

THE CHILDREN OF JUMLA, NEPAL

PART I:

Reduction of Child Deaths and Pneumonia Cases

Through Pneumonia Case Management

and Vitamin A Supplementation

at the Community Level

Nils M.P. Daulaire, M.D., M.P.H.

and

Mary E. Taylor, Ph.D.

Authors:Nils M.P. Daulaire, M.D., M.P.H.
President and CEO
Global Health Council
1701 K Street NW, Suite 600
Washington, DC 20006

Mary E. Taylor, M.H.S., Ph.D.
PO Box 1330
Norwich, VT 05055

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OVERVIEW

When the activities described in this paper began in 1986, the children of Jumla District in western Nepal had one of the highest stable mortality rates of any population in the world outside of war and famine conditions: nearly one of every three children born did not survive to their fifth birthday.

The Jumla Community Health Project has now documented dramatic declines in deaths and in pneumonia cases among these children. These declines are the direct result of two Child Survival interventions which have been carried out at the community level exclusively by trained villagers:

- detection of pneumonia cases and their treatment with oral antibiotics (PNEUMONIA CASE MANAGEMENT); and
- routine periodic dosing of all children with vitamin A capsules (VITAMIN A SUPPLEMENTATION).

As a result of pneumonia case management alone, child deaths in Jumla decreased by 28%. Vitamin A supplementation further reduced child mortality by 26%, and reduced the number of pneumonia cases among children by 33%.

These findings are particularly important because these services can be readily replicated at low cost. Their striking effects on child health and survival are

directly relevant to community health programs throughout the world, particularly those carried out by grassroots groups and non-governmental organizations.

This report describes the first two phases of this community-based health program in detail so that others can benefit from Jumla's experience. Later phases, in which diarrhea and immunizable diseases have also been addressed, will be described in a companion paper.

The successes of these cost effective programs have led to a strong demand among the women of Jumla for family planning services because of the broad -- and correct -- perception that their children are no longer so likely to die.

SETTING

Jumla is one of the most remote and inaccessible districts in Nepal, cradled between high Himalayan peaks on three sides and an impassable river on the fourth. A five day walk is required to reach the nearest road; the only alternative means of entering the district is by small twin-engine plane which can land only at the short dirt airstrip at the outskirts of the district's small administrative center.

Travel throughout the area is possible only by foot, and it takes more than two days to walk from one end of the district to the other, crossing passes of over

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12,000 feet. Even the valley bottoms lie above 7,000 feet. Because of its altitude and its location directly adjacent to mountain peaks rising to more than 20,000 feet, winters in Jumla are cold and long, and the growing season is short.

These surrounding mountains block much of the monsoon rainfall on which Nepali farming depends, making the area dry. Yet, because of its isolation and terrain, food cannot readily be imported. Most of the district's 80,000 inhabitants therefore devote their lives to growing meager crops in the steep rocky soil in order to survive.

Not surprisingly, Jumla is an area of chronic food shortage with high levels of malnutrition, particularly among women and children. This situation is particularly severe each year in late spring and early summer, when the previous year's food stocks are depleted and the new crops have not yet been harvested.

Little has changed in the lives of the villagers of Jumla since the settlement of this remote area by Hindu refugees fleeing the Mogul invasion of India more than 700 years ago. Poverty is universal, and the average annual income is less than \$75. Barely one in three men and less than one in twenty women can read or write.

Human and animal labor predominate, and machinery is virtually non-existent. Women have a particularly high burden:

they generally devote 14 to 16 hours a day working in the fields, collecting firewood and forage from the forests, and preparing meals. Their social status is extremely low in comparison to men, and they have little economic power. By tradition, they must sleep outside the house with the domestic animals during their menses -- even in mid-winter -- to avoid ritual pollution of their husbands and households.

People live in small, tightly clustered villages consisting of long flat-roofed mud and stone houses, snuggled together on steep hillsides to preserve the precious valley bottoms for farming. Domestic animals are quartered in the ground level of these houses. Most clothing and household implements are homespun and handmade. Radios, flashlights, and even watches are rare luxuries.

Only the administrative center and a few small villages are served by electricity, which is generated by some recently installed micro-hydro plants. In the rest of the district all heat, illumination and cooking are by firewood. The wood which is used is a highly resinous pine which produces a dense oily smoke that fills and impregnates the poorly ventilated and chimneyless houses to within inches of the floor.

As a consequence of this constant exposure to smoke, the people of Jumla are renowned throughout Nepal for their black clothes and their sooty skin. This extreme level of indoor air pollution and

widespread smoking of local tobacco leaf is believed to contribute to high rates of respiratory disease; it is rare to visit a Jumla household in which a majority of the residents are not coughing.

Health services and health conditions

Despite these physical obstacles, a number of Jumla's characteristics made it a promising site for an intervention study.

First was the absence of other health and social services which could otherwise make it difficult to determine whether a change in health status was due to the program or to extrinsic factors. Jumla's remoteness meant that modern health services were virtually non-existent. At the time the study began, hardly any of the district's population outside the administrative center had effective access to any reliable primary health care or simple drugs such as antibiotics. Immunization coverage was also very low, since outreach efforts of the national Expanded Program on Immunization were severely hampered by Jumla's terrain. Measles immunization coverage was found to be under 15 percent during the years of this study, despite widespread public awareness of the devastating effect of the measles epidemics that periodically swept through Jumla's villages.

This lack of other services made it possible to determine the effect of various program interventions without having to

disentangle these effects from those of other ongoing health or development activities.

Jumla's extraordinarily high levels of childhood mortality and illness also made it potentially easier to recognize and to confirm rigorously and statistically any changes that might result from these services. At the start of this program, nearly one of every five children born did not survive through the first year of life, and nearly one of three did not survive to age five (Figure 1); pneumonia and diarrhea were the leading causes of child death. With such high baseline levels, proportional changes that might be missed elsewhere would be more readily discernable.

Given Jumla's poverty, climate and isolation, it was not surprising that levels of childhood malnutrition were also very high. More than a quarter of all newborns were low birthweight, and a similar proportion of children between one and five years old were found to be severely malnourished by armband measure.

Although breastfeeding was universal and bottlefeeding was unheard of, colostrum was discarded due to cultural beliefs and so children did not begin breastfeeding until several days after birth. Furthermore, mothers' extensive agricultural responsibilities meant that they were often separated from their infants from early morning to late afternoon, making frequent feeding

impossible.

Maternal health was also found to be poor. Most women were married by the time they reached their mid-teens and could expect to bear seven or more children over the next thirty years. Modern family planning was virtually nonexistent. Pregnancy risks were very high, with one in every ninety pregnancies resulting in the death of the mother (by contrast, barely one in every 8,000 pregnancies in the West results in the mother's death). In conjunction with Jumla's high fertility this meant that, of every 12 women in Jumla's villages, one would not survive her childbearing years.

PROGRAM SERVICES AND IMPACT ASSESS- MENT

In the face of these daunting statistics, and given the limitations of resources available for Jumla, the project adopted a modest and phased approach. This approach was aimed at developing and testing strategies for low-cost and potentially high-impact services that could be sequentially added, each on top of the last.

The program's commitment to affordable and potentially sustainable interventions could only be carried out using local villagers as health service delivery workers. It was recognized from the start that many well-intended community

health programs have foundered because workers have been overwhelmed with too many activities to be digested and properly conducted all at once; therefore, the Jumla workers would be trained to master the necessary tasks one limited set at a time. This would also make it possible to measure the mortality effects of individual interventions.

However, some analysts have maintained that in conditions of such high levels of malnutrition and overall mortality and morbidity, any reductions in deaths from one cause are likely to be matched by increases in deaths from other causes ("replacement mortality"), with no net benefit.¹ Therefore, it was critical to look not just at the immediate effect of the program services on specific causes of death, but to focus particularly on their overall and cumulative mortality impact. Thus, a reduction in total child mortality was defined as the principal desired outcome.

A major effort was undertaken to document rigorously any mortality effects. Since health staff may feel they have a vested interest in finding positive effects from programs they themselves are responsible for carrying out, the potential for bias in the reporting of deaths was eliminated by setting up separate staff and an independent reporting structure to assess mortality; both field workers and managers responsible for mortality assessment were totally separate from program service staff. Within the program's health services staff

and structure, reporting requirements were limited to the bare minimum needed for management purposes so that the service elements would be more directly replicable in other developing country situations.

During the project's initial four years (1986-1990), the service intervention study was carried out in two distinct phases. The first (1986-1989) focused exclusively on pneumonia detection and treatment. The second (1989-1990) added routine vitamin A supplementation to the ongoing pneumonia services. Following the end of the study component, these services were maintained up until mid 1994, at which point the Ministry of Health and a local NGO informed donors that outside support was no longer needed.

PNEUMONIA CASE MANAGEMENT

Pneumonia is today the single largest killer of children in the world, accounting for more than four million deaths a year. The large majority of these children die never having been admitted to hospitals, and most come from households in areas unserved or underserved by trained health professionals or reliable health facilities. Therefore, a key to substantially reducing pneumonia deaths worldwide lies in strategies which do not absolutely require health professionals or inpatient hospital facilities.

Basis for diagnosis and treatment

Jumla was one of the earliest large-scale community-based programs to incorporate a new strategy for pneumonia control known as *standard case management*. The scientific basis for this approach, which has been well documented by the World Health Organization,² is now broadly accepted.

Standard case management consists of making a presumptive diagnosis (or "classification") of pneumonia based on a limited set of physical findings -- principally fast breathing or the observed presence of chest indrawing. Stethoscopes, chest X-rays, and other "high tech" and professional-intensive approaches are not required.

Studies have found that the large majority of serious and fatal pneumonias in the Developing World are caused by a small number of bacteria types, which are highly sensitive to a variety of low-cost antibiotics. This has meant that specific laboratory or microscopic identification of the particular organism responsible for any given case of pneumonia is not necessary in the large majority of cases.

Therefore, children classified as having pneumonia are then treated over a five day period with a standardized regimen of one of these antibiotics without need for further testing. Where possible, seriously ill children (again following standard definitions) are referred for hospitalization.

In Jumla, the WHO protocols were simplified even further. This was necessary to accommodate the realities of barely literate village health workers operating without the benefit of referral facilities, hospitals, or physician back-up.

The project decided to concentrate exclusively on pneumonia, as this accounts for virtually all deaths due to acute respiratory infections. No effort was devoted to household treatment of coughs and colds, since there is no evidence that any such treatment has any effect whatever on mortality or on the likelihood of progression to serious illness.

For all ages between birth and five years, a single cutoff rate of 50 breaths per minute or more was adopted as the basis for classifying a child with cough as having pneumonia.³ The use of a single rate greatly simplified health worker training and reduced the likelihood of confusion and misclassification among health workers.

More recently, WHO adopted a simplified recommendation for standard case management by community workers. This approach uses two breathing rates: 60 under 2 months and 50 above that age. As of 1993, the Jumla program also adopted this approach. However, the results described here reflect the program's experience using only one single cutoff rate of 50 for all age groups.

Measurement of breathing rates

The measurement of breathing rate was initially problematic among Jumla's community workers, since none had watches or other objective means of determining when a minute had elapsed. As a first step, an effort was made to teach these workers to make a subjective determination of fast breathing, but despite considerable training efforts, this approach was found to be inadequate.

Since some objective measure was necessary, sand timers were first tried. Unfortunately, inexpensive sand timers were found to be highly inaccurate and unreliable, while high quality sand timers cost in excess of \$5 apiece and had to be imported from Europe. To deal with this issue, a prototype electronic beeper was developed late in 1986 specifically for the Jumla program.

This Jumla Timer was designed to beep after 30 seconds, since it was found that the difficulty of keeping a child still for a full minute outweighed the slight increase in accuracy which could be gained by a full minute count. The timer provided the added advantage of giving the worker an objective basis for *withholding* treatment, which workers otherwise found difficult in the face of a worried mother. In fact, this strange beeping device soon gained notoriety throughout the district as a supernatural tool capable of judging the cause and severity of a child's cough, and

contributed considerably to a rise in the status of the community health workers using them.

The Jumla Timer proved to be such a useful and appropriate use of technology that it was subsequently modified and improved for mass production by WHO and UNICEF and has now been adopted for worldwide use by community health workers involved in pneumonia case management. Its projected unit cost is \$3 to \$4.

Treatment

All children who met the criteria for pneumonia (i.e. fast breathing or chest indrawing), whatever the level of severity, were treated exclusively with oral antibiotics in their own homes. Referral, inpatient treatment, or treatment with injectable antibiotics were not feasible in the Jumla context and were not attempted.

Field workers were supplied with only one antibiotic, oral co-trimoxazole (trimethoprim sulfamethoxazole) in syrup form, which cost less than \$0.50 per treatment course. Although this was several times more expensive than the cost of treating with co-trimoxazole tablets (which at UNIPAC costs would be approximately \$.07 per treatment course), young children were more willing to accept the flavored syrup than the bitter tablets.

Recognizing that antibiotics have to be

swallowed by the child in order to work, the project was willing to accept the extra costs as well as the difficulties of transporting liquids in order to ensure use-effectiveness. Definitive studies on the use and cost-effectiveness of tablets versus syrup have yet to be conducted.

A small plastic bottle just big enough to hold the five day supply of syrup was given to the mother. She was also given an inexpensive, domestically manufactured plastic spoon just big enough to hold one teaspoonful (5 cc), with markings for one half and one quarter this amount visible on the inside; these were the appropriate doses for children over 12 months, 3-11 months, and under 3 months, respectively. Each mother was carefully taught how to feed the syrup to the child, and told the importance of completing the full five days of medicine.

Selection, training and deployment of health workers

Health workers were selected from their communities by local program managers on the basis of community reputation, willingness and ability to walk regularly to all the houses in their service area, and basic literacy skills for record-keeping. Unfortunately, only a few women were able to meet the last two criteria, so most workers were men. It was acceptable in the cultural context of Jumla for these men to meet with and discuss child health issues with mothers, an activity essential for effectiveness.

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The workers received nine days of small group training which included lectures, demonstrations, role play, and observation of actual cases. In addition to learning how to recognize and treat pneumonia and keep basic records, they were taught how to educate mothers about the danger signs of pneumonia and to encourage them to seek care quickly.

All of Jumla's more than 13,000 children under five were covered by this program. Each health worker visited each of the approximately 160 households in his/her area every two weeks to check any child with a cough and cold and to talk to mothers about danger signs of pneumonia. Home treatment with antibiotics was initiated for all children classified as having pneumonia. The health worker followed up on each sick child after two days and at the end of the treatment course.

In the event that a child failed to respond to co-trimoxazole, oral chloramphenicol was available as a second line antibiotic. To avoid confusion on the part of the health workers and the risk of labelling the latter as a "better" medicine, chloramphenicol was handled only by program supervisors. As it turned out, it was only rarely used and did not appear to play an important part in the program.

Phase-in and study period

In order to allow a realistic period to train and deploy 80 health workers and to

develop and put in place adequate management and supervisory systems for an entirely new program intervention, pneumonia case management services were phased in throughout the nearly 200 villages and hamlets of the district over the course of the first year. The study was subsequently continued for an additional two years to determine the impact of the program. During this period the *only* services provided were for pneumonia case management. The formal pneumonia study ended in mid 1989.

Mortality assessment

From the start of the study, a separate data collection system was set up to assess mortality. This impact assessment program carried out complete and detailed registration of each birth and child death in a representative selection of villages comprising nearly two thirds of the district's population.

One person in each village was recruited as an enumerator. He/she was paid a small monthly stipend, with a supplement for each birth and death which was reported. This incentive system assured that few events were missed (less than 1 percent by subsequent survey), and a supervisory verification system prevented false reporting of events which had not actually occurred.

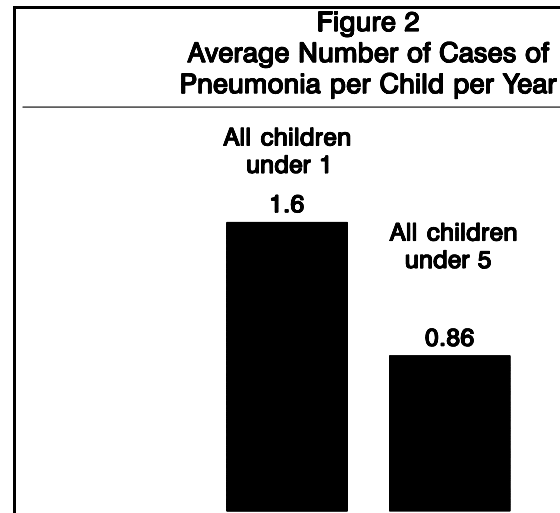
Supervisors for the vital events registration system visited each village monthly. As part of their verification of the events reported to them by the

enumerators, they conducted detailed interviews on each birth and death. Death registration included cause of death determination through a process known as "verbal autopsy," in which parents were interviewed regarding symptoms surrounding the child's death. These symptoms were recorded by the supervisors, and a panel of clinicians subsequently assigned probable cause of death.

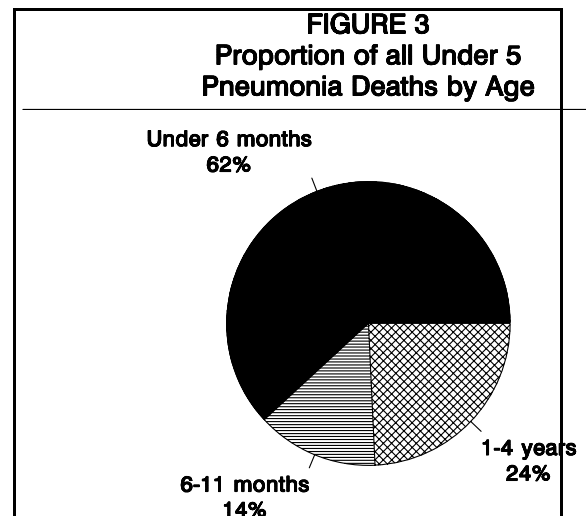
During the three years of the pneumonia study, 2,101 child deaths were documented and cause of death assigned.

Patterns of pneumonia illness and deaths

Based on these classification criteria, pneumonia case rates were found to be very high: each year, there was an average of nearly one case of pneumonia recorded for every child under 5 (Figure 2). The first year of life was a particularly high risk period, with an average of more than one and a half cases recorded per infant per year. This clearly demonstrated the priority of addressing children under one in a pneumonia control program.



The need to focus on infants was borne out by mortality data which showed that pneumonia was the leading cause of death among infants who survived the first week of life. A detailed examination of these deaths showed that these pneumonia deaths especially predominated in the first six months of life (Figure 3).



Starting shortly after six months, the risk

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of pneumonia death declined progressively. Meanwhile, diarrhea deaths increased dramatically starting at the time of weaning, which begins at six months in Jumla. This is no doubt exacerbated by the young children's increased mobility at this age, and their common practice of mouthing the objects lying around in their very unsanitary household environments.

After the first year of life, diarrhea deaths predominated, and pneumonia became a very small part of the mortality of older children. Again, this finding underlined the importance of focusing on the youngest.

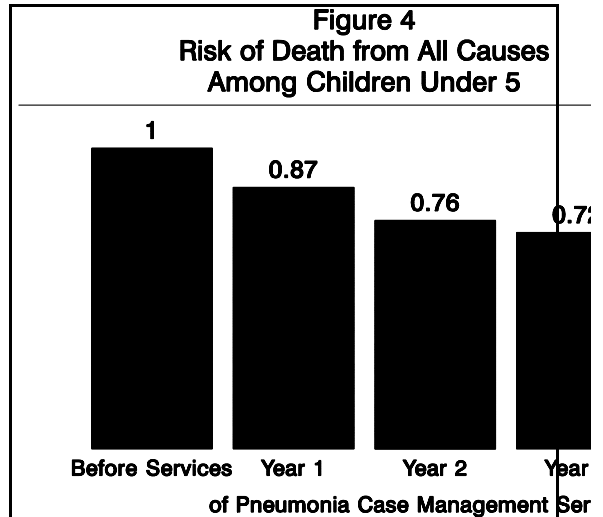
A review of deaths attributed to pneumonia highlighted the acute and critical nature of this illness. Based on mothers' histories, it was found that, on the average, children died within three and a half days of the first signs of pneumonia. During their last day of life, most of these children were so sick that they were unable to eat or drink. Among the very youngest, the course was even more rapid.

The fast deterioration of children with fatal pneumonia reinforced the need for rapid action and underlined the importance of *mothers* recognizing and acting on the first signs of pneumonia. Once this had been identified by program managers as a critical element of effective case management, even more emphasis was given to maternal education as part of routine house visiting. The result was

that the proportion of pneumonia treatments that were started because of mothers actively seeking help (rather than the health worker discovering the case as a result of routine house visits) rose from 15% in the first year to 56% by the third year of the program. Mortality reduction directly reflected this increase.

Impact On Mortality

As the goal of the program was reduction in overall child mortality this, rather than pneumonia-specific mortality, was considered the key outcome. The effect of the pneumonia case management services was progressive and dramatic, reflecting progressive improvements in early case finding and self-referral (Figure 4). *By the third year of services, child deaths were reduced by 28 percent.*



This large decline was analyzed statistically and found to be highly significant. Analysis showed that this change could not be due to any natural decrease in

mortality over time, nor could it be explained by any other changes in health services or the conditions of life in Jumla aside from this program.

Surprisingly, the decline in mortality was observed not only among pneumonia-specific deaths (which dropped by 30%), but in deaths ascribed to numerous other causes, particularly measles and diarrhea. Since no meaningful increase in measles immunization coverage and no significant diarrhea control measures were undertaken during this time, the early treatment of pneumonia (a common end-stage complication of both measles and persistent diarrhea) was the only likely explanation.

Interpretation

It would appear that the pneumonia program's broad impact across several different immediate causes of death was the result not only of lives directly saved by treatment but also of improved health status among the large number of children who received early treatment for pneumonia. It is known that most pneumonia episodes are not directly fatal, even in the absence of antibiotic treatment. However, because each episode is so debilitating, it leaves the child greatly weakened and susceptible to future illnesses of various kinds. Jumla's children, with an average of more than 1 ½ episodes of pneumonia per child in the first year of life, were particularly ravaged by this disease. The added stress of a later episode of pneumonia, diarrhea

or measles was all that was necessary to kill them.

With the establishment of pneumonia services, the picture changed radically. Early case detection and self referral resulted in antibiotic treatment early in the course of the illness for most of Jumla's children. Dramatic improvement was generally seen within one to two days of starting antibiotics.

This program appeared to substantially reduce the overall burden of disease faced by these children. Because they emerged from their illness stronger and healthier than they otherwise would have, they were in far better shape to handle future illnesses of all sorts, and were, therefore, far less susceptible to death from a variety of causes in addition to pneumonia.

In view of this, pneumonia treatment might well be considered part of a strategy to prevent future illnesses, as well as a direct curative strategy.

Implications

Following its publication in the *Lancet* in 1991,⁴ this study has been widely cited as evidence that the pneumonia standard case management approach can be highly effective in reducing mortality in areas with high pneumonia rates.

The study has proven that community health workers are fully capable of carrying out standard pneumonia case

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management, as long as certain programmatic conditions can be met. These conditions include adequate training and supervision (in the case of Jumla's community workers, 9 days of training devoted exclusively to pneumonia, and supervisory visits in the field every two weeks), reliable means to do an objective respiratory count (such as the Jumla Timer or the new UNICEF Timer), and a dependable and timely antibiotic resupply system (since no lives can be saved without medicines). These substantial reductions in deaths can be achieved even in the complete absence of referral facilities and higher level medical staff.

Starting a primary child health care program with pneumonia services turned out to be extremely popular and effective, since people felt immediate and tangible benefits. This reinforced the willingness of community workers to accept and apply the standard case management model. Notably, programs in other settings that have focused on training doctors and nurses have often encountered far more resistance to this approach, as established clinical habits have had to be un-learned.

The cost of this program was not high. In Jumla (where treatment rates and antibiotic needs were greater than would be found in most other places) the average cost per child covered was less than \$4 per year. This cost included salaries for all the community workers, who were paid on a part-time basis, as

well as supervisory and management costs; it did not, of course, include the costs associated with the research aspect of the program.

VITAMIN A SUPPLEMENTATION

Once the research portion of the pneumonia program was completed in 1989, research attention shifted to other complementary and potentially important sources of child mortality reduction. Periodic mass vitamin A supplementation appeared promising for a variety of reasons.

Research published in 1986⁵ indicated that mass vitamin A supplementation with inexpensive capsules might have a major direct benefit on reducing childhood deaths in developing countries. By 1989 no additional studies had yet been completed which might confirm or refute this staggering premise, and considerable controversy raged in the scientific community about whether a "magic bullet" in the child survival effort had been discovered.

Regardless of its general mortality impact, benefits of vitamin A in preventing childhood blindness due to xerophthalmia (a devastating deterioration of the eye due to vitamin A deficiency) had been long established. Among the more than 2,000 deaths reviewed in the Jumla pneumonia trial, eye signs suggestive of severe xerophthalmia had often been reported.

This suggested that vitamin A deficiency was widespread among these children. This premise was borne out by a survey conducted at the end of the pneumonia trial which found that more than 13 percent of Jumla's children suffered from xerophthalmia -- six times the level considered by the World Health Organization to indicate a vitamin A deficiency problem of public health proportions.

Since the benefit of vitamin A supplementation on this degree of xerophthalmia was well-established, it was appropriate to proceed with a widescale supplementation program among the children of Jumla even without the potential for mortality reduction. The existing vital events reporting system made it feasible to assess any mortality effects with little additional effort.

Supplementation program

All children under five throughout Jumla district were targeted to receive high-dose vitamin A capsules. Above 12 months of age, the standard dose was one whole capsule (200,000 IU). Because extraordinarily high rates of xerophthalmia had been found even among children under a year old, all infants were also supplemented. The dosage used was one half capsule for children between 6 and 12 months of age, and one quarter capsule for those under 6 months of age. These smaller doses were administered by snipping the end off a

capsule and administering a proportional number of drops.

Under circumstances of mild levels of xerophthalmia in a population, supplementation every six months is generally recommended. In severe deficiency areas such as Jumla, supplementation every four months is considered more appropriate,⁶ so this more frequent schedule was adopted.

Program management

Pneumonia program supervisors were taught to administer vitamin A. To avoid confusion and the likelihood of missed or multiple dosing, a village-by-village mass campaign was instituted. The community health workers assisted in assembling all children in a village to be dosed on the same day, and all the villages to be covered in each round received vitamin A capsules over a period of less than two weeks.

This approach was considerably simpler than relying on child registers to target each individual child. As a result, nearly all of Jumla's children were able to receive vitamin A over a short period. This approach also simplified the management tasks of storage and distribution of vitamin A capsules to health workers.

During the four month interval between campaigns, the capsules were not made available to health workers so there would be no possibility of accidental overdosing, which could potentially

result in toxicity.

Phase-in and study period

The pneumonia case management program had required more than a year to phase in throughout Jumla district. The vitamin A program was considerably simpler, and the phase-in was planned to be completed throughout the district by the second round of supplementation, i.e. within less than six months.

The first round, during which only part of the district could be fully covered, was used to allow a comparison of communities with and without supplementation for this initial period. Based on data available from the three prior years of vital events collection, communities which received supplementation in the initial round were matched with similar villages in which earlier child mortality had been nearly identical. This allowed a valid comparison of mortality in supplemented and unsupplemented children.

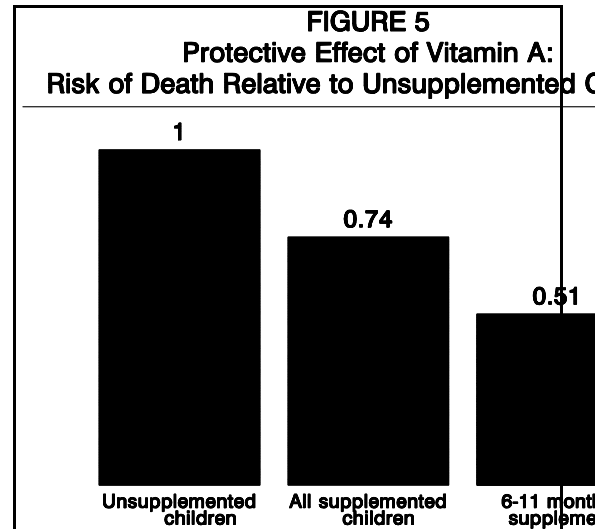
Mortality assessment

Vital events registration and cause-of-death determination took place exactly as during the pneumonia study. Only the initial five month comparison period was used in assessing the mortality effect of vitamin A supplementation, since this was the only period during which there was a matched control.

Impact On Mortality

Mortality in villages which had received supplementation was 26 percent lower than in the villages which had not yet received vitamin A.

Even though this study only assessed the effects of only one single dose of vitamin A over a relatively short period, Jumla's high underlying child mortality rates allowed this dramatic impact to be observed. The reduction was statistically significant and could only be explained by the vitamin A.



The effect was greatest in children between 6 and 12 months, where the risk of death was cut nearly in half, but was also apparent in all older age groups (Figure 5). Infants under 6 months of age did not appear to benefit from the supplementation, but there was also no indication that these children suffered any substantial problems or compli-

cations from receiving vitamin A.

By cause of death, the greatest benefit of vitamin A appeared to be among children dying from diarrhea, where a one third reduction was observed. The risk of pneumonia death showed a much smaller decrease. However, the number of pneumonia deaths was relatively small in the age groups most affected by vitamin A (children between 6 months and 5 years old), and so it was not possible to determine whether this reduction was due to supplementation or simply to chance variation.

Implications

The benefit of vitamin A supplementation for child survival among the children of Jumla was unmistakable. Following the five month comparison period, which was analyzed and published in the *British Medical Journal*,⁷ similar dramatic improvements in survival were noted for the entire child population of Jumla, and the government has assured continuation of the program.

Based on this study and several others published since 1989, it is now clear that vitamin A supplementation can have a tremendous effect on reducing child mortality in areas where vitamin A-rich foods are not part of an early childhood diet. Discussion continues as to whether improvement in vitamin A status is best and most sustainably achieved by changes in diet or by capsule distribution.

In Jumla, changing the foods which are grown and given to young children is likely to require many years of intensive and costly educational input because of strong underlying cultural beliefs concerning child feeding. Four years of experience to date has shown that capsule distribution on a periodic mass campaign basis can be programmatically sustained within the managerial resources of a community health program.

Furthermore, the total programmatic costs of this effort, at less than \$0.20 per dose, have proven to be affordable. The dramatic impact on mortality in Jumla resulted in an estimated cost of less than \$11 for every life saved, which makes vitamin A capsule supplementation in this setting one of the most cost-effective child survival strategies ever documented.

VITAMIN A AND PNEUMONIA CASE RATES

While a number of studies confirming the life-saving benefits of vitamin A have now been completed and published, few of these have been designed to look also at the effect, if any, on the likelihood of developing pneumonia.

Concerns have even been raised that vitamin A might have some sort of adverse risk on pneumonia, since pneumonia deaths have not shown the type of strong reduction seen in overall mortality and in diarrhea deaths.

The Jumla study offered a rare opportunity to assess whether vitamin A supplementation might have an effect on a child's likelihood of developing pneumonia. Since pneumonia had been the focus of the original research, a considerable baseline was available for comparison purposes. Since pneumonia case detection and treatment continued throughout the vitamin A supplementation program, changes in the likelihood of illness could be assessed.

Morbidity assessment

This analysis was based on the same comparison period as the vitamin A mortality study, and compared the difference in risk of pneumonia illness between children in supplemented and unsupplemented communities. As part of routine program management, the pneumonia control program had collected bi-weekly data by village on the number of pneumonia cases which had been detected and treated. Given the continued high coverage of the pneumonia program, this provided an excellent approximation for the actual number of pneumonia cases which were occurring in these villages.

Since the communities which received the initial round of vitamin A capsules had been matched with control communities on the basis of prior mortality rather than pneumonia case rates, this assessment was carried out both on a side-by-side comparison basis and with adjustments

for any pre-existing differences in morbidity which might be found.

Impact On Pneumonia Morbidity

The communities which received early dosing with vitamin A capsules showed a 33% lower rate of pneumonia cases.

This reduction mirrored the reduction which had been observed in total child mortality. Not only were fewer children dying, fewer were getting sick enough with pneumonia to require antibiotic treatment. Even taking differences in baseline into consideration, the reduction was highly statistically significant and could not be explained by any factor other than the vitamin A supplementation.

Implications

In a population of children with high rates of pneumonia, high mortality, and considerable levels of vitamin A deficiency, it appears from this study that vitamin A supplementation has a direct protective effect on the likelihood of developing pneumonia. As a result, the demand on pneumonia standard case management services and the need for antibiotics may be reduced.

This is the first finding of this effect to be reported⁸ and indicates that vitamin A may be a useful preventive strategy among similar groups. Given vitamin A's proven benefits on overall child survival, this study makes it even more clear that it

has an important place in most community health programs.

AFTERWORD

Following the end of the research period described in this paper, the remarkable mortality reductions described here were sustained and were further augmented by a set of complementary services directed at the early detection and treatment of childhood diarrheas and the promotion and support of the government's immunization services.

This phased approach to the development of primary health services has proven itself to be both effective and manageable. Despite the wider range of services which they now deliver, Jumla's community health workers have not been overwhelmed by their responsibilities. In fact, they have taken the lead in requesting training to carry out new services, in response to requests from their villages.

Because the very first services which they provided, pneumonia case management, gave such tangible and rapid results, the community workers gained substantial credibility and authority in the villages. This is in marked contrast to programs in which field workers focus initially on health education and prevention -- even though these may in fact offer considerable potential long-term benefits -- but where their efforts are ignored or

rejected by communities who want action rather than talk. This is a clear example of the necessity to understand the perceived needs of the population to be served as well as their particular public health situation.

The credibility that Jumla's workers gained through pneumonia case management made it possible for them to gain ready acceptance for vitamin A supplementation. Later it made it far easier to introduce oral rehydration, which in many other programs is not readily accepted by families because it is not viewed as a medicine and because it does not cure the most apparent symptoms of diarrhea. Workers have to be believed in order to be effective educators.

The rapid and sustained decrease in child mortality achieved in Jumla has resulted in a broad popular awareness, increasingly expressed in community meetings, that large family size is no longer necessary or desirable. By the fifth year of the program, mothers and community leaders had begun to request assistance in family planning. Based on these requests, efforts have been undertaken to incorporate these services into Jumla's community health programs provided by the government.

As these effects have been accomplished by local villagers working with community-

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based structures and local indigenous organizations, there have been deeply felt changes in empowerment on the part of villagers, particularly women, and a recognition that positive changes are possible, even within the continued severe economic constraints of Jumla.

The approach which was carried out in Jumla is fully appropriate for non-governmental organizations and for well-managed governmental programs throughout the developing world which take a community-based approach. At a total programmatic cost of less than \$1 per capita per year, it would appear that this model is both appropriate and sustainable, given minimal levels of external or locally generated financial support.

The children of Jumla have benefitted tremendously from these services, and in turn have taught us a great deal about the realities of primary health care. These lessons have broad applicability for underserved populations throughout the world.

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