The CommCare Evidence Base for Frontline Workers

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47 studies have been conducted exploring CommCare's impact on frontline programs and the populations they serve, mostly in low-resource settings. Collectively, these studies provide strong evidence that equipping Frontline Workers (FLWs) with a mobile solution like CommCare can strengthen FLW performance and improve client behaviors and outcomes.

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Executive Summary

CommCare (www.commcarehq.org) is a customizable, open source mobile platform that enables non-programmers to build mobile applications for data collection, counseling, behavior change, and a variety of other functions. To date, hundreds of organizations have used CommCare to build mobile applications that are designed to support frontline workers (FLWs) across a variety of sectors in low-resource settings. FLWs use CommCare to track and support their clients with registration forms, checklists, SMS reminders, and multimedia—all on simple Java-enabled phones or Android smart phones and tablets. Currently, CommCare users submit over 1 million forms per month from 50+ countries around the world.

CommCare was first developed by the software company Dimagi (www.dimagi.com) in 2007 to reduce gaps that frontline programs face in delivering services to populations in low-resource settings. The purpose of this literature review is to assess all available evidence to see if CommCare achieves this goal, and effectively strengthens FLW performance, improves frontline programs, and positively impacts the health outcomes and behaviors of the clients FLWs serve.

This paper synthesizes the findings from 47 studies on CommCare's impact on FLW programs in low-resource settings. **The result was categorizing all available studies into the four research themes highlighted below**. These include 9 studies that assess client health behaviors, including 3 papers in 2015 that have statistically significant results. An additional 26 papers demonstrate improvement in FLW performance, quality of care, and program efficiency. The remaining 12 papers demonstrate the applicability and feasibility of deploying CommCare.

Theme 1: Clients are improving their health outcomes and behaviors

Pregnant women tracked through CommCare were 73% more likely to attend three or more antenatal care visits, 36% more likely to use a permanent method of contraception, and their children were 29% more likely to begin eating solid food by 6 months than the control group [Borkum, 2015].

Theme 3: Quality of care is increasing

In Nigeria, CommCare increased the antenatal care visit quality score from 13.3 at the baseline to 17.2 (out of 25) at the end line. CommCare improved the frequency in which healthcare providers performed more technical aspects of care during antenatal care visits [McNabb, 2015]

Theme 2: FLWs are improving their performance in the field

A study on CommCare in India showed a 22% increase in FLW knowledge of at least three to five pregnancy danger signs [Intrahealth, 2012].

Theme 4: Programs are running more efficiently

The introduction of CommCare in a project in India improved data completeness from 67% to 84%, and reduced the average data transmission time from FLWs to supervisors from 45 days to 8 hours when switching from a paper-based system to CommCare [Medhi, 2012].

Figure 1: CommCare MCH Application
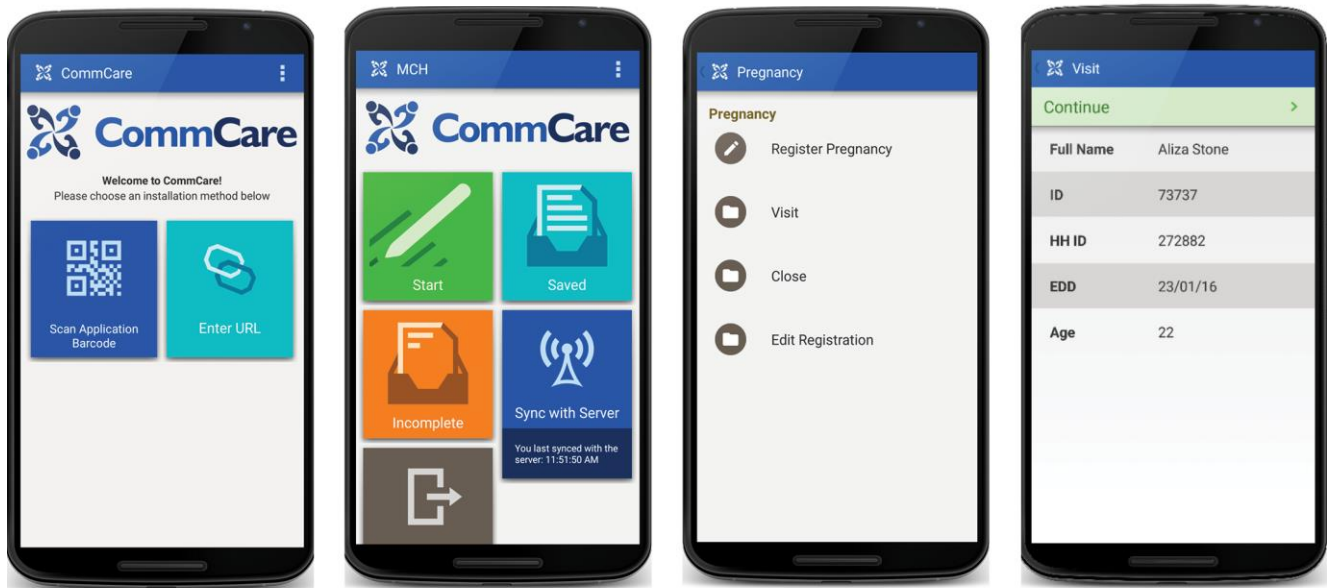
Introduction to CommCare: Mobile job aid for FLWs

CommCare is an open source mobile and web cloud product used by FLWs across a variety of sectors. It is the only platform for FLWs that is open source, supports longitudinal client tracking, is specialized for low-literate users, runs on Java and Android phones, runs offline, integrates SMS for performance improvement, and has an application builder designed for non-programmers. CommCare is actively used in over 300 projects in 50+ countries.

CommCare replaces the conventional practice of an FLW manually tracking their work via paper registers. Instead, FLWs are equipped with an inexpensive phone running open source and easy-to-navigate mobile applications that run in multiple languages. Using CommCare, FLWs can register and follow up with clients using customized mobile forms developed through programs working with low-literate FLWs in several countries. CommCare automatically submits visit data in real-time to a central cloud server. Data on the server is privacy-protected, backed up, and accessible to frontline programs' supervisors and managers worldwide.

CommCare applications have been designed and implemented for frontline programs addressing use cases across the health, agriculture, and development sectors, including maternal and child health (MCH) (Figure 1), infectious and chronic disease, agriculture, education, humanitarian response, and gender-based violence.

There are other technologies than CommCare for providing mobile applications for FLWs, including those developed by D-tree International (who have also deployed and studied CommCare), Medic Mobile, eMocha, and Mobenzi. While these systems provide many similar functions as CommCare, to our knowledge, none of these systems allows non-programmers to configure new applications. We were also able to find only a few studies on these alternative systems.

Methodology

Literature Reviewed

This evidence base is comprised of 47 papers evaluating CommCare's impact on frontline programs. This includes all 35 of the peer-reviewed publications on CommCare we are aware of, in addition to 12 unpublished (also called "grey literature") studies. There are numerous other grey literature studies, many of which were included in past versions of the CommCare Evidence Base. In this review, we included only the ones that we judged to contribute substantially to the themes discussed below, beyond the peer-reviewed studies.[1] The peer-reviewed

[1] Grey studies include [Borkum, 2015] [Braun, 2015] [CHS, 2013] [Dell, 2015] [Hackett, 2015] [IntraHealth, 2012] [Lee, 2015] [Nascimento, 2014] [Rema, 2013] [Schuttner, 2011] [WorldVision, 2012] [Worldvision, 2013]
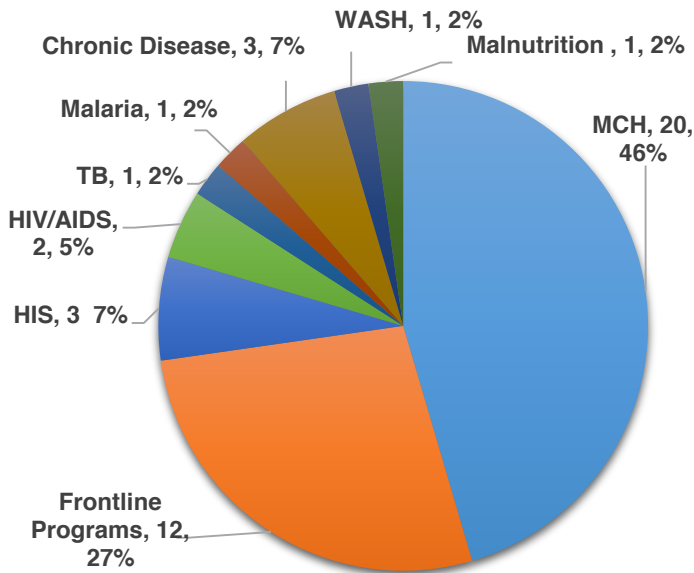
papers include three papers on a PDA-based system that is a precursor to CommCare.[2]

The CommCare platform also supports applications for supply chain management and SMS messaging, which are beyond the scope of this review.

Figure 2 below reflects the wide spread of CommCare use cases across health and development sectors.

Figure 2: Papers by Sector

Figure 2 shows the distribution of CommCare studies across health sectors, with the majority of sector-specific studies in MCH (46%).

While some studies discuss CommCare in the general context of frontline programs (27%) or health information systems (HIS) (7%), the other two-thirds of the literature evaluate CommCare within a specific programmatic area. The topics covered infectious disease—such as tuberculosis (TB), HIV/AIDS, and Malaria—chronic disease, water, sanitation, and hygiene (WASH), malnutrition, and most prominently, MCH. CommCare's strong pool of evidence in MCH is apparent throughout this review, as a large portion of the impact being evaluated is in antenatal and postnatal care (ANC and PNC), institutional delivery, and child health.

Organizational Framework

The purpose of this document is to evaluate the body of evidence assessing CommCare's impact on frontline programs and the populations FLWs serve.

Of the 47 studies reviewed, 12 papers evaluate the feasibility and acceptability of CommCare, 26 papers evaluate CommCare's impact on frontline workers and programs, and 9 evaluate CommCare's impact on client health outcomes and behaviors.

Figure 3: Growth of the Evidence Base
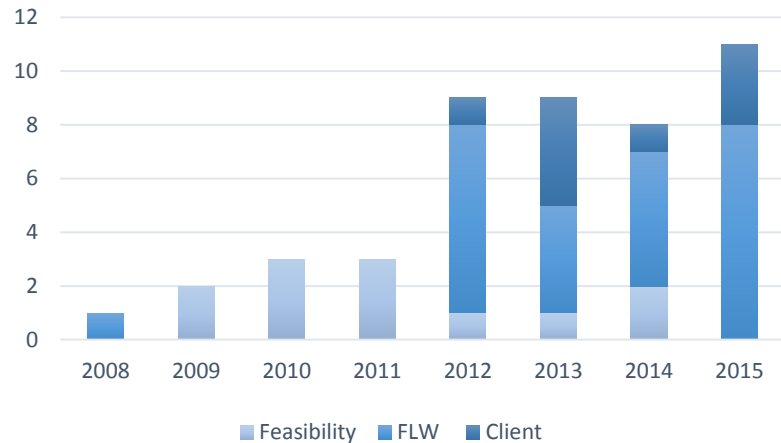
Figure 3 maps the growth of the CommCare Evidence Base from 2008 to 2015, most notably the growth of studies on client health outcomes and behaviors.

Along with the growth in the quantity of studies that have been released, between 2012 and 2015 we also saw a proportional increase of studies that assess the impact of CommCare use on client health outcomes and behaviors. Note that for published studies, the dates refer to the date of publication rather than the date of the project. There has also been an increase in the number of statistically significant results assessing CommCare's impact. Since 2013, five randomized control trials (RCTs) and three studies with other statistically significant results have been released. All three of the studies with statistically significant results on health outcomes or behaviors are from 2015.

A brief description of each paper can be found in Appendix A.

Based on the 47 papers we reviewed, the following findings are organized by four overarching themes identified in the literature: client health outcomes and behaviors, FLW performance, quality of care, and program efficiency. Note that some studies are relevant across multiple themes.

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[2] CommCare pre-cursor studies include [DeRenzi, 2008] [Mitchell, 2012] [Mitchell, 2013]

Theme 1: CommCare improves client health outcomes and behaviors

The field of mHealth is often criticized for lacking rigorous evaluations of its impact, especially in the areas of health outcomes and behaviors [Agarwal, 2015]. Several recent studies on CommCare have addressed this gap by demonstrating that mHealth can positively impact health outcomes and behaviors. This section describes details of two studies released in 2015: one is an RCT that measures key health-seeking behaviors in India, while the other evaluates maternal and infant mortality compared to a comparable control in Guatemala. Additionally, this section presents another recent RCT (whose details have not yet been released) as well as a series of prior studies that support similar conclusions. Note that all studies in this theme are on studies that evaluate CommCare for MCH.

Bihar: Improved Client MCH Outcomes and Behaviors

A study conducted by Mathematica Policy Research provides statistically significant evidence of substantive change in client behaviors from equipping

FLWs with CommCare [Borkum, 2015]. While not yet peer-reviewed, the 82-page report is available online and provides extensive details of the study. The study was conducted in the Saharsa district in Bihar, India—a district that has had persistently low health outcomes in one of India's poorest and most populous states.

The data collected by the study includes surveys of 1,500 women on their health-seeking behaviors. The 1,500 women were sampled from 70 sub-centers in Saharsa district, half of which were randomized to be in the intervention group, with the other half in the control group. All 70 sub-centers received the benefit of extensive health system strengthening implemented by CARE International in several districts in Bihar. The services included beneficiary mapping, home visit trainings and resources for FLWs, reproductive and family health counseling tools, facility-based interventions to improve the quality of deliveries, and an Interactive Voice Response (IVR) system delivering health messages to households developed by BBC Media Action and Grameen Foundation. The only difference between the women surveyed in the control and intervention areas was that FLWs in the intervention were

supported by MOTECH Suite implementation (also led by CARE), which equipped each FLW with CommCare.

There were statistically significant impacts on FLW interactions and all health domains that were considered, except for child immunizations. All of these statistically significant impacts were positive, i.e., improved by the information and communication technology (ICT) intervention. Figure 4 below shows the improvement in the intervention group as percentage increase relative to the control group among the statistically significant primary outcomes. These results are especially notable given the strong (mostly non-ICT) efforts in the control arm. This study shows the value-add benefits of ICT in addition to extensive support for the community health system.

Figure 4 shows statistically significant improvements across ANC and delivery, child health, and family planning. Most notably, the number of women who attended at least three ANC visits was 73% higher among those being tracked by CommCare as compared to the control group. Interestingly, the study found that increases in client health outcomes were not consistently accompanied by increases in client knowledge of such behaviors, which indicates that the use of CommCare addressed other barriers to client health-seeking behaviors, such as cultural norms.

The report also suggests several areas for improvement in the implementation of CommCare and MOTECH Suite. There were a few indicators where behaviors decreased, though these were not statistically significant results. On a programmatic level, the study reported challenges with data connectivity and broken mobile phones, which sometimes resulted in poor coordination between FLWs and supervisors, and an increased workload due to the continuation of paper documentation required by the government. It also highlighted low understanding and usage of the supervisor app, resulting in no substantial increase to FLW supervision. Despite these logistical challenges and the lack of improvements in supervision, equipping FLWs with CommCare created a significant impact on client health outcomes and behaviors.

These improvements in ANC, delivery, child health, and reproductive health align with the large body of evidence discussed below, indicating that CommCare's case management system improves FLWs ability to track women throughout pregnancy and connect them to vital services.

Figure 4: Statistically Significant Impact of ICT Intervention in Bihar

Statistically Significant Indicators:
- At least 3 ANC visits***: 73%
- At least 90 IFA tablets consumed***: 58%
- Use of permanent methods of contraception**: 36%
- Use of any modern method of contraception (ever)***: 34%
- Use of temporary methods of contraception (ever)**: 32%
- Child began eating solid food by age 6 months**: 29%
- Use of any modern method of contraception (current)**: 26%
- Obtained phone number of ambulance, private behicle, or FLW for delivery**: 23%
- Immediate breastfeeding***: 22%
- Child eats solid or semisolid food*: 16%
- Skin-to-skin care*: 13%
- At least 2 TT injections**: 5%

*/**/*** Statistically different from zero at the .1/.05/.01 levels

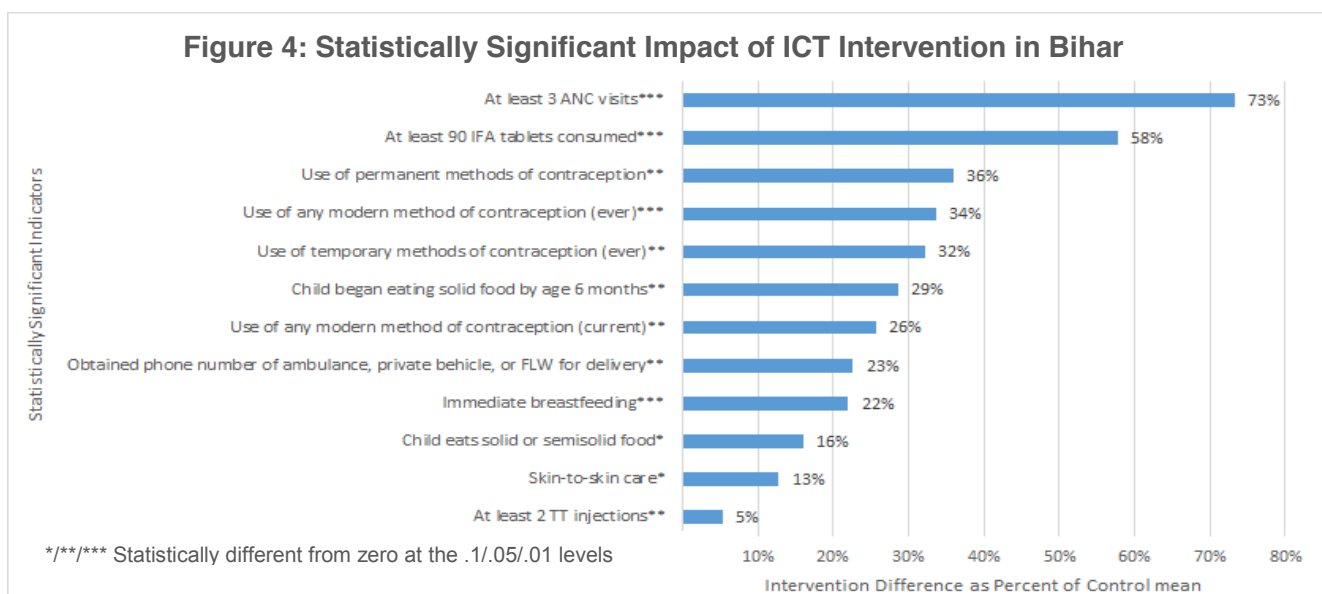Intervention Difference as Percent of Control mean

Figure 4 presents the statistically significant improvements in ANC, child health, and family planning in the CommCare intervention group. Highlights include a 73% increase in women who attended at least 3 ANC visits, 58% increase in women who consumed 90 IFA tablets, and 36% increase in women using a permanent method of contraception as compared to the control [Borkum, 2015].

Guatemala: Reduced Maternal and Infant Mortality

A study on TulaSalud's implementation of CommCare in Guatemala provides evidence of reduced maternal mortality rates (MMR) and infant mortality rates (IMR) as compared to the control areas, and the provincial average. Over the five-year intervention, MMR decreased from 309 to 254 maternal deaths per 100,000 live births, and IMR decreased from 25 to 13 infant deaths per 1,000 live births in the intervention group [Martinez-Fernandez, 2015].

The ICT intervention took place in Alta Verapaz, a predominantly rural region of northern Guatemala with high maternal and infant mortality rates (MMR and IMR). 125 FLWs in Alta Verapaz were equipped with mobile phones and the Kawok system developed by Tulasulud, which was built on CommCare, to assist with making consultations, collecting and sending epidemiological data on clients, receiving continuous training, and performing community health promotion and prevention activities. After five years of this intervention including CommCare (2008 to 2012), an observational study was conducted to compare the MMR and IMR between the districts with FLWs using CommCare, and those without it. Both the intervention and control areas had similar hospital access, racial/ethnic makeup, age, education, etc.

The study found that in intervention areas, MMR decreased from 309 to 254 maternal deaths per 100,000 live births (p<0.05), and IMR decreased from 25 to 13 infant deaths per 1,000 live births (p=0.054). Figure 5 describes the IMR rates over time in the areas with and without the ICT intervention, as well as the entire region between 2008 and 2012.
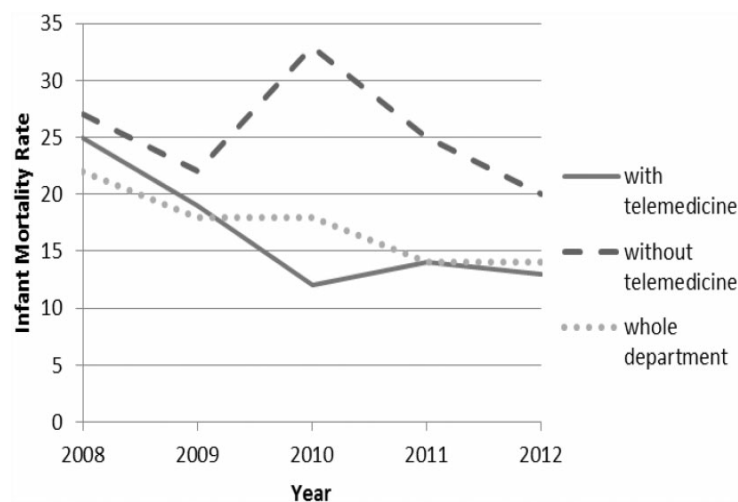
Figure 5: IMR from 2008 to 2012

Figure 5 maps the decrease in IMR rate from 25 to 13 infant deaths per 1,000 live births within the intervention as compared to the control areas and entire region over the course of the five-year CommCare intervention [Martinez-Fernandez, 2015].

Tanzania: Increased Facility-Based Delivery Rates

The results from an RCT in rural Tanzania report that mothers tracked by FLWs using CommCare had increased facility-based delivery (FBD) rates, especially among first-time mothers with low ANC uptake [Hackett, 2015]. As with the study in Bihar, both the control and intervention group received health system strengthening – in this case by World Vision. The FLWs in the intervention group were also equipped with CommCare (implemented and supported by D-tree International) to assist data collection, education, danger sign identification, and referrals.

The study included 32 villages that were cluster-randomized to control or intervention. The intervention reported that women counseled by FLWs using CommCare were twice as likely to have a FBD (OR, 1.92; p, 0.02). First-time mothers with low ANC uptake were impacted the most by the ICT intervention, with FBD rates that were 32% higher than the control group.

Prior Studies on Client Health Outcomes and Behaviors

Several other studies, most published prior to 2015, also showed client health-seeking behavior change in the areas of ANC, institutional delivery, and PNC.

In India, Catholic Relief Services (CRS) found that the average woman attended 41% more ANC sessions after CommCare was implemented, with 58% more women attending three or more ANC visits. Figure 6 below indicates that the most significant increases in average number of ANC visits attended was observed among women with a 5th grade education or lower [Ranganathan, 2015].
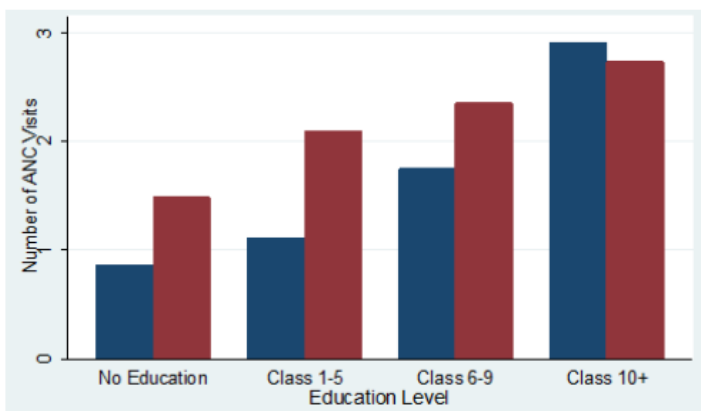
Figure 6: ANC Visit Frequency by Education Level

Figure 6 compares the impact on number of ANC visits across education levels, highlighting the largest impact among pregnant women with a 5th grade education and lower [Ranganathan, 2015].

Four prior studies reported high rates of institutional delivery among clients of FLWs using CommCare [Hoy, 2014] [World Vision, 2012] [World Vision, 2013] [Mitchell, 2013]. For example, CommCare was used in Zanzibar to increase the institutional delivery rates, especially in cases of complicated pregnancies [Hoy, 2014]. Traditional birth attendants (TBAs) were equipped with CommCare to identify danger signs, refer clients, record family members' permission to transport the women in case of emergencies, and facilitate payment to local vehicle owners to transport women to a facility. The intervention reported a 68% facility delivery rate, compared to the baseline of 40% and 23% recorded in the two control areas.

While these studies do not have the sample size to provide statistically significant results, they demonstrate that the effects of CommCare hold over a wide range of geographies and MCH programs. The results show that women of lower education levels [Ranganathan, 2015], previously lower ANC uptake [Hackett, 2015], and lower casts [Borkum, 2015] experience a higher positive impact in CommCare interventions. Taken together, there is a strong pool of evidence indicating that pregnant women who are tracked by FLWs using CommCare have improved health outcomes and behaviors in the areas of ANC, institutional deliveries, and child health.

Theme 2: CommCare empowers FLWs to improve their performance

There is a large body of evidence evaluating how equipping FLWs with CommCare effects performance. This section presents findings in three areas: FLW legitimacy and client interaction, FLW knowledge, and FLW activity.

FLW Legitimacy and Client Interaction

Several studies have shown that CommCare improves FLWs' personal credibility and the credibility of the health messages they deliver [Bhavsar, 2012] [Medhi, 2012] [Schwartz, 2013] [Braun, 2015]. These findings have emerged from qualitative interviews with FLWs, who have reported that CommCare enhances their credibility in their community, and clients and their families perceive recorded messages as more trustworthy. CommCare is widely viewed as an independent, objective source of information, which greatly benefits FLWs' ability to deliver sensitive messages. FLWs and clients in Tanzania reported that CommCare is a highly acceptable counseling tool, particularly for its improved sense of privacy and trust with clients [Braun, 2015].

A study of 50 FLWs in India found that home visits with pregnant women were more inclusive and interactive—the client's husband and mother-in-law were 60% and 110% more likely to participate, respectively, and the client was 33% more likely to ask questions when CommCare was used by the FLW [Mohamed, 2014]. The Mathematica study in Bihar also found that FLWs who use CommCare were 37% more likely to report a high level of confidence in their skill and ability to do their jobs, and were 20% more likely to run sub-center meetings by themselves [Borkum, 2015].

FLW Knowledge

FLWs who use CommCare for MCH interventions have been shown to be more knowledgeable about the health topics and services they provide. Two studies on CommCare in India showed improvements in FLW knowledge of at least three to five pregnancy danger signs by 22% [Intrahealth, 2012].

FLW Activity

FLWs whose tasks are tracked through CommCare have been found to perform more efficiently and consistently. A study in South Africa observed an increase in adverse event form submission from 5% to 27% when switching from paper forms to

CommCare [Chaiyahati, 2013]. Two studies in India found that CommCare improves FLW performance during home visits, particularly in their frequency and timeliness [Ranganathan, 2015] [Borkum, 2015]. In particular, CRS found that the percentage of women ever visited by a FLW increased by 15%, the number of FLW visits per pregnant women nearly doubled, and the percentage of women receiving counseling from their FLW increased by 28% after introducing CommCare [Ranganathan, 2015]. Mathematica surveyed beneficiaries on FLW home visit consistency and found that FLWs using CommCare were more likely to conduct visits at critical times throughout pregnancy and early childhood than in the control group (Figure 7) [Borkum, 2015].

Figure 7: FLW Visit Frequency (reported by clients)

■ Control ■ Treatment (regression adjusted)
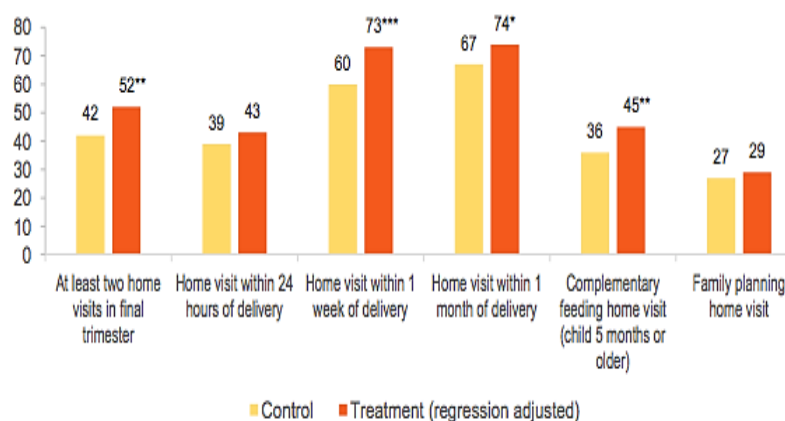
*/**/*** Significantly different from zero at the .1/.05/.01 level

Figure 7 reports increases in FLW visit frequency, particularly in the final trimester and within one week of delivery, among women in the CommCare intervention group as compared to the control [Borkum, 2015].

Home visit consistency improved at every recorded stage of maternal and newborn care among FLWs who used CommCare in the Mathematica study. These findings reinforce the notion that CommCare's capacity to track when and how FLWs perform tasks in the field increases performance and accountability.

Additions to CommCare that improve performance

Two RCTs have been conducted to measure the added impact of supplemental features to the CommCare application on FLW performance. The first study uses SMS reminders while the second uses web- and voice-based performance feedback, to evaluate the added impact of the CommCare additions on FLW performance.

SMS Feedback

A RCT in Tanzania found that SMS feedback generated from data collected by CommCare increased FLW visit frequency. The approach hinges on the fact that FLWs' visits are reported in near real-time to CommCare HQ, where they are monitored by FLW supervisors. The study found that SMS reminders that were escalated to a supervisor in the case of a missed visit improved FLW visit timeliness by 86%, compared to CommCare-using FLWs who did not receive SMS reminders [DeRenzi, 2012].

Self-Tracking Tool

The RCT in India was conducted to measure the impact of phone-based motivational messages on FLW performance [Lee, 2015]. The intervention was randomized into two groups, one who received generic advice and encouragement messages irrespective of their performance, and the intervention group who was given a self-tracking tool allowing FLWs to monitor their own performance through visual graphs and audio messages.

The study found that the intervention group made 21.5% more visits than the control group within the 12-month intervention period. Within the intervention group, most FLWs used both web- and voice-based feedback channels, highlighting the demand for diverse feedback mechanisms in FLW programs.

Theme 3: CommCare Improves Quality of Care

Many under-resourced facilities are hampered by inconsistent training of health workers, high patient loads, and minimal resources to perform medical tasks. CommCare has addressed some of these pain points by guiding health workers through clinical processes to improve adherence to protocols.

ANC and Delivery

CommCare has proven effective in improving ANC and delivery. In Nigeria, Pathfinder International found that CommCare increased the ANC visit quality score from 13.3 at baseline to 17.2 (out of 25) at endline in ANC clinics. The study found that CommCare improved the quality of health counseling during ANC, and the frequency at which healthcare providers performed more technical aspects of care during ANC visits, particularly the increased provision of HIV tests from 67.5% to 82.2% [McNabb, 2015]. In India, a mobile partograph (mLabour) built on the CommCare platform was created to overcome barriers to partograph use in under-resourced health systems. mLabour provides labor unit staff with data-driven decision support, automatic graphing to replace the paper partograph, and reminders prompting clinicians to conduct patient exams [Khalid, 2015].

Adherence to Protocols

CommCare has also been used to improve adherence to protocols by FLWs in low-resource settings. An RCT in South Africa found that FLWs using CommCare for cardiovascular disease (CVD) screenings had no errors in calculating risk scores, compared to 3.8% error when using the paper tool [Surka, 2014]. Clinicians using a CommCare precursor for Integrated Management of Childhood Illness (IMCI) classification completed an average 20% more of the required steps [DeRenzi, 2008] and completed more accurate disease classifications (90.9% versus 82.7%) that were more consistent across clinics [Mitchell, 2013]. CommCare has also been used to improve the accuracy of disease screenings for HIV in South Africa [Mitchell, 2012], Acute Malnutrition in India [Chanani, 2014], and Rheumatic Heart Disease (RHD) in Zambia [van Dam, 2015]. Two studies have found CommCare to improve medicine dosing [Segal, 2015] [Palazuelos, 2013]. In India, CommCare was used to improved efficiency in calculating prescription dosages by 20%, and decreased consultation time [Segal, 2015]. In Mexico

and Guatemala, CommCare use resulted in a higher medicine dosing accuracy compared to paper-based tools [Palazuelos, 2013].

Theme 4: CommCare improves program efficiency

As CommCare empowers FLWs and improves clinical processes, the effects of the technology in turn improve the program level. The following studies report the effects of CommCare that are not specific to client behaviors and outcomes or FLW performance, but rather improve processes at a programmatic level.

Worker Productivity

Several studies discuss the impact of CommCare on data collection and transmission in projects across WASH, malaria, and HIV programs. A WASH study across Vietnam, Cambodia, and Mozambique found that CommCare improved the efficiency of water data quality transmission from water supply structures to upper administrative levels [Ball, 2013]. Research on the use of algorithms to evaluate data submitted by FLWs found that CommCare is able to identify false data with 80% sensitivity and 90% specificity, validating CommCare as a monitoring and evaluation and data collection tool for frontline programs [Birnbaum, 2012]. Two studies discuss the impact of CommCare's improved data collection on infectious

disease control efforts. In Zimbabwe, improved transmission of malaria test data through CommCare resulted in faster and more accurate diagnoses [Dell, 2015]. A study by MEASURE Evaluation in Mozambique found CommCare to be a more efficient, effective, and cost-effective tool for monitoring HIV/AIDS patient adherence to treatment programs and appointments than paper-based systems [Nascimento, 2014]. An RCT in South Africa found that FLWs using CommCare for CVD screenings took 25% of the time to be trained than FLWs using paper-based screening tools, and 41% less time to diagnose patients for CVD than those using paper-based tools [Surka, 2014].

Communication and Supervision

As a result of improved data collection and accessibility, several studies have found CommCare can impact supervision and communication within frontline programs. In one project in India, improved data completeness via CommCare resulted in a reduction in average data transmission time from FLW to supervisor from 48 days to 8 hours [Medhi, 2012]. The Mathematica study in Bihar found that FLWs who used CommCare were 31% more likely to communicate about coordinating home visits in their catchment area than FLWs who did not use CommCare (p=.018). It also highlighted challenges with supervision, such as low understanding and usage of the supervisor app, resulting in no

substantial increase to FLW supervision (although none of supervision indicators were statistically significant) [Borkum, 2015]. Both studies in India saw improved communication with the use of CommCare by FLWs, although only minor improvements in direct supervision were observed.

Challenges

Several of the studies also describe challenges with implementing CommCare. Several studies cited technical challenges, such as broken phones that remained unfixed, lack of convenient power source to charge the devices, and inconsistent connectivity which limited data sharing and synchronization among FLW teams [Chaiyahati, 2013] [Rema, 2013] [Borkum, 2015].

Several studies also listed programmatic issues that limited the impact of introducing CommCare. One challenge in large-scale mHealth implementations is limited IT capacity within adopting organizations to address the technical issues listed above and maintain the technology [DeRenzi, 2012] [Chaiyahati, 2013]. Low adoption rates among users, or the decrease in usage over time—often referred to as the 'novelty effect' of new technology—has also been observed in CommCare projects [Borkum, 2015] [Chaiyahati, 2013] [DeRenzi, 2012] [Lee, 2015] [Segal, 2015]. Chaiyahati attributed low adoption rates to the disconnect between the application designed by the implementing organization, and the actual value it provided FLWs in their everyday work. In this case, the FLWs reported that they did not find the primary functionality of the application useful, although using the mobile phones for SMS and phone calls did improve communication between FLWs and their clients, and coordination among FLWs [Chaiyahati, 2013].

The Mathematica study also reported that the CommCare technologies to support supervision had several challenges (though they have since been improved), and that CARE had to give a very high level of training – 16 3-hour sessions over the course of 8 weeks– to achieve this level of impact [Borkum, 2015]. Other programmatic issues highlighted in CommCare projects include delayed top-up payments to FLWs [Borkum, 2015], limited stock of medical supplies (in this case, TT injections) [McNabb, 2015], and the risk of inaccuracy in self-reported data [DeRenzi, 2012]. Finally, mHealth programs moving to scale face the challenge of integrating with government health information systems [Borkum, 2015] [WorldVision, 2013]. Borkum highlighted this as a challenge raised by FLWs whose workload increased with CommCare as the government still required paper registers [Borkum, 2015]. Aside from double-documentation, there is also the more technical, and sometimes political, challenge of integrating the data collected through CommCare into the local health information reporting system [WorldVision, 2013].

Conclusion

The collective findings from the 47 papers assessing CommCare as a tool for FLWs and programs supporting FLWs are encouraging. They demonstrate the potential for organizations to use CommCare in an effort to strengthen frontline programs through improved client health outcomes and behaviors, FLW performance, quality of care, and program efficiency.

The evidence demonstrates that CommCare can strengthen frontline programs, but it is the FLWs themselves who deliver the critical services to underserved populations. Organizations must continually train and support their frontline workers in order to leverage the vast potential of integrating mobile technology into service-delivery systems, both for health and non-health sectors.

We are encouraged by the upward trend in literature evaluating CommCare's impact on client health outcomes and behaviors. As the CommCare Evidence Base expands, we hope to see more rigorous studies of this kind, with a focus on CommCare's impact on client outcomes. As the most direct measure of public health impact, these studies continue to play a vital role in evaluating and improving CommCare as a tool for FLWs.

Appendix A: Table of Evidence

*Grey literature is marked with an asterisk (*) in the Citation column.

Category	Citation	Highlights	Country	Sector
Feasibility	Amoah, 2014	*Describes potential for smart phone applications to empower health workers, and the need for evaluation of such tools*	Ghana	MCH
Feasibility	Bhavsar, 2014	*CommCare effects wide program-level and organizational-level change*	India	Frontline Programs
Feasibility	Bogan, 2009	*Describes CommCare applications being used in Tanzania*	Tanzania	Frontline Programs
Feasibility	Braa, 2010	*Presents flexible approach for utilizing DHIS2.0, OpenMRS, and CommCare together*	Sierra Leone	HIS
Feasibility	Chaiyahati, 2013	*CommCare use results in five-fold increase in adverse event submission rates using CommCare compared to paper*	South Africa	TB
Feasibility	DeRenzi, 2011a	*Presents case management framework*	Unspecific	HIS
Feasibility	DeRenzi, 2011b	*Outlines six key functions for mobile health (mhealth)*	Unspecific	Frontline Programs
Feasibility	Mangilima, 2010	*CommCare improves data collection, monitoring, and reporting for Home Based Care delivery systems*	Tanzania	Frontline Programs
Feasibility	Mhila, 2009	*When used as community-based social support of chronic patients, CommCare results in "much easier, much faster, and potentially more accurate reporting," saving CHWs 4 hours/month compared to the paper reporting system*	Tanzania	Chronic disease
Feasibility	Routen, 2010	*Describes how CommCare can be used to support family planning*	Unspecific	MCH
Feasibility	**Schuttner, 2011***	*CommCare helps improve linkages between the community and health care center*	Zambia	Frontline Programs
Feasibility	Treatman, 2012a	*Commcare empowers adolescent girls when used as a job aid by community health workers in Bihar*	India	Frontline Programs
FLW	Ball, 2013	*CommCare improved the efficiency of water quality data transmission in three distinct water supply structures across Vietnam, Cambodia, and Mozambique, and increased data availability at upper administrative levels in Mozambique.*	Cambodia Mozambique Vietnam	WASH
FLW	Birnbaum, 2012	*CommCare can use algorithms that detect outliers and identify FLWs who are submitting false forms*	Tanzania	HIS
FLW	**Braun, 2015***	*CommCare is a highly acceptable counseling tool, particularly for its improved sense of privacy and trust with clients*	Tanzania	MCH
FLW	Chanani, 2015	*CommCare significantly improves average screening error rates for Acute Malnutrition, and reduce variability in FLW performance.*	India	Malnutrition
FLW	Chittamuru, 2012	*CommCare lends credibility to the message of FLWs by allowing FLWs to work around cultural and social barriers when discussing sensitive or taboo topics*	India	MCH
FLW	Davidyock, 2014	*CommCare has good discriminatory screening ability in diagnosing 190 subjects with moderate or worse COPD.*	USA	Chronic Disease
FLW	Dayalu, 2015	*Metadata is used to explore how CommCare is adopted and used over time by humanitarian workers in resource-poor settings, demonstrating the utility of mobile technology for programmatic design and evaluation.*	Unspecified	Frontline Programs

FLW	**Dell, 2015***	*CommCare accurately captures and transmits malaria test data, demonstrating the potential for mobile, camera-based systems to assist health workers in low-resource environments with the process of quickly and accurately diagnosing a variety of infectious diseases.*	Zimbabwe	Malaria
FLW	DeRenzi, 2008	*A pre-cursor to CommCare provided electronic guidance that increased adherence to clinical protocols by ~20%*	Tanzania	IMCI
FLW	DeRenzi, 2012	*Reminders and escalation to supervisor increased timeliness of visits by 85%*	Tanzania	Frontline Programs
FLW	**IntraHealth, 2012***	*CommCare improves FLW knowledge of at least 3 of 5 danger signs from 48% to 70% after four months of use*	India	MCH
FLW	Kanter, 2014	*CommCare has the advantages over a paper-based survey in its capacity for multiple languages, and faster data collection with equivalent reliability and validity.*	Guatemala	HIS
FLW	Kaphle, 2015	*CommCare adoption by FLWs can positively impact the quality and experience of care they provide. Individual characteristics, especially literacy and age, can be important elements affecting technology adoption and the way users leverage the technology for their work.*	India	Frontline Programs
FLW	Khalid, 2015	*mLabour, a mobile partograph built on the CommCare platform, is designed to overcome known barriers to partograph use by providing decision support, automatic graphing, and reminders prompting clinicians to conduct patient exams*	India	MCH
FLW	**Lee, 2015***	*Self-tracking CommCare app for ASHAs with visual graphs and audio feedback on performance increases home visit frequency by 21.5% compared to control.*	India	MCH
FLW	McNabb, 2015	*CommCare leads to improvements in quality of ANC care by CHEWs, improves quality scores related to frequency that CHEWs performed technical aspects of care, and has a strong effect on the counseling provided by CHEWs*	Nigeria	MCH
FLW	Medhi, 2012	*CommCare use by FLWs reduces average program data transmission time from 45 days to 8 hours; improves data completeness from 67% to 84%; and improves social respect within the community, as reported by FLWs*	India	HIS
FLW	Mitchell, 2012	*Pre-cursor to CommCare effectively screens HIV patients*	South Africa	HIV/AIDS
FLW	Mitchell, 2013	*Pre-cursor to CommCare improves the consistency, accuracy and completeness of IMCI assessments*	Tanzania	IMCI
FLW	Mohamed, 2014	*CommCare increases the duration of client visits and engages more decision makers*	India	MCH
FLW	**Nascimento, 2014***	*CommCare is more efficient, effective, and cost-effective tool than paper systems in conducting searches for HIV/AIDS patients that defaulted on ARTs, missed appointments, or lab test dates*	Mozambique	HIV/AIDS
FLW	Palazuelos, 2013	*CommCare improves medicine dosing accuracy over paper tool, and enhances FLW credibility within communities*	Mexico/ Guatemala	Frontline Programs
FLW	Segal, 2015	*CommCare improves clinician efficiency in calculating prescription dosages by over 20%, and decreases average consultation time by 1.5 min*	India	Frontline Programs

FLW	Surka, 2014	*CommCare enhances screening for CVD by enabling faster and easier trainings, more efficient screenings, and by reducing the margin of error in calculating CVD risk scores compared to the paper-based tools*	South Africa	Chronic disease
FLW	Schwartz, 2013	*CommCare informs client counseling sessions, tracks clients, and helps ASHAs deliver appropriate information*	India	MCH
FLW	Treatman, 2012b	*CommCare's multimedia improves experience for clients and FLWs*	India	Frontline Programs
Client	**Borkum, 2015***	*RCT on CommCare found statistically significant improvements in antenatal care, delivery, child health, and reproductive health with the addition of CommCare to maternal and child health programs*	India	MCH
Client	**CHS, 2013***	*CommCare use for family planning counseling leads to increased demand for family planning services*	Benin	MCH
Client	**Hackett, 2015***	*CommCare intervention found that women counseled by FLWs using CommCare were twice as likely to have a facility-based delivery, with the highest impact on institutional delivery rates among first-time mothers with previously low ANC uptake.*	Tanzania	MCH
Client	Hoy, 2014	*CommCare intervention achieved an institutional delivery rate of 71% compared to the regional average of 32%*	Tanzania	MCH
Client	Martínez-Fernández, 2015	*CommCare intervention group area shows maternal and child mortality indicators (maternal and infant mortality) that are not only lower than the indicators in the control area, but also lower than the provincial average.*	Guatemala	MCH
Client	Ranganathan, 2015	*CommCare intervention increased the average number of ANC sessions per woman by 41%, with 58% more women attending 3 or more ANC visits. It also doubled the number of FLW visits per woman.*	India	MCH
Client	**Rema, 2013***	*CommCare intervention improves mothers' ability to identify danger signs during pregnancy and postpartum period.*	Mozambique	MCH
Client	**WorldVision, 2012***	*Pregnant women that had access to CommCare had a higher likelihood of accessing antenatal care, have births assisted by a skilled provider, know pregnancy danger signs, seek care at a facility, and be more prepared for birth (64%) than in five similar studies, where rates varied between 7% and 48%.*	Mozambique	MCH
Client	**WorldVision, 2013***	*CommCare is attributed with an improvement in women who received antenatal care (20%), had skilled deliveries (22.3%), had birth plans that coordinated with a facility (12.6%), and who had increased knowledge of pregnancy danger signs (12.6%)*	Afghanistan	MCH

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