Subsidies, Information, and the Timing of Children's Health Care in Mali

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Abstract

Sustained progress on child mortality requires better curative care. However, policy instruments intended to increase access to healthcare may only incompletely reduce underuse or create overuse. We conducted an RCT of 1,768 children in Mali that cross-randomized primary care subsidies and community health worker visits. We analyze how these interventions affect the targeting of acute care, which depends not only on overall demand, but on whether children receive care when actually sick. We collect nine weeks of daily symptom and health care data to measure demand conditional on need for care, as defined by WHO standards. Parents are over five times more likely to seek care when it is medically indicated, yet the probability of getting needed care remains below 5% in the control. Subsidies increase utilization by over 250%, significantly reducing underuse with moderate effects on overuse. Health worker visits have little aggregate effect on care usage.

Keywords: demand for acute care; children's health care; health care underuse and overuse; health care subsidies; community health workers; Mali

JEL codes: I11, I12, O15

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1 Introduction

In the last two decades, great strides have been made in reducing child mortality, primarily through preventive care programs (e.g. Bhatt et al., 2015). Nonetheless, over five million children under five years died in 2018 alone (Hug et al., 2019). The current consensus is that further progress requires better care for children who are acutely ill. Two demand-side policies have played a key role in this effort: health care subsidies that provide free access to basic services, and home visits by community health workers, who monitor the health of the child and educate caretakers about symptoms.

The policy debate on how to fund primary care for children is longstanding, and a major push is underway towards subsidized care to achieve universal health care (UHC) for children and mothers (e.g. Save the Children, 2008; UK Secretary of State for International Development, 2009; Jamison et al., 2013). By 2016, 33 African countries had developed financing strategies to achieve UHC (Barroy et al., 2016; Cotlear and Rosemberg, 2018), and Mali's Ministry of Health announced the intention to provide free care in 2019 (Adepoju, 2019). The removal of user fees has been accompanied by a rapid expansion of community health worker (CHW) programs (Singh and Sachs, 2013). As part of their role CHWs conduct basic triage, that is, they monitor symptoms and guide the use of formal care. By recent estimates CHWs cover over 3 million people in Mali (Pascal Saint-Firmin et al., 2021).

As African health care systems move towards more fully subsidized access – at considerable cost – it is important to understand how health care demand is affected. Are unfilled health care needs better met? What share of expenses may be paying for unnecessary treatment? In other words, we need to understand the effects on the allocation of acute care. It is known that subsidies for *preventive* care can greatly reduce underuse ('Ashraf et al. (2010); Dupas and Cohen (2010); Ashraf et al. (2013); Dupas (2014); Miguel and Kremer (2004), see also 'Kremer and Glennerster (2012)). But unlike preventive care, acute care is only sometimes needed, and the decision when to seek care is up to the child's caretakers at home. Subsidies increase demand, which can lead to a more efficient allocation of care if it

succeeds in alleviating underuse for children in need of a doctor, but also risks overtaxing very resource-constrained healthcare systems if it induces overuse for children who do not need care. In this context, a rationale for the triage activities as part of typical CHW programs may be that they could further improve the allocation of acute care by encouraging necessary and preventing unnecessary doctor visits. But these activities are valuable only if parents have trouble judging when their child is in need of a doctor's evaluation.

Assessing the (mis)allocation of acute care requires information on healthcare utilization *conditional on the child's health status* to distinguish an unfilled need for care from demand saturation and overuse from appropriate use of care. At present, there is only limited evidence on the health effects of removing user fees, and those studies cannot typically directly identify misallocation (Tanaka, 2014; Powell-Jackson et al., 2014; Ridde and Morestin, 2012; Dzakpasu et al., 2013). Similarly, studies on the demand side effects of health insurance most often measure unconditional demand for care and health outcomes, but not allocation (King et al., 2009; Thornton et al., 2010; Malani et al., 2021).

In this study, we conducted a randomized control trial of a healthcare program that offers families (i) a health care subsidy, which reduced primary care cost per formal care visit for children under five years by 72% on average, and (ii) biweekly visits from a community health worker, who monitors the child's symptoms and advises on need for care. Our main contribution is a novel way of measuring the allocation of care. Nine months after intervention start, we collected nine weeks of detailed daily data on children's health and health care in weekly home visits. We recorded 14 symptoms drawn from the WHO/Unicef Integrated Management of Childhood Illness (IMCI) guidelines for CHWs, used in over 80 countries. These allowed us to classify each day in an illness spell as either "early" for care or "care required", as defined by the IMCI.

While the optimal allocation of care is unobserved, the IMCI guidelines provide at minimum an assessment of the *relative* value of health care on different spell days, and represent an approximation of policymaker preferences conditional on observables. Suppose an inter-

vention induces visits to the clinic on "early" days and some, but not on all "care required" days; based on the IMCI benchmark this constitutes an increase in overuse while leaving some underuse of care unaddressed. Within this framework, subsidies lower the parents' cost threshold and could thereby reduce underuse, but also risk increasing overuse. The CHW here has the potential to reduce both overuse and underuse if parents have difficulty identifying a child's need for healthcare. In this case the subsidy and CHW visits could be complements: the subsidy increases access to curative care, and the CHW help parents use this benefit efficiently.

In the control group of our sample, we find that overuse of care was rare, whereas underuse was rampant, with a probability of care-seeking on a "care required" day of five percent or lower. Nonetheless, the probability of a doctor visit was more than five times higher on "care required" than on "early" days, consistent with parents already being able to distinguish need for care. The subsidy increased the daily probability of seeking formal care by 270 percent and the total value of care received by 77 percent, without crowding out private spending. More than 70% of these additional doctor visits were recommended according to IMCI guidelines. By contrast, the CHW visits had no aggregate effects on demand or the allocation of care between "early" and "care required" days – even though they positively affected health knowledge, use of preventive care, malnutrition rates, and diarrhea incidence and care one year later (Dean and Sautmann, 2023).[1]

Overall, our results suggest that cost constitutes a primary barrier to appropriate care in our population, and that subsidies will primarily reduce underuse, not increase overuse. Difficulty identifying a child's need for care is not a significant factor in the misallocation of curative care, and consequently, the CHWs do not lead to further improvements. The results are encouraging for the planned roll-out of subsidized care in Mali. Our findings complement a study in Bamako over the same period by the NGO Muso and the Malian Ministry of Health in 2008-2015 (Johnson et al., 2013, 2018), which found reduced incidence of febrile

[1] In an earlier version of this paper we also showed tentative evidence that the CHW improved care seeking for the youngest children (Sautmann et al., 2020).

illness and mortality after the introduction of CHW visits, user fee removal, and health system strengthening measures (although the program effects cannot be easily distinguished from other time trends). Our experiment directly shows changes in curative care seeking in response to the subsidy, pointing to a potential pathway for positive health outcome effects. The role of CHWs in acute care utilization call for further study, given the important role of CHW interventions in health policy in general and in Mali in particular.

Our paper contributes to the literature on curative health care for children in low-income countries. Research on the detailed impacts of policies intended to improve acute care is still fairly rare, with some exceptions, such as Powell-Jackson et al. (2014); Okeke (2023). We show that underuse is pervasive at the extensive margin of acute care utilization and that subsidies can substantially improve this misallocation. These results contrast with Cohen et al. (2015) and Lopez et al. (2022), who examine the effect of subsidies for malaria drugs at the point of purchase and document significant rates of overtreatment that increase with subsidization. Similarly, patient audit studies have found pervasive non-indicated or mis-targeted medical treatment (Das et al., 2016; Currie et al., 2014). This points to a challenging twin problem, where underuse at the extensive margin, in the form of too few contacts with the health care system, occurs simultaneously with overuse at the intensive margin, in the form of overmedication conditional on such a contact.

2 Study Background and Data Collection

Mali has high rates of fertility and maternal and child mortality. The Malian health care system builds on a network of community health clinics (CSCOMs). At the time of the study, CSCOM care was partly subsidized, but primarily funded by user fees. Public health care is flanked by a private sector with higher prices and informal sources such as market stalls.

This study was conducted in Sikoro, a peri-urban area of the capital Bamako. Study participants generally live relatively close to formal healthcare providers, meaning travel

time is not a major constraint on care seeking. This is typical of the 45% of West Africans that live in urban settings, the population to which our results are most likely to generalize.

2.1 Study Design and Sample

Mali Health started the Action for Health (AfH) program in 2010 in collaboration with two local CSCOMs.

Children in the program are entitled to free consultations at a partner clinic, and free treatment for diarrhea/malnutrition, malaria, vaccine-preventable diseases, and respiratory infection. Families are also assigned a CHW who visits every two weeks and evaluates children for signs and symptoms that may warrant triage to a clinic. Families can call on the CHW for guidance on the child's health and the need to see a doctor. Unlike in other programs especially in rural areas, the CHWs do not themselves administer medical tests or treatment.[2] The goal is to help families to provide adequate care at home where possible and see a trained medical provider when necessary, who can conduct medical tests (e.g. malaria), assess for treatable infections (bacterial, inflammation), and look for signs that require immediate intervention (dehydration, respiratory distress). Additionally, the CHWs teach good health practices and dispense preventive products such as water chlorination tablets. We analyzed the effects of the AfH interventions on preventive care and longer-term health in a separate paper (Dean and Sautmann, 2023).

The clinics in this study were financially supported by Mali Health and subject to quality control. We assume that the standard of care provided meets WHO expectations about quality when formulating treatment recommendations for low-income countries. While we cannot rule out supply side responses, Mali Health controlled costs in the subsidy group by enforcing treatment guidelines for common diagnoses and conducting regular audits. The subsidy did not change the average value of services received per visit (see section 2.2).

The study took advantage of a planned roll-out wave for AfH. In mid-2012, Mali Health

[2]While CHW programs were initially conceived to serve remote locations, a significant share of CHWs operate in urban areas. In Mali, 6% of CHWs work in Bamako (Pascal Saint-Firmin et al., 2021).

identified all families with eligible children in the expansion area who satisfied a proxy-means test. The baseline survey took place in 2012. The subsidy and CHW components of the program were cross-randomized at the compound level, stratified by average household assets, number of eligible children, and location. The study sample is small relative to the overall population, mitigating concerns over general equilibrium effects or spillovers due to differential disease transmission. In Dean and Sautmann (2023) we find significant CHW effects on health knowledge, suggesting limited information spillovers.

All households found at baseline were included in the random assignment to the different treatment groups and revisited in 2013 during the period of highest malaria and diarrhea incidence (September-November). The health workers in the two CHW treatment groups were trained and supervised separately, to avoid spillovers.[3]

Of the 1804 eligible children identified in the census, 1732 were found at baseline and enrolled in the study. The interventions started in early 2013. Attrition between baseline survey and follow-up was 8-11% across arms, the differences are not significant (3 refusals, 5 deaths, and 157 moves from the area). The remaining baseline sample consisted of 1567 children from 990 households in 642 compounds. We included an additional 201 3-12 months old children who were newly reported by the caretakers in the study. Newborn children were enrolled in AfH either by the CHW or by a program officer who visited study households every 3 months. Table B.1 in the appendix shows the sample over the study period.

Table B.2 in the appendix shows sample characteristics and confirms balance. There are on average more than six people in a household, due in part to polygamous marriages. About half of the household heads are literate and 73% speak the *lingua franca* Bambara. Households report on average about US$6600 in assets, with an owner occupancy rate of 41%. Only 13% of household heads earn a regular salary. The closest source of formal health care is on average 546 meters away (less than 0.4 miles). The study children are well below age-typical weight for height (normalized using W.H.O. reference distributions). We

[3]To manage travel distances, Mali Health paired health workers of similar experience and quality and assigned one of each pair to the CHW-only or the full program arm in an overlapping pattern by stratum.

control for these covariates below, except weight for height, which may be affected by the interventions.

2.2 Health Calendar

Aided by simple pictorial diaries developed for this purpose, we collected daily information on key symptoms, health consultations, and medications over the course of nine weeks. Surveyors visited weekly to avoid long recall periods (Das et al., 2011) and were instructed not to comment on the child's health.[4]

Symptom Calendar. The symptoms we record are based on the C-IMCI guidelines by the WHO (see also below). The survey explicitly asked about convulsions, fits, or spasms; lethargy or unconsciousness; inability to drink; vomiting; coughing; difficulty breathing; more than three loose stools; blood in the stool; sunken eyes; and unusually hot skin. We constructed indicators for skin conditions, cold symptoms, ear pain, stomach pain, and injuries from responses on "other health changes". Appendix C provides a detailed description.

Consultations. Caretakers were also asked if they discussed their child's health with anyone, and we recorded their job title, facility, waiting time, treatments received and costs incurred. Appendix Table B.3 provides an overview of these consultations, grouped into CSCOM visits; private doctors, hospitals or clinics; pharmacies; and purchases from informal providers.

The table shows that the subsidy program reduced the average cost of a CSCOM visit to the household by 71%, from CFA 2850 to 933 (476 CFA equaled 1 USD in 2013). Families paid at non-participating clinics or if the child received services not covered under AfH. CSCOMs provide similar value per visit with and without the subsidy (CFA 3652-3807), suggesting that doctors did not respond to the subsidy by raising costs. The difference in cost and value is due to the subsidy and to families seeking help to pay for the child's care,

[4]We cannot rule out all Hawthorne effects, but argue they likely faded out: in the baseline pilot of the health diaries, initially elevated symptom reporting rates stabilized after just one week, consistent with the behavior of doctors when observed by other doctors (Das et al., 2008).

e.g. from relatives. Wait times at the CSCOM are somewhat longer with the subsidy than without (47 vs. 36 mins). All study patients frequent the same CSCOMs, but it is possible that subsidized patients receive more comprehensive medical tests, which require waiting. We cannot rule out that they see different personnel, visit at busier times of the day, or wait longer because their symptoms are less urgent.

Private providers are pricier (CFA 5371), prescribe more medications, and have longer wait times than CSCOMs (75 mins), whereas a typical pharmacy visit is shorter and less expensive (12 mins wait time, cost of CFA 1474), has fewer antibiotic and antimalarial sales, and only 61% of the time occurs on a day when care is required by IMCI standards (compared to 74-79% with formal care). Purchases from informal sources such as peddlers, stalls, healers, or Islamic marabouts come at an even lower cost (CFA 241, 2 mins wait) and with lower rates of prescription drug purchases, and 58% of the time on "care required" days. Overall, the data suggest that parents use pharmacies and informal sellers more often on "early for care" days to support home care with remedies such as pain killers or cough syrup.[5]

For our analysis, we classify CSCOMs and private providers as formal care. The interventions are not intended to promote medical consultations at pharmacies or informal sellers, where the provider is not licensed or trained to make a diagnosis or sell prescription drugs (even though they may do so in practice). Table B.3 shows that demand for private providers, pharmacies, and informal visits in the subsidy arms falls by 50%, 32%, and 26%, respectively, suggesting that households recognize private providers as the closest substitute for a public clinic visit. Nonetheless, in Appendix table B.7 and figure B.2 we repeat our main analysis of demand while including pharmacies as a close substitute for clinic-based formal care. The key conclusions are very similar.

[5]We did not explicitly ask about CHW visits to avoid a connection between the survey and Mali Health. Data on self-reported visits suggests high rates of measurement error and is not included here, see also Dean and Sautmann (2023).

2.3 Illness Spells and IMCI classification

We use the health calendar to construct illness spells. Our focus is on "pre-care" spell days up to the first contact with the formal health system. We identify "overuse" and "underuse" of care relative to community health guidelines out of the IMCI, the WHO's and UNICEF's primary children's health program, which has been adopted by over 80 countries (Bryce et al., 2004). The C-IMCI rule charts for CHWs use easy-to-spot symptoms to classify symptoms into gastrointestinal illness, respiratory illness, and so on (see Gove (1997) on the effectiveness of these checks), and to make a recommendation for triage into formal care based on severity and duration of symptoms. These care-seeking recommendations provide an intuitive assessment of a child's need for formal health care, and we assume they take into account the expected quality of care and resource constraints in LMIC healthcare system. For instance, since a cough often indicates a viral infection, it requires an assessment for a more serious illness such as tuberculosis only after 14 days. Diarrhea alone can be treated with home remedies, but in the presence of sunken eyes (dehydration) or blood in the stool (dysentery) requires immediate attention. Appendix C describes in detail how we use these rules to classify every pre-care spell day as either an "early" day (i.e. before care should be sought) or a "care required" day (on or after the day at which care should be sought). As an example, consider a child with cold symptoms who develops a fever on day 3, visits the CSCOM on day 5, and recovers on day 8. This is a five day pre-care spell with three care-required days (days 3-5) that ends in a consultation.[6] The symptoms we collected focus on conditions that mothers and surveyors can easily recognize. We also interpret the IMCI guidelines conservatively, and the IMCI itself is not exhaustive. As a result, our classification as "care required" represents a lower bound for need for care.

We use IMCI-defined need for care to assess welfare since the socially optimal allocation of

[6]Table B.4 in the appendix shows a complete breakdown of all formal consultations during and outside of a spell. Only 5% of visits occur outside a spell. Of the rest, 88% (or 494) constitute the first formal visit during a spell. Later visits almost exclusively occur after a spell entered "care required" status and when the child is still exhibiting symptoms.

care is unobserved and demand is distorted by market imperfections, information frictions, and uninternalized externalities. Conditional on the limited information an outside observer has, the IMCI provides at a minimum a *ranking* of when healthcare is most valuable, but many policymakers would likely also agree that all children should receive care when the IMCI recommends it. Studying demand as a function of symptom severity complements studies that measure mortality or health outcomes by providing direct information on care seeking behavior and potential overuse of care.

Appendix Table B.5 shows pre-spell days per child and the share on which each symptom is present, in total and by care-required status. On average, 16.3 of 59.8 observed days per child (27%) were (pre-care) spell days, and on 6 of them there was a need for care. Convulsions, lethargy, inability to drink, and vomiting should trigger immediate care, so they always occur on care-required days. The biggest contributor to need for care is fever (hot skin). The data show that the children in our sample are often ill with symptoms that point to dangerous conditions like malaria, but also often experience less severe symptoms.

Appendix table B.6 summarizes the observed pre-care spells. Due to spells recorded in the first week of the survey or after survey interruptions, 464 illness spells are potentially left-censored. We exclude these spells from our main analysis below because need for care cannot be determined based on symptom duration. Our results are robust to including these spells (Appendix Table B.8). This leaves us with 3747 spells, with an average length of 6.43 days.

Note that in most of these spells, the child receives no formal care and eventually recovers from the illness unaided. The potential for spontaneous recovery is an important property of acute illness and requires updating the care-seeking decision over time. If recovery always required medical care, it should always be received on day 1 of the spell, and any delay would constitute underuse.

3 Demand for Acute Health Care

We treat a parent's decision to seek acute health care for their child as a dynamic choice, that is, a decision *on what day t* to see a doctor during an illness spell. This is based on the observation that for many illness spells, it is initially likely that the child will recover fully without medical intervention, but as time goes by, the probability of recovery without treatment decreases, and it is optimal to seek formal health care to avoid further suffering (or worse). This notion can be formalized in a model of belief updating described in Appendix A, where we show that the value of care increases day by day and eventually exceeds the cost, as seen in figure 1. This model of the decision to seek care illustrates why we need daily data to analyze the allocation of health care. Not seeking care immediately when a spell enters "care required" status is "underuse" of care based on the risk of harm, even if the child eventually sees a doctor. On the other hand, when care is not yet required, there is sufficient uncertainty whether care will be needed at all, and a doctor visit at this time is "overuse" of care. Without learning and the possibility of recovering without treatment, the choice to seek care would be a simple yes/no decision on the first day of illness, because getting earlier care for the same illness is always better.

We assume that the policymaker faces a similar stopping problem, albeit with different parameters: the optimal threshold for recommending a doctor visit depends on the social costs vs. expected benefits from formal healthcare at time t. This is consistent with official care seeking recommendations such as the IMCI (see previous section), where duration of symptoms is a key indicator for health care needs.

The policymaker and parent may differ both in the threshold they use (due to different perceived costs) and in beliefs about the value of care (due to different information about illness severity). When the parents' cost threshold is higher than that of the policymaker, the parent will not always take a child to the doctor when optimal, an incidence of *underuse* or visiting the doctor *too late* relative to policymaker preferences. A subsidy that lowers the care-seeking threshold of parents can increase utilization, but if the threshold becomes too

low, *overuse*, or *early* care, may now occur (see panel A of figure 1). In a heterogeneous patient population a subsidy policy may eliminate some underuse, yet simultaneously create some overuse.

Disagreement between the parent and the policymaker may also arise if parents cannot distinguish between more and less severe illness, e.g. a diarrhea spell with or without signs of dehydration. Parents who do not know what symptoms indicate need for care will both *overuse and underuse* care (see panel B of figure 1). Subsidies can not address this because they can only monotonically increase utilization, but a successful information intervention – e.g. in the form of a CHW who monitors symptoms – may improve allocative efficiency if parent and policy maker have the same cost threshold. However, improving information alone may be ineffective, or even counterproductive, when cost thresholds are not aligned, as shown in Sautmann et al. (2020).

In summary, if the main barrier to a good allocation of care is high cost, parents in the control group will seek care primarily on care-required days, but we will see significant underuse. If poor information is an important barrier, then care seeking will be only weakly correlated with "care required" status, and we may see both overuse and underuse (observation 1). A subsidy will increase utilization and reduce underuse, but also potentially increase overuse (observation 2). If the subsidy aligns the cost threshold and the CHW intervention aligns information, then the two interventions may complement each other in decreasing both underuse and overuse (observation 3). Observation 3 is a motivation for combining interventions: subsidized care gives families access to health services, while better information ensures that they make efficient use of this benefit.

4 Results

We begin by verifying that subsidies increase the unconditional utilization of acute care. The regressions in Table 1 include dummies for "receiving the subsidy", "receiving CHW visits", and their interaction, along with child and household covariates and stratum fixed

effects (standard errors clustered at the compound level). Subsidies increase the number of formal care visits by 163 percent (0.354 visits) with only a small substitution effect from other formal care to CSCOM care (columns (1)-(3)). With a price decrease of 67 percent (Table B.3), this implies a price elasticity of demand of -3.7. The subsidy does not crowd out private expenditures but fully translates into additional health care consumption (columns (4)-(6)). The subsidy groups also increase wait time by about 17 minutes per child (column (7)). The total value of care consumed increases by 77 percent (CFA1291) relative to the control (column (8)). In contrast, the CHW intervention has no effect on unconditional health care use. These results echo the health insurance literature, which has found that lower out-of-pocket expenditure is matched by increased utilization (see Das and Do, 2023), but they do not allow us to differentiate needed and unneeded care.

Table 2 shows health care utilization by need for care at the level of the individual illness spell. With 907-967 spells across treatment groups, we see no significant effects on illness incidence in year 1 of the program. There is considerable scope for both underuse and overuse (IMCI based): out of 955 spells in the control, 50.2% never require care. In only 11% of the 476 spells where care was required, the child saw a doctor (yet in most cases the spell did end eventually, illustrating the challenge of improving child health outcomes through acute care: it is necessary to treat a large number of spells in order to prevent the small portion that may become truly dangerous to the child).

Across treatment arms, a fairly stable 74-80% of consultations occur when care is required, but in absolute terms there are an additional 80 (91) "care required" consultations in the subsidy-only (full-program) group compared to 22 (32) additional "early" consultations. In the control group (CHW only group), only 1.9% (1.4%) of all spells do not require care but receive a consultation, whereas 5.5% (5.7%) do require care and end in a consultation. In the subsidy arms, these shares rise to 4.4-5.2% vs. 14.7-14.9%. Put differently, overuse occurs in only around 5% of spells, but conditional on requiring care, the chance that a spell eventually ends in a doctor visit rises from at most 11% to 29%.

While informative, these numbers cannot isolate the effect of the policy interventions on parents' care-seeking behavior, because whether a pre-care spell enters care-required status or not and what share of consultations occur when care is required are joint outcomes of illness incidence and demand for healthcare.[7]

We therefore next estimate the daily *hazard* of formal care, that is, the probability of seeking care on pre-care spell day t, conditional on an ongoing spell. Figure 2 shows the hazard of care on each day by treatment arm and "care required" classification, estimated by regressing care seeking on a full set of interacted indicator variables. In addition to this non-parametric approach we estimate a Cox proportional hazard model where the hazard at t conditional on X_{it} is

$$h(t|x_{it}) = \lambda_0(t)e^{X'_{it}\beta}.$$

The independent variables X_{it} shift the probability of seeking care proportionally on all days, an assumption that delivers a good description of our data (Appendix Figure B.1). Table 3 reports the coefficient estimates in Panel A, controlling for baseline household characteristics and stratum fixed effects, and the hazard ratios for each subgroup of interest in Panel B.

Our first result here is that parents behave very differently on early and care-required days. The control group is 5.5 times more likely to seek care on a care-required day (Table 3 B(2)). The probability of care-seeking on any "early" day is below one percent (Figure 2). However, even when care is required the probability of a visit is never higher than 6 percent. This suggests that parents are well able to gauge the seriousness of their child's illness but face a high cost barrier (Observation 1).

Next, the subsidy significantly increases care-seeking, by 270% in the subsidy-only arm and by 291% in the full-program arm (Table 3 Column (1)). Although the proportional hazard of care is similar, the effect of the subsidy is much larger when care is required: relative

[7]Note that these (endogenous) figures contain in principle a lot of information about the characteristics of healthcare demand. For example, to the extent that the subsidy induces "early" care in spells that would have eventually entered care-required status, the share of "care never required" spells will increase. However, while our point estimates do not show such an increase, our sample is not powered for a precise effect estimate.

to the reference group of "early" days in the control, parents seek care 14 (17) times more often when care is required and they receive the subsidy (full program) (column (2)). By comparison, when care is not required, care is sought only 2.5 (3.6) times more often. The difference can also be seen clearly in Figure 2. Again, this suggests that an important barrier to needed health care is simply the cost of care. In this sample, even heavy subsidization of primary care did not lead to rampant overuse of care, while successfully encouraging needed care. However, underuse was far from eliminated. Indeed, there is little room to reduce overuse, given the low daily hazard of care when care is not required, but there is substantial room to decrease underuse further.

In contrast with the encouraging findings about subsidized care, we find little impact of the CHW treatment on daily demand. On average, the CHWs do not appear to improve the allocation of care. Given the extremely low probability of "early" care seeking to begin with, it is perhaps not surprising that they do not reduce overuse; however, they also do not significantly improve underuse. There is no evidence of a complementarity between CHWs and subsidies for efficient care-seeking. In Dean and Sautmann (2023) we show that CHWs are more effective for measures of preventive care, supported by longer-term effects on illness incidence. An earlier version of this paper discusses CHW effects on preventive vs. curative care, age-specific impacts, and potential pathways in more detail (Sautmann et al., 2020).

5 Conclusion

The prevailing view in international health policy today is that subsidies are needed to close remaining gaps in access to care. Many countries have begun to remove health care user fees for children, and Mali announced plans to adopt this policy in 2019. However, we have relatively sparse evidence how this affects patterns of utilization.

This study opens the "black box" of the extensive margin of health care demand and the effects of demand-side interventions. Our main contributions are our a panel of very detailed daily health data and the classification of need for care using IMCI guidelines. Our data

make a strong case for collecting illness data in the home, making visible the many spells that never receive any formal care. By comparison, data collected at the point of use is subject to strong differential selection, as the intervention changes who visits the clinic. Our hazard estimates of daily health care use conditional on health status remove the confounding effects of illness incidence and permit the direct benchmarking against WHO recommendations.[8]

Our results have very encouraging implications for the subsidy debate. First, the cost of care is a primary barrier to effective care seeking in the urban population we study. Underuse is rampant, despite physical proximity to the clinic: care is either sought late in the spell or, in the majority of cases, not at all. The welfare cost of subsidies could be prohibitive if they lead to substantial mis-targeting and overuse of health care, risking overburdening the severely limited capacity of health care systems in poor countries and thus diverting resources away from those most in need. However, while subsidies nearly triple health care usage in our sample, the additional demand comes largely from children for whom medical care is recommended according to WHO guidelines. One reason is that parents are clearly able to recognize serious illness and are nearly six times more likely to seek care on "care required" days compared to "early" days. This finding *a priori* suggests that additional information on the child's health status can only have limited effects, and this is what we find; the CHW visits do not affect care-seeking probabilities significantly.

The role of CHW visits for access to curative care seeking deserves some critical examination. It is possible that CHWs have greater impacts in rural areas where geographical access barriers are higher. There is also some indication that CHWs may have a positive effect on care seeking in the first few months of life (Sautmann et al., 2020). That said, for many families in our sample, CHW triage does not contribute to a better allocation of care, and governments or NGOs like Mali Health may want to increase the time CHWs spend on prevention or explore a greater focus on other activities with high potential for impact, such as patient advocacy vis-a-vis the clinic provider.

[8]Another potential benefit of estimating health care use in this manner is that it would allow much more accurate out-of-sample predictions under different illness conditions.

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Tables and Figures

Table 1: Treatment effects on amount and cost of care per child: acute care utilization, private expenditure, private time cost, and value of care.

	Number of visits per child			Private cost per child (CFA)			Wait time	Value per child (CFA)	
	All formal	CSCom	Other formal	Total	CSCom	Other formal	per child (hrs)	Total	CSCom
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Received subsidy	0.354***	0.380***	-0.027	-105.639	185.630	-142.679	0.286***	1291.321***	1564.894***
	(0.056)	(0.051)	(0.025)	(262.633)	(130.990)	(174.615)	(0.086)	(339.978)	(236.044)
Received CHW visits	0.029	0.028	0.002	424.938	172.183	-16.402	0.082	436.928	173.547
	(0.043)	(0.035)	(0.026)	(279.224)	(142.342)	(178.187)	(0.081)	(299.418)	(163.638)
Subsidy x CHW	0.045	0.065	-0.020	-534.792	-151.835	-106.281	-0.041	-333.729	20.151
	(0.080)	(0.074)	(0.029)	(366.261)	(215.031)	(204.252)	(0.128)	(464.208)	(337.863)
Control group mean	0.217	0.153	0.065	1461.672	353.302	369.797	0.264	1671.343	523.071
N	1768	1768	1768	1768	1768	1768	1768	1768	1768

Notes: The independent variables are indicators for receiving the subsidy (in the subsidy and full program group), receiving CHW visits (in CHW-only and full program group), and their interaction (in the full program group). Cost and value shown in CFA; 476 CFA equaled 1 USD in 2013. Covariates include household assets; distance to closest formal care provider; gender, age, literacy of household head; and child gender. Stratum FE included. Standard errors clustered at the compound level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Spells and consultations by treatment group.

	Treatment groups				Full sample
	Control	CHW only	Subsidy only	Full program	
Consultations					
Care required	0.746	0.800	0.769	0.742	0.759
	(0.050)	(0.053)	(0.035)	(0.037)	(0.021)
Observations	71	65	173	194	503
Spells					
Care never required	0.502	0.438	0.495	0.479	0.479
	(0.020)	(0.022)	(0.018)	(0.023)	(0.011)
		[0.031]	[0.810]	[0.451]	
Care never required, consultation	0.019	0.014	0.044	0.052	0.032
	(0.004)	(0.004)	(0.008)	(0.009)	(0.003)
		[0.451]	[0.004]	[0.001]	
Care ever required	0.498	0.562	0.505	0.521	0.521
	(0.020)	(0.022)	(0.018)	(0.023)	(0.011)
		[0.031]	[0.810]	[0.451]	
Care ever req., consultation	0.055	0.057	0.147	0.149	0.102
	(0.008)	(0.009)	(0.014)	(0.012)	(0.006)
		[0.927]	[0.000]	[0.000]	
Observations	955	918	907	967	3747
Care never required spells*					
Ended in consultation	0.038	0.032	0.089	0.108	0.067
	(0.009)	(0.010)	(0.015)	(0.019)	(0.007)
Observations	479	402	449	463	1793
Care ever required spells*					
Ended in consultation	0.111	0.101	0.290	0.286	0.195
	(0.017)	(0.016)	(0.024)	(0.023)	(0.011)
Observations	476	516	458	504	1954

Notes: The sample includes uncensored and right-censored pre-care spells, and consultations ending the spell, if any. "Consultations: Care required" is the share of consultations occurring on a care-required day. "Care never required" are pre-care spells that do not enter care-required status. "Care ever required" are pre-care spells that enter care-required status before formal care is received. Standard errors shown in parentheses, p-values for the difference between each treatment group and the control in brackets. Standard errors are clustered at the compound level.

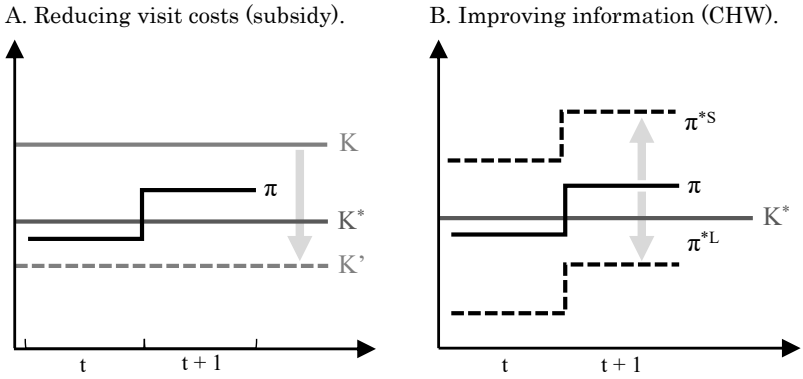
**Note that share of pre-care spells that enters care-required status is endogenous to the demand for healthcare.*

Table 3: Treatment effects in a Cox proportional hazard model.

Panel A: Treatment effect coefficient estimates		
	Average treatment effect	TE by care required
	(1)	(2)
Care required		1.705***
		(0.263)
Received subsidy	0.993***	0.907***
	(0.175)	(0.305)
Subsidy x Care req.		0.033
		(0.328)
Received CHW visits	0.006	-0.160
	(0.221)	(0.406)
CHW x Care req.		0.065
		(0.426)
Subsidy x CHW	0.069	0.369
	(0.256)	(0.477)
Subs. x CHW x Care req.		-0.227
		(0.510)
Panel B: Hazard ratios in each subgroup, relative to reference group		
	Treatment groups	Treatment groups care req. vs. not req. days
	(1)	(2)
Control, care required		5.501
		(6.48)
Subsidy only group	2.700	
	(5.68)	
Subsidy only, care not req.		2.477
		(2.98)
Subsidy only, care req.		14.084
		(9.86)
CHW visits only group	1.006	
	(0.03)	
CHW visits only, care not req.		0.852
		(-0.39)
CHW visits only, care req.		5.002
		(5.37)
Full program group	2.910	
	(6.37)	
Full program, care not req.		3.583
		(3.46)
Full program, care req.		17.334
		(8.34)
N	3747	3747
Reference group	Control group	Control, care not req. days
Ref. group mean daily prob. of care	0.011	0.005

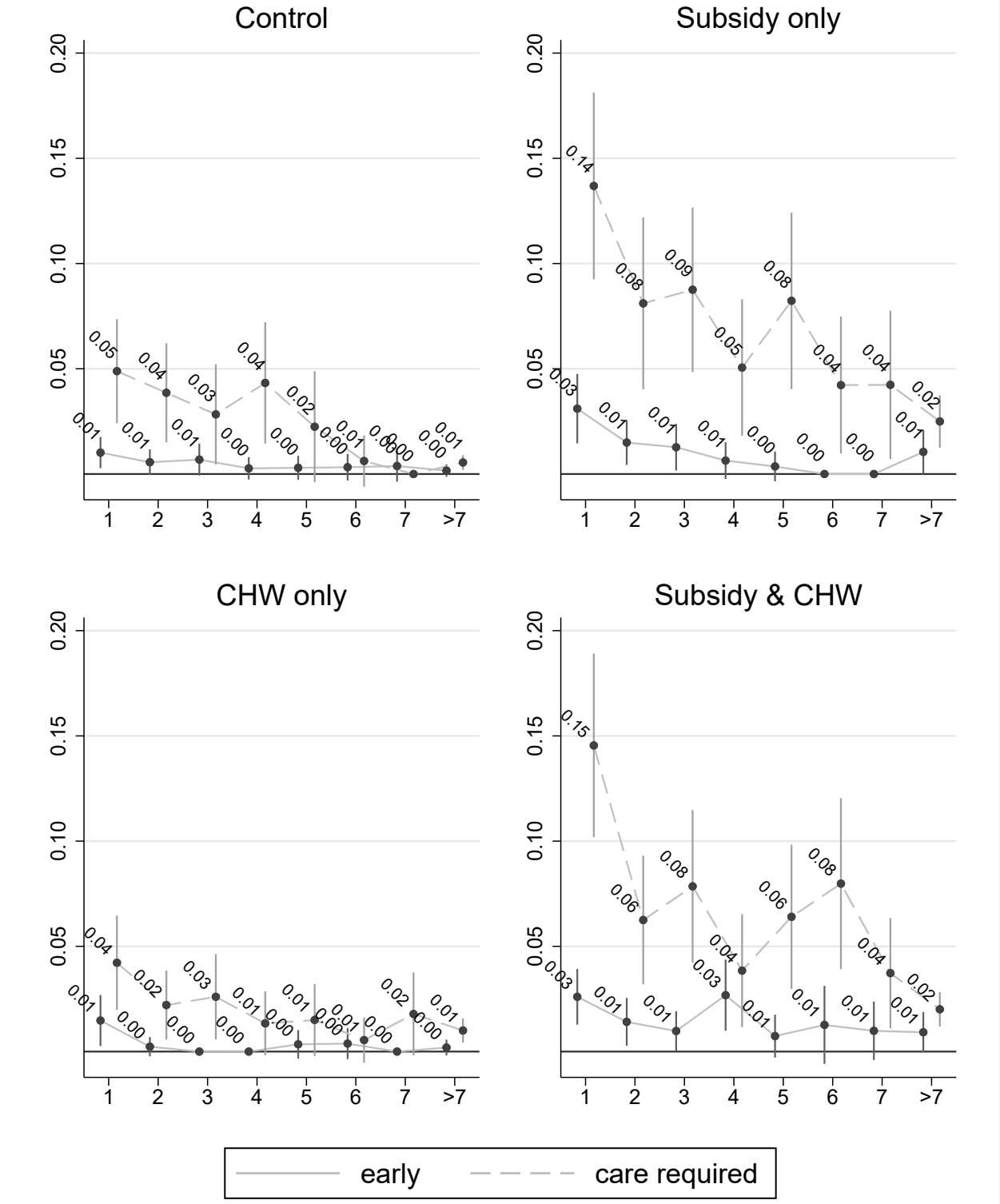
Notes: The sample includes only uncensored and right-censored (pre-care) spells. Panel A shows the raw coefficients; the independent variables are indicators for receiving the subsidy (in subsidy and full program group), receiving CHW visits (in CHW-only and full program group), and their interaction (in the full program group); interacted in column (2) with a daily indicator for "care required" according to the IMCI. Panel B shows the hazard ratios for each subgroup relative to the reference group; in column (1), this is the control and the subgroups are the 3 treatment groups, in column (2) the reference are spell days when care is not required in the control and the subgroups are care-required and care not required days in the 3 treatment groups. Covariates include household assets; distance to closest formal care provider; gender, age, literacy of household head; and child gender. Stratum FE included. Standard errors clustered at the compound level in parentheses.
Significance levels: * $p < 0.10$, ** $p < 0.05$, * $p < 0.01$ (in Panel A only).

Figure 1: The effect of providing a subsidy (A) and acute care information (B).



Notes: The updated belief about illness severity π determines the value of receiving care and is increasing each period. Panel A: Parents have a higher cost threshold than the policymaker, $K \geq K^*$, and seek care in neither period, even though at K^*, care in $t+1$ is optimal (underuse). Lowering the cost threshold may induce care in $t+1$ (optimal use, at K^*) or even in t (overuse, at K'). Panel B: if triage by the CHW updates parental beliefs π to the policymaker's (severe illness with π^{*S} or less severe illness with π^{*L}), it can increase use for severe cases and reduce it for less severe ones (less overuse and underuse at shared cost threshold K^*).

Figure 2: Daily probability of care seeking by early vs. care-required classification according to the C-IMCI.



Notes: Each graph shows a different treatment arm. The x-axis shows day of the spell; spell days after day seven are grouped. Numbers are the point estimates, bars represent 95% confidence intervals. Standard errors clustered at the compound level.

Supplemental Materials

A A model of care seeking

We develop a simple dynamic model of health care seeking in response to acute illness in order to define overuse and underuse and to derive predictions for the impact of the experimental treatments on health care demand. For clarity, we make a number of simplifying assumptions, but as we discuss these are not central to our main results.

Formally, denote the parent's belief that the illness will continue another day by π_t. Each day t of the spell, the parent decides to either visit a provider who can evaluate and treat the child, or wait another day, and with probability $(1 - \pi_t)$ the illness passes on its own.

Consider a child in an ongoing illness spell with symptoms $\gamma \in \Gamma$. Let $t \geq 1$ denote the number of days the child has been sick. Parents experience a fixed sickness disutility $-S < 0$ every day their child is ill. On any day, the parent can take the child to the doctor, which leads to immediate recovery. The expected total cost of the consultation is $-C < 0$ in utility terms. Future costs and benefits are discounted at a rate δ.[9] Assume that symptoms γ can be caused by one of a set of possible underlying conditions $\{I_1, ...I_N\}$, each with a different (constant) probability of spontaneous recovery $(1 - \pi(I_n))$. The non-recovery probability π_t depends therefore on the parents' belief about the possible underlying illnesses causing γ.

Lemma 1 shows that uncertainty about the underlying illness and Bayesian updating imply that illnesses with high recovery probability become less and less likely over time, meaning that the probability of spontaneous recovery must fall.

Lemma 1. *For given symptoms γ, denote by $\pi = \{\pi_t\}_{t=1}^{\infty}$ the sequence of beliefs that the child will not spontaneously recover in period t, conditional on symptoms still being observed*

[9] For ease of notation we suppress the dependence of C and S on symptoms γ. The analysis does not change substantially if illness disutility and doctor costs change over time, as long as $\frac{C}{\delta(C+S)}$ is weakly decreasing. In reality, treatment may also be unsuccessful, for example due to low quality of care. This matters for the value of a doctor visit, which is contained indirectly in S; but in addition it introduces the possibility of repeat visits. We do not account for this, because it adds complexity to the model without changing the basic conclusions about parental behavior.

in that period. If there are at least two illnesses that can cause γ with distinct recovery rates (i.e. $\pi(I_i) \neq \pi(I_j)$ for some pair of illnesses I_i and I_j), the probability of spontaneous recovery declines over time, so that

$$\pi_t < \pi_{t+1}.$$

Proof of Lemma 1:

Note that Bayesian updating implies

$$P_{t+1}(I_n) = \frac{\pi(I_n)P_t(I_n)}{\sum_{m=1}^{N} \pi(I_m)P_t(I_m)} = \frac{\pi(I_n)P_t(I_n)}{\pi_t(P_t)}.$$

Where $P_t(I_n)$ is the probability that condition I_n is causing the illness and $P_t \in \Delta(N)$ is the probability distribution over all possible conditions in period t. We use the notation $\pi_t(P_t)$ to make explicit that beliefs about recovery probability at time t depend only on P_t.

Thus, the probability of illness I_n (strictly) decreases if its recovery rate is above average, and increases if it is below average. This means that the time-t distribution of recovery rates first-order stochastically dominates the time $t+1$ distribution, and $\pi_t(P_t)$ must increase over time. □

If additional symptoms manifest over time, and the probability of recovery π_t is decreasing in the number of symptoms, then this will act to strengthen the effect.

A strictly decreasing recovery probability in turn implies that it may be optimal to delay care to determine whether the underlying illness is serious enough to warrant treatment. It can be shown that a solution to the parents' dynamic decision problem is based on a simple cut-off strategy in beliefs:

Proposition 1. *An optimal strategy is to seek formal health care if and only if*

$$\pi_t \geq K \equiv \frac{C}{\delta(S+C)}.$$

In other words, parents wait until the probability of remaining ill rises above some thresh-

old K before seeking care. This threshold is increasing in the utility cost and decreasing in the benefit of treatment.[10]

Proof of Proposition 1:

We show that the parent has no desire to deviate from this strategy given that it is used in all future periods. First consider the choice of the parent when beliefs first cross the threshold, so that $\pi_t(P_t) < K$ but $\pi_{t+1}(P_{t+1}) \geq K$. In this case, they can either choose to go to the doctor in the current period, and pay cost $-C$, or wait and follow the equilibrium strategy to go in the next period if the child is still sick. The latter has an expected cost of $\pi_t(P_t)\delta(-S-C)$, so $\pi_t(P_t) < K$ ensures that it is optimal not to consult a doctor today. Since $\pi_{t+1}(P_{t+1}) \geq K$ and π_t weakly increases over time, the same logic ensures that it is also optimal to go immediately in $t+1$ and any period after. Now consider $t-1$. Here, the choice is between going immediately or waiting for two periods before receiving treatment. The utility from waiting is

$$\begin{aligned} \pi(P_{t-1})\delta(-S+\pi(P_t)\delta(-S-C)) &< \\ \pi(P_{t-1})\delta(-S-C) &\leq -C \end{aligned}$$

where the first inequality uses that $\pi(P_t)\pi_t$ is below the threshold K. Iterating this argument shows that it is optimal to wait in all earlier periods $t-k < t-1$ where $\pi_{t-k}(P_{t-k})$ is below K. □

Within our framework, the policymaker solves a similar problem as the parent, but with different parameters. First, she may have a different threshold K^*. For example, the parents' cost of treatment C may differ from the policymaker's C^* if the parents are credit-constrained, so that the utility cost of a doctor visit is very high. Similarly, parents' evaluation of benefits S of curing a disease may not account for infection rates for others or

[10]Note that a monotonic π_t and constant K make the problem recursive. However, even if both follow non-monotonic time profiles, that optimal decision will typically take the form of a cut-off strategy, where the cut-off is increasing in cost and decreasing in benefits from treatment. It will just be a harder problem to solve.

long-run human capital effects for the child incorporated in the policymaker's S^*.[11]

Second, the parent may be unable to interpret the child's symptoms. In order to capture this, we assume that the policymaker can differentiate sub-cases $\{\gamma^{*i}\}_{i=1}^{M}$ of symptoms γ, with distinct probability distributions over possible illnesses (with the beliefs of the policymaker and parents connected via Bayes' rule). An example is diarrhea: while parents may only know that diarrhea can sometimes be dangerous, a more informed observer would be able to distinguish dangerous cases of dehydration or dysentery from harmless infections by looking for the additional symptoms of blood in the stool and sunken eyes. We denote as π_t^{*i} the beliefs of the policymaker at time t after having observed symptoms γ^{*i}.

Examples in Figure 1

We demonstrated the effects of the two policies with a simple example; here we provide the numerical details.

Suppose that symptoms γ can be caused by two illnesses, one severe (I_S) and one less severe (I_L), with $\pi(I_S) > \pi(I_L)$. Panel A shows a parent with a treatment threshold above the policymaker's, $K > K^*$, but where neither can distinguish between I_S and I_L, meaning that both hold the same beliefs π. We assume here that I_S and I_L are initially equally likely, so that $\pi_t = \frac{1}{2}(\pi(I_S) + \pi(I_L))$. Letting $\epsilon > 0$ such that $\pi(I_S) = \pi_t + \epsilon$ and $\pi(I_L) = \pi_t - \epsilon$, Bayesian updating implies that $\pi_t < \pi_{t+1} = \frac{\frac{1}{2}\pi(I_S)^2 + \frac{1}{2}\pi(I_L)^2}{\pi_t} = \pi_t + \frac{\epsilon^2}{\pi_t}$. This provides the path of beliefs in panel A.

For panel B, assume that the policymaker can additionally interpret the symptoms γ better than the parent. Specifically, she can distinguish symptoms γ^{*L}, which indicate a higher probability of I_L, and γ^{*S}, which indicate that the child is more likely to be seriously ill with I_S. An example is the distinction between simple diarrhea and diarrhea with blood in the stool. Bayesian reasoning implies that $\pi^{*L} < \pi < \pi^{*S}$, where the beliefs of the parents π are the average of the beliefs π^{*L} and π^{*S} of the policymaker. Specifically, assume that under

[11] A similar effect would occur if parents underestimate the value of treatment, for example because they believe that it has little effect on the probability of recovery (see footnote 9). This is particularly a concern given that health care is an experience good that is difficult to evaluate *ex ante*.

γ^{*L} there is an initial probability of illness I_S of 0.25, and a probability of illness I_L of 0.75. It can be shown that $\pi_t^{*L} = \pi(P_t(\gamma^{*L})) < \pi_t$, and $\pi_t^{*L} < \pi_{t+1}^{*L} = \pi(P_{t+1}(\gamma^{*L})) < \pi_t$, π_{t+1}. To the policymaker observing the low severity symptom, the probability of not recovering is lower than to the parent in either period. Under γ^{*S}, the probabilities of illnesses I_S and I_L are reversed, so that $\pi_t^{*S} > \pi_t$ and $\pi_{t+1}^{*S} > \pi_{t+1}$. This implies that $\pi_t^{*L} = \pi(P_t(\gamma^L)) = \pi_t - \frac{1}{2}\epsilon < \pi_t$, and $\pi_{t+1}^{*L} = \pi(P_{t+1}(\gamma^L)) = \pi_{t+1} - \frac{\epsilon}{\pi_t} < \pi_t$: the probability of not recovering is increasing, but actually lower than the initial π_t in either period. Under γ^{*S}, the probabilities of illnesses I_S and I_L are reversed, so that $\pi_t^{*S} = \pi(P_t(\gamma^{*S})) = \pi_t + \frac{1}{2}\epsilon$ and $\pi_{t+1}^{*S} = \pi(P_{t+1}(\gamma^{*S})) = \pi_{t+1} + \frac{\epsilon}{\pi_t}$.

In this setting, the health workers teach the families to differentiate between different subsets of symptoms $\{\gamma^{*i}\}_{i=1}^{M}$, thereby aligning beliefs between parent and policymaker.

B Additional tables and figures

B.1 Tables

Table B.1: Sample changes over time.

	Control	CHW	Subsidy	CHW & Subsidy	All
Eligible children (2012 census)	474	446	458	426	1804
At baseline: not found/absent/moved	21	22	17	7	67
At baseline: had died	2	1	0	0	3
At baseline: refusal	0	0	2	0	2
Enrolled children 2012	451	423	439	419	1732
	100%	100%	100%	100%	100%
Household/child temporarily absent	10	8	15	9	42
Household/child moved	36	25	27	22	110
Could not be determined/not found	3	2	0	0	5
Has died	0	1	3	1	5
Refusal	0	0	0	3	3
Present at follow-up	89%	91%	90%	92%	90%
Present at follow-up 2013	402	387	394	384	1567
	100%	100%	100%	100%	100%
Added after baseline	54	43	45	59	201
	13%	11%	11%	15%	13%
Final sample 2013	456	430	439	443	1768

Notes: At baseline, 1732 children were surveyed in households that had been identified as eligible during the census (before assignment to treatment). 1567 of those children were re-surveyed at follow-up. In addition, 201 children were newly enrolled into the study in existing study households. These children should have also been enrolled into the intervention following normal operating procedures. A Pearson Chi-square test that attrition post baseline is independent of the treatment group is not rejected (p=0.497).

Table B.2: Demographics and balance.

	Child characteristics			Characteritics of household head					Household characteristics			Compound
	Male	Age (yrs)	Weight for height	Literate	Speaks Bambara	Male	Has salary	40 yrs. or older	Number of members	Owner occupiers	Total assets (in log USD)	Distance to closest formal care (in meters)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Subsidy only group	0.009	-0.005	0.091	0.033	-0.063	-0.021	-0.009	-0.003	0.178	0.048	0.288	-33.394
	(0.03)	(0.09)	(0.13)	(0.05)	(0.05)	(0.03)	(0.03)	(0.04)	(0.32)	(0.05)	(0.20)	(22.42)
CHW only group	-0.022	0.076	0.058	-0.022	-0.037	-0.024	-0.002	-0.015	-0.001	0.067	0.231	0.725
	(0.04)	(0.10)	(0.13)	(0.05)	(0.05)	(0.03)	(0.03)	(0.05)	(0.31)	(0.05)	(0.21)	(23.17)
Full program group	0.022	-0.021	0.028	0.129***	-0.076	-0.001	-0.043	0.046	0.407	0.053	0.215	-24.155
	(0.03)	(0.09)	(0.14)	(0.05)	(0.05)	(0.03)	(0.03)	(0.05)	(0.31)	(0.05)	(0.20)	(23.37)
Control group mean	0.515	2.706	-0.655	0.467	0.729	0.903	0.131	0.418	6.234	0.405	6.458	578.146
N	1763	1768	1306	1242	1242	1241	1242	1256	1238	1208	1208	642

Notes: Coefficients from a regression of the outcome variable on treatment indicators. Standard errors clustered at the compound level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B.3: Summary statistics on different types of healthcare "visits": cost, types of medications received, and wait times.

				Informal/no consultation	
	CSCOM (no subsidy)	CSCOM (subsidy)	Private provider	Pharmacy	Other
Cost to household (CFA)	2842	944	5371	1474	241
	(252)	(108)	(549)	(100)	(12)
Value (CFA)	3652	3807	.	.	.
	(250)	(129)			
Wait time (minutes)	36.18	47.10	75.31	12.02	1.89
	(4.40)	(2.67)	(11.71)	(3.05)	(0.30)
Any antibiotic	0.394	0.463	0.684	0.309	0.221
	(0.011)	(0.013)	(0.054)	(0.030)	(0.010)
Any antimalarial	0.159	0.185	0.467	0.082	0.030
	(0.008)	(0.010)	(0.058)	(0.018)	(0.004)
Care required	0.738	0.788	0.782	0.607	0.586
	(0.441)	(0.409)	(0.416)	(0.489)	(0.493)
Number of visits	139	509	87	439	2403
Arms without subsidy	139	-	58	261	1379
Arms with subsidy	-	509	29	178	1024

Notes: CSCOM refers to local clinic or associated reference hospital (CSREF). Private provider is a private doctor, hospital, or health center provided e.g. by the Red Cross. Informal sources other than pharmacy purchases (without a formal consultation) include peddlers, market, traditional or religious healers,and midwives. Costs, prices, and wait times are added up for all connected consultations, e.g. doctor visit and medication purchase. Costs per visit are for consultation and treatment as reported by the caretaker. Value/total cost is imputed from private cost and median prices, by consultation type and treatment received. Standard errors in parentheses.

Table B.4: All observed formal consultations by treatment group.

Formal visits by cause of visit			Acute			Follow-up during spell				
		ALL	all	early	care required	all	early	care required	Follow-up after spell	Prevention/ other
Control	Avg. visits per child	0.213	0.186	0.048	0.138	0.013	0.000	0.013	0.002	0.011
	(Std. error)	(0.015)	(0.020)	(0.010)	(0.017)	(0.006)	(0.000)	(0.006)	(0.000)	(0.005)
	Percent of visits		100%	26%	74%	100%	0%	100%		
CHW	Avg. visits per child	0.228	0.191	0.049	0.142	0.019	0.005	0.014	0.002	0.016
	(Std. error)	(0.028)	(0.022)	(0.010)	(0.018)	(0.007)	(0.005)	(0.006)	(0.000)	(0.006)
	Percent of visits		100%	26%	74%	100%	25%	75%		
Demand in % of control		*107%*	*102%*	*101%*	*103%*	*141%*	-	*106%*	*106%*	*148%*
Subsidy	Avg. visits per child	0.565	0.481	0.105	0.376	0.055	0.002	0.052	0.005	0.025
	(Std. error)		(0.032)	(0.015)	(0.029)	(0.013)	(0.002)	(0.013)	(0.003)	(0.007)
	Percent of visits		100%	22%	78%	100%	4%	96%		
Demand in % of control		*266%*	*258%*	*217%*	*272%*	*415%*	-	*398%*	*208%*	*229%*
Subsidy & CHW	Avg. visits per child	0.639	0.508	0.133	0.375	0.095	0.002	0.093	0.005	0.032
	(Std. error)		(0.034)	(0.019)	(0.029)	(0.021)	(0.002)	(0.021)	(0.003)	(0.010)
	Percent of visits		100%	26%	74%	100%	2%	98%		
Demand in % of control		*300%*	*272%*	*276%*	*271%*	*721%*	-	*703%*	*206%*	*288%*

Notes: The table reports averages (per child) in absolute terms and in percent of the control group. "ALL" includes all observed formal consultations (CSCOM, private care, or hospital). "Acute care" denotes the first event during a symptom spell, the consultations relevant to the Cox hazard estimates. "Follow-up" visits are other visits during a symptom spell as well as visits outside a spell reported as follow-up visits. "Prevention/other" visits are not associated with spells and contain all other consultations (e.g. for vaccinations). Follow-up and preventive visits are excluded from the hazard analysis because it cannot be known whether they are medically indicated (based on IMCI classifications) and they do not constitute acute care for an illness. Percentage increases in follow-up and prevention visits are high, but absolute numbers are very low. In total, the increase in visit frequency between the control and the subsidy groups ranges between 266% and 300%, similar to the estimated increase in hazard rates from acute-care visits only.

Table B.5: Symptom occurrence in total and by need for care (IMCI).

	All days		Illness days		Care required days		Care not required days	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Convulsions, spasms	0.001	(0.03)	0.003	(0.06)	0.007	(0.08)	0.000	(0.00)
Lethargic or unconscious	0.014	(0.12)	0.039	(0.19)	0.082	(0.27)	0.000	(0.00)
Unable to drink	0.004	(0.06)	0.010	(0.10)	0.021	(0.14)	0.000	(0.00)
Vomiting everything	0.013	(0.11)	0.039	(0.19)	0.084	(0.28)	0.000	(0.00)
Coughing	0.118	(0.32)	0.347	(0.48)	0.419	(0.49)	0.284	(0.45)
Difficulty breathing	0.017	(0.13)	0.047	(0.21)	0.066	(0.25)	0.030	(0.17)
¿3 loose stools	0.027	(0.16)	0.083	(0.28)	0.122	(0.33)	0.048	(0.21)
Blood in stool	0.002	(0.05)	0.007	(0.08)	0.013	(0.11)	0.001	(0.03)
Sunken eyes	0.007	(0.08)	0.019	(0.14)	0.039	(0.19)	0.001	(0.02)
Unusually hot	0.090	(0.29)	0.275	(0.45)	0.529	(0.50)	0.052	(0.22)
Unusually cold	0.000	(0.01)	0.000	(0.01)	0.000	(0.02)	0.000	(0.00)
Rash/Spots/Itch	0.009	(0.09)	0.032	(0.18)	0.027	(0.16)	0.036	(0.19)
Cold Symptoms	0.188	(0.39)	0.610	(0.49)	0.530	(0.50)	0.679	(0.47)
Ear ache	0.003	(0.06)	0.010	(0.10)	0.018	(0.13)	0.003	(0.06)
Wound/Injury/burn	0.012	(0.11)	0.038	(0.19)	0.019	(0.14)	0.055	(0.23)
Other	0.013	(0.11)	0.044	(0.21)	0.030	(0.17)	0.057	(0.23)
Observations	105808		24086		11266		12820	

Notes: The table shows the occurrence of each recorded symptom as share of all recorded days, as share of all recorded days with any illness (i.e. days part of an illness spell) and as share of "care required" vs. "care not required" days according to the IMCI. The first four symptoms are danger signs and always occur on "care required" days. Symptoms that do not themselves indicate need for care, such as cold symptoms, can co-occur on care-required days.

Table B.6: Pre-care spell length (time to care), by type of censoring.

	Mean	SD	95th%	Max	N
Uncensored and right-censored only spells					
All spells	6.43	6.92	19	61	3747
Care required	7.48	8.73	25	61	1954
Care not required	5.28	3.82	14	33	1793
Left-censored spells					
All spells	10.23	10.60	33	64	464
Care required	12.95	12.75	43	64	277
Care not required	6.20	3.28	13	16	187

Notes: Summary statistics for the pre-care spells constructed from the data and used in the analysis. A pre-care spell denotes the "time to care" and consists of any contiguous set of days on which the caretaker reports illness symptoms, but a formal care visit has not yet occurred. "Care required" denotes spells in which symptoms at any point indicate a need for care. "Care not required " denotes spells in which care is not required at any point before a formal care visit takes place (if any). For the purposes of estimating the daily "hazard of care" and defining care-required status, the spell cannot be left-censored. A spell is left-censored if the last day before the first observed spell day is missing from the data, meaning that we cannot know the total length of the spell. The spell may be right-censored, including if it ends without a formal-care consultation (so that the time by which the caretaker would have sought care if the spell had continued is not observed, but known to be longer than the length of the spell) or uncensored, if it ends in a formal-care consultation, in other words, the exact time to care is known.

Table B.7: Treatment effects in a Cox proportional hazard model, treating pharmacies as "formal care".

Panel A: Treatment effect coefficient estimates		
	Average treatment effect	TE by care required
	(1)	(2)
Care required		1.232***
		(0.175)
Received subsidy	0.593***	0.341
	(0.143)	(0.212)
Subsidy x Care req.		0.291
		(0.234)
Received CHW visits	0.250	0.273
	(0.153)	(0.227)
CHW x Care req.		-0.170
		(0.264)
Subsidy x CHW	-0.191	-0.128
	(0.197)	(0.309)
Subs. x CHW x Care req.		0.048
		(0.348)
Panel B: Hazard ratios in each subgroup, relative to reference group		
	Treatment groups	Treatment groups care req. vs. not req. days
	(1)	(2)
Control, care required		3.427
		(7.06)
Subsidy only group	1.809	
	(4.15)	
Subsidy only, care not req.		1.407
		(1.61)
Subsidy only, care req.		6.449
		(10.23)
CHW visits only group	1.284	
	(1.63)	
CHW visits only, care not req.		1.314
		(1.21)
CHW visits only, care req.		3.800
		(6.84)
Full program group	1.917	
	(4.80)	
Full program, care not req.		1.238
		(0.96)
Full program, care req.		5.018
		(8.06)
N	3747	3747
Reference group	Control group	Control, care not req. days
Ref. group mean daily prob. of care	0.020	0.013

Notes: The sample includes only uncensored and right-censored (pre-care) spells. Panel A shows the raw coefficients; the independent variables are indicators for receiving the subsidy (in subsidy and full program group), receiving CHW visits (in CHW-only and full program group), and their interaction (in the full program group); interacted in column (2) with a daily indicator for "care required" according to the IMCI. Panel B shows the hazard ratios for each subgroup relative to the reference group; in column (1), this is the control and the subgroups are the 3 treatment groups, in column (2) the reference are spell days when care is not required in the control and the subgroups are care-required and care not required days in the 3 treatment groups. Covariates include household assets; distance to closest formal care provider; gender, age, literacy of household head; and child gender. Stratum FE included. Standard errors clustered at the compound level in parentheses.

Significance levels: * $p < 0.10$, ** $p < 0.05$, * $p < 0.01$ (in Panel A only).

Table B.8: Treatment effects in a Cox proportional hazard model, including left-censored spells.

Panel A: Treatment effect coefficient estimates		
	Average treatment effect	TE by care required
	(1)	(2)
Care required		1.564***
		(0.241)
Received subsidy	1.032***	0.849***
	(0.159)	(0.275)
Subsidy x Care req.		0.177
		(0.299)
Received CHW visits	0.090	0.127
	(0.199)	(0.329)
CHW x Care req.		-0.146
		(0.353)
Subsidy x CHW	-0.062	0.077
	(0.232)	(0.403)
Subs. x CHW x Care req.		-0.047
		(0.437)
Panel B: Hazard ratios in each subgroup, relative to reference group		
	Treatment groups	Treatment groups care req. vs. not req. days
	(1)	(2)
Control, care required		4.780
		(6.48)
Subsidy only group	2.807	
	(6.48)	
Subsidy only, care not req.		2.338
		(3.09)
Subsidy only, care req.		13.347
		(10.87)
CHW visits only group	1.094	
	(0.45)	
CHW visits only, care not req.		1.135
		(0.39)
CHW visits only, care req.		4.687
		(5.73)
Full program group	2.888	
	(6.71)	
Full program, care not req.		2.525
		(3.18)
Full program, care req.		11.882
		(9.40)
N	4211	4211
Reference group	Control group	Control, care not req. days
Ref. group mean daily prob. of care	0.011	0.005

Notes: The sample includes all (pre-care) spells and classifies spell days as "care required" and "care not required" treating the first observed day of the spell as the actual first day. Panel A shows the estimated coefficients; the independent variables are indicators for receiving the subsidy (in subsidy and full-program group), receiving CHW visits (in CHW-only and full program group), and their interaction (in the full program group); interacted in column (2) with a daily indicator for "care required" according to the IMCI. Panel B shows the hazard ratios for each subgroup relative to the reference group; in column (1), this is the control and the subgroups are the 3 treatment groups, in column (2) the reference are spell days when care is not required in the control and the subgroups are care-required and care not required days in the 3 treatment groups. Covariates include household assets; distance to closest formal care provider; gender, age, literacy of household head; and child gender. Stratum FE included. Standard errors clustered at the compound level in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, * $p < 0.01$ (in Panel A only).

B.2 Figures

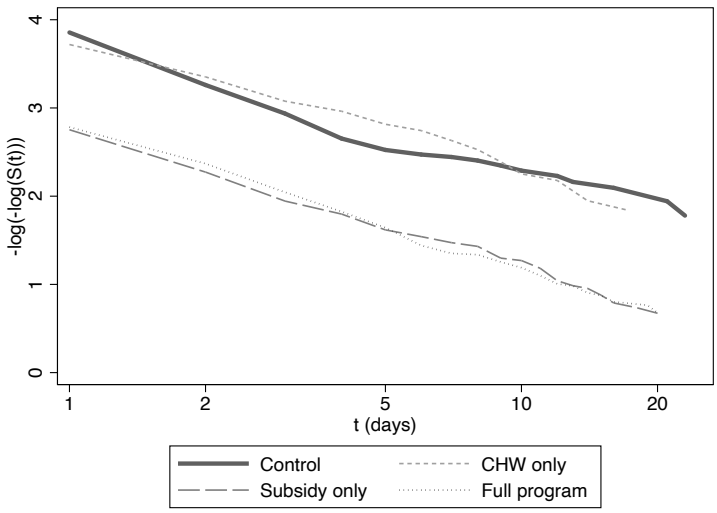
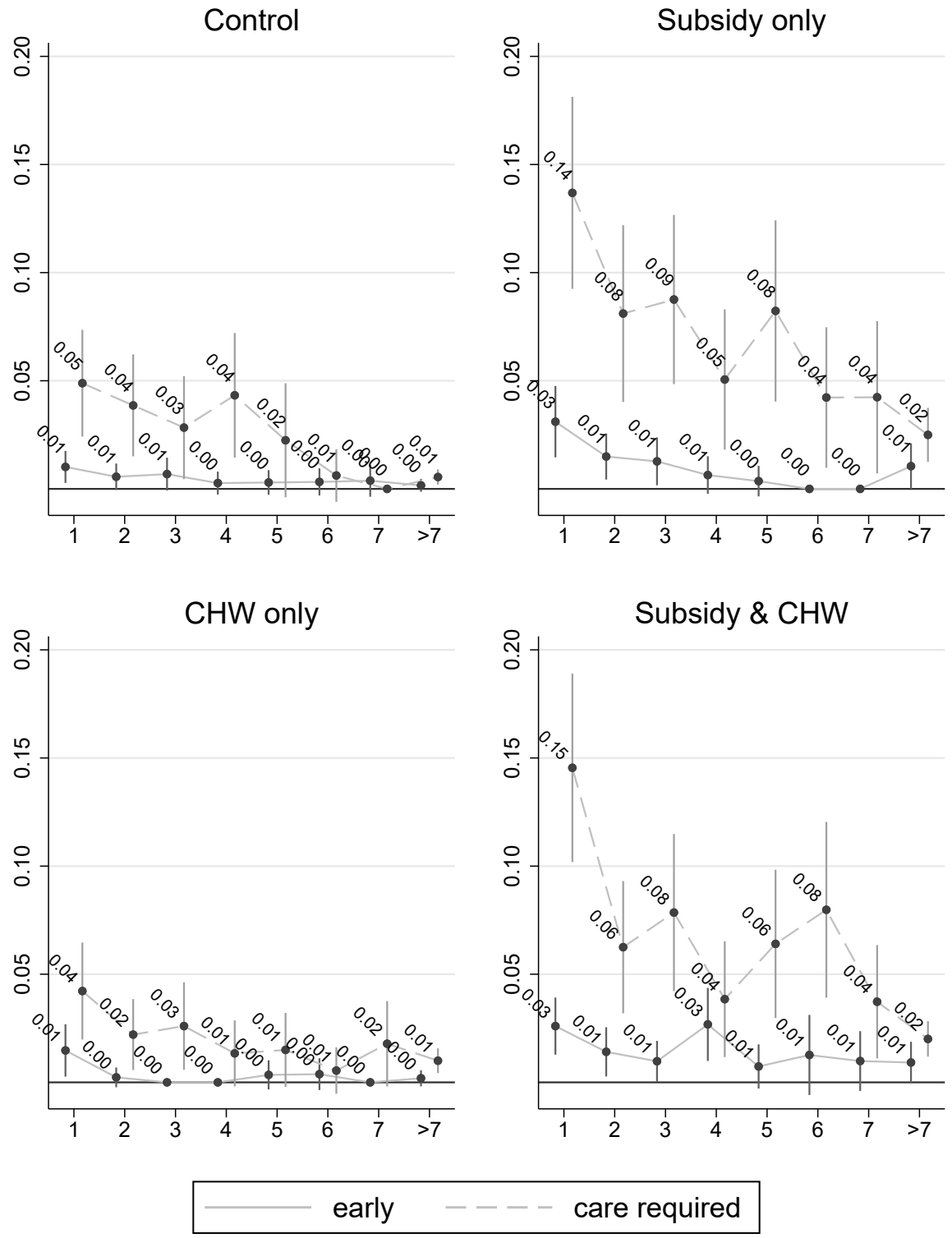


Figure B.1: Predicted survivor functions by treatment arm.

Notes: Plot of the transformed survival function against time in log scale, by treatment arm. If the hazard function is proportional, the transformed survival function should be parallel for different covariate values. The subsidy and full program curves are nearly identical. The CHW and control curves are roughly shifted up in parallel. The difference in slope across control and treatment is small in comparison to the magnitude of the downward shift in S(t) in the groups that receive the subsidy, so the proportionality assumption provides a good approximation of the data.

Figure B.2: Daily probability of care seeking by early vs. care-required classification according to the C-IMCI, including pharmacies as "formal care".



Notes: Each graph shows a different treatment arm. The x-axis shows day of the spell; spell days after day seven are grouped. Bars represent 95% confidence intervals. Standard errors clustered at the compound level.

C Health Diary, Symptoms, and IMCI Classifications

We collected daily information on symptoms, health consultations, and medications taken in weekly visits over the course of nine weeks from the child's primary caretaker (usually the mother). Caretakers could use pictorial diaries (Figure C.3) to mark off symptoms and health-related events. The diary had entries for eight major symptoms, the mother's level of concern about the child, and doctor and pharmacy visits. The surveyor then reconstructed the child's health history during the visit.

The full list of symptoms was chosen in collaboration with Mali Health to cover main causes of childhood mortality (malaria,acute respiratory infection, diarrheal disease, vaccinable diseases) and based on the Integrated Management of Childhood Illness (IMCI) guidelines (see WHO Department of Child and Adolescent Health and Development, 2005; WHO, 2014). The IMCI is a joint program of the World Health Organization and UNICEF and aims at establishing simple procedures for the management of the main causes of morbidity and mortality of small children. Rosales and Weinhauer (2003) have adapted the IMCI for use by community health workers, who typically have no formal medical training, but can be instructed to follow simple diagnosis protocols ("algorithms"). These protocols are mainly designed to detect a need for a formal medical evaluation. Symptoms are classified into acute danger signs and signs that point to a particular illness or class of illnesses, e.g. malaria. The choice of symptoms collected in the survey was partly based on ease of observation and description for both surveyors and mothers, and the explicit rules found in the IMCI guidelines for referral to formal care. They are:

- Convulsions, fits, or spasms (danger sign)
- Lethargic or less conscious (danger sign)
- Unable to drink or breastfeed (danger sign)
- Vomiting everything (danger sign)
- Coughing (respiratory disease)

Nom de l'enfant :_____ ID Ménage :_____ ID/Nom Enqueteur : _____Semaine : _____

ENFANT							
SYMPTÔMES	*JOURS*						
							
Jour 							
Mère été inquiété pour la santé de l'enfant 							
Convulsions, crises, ou spasmes 							
Léthargique/ moins conscient 							
Refuse l'allaitement ou de boire 							
Vomir tout 							
Toux 							
Difficulté à respirer 							
Diarrhée 							
Peau chaud à toucher 							
Médecin visité 							
Pharmacien visité 							

Figure C.3: Sample of the health diary.

Notes: Health diary sheets were given to the child's caretaker (usually the mother) to complete until the next survey visit. The diaries were provided as a memory aid, but survey records were also taken if the caretaker did not fill in the health diary.
Each diary sheet covers one week and columns correspond with days. At each visit, the enumerator started a new sheet by entering the days of the week along the top. The last day corresponds with the next visit of the enumerator. The first day corresponds with the current visit and is intended for recording any health events later in the same day. The first row asks whether the mother was concerned about the child's health; the next rows collect the most common and important symptoms, and the last two rows ask about doctor and pharmacy visits.

- Difficulty breathing (respiratory disease)
- Diarrhea
  - If diarrhea reported: more than three loose stools per day? (diarrheal disease)
  - If diarrhea: blood in the stool? (indicator for dysentery)
  - If diarrhea: sunken eyes? (indicator for dehydration)
- Unusually hot skin (under 2 months of age: unusually cold skin) (fever)

In addition to this list, we manually classified any symptoms recorded under "other health changes" into "cold symptoms", "ear pain", "skin rash", "wound or injury", "unusually hot" (typically recorded as "fever" or "malaria"), "head/neck/eye pain", "stomach pain", and "other". Fever-related symptoms were then grouped with "unusually hot skin".

Based on the C-IMCI, we then used guidelines on urgent or non-urgent referral to a clinic to determine when a child should seek formal care. All our classification decisions are aimed at defining minimal need for care. We do not collect all the symptoms the IMCI specifies (e.g. breathing rate or observance of chest in-drawing). We also interpret the need for care conservatively where the guidelines are not fully conclusive, e.g. for diarrhea. Lastly, a non-urgent referral is interpreted as "within 24 hours", that is, care should be sought at least on the next day. Only an immediate/emergency referral is interpreted to mean care on the same day. Specifically, the following rules were applied:

1. Any of the danger signs require immediate (same day) care.
2. Diarrhea with blood in the stool or sunken eyes requires immediate referral on suspicion of dysentery or severe dehydration, respectively.
3. Diarrhea without signs of dysentery or dehydration requires follow-up by the health worker after 5 days, but a doctor visit only with other complications. We therefore classify diarrhea spells as not requiring formal care, unless there are other symptoms.
4. Fever with a rash and cough or cold symptoms requires immediate referral on suspicion of measles.

5. Fever without cough, cold symptoms, difficulty breathing, rash, or ear infection requires immediate referral on suspicion of malaria.
6. Any other fever requires a non-urgent referral for generalized fever (i.e., care is required on the next day).
7. A simple cough requires non-urgent care after 14 days on suspicion of tuberculosis.
8. Cold symptoms and difficulty breathing require non-urgent care after 14 days on suspicion of a bacterial rather than viral infection.
9. Ear pain should lead to non-urgent referral for acute or chronic ear infection (i.e., care is required on the next day).

Note that cough or cold symptoms alone, while very frequent, are typically signs of a simple cold and do not require formal care. Note also that we do not classify children with wounds or injuries or children with pain symptoms other than ear pain to require formal care. These are symptoms that were reported frequently but are not mentioned in the C-IMCI guidelines. Lastly, we classified Sikoro as a low-malaria region, on the basis that malaria only occurs seasonally and the Malian government mandates malaria testing for all potential malaria cases. In high-malaria regions, the guidelines prescribe that any fever is treated as likely malaria, regardless of accompanying symptoms and often without additional testing, and requires immediate action. In low-malaria regions, a generalized fever requires medical care only a day later.