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High Immunization Coverage but Delayed Immunization Reflects Gaps in Health Management Information System (HMIS) in District Kangra, Himachal Pradesh, India—An Immunization Evaluation

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Abstract

Background: Complete and timely childhood immunization is one of the most cost-effective interventions in improving child survival in developing countries. Computerized HMIS has been recently introduced to collect aggregated data on service beneficiaries in Himachal Pradesh. HMIS provides coverage estimates for immunization while information on timeliness is currently not available. Hence we conducted a study to validate coverage and assess the timeliness of immunization in Kangra District of Himachal Pradesh. We surveyed mothers (224) of children aged 12 - 23 months (as on January 2008) and selected 32 clusters in the district between January and March 2008. Design/Methods: We conducted a cross sectional survey and selected 32 clusters by probability proportional to size method whereas seven eligible children per cluster were randomly selected. We interviewed mothers using a structured interview schedule, examined immunization card & looked for Bacillus Calmette Guierre (BCG) Scar. Vaccination after 30 days from national schedule was considered "delayed". We computed proportions of children completely immunized, immunization delayed, frequency of reasons for delay and 95% Confidence Interval (CI) for significance of associated factors. We conducted a case control analysis of factors associated with timely immunization by taking timely immunized children as cases and delayed immunized ones as controls. Results/Outcome:

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Reported coverage was universal (100%). Validated full immunization coverage was 94.2% by card/record & 99% by history. Only 29.5% (CI = 20.6% - 37.4%) of children were fully immunized as per schedule (delay less than 30 days). Median delay was 21 days for BCG, 28 days for Diptheria Pertussis Tetanus (DPT 3) and 25 days for measles. Among those with delayed vaccinations, reasons were forgetfulness (36%), lack of correct knowledge (27%) & mother gone to parents' home (27%) & insufficient children in a camp to open full dose BCG vial (22%). Our case control analysis of timely vaccinated versus delayed vaccination revealed that "precall" (reminder) was significantly [OR = 0.1, CI = 0.2 - 0.5] protective against delayed vaccination. Logistic Regression of delay > 30 days revealed that having returned unimmunized from immunization camp earlier due to insufficient children to open vaccine vial (because of high wastage factor) was significantly associated with delayed immunization (p = 0.0000), while knowledge of date of immunization camp was significantly protective from delayed immunization (p = 0.0026). 68% of the children were having at least one immunization delayed over 30 days from recommended schedule, while the proportion of children whose immunization was delayed by over 90 days was 9.4%. Conclusions: Validated field coverage estimates are lower than reported which can be due to inclusion of children of migrants in numerator & not in the denominator. High proportion of children (>70%) were delayed, suggesting implications for WHO's strategy of measles control & national Tuberculosis (TB) control programmes, as 4.5% of them had suffered from measles. To avoid delays we recommend (i) use of mono dose vials for BCG; (ii) precall notice to mothers; (iii) modification of HMIS software to track immunization status and timeliness of individual beneficiaries rather than aggregate numbers.

Keywords

Immunization Coverage, Delay, Gaps, Information Technology, Health Information Systems

1. Introduction

Childhood immunization is one of the most cost-effective activities in health care. Immunization against common childhood diseases has been an integral component of mother and child health services in India since adoption of the primary health care approach in 1978. The programme was given the status of a National Technology Mission in 1986 (Government of India [GoI]) to provide a feeling of urgency and commitment to achieve the goals within the specified period. Universal Immunization Programme (UIP) became a part of the Child Survival and State Motherhood Programme in 1992 and Reproductive and Child Health (RCH) Programme in 1997. The GoI also launched Immunization Strengthening Project to achieve the goal of 100% routine immunization by 2010 (10^{th} five-year plan) [1].

The Reported coverage has remained high since 1990, but national coverage reports of over 100% coverage suggest problems with the accuracy of those reports. With coverage evaluated through coverage surveys there has been a recent disturbing decline in immunization even in well performing states. The District Level Household Survey (RCH) 2004 reported immunization coverage in District Kangra to be 95% [2]. The National Family Health Survey conducted in 2005-06 reported a decline in complete immunization coverage from 83% to 74 % in the state of Himachal Pradesh from 1998-1999 [3].

Achieving good disease control requires not just high coverage, but immunization events to be delivered on time. Assessment of delay in age-appropriate vaccination provides more information about timeliness of vaccination than up-to-date vaccination coverage as they reflect adequacy of protection. Age-appropriate indicators should also be incorporated as vaccination coverage estimators in population-based surveys [4]. Dombkowski *et al*. found that large family size, parental education, absence of a usual health provider etc. were factors for experiencing vaccination delays [5]. Bolton *et al*. found that only 54% of 24-month-old children were up-to-date for the primary series [4].

Study Setting

District Kangra is hilly district in North Indian state of Himachal Pradesh with a population of 1.339 million (2001 census), which is 22 percent of the state population. The population density of the district is 233 persons

per square kilometer against 109 persons of the state. Only five percent of the population of the district lives in urban area as against 10 percent of the state. 64% of the villages are connected by road. The literacy scenario shows that 80 percent of the district population as against 76 percent of the state population (aged 7+) was literate. 73 percent of the females in the district as against 67 percent of the females in the state (aged 7+) were literate. The gender gap in literacy (14.5) is the lowest in the state. One health sub-center covers population of 3071 compared to 2838 for the state and 5401 for the country.

Computerized Health Management Information System (HMIS) has been recently introduced to collect aggregated data on health service beneficiaries in Himachal. HMIS provides coverage estimates for immunization but information on timeliness is currently not available. Hence we conducted a study to validate immunization coverage as reported by HMIS and assess the timeliness of immunization in Kangra District of Himachal through cross sectional survey. The actual immunization coverage for the district and age appropriate vaccination was studied in relation to knowledge of the beneficiaries and other determinants.

2. Methods

We conducted a cross sectional retrospective survey among mothers of children aged 12 - 23 months old as on 1/1/08 (as the survey stretched over three months, we defined the eligible children in absolute terms as all children born in the calendar year 2006).

2.1. Sample Size

Using 95% estimated coverage, desired precision +/− 5%; and number of clusters as 32, only 7 children per cluster are required (Table C2, Immunization coverage cluster survey Reference Manual) [6]. Total sample size works out to (32 × 7) 224 children.

2.2. Sampling Procedure

We used cluster technique for immunization coverage assessment with probability proportional to size for selection of primary sampling units (sampling frame of primary units was taken from the District computer (health management information system software). Within the cluster 7 eligible children were taken. Within the cluster the first house is selected randomly, (a spot map was prepared by discussion with local people, and then a dice was tossed on the map, the point where the dice rested was taken as starting point), and then we moved in one random direction till the required number of eligible children were covered. Efforts were made to contact mothers if they have gone to work in farms and then locate the immunization cards. Children and mothers who were not available in the village on the day of survey, having gone to relative's place were excluded and next house with eligible child was sampled.

2.3. Data Collection

We administered a structured interview schedule (in local Kangri dialect/ Punjabi language as appropriate) that included demographic variables, knowledge about immunization, misconceptions regarding immunization, injection safety, client convenience, and vaccine preventable diseases. We also examined the immunization card, looked for BCG Scar, and recorded the immunization status and interpreted the timeliness of the vaccination. We also enquired about the occurrence of vaccine preventable diseases in the children. Ample time (30 minutes) was given to the parents to look for the card in case if it was not readily available.

2.4. Ethical Considerations

A local female accompanied us (Health worker/Anganwari worker) so that the mothers felt comfortable in participating in the survey. Confidentiality of information was maintained through coding in accordance with the principles embodied in the declaration of Helsinki. Mothers were educated about the correct responses to the questions, the immunization schedule and correct site of injection administration, their queries were addressed after completing the questionnaire.

The immunization status was classified as per immunization card/record and as per history by mothers. The standard immunization schedule was taken as Bacillus Calmette Guerrin (BCG) and Diphtheria Pertussis Tetanus (DPT-1), (Oral Polio Vaccine) OPV-1 at age 6 weeks, DPT-2, OPV-2 at 10 Weeks, DPT-3 & OPV-3 at 14

Weeks and measles at 36 weeks (9 months) [7]. Complete immunization was defined as all the above vaccines and first dose of vitamin-A. A delay of over 30 days from the recommended schedule was considered significant.

2.5. Statistical Analysis

We computed proportions completely immunized, delayed, frequency of reasons for delay & 95% Confidence Interval (CI). We conducted a case control analysis of factors associated with timely complete immunization with timely immunized as cases and delayed as controls. The analysis was done using Epi Info software, an open-source software for public health professionals developed by Centre for Disease Control Atlanta.

3. Results

The spatial location of 32 clusters selected is depicted in **Figure 1**. There are 12 medical administrative units (blocks) in Kangra. The names of villages and blocks are listed along with.

3.1. Population Characteristics

The mean age of respondents (mother) was 26.3 years. 31% lived in permanent houses. The median education level of respondents (mother) was 10 years of education. Most were Hindu (99%). 33% of the respondents belonged to general caste, 26% belonged to scheduled tribes or scheduled castes and the rest belonged to other backward classes. The median distance to be travelled to reach health sub center was 15 minutes and to PHC was 40 minutes. 53% reported a monthly income of below Rs.3000 ($50) per month. Health workers had visited 62% of the respondents in the last one month.

3.2. Immunization Coverage

Reported coverage was universal (100%). The immunization coverage as per history was 99.1 % and 94.2% by cards or record. All children except one were given immunization cards. Card availability with family was 96 %. The BCG-measles dropout rate was 0.5% as per history and 3.2% as per record (**Table 1**).

One totally unimmunized child (not received any vaccination at all) was found in the survey. This unimmunized child was son of a contractor from Jharkhand, but residing in the area near brick kiln since last five years.

3.3. Knowledge of Immunization

29% respondents were able to recall the correct immunization schedule and rest could not. Another 36% were able to recall partially. 28 % responses were incorrect about the immunization schedule for infants and a further

Figure 1. Spatial distribution of villages selected for assessment in Kangra-HP.

8% were unable to recall at all. 54% had a misconception that immunization is not given during fever. 56% respondents reported that source of knowledge of immunization was the health worker.

Only 44% mothers reported having ever read the immunization card. 74% respondents reported being sent a reminder on or before the due date (Precall) by health workers or Anganwari workers.

3.4. Timeliness of Vaccination

Analysis of the timeliness revealed that only 29% of the children were fully immunized as per schedule (delay not more than 30 days). Median delay was 21 days for BCG and 16, 21.5 and 28 days for the three doses of DPT vaccine respectively. The median delay for measles was 25 days. Analysis of the immunization records revealed that 68% of the children were having at least one immunization delayed over 30 days from recommended schedule. The delay by number of doses is shown in **Figure 2**.

3.5. Delay by Type of Vaccine

19% children did not receive BCG by 2.5 months. Those having at least one dose of DPT delayed by over 30 days constituted 38% of children and in case of measles, those having delayed immunization by over 30 days were 36% of children.

36% respondents reported a waiting time of more than 15 minutes at the immunization camp. 85% respondents found the location of the immunization camp convenient.

Age related delays are shown at **Figures 4-6**. Among those with delayed vaccinations the major reasons for delay was forgot in 36% followed by lack of correct knowledge regarding when the injection was due (27%) and mother having gone to parents' home (27%). 24% delays were due to insufficient children in a camp to open the vial. The delay due to insufficient children was responsible for 75% of delayed BCG injections (**Table 2**).
A case control analysis (**Table 3**) of timely vaccinated versus Delayed/ partial immunized children revealed

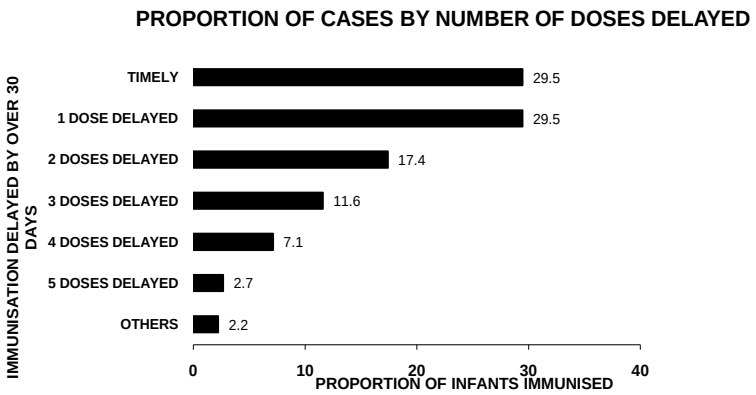

Figure 2. Proportion of cases by number of doses delayed.

Table 1. Summary of immunization status.

	Immunization status	
	By card or record	By card or history
Vaccine	N (%)	N (%)
BCG	222 (99.1)	223 (99.6)
DPT–1	223 (99.6)	223 (99.6)
DPT–2	223 (99.6)	223 (99.6)
DPT–3	221 (98.7)	223 (99.6)
MEASLES	215 (96.0)	222 (99.1)
VIT A	211 (94.2)	222 (99.1)
ALL	211 (94.2)	222 (99.1)

Classification of Immunisation Status by timeliness	Frequency	Percent
Fully immunized as per schedule	65	29.0%
Fully immunized but not as per schedule	152	67.9%
Partially immunized as per schedule	5	2.2%
Partially immunized but not as per schedule	1	0.4%
Not immunized at all	1	0.4%
Total	224	100.0%

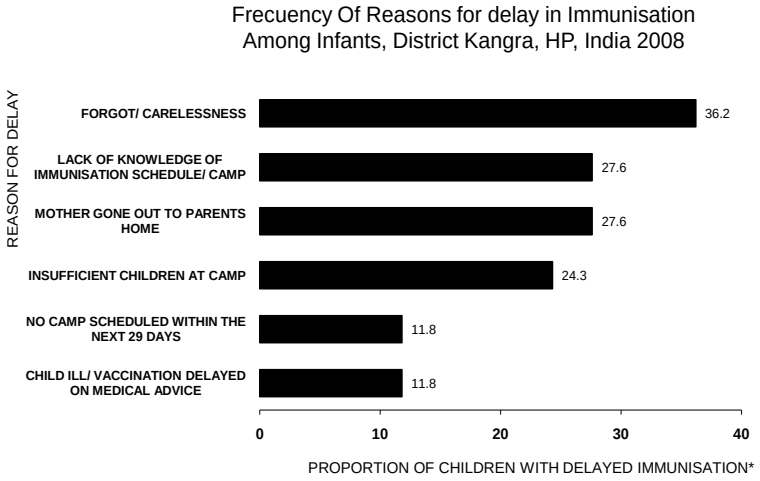

Figure 3. Frequency of Reasons for delay in Immunization among infants.

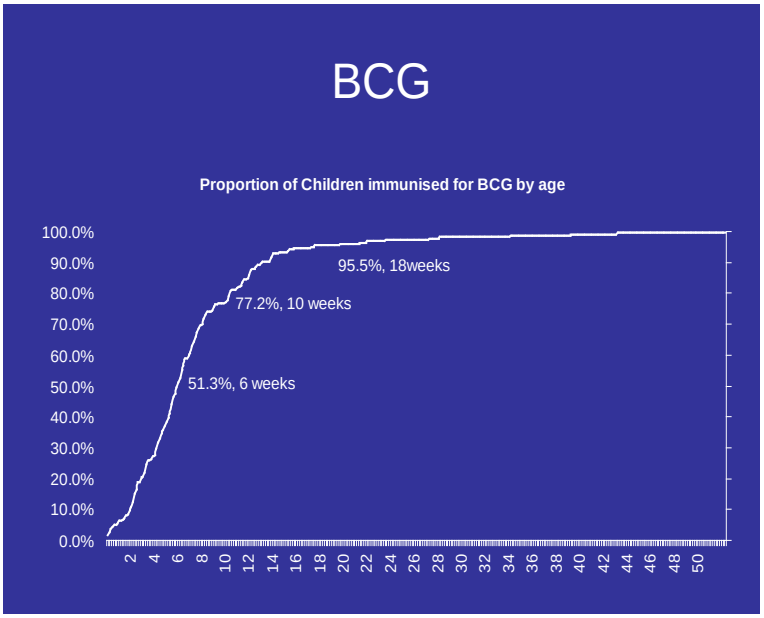

Figure 4. Proportion Of Children Immunized for BCG by Age at Different time intervals.

that Precall (sending message on or before the due date of immunization) was significantly associated with timely vaccination [**Odds Ratio (OR) = 0.1, 95% CI = −0.2 - 0.5]**.

Using criteria of delayed immunization as delay of over 90 days, the proportion of children whose immunization was delayed was 9.4%.

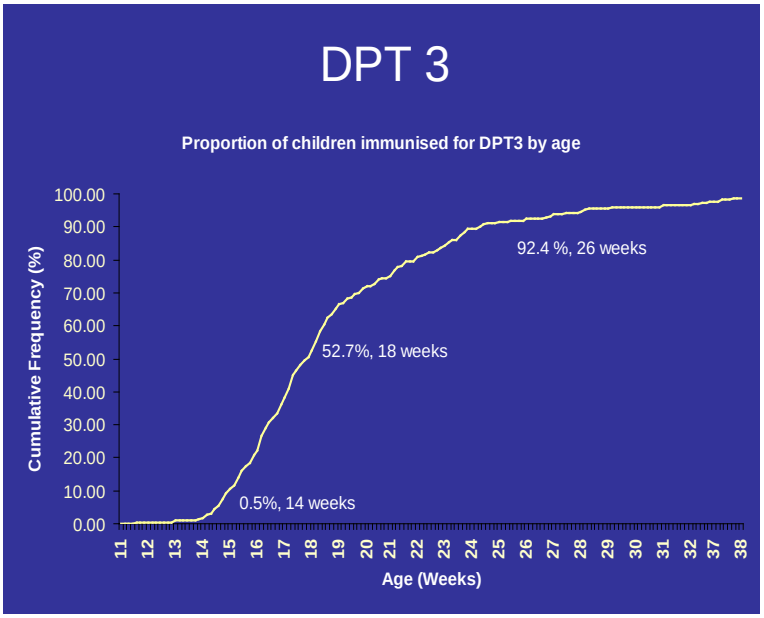

Figure 5. Proportion of children immunized for DPT 3 by age at different time intervals.

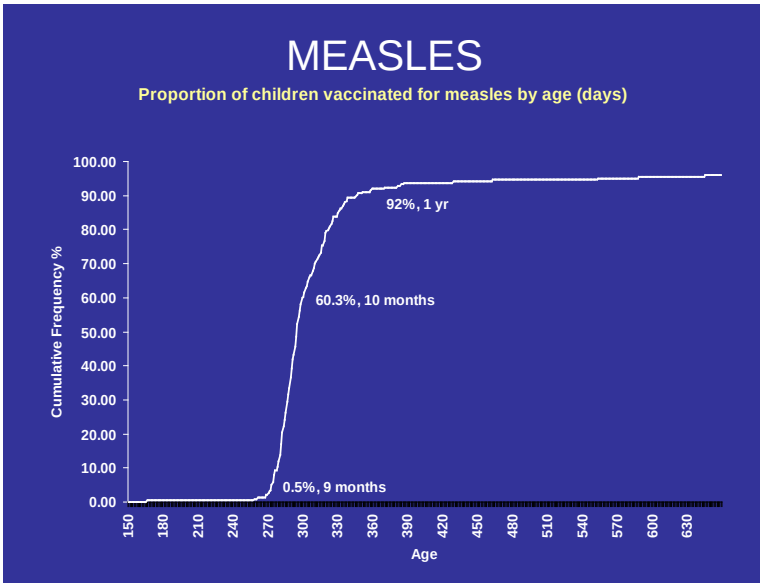

Figure 6. Proportion of children immunized for measles by age at different time intervals.

Logistic Regression of delay> 30 days revealed that having returned unimmunized from Immunization camp earlier due to insufficient children to open vaccine vial (Because of high wastage factor) was significantly associated with delayed immunization ($p = 0.0000$), while knowledge of date of immunsation camp was significantly protective from delayed immunization ($p = 0.0026$) (**Table 4**).

3.6. Injection Safety

Validation of injection site from mothers revealed that 46% had received at least one injection in the buttocks. 59% of respondents reported fever after injection. The health workers had informed them about fever but not about other adverse events.

Table 2. Reasons for delayed vaccination (more than 30 days) by type of vaccine, district Kangra, HP, India 2008.

Reason for Delay	BCG		Measles		DPT		Total	
Number of children	46	(%)	93	(%)	86	(%)	**152**	(%)
Forgot/carelessness	2	(4.3)	**28**	**30.1**	25	29.1	**55**	36.2
Lack of knowledge	1	(2.2)	39	41.9	2	2.3	**42**	27.6
Mother gone to parents home	6	(13.0)	9	9.7	27	31.4	**42**	27.6
Insufficient children to open multi dose vaccine vial	**34**	**(73.9)**	3	3.2	0	0.0	**37**	24.3
No reason	1	(2.2)	0	0.0	17	19.8	**18**	11.8
Child ill	2	4.3	4	4.3	12	14.0	**18**	11.8
Reached late	0	0.0	2	2.2	1	1.2	**3**	2.0
Mother ill	0	0.0	0	0.0	1	1.2	**1**	0.7
Fear of side effects	0	0.0	0	0.0	1	1.2	**1**	0.7
Date of immunization not ascertained	2	4.3	8	8.6	1	1.2	**11**	7.2

Table 3. Case control analysis of timely immunization versus others (delayed/partial immunized) children, District Kangra, Himachal Pradesh, India 2008.

Factor	Timely immunized completely		Delayed/ partial immunized children		OR	CI (95%)		Total	
	N = 65	(%)	N = 159	(%)				N = 224	(%)
Caste general	20		56		1.2	0.6	2.3	76	
Caste OBC[1]	21		37					58	25.9
Caste SC/ST[2]	24		66					90	40.2
Mother literacy > 10 (median)	24		59		1.0	0.5	1.8	91	40.6
Father literacy > 10 (median)	32		63		0.7	0.4	1.2	87	38.8
Type of house permanent = 2	20		49		1.0	0.5	1.9	69	30.8
Monthly family income < ($50)	36		82		0.9	0.5	1.5	118	52.7
Number of children <2	27		57		0.8	0.4	1.4	84	37.5
Distance health sub centre > 15 min	27		71		1.1	0.6	2.1	98	43.8
Distance primary health centre > 40 min (median)	31		80		1.1	0.6	2.0	111	49.6
Decision maker self/husband	19		54		1.2	0.7	2.4	73	32.6
Knowledge of immunization schedule	23		41		1.7	0.7	2.4	64	28.6
Misconception fever	33		71		0.8	0.5	1.5	104	46.4
Source of knowledge immunization health worker	32		94		1.2	0.7	2.2	126	56.3
Knowledge of day & place where immunization service is available	49		139		2.3	1.1	4.7	188	83.9
Read immunization card	43		88		0.6	0.4	1.2	131	58.5
Fever following immunization	34		101		1.6	0.9	2.9	135	60.3
Health worker visited in last month	38		101		1.2	0.7	2.2	139	62.1
Precall-reminded by MPW/AWW[3]	58		107		0.1	0.2	0.5	165	73.7
Camp convenient	57		133		1.4	0.6	3.3	190	84.8
Waiting time > 15 min (median)	19		62		1.5	0.8	2.9	81	36.2

[1]OBC–Other Backward Caste (these are backward communities, but better off socially than scheduled castes and scheduled tribes).
[2]SC/ST–Scheduled Castes/ Scheduled Tribes (these are under privilededged and marginisalised communities traditionally).
[3]MPW–Mutipurpose Health workers/AWW-Anganwari Workers (nutrition and preschool education volunteers).

Table 4. Factors responsible for delayed immunization [logistic regression] unconditional logistic regression.

Term	Odds Ratio	95% C.I.		Coefficient	S. E.	Z-Statistic	P-Value
Knowledge of date of immunization camp	0.2598	0.1082	0.6237	−1.3480	0.4469	−3.0164	0.0026
Knowledge of immunization schedule	1.1114	0.8041	1.5361	0.1056	0.1651	0.6394	0.5226
Mother's literacy	1.0075	0.9139	1.1106	0.0074	0.0497	0.1498	0.8809
Having returned unimmunized from immunization camp earlier due to insufficient children to open vaccine vial (because of high wastage factor)	5.5722	2.5536	12.1593	1.7178	0.3981	4.3148	0.0000
Constant	*	*	*	−0.0697	0.8909	−0.0782	0.9376
Convergence				Converged			
Iterations				7			
Final -2*Log-Likelihood				218.8093			
Cases included:				223			
Test	Statistic	D.F.			P-Value		
Score	40.7748	4			0.0000		
Likelihood ratio	52.1042	4			0.0000		

3.7. Vaccine Preventable Disease (VPD) Surveillance

4.5% of the children had suffered from measles. All these were in non outbreak situations.

4. Discussion

Validated field coverage estimates are lower than reported which can be due to inclusion of children of migrants in numerator & not in the denominator. High immunization rates observed could be explained by high literacy and educational level. The high coverage correlates with the earlier District Level Household Survey (DLHS). However, the discrepancy in history and record calls for improvement of records. The difference in immunization by history and record (**Table 1**) points to gaps in record keeping by health workers and retention of health cards by the clients. The parents told that measles injection was given but not entered in the record and they forgot to carry it to the camp; however it should have been updated later by the health worker.

The proportion of mothers who read the card is low, despite the fact that most of them were literate. Moreover they seemed to be dependent on the precall, which explains the high coverage despite low awareness.

Though there is no mention of delay in immunization under the national immunization programme, it will be prudent to ensure that children are not unnecessarily exposed to risk of infections. In states with high vaccination coverage, we need to focus on timeliness and surveillance for timely age-appropriate vaccination. This will further improve immunization delivery effectiveness and ensure low dropouts, as delayed first dose is associated with higher chances of dropout.

Carelessness (forgetting) by parents for timely immunization has been the major factor for missing the immunizations. Lack of correct knowledge contributed to delay mainly in measles vaccination. This is similar to as described by M. Mujibur Rahman, M. Aminul Islam *et al*. delayed or non-immunization was associated with low socio-economic status, maternal illiteracy, and lack of mothers' knowledge on vaccine preventable diseases [8]. Non-availability of sufficient children (**Figure 3**/**Table 4**) was a major factor for delay in BCG as the multi dose vial is being used and getting 8 eligible children in a small hamlet is difficult. This delay exposes the child to risk of Tuberculosis (TB) therefore the multi dose vials should be replaced by single dose or 2-3 dose vials to ensure success of outreach camps. Fever was responsible for delays especially for DPT.

Our findings on role of precall (**Table 3**) are consistent with other published literature [9] [10]. Immunization surveillance and pre-emptive mobilization of beneficiaries before the camp is recommended to improve timeli-

ness. The incorrect injection site is a cause for concern and this study attempted to validate the injection site from the beneficiary.

The low recall of immunization schedule could be due to the fact that they forgot after completing the primary immunization and also low knowledge itself among the community is the cause of forgetfulness.

None of the children had suffered from diphtheria, pertussis, tetanus or tuberculosis. However, sporadic measles cases were reported which indicated low vaccine efficacy, and remind us of the need for second dose of measles.

5. Recommendations

To avoid delays we recommend (i) use of mono dose vials for BCG; (ii) precall notice to mothers; (iii) modification of HMIS software to track immunization status and timeliness of individual beneficiaries rather than aggregate numbers. We also recommend educating health workers regarding injection sites and safety and importance of precall for timely vaccination.

Acknowledgements

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