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Home-based records and vaccination appointment stickers as parental reminders to reduce vaccination dropout in Indonesia: A cluster-randomized controlled trial

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Abstract

Introduction: Limited evidence is available about the effectiveness of strategies to remind caregivers when to bring children back for future vaccinations in low- and middle-income country settings. We evaluated the effectiveness of two reminder strategies based on home-based vaccination records (HBR) in Indonesia.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2019.09.040>.

Methods: In this cluster-randomized controlled trial involving 3616 children <1 year of age, 90 health facilities were randomly assigned to either a control group or one of two intervention groups: (1) HBR-only group, where healthcare workers provided an HBR to any child without an HBR during a vaccination visit and instructed the caregiver to keep it at home between visits, or (2) HBR + sticker group, where, in addition to HBR provision, healthcare workers placed vaccination appointment reminder stickers on the HBR. The primary outcome was receipt of the third dose of diphtheria-tetanus-pertussis-containing vaccine (DTPcv3) within 7 months and the secondary outcome was receipt of a timely DTPcv3 dose.

Results: Control group DTPcv3 coverage was 81%. In intention-to-treat analysis, neither intervention group had significantly different DTPcv3 coverage compared with the control group (RR = 0.94, 95% confidence interval [CI] 0.87; 1.02 for HBR-only group; RR = 0.97, 95% CI 0.90; 1.04 for HBR + sticker group) by study end. However, children in the HBR + sticker group were 50% more likely to have received a DTPcv3 vaccination (RR = 1.46, 95% CI 1.02, 2.09) within 60 days of DTPcv1 vaccination, compared with children in the control group; children in the HBR-only group were not more likely to have done so (RR = 1.05, 95% CI 0.71, 1.55).

Discussion: Reminder stickers had an immediate effect on coverage by improving the proportion of children who received a timely DTPcv3 dose but no effect on the proportion who received DTPcv3 after 7 months. Coupling reminder stickers with strategies to address other reasons why children do not return for vaccination visits should be further explored.

Keywords

Vaccination; Indonesia; Vaccination reminder

1. Introduction

The World Health Organization (WHO) recommends more than 10 vaccinations through early childhood to ensure protection against multiple diseases. WHO also recommends timely receipt of these vaccinations to ensure optimal protection [1]. A variety of interventions are available to remind parents to ensure they bring their child back to a health facility for all recommended vaccinations. These interventions are commonly described as parental reminder/recall systems, and they are used to remind a target population that vaccinations are due (reminders) or late (recall); these interventions are considered a key vaccine utilization tool available to healthcare providers [2]. Parental reminders can include letters or postcards to patients, person-to-person telephone calls, computerized telephone messages, combinations of postcards and telephone messages, community outreach, or reminders for healthcare providers alongside parents. Evaluations of parental reminders show a positive effect on vaccination uptake, with systematic reviews indicating that they can increase vaccination coverage by 4–20% [2–5]; however, nearly all studies described in these reviews were set in high-income countries.

In the 2015 systematic review of parental reminder studies, Harvey et al. identified 13 randomized controlled trials (RCTs) of parental reminders; 11 used postal-based reminders and 2 used telephone reminders [3]. The majority of the reviewed studies were based in the United States; two were based in Pakistan, a lower-middle-income country [3,6,7]. The

Pakistan-based studies assessed the feasibility of using a future vaccination appointment date sticker on the child's home-based record (HBR) or vaccination card and found that this strategy improved coverage of the third dose of diphtheria-pertussis-tetanus (DTPcv3) vaccine by 10–20%. Although these studies showed promising results, they were both of short duration (3 months), and the interventions were implemented by study personnel rather than healthcare providers. As highlighted by the systematic reviews and the two Pakistani studies, additional evaluation of HBR-based parental reminder strategies is needed in other low- and middle-income country settings to help researchers better understand their possible benefits.

WHO has long recommended that, globally, all children should receive an HBR (paper or electronic) to ensure that the caregiver is aware of the vaccination services the child has and has not received, to support health workers' ability to determine vaccination status, and to empower caregivers in the care of the child; consequently, their recommended use is ubiquitous worldwide [8]. Placing a parental appointment sticker on the HBR could be a simple strategy for ensuring that parents return promptly for the next recommended childhood vaccination. Yet, in some countries, the proportion of caregivers who receive, maintain, or are allowed to keep the child's home-based record at home can be quite low, which may limit the opportunity to use them as a means of providing parental reminders of future vaccinations. In Indonesia, for instance, a 2012 survey showed that only 41% of children aged 12–23 months had an HBR present during the household-based interview, even though 71% of parents indicated their child had received at least one recommended vaccination and that they knew the Indonesia government recommends that every child should have an HBR [9,10]. In Indonesia, a high proportion of children (97% in 2012) in Indonesia received the first dose of DTPcv, however, a substantial proportion of children (15%) dropped out by the third DTPcv dose, resulting in Indonesia having the fourth highest number of children (one million) globally who failed to complete the 3-dose DTPcv series.

Since little evidence exists about the effectiveness of vaccination reminders placed on a child's HBR in low- and middle-income countries despite their promise shown in several high-income countries, the authors implemented a cluster-randomized control trial in Indonesia designed to estimate the effect of low-cost parental reminder interventions using HBRs on completion and timeliness of the 3-dose DTPcv series.

2. Methods

2.1. Study design, recruitment, and randomization

A cluster-randomized controlled trial (cRCT) design was used to measure the effect of each intervention, randomizing at the health facility level into one of three study groups. West Java province was selected because it has the largest population in Indonesia. Five districts in Indonesia's West Java province (Cianjur, Cirebon, Kota Bundung, Kota Depok, and Sukabumi) were purposively chosen using the following criteria: (1) no known or anticipated activities were ongoing in the district to improve vaccination service utilization, (2) no communications messages were scheduled to promote home-based record ownership, and (3) they had a sufficiently large estimated target population to support study sample size requirements. The study intervention period began on January 1, 2016, and lasted 7 months.

All public health facilities that provided vaccinations in these districts were included in the study sampling frame. Facility eligibility criteria included being government-owned (public), routine provision of vaccination services, and having an estimated number of annual births ≥ 360 ; the latter was used to aim to have at least 30 children, on average, attend for DTPcv1 vaccination in a single month. The initial sampling frame contained 264 public health facilities; two were omitted because they had no information on the number of annual births, and 32 were omitted because they had <360 annual births. To reduce possible confounding by district, the facility sampling frame was first stratified by district; then, within each district, six facilities were randomized to each study group using simple random sampling, for a total of 30 randomized facilities per group.

All children who received DTPcv1 in a study health facility in January 2016 and had the vaccination recorded on the facility vaccination register were eligible for inclusion in the study. The district health management teams and facility officer-in-charge gave consent for participation in the study prior to randomization. This study was approved by the institutional review boards of the University of Indonesia and US Centers for Disease Control and Prevention (CDC).

2.2. Study groups and intervention procedures

The three study groups consisted of two intervention arms (HBR-only and HBR + sticker) and one control arm. In HBR-only study group health facilities, healthcare providers were instructed to provide an HBR to a caregiver of a child any time the caregiver had not yet received an HBR or had forgotten to bring the HBR to the vaccination visit. If the HBR was a replacement, the provider was to update the replacement HBR with information from the vaccination register. The provider was instructed to tell the parent to keep the HBR at home and to remember to bring it back at the next vaccination visit.

In the HBR + sticker intervention health facilities, healthcare providers followed the same HBR provision rules as those in the HBR-only study group, but also affixed a future vaccination visit reminder sticker to the front of the home-based record for children still due for a future vaccination, wrote the date of the next vaccination visit on the reminder sticker, and explained the purpose of the sticker to the caregiver. The sticker was bright yellow, approximately 50 mm in width and 12 mm in height, and had a back adhesive that was removed when the provider applied the sticker to the HBR. All children coming for vaccination were eligible for this intervention. In control study group health facilities, healthcare providers followed their usual practice for vaccination reminders, home-based record provision, and home-based record storage location. Indonesia immunization training guidelines instruct healthcare providers in Indonesia to simply ensure that caregivers are aware they should return for future vaccinations, but little information about how to ensure their awareness is systematically provided.

For healthcare provider orientation to the interventions and provision of intervention materials, a cascading approach that would mimic how Indonesia introduces a new health intervention was used so that our study outcome measurements would best reflect intervention effectiveness. The cascade approach started with an orientation for national, province, and district health management staff and partner organizations (UNICEF and

CDC) in October 2015. After this orientation, the province and district health teams were instructed to orient intervention health facilities and provide intervention materials prior to January 2016.

2.3. Outcomes

The primary outcome of interest was for children to receive DTPcv3 before the end of the study. Vaccination status was determined by retrospective review of the health facility vaccination register. At study end, trained data collectors visited each study facility and abstracted the complete vaccination record for each child that had received DTPcv1 in January 2016. Information abstracted on each child included gender, date of birth, and notation of all vaccinations received.

Two methods were used to calculate the secondary outcome of interest, timeliness of a DTPcv3 vaccination: (1) receipt of DTPcv3 within a certain time period after DTPcv1 to reflect adherence to their future vaccination appointment date, and (2) time to DTPcv3 vaccination or end of intervention period. For the first method, a binary variable was created for each child that indicated receipt of DTPcv3 56–60 days after receiving DTPcv1 because 56 days is the minimum recommended spacing between these doses. Additional binary variables indicating receipt of valid DTPcv3 within 70 days of DTPcv1 and within 90 days of DTPcv1 were also created. For the second method, a variable defined as the number of days between DTPcv1 vaccination and either DTPcv3 vaccination (event) or end of study (censoring) was created. The latter variable was used in survival analyses.

2.4. Statistical analysis

The following assumptions were made to calculate the a-priori sample size: (a) 70% DTPcv3 coverage in control groups, based on 2014 coverage information in study districts; (b) 40 children per facility, based on average target population of children <1 year of age; (c) intraclass correlation coefficient of 0.10, based on recent household surveys; (d) alpha of 0.05; and (e) power of 80% to detect an absolute increase of 11% in the proportion of children receiving DTPcv3 in the intervention versus control study groups (based on results from previous reminder studies showing 10–35% coverage increase) [2,3]. The target sample size was 30 facilities per group, yielding a total target sample of 1200 children in each study group.

Before being analyzed, the dataset was examined for any invalid or missing dates of birth, invalid dates of DTPcv vaccination, and invalid doses. Invalid dates of birth and vaccination were identified by examining if any dates of DTPcv vaccination came before the dates of birth; those that occurred were reconciled if feasible, and those that could not be reconciled were excluded. Invalid doses were defined as those with a minimum interval between DTPcv doses of <28 days. For all analyses, only valid DTPcv dose data were used.

2.5. Intention-to-treat analysis

Our primary analyses were intent to treat (ITT), with individuals analyzed according to the group with which their facility was randomized. We modeled binary and continuous outcomes using generalized estimating equations (GEE) with a log link function to calculate

risk differences and risk ratios with 95% confidence intervals (CI). A cluster effect for facility, with an exchangeable correlation structure, was included in the model. Covariates used in the model were child's sex (male/female), age of child at DTPcv1 vaccination date (in days), hepatitis B birth dose vaccination status prior to receipt of DTPcv1 (yes/no), and child's home district.

We conducted a survival analysis by modeling time to DTPcv3 vaccination using a Cox proportional hazards model to calculate hazard ratios with 95% CI. A cluster effect for facility was included in the model alongside previous covariates. The calculation of survival time started at the day of DTPcv1 and ended the day of DTPcv3 vaccination or end of study period. SAS version 9.3 and SAS-callable SUDAAN were used for analysis of data.

2.6. Per-protocol analysis and health worker survey

To assess adherence to the intervention, staff members at every intervention health facility were interviewed at the end of the study to provide information on which month they received intervention materials (reminder stickers and additional home-based records) and their acceptance and use of the interventions. All health workers who were involved in administering vaccinations at the facility were included in these interviews conducted by trained data collectors. A-priori, a decision was made that if intervention materials had arrived after the start of the intervention period, a per-protocol analysis would be conducted whereby intervention facilities would be reclassified into the appropriate study group and the various analyses redone per the previous methods.

2.7. Post-hoc analyses

In a post-hoc analysis, the researchers re-analyzed their primary and secondary outcomes of interest using ITT among only those children who had received a second dose of DTPcv (DTPcv2), under the theories that intervention facility healthcare providers would be more experienced with implementing the interventions by the DTPcv2 visit and thus would adhere better to the intervention protocols. Additionally, since a number of healthcare providers in the intervention groups failed to receive intervention materials in the first month of the intervention but did receive them in the second month of the intervention, a higher overall proportion of the intervention facilities would be implementing the intervention protocol by the time of the DTPcv2 visit.

3. Results

Of the 3633 child immunization records abstracted from health facilities, 17 were discarded (12 from Group 1 facilities and 5 from Group 2 facilities) because they had invalid vaccination data. Vaccination records from 3616 children in 90 health facilities were analyzed (Fig. 1). Most baseline indicators were similar across study groups; however, children in the HBR-only study group were generally older at time of Penta1 vaccination (88 days of age versus 77–79 days) and less likely to have received Bacillus Calmette–Guérin (BCG) vaccination (90% versus 95%) at baseline compared with children in the other two groups (Table 1).

During the 60 (response rate = 100%) healthcare provider surveys, 21 intervention providers indicated receipt of intervention materials (cards and/or stickers) after the presumed start of the intervention on 1 January. Therefore, for the per protocol analyses only, we reclassified facilities based on whether or not they had received intervention materials before January and reanalyzed the results per protocol. Among the 30 HBR + sticker intervention facilities, 7 were reclassified as HBR-only and 3 were reclassified as control for purposes of the per protocol analysis. Among those 10 that received intervention materials after the start of the intervention period on 1-January-2016, 9 had received the materials to initiate the intervention as of 1-February-2016 and 1 received the materials to initiate by 1-May-2016. Among the 30 HBR-only facilities, 11 were reclassified as control for the per protocol analysis; among these 11 who received intervention materials late, 7 had received them as of 1-February-2016, 1 as of 1-March -2016 and 3 as of 1-April-2016.

3.1. Primary outcome

Under ITT analysis, by the end of the 200-day study period, no significant difference was noted in the proportion of HBR + sticker group children who had received DTPcv3 vaccination (77%) compared with the control group (81%) (RR = 0.97, 95% CI:0.90, 1.04), nor in the proportion of HBR-only group children who had received DTPcv3 (74%) compared with those in the control group (RR = 0.94, 95% CI:0.87, 1.02) (Table 2).

Under per protocol analysis, no significant difference was found in the proportion of HBR + sticker group children who had received DTPcv3 vaccination (77%) compared with children in the control group (78%) (RR = 0.99, 95% CI: 0.98, 1.09), nor in the proportion of HBR-only group children who had received DTPcv3 (74%) compared with those in the control group (RR = 0.96, 95% CI: 0.88,1.05) (Table 3). Using a modified per protocol analysis approach where intervention facilities were not reclassified into the control group if they had not received any intervention materials by January 2016, but instead these facilities were dropped from the analysis, the results were virtually the same as in the intention-to-treat analysis.

3.2. Secondary outcomes

Under ITT analysis, children in the HBR + sticker group were nearly 50% more likely to have received a valid DTPcv3 vaccination within 60 days of DTPcv1 vaccination (DTPcv3 coverage at 60 days = 32%) compared with children in the control group (23%); (RR = 1.46, 95% CI: 1.02, 2.09) (Table 2). Children in the HBR-only group were 5% more likely to have done so when compared with those in the control group, although this difference was not significant (DTPcv3 coverage at 60 days = 24%), (RR = 1.05, 95%CI:0.71, 1.55) (Fig. 2). By 90 days after DTPcv1 vaccination, the likelihood of DTPcv3 vaccination in the HBR + sticker group compared with control group children was equal (61%), (RR = 0.99, 95% CI: 0.96, 1.03) (Table 2, Fig. 2). Survival analysis results indicated similar trends; HBR + sticker group children had a 9% greater likelihood of time to DTPcv3 vaccination within 60 days of DTPcv1 (HR: 1.09, 95% CI: 0.96, 1.22) compared with control group children, whereas there was no difference in time to DTPcv3 vaccination within 60 days between HBR-only children and control group children (HR: 0.99, 95% CI: 0.89, 1.09).

Compared with ITT results, under per protocol analysis the HBR + sticker intervention showed a significant and stronger effect on the proportion of children in the HBR-only group who received a more timely DTPcv3 vaccination compared with control group children (Table 3). In total, 13% (95% CI: 2%, 24%) more children in the HBR + sticker group received DTPcv3 within 60 days of DTPcv1 (coverage = 37%) compared with control group children (coverage = 24%) and 10% (95% CI: 1%, 22%) more within 70 days (57% versus 47%) (Fig. 3). By 100 days, the proportion was equal (69%) (RD: 0%, 95% CI: [0]9%, 8%) between these groups, again indicating a transient timeliness effect from the HBR + sticker intervention. Survival analysis results indicated timeliness effects that were also stronger compared with ITT results. HBR + sticker group children were 23% more likely to have received a more timely DTPcv3 vaccination within the 200-day follow-up period compared with control group children (HR: 1.23, 95% CI: 1.11, 1.37). Per protocol survival analysis indicated HBR-only group children were 11% more likely to have received a more timely DTPcv3 vaccination compared with control group children (HR: 1.11, 95% CI: 1.02, 1.22).

In a post-hoc analysis among only children who received DTPcv2 (n = 3088, 85% of total), children in the HBR + sticker group were significantly more likely to have received a more timely DTPcv3 vaccination (within 30 days of DTPcv2) than control group children (RR: 1.61, 95% CI: 1.23, 2.10); children in the HBR-only group were also more likely to have received a more timely DTPcv3 vaccination but this was not statistically significant (RR: 1.12, 95% CI: 0.82, 1.53) (Table 3). By the end of the 200-day study period, children across all three study groups were nearly equally likely to have received DTPcv3 vaccination (RR for HBR + sticker group: 1.03, 95% CI: 0.98, 1.07; RR for HBR-only group: 0.99, 95% CI: 0.93, 1.04).

3.3. Healthcare provider acceptability

During post-intervention healthcare provider surveys in each of the two intervention groups (30 providers in each group), 100% of the 60 providers in both groups indicated they allow caregivers to keep the HBR at home between healthcare visits. When asked how they communicate to caregivers about when to come back for the next childhood vaccination visit, most HBR + sticker group providers used the sticker (90%) and a verbal reminder (86%); smaller numbers used an additional written reminder or additional note on the card alongside the use of the sticker (33%). Among HBR-only providers, 80% used a verbal reminder and 47% used a written reminder or a note on the card. All (100%) providers in both the HBR-only group and the HBR + sticker group were supportive of using reminder stickers on the HBR because they believed it helped remind the parent of future vaccination visits. Providers reported that the yellow color of the sticker contrasted well with the HBR, so it drew the attention of the caregiver and the placement of the sticker on the front of the HBR meant that the caregiver did not have to open the book to see the next date of vaccination. In the HBR + sticker group, 100% of providers were also supportive of continuing to use the reminder stickers, although 17% indicated some problems with using them. The main problem reported was that the providers sometimes found that the sticker backing was difficult to remove.

The providers in both intervention groups also provided feedback specific to the HBR component of the intervention. In the post-intervention survey, only 60% of providers in both groups indicated they always provided a replacement HBR to those who came without an HBR (and had received one previously), and about 40% and 30% of HBR + sticker and HBR-only providers, respectively, indicated they supported the continued policy of providing a replacement HBR. When further queried about this feedback, providers reported that having to fill in a replacement HBR was a “nuisance”; others suggested providing a small card as a substitute until the parent returned with the old HBR. Multiple providers also indicated that if the distance was not far, they sent parents back home to retrieve the forgotten HBR rather than issuing a replacement HBR.

4. Discussion

Children who attended facilities that provided sticker-based reminders of future vaccination appointments were more likely to receive timely DTPcv3 vaccination compared with children in the control group; therefore, children in these groups were vulnerable to the diseases these vaccines protected against for shorter periods during their first year of life. However, the positive effect on timeliness of vaccination did not translate into overall higher DTPcv3 coverage by the end of the 7-month study period compared with coverage in the control group. In our primary analysis, providing a new home-based record to parents of children who came without one did not have any effects on vaccination coverage or timeliness, although our post-hoc analysis (i.e., including only children who had received DTPcv2) did indicate that timely vaccination coverage did improve among children in the HBR-only group compared with the control group, possibly identifying a group receiving better delivery of the intervention. A high proportion of healthcare providers did indicate they were not supportive of providing new home-based records to children, which could have factored into the modest effects of both interventions. The reminder sticker strategy may be a consideration if packaged with other interventions designed to improve parents’ knowledge and demand for vaccination, and in the context of better provider acceptance of the strategy or delivery mechanism.

Our results differ from the two HBR-based sticker reminder studies conducted in Pakistan that reported a positive effect of the intervention on completion of the DTPcv series [6,7]. A number of study characteristic differences may explain why our results differ from the studies in Pakistan. Specifically, our study was longer (7 months versus 3 months); used healthcare providers to implement the interventions rather than trained study personnel in Pakistan; included more study sites (90 health centers versus 5 in Pakistan); had relatively high baseline coverage (final control group DTPcv3 coverage was 81% versus 55% in Pakistan); experienced a lag in intervention startup in many study sites, whereas no reported lag occurred for the Pakistan study. All of these factors may have contributed to our results showing a more modest impact of home-based records and stickers as vaccination visit reminders compared with the previous Pakistan studies. However, our study may reflect more realistic results, at least for the Indonesia setting, considering that we used a similar approach to how the Indonesia Ministry of Health typically rolls out such interventions. In a 2018 Cochrane Collaboration review of 23 high-income country setting studies examining patient reminder or recall interventions for childhood vaccination, there was a pooled

improvement in vaccination coverage of 8% (pooled RR = 1.22) from reminders, although the reminder types were numerous (postcards, text messages, auto phone dialers, telephone calls and letters to patients) [2,11]. Three studies from low-income country settings were not excluded from the review, but the review authors noted an overall positive but relatively low effect of the reminders evaluated in these studies. Although a variety of differences can exist between high income and middle or low income country immunization programs, the variation in results across low to high income country settings indicate the need to generate more evidence on reminder intervention effectiveness in low and middle income country settings.

One factor that may explain why control group health facilities eventually achieved the same level of coverage as the HBR + sticker intervention facilities is the use of a strategy in Indonesia known as sweeping. Although it is not meant to be a core strategy for vaccinating children, sweeping occurs every quarter and acts as a short vaccination campaign run by facility and community-based health workers to catch up all children <12 months of age who failed to return for vaccination at a health facility or outreach vaccination site. The 2012 Indonesia immunization program review cited this strategy as unsustainable and urged the government to focus on investments in fixed and outreach-based vaccination as more sustainable strategies. It is possible that the sweeping activities succeeded in catching up those children who were missed, while in the HBR + sticker intervention group, those children who would have been vaccinated through sweeping instead ended up coming to the facility due to the effect of the sticker as a reminder of the next vaccination visit. Another possible explanation for the sticker having an effect on more timely vaccination but not on increased vaccination coverage is the timing of the sticker as a reminder, since it was provided at least 28 days prior to when the next visit would occur. The period between a reminder and the event for the reminder may dilute the reminder effect, particularly if the sticker-enhanced home-based record is not stored in a visible location in the household. It is possible that reminders provided closer to the potential visit, such as a phone-based text message to the parent one week prior to the visit or a mailed postcard received by the parent just prior to the visit, could have more effect.

The sticker and HBR strategy in our study was designed to encourage a change in behavior for the caregiver and appeared to be modestly successful in getting a significantly higher number of individuals to bring their children for more timely vaccinations than compared to control group individuals. However, the barrier addressed by these reminders is only one factor that determines why a child is incompletely vaccinated; other barriers also must be addressed for the reminder to work and effect change. Such health-sector-based examples can include vaccine stock-outs or lack of health workers when a parent returns with their child for a vaccination visit. Caregiver-based examples can include a parent being concerned about their child potentially developing a fever after vaccination. In particular, if parents have not been informed that post-vaccination fever can be a normal response, this reaction may result in their refusal to allow the child to receive any more vaccinations, whether or not they are reminded by the sticker and home-based record [12–14]. Indeed, an unpublished 2014 immunization dropout study by UNICEF Indonesia reported that 70% of surveyed mothers of incompletely vaccinated children thought that fever after vaccination was not normal, 60% did not perceive any tangible benefits (i.e. immunity from disease, cost

savings, avoid death and disability) from vaccination of the child and only 34% indicated strong trust in their local health workers. These multiple maternal perceptions can lead to incomplete vaccination and would be challenging to solve through use of stickers and/or home-based records alone. A package of interventions which included the sticker alongside addressing interpersonal communications for immunization which would also address parental concerns about fever following vaccination and benefits of vaccination would be a useful strategy to build trust of the healthcare provider. Several previous reviews of strategies to improve community demand have identified the importance of the healthcare provider as a key and trusted source of immunization information, so establishing the provider – parent communication foundation first is critical for such reminder-recall strategies as the sticker to function well [12,15,16].

Although our study indicated that the use of stickers as reminders had only a modest effect on improving timeliness of vaccination, such an improvement can still be useful for decreasing vaccine-preventable disease (VPD) morbidity when translated into a population-level effect. Several studies have shown that delayed vaccination is an important determinant of VPD morbidity in several high-income countries and may also contribute to disease outbreaks in other settings [17–20]. Vaccination delays can generally result in the most vulnerable group of children having more severe morbidity and higher mortality rates. Additionally, delays have economic impacts; a recent US-based study of delayed pertussis vaccination (which is included in the pentavalent vaccine used in Indonesia) indicated that pertussis vaccination at the exact recommended age in the United States could result in \$1 million in healthcare cost savings and prevention of 278 pertussis cases annually [21]. A future cost-effectiveness article is planned for this Indonesia study to better document the economic impact.

This study has a number of limitations. Although we tried to address exposure misclassification through per protocol analysis, we did identify a number of intervention group facilities that did not start the intervention during the expected timeline. We also did not have information at an individual level about whether a parent who attended an intervention facility actually received the specified reminder, so it is possible that even the per-protocol analysis may have underestimated the interventions' effects. Within our per-protocol analysis where multiple HBR + sticker facilities were re-classified as HBR-only, a majority of these facilities did initiate the intervention within 1–2 months after the 1-January start of the study; thus, children attending these facilities for their DTPcv2 dose would likely have been exposed to the intervention. However, any intervention effects within these facilities would have resulted in an under-estimate of the HBR + sticker effect even under per-protocol analysis, thus our observed results would be an under-estimate even under the per protocol analysis. The use of facility-based vaccination records to ascertain vaccination status meant that researchers were restricted to individual-level covariate data already routinely collected through this system; thus, in the per-protocol analysis, they could not control for other covariates commonly included in such analyses, such as maternal education, birth order of child, or parents' income status and ethnicity. Additionally, children may have been misclassified with respect to the outcome (receipt of vaccination) as we only reviewed facility registers and did not also review home-based records; this misclassification would be non-differential due to our study design, and may have resulted in an

underestimate of the true strength of association between exposure and outcome. Our use of facility-based registers may have also missed children who tended to be more transient, i.e. moving from one facility to another for each vaccination visit and could be at higher risk of not having been recorded in the register; however any effect of this issue would be non-differential due to the study design as well. Based on anecdotal reports from government health staff, the area where this study occurred had little health infrastructure beyond the public health facilities that were part of this study, hence it is considered that a low proportion of children moved between facilities in these areas. The healthcare provider interviews did reveal that the Indonesia MoH did not have standard protocols in place on how to remind parents about future vaccination visits, such that providers followed a variety of localized practices including creating their own written reminders. It may be possible that the introduction of the sticker intervention could have interfered with these existing provider practices, and as such, it would have been useful to have conducted baseline interviews with providers around these existing practices to better document, then control for such practices. Last, the control group coverage was about 10% higher (70% versus 81%) than had been assumed in the sample size calculations for seeing a desired effect size of >11%; the number of facilities would have to have been increased to 150 to have this same level of precision.

This study has several strengths. It was designed to closely mimic an effectiveness study and with scalability in mind by ensuring that health workers implemented the intervention rather than the study staff. The involvement of study staff members was further minimized by using a cascade-style training approach wherein district health teams oriented health workers to the interventions, as is typical for rollout of these types of interventions in Indonesia. Additionally, our per-protocol analysis of DTPcv3 coverage and timeliness and sensitivity analysis among only DTPcv2 recipients largely mirrored our ITT analysis.

Despite finding no effect on DTPcv3 coverage, further replication of this study with a modified intervention strategy and particularly in low-income countries with limited immunization program resources, would be useful for ensuring a full picture of the effects of these interventions. In any future research, including a follow-up survey of parents exposed to such reminder interventions, determining how they use home-based records in the home would be useful. The use of stickers and home-based records as reminders may also need to be included in an integrated healthcare provider–caregiver communications package designed to ensure parents receive adequate information on the benefits of vaccination, the likelihood of side effects and adverse events following immunization and how they should respond, when and where to return for future vaccination visits, and the use of an appointment reminder sticker on the home-based record, displayed in a visible location in the house.

5. Conclusion

Compared with standard practice, the combined use of the home-based record and an inexpensive appointment reminder sticker placed on the front of the home-based record led to modest improvement in the timeliness of DTPcv3 vaccination in our intervention group. Although substantial research is focused on assessing the effect of more expensive vaccination appointment reminder options (such as text or voice messages), additional

efforts are still needed to examine the effects of simple, easily deployable reminder options in resource-limited settings where logistical hurdles to deploying more sophisticated options exist. Further understanding the benefits and limits of such simple reminder options (like the reminder stickers) in other low- and middle-income country settings will provide valuable information to program managers considering the multiple options available for ensuring children continue to return and complete all recommended vaccinations.

References

- [1]. Establishing and strengthening immunization in the second year of life Geneva, Switzerland: World Health Organization; 2018 [Available from: <http://apps.who.int/iris/bitstream/handle/10665/260556/9789241513678-eng.pdf?ua=1>.
- [2]. Jacobson Vann JC, Szilagyi P. Patient reminder and recall systems to improve immunization rates. The Cochrane Library; 2005.
- [3]. Harvey H, Reissland N, Mason J. Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: a systematic review and meta-analysis. *Vaccine* 2015;33(25):2862–80. [PubMed: 25944299]
- [4]. Oyo-Ita A, Wiysonge CS, Oringanje C, Nwachukwu CE, Oduwole O, Meremikwu MM. Interventions for improving coverage of childhood immunisation in low- and middle-income countries. The Cochrane Library; 2016.
- [5]. Oyo-Ita A, Nwachukwu CE, Oringanje C, Meremikwu MM. Cochrane review: interventions for improving coverage of child immunization in low-and middle-income countries. *Evidence-Based Child Health: Cochrane Rev J* 2012;7(3):959–1012.
- [6]. Usman HR, Rahbar MH, Kristensen S, Vermund SH, Kirby RS, Habib F, et al. Randomized controlled trial to improve childhood immunization adherence in rural Pakistan: redesigned immunization card and maternal education. *Trop Med Int Health* 2011;16(3):334–42. [PubMed: 21159080]
- [7]. Usman HR, Akhtar S, Habib F, Jehan I. Redesigned immunization card and center-based education to reduce childhood immunization dropouts in urban Pakistan: a randomized controlled trial. *Vaccine* 2009;27(3):467–72. [PubMed: 18996423]
- [8]. WHO. Practical guide for the design, use and promotion of home-based records in immunization programmes. 6/1/2015 ed. Geneva, Switzerland: World Health Organization; 2015.
- [9]. DHS. Indonesia Demographic and Health Survey 2012. MEASURE DHS; 2012 8 2013.
- [10]. Osaki K, Hattori T, Toda A, Mulati E, Hermawan L, Pritasari K, et al. Maternal and Child Health Handbook use for maternal and child care: a cluster randomized controlled study in rural Java Indonesia *J Public Health* 2018.
- [11]. Vann JCI, Jacobson RM, Coyne-Beasley T, Asafu-Adjei JK, Szilagyi PGJCDSR. Patient reminder and recall interventions to improve immunization rates. *Cochrane Database Syst Rev* 2018(1).
- [12]. Wallace AS, Mantel C, Mayers G, Mansoor O, Gindler JS, Hyde TB. Experiences with provider and parental attitudes and practices regarding the administration of multiple injections during infant vaccination visits: lessons for vaccine introduction. *Vaccine* 2014;32(41):5301–10. [PubMed: 25092632]
- [13]. Thomson A, Robinson K, Vallee-Tourangeau G. The 5As: a practical taxonomy for the determinants of vaccine uptake. *Vaccine* 2016;34(8):1018–24. [PubMed: 26672676]
- [14]. Gust DA, Strine TW, Maurice E, Smith P, Yusuf H, Wilkinson M, et al. Underimmunization among children: effects of vaccine safety concerns on immunization status. *Pediatrics* 2004;114(1):e16–22. [PubMed: 15231968]
- [15]. Gust DA, Kennedy A, Shui I, Smith PJ, Nowak G, Pickering LK. Parent attitudes toward immunizations and healthcare providers the role of information. *Am J Prev Med* 2005;29(2):105–12. [PubMed: 16005806]
- [16]. Kumar D, Chandra R, Mathur M, Samdariya S, Kapoor N. Vaccine hesitancy: understanding better to address better. *Isr J Health Policy Res* 2016;5:2. [PubMed: 26839681]

- [17]. Akmatov MK, Kretzschmar M, Krämer A, Mikolajczyk RT. Timeliness of vaccination and its effects on fraction of vaccinated population. *Vaccine* 2008;26(31):3805–11. [PubMed: 18565626]
- [18]. Siedler A, Hermann M, Schmitt H-j, Von Kries R. Consequences of delayed measles vaccination in Germany. *Pediatr Infect Dis J* 2002;21(9):826–30. [PubMed: 12352803]
- [19]. Kolos V, Menzies R, McIntyre P. Higher pertussis hospitalization rates in indigenous Australian infants, and delayed vaccination. *Vaccine* 2007;25(4):588–90. [PubMed: 16971026]
- [20]. Immunisation Grant C. and the importance of good timing. *NZ Med J* 2004;117 (1199):4.
- [21]. Curran D, Terlinden A, Poirrier J-E, Masseria C, Krishnarajah G. Vaccine timeliness: a cost analysis of the potential implications of delayed pertussis vaccination in the US. *Pediatr Infect Dis J* 2016;35(5):542–7. [PubMed: 26835971]



Fig. 1. CONSORT diagram for Indonesia vaccination reminder cluster randomized control trial, 2015–2016. Definitions: sticker = reminder sticker placed on to the child's home-based record.

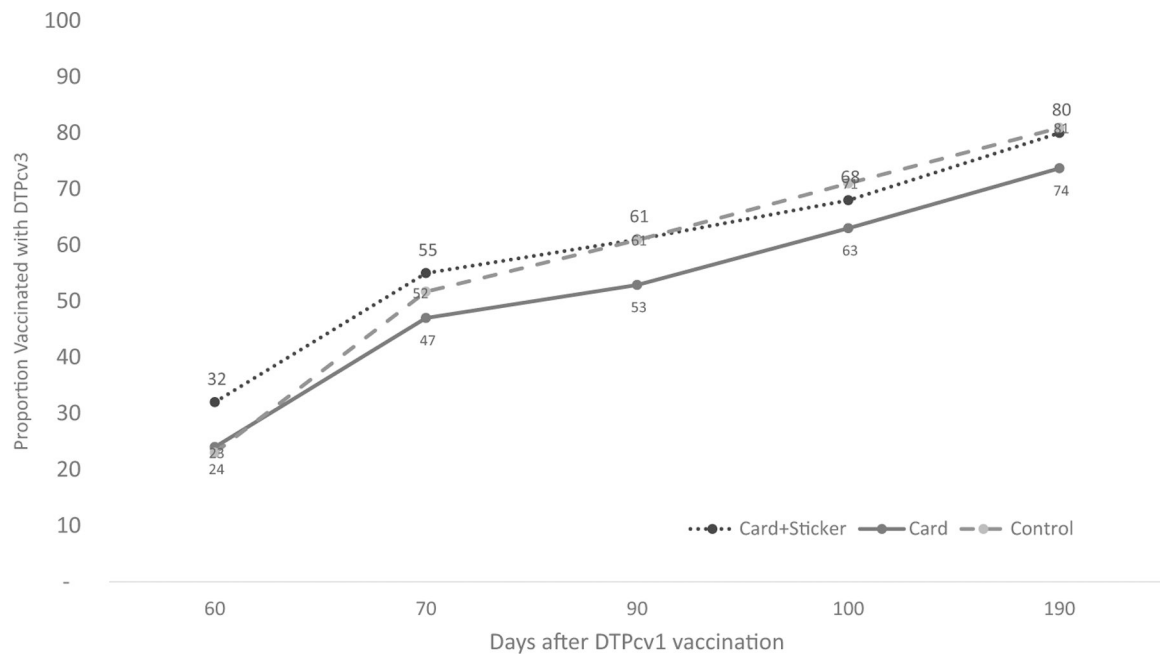


Fig. 2.

Intention-to-treat analysis of time to DTPcv3 vaccination by study group for parental reminder intervention cluster randomized, controlled trial in 90 health facilities, Indonesia 2015–2016. DTPcv = Vaccine containing diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b antigens; DTPcv1 = 1st dose of DTPcv vaccine; DTPcv3 = 3rd dose of DTPcv vaccine.

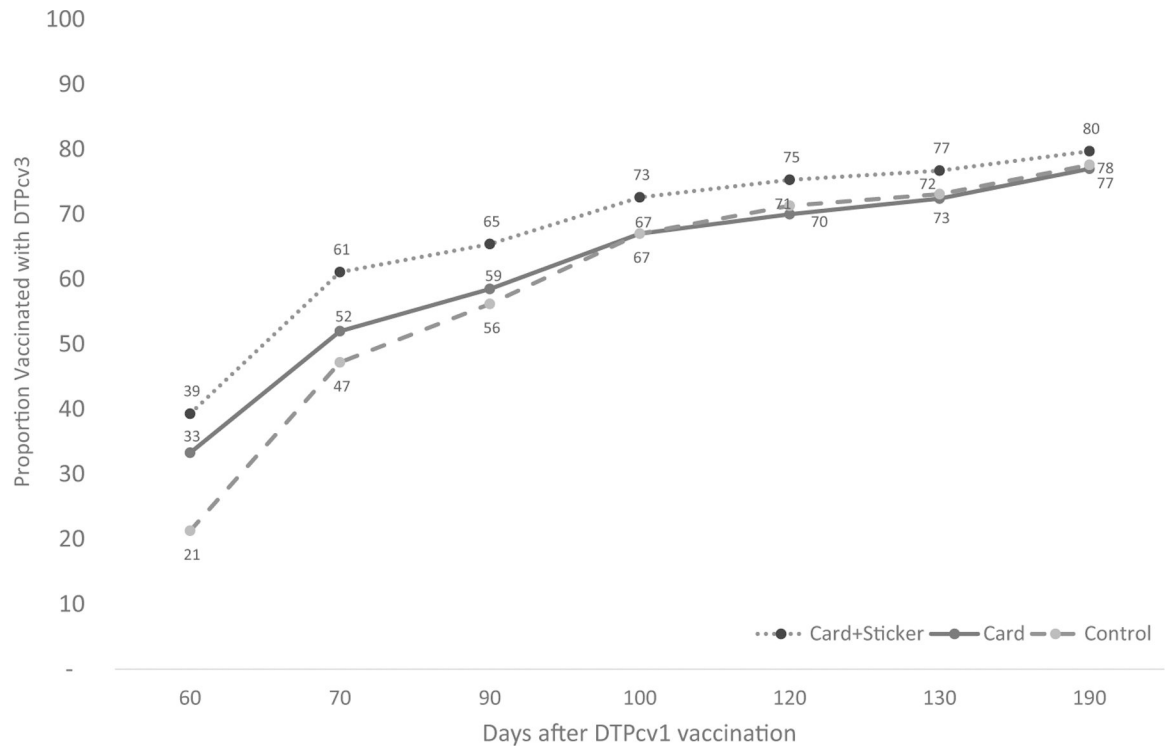


Fig. 3.

Per protocol analysis of time to DTPcv3 vaccination by study group for parental reminder intervention cluster randomized, controlled trial in 90 health facilities, Indonesia 2015–2016. DTPcv = Vaccine containing diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b antigens; DTPcv1 = 1st dose of DTPcv vaccine; DTPcv3 = 3rd dose of DTPcv vaccine.

Table 1

Characteristics of study participants and sites among study groups for parental reminder intervention cluster randomized, controlled trial in 90 health facilities, Indonesia 2015–2016.

Characteristic	Total	Study group		
		Group 1: home-based record and appointment sticker	Group 2: home-based record only	Group 3: Control (Reference)
Number of vaccination records	3616	1103	1434	1079
Child's home district, % (95% CI)				
1	9 (3, 15)	10 (0, 20)	7 (0, 16)	10 (0, 22)
2	33 (20, 46)	34 (11, 57)	34 (10, 58)	31 (9, 53)
3	26 (14, 38)	26 (7, 45)	29 (6, 52)	23 (4, 41)
4	11 (5, 18)	10 (0, 19)	14 (1, 28)	9 (0, 19)
5	20 (11, 30)	20 (4, 36)	16 (1, 30)	27 (5, 48)
Child's sex, % (95% CI)				
Male	49 (47, 51)	48 (46, 51)	49 (46, 52)	50 (46, 53)
Female	51 (49, 53)	52 (49, 54)	51 (46, 54)	51 (47, 54)
Mean age of child at Pentaval vaccination, days (95% CI)	82 (77, 87)	79 (74, 83)	88 (75, 100)	77 (73, 81)
Mean age of child at end of follow-up period, days (95% CI)	282 (271, 287)	279 (274, 284)	288 (275, 300)	277 (273, 280)
Pentaval vaccination date available in child's record, % (95% CI)				
Yes	100 (100, 100)	100 (99, 100)	100 (100, 100)	100 (100, 100)
No	0 (0, 0)	0 (0, 1)	0 (0, 0)	0 (0, 0)
Yes	93 (90, 95)	95 (91, 98)	90 (83, 97)	95 (92, 98)
No	7 (5, 10)	5 (2, 9)	10 (3, 17)	5 (2, 9)
Child's HepB birth dose vaccination status, % (95% CI)				
Yes	85 (80, 89)	87 (80, 94)	82 (73, 91)	85 (77, 92)
No	15 (12, 20)	13 (6, 20)	18 (8, 27)	15 (8, 23)

CI = Confidence interval; BCG = bacille Calmette-Guerin vaccine; HepB = Hepatitis B vaccine; Penta = pentavalent vaccine, containing diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b antigens.

Table 2

Intention-to-treat analysis of DTPev3 vaccination and timeliness by study group in parental reminder intervention cluster randomized, controlled trial in 90 health facilities, Indonesia 2015–2016.

Intervention effect	Group 1: home-based record and appointment sticker			Group 2: home-based record only			Group 3: Control (Reference)	
	RR or HR (95% CI)	RD (95% CI)	DTPev3 coverage	RR or HR (95% CI)	RD (95% CI)	DTPev3 coverage	DTPev3 coverage	DTPev3 coverage
DTPev3 vaccination by end of 200-day study period	0.97 (0.90, 1.05)	-0.04 (-0.12, 0.03)	77%	0.94 (0.87, 1.02)	-0.07 (-0.14, 0.01)	74%	78%	
DTPev3 vaccination within 60 days of DTPev1	1.46 (1.02, 2.09)*	0.09 (0.01, 0.20)*	32%	1.05 (0.71, 1.55)	0.01 (-0.10, 0.11)	24%	23%	
DTPev3 vaccination within 70 days of DTPev1	1.02 (0.82, 1.26)	0.02 (-0.09, 0.14)	55%	0.85 (0.68, 1.05)	-0.05 (-0.17, 0.06)	47%	52%	
DTPev3 vaccination within 90 days of DTPev1	0.98 (0.83, 1.17)	0.00 (-0.12, 0.11)	61%	0.84 (0.73, 1.03)	-0.08 (-0.19, 0.03)	53%	61%	
Time to DTPev3 vaccination over 200-day study period	1.00 (0.91, 1.10) /	N.A.	N.A.	0.95 (0.86, 1.04) /	N.A.	N.A.	N.A.	

Models for calculating effect include covariates for child's BCG vaccination status, age at DTPev1 vaccination, sex, district, and facility (cluster variable). Control group is reference for all measures of association.

CI = Confidence interval; RR = Risk ratio; HR = hazard ratio; RD = Risk difference; DTPev = vaccine containing diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b antigens; DTPev1 = 1st dose of DTPev vaccine; DTPev3 = 3rd dose of DTPev vaccine; N.A. = Not applicable to given intervention effect.

* Confidence intervals do not include the null value.

/ Listed value is a hazard ratio; otherwise, all other values in given column are risk ratios.

Table 3

Per protocol and post-hoc analyses of DTPev3 vaccination and timeliness by study group for parental reminder intervention cluster randomized, controlled trial in 90 health facilities, Indonesia 2015–2016.

Population	Intervention effect	Group 1: home-based record and appointment sticker			Group 2: HBR-only			Group 3: control (Reference)	
		RR or HR (95% CI)	RD (95% CI)	DTPev3 coverage	RR or HR (95% CI)	RD (95% CI)	DTPev3 coverage	DTPev3 coverage	DTPev3 coverage
PP groups	DTPev3 vaccination by end of 7-mo study period.	0.99 (0.97, 1.09)	-0.02 (-0.10, 0.06)	77%	0.96 (0.88, 1.05)	-0.06 (-0.14, 0.03)	74%	78%	
	DTPev3 vaccination within 60 days of DTPev1.	1.64 (1.16, 2.33)*	0.13 (0.02, 0.24)*	37%	1.16 (0.81, 1.65)	0.03 (-0.06, 0.13)	28%	24%	
	DTPev3 vaccination within 70 days of DTPev1.	1.24 (1.02, 1.51)*	0.11 (0.01, 0.22)*	57%	0.93 (0.74, 1.16)	-0.03 (-0.15, 0.08)	47%	43%	
	Time to DTPev3 vaccination within 7-mo study period.	1.23 (1.11, 1.37)*¹	N.A.	N.A.	1.11 (1.02, 1.22)*¹	N.A.	N.A.	N.A.	
ITT groups	Time to DTPev3 vaccination within 7-mo study period. (CP method)	1.17 (1.06, 1.28)*¹	N.A.	N.A.	1.04 (0.95, 1.15) ¹	N.A.	N.A.	N.A.	
DTPev2 only ²	DTPev3 vaccination by end of 7-mo study period.	1.03 (0.98, 1.07)	N.A.	89%	0.99 (0.93, 1.04)	N.A.	86%	87%	
	DTPev3 vaccination within 30 days of DTPev2.	1.61 (1.23, 2.10)*	0.20 (0.08, 0.32)	55%	1.12 (0.82, 1.53)	0.04 (-0.07, 0.16)	39%	35%	
	Time to DTPev3 vaccination within 7-mo study period.	1.31 (1.18, 1.45)*¹	N.A.	N.A.	1.16 (1.05, 1.27)*¹	N.A.	N.A.	N.A.	

Models for calculating effect include covariates for child's BCG vaccination status, age at DTPev1 vaccination, sex, home district, and facility (cluster variable).

CI = Confidence interval; RR = Risk ratio; HR = hazard ratio; RD = Risk difference; DTPev = vaccine containing diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b antigens; DTPev1 = 1st dose of DTPev vaccine; DTPev3 = 3rd dose of DTPev vaccine; N.A. = Not applicable to given intervention effect; CP method = survival analysis method using the counting process approach whereby participant time is classified based on when their assigned facility received intervention materials; PP group = per protocol reclassification of study groups; ITT = intention to treat classification of study groups.

* Confidence intervals do not include the null value.

¹ Listed value is a hazard ratio, otherwise all other values in given column are risk ratios.

² Population sub-group that includes only participants that received DTPev2 vaccination.