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Effectiveness of a Multi-level Asthma Intervention in Increasing Controller Medication use: A Randomized Control Trial

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Introduction

Childhood asthma prevalence and morbidity is more common in ethnic minorities, and the highest rates in the U.S. are found in Puerto Rico [1-5]. Numerous factors have been implicated in explaining the higher rates of asthma morbidity among minority children [6-9], both on the basis of empirical evidence and a theoretical model that consolidates the evidence. Poor self-management by families [10] may be an important factor in explaining the observed disparity, and for this reason we previously tested a culture specific family management intervention called CALMA. Results from a randomized clinical trial showed that CALMA was effective in reducing emergency room visits, hospitalizations, night asthma symptoms, and asthma exacerbations while also improving quality of life and parental perceived effectiveness in managing asthma and Puerto Rican families [11].

However, CALMA was not effective in increasing the reported use of controller medications and its impact on daytime symptoms was not evident. There is growing evidence that comprehensive interventions that combine physician education, organizational change, with patient education may be the most powerful approach to achieving desired asthma outcomes such as reduction of patient symptoms, increase in report and dispensing of controller medication, and reduction of costs [12-14].

Building on this literature, we developed a provider and clinic training program by culturally adapting our intervention to several evidence-based comprehensive interventions [15-19], designed to train primary care physicians (PCPs) to diagnose, manage and treat asthma according to the NAEPP guidelines (NHLBI) [20].

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We present here the results of a group-randomized trial to test the effectiveness of a new comprehensive program, which we called CALMA -plus, in increasing two main outcomes; reported controller medication use and reducing asthma symptoms. CALMA-plus involved the CALMA home-based family intervention (CALMA only), plus educational training of physicians and nurses, as well as screening for asthma in clinics serving Medicaid island Puerto Rican children with asthma. Because the provider training was expected to have an impact on the entire clinical setting where trained providers work, as well as the patients using that setting, we randomized clinic groups rather than individual patients. We compared the CALMA-Plus intervention to a CALMA-only group, which we expected to obtain the same benefits as we have previously documented [11].

The CALMA-Plus intervention was partly based on a conceptual model developed by our research team in order to explain asthma health disparities in Latino children [8, 21]. The model is based on the conceptualization that health disparities in pediatric asthma result from a complex interaction of factors related to four main domains: the individual and the family, the environment or context in which the child lives, the health care system, and the provider characteristics (which includes training of the provider). In our previous research we had addressed the individual and family component of the model, as well as the environmental context (allergens and triggers) with the development of the CALMA-only intervention [11]. We had partly addressed the health care system domain, by providing evidence on how a government reimbursement policy for physicians treating children with persistent asthma and public insurance was related to significantly lower controller medication dispensing among these children as compared to children with private insurance [22, 23]. However, we had not addressed the extent to which the clinic environment and provider training (part of the health system domain) was related to asthma disparities, particularly as it related to controller medication use. In addition, the physician training component of CALMA-plus was based on the Physician Asthma Care Education (PACE) program and used the same theoretical framework described by the originators of this program [24, 25]. The PACE program is based on the social cognitive theory of self regulation (i.e. the learner's efforts to evaluate and react to a problem) for guiding physicians to enhance their therapeutic skills in treating childhood asthma [24].

To our knowledge, this is the first time that a comprehensive program focused on reduction of health care treatment disparities has been tested among Latino children with asthma. Other comprehensive multilevel programs have been found to significantly increase parental reports of controller medication use or prescription practices for controller medication [14, 17, 24, 25]. However, none have been developed for Latino children with asthma. The adaptation of interventions to different cultural groups is necessary because both patient and providers health behaviors have been found to be affected by cultural and contextual variables [26, 27]. We hypothesized that parents of children in the CALMA-plus group would report more controller medication use (main outcome) and fewer asthma symptoms as compared to children in the CALMA-only group.

Methods

Design of the Group Randomized Clinical Trial

The group randomized trial design focused on Independent Provider Associations (from now on referred as clinics) that were subcontracted by the dominant insurance company serving the San Juan metropolitan area of Puerto Rico. Nineteen clinics were eligible for recruitment and randomization. After approval of the Internal Review Board of the University of Puerto Rico, these nineteen clinics were invited into the study, and eight agreed to participate. Clinics were selected if they were sub-contracted by the same Insurance Company and were located in the San Juan metropolitan area of Puerto Rico. Only 19 clinics met this criterion, since most of the other clinics in the San Juan Metropolitan area were sub-contracted by different Insurance Companies. Participating and non-participating clinics were similar in that all children were under the public government health plan and in rates of children with asthma attending the clinics. Clinics were randomized into the CALMA-only or CALMA-plus arms using the stratified randomization lists capabilities of nQuerry software version 6. The strata for the random assignment for both experimental conditions were created by matching these eight clinics into four groups of two clinics based on the number of pediatric lives served in each clinic. Each group of two clinics represented a different strata and one clinic from each strata was assigned to each experimental condition.

Participant Selection and Screening

Potential study participants for both study arms were selected on the basis of a computerized claims data algorithm and on the Health Plan Employer Data and Information Set (HEDIS) criteria for classifying children with persistent asthma [28]. Inclusion criteria required that the child have at least one claim with a diagnostic code for asthma or reactive airway disease (International Classification of Diseases (ICD 9) diagnostic code 493.xx) and in the last year period had either 1) been hospitalized for asthma, or 2) had at least 2 Emergency Department (ED) visits, or, 3) 3-5 ambulatory visits due to asthma or, 4) utilized asthma medications from 2 of the following therapeutic categories: anticholinergics, cromolyn, sympathomimetics, steroid inhalants, methylxanthines, leukotriene inhibitors, or corticosteroids. All children were enrolled in the government insurance plan funded with Medicaid funds. To qualify for this public insurance plan, the family had to be 200% below the poverty level of Puerto Rico ($9,600 a month, plus $2,280 for each additional household member).

Using the HEDIS criteria, 970 children were identified through the claims data and 177 were referred, either by other participants or by the clinics, for a total of 1147 potential eligible cases. Of these, 509 were screened by phone after obtaining oral informed consent (See Figure 1). The remaining cases were not screened since the desired number of participants had been reached. Eligibility criteria for selection during phone screening were: 1) families with a child between the ages of 5 to 12 years of age, 2) poor asthma control, as defined by any of the following: (a) use of any asthma medication more than once a week *in the last four weeks* (b) experiencing asthma symptoms such as wheezing, because of asthma either daily or continuously *in the last four weeks*, c) using the ED two or more times during the last year, d) using oral steroids or having been hospitalized during the last year. Exclusion

criteria were: 1) currently participating in another asthma study and, 2) no appropriate address for follow-up in the claims data. At the time of screening, the caregiver was defined as the adult legally responsible for the child and was the only person authorized to complete the screening procedure. Of the 509 children phone screened, 64 were not eligible for a total of 445 eligible children. Of these 404 were enrolled into the study by project staff, 204 from the CALMA-only clinics and 200 from the CALMA Plus clinics (see Figure 1).

Description of Interventions

CALMA Intervention—Both study Arms 1 and 2 used an evidence based asthma intervention called CALMA previously tested and described elsewhere [11]. Briefly, asthma counselors or lay interviewers were trained to deliver eight asthma education modules that were administered over the course of two home visits. Home assignments, and a telephone booster for reinforcement of recommended plan(s) also comprised the intervention. The CALMA modules were designed to help families with managing the child's asthma in the following areas: nature of asthma, barriers to treatment, types of medications, follow-up appointments, action plans, asthma triggers and environmental avoidance techniques, identification of onset of symptoms and early management, communication with the provider, and stressors related to psychological well being. The intervention was culturally adapted using a collaborative participatory research approach described in detail elsewhere that involved all affected partners in the research process [29].

CALMA-plus Intervention—Participants in Arm 2 received the CALMA intervention and were treated in clinics where their primary care providers received the CALMA-plus intervention. Physician education was addressed by adapting the content from the Physician Asthma Care Education (PACE) program [25]. Similar to the PACE program, physicians in the CALMA-plus intervention were offered training in three interactive seminars lasting an hour and aimed at enhancing their clinical skills to diagnose, manage and treat asthma according to the NAEPP guidelines. The training provided opportunities to practice the skills learned, and used multifaceted educational tools. The seminars included brief lectures from local pediatric pulmonologists, case studies that presented clinical problems, and distribution to providers of materials for patients that addressed the advantages of visiting the clinic instead of the ED, the importance of adhering to treatment, and how to use controller medications.

In addition to this physician educational program based on the PACE program, CALMA-plus included training of the physicians in filling out an adapted asthma review form (ARF) (18). This form was designed to aid physicians to make an asthma diagnosis, and improve prescription practices based on the NAEPP guidelines [20]. The ARF included a patient treatment plan to aid the patient in adhering to the prescribed treatment (see online supplement for copy of these forms). The form also consisted of a checklist to aid the physician in making an asthma diagnosis and or determining asthma control according to guidelines. The ARF contained NAEPP [20] recommended medications that were in the formula of the government health plan for step up or step down medications according to the patient's severity or asthma control level. Furthermore, CALMA-plus included screening of presence or absence of asthma (four questions included in the ARF) to all children attending

the clinics. Research staff conducted bi-weekly visits to the clinic for a period of 18 months for administration of these four first questions and for documentation of the number of asthma review forms completed by PCPs. Pediatric pulmonologists visited the clinics periodically to motivate practicing physicians from clinics that had the lowest compliance with the asthma review form. The adaptation of the PACE program and asthma review form to our culture and the context in which physicians were practicing was done using a collaborative participatory research (CPR) approach [30] that involved several focus groups and a weekend workshop with PCPs, and administrators.

Training of the physicians and other staff was performed in each clinic. Training was done prior to initial assessment of participants. Not more than a month elapsed between training of physicians and implementation of the provider intervention.

Preserving Fidelity of the CALMA-only and CALMA plus Interventions

Fidelity of the CALMA-only intervention was maintained by training and certification of intervention counselors, monitoring of counselors by field supervisors, audio taping of all interviews and interventions, and review of 20% of audiotapes to assure the intervention was delivered as intended. Re-certification of asthma counselors was required if the audiotape and or checklists revealed poor fidelity to the standardized intervention. Fidelity of the provider intervention was checked by visits to the Clinics to check if asthma forms had been completed by physicians, and by reminding them of the need to fill out the forms.

Study Measures

All family participants (N=404) completed an in-home baseline interview, a shortened telephone six month follow up, a 12 month face to face follow up home interview, and an 18 month telephone follow up. All measures were adapted for use among Spanish-speaking populations using multi-stage, state-of-the-art methods for cross-cultural adaptation [31].

Child Primary Asthma Outcomes—*Controller* medication use was evaluated retrospectively by asking the mother whether the child had used prescribed asthma medication in the last six months by the child's physician. If the parent said the child was using medication then the interviewer asked the parent to bring the medication for an in-home physical observation of the medication itself in the face to face interviews (baseline, and 12month follow up). If the parent did not have the medication at home they were asked to identify prescribed drugs from a card which showed pictures and names of the following *controller medications:* leukotrienes such as montelucast and zafirlukast, inhaled corticosteroids such a ciclesonide, mometasone, fluticasone, beclomethasone dipropionate, triamcinolone acetonide, as well as combination inhaled corticosteroid/long-acting beta agonists, such as flovent and salmeterol, symbicort and zenhale. Rescue medications or short acting beta agonists assessed were: albuterol, metaproterenol, pibuterol and terbutaline. The medication use questions did not inquire about frequency or adherence to medication. Therefore, medication use in this study does not refer to daily use of controller medication, since it is possible that the child could have used it only once.

Symptom days is an index of asthma morbidity estimated by caregivers' reports of symptoms during the day or night during the past 30 days prior to the follow-up interview. Improvements of two to three symptom days or nights are clinically meaningful [32].

Child Secondary Asthma Outcomes—Controller medication use and symptom days were analyzed as secondary outcomes for the six month and 18 month follow up telephone interviews. We also examined parental reports of 12 month ED visits and hospitalizations in addition to asthma control. *Asthma control* was assessed with the Pediatric Asthma Therapy Assessment Questionnaire (ATAQ) [33, 34] that measures asthma symptoms and consequences within the last 4 weeks in children 4 to 11 years. Control domains are scored from 0 to 7 with 0 indicating no asthma control problems and higher scores indicating higher asthma control problems with 1-3 not well controlled, 4-7 poorly controlled. *Emergency Department visits and number of hospitalizations* was measured with items that assessed the number of ED visits or hospitalizations in the last 6 and 12 months. *Demographic Information* includes the family's income and educational level, perception of poverty, Medicaid status, marital status, and household composition.

Data Analyses

We first checked to see if the participants in the CALMA-only and CALMA-plus study arms were comparable in terms of demographic and clinical variables available at baseline. After some differences were discovered, we made adjustments using inverse probability weights (IPW) that were based on estimated propensity scores [35-37]. Propensity scores were estimated using a logistic regression model that included the following predictors: child's gender, primary caretaker's education, caretaker's marital status, household income, social assistance, and perception of poverty.

Primary analyses took into account the cluster-randomized design using mixed models that recognized the multilevel structure of the data where individual patients were nested within one of the eight clinics [38]. Three primary outcomes were analyzed at the twelve months follow up: a binary indicator of whether a controller had been used in the past 6 months, a count of days in the past 30 days when asthma symptoms were present, and a count of nights in the past 30 days when symptoms were present. The first of these outcomes was modeled with a logit link using a binomial distribution, and the last two were modeled with a log link using a negative binomial distribution. The pattern of missing data was very similar for all primary and secondary outcome variables. At baseline about 7% of subjects had missing data, at end of treatment about 12%, and by follow up about 18% of data were missing. Comparison of missing data by treatment groups did not reveal any consistent pattern of missing data being more frequent on any of the two treatment groups. Rather than restricting the analysis to those with complete data, we used multiple imputation (20 imputed data sets) to adjust for effects of missingness assuming missing at random [39]. All models were estimated using the GLIMMIX procedure of SAS Version 9.3, and multiple imputations was carried out with the MI and MIANAZE procedures of the same software.

Power Analyses

An *a priori* power analysis was conducted when funding was sought, but we were unable to implement the original design (which would have involved a larger number of clinics) because of changes in health administration policies. These changes resulted in there being more insurance companies and fewer clinics within each company. As a result we were only able to obtain eight clinics near the university within an insurance company to randomize.

We calculated post-hoc power estimates that take into account the number of clinics and patients recruited, the adjustment for clustering and the multiple imputation. These analyses revealed that we had approximate power at the 80% and 90% levels for the following odds/risk ratios for each of the three primary outcomes (80% power effect; 90% power effect): Controller use (2.4, 2.7); Days with symptoms (1.5, 1.6); Nights with symptoms (1.8, 2.0).

Results

Table 1 summarizes the demographic characteristics of the two treatment arms after IPW adjustment. Before adjustment, the two groups were very similar on most baseline covariates with the exception of statistically significant differences on household income, receiving social assistance and perception of poverty. After IPW adjustment these differences were no longer evident. The majority of participants in both groups (CALMA-only, CALMA-plus) reported at baseline having been prescribed a controller medication during the past year that was physically verified by the interviewer and was coded as a controller medication (63%, 69%). However, groups showed high mean rates (7.42, 7.1 of days with symptoms), poor asthma control (4.02 % both groups), high rates of emergency department use (ED) (2.00%, 1.96%) and hospitalizations (1.13%, 1.07%) in the previous six months of the baseline interview.

Table 2 shows the mean percent of the primary and secondary outcomes in the two treatment arms for the original data. Parents in both groups were less likely to report that their child was prescribed a controller medication at 12 months (44.1%, 52.0%) compared to baseline (62.6%, 69.4%). They also reported fewer mean percent of days with symptoms (4.4%, 4.2%) compared to baseline (7.4%, 7.0%) and fewer mean percent of nights with symptoms (2.7%, 2.2%) versus (4.5%, 4.0%). For all three primary outcomes at twelve months, the mean differences between treatment arms were small but in the predicted direction. Children in the CALMA-plus group had higher rates of controller use than those in the CALMA-only group (52.0% vs. 44.1%), lower mean percent of symptom days (4.20% vs. 4.40%) and of symptom nights (2.20% vs. 2.70%).

We next tested whether the better outcomes for the CALMA-plus group could be attributed to the treatment itself rather than chance assignment of one or more of the eight clinics. To do this we used mixed model analysis that treated patients within clinics as clustered. The results of these analyses are shown in Table 3. After adjusting for clinic variation, we observed little difference between the CALMA-plus and the CALMA-only interventions in terms of reported controller medication use, the counts of symptom nights and days, and the twelve secondary outcomes. For all three primary outcomes at twelve months, the mean differences between the two interventions were small. Two of the differences were in the

predicted direction: CALMA-plus had higher rates of controller use than CALMA-only, and lower mean percent of symptom nights. The contrast of CALMA-plus with CALMA-only for symptom days is positive, which is not in the predicted direction. Moreover, corresponding hypothesis tests were not significant; each test failed to reject the null hypothesis. The 95% confidence intervals for the counts of days and nights with asthma symptoms, ED visits and hospitalizations suggest that the addition of the clinic and provider component to CALMA did not produce a clinically meaningful improvement. However the confidence intervals and odds ratios on controller medication use did not rule out a clinically important treatment effect. The finding for controller use must be considered inconclusive.

We also explored whether the results might differ by the child's level of asthma symptoms (Table 4). We did this by sorting the children into one of three symptom groups (children with no symptoms at night, children with one to four night symptoms and children with five or more night symptoms), based on their baseline nights with symptoms. The lower third of these (no night symptoms) might be considered to have mild level of asthma symptoms overall. The baseline rate of controller medication use among children with mild asthma symptoms was (56%, 60%) respectively, in the CALMA-only and CALMA-plus groups, and it was (40%, 54%) at 12 month follow-up, but the difference was not statistically significant ($t(6) = 1.31$; $p < .24$) (see Table 4). The difference in controller medication in the CALMA-plus group at 12 months relative to CALMA-only was small.

Discussion

We used a group randomized design to test whether adding provider training and a systemic clinic-level intervention to an evidence-based and culturally sensitive family intervention (CALMA) would increase the reported use of controller medication and reduce asthma symptoms among low income Puerto Rican children with persistent asthma. After adjusting for clinic variation, we observed little difference between the CALMA-plus and the CALMA- only interventions in reported controller medication use, counts of symptom nights and days and twelve secondary outcomes. Although the additional provider-focused component of CALMA-plus did not have the predicted effect, the core CALMA intervention appeared to be effective in both the CALMA-only and CALMA-plus groups in ways that had been previously documented [11]. Our supplemental analyses (data not shown) showed that at both follow up times participants in both groups had lower rates of hospitalization, ED use, days with symptoms and nights with symptoms at both 12 month and 18 month follow-up times. Consistent with the 2008 trial we did not find a statistically significant increase in controller use in either the CALMA-only or CALMA-plus groups.

The CALMA-plus intervention was developed on the basis of literature documenting lower ED visits and hospitalizations with provider trainings using the PACE program [15, 16] and increased use of controller medication in a cross sectional design [25]. However, at two year follow up, the PACE intervention alone was not found to significantly increase controller medication use [16]. Other studies have found that provider education alone is not effective in increasing reported controller medication use [14, 40]. Nevertheless more comprehensive multi-level interventions which include family management education, physician education and organizational change, have found a significant increase in parental report of controller

medication use and or prescription practices, among other asthma outcomes [14, 17]. Because of this, we decided to develop a multi-level intervention that would combine physician training with clinic screening and family education on self management of asthma. However, contrary to these findings [14, 17] we did not find a significant increase in reported controller medication use. These multilevel interventions compared the experimental group with usual care. Comparison of an intervention with usual care increases the chance of obtaining an effect compared to studies in which two interventions are compared (one of which is evidence based). Furthermore, these studies used a similar design to ours and randomized clinics [14, 17] had a greater number of clinics in their design (42 and 22 respectively) as compared to the eight clinics available in the present study. Thus, both the comparison with an evidence based intervention and the relatively small number of clinics available to us, limited statistical power and were therefore significant limitations to our study design.

Several other factors might have influenced the present findings. Exposure to the provider training was limited, with only 17 out of 32 providers attending the training sessions. PCPs were supposed to complete an asthma review form but bi-weekly visits to obtain these forms showed that most physicians did not comply with this task even though the medical directors were highly interested in having their physicians trained by our team. Barriers to compliance may be related to the observed high volume of patients and insufficient resources (i.e. no case management personnel, only one nurse per clinic) to attend this high volume. Low capitation fees assigned by the government to the clinics that attend Medicaid children may be related to the lack of resources available at the clinics [23]. Furthermore, there is evidence that physicians face several barriers to prescribing controller medication particularly inhaled corticosteroids [41-43]. Barriers stated by these investigators include: lack of familiarity with NAEPP medication guidelines, lack of agreement with the same, lack of self-efficacy in motivating patients to use and adhere to the medication, and lack of outcome expextancy or trust by the provider that the patient will adhere with the treatment. CALMA-plus addressed the first two barriers, but less emphasis was given to the lack of self efficacy and outcome expectancy. In fact, in a recent survey of practicing pediatrians in Puerto Rico, 80% reported lack of adequate insurance of the patient to pay for medication and their belief that patients would not comply with the treatment (83%) as the most important barriers for prescribing controller medication to low income children [22].

We wondered if contact hours between the children in the CALMA- plus might have been so limited that the children were essentially unexposed to the provider intervention. From previous analyses we knew that a high percentage of children on the island use the ED as their primary source of care and rarely go to outpatient visits [44]. Our results showed that at the six month follow-up, 71% of the children in the CALMA-plus group as compared to 66% of the CALMA-only group had visited their PCP in the prior 6 months. At 12 month and 18 month follow up 74% and 63% of the children in the CALMA-plus and 67% and 55% in the CALMA-only intervention respectively had visited their PCP. These results show that more than one quarter of the CALMA plus children were not exposed to the PCP intervention thus reducing the possibility of obtaining an effect for the experimental intervention.

We recognize other limitations of our study. First, our analyses and results are subject to the limitations inherent in self report data, particularly medication use [45]. We realize that measuring controller medication use in the last six months does not capture the details of the frequency and regularity of use. However, the CALMA-plus intervention aimed mainly to improve prescription practices of physicians as measured by parental reports and medical charts. Since it is possible that physicians prescribed controller medication that were not filled by the family, we reviewed the medical charts of all the children in the CALMA-plus intervention for the periods including the time that included baseline and 12 month follow up. We found no statistically significant difference in the percent of patients with controller prescription documented by the PCP in the medical charts at baseline (46.1 %), as compared to those prescribed at 12 month follow up (45.3%). However, the percentage of prescriptions recorded in the medical charts is considerably lower than the percentage reported by parents at baseline (69.4%) and 12 month follow up (52.0%) suggesting over reporting by parents or under-documentation of prescriptions by physicians or a combination of both. Second, our study participants were limited to island Puerto Rican children with persistent asthma enrolled in Medicaid and our results may not be generalizable to children of different cultural backgrounds or contexts.

We know that many children with asthma are undertreated, particularly inner city low income children [46] and in Puerto Rico under-treatment is even more dramatic that in other cities of the US [23, 47, 48]. However, it seems that in this sample of children with persistent asthma, more than half of the children at baseline and follow up reported controller medication use (our primary outcome). Nevertheless, the vast majority of children had poor asthma control, high rates of ED utilization and asthma symptoms, suggesting low adherence to the controller medication. Prior studies comparing rates of adherence to controller medication between children with persistent asthma attending primary care clinics in Rhode Island and Puerto Rico found low rates of adherence to controller medication by island and Rhode Island Latino children as compared to similar non Latino white children [49]. Parental beliefs about controller medications and family organization were identified as important factors predicting adherence to medication.

The CALMA-only intervention may need to be expanded to include more behavioral and educational reinforcements on the need for adherence and appropriate use of controller medication, as well as change towards more positive parental beliefs for controller medication use.

Interventions that focus on training the patient and a family coordinator or care management to provide the physicians (during the patient visit) with important and necessary information for them to prescribe controller medications, might be more promising. For example, Bonner et al. [50] trained a family coordinator to provide intensive individualized asthma education to families and coached them to present to their doctors detailed asthma histories. In addition, the family coordinator or nurse accompanied the family to the doctor's visit and prompted physicians, about the patient's daily symptoms, fluctuations in peak flow and asthma history. This multi-level intervention resulted in a significant increase in the prescription of controller medication to children randomized to the experimental as compared to the control group.

Conclusion

Our findings suggest that changing physician practice behaviors is a difficult and complex process and that several limitations of our study, and the context in which physicians practice, may have been related to our findings. Comparison of CALMA plus with an evidence based intervention instead of usual care, a small number of clinics, limited number of providers that received the training, lack of compliance of providers with implementation of the asthma review form, and the fact that a significant number of the children were not exposed to the intervention, may have contributed to the lack of significant change between groups in the use of controller medication among low-income children with persistent asthma attending primary care clinics in Puerto Rico. In addition, physicians attending these children were working with low economic incentives, heavy work loads and lack of sufficient resources. Future interventions should respond to the limitations of the present study design and provide more resources to providers that will increase provider participation in training and implementation of the intervention. Training of patients and family coordinators to provide physicians with important asthma information at the doctor's visit may also be necessary to improve prescription practices.

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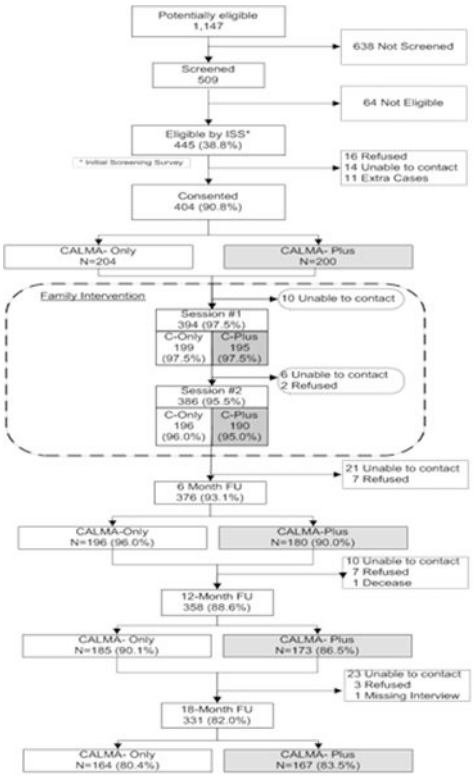

Figure 1.
Consort Diagram.

Table 1

Demographic, Primary and Secondary Outcomes of CALMA-only and CALMA-plus at Baseline

	Propensity Adjusted				
	CALMA (N=204)		CALMA+ (N=200)		
Child Characteristics	**%/Mean**	**CI***	**%/Mean**	**CI**	**P value**
Male	67.7	(64-71.2)	68.5	(65.7-71.2)	0.68
Age	8.3	(7.9-8.6)	8	(7.5-8.5)	0.19
Primary Asthma Outcomes					
Controller Medication Use (Self-Reported)					
Any	62.6	(47.9-75.2)	69.4	(54.2-81.2)	0.45
Leukotrienes	43.5	(38.4-48.6)	49.4	(33.4-65.4)	0.44
Inhaled Corticosteroids (ICS)	45.9	(34.1-58.2)	51.9	(40.8-62.8)	0.45
Days with Symptoms (30D)	7.4	(6.2-7.9)	7	(5.2-7.6)	0.7
Nights with Symptoms (30D)	4.5	(2.8-6.1)	4	(3.1-5.0)	0.62
Secondary Asthma Outcomes					
Asthma Control	4	(3.7-4.4)	4	(3.6-4.4)	0.99
Emergency Room Visits					
Self-reported (6M)	2	(.8-1.3)	2	(.8-1.5)	0.84
Hospitalizations					
Self-reported (6M)	1.1	(.8-1.5)	1.1	(.8-1.3)	0.76

	Propensity Adjusted				
	CALMA (N=204)		CALMA+ (N=200)		
Caretaker Characteristics	**%/Mean**	**(CI)***	**%/Mean (CI)**	**(CI)***	**P value**
Mother Educational level					0.98
Less than High School	22.1	(11.9-37.1)	21.8	(15.4-29.8)	
High School/Equivalent	40.8	(30.0-52.5)	40.6	(29.2-53.0)	
Some College/College Degree	37.1	(32.5-41.9)	37.7	(31.5-44.3)	
Household Annual Income					0.99

	Propensity Adjusted				
	CALMA (N=204)		CALMA+ (N=200)		
Child Characteristics	**%/Mean**	**CI***	**%/Mean**	**CI**	**P value**
$6,000 or less	58.4	(47.9-67.9)	58.3	(54.8-61.8)	
$6,001 to $12,000	21.1	(17.0-25.9)	20.8	(18.7-23.1	
$12,001 to $25,000	16.6	(13.5-20.3)	17	(11.0-25.3)	
$25,001 or more	3.9	(2.13-7.1)	3.9	(2.6-5.7)	
Received Social Assistance	83.6	(79.1-87.3)	83.3	(72.6-90.4)	0.94

Notes: CALMA+ Treatment group; 30D - 30 days 6M - 6 months Statistical significance was ascertain using X^2 or t-Test CI* Refers to 95% Confidence Intervals
Percentages are shown after Inverse Probability Weight adjustment based on estimated propensity scores. These were estimated using a logistic regression model that included the following predictors: child's gender, primary caretaker's education, caretaker's marital status, household income, social assistance, and perception of poverty.

Table 2

Means of Primary and Secondary Outcomes at Baseline, 6 months, 12 months and 18 months Follow-up

	Baseline		Follow-Up 6M		Follow-Up 12M		Follow-Up 18M	
	CALMA-only (N=204)	CALMA-plus (N=200)	CALMA-only (N=196)	CALMA-plus (N=180)	CALMA-only (N=185)	CALMA-plus (N=173)	CALMA-only (N=164)	CALMA-plus (N=167)
	%/Mean (CI)	%/Mean (CI)	%/Mean (CI)	%/Mean (CI)	%/Mean (CI)	%/Mean(CI)	%/Mean (CI)	%/Mean (CI)
Controller Medication Use (Self-Reported)	62.6 (47.9-75.3)	69.4 (54.2-81.3)	56.6 (42.0-70.2)	66.9 (60.3-72.9)	44.1 (29.6-59.8)	52.0 (42.0-62.8)	59.4 (47.5-70.2)	69.5 (68.1-70.7)
Days with Asthma Symptoms (30D)	7.4 (5.2-9.6)	7.0 (6.2-7.9)	3.9 (2.9-4.8)	4.4 (2.7-6.0)	4.4 (3.8-5.0)	4.2 (2.0-6.3)	3.2 (2.0-4.5)	3.0 (1.6-4.4)
Nights with Asthma Symptoms (30D)	4.5 (2.8-6.1)	4.0 (3.1-5.0)	2.6 (2.2-3.0)	3.3 (2.3-4.4)	2.7 (1.8-3.6)	2.2 (1.2-3.2)	2.0 (1.6-2.4)	2.8 (1.5-4.1)
Asthma Control (ATAQ Score)	4.0 (3.7-4.4)	4.0 (3.6-4.4)	3.5 (3.3-3.7)	3.7 (3.2-4.2)	3.3 (2.8-3.9)	3.5 (3.0-4.1)	3.2 (2.9-3.6)	3.1 (2.9-3.4)
ED visits (Self-reported) (6M)	2.0 (1.7-2.3)	2.0 (1.6-2.3)	1.2 (.8-1.7)	1.1 (.99-1.2)	1.1 (.5-1.8)	.79 (.5-1.1)	.47 (.4-.6)	.62 (.5-.8)
Hospitalization (Self-reported) (6M)	1.1 (.8-1.5)	1.1 (.8-1.3)	.34 (.2-.5)	.61 (.30-.96)	.43 (.3-.6)	.43 (.12-.75)	.10 (.05-.15)	.14 (.10-.18)

Notes: CI – 95% Confidence Intervals
CALMA-plus Treatment group
30D - 30 days 6M- 6 months
Percentages are shown after Inverse Probability Weight adjustment based on estimated propensity scores.

Table 3

Contrasts Between CALMA- only and CALMA-plus Treatment Arms for Primary and Secondary Outcomes

	Coeff	95% (CI)				
Primary Outcome (12 MO)	**B**		**e^b**	**DF**	**T**	**p value**
Controller Use 12 Mo	0.299	(-0.537,1.134)	1.349	4.55	0.95	0.39
Symptom Days (last 30 days)	0.009	(-0.431,0.449)	1.009	4.43	0.06	0.96
Symptom Nights (last 30 days)	-0.149	(-0.724,0.424)	0.861	4.49	0.70	0.52
Secondary Outcomes						
ER Visits 6 Mo	0.157	(-0.399,0.714)	1.169	3.80	0.80	0.47
ER Visits 12 Mo	-0.363	(-0.972,0.245)	0.695	4.43	1.60	0.18
ER Visits 18 Mo	0.157	(-0.399,0.714)	1.169	3.80	0.80	0.47
Hospitalizations 6Mo	-0.101	(-1.140,0.937)	0.903	4.02	0.27	0.80
Hospitalizations 12 Mo	-0.101	(-1.140,0.937)	0.903	4.02	0.27	0.80
Hospitalizations 18 Mo	0.247	(-0.815,1.310)	1.28	3.21	0.72	0.52
Controller Use 6 Mo	0.436	(-0.431,1.303)	1.546	4.49	1.34	0.24
Controller Use 18 Mo	0.384	(-0.261,1.029)	1.468	4.22	1.62	0.18
Symptom Days 6 Mo	0.009	(-0.431,0.449)	1.009	4.43	0.06	0.96
Symptom Days 18 Mo	-0.048	(-0.598,0.502)	.953	4.44	0.23	0.83
Symptom Nights 6Mo	-0.149	(-0.724,0.424)	.861	4.49	0.70	0.52
Symptom Nights 18Mo	0.264	(-0.27,-0.806)	1.302	4.34	1.32	0.25

Note: The regression coefficient represents the difference between CALMA-plus minus CALMA-only in the regression models. The exponentiated coefficient represents a rate ratio for count variables or an odds ratio for dichotomous variables. The contrasts were estimated using generalized mixed models that represented the clinics as random effects nested within treatment conditions.

Table 4

Model based estimated probabilities of control medication use at baseline and 12 months follow up conditional on treatment group and baseline asthma symptom level.

Treatment Group					
CALMA ONLY			**CALMA PLUS**		
Asthma Symptom Level	Baseline	12 Months	Asthma Symptom Severity	Baseline	12 Months
Mild Symptoms	.56 (.37-.74)	.40 (.23-.58)	Mild	.60 (.40-.81)	.54 (.34-.76)
Moderate Symptoms	.64 (.47-.81)	.44 (.27-.61)	Moderate	.77 (.64-.91)	.48 (.32-.64)
Severe Symptoms	.77 (.61-.92)	.56 (.37-.76)	Severe	.78 (.62-.94)	.60 (.41-.80)

Note. Asthma Symptom Level (Last 30 days) Mild Symptoms= 0 nights with symptoms, Moderate Symptoms = 1- 4 nights with symptoms, Severe Symptoms = 5 or more nights with symptoms. Entries on table represent model based least squares means representing the probability of using control medication as a function of asthma symptom level at baseline and at 12 months follow up.