMG/Nepal, JSI, USAID, NTAG, and UNICEF; 1999.

19. Fiedler JL. The Nepal national vitamin A program: prototype to emulate or donor enclave? *Health Policy Plann.* 2000;15(2):145–156.

20. Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, wasting, and micronutrient deficiency disorders. In: Jamison DT, Breman JG, Measham AR, et al. *Disease Control Priorities in Developing Countries.* 2nd ed. Washington, DC: World Bank; 2006.

21. Fiedler JL. *The Nepal National Vitamin A Program: Cost Estimates for 2000 and Alternative Configurations of a Nationwide Program.* Special Initiatives Report No. 41. Bethesda, MD: The Partners for Health Reformplus Project, Abt Associates Inc; 2001.

22. Thapa S, Choe MK, Retherford RD. Effects of vitamin A supplementation on child mortality: evidence from Nepal's 2001 Demographic and Health survey. *Trop Med Int Health.* 2005;10(8):782–789.