9 Decentralized Supervision of Community Health Programs: Using LQAS in Two Districts of Southern Nepal

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Using modern tools of statistical quality control, simple field epidemiology can both motivate and lead community health efforts to achieve higher coverage of essential services. Even basic health workers can measure their accomplishments, which motivates all involved to strive toward agreed-upon goals. This effort at the community level reflects global efforts such as the goals of the World Summit for Children, which are measurable and drive action at all levels. The importance of repeated measurement at the local level is well illustrated in this chapter.

INTRODUCTION: DECENTRALIZING HEALTH SYSTEM MONITORING

Community-oriented approaches to organize health programs have been advocated for more than 75 years (Taylor-Ide and Taylor 2002). In the 1980s and 90s, national and international health and development agencies increasingly promoted decentralized service delivery and health systems management, emphasizing bottom-up, community-oriented methods. Several examples of successful community health programs are documented (Wyon and Gordon 1971, Villegas 1978, Rohde et al. 1993, Arole and Arole 1994, Taylor-Ide and Taylor 1995). While the methods used for bottom-up management are not described in detail, it is clear from those published examples that the programs used data about program progress to show management how to improve effectiveness. Planning and program design also require data to ensure effectiveness. John Wyon and other community-oriented primary health practitioners argue that community health workers ought to use epidemiological information to focus local health programs on the most frequent, serious, and preventable causes of death and illness (see the introduction to this book, and Taylor-Ide and Taylor 2002). In their book, Daniel Taylor-Ide and Carl Taylor list seven steps in a community-oriented approach, of which steps 2–5 and 7 involve data collection and analysis:

1. Create coordinating committees and improve their capacity.
2. Identify successes.
3. Study successes and visit other communities.
4. Conduct self-evaluation.

5. Make decisions based on agreed-upon problem areas and priorities.
6. Involve as many people as possible in decision-making.
7. Monitor the momentum to identify gaps in action and to make midcourse corrections.

This chapter demonstrates a simple community data-gathering method, which local supervisors used in two districts of the Terai of Nepal (south of Kathmandu) to increase the impact of their health programs. This method, Lot Quality Assurance Sampling (LQAS), represents a practical alternative to cluster surveys (Henderson and Sundaresan 1982), a widely used method, to obtain objective information about community outcomes.

What LQAS Is and How It Works

During the mid-1980s, health system evaluators explored the applications of industrial quality control methods to assess health worker performance (Stroh 1985, Valadez 1986, Reinke 1988). LQAS received considerable attention as a potentially practical and easy-to-use method for assessing local health systems in developing-world settings. LQAS was originally developed in the 1920s to control the quality of industrially produced goods (Dodge and Romig 1944). The principle is that a line supervisor takes a small random sample of a recently manufactured lot of goods from a production unit such as an assembly line or machine. If the number of defective goods in the sample exceeds a predetermined number, then the lot is rejected; otherwise it is accepted. This allowable number is called the *decision rule.* The number of allowable defective goods is determined statistically (Dodge and Romig 1944, Lwanga and Lemeshow 1991, Valadez 1991) based on a production standard and a statistically determined sample size. The sample size is set so that a manager has a high probability of accepting lots in which a predetermined proportion of the goods are of high quality, and a high probability of rejecting lots that fail to reach the production standard.

In health systems, an example of a *production standard* is a predetermined population coverage benchmark for an intervention such as immunization, communications about how to prepare and use oral rehydration solution, the quality of deliveries performed by a medically trained provider, or promotion of contraceptive use. Health system managers at either the national or district level can set such coverage benchmarks or targets.

In health systems, a *lot* can be the defined community or catchment area of a health facility or of a health worker. In this chapter, the lot used in the demonstration is a *supervision area* (SA). The *production unit* is the set of health workers working under the supervisor who manages the SA. In this setting, the purpose of using LQAS is to determine whether a specific SA reaches a predetermined coverage benchmark and to compare the performance of different SAs.

LQAS judgments about supervision areas have a percentage of error, namely, the probability of misclassifying an SA as either having achieved the benchmark or not having achieved it. In standard statistical nomenclature, they correspond to alpha (α) and beta (β) errors. The α error is the likelihood of rejecting a sample incorrectly-in this case, of falsely determining that the desired level of performance had *not* been met when it reality it had. The β error is the likelihood of accepting an SA as performing adequately when it falls short of the expected performance. These errors correspond to the specificity and sensitivity of the procedure.[1]

To use LQAS, health system managers need to identify two thresholds. The first is the *coverage benchmark*, which is the proportion of the community that health workers ought to reach during a predetermined period, such as one year. The coverage benchmark should

1. The α error is a *health system risk*, since the health program would invest unnecessarily to improve the performance of health workers in supervision areas that have actually reached a coverage benchmark. In epidemiological terms, $1-\alpha$ is equivalent to *specificity*, which is the probability of correctly identifying SAs that reach performance benchmarks. The β error is community risk, since beneficiaries would receive health services that leave unacceptably large portions of the population uncovered. In epidemiological terms, $1-\beta$ is equivalent to *sensitivity*, which is the probability of correctly identifying supervision areas that cover an unacceptably low proportion of the population. In traditional industrial terms, *health system risk* and *community risk* are *producer risk* and *consumer risk* (Dodge and Romig 1944).

increase over time as the program progresses and service delivery improves. In public health terms, a threshold can be an *annual coverage target.* The lower threshold is an unacceptably low level of coverage that should provoke managers to identify the problem causing the failed service delivery and to resolve it with a focused investment of time and resources.

Two characteristics have made LQAS attractive to health system evaluators. First, a supervisor needs only a small sample to judge whether a health worker's performance has reached a predetermined level (threshold). With such small samples, data collection does not seriously compete for time for providing health services. Second, the sampling procedures and analyses are rather simple. Because LQAS was originally intended for use by factory supervisors, these procedures could be carried out by a minimally educated person. Managers of international health workers are typically more educated than the line supervisor of yesteryear. Yet this benefit is still welcome to overworked supervisors and health workers, who need management tools that can easily be understood in their own cultural context and are easy to use. These two characteristics in particular make LQAS valuable as a practical management tool for monitoring and evaluation of community health services that seek to include community members in management.

Another attractive feature of LQAS is that the data from individual SAs can be combined into an estimate of a coverage proportion for an entire program area that includes multiple SAs. Weighting the result from each SA by the size of its population and taking the mean of the program area can increase the accuracy of the estimate,[2] particularly in comparison to estimates obtained with the 30-cluster sampling approach. [3]

2. Weighting increases precision by a small amount and is not necessary for most applications, because the precision gained typically does not have programmatic implications. See Valadez 1998 for examples.
3. This coverage estimate usually has greater precision than the one obtained with the 30-cluster method (Henderson and Sundaresan 1982), the other commonly used sampling method, because stratified random (or systematic) samples generally have narrower confidence intervals than cluster samples

The growing interest in using LQAS was captured in a review of 34 LQAS applications assessing immunization coverage, antenatal care, use of oral rehydration therapy, growth monitoring, family planning, disease incidence, and the technical skills and knowledge of health workers (Robertson et al. 1997). It has also been used to assess the accuracy of health records, outreach of community health workers, and health worker training programs (Valadez 1991, Valadez et al. 1996, Valadez et al. 1997). In Nicaragua, Malawi, and Armenia, networks of NGOs have used LQAS to track national disaster relief and reproductive health programs (Valadez et al. 2001a, 2001b, 2001c). This chapter focuses on using LQAS to assess coverage of SAs with integrated health services in a maternal and child health project in rural Nepal.

This chapter attempts to advance the development of LQAS methodology for community-based public health practitioners and health system managers by:

- Presenting a simplified, field-tested LQAS table that community-based public health practitioners can use in any field setting;
- Explaining a case application of LQAS used by local supervisors rather than specialized interviewers;
- Showing how LQAS can be applied for regular supervision or monitoring;
- Summarizing LQAS results collected at four time points to monitor a community-based NGO program in Nepal for maternal and newborn care, child survival, and family planning interventions;
- Presenting a cost analysis of LQAS compared to cluster sampling;
- Discussing the utility of this system to practitioners.

(Note 3, cont.) of the same size. As others have pointed out, "stratified samples often have narrower confidence intervals than simple random samples. This is because some subjects are selected from each and every strata [sic], making it impossible to miss some strata completely" (Robertson et al. 1997, 201). In operational terms, the strata are the SAs. Also, LQAS does not have a design effect, which for cluster samples is usually assumed to be two, due to the intra-cluster correlation resulting from choosing contiguous households within clusters (Henderson and Sundaresan 1982).

Program Area: Tautahat and Bara Districts, Nepal

The program area, in the Rautahat and Bara districts, is contiguous with districts in Nepal's Narayani Zone of the Central Development Region in the Terai, south of Kathmandu. The districts border India to the south and include communities of 33 Village Development Committees (VDCs) in Rautahat District and 17 VDCs in Bara District. The VDC is the basic unit of community organization. One VDC contains nine communities or wards. The total beneficiary population in the program area is 140,021 people, including 52,896 women of childbearing age, 39,557 children under five years of age, and an estimated 47,568 newborns expected during a four-year cycle of the program.

The health program is supported by Plan International's field office for the Rautahat and Bara Districts of Nepal. Plan International is a child-focused international NGO working in more than 40 nations. It will continue supporting the health program beyond four years because it has long-term commitments to the communities with which it works.

During 1996, the national under-five mortality in Nepal was 118 per 1,000 live births, with an infant mortality rate of 79 per 1,000 live births. Mortality was consistently higher in rural areas. The maternal mortality rate in Nepal was 539 per 100,000 live births (Pradhan et al. 1996). Only 10% of births are attended by medically trained personnel (World Summit for Children indicator, Nepal 1996).

According to Plan International's 1995-96 situational analysis, the under-five mortality rate in the program area was identical to the rate determined by the national Demographic & Health Survey. Among the leading causes of child death listed by the Ministry of Health (MOH) and cross-validated with local clinic records were diarrhea, pneumonia, perinatal causes, malnutrition, and measles. Plan International worked with all 50 VDCs to identify local health priorities. VDCs, district MOH managers, and local Plan International health system managers selected four interventions to implement in the two selected districts: diarrhea case management, pneumonia case management, family planning, and maternal and newborn care. They also agreed to support the MOH to enhance Expanded Programme on Immunization (EPI) and vitamin A coverage.

Program Management

The program supported services at both MOH health care facilities and the community level by improving supervision, case management, monitoring, drug supply, and community mobilization. This chapter focuses exclusively on the community-level activities. The program area consists of 50 VDCs, each one comprising 9 wards or communities, for a total of 450. Each VDC has one MOH health facility. Each facility has one village health worker (VHW), who is supervised by a senior manager (Health Post In-Charge). Each VHW supervises nine female community health volunteers (FCHVs) and trained traditional birth attendants (TBAs). Supervision of VHWs at the community level had been weak due to lack of transport, incentives, and management systems. Plan International's program was designed to improve community-level supervision and management.

The program area was organized into seven SAs, each one managed by a Plan International field area supervisor (FAS). Each FAS has experience working in the MOH community health system and is qualified as a nurse, midwife, or health assistant. These supervisors work with the MOH district health officer to train VHWs; then they aid the VHWs to train and supervise FCHVs and TBAs. Each FAS trains and supports 7 to 8 VHWs, each of whom is in turn responsible for 9 FCHVs. Therefore, on average, each FAS has at least 63 FCHVs and additional TBAs in his/her supervision area.

FASs train VHWs in management, leadership, and supervision skills, and update VHWs' clinical skills for each intervention. FASs are trained to use a simple supervision checklist to observe FCHVs and TBAs. These checklists determine whether the FCHVs and TBAs are implementing planned interventions, have basic equipment and supplies, and use focus groups to assess community satisfaction. Each FAS aids the VHWs to carry out joint supervision visits two to three times a month to FCHVs as a part of competency-based training.

The program began service delivery in 1997. Plan International introduced LQAS in 1999 for routine community-based monitoring by FASs of mothers, children 0–23 months of age, and women 15–49 years of age to determine whether they received health services and information. All FASs said they would benefit from such empirical information if data collection were not time consuming and results could be rapidly interpreted and used for supervising FCHVs and TBAs.

METHODS: IMPLEMENTING DECENTRALIZED SUPERVISION

This section summarizes the methods used for setting sample sizes, training, questionnaire development, sampling procedures, and coverage benchmarks. FASs collected LQAS data four times at six-month intervals from June 1999 to January 2001. The FASs and the manager chose this six-month sampling interval. The program regularly measured indicators to monitor knowledge and behavior related to diarrhea case management, pneumonia case management, maternal and newborn care, family planning, and EPI. A few of the results from these observations are reported here. Our purpose is to show how LQAS was used and the type of information it provides, rather than to report the program outcomes.

Sample Sizes and LQAS Tables

A sample size of 19 households was selected for this assessment, allowing specificity and sensitivity of greater than 90% (<10% error). While smaller sample sizes exist for which α and β errors are also <10% for some coverage benchmarks (e.g., samples ranging from 10 to 18), we do not recommend these smaller sample sizes, despite the improved feasibility of such smaller samples. If an initial rather low coverage benchmark is selected that allows a small sample size (e.g., 40% coverage and n=15, with a decision rule of 8 correct responses) and the coverage benchmark is subsequently changed, requiring a larger sample and a different decision rule (e.g., 65% and n=17 with a decision rule of 11), the data collector would have to return to the SA to collect the additional data from the larger sample. By selecting a sample of 19, the manager can change coverage benchmarks later without having to collect additional data. In practice, supervisors assess several interventions simultaneously with different coverage benchmarks. Using a standard sample size of 19 yields sufficient data to make judgments about all interventions, regardless of their coverage benchmarks. For interventions intended for narrow age groups (e.g., exclusive breastfeeding assesses the 0–5-month age cohort) or for individuals with specific characteristics (e.g., use of oral rehydration therapy for children who have had diarrhea in the last two weeks), LQAS judgments are made with sample sizes other than 19 (see Valadez et al. 2001b).

In practice, FASs have been most interested in identifying SAs that reach a coverage benchmark and those that deviate from it substantially. Table 1 is the basic LQAS tool used for making this judgment. Supervisors have been less interested in lower thresholds and have been satisfied with Table 1's display, which has coverage benchmarks only. This simple format has aided supervisors to select decision rules for a variety of sample sizes and a wide range of coverage benchmarks. In practice, Table 1 has been the most useful LQAS tool for field settings and requires a minimal amount of technical knowledge to use. This table was introduced in Nepal during 2000 and was successfully field-tested in other locations (Valadez et al. 2001c, Valadez et al. 2001c).

In addition to reducing the LQAS decision rules to a single page, Table 1 has another important attribute. While previous tables required counting the number of interviewees who did not receive an intervention, Table 1 embraces the opposite logic, because it requires counting the number who received it. Field staff frequently said that they were used to counting positives for numerators (for example, number of children vaccinated) and that counting negatives was confusing.

A supervisor uses Table 1 by following three steps:

1. Identify the coverage benchmark for an indicator from the top row. However, if the table is used to determine whether an SA is below average, then the average coverage, instead of the coverage benchmark, is located along the top row.
2. Identify the sample size in column 1. In most cases, the sample size is 19.
3. Find the cell where the sample size and the coverage benchmark intersect. That is the decision rule. For example, the decision rule for a coverage benchmark of 80% and a sample size of 19 is 13. A supervisor judges SAs as having reached the benchmark if at least 13 of 19 have the behavior or knowledge stipulated in the indicator.

TABLE I

Optimal LQAS Decision Rules for Sample Sizes of 12–30 and Coverage Benchmarks or Average Coverage of 20–95%

Sample Size	Annual Coverage Benchmarks (for Monitoring and Evaluation) or Average Coverage (Baselines, Monitoring, and Evaluation)																	
	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
12	*na*	*na*	1	1	2	2	3	4	5	5	6	7	7	8	8	9	10	11
13	*na*	*na*	1	1	2	3	3	4	5	6	6	7	8	8	9	10	11	11
14	*na*	*na*	1	1	2	3	4	4	5	6	7	8	8	9	10	11	11	12
15	*na*	*na*	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13
16	*na*	*na*	1	2	2	3	4	5	6	7	8	9	9	10	11	12	13	14
17	*na*	*na*	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	*na*	*na*	1	2	2	3	5	6	7	8	9	10	11	11	12	13	14	16
19	*na*	*na*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20	*na*	*na*	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
21	*na*	*na*	1	2	3	4	5	6	8	9	10	11	12	13	14	16	17	18
22	*na*	*na*	1	2	3	4	5	7	8	9	10	12	13	14	15	16	18	19
23	*na*	*na*	1	2	3	4	6	7	8	10	11	12	13	14	16	17	18	20
24	*na*	*na*	1	2	3	4	6	7	9	10	11	13	14	15	16	18	19	21
25	*na*	1	2	2	4	5	6	8	9	10	12	13	14	16	17	18	20	21
26	*na*	1	2	3	4	5	6	8	9	11	12	14	15	16	18	19	21	22
27	*na*	1	2	3	4	5	7	8	10	11	13	14	15	17	18	20	21	23
28	*na*	1	2	3	4	5	7	8	10	12	13	15	16	18	19	21	22	24
29	*na*	1	2	3	4	5	7	9	10	12	13	15	17	18	20	21	23	25
30	*na*	1	2	3	4	5	7	9	11	12	14	16	17	19	20	22	24	26

na: not applicable, meaning LQAS cannot be used in this assessment because the coverage is either too low or too high to assess an SA.
Notes: α and β errors < 10% for all decision rules except where noted. Lightly shaded cells indicate where α or β errors are ≥10%.
Darker cells indicate where α or β errors are ≤15%.

Training and Questionnaire Development

The authors trained the seven FASs and additional support staff to use LQAS to survey 19 households in the VDCs where they supervise FCHVs and TBAs. The manager trained everyone working in the program, including the secretary, accountant, and others, to heighten their involvement. This decision is consistent with the principle of involving as many people as possible in decision-making (Taylor-Ide and Taylor 2002, step 6). Training was carried out over three days, during which time the team reviewed and refined the survey questionnaire and learned LQAS principles, sampling procedures, and how to interpret results. Each FAS or staff person visited 9.5 households on average.

Parallel Sampling and Questionnaire Development

Three short questionnaires were developed, corresponding to the three client groups the program served: women 15–49 years, mothers of children 0–11 months, and mothers of children 12–23 months. Women 15–49 years were sampled to assess their use of family planning methods and to calculate the contraceptive prevalence rate. Mothers of children 0–11 months were selected to assess their knowledge of pneumonia management and maternal and newborn care, including exclusive breastfeeding. Mothers of children 12–23 months were visited to assess EPI and vitamin A coverage, continuing breastfeeding, and DCM knowledge. Exclusive, complementary, and continuing breastfeeding were assessed with the subsamples of children 0–5 months, 6–9 months, and 12-23 months, respectively. Management of diarrhea was assessed using the stratum of mothers of children 0–23 months whose children had had diarrhea in the last 2 weeks. The only questions duplicated in the surveys were related to management of diarrhea, because children were needed who had had diarrhea in the previous two weeks; by including related questions in the surveys for both mothers of children 0–11 and 12–23 months, sufficient observations were available to measure diarrhea prevalence.

Data were collected using a standard two-stage sampling procedure. In the first stage, 19 wards in each supervision area were sampled in proportion to their size. First, a sampling frame was constructed for each supervision area with VDC and ward names located in column one, with population sizes for each ward in column two, and a running cumulative summary of the population in column three. Second, a sampling fraction was created by dividing the total supervision area population by the LQAS sample size of 19. Third, a random number between 1 and the sampling fraction was selected. The ward having the corresponding person in the cumulative population column of the sampling frame was selected as the first sampling element. The next ward was identified by adding the sampling fraction to the first randomly selected number. All remaining sampling elements were selected by continuing to add the sampling fraction to the preceding sum. The program manager performed all the steps in the first-stage sampling.

In the second stage, households were selected in the identified wards. The FAS and trained support staff visited the sampled wards in their SA and located its geographical center. The FAS divided the ward into three to five segments and chose one randomly, using a random number table. The FAS then went to that segment and divided it into three to five additional segments, choosing one randomly. He or she continued this process until a small number of houses remained—usually fewer than 15. One house was then selected randomly. For the second-stage sample, some supervisors preferred to use the spin-the-bottle method applied in the EPI cluster sample method (Henderson and Sundaresan 1982, World Health Organization 1996).

Once a single house was selected randomly, the interviewer inquired whether a nonpregnant woman 15–49 years of age and in union lived there. If so, she was asked for her consent to respond to the family planning questionnaire. If a woman in the household had a child of either 0–11 months or 12–23 months, she was invited to answer questions in the corresponding questionnaire. Two children, one from either cohort, were never selected from the same household, since the questions about diarrhea case management required analyzing children 0–23 months. All children for this analysis, therefore, had to reside in different households. Otherwise, the diarrhea management practices of a single household would be overrepresented. Therefore, the minimum number of households that an interviewer visited to carry out a survey in any ward was two; the maximum was three. The use of one random point to start a search for households for each of the three questionnaires independently we call *parallel sampling.*

The questionnaires required little time to complete. The family planning questionnaire took 5 minutes, the one for mothers of children 0–11 months took 15 minutes, and that for mothers of children 12–23 months took 10 minutes. Similarly, the search for appropriate households required little time. A woman aged 15–49 years nearly always lived in the first house. One child in either age group could also be located rapidly. The sampling took place during the Nepali monsoon, which exacerbated travel problems. Nevertheless, the total time spent in a ward was about one hour. The entire sample of 399 observations (7 SAs x 3 questionnaires x 19 observations) or 133 sets of 3 questionnaires was collected in 2.5 days. Staff said that because community residents knew them, the women did not resist answering questions. Sampling carried out in an area with dispersed rural populations (Valadez et al. 2001b) or underdeveloped roads to remote areas can take longer to complete (Valadez et al. 2001c).

During June 2000, the FASs used a different approach for data collection. Rather than organizing data collection over an intensive 2.5 days, they decided to collect monitoring data while carrying out their normal work in communities. Therefore, at the beginning of the month they identified the communities to be sampled. They selected houses to interview after they finished other duties in the community, such as providing supplies or competency-based training to the community health workers. While the data collection period extended to as much as 19 days, the evaluation cost less, because the FASs were already scheduled to travel to SAs for supervision. The FASs preferred this approach and continued to use it for subsequent monitoring.

Coverage Benchmarks and Decision Rules

Supervisors assessed the interventions with coverage benchmarks they set, based on the 1997 baseline survey collected with a standard cluster sample method. All FASs used the same benchmarks for a given intervention to permit comparison of SAs. Initial coverage benchmarks and corresponding decision rules for each intervention are recorded in the upper rows of Tables 2 and 3. Only a selection of the indicators is presented here to show how the supervision system works.

RESULTS: HOW DATA WERE USED FOR DECISION-MAKING

Selected results are presented in the four parts of this section to demonstrate how the Nepal team used the new LQAS tools. The first part shows how at one point in time, FASs judged each SA according to a coverage benchmark. The second section presents LQAS results at four points in time to show development trends in the project area. The third section aggregates data from the LQA samples in seven FASs to calculate coverage proportions for the entire program area at four points in time. The fourth one is a cost analysis of LQAS. All LQAS analyses carried out by FASs used hand-tabulated tally sheets to aggregate the questionnaire data. Project managers cross-checked FASs with tables calculated with EpiInfo 6.04. However, computer-generated results were less useful for immediate decision-making than the hand-tabulated results, which were immediately used for decision making.

All practices, except exclusive, complementary, and continuing breastfeeding, and diarrhea case management, were assessed in each SA using samples of 19. Because exclusive, complementary, and continuing breastfeeding assessments used small subsamples of children, LQAS judgments were not made, since α and β were unacceptably high. Rather, the data were analyzed only in the aggregated form as coverage proportions. For assessment of the behavior of mothers whose children 0–23 months had had diarrhea in the preceding two weeks, subsample sizes varied from 12 to 18. LQAS decision rules for these sample sizes were taken from Table 1.

Assessing Supervision Areas at One Point in Time: A Supervisor's Perspective

Table 2 contains the results for six indicators for maternal and newborn care, diarrhea case management, and family planning. Additional indicators were used to review these services (see Child Survival Technical Support Project and CORE Monitoring and Evaluation Working Group 1999, and Valadez 2000 for a full set of indicators). However,

TABLE 2

LQAS Judgments for Selected Community Interventions

	Behavior			Knowledge			
	MNC Children 0–11 Mos.	*DCM Children 12–23 Mos.*	*FP Women 15–49 Yrs.*	*MNC Children 0–11 Mos.*	*MNC Children 0–11 Mos.*	*DCM Children 12–23 Mos.*	
	Assisted delivery with trained TBA or clinician	*Correctly prepares ORS*	*Contraceptive use*	*Pregnancy danger signs*	*Postnatal danger signs*	*Dehydration danger signs*	
Baseline results	*Not included in baseline survey*	*Not included in baseline survey*	20.7% §	30.7%	*Not included in baseline survey*	12.7%	
Coverage Benchmark: Decision Rule	*na*	*na*	30%: 3	45%:6	*na*	35%: 4	
Avg. Coverage: Decision Rule	43.6%:6	52.7%:8	34.5%:4	51.3%:8	41.8%:6	48%:7	
Supervision Area							*Total No. of Indicators Not Reaching Coverage Benchmarks or Below Avg.*
1	7	7*	5	9	5*	6*	3
2	9	7*	3*	8	8	5*	3
3	2*	12	4	(5*)	5*	12	3
4	13	9	(2*)	(5*)	2*	9	3
5	4*	11	4	15	13	14	1
6	15	16	13	16	16	15	0
7	5*	8	7	6*	3*	4*	4
Total Below Avg. or or Substandard FASs	3	2	2	3	4	3	17

Notes: MNC=maternal and newborn care; DCM=diarrhea case management; FP=family planning; ORS=oral rehydration solution.

§ A cluster sample was used for the baseline survey, which sampled mothers of children 0–23 months of age for all indicators. Therefore, contraceptive use as calculated at baseline is not an accurate measure, since the 14–49-year cohort of women is required.

◯ indicates an SA that has not reached a benchmark. * indicates an SA with below average coverage.

only six are presented to demonstrate how the LQAS method was used in Nepal.

An SA is judged according to whether it has reached the coverage benchmark and whether it has achieved at least average coverage. SAs not reaching a benchmark are circled. Those below average are marked with an asterisk. SAs having both a circle and an asterisk have the highest priority for improvement. Those marked with either a circle or an asterisk (but not both) are the next highest priority.

The first indicator discussed is *knowledge of pregnancy danger signs,* found in column 5 of Table 2. The baseline measure of September 1997 revealed that 30.7% of respondents knew two or more danger signs. The program members planned to increase the proportion to 45% by June 1999. The LQAS decision rule for this coverage benchmark is 6 (see Table 1). In June 1999, the FAS interviewed 19 mothers and then counted the number who knew two or more pregnancy danger signs. The results are in the rows of Table 2 labeled 1–7 for each SA. Of the seven SAs, two (SAs 3 and 4) did not reached the 45% coverage benchmark, since fewer than 6 women knew two or more danger signs. The FAS drew a circle around them to show their status. They then calculated the average coverage, which was 51.3%.[4] The FASs used the decision rule from Table 1 for average coverage to identify SAs that fell substantially below average coverage. The procedure they used was to round up the coverage estimate to the nearest 5% interval. Therefore, 51.3% rounded-up to 55%. The corresponding decision rule is 8. Three of the seven SAs were below average and are marked with an asterisk. SAs (3 and 4), marked with both a circle and an asterisk were the highest priority for improvement, because their populations had the greatest health risks. SA 7 was the next highest priority for improvement. Although it had reached the benchmark, it was substantially below average coverage. The previous indicator, Contraceptive Use, revealed two priority SAs (2 and 4). SA 4 was the highest priority, however, because it had not reached the coverage benchmark and had substantially below average coverage.

4. This coverage is actually a weighted coverage calculated by a computer. However, an unweighted or crude coverage calculation done by hand would have been sufficient.

The indicator *knowledge of dehydration danger signs* revealed a different pattern, because all SAs had reached the coverage benchmark of 4. Nevertheless, three SAs (1, 2, and 7) exhibited below average coverage and were thus the areas where improvement would most increase the overall impact of the program. The remaining three indicators did not have baseline values, because the FASs had decided they were important indicators to track after the baseline had been completed. Therefore, the monitoring data were used to identify SAs that were below average. They are identified with asterisks in Table 2.

The marginal totals in Table 2 reveal that SA 7 was identified as a priority four times, and four other SAs were priorities three times. *Knowledge of postnatal danger signs* had the largest number of priority SAs (four), while *assisted delivery, knowledge of pregnancy danger signs,* and *knowledge of dehydration danger signs* were priorities for three SAs. By using these results, the manager knows both which interventions and which SAs should be given time and resources to address community health needs most effectively and efficiently.

Assessing Supervision Areas at Four Points in Time: A Supervisor's Perspective

Table 3 tracks the program's performance for two indicators at four six-month intervals ranging from June 1999 to January 2001. These indicators were introduced after the program began in September 1997, so there are no baseline measures. Nevertheless, a row is included in the table where the baseline value would go. In June 1999, all SAs were assessed to determine whether they ranked below average. Two SAs were below average for *correctly prepares oral rehydration solution* and four were below average for *knows postnatal danger signs.* These SAs hence became the priority SAs for supervisors to focus on to enhance the performance of community health workers. After the first monitoring, the FASs established performance benchmarks for the next six months. In general, they raised the benchmark by about 10–20% above the average coverage. For example, at Time 2, average coverage for the first indicator was 68.2%; FASs set the coverage benchmark for Time 3 at 80%, which is about 10% higher. At each time period, the manager met with FASs and jointly decided on benchmarks

TABLE 3

LQAS Judgments for Demonstrating Correct Preparation of Oral Rehydration Solution and Knowledge of Postnatal Danger Signs (June 1999–January 2001)

	Correctly Prepares ORS: Children 12–23 Months				*Knows Postnatal Danger Signs: Children 0–11 Months*			
Dates monitoring data were collected	*June 1999*	*January 2000*	*June 2000*	*January 2001*	*June 1999*	*January 2000*	*June 2000*	*January 2001*
Baseline results	*Not included in baseline survey*				*Not included in baseline survey*			
Coverage benchmark: decision rule	*na*	65%:10	80%:13	95%:16	*na*	55%:8	70%:11	95%:16
Avg. coverage: decision rule	52.6%:6	68.2%:11	85.7%:15	91.3%:16	41.8%:6	59.6%:9	83.9%:14	92.2%:16
SA 1	7*	7* (circled)	12* (circled)	17	5*	17	16	19
SA 2	7*	9* (circled)	17	18	8	12	19	19
SA 3	12	14	17	19	5*	7* (circled)	18	17
SA 4	9	13	17	19	2*	19	10* (circled)	13* (circled)
SA 5	11	17	18	18	13	15	18	19
SA 6	16	19	19	19	16	14	18	18
SA 7	8	12	15	13* (circled)	3*	8*	12*	16
Total below avg. or substandard FASs	2	2	1	1	4	2	2	1

Notes: ◯ indicates an SA that has not reached a benchmark. * indicates an SA with below average coverage.

for the next period based on what they thought was feasible to achieve.

It is interesting that the SAs that did not reach performance benchmarks for the first indicator were not necessarily those that did not reach it for the second one. For example, for the first indicator, SA 1 was below average for three of four time periods. However, it was below average for only the first time period for the second indicator. In another example, SA 7, for the first indicator, was below average for the last time period only; however, for the second indicator it was below average for three time periods. The assumption is that the service problems in an SA are not necessarily associated with any other intervention. Therefore, all critical parts of the community health program should be monitored at each point in time.

During the last three monitoring periods, coverage benchmarks were established for all indicators. SAs during those time points were judged both on whether they reached benchmarks and on average coverage. SAs displaying both a circle and an asterisk for an indicator are the highest priorities for improvement.

The final observation is that both indicators show a continuous increase in performance over the four time periods. Problems are evident at each point in time but did not persist, very likely due to interventions by the supervisors in response to the data. Each of the key community health indicators can be tracked using a table like Table 3 to manage the program, identify the location of problems, track progress, and identify SAs that excel.

Assessing Supervision Areas at Four Points in Time: A Manager's Perspective

The preceding sections displayed how FASs used LQAS data to identify their SA problem-solving priorities and the performance of each SA relative to other SAs. Both applications helped the FASs and their manager to determine which interventions and locations needed technical assistance. This section shows how the program manager or district health officers can use the same data to track the entire community program over time. The main difference is that the data are aggregated; Table 4 displays the weighted coverage proportions of seven indicators with confidence intervals.

TABLE 4

Coverage Proportions and Confidence Intervals for Selected Indicators

Indicator	*-- Weighted Coverage Proportion and Confidence Interval --*				
	*Baseline**	*Û———————Monitoring Û---------Û————§Û*			
	Sept. 1997	*June 1999*	*Jan. 2000*	*June 2000*	*Jan. 2001*
Delivery assisted by clinician or medically trained TBA	*na*	43.6% (±7.9%)	59.2% (±8.3%)	64.5% (±8.3%)	53% (±8.8%)
Knowledge of two or more pregnancy danger signs	30.7% (<10%)	51.3% (±8.6%)	77.9% (±7.1%)	93.5% (±4.2%)	98.6% (±2.1%)
Knowledge of two or more postnatal danger signs	*na*	41.8% (±8.5%)	59.6% (±8.4%)	83.9% (±6.3%)	92.2% (±4.6%)
Demonstrates correct ORS preparation	*na*	52.7% (±8.6%)	68.2% (±8%)	85.7% (±6%)	91.3% (±4.9%)
Knowledge of two or more dehydration danger signs	12.7% (<10%)	48% (±8.6%)	75.3% (±7.4%)	93.7% (±4.2%)	94.1% (±4.1%)
CPR, modern method**	20.2% (<10%)	33.4% (±8.5%)	38% (±8.8%)	61.7% (±7.7%)	53.4% (±9%)

Notes: * Baseline data were collected using an EPI cluster sample for which the confidence interval is assumed to be <10%. Any indicator not included in the baseline is marked as *na*.

** The standard EPI cluster sample includes mothers of children 0–23 months for all interventions. Therefore, the baseline measure of the contraceptive prevalence rate is of that group of women, as well, which is not a true CPR estimate, since the family planning method use of that group of women cannot be assumed to be the same as among women 15–49 years of age. The latter group was sampled during June 1999–January 2001.

Indicators for safe motherhood, diarrhea case management and family planning interventions are included. As in the previous section, only a selection of indicators is presented to demonstrate the use of the LQAS data. Three indicators did not have a baseline measure, because they were introduced after the program began. All interventions display an increase in coverage by January 2001, although assisted delivery and contraceptive prevalence showed slight declines between June

2000 and January 2001. However, the confidence intervals do not indicate slippage.

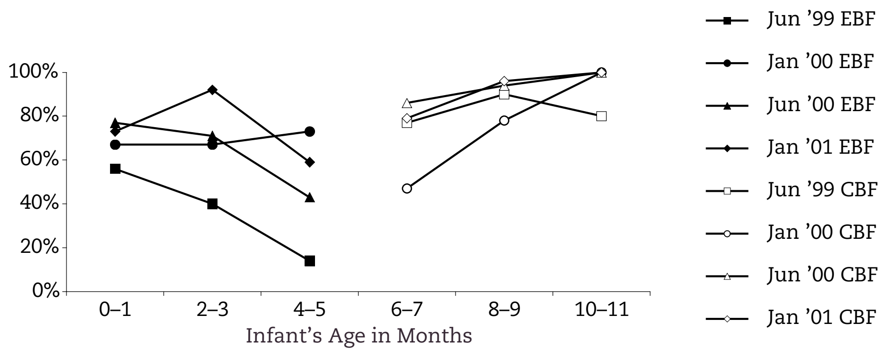
FASs think that coverage decreased for assisted delivery because priorities during June 2000–January 2001 had shifted from safe motherhood to other interventions. In earlier years, all FASs had made it a priority to increase assisted delivery. By June 2000, FASs were satisfied that pregnant women and their families were embracing this practice and shifted attention to other priorities. However, based on the January 2001 results, FASs concluded that safe motherhood interventions needed to be emphasized continuously for the improvement to be sustainable. This may be because there is little transfer of information between different cohorts of pregnant women and their families. Therefore, FASs need to promote the use of trained health workers during delivery for coverage rates to be maintained.

The contraceptive prevalence rate also decreased slightly during January 2001;[5] however, even at that time, a person was 3.75 times more likely to use a family planning method as compared with baseline.[6] In June 1999, most family planning users sought permanent methods (47.5%=tubal ligation, 5%=vasectomy). Twenty-five percent chose hormonal methods (12.5%=injectables, 7.5%=pill, 5%=Norplant), 20% selected condoms, and 2.5% practiced lactational amenorrhea. By January 2001, the pattern of use of family planning methods had changed. A smaller percentage selected permanent methods (21.7%=tubal ligation, 1.4%=vasectomy). Larger proportions of the women used hormonal methods (injectables=27.5%, pill=14.5%), and 33.3% used condoms. Only 1.4% said that abstinence was their chosen family planning method. Both the increase in the contraceptive prevalence rate, and the changed pattern of method use, may be due to the increased availability of family planning methods in the program area. Before family planning became a community priority, procurement of family planning methods had been a major challenge that FASs and their manager had to overcome.

5. The reduction in CPR in January 2001 could be a regression effect. See Campbell and Stanley 1966 and Valadez and Bamberger 1994.
6. This odds ratio was calculated as part of a trend analysis, not reported here. Because LQAS data, in aggregate, are a stratified random sample, statistical tests can be used, since such observation is independent of every other observation.

FIGURE 1

Exclusive Breastfeeding of Infants 0–5 Months and Complementary Breastfeeding of Infants 6–11 months



FASs also cited another reason for the decreases in assisted deliveries and contraceptive use in January 2001, namely, the political instability and violence in Nepal at that time. These factors could have prevented women from obtaining assistance for deliveries and made family planning methods unavailable.

The final key intervention category is breastfeeding. Figure 1 tracks exclusive and complementary breastfeeding practices at each of four time points. The data show that, at Time 1, only 56% of women exclusively breastfed infants aged 0–1 months. By the time these infants reached 4–5 months of age, only 14% of the cohort was exclusively breastfed. However, by Time 4, 73% of infants 0–1 months were exclusively breastfed, with 59% of the 4–5-month-old cohort being exclusively breastfed. Although the trend lines fluctuate over the four time points, the trend suggests that, by Time 4, more infants in the older stratum were exclusively breastfed. Some of the variation in breastfeeding results over time may be due to the small sample sizes of each monthly cohort. When data for children 0–11 months are broken down into six two-month cohorts, each one has, on average, 22 children. While the confidence interval for each point estimate is wide, some trends are nevertheless evident.

The right-hand portion of Figure 1 displays complementary breastfeeding. Little change is evident when Time 1 and Time 4 are compared, except in the 10–11-month cohort. This result also suggests that women are breastfeeding their children longer.

Other analyses examined exclusive breastfeeding among infants 6–11 months. Results suggest that a reason complementary feeding was low among infants 6–7 months is that 26.7% still exclusively breastfed; 8% of infants 8–9 months also still exclusively breastfeed. This practice may suggest either resource deprivation in these communities or lack of knowledge about the need to provide supplementary food when infant reach six months of age. Interestingly, the trend lines with the highest proportions of exclusive breastfeeding of infants aged 0–11 months are in the January measures. This may suggest a seasonal influence.

In conclusion, this section has illustrated the diverse uses of LQAS data at both the community and managerial levels. Some were quite simple, while others were more sophisticated.

Cost Analysis

The total field costs for the cluster sample used at the baseline was $6,548, while the initial LQAS application cost $2,947.[7] The second LQAS application cost $1,180. The baseline and initial LQAS applications included training costs, while the recurrent application included refresher training at lower cost. See Table 5.

However, because LQAS uses FASs who are already employed rather than special interviewers, many costs, such as salaries, were already being paid by the program. If the supervisors had not been participating in this assessment, they would have been carrying out other essential tasks. These represent opportunity costs. The marginal costs columns shows additional money spent for LQAS in both its initial use ($1,585) and recurrent use ($456). None of the cluster sample costs are considered opportunity costs.

The main savings in recurrent costs is the elimination of training costs. The team also reduced costs by shortening the questionnaire. The costs of using expatriate trainers are not included in this analysis of both the cluster sampling and LQAS, because those costs can vary substantially across different organizations. The January 2000–2001 applications included no outside technical assistance.

The total cost for each questionnaire set of the recurrent application of LQAS are equivalent to a 1986 application that estimated $9 (in 1999 dollars) (Valadez 1991). However, the application in Nepal cost sub-

TABLE 5

Comparison of the Cluster Sampling for a Baseline and the Costs of LQAS for Monitoring

	September 1997	*June 1999*		*January 2001*	
	Cluster Sample Baseline Costs	*LQAS Costs*	*Opportunity Cost =Marginal Cost*	*LQAS Costs*	*Opportunity Cost =Marginal Cost*
Salaries	$2,498	$1,328	$0	$724	$0
Transportation	$673	$420	$420	$413	$413
Materials	$816	$403	$403	$43	$43
Food/Accommodation	$2,561	$796	$762	$0	$0
Total Costs	$6,548	$2,947	$1,585	$1,180	$456
Total Cost per Set	$21.83	$22	$12	$9	$3
Total Cost per Observation	$21.83	$7.39	$3.97	$2.96	$1.14

stantially less than the $5,000 to $8,000 reported elsewhere, both for other LQAS applications and for cluster sampling (Singh et al. 1996). The lower costs of this study are probably due to two factors: (1) the monitoring system is decentralized, which minimized travel costs, including food, accommodations, and transport, and (2) local supervisors are able to work more rapidly in their communities than interviewers not known by residents.

Collecting the baseline data for this project using cluster sampling cost more than twice as much as collecting the LQAS data. When only marginal costs are considered for this decentralized LQAS application, then cluster sampling was more than four times more expensive than this decentralized application of LQAS. The reasons are: More data collectors are required for the cluster sample; and centrally organized teams travel to 30 clusters, which results in considerably higher transportation, food, and lodging costs than when seven FASs travel locally to their own communities to visit 133 households. This analysis shows that decentralized monitoring and supervisions systems are substantially more cost effective than centralized approaches.

The costs of LQAS were recently analyzed in Armenia, where three organizations used LQAS in a baseline study for their reproductive health program. The average total cost per organization was $2,740, which is comparable to the initial application of LQAS in Nepal ($2,947) (see Valadez et al. 2001a).

DISCUSSION

During the 1990s, LQAS was used for two different management purposes:

1. to collect *population-based data* with a known confidence interval. Health system (α) and community (β) risks were less emphasized. Professionals working in the EPI have driven this development (World Health Organization 1996, Robertson et al. 1997, Bhattacharyya et al. 1998). WHO's training manual embraces this approach (World Health Organization 1996);
2. to assess supervision areas with known health system and community risks. This community-oriented approach emphasized decentralized data collection and analysis using LQAS.

> Calculating coverage proportions was a secondary interest. *Community-oriented* health practitioners have written about this approach (Stroh 1985, Valadez 1991, Vargas 1998).

This chapter describes a community-oriented application of simplified LQAS tools used by local supervisors at four points in time to improve their programs. Supervisors did not find the concept of coverage benchmark difficult to grasp as they already had established coverage targets for the project. Table 1, which displayed decision rules, was more acceptable to field supervisors than other LQAS tables that also showed α errors and β errors. Although the latter (more standard) tables are preferred by epidemiologists and some managers (Lwanga and Lemeshow 1991, Valadez 1991, Valadez 1998), they were confusing to field supervisors.

Training in data analysis used examples such as the results presented in Table 2. FASs saw the benefits of identifying both specific program interventions and SAs that were performing at substandard levels. Pinpointing program interventions that were not successful highlighted the topics on which health workers needed retraining, while identifying SAs that needed specific technical support indicated which supervisors needed this support. Both of these analyses are necessary to improve the management of decentralized health systems.

After data are collected, each FAS and support staff tallied the results from their SA by hand and shared the results in a joint meeting with other supervisors and support staff. It took approximately one-half day to complete this task and to double-check tallies. The joint meeting provided a forum for discussing results and to assist supervisors to observe the performance of their SA vis-à-vis other SAs. Group discussion helped FASs to plan programmatic changes for their SAs and to request technical assistance from other FASs and the manager. Discussions also helped the program manager identify systematic problems that affected multiple FASs and identify specific SAs needing attention. The program manager was also able to identify the supervisors whose SAs exhibited the fewest substandard interventions and use them as technical advisors for other SAs with program problems. Supervisors were motivated by seeing how their SAs compared to those of other FASs.

In our experience, a factor that constrains program monitoring is the time required to collect data. Overworked local staff may view data collection as a waste of time. For this reason, independent interview teams are often employed to carry out surveys. However, the local supervisors participating in this decentralized application of LQAS did not have this reaction. They agreed that the LQAS sample of 19 was small and did not compete with other responsibilities. Also, in the first application, they noted the importance of visiting beneficiaries in the age ranges of the interventions and hearing for themselves responses to survey questions. By so doing they were able to judge the strengths and weaknesses in their programs and had already begun the reform process before all the data were collected.

From 1999 to 2001, Tables 2 and 3 were the most useful analyses for supervisors and their staff. They also provided the most useful inputs for immediate decision-making by supervisors and the program manager. Table 4, with the aggregate measures of coverage, was useful to the manager to judge the overall progress of the project and to report to his donor and supervisors. It also provided measures to compare with baseline information. However, the coverage proportions did not prove to be of immediate interest to field supervisors, because these figures did not reflect their own individual work in their SAs, as did the LQAS results.

Cost analyses indicate that this decentralized application of LQAS is inexpensive relative to cluster sampling, and when applied regularly, the marginal cost was less than $500. In January 2001, FASs said they would use LQAS as part of their ongoing supervision system every six months and that LQAS has enabled them to steadily improve each intervention.

The Taylors' Seven Steps for Developing Community-Oriented Health Programs

This chapter demonstrates how important a practical and inexpensive yet highly scientific method for gathering, analyzing, and using data at the community level can be for effective supervision and management. The use of LQAS in Nepal resulted in ongoing improvements in the performance of health workers and ultimately in the health of communities. While the LQAS approach was not developed in response to the

Taylors' seven steps emphasizing community participation, those seven steps and the LQAS approach can be linked, as follows:

1. **Create coordinating committees and improve their capacity:** In Nepal, these committees included the FASs at a program level. At an SA level, they included community health workers. Our next task is to involve the community more in using LQAS.
2. **Identify successes:** This is one purpose of using LQAS.
3. **Study success and visit other communities:** FASs who were not reaching coverage benchmarks were able to visit FASs that were successful. However, in most cases they preferred to understand for themselves first why they lagged behind other FASs. Often visiting other communities was not necessary.
4. **Conduct self-evaluation:** This is a central purpose of the community-oriented version of LQAS, as it was applied in Nepal: workers evaluate themselves objectively.
5. **Make decisions based on agreed-upon problem areas and priorities:** FASs met to discuss LQAS results and to identify priorities. Managers used the data as the basis for allocating their attention to priority interventions and supervisors.
6. **Involve as many people as possible in decision-making:** All FASs were involved in decision-making. We have yet to learn how to include community members in the actual decision-making. However, local people were informed of the results and of the priorities for the next six-month period. In this manner, many people were involved.
7. **Monitor the momentum to identify gaps in action and to make midcourse corrections:** The six-month assessment ensured periodic review and revision of action strategies to achieve agreed-on benchmarks, which were progressively raised.

In the context of this collection of experiences with community-based health care (CBHC), this experience in Nepal shows clearly how critical the effective collection and use of data is to improving CBHC services. Because of its low costs, ready acceptance, and ability to be understood by field workers, we think the LQAS approach offers great promise in making ongoing collection and use of data part of the delivery and management of CBHC, rather than being confined to academic studies and generally ignored in the field. Now more long-term applications of LQAS are needed so that additional refinements can be identified and cost analyses can be replicated. We also need to engage communities more actively in using the data to understand and improve the health of their members.

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