The cost-savings of implementing kangaroo mother care in Nicaragua

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ABSTRACT

Objective. *To examine the costs of implementing kangaroo mother care (KMC) in a referral hospital in Nicaragua, including training, implementation, and ongoing operating costs, and to estimate the economic impact on the Nicaraguan health system if KMC were implemented in other maternity hospitals in the country.*

Methods. *After receiving clinical training in KMC, the implementation team trained their colleagues, wrote guidelines for clinicians and education material for parents, and ensured adherence to the new guidelines. The intervention began September 2010. The study compared data on infant weight, medication use, formula consumption, incubator use, and hospitalization for six months before and after implementation. Cost data were collected from accounting records of the implementers and health ministry formularies.*

Results. *A total of 46 randomly selected infants before implementation were compared to 52 after implementation. Controlling for confounders, neonates after implementation had lower lengths of hospitalization by 4.64 days (P = 0.017) and 71% were exclusively breastfed (P < 0.001). The intervention cost US$ 23 113 but the money saved with shorter hospitalization, elimination of incubator use, and lower antibiotic and infant formula costs made up for this expense in 1–2 months. Extending KMC to 12 other facilities in Nicaragua is projected to save approximately US$ 166 000 (based on the referral hospital incubator use estimate) or US$ 233 000 after one year (based on the more conservative incubator use estimate).*

Conclusions. *Treating premature and low-birth-weight infants in Nicaragua with KMC implemented as a quality improvement program saves money within a short period even without considering the beneficial health effects of KMC. Implementation in more facilities is strongly recommended.*

Key words Child development; premature birth; Nicaragua.

An estimated 13 million babies are born prematurely worldwide each year, with 92% of them born in less developed countries (1). Premature infants are more likely to suffer from respiratory and sensory deficits and learning disabilities than infants carried to term (1, 2). The proportion of all babies born premature in Nicaragua is 9.3%, higher than the regional average of 8.6% (3). Kangaroo mother care (KMC), defined as skin-to-skin contact between the mother and newborn to keep the infant warm, exclusive or near-exclusive breast feeding, and early discharge home from hospitals, has been shown to reduce infant morbidity and mortality (4–6). Due to its simplicity, KMC reduces or eliminates the need for sophisticated, expensive equipment such as incubators and reduces the need for highly skilled medical personnel. It can therefore be applied in remote maternity units in low-resource settings (7). The KMC method of care reduces newborn mortality by preventing infections and hypothermia and promoting weight gain through increased breastfeeding (8). It also helps parents and caregivers form emotional bonds with the infant, strengthening the family unit (4).

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The maternal and neonatal hospital in Nicaragua participating in this program is a 270-bed national referral and teaching hospital in Managua that provides medical and surgical care in obstetrics, gynecology, neonatology, and adolescent health. Just under 11 000 deliveries are performed there annually, of which 18% are premature deliveries and 14% are low-birth-weight (LBM). Between 2007 and 2010, the proportion of premature deliveries at the hospital increased (9). Before the KMC intervention at this hospital began in September 2010, preterm infants were admitted to nutritional recuperation rooms where they remained mostly in incubators for their entire length stay. Parents were only allowed to visit once per day, and the infants were fed exclusively with infant formula. Following discharge from the ward, these infants were not followed for systematic monitoring to assess their growth, development, and overall health.

Given the high burden of premature and LBM neonates in Nicaragua, a partnership was established between the Ministry of Health of Nicaragua (MINSA) and the U.S. Agency for International Development (USAID) Health Care Improvement Project (HCI) to support KMC implementation in the referral hospital with a plan to spread the practice to other hospitals after the initial phase. The intervention began with a 15-day KMC training at a specialized center in Bogota, Colombia, for three health workers from the referral hospital and a staff member from HCI who together comprised the KMC implementation team. The team returned to the referral hospital and implemented the new program in the facility for all infants of birth weight less than 2 500 g or born before 37 weeks of gestation.

There have been few published economic analyses conducted for KMC, and they have generally stated that the intervention is cost-efficient for managing LBM and premature infants, particularly in low-resource settings (7, 10). However, these studies examined operating costs but did not include the cost of training health providers on KMC so that they can effectively implement the intervention consistently with parents of premature and LBM infants. Other studies of KMC training programs for health providers have not included cost analysis or have presented its efficiency as a theoretical costing exercise (11–13).

This study examined the costs of implementing KMC in the referral hospital in Nicaragua, including costs for training health providers and implementing the program in the hospital, and the intervention's operating expenses. It also used the data from the referral hospital to estimate the economic impact on the Nicaraguan health system if KMC were implemented in other maternity hospitals in the country.

MATERIALS AND METHODS

Intervention

After consultation and planning between MINSA and HCI, three clinicians from the referral hospital were accompanied by an improvement expert from HCI for a three-week training at the Kangaroo Foundation in Bogota, Colombia, in April 2010. The hospital staff included one neonatologist, one registered nurse, and one psychologist in order to create a multi-disciplinary approach to implementing KMC. On their return, dedicated space in the referral hospital was secured for the KMC program, and furniture, equipment, and supplies were purchased. The implementation team advocated for support for the introduction of KMC through a series of meetings with clinical staff and hospital management during which the evidence for the effectiveness of KMC was presented and discussed. The team provided formal, four-hour, clinical training sessions for other hospital staff and helped clinicians and other staff plan the changes required to insert the new care practices into their standard operating procedure.

The training was repeated as new staff joined the unit. While there was no periodic reinforcement training, there was ongoing monitoring of compliance with care protocols. When gaps were identified in compliance with care protocols, the RN or physician-in-charge would review the protocol for KMC care with team members.

The implementation team also developed a clinical management protocol manual; new clinical intake forms (to identify eligible infants for the program); informed consent forms; and an education manual for "Kangaroo Parents." Once implemented, daily educational presentations, designed by the psychologist, and including group meetings to discuss infant feeding and care, were delivered for parents. The implementation team used a quality-improvement approach that included routine monitoring of the indicators of compliance with the new standards of care and promptly addressing deficiencies in quality performance by working closely with clinical staff and facility managers to motivate adherence to the KMC guidelines.

Study design

This pre-/post-intervention study used data collected from patient medical charts and accounting records from the implementing agents. Premature infants, defined as those born at a gestational age of less than 37 weeks or with a birth weight lower than 2 500 g born at the referral hospital between January and September 2010 (pre-intervention) and October 2010 and June 2011 (post-intervention) were included in the sample. This hospital was chosen because it is the largest maternal hospital in the country and was selected by MINSA to participate in this initial implementation phase. A review of medical charts for the nine months before the intervention and nine months following its implementation allowed collection of data on infant weight, medication and formula consumption, and incubator use over the course of hospitalization. The pre- and post-intervention groups were matched on gestational age and weight at admission. No neonates were included in either group if they had medical problems other than those related to prematurity. All neonates included in the study had to be clinically stable and breathing without mechanical ventilator assistance. Data were collected by trained chart reviewers and collated anonymously for analysis. Information on the cost of implementing KMC was collected from the accounting records of HCI and MINSA costing records and formularies.

Because the study used secondary data already collected anonymously from patients as part of their routine medical care, the study was exempt from institutional ethics board review. Permission for data collection was sought and obtained from hospital administrators.

Analysis

A Fisher's exact test and Student's *t*-test were performed for proportions

and continuous variables respectively to determine differences between neonates in the pre- and post-KMC periods. Multiple linear regressions were used to estimate the difference in lengths of hospitalization controlling for potential confounders of admission weight and age.

Costs for the treatment of neonates in the two groups were calculated by multiplying the lengths of hospitalization determined from the regression results by average daily hospitalization cost. Average drug and infant formula costs were also included. For the post-KMC group, the total cost to MINSA and HCI for implementing the KMC program was added. All costs were collected as 2011 Nicaraguan *cordobas* and converted to 2011 U.S. dollars using the prevailing exchange rate (14).

Cost-effectiveness of implementing KMC in the referral hospital was determined using decision-tree analysis with inputs of data obtained from the hospital and from the project implementers.

Costs, personnel time, and epidemiological data extrapolated from the referral hospital example and estimates from other hospitals of the number of babies delivered were used as inputs into a decision tree to compare the hypothetical KMC intervention with business-as-usual in order to estimate the economic impact of implementing KMC in other maternal health facilities beyond the referral hospital. Monte Carlo simulations using the sampling distribution of uncertain variables were conducted to determine the precision of the estimate.

RESULTS

Ninety-eight charts from inpatient stays were reviewed: 46 before implementation of KMC and 52 in the period nine months after implementation. These were selected at random from among all charts from newborns over this period. Newborns from the period after KMC introduction were slightly lighter and had lower gestational age, although these differences were not statistically significant. The lower weight on discharge in the period after KMC introduction reflects the fact the discharge criteria for neonates in the KMC program include a lower weight than the discharge criteria before the change. Neonates after implementation of KMC had shorter hospitalizations, a substantially higher proportion of mothers breastfeeding, and correspondingly lower consumption of formula (Table 1).

The costs for all drugs and infant formula used by the sampled newborns were entered into a model to calculate average costs for neonates in the two groups, and found to be US$ 4.97 before KMC and US$ 3.65 after KMC. The difference was due primarily to lower cost for infant formula and medications in the post-KMC period. The total average cost for care for a neonate was US$ 2 322 in the pre-KMC period and US$ 1 808 in the KMC period. The largest part of these costs was training the three health professionals at the regional KMC training center for 15 days. The combined cost, considered a single, fixed expense, was just over US$ 23 000. The additional per-patient cost included consumables given to the parents of each neonate (Table 2).

Analysis of the costs comparing the KMC to no KMC showed that the amount of money saved on inpatient treatment of high-risk neonates in the KMC program would offset the cost of initial training and implementation of health workers and changes to the hospital system after treatment of 45 premature neonates or 1–2 months of deliveries. After 12 months, implementing KMC in this referral hospital is projected to save more than US$ 233 000 (Figure 1).

The second model that was used to calculate the projected comparative cost of expanding the scope of KMC training to include the 12 other largest maternal hospitals in Nicaragua that were not part of the initial implementation included the inputs listed in Tables 2 and 3. Salaries were obtained from MINSA records. The cost for the KMC training program of hospital staff was based on having two physicians and one RN per hospital attending a 10-day training session conducted by the three trainers who implemented the program in the referral hospital. It includes the costs of trainers' per diem allowances, transport, and accommodation, estimated from previous experience of similar projects from HCI. The distributions representing the uncertainty in the estimates were based on the sampling distributions found in the data from the referral hospital. Two different estimates were used for expected prevalence of incubator use in the 12 hospitals: one based directly on what was found in the referral hospital, and another based on a conservative estimate of one-quarter of the usage level at the referral hospital, given that this hospital is a national referral center and thus more likely to treat a higher proportion of very sick premature neonates.

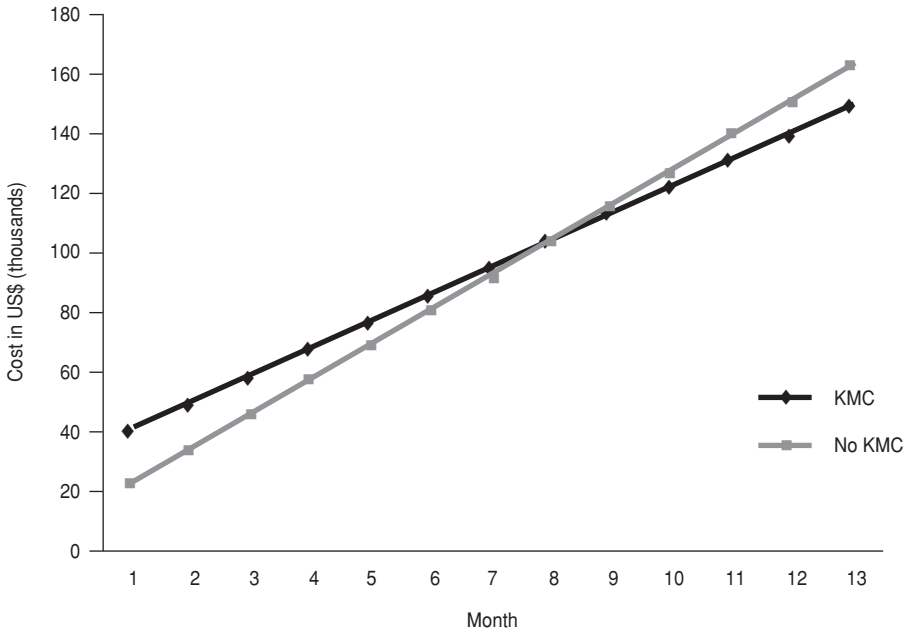
Point estimates for the difference in cost between the KMC and no KMC strategies show that even with the conservative estimate, implementing KMC is expected to begin to save money after fewer than 275 neonates are treated, or less than five months after full implementation. After 12 months of implementation, KMC is estimated to save more than US$ 233 000 using the referral hospital incubator use data or around US$ 166 000 with the more conservative incubator use estimate (Figure 2). However, these results are point estimates not taking into account the confidence intervals of data obtained from samples. Using the uncertainty in the model inputs, the acceptability curves show the probability of KMC implementation in

TABLE 1. Characteristics of infants before and after implementation of kangaroo mother care (KMC),[a] Nicaragua, January 2010–June 2011[b]

	Before KMC	After KMC	*P*
Number (%)	46 (47)	52 (53)	
Mean gestational age (weeks)	33.0	31.9	0.183
Mean weight (g)			
Admission	1 377	1 329	0.400
Discharge	1 753	1 660	0.002
Gain (%)	376 (27)	331 (25)	0.410
Discharge to observation[c] (%)	1 (2)	2 (4)	0.608
Hospitalization days	22.6	19.4	0.149
Exclusive breastfeeding (%)	0 (0)	37 (71)	< 0.001
Total formula consumed (mL)	3 876	1 042	< 0.001

[a] Defined as skin-to-skin contact between mother and newborn to keep infant warm; exclusive or near-exclusive breastfeeding; and early discharge home from hospitals.
[b] Multiple linear regressions yielded an estimated average difference in length of hospitalization between neonates in the pre-KMC and post-KMC periods of 4.64 days ($P = 0.017$) controlling for gestational age and admission weight.
[c] Newborns discharged from preterm infant care ward but remaining under observation in another ward.

FIGURE 1. Cost of treating premature neonates prior to kangaroo mother care (KMC) intervention versus the cost of the intervention plus the cost of treating the neonates after the intervention, Nicaragua, from September 2010[a]



[a] In 2011 Nicaraguan *cordobas* converted to 2011 U.S. dollars based on the prevailing exchange rate.

TABLE 2. Cost of implementing a kangaroo mother care (KMC) intervention, Nicaragua, September 2010–June 2011[a]

Type of cost	Activities or materials	US$
Actual fixed	15-day training session at the regional KMC training center in Bogota, Colombia, for three health workers	17 088
	Furniture for counseling room	1 556
	Belts, clothing, and equipment for breastfeeding	1 515
	Durable medical equipment	841
	Workshop and other sessions to review/adapt tools	650
	Counseling literature	768
	Promotional materials	695
	Subtotal	23 113
Projected fixed (for 12 hospitals)	10-day training session at 12 hospitals, with three trainers, two physicians, and one registered nurse per hospital, and including trainers' per diem and estimated travel and accommodation costs	96 300
	Furniture for counseling room	3 000
	Belts, garments, and equipment for breastfeeding	1 515
	Durable medical equipment	2 522
	Workshop and other sessions to review/adapt tools	1 300
	Counseling literature	768
	Promotional materials	795
	Subtotal	106 200
Additional per-patient	KMC garments (e.g.,cloth wraps)	2
	Other consumables	1
	Parent education literature	0.63
	Subtotal	3.63

[a] In 2011 Nicaraguan *cordobas* converted to 2011 U.S. dollars based on the prevailing exchange rate.

the 12 hospitals being cost-saving over time. Even under conservative assumptions, using KMC is projected with almost 100% certainty to produce savings after one year of implementation.

DISCUSSION

While there have been few economic analyses of KMC, there have been studies that demonstrate the costs and impact of various postnatal care services that are part of KMC. Darmstadt et al. (15) estimated that the promotion of early and exclusive breastfeeding practices, keeping the infant warm, and paying special attention to feeding and hygiene of preterm and LBM infants could avert 6%–19% of deaths in 60 low-income countries at a cost of US$ $0.36–0.71 billion. Several different programs to increase breastfeeding of LBM infants have been found cost-effective in various settings (16, 17). Results from this study are consistent with these previous findings.

The KMC method was developed in the 1970s by Colombian pediatricians and has been endorsed by the World Health Organization (WHO), which published KMC practice guidelines in 2003 (18). However, in Latin America, with the exceptions of Colombia and Brazil, the practice has not been made widely available to parents of LBM children despite its demonstrated effectiveness, longevity, and recognition (19). In Nicaragua, KMC was viewed as a strategy for use in very low-income settings and was therefore stigmatized as inferior to interventions based on high technology despite contrary evidence. Because there was no advocacy (including dissemination of the evidence of its effectiveness), many practicing clinicians were not aware of KMC as a clinically effective patient management option. In addition, investment in the equipment and training required for successful implementation was inadequate. The strategy adopted in the 2010 intervention was to address these implementation challenges. Previous KMC interventions had focused narrowly on training in methods without addressing operational barriers to implementation.

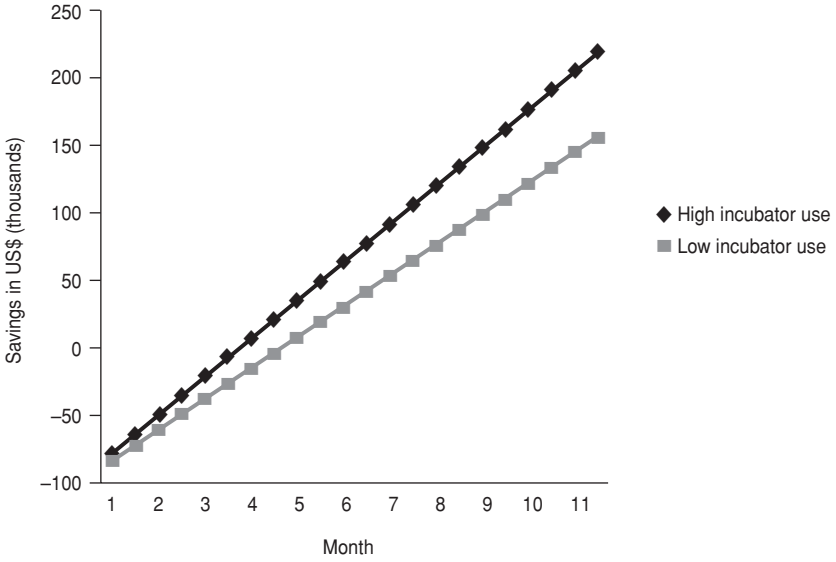
In 2009, USAID initiated support to develop KMC in Latin America and the Caribbean (LAC) through the LAC Neonatal Health Alliance. Since then, USAID has supported development of KMC programs in 10 LAC countries: Bolivia, Dominican Republic, Ecuador, El Salvador, Haiti, Honduras, Guatemala, Nicaragua, Paraguay, and Peru. Technical support for these programs is provided by HCI and the Maternal and Child Health Integrated Programs (MCHIP) (19, 20). The important aspect of the intervention in Nicaragua is that it combined comprehensive content training on KMC with improvement

TABLE 3. Inputs for cost comparison model for extending a kangaroo mother care (KMC) intervention to 12 hospitals, Nicaragua, September 2010[a]

Input	Estimate	Distribution	Source
Probability of using incubator (no KMC)	0.33	Binomial (n = 46)	RMH[b] experience
Average days in incubator	11.8 days	Normal (s = 1.5)	RMH[b] experience
Length of stay with KMC	19.4 days	Normal (s = 1.5)	RMH[b] experience
Length of stay without KMC	24.0 days	Normal (s = 1.5)	RMH[b] experience
Medication/formula cost with KMC	US$ 3.65	Normal (s = 0.4)	RMH[b] experience
Medication/formula cost without KMC	US$ 4.97	Normal (s = 0.5)	RMH[b] experience
Additional costs for KMC	US$ 3.93	Normal (s = 0.4)	RMH[b] experience
Cost of hospital day	US$ 93.00		RMH[b] experience
Cost of incubator day	US$ 27.00		RMH[b] experience
Number of additional hospitals	12		MINSA[c] data
Number of staff for KMC training per hospital	3		RMH experience
Number of KMC trainers required	3		RMH experience
Number of days for training	10		RMH experience
Premature, low-birth-weight neonates per month in 12 hospitals	350		MINSA data
Salary per physician per day	50		MINSA data
Salary per registered nurse per day	17		MINSA data

[a] Costs in 2011 Nicaraguan cordobas converted to 2011 U.S. dollars based on the prevailing exchange rate.
[b] RMH: Referral Maternity Hospital.
[c] Ministry of Health.

FIGURE 2. Cost-saving estimates for different model assumptions related to incubator use in 12 maternal hospitals, Nicaragua, from September 2010[a]



[a] In 2011 Nicaraguan *cordobas* converted to 2011 U.S. dollars based on the prevailing exchange rate.

methods implemented by HCI to ensure that changes in the facility were made to institutionalize KMC as routine practice in the care of premature and LBM infants.

Limitations

One major limitation of this study was the absence of a control group. Modeling calculations were based on the assumption that all changes seen from the pre-KMC baseline to the period after KMC was put in place were due solely to KMC and not to an unrelated temporal trend. There were no other changes in neonatal care implemented at the referral hospital and no regional or national programs that may have affected maternal and neonatal health over the period, so there was no reason to consider this assumption as flawed. However, the study would have been strengthened with a control group to clarify how much of the observed changes could be specifically attributed to implementing KMC. Because the hospital for the initial intervention is a national referral facility, it is possible that it receives a higher proportion of high-risk deliveries and therefore may be caring for more complicated and medically needy patients than the 12 hospitals being considered in the model for scaling up the program. This is why two model outputs—one using the referral hospital data and one using a substantially more conservative use of incubators—were presented. If more complete patient data had been available from the 12 other hospitals, they could have been used as inputs for greater accuracy.

For this analysis, it was assumed that the overall clinical outcomes of neonates treated with KMC or no KMC were essentially the same. The long-term benefits of KMC, including the higher rate of exclusive breastfeeding found among neonates in the post-KMC period, were not taken into account. Including health and economic impacts of these benefits such as improved cognitive development of the infant (21) and a lower risk of stunting and wasting (22) would have made the implementation cost-saving at an even earlier point. Any future study of the efficiency of the program would be improved by looking at clinical indicator outcomes over a longer period to obtain a true measure of the incremental effectiveness of KMC.

Even with these limitations—and under conservative assumptions of treatment cost for premature neonates without KMC—it is clear that implementation of the program saved the hospital and therefore MINSA a substantial amount of money a few months after implementation and would likely save MINSA even more money within a few months of expanding the program to the 12 additional hospitals. When accounting for uncertainty in the model predicting cost-savings in the 12 scale-up hospitals, a high level of certainty is reached before the end of the first year of implementation. A prediction of incubator use of half of what was seen in the referral hospital was used to account for the possibility that sicker neonates were taken to the referral hospital because it is likely to be the

facility best equipped to handle the most difficult cases. Almost no difference in the predicted outcome was found when this lower incubator input was used, indicating that the incubator is not a major driver of cost differences between the KMC and business-as-usual strategies.

Conclusion and recommendations

Evidence indicates that implementation of KMC using quality improvement methods to institutionalize changes in clinical practice in this setting saved money in less than two months by decreasing lengths of stay, incubator use, and antibiotic and formula consumption by premature and LBM infants. Modeling with conservative assumptions suggests that implementing the program in 12 of Nicaragua's largest maternity hospitals would also be cost-saving in less than one year. Given that an investment of just over $100,000 required to initiate the program in the 12 facilities is about 0.007% (23) of national spending on health and that the investment will lead to substantial savings in a short time, we strongly recommend implementing KMC in those facilities.

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Conflicts of interest. None.

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RESUMEN

Reducción de costos mediante la implantación del método madre canguro en Nicaragua

Objetivo. Analizar los costos de la implantación del método madre canguro en un hospital de referencia de Nicaragua, incluidos los costos de capacitación, implantación y funcionamiento, y calcular la repercusión económica en el sistema de salud nicaragüense si se aplicara el método en otras maternidades del país.

Métodos. Tras recibir capacitación clínica en el método, los miembros del equipo encargado de su implantación capacitaron a sus colegas, elaboraron directrices para los médicos y material educativo para los padres, y garantizaron la adhesión a las nuevas directrices. La intervención empezó en septiembre del 2010. El estudio comparó los siguientes datos: peso de los lactantes, empleo de medicamentos, consumo de leches maternizadas, uso de incubadoras, y hospitalizaciones durante los seis meses previos y posteriores a la implantación. Los datos relativos a los costos se recopilaron a partir de los registros contables de los ejecutores y los formularios del Ministerio de Salud.

Resultados. Los datos de 46 lactantes seleccionados aleatoriamente antes de la implantación se compararon con los de 52 lactantes del período posterior a la intervención. Mediante el control de los factores de confusión, después de la intervención, el tiempo medio de hospitalización de los recién nacidos fue inferior en 4,64 días ($P = 0{,}017$), y el 71% ($P < 0{,}001$) de los lactantes recibieron lactancia materna exclusiva. La intervención tuvo un costo de US$ 23 113 pero el dinero ahorrado gracias a la menor duración de las hospitalizaciones, la eliminación del uso de incubadoras, y la reducción de los costos en antibióticos y leches maternizadas compensó estos gastos en uno a dos meses. Se proyecta extender el método a otros 12 establecimientos sanitarios de Nicaragua para ahorrar aproximadamente US$ 233 000 (con base en el cálculo del uso de incubadoras en el hospital de referencia) o US$ 166 000 (con base en un cálculo más conservador del uso de incubadoras) al cabo de un año.

Conclusiones. El tratamiento de los neonatos prematuros y con bajo peso al nacer mediante el método madre canguro, implantado como un programa de mejora de la calidad en Nicaragua, ahorra dinero en un período corto, incluso sin tener en cuenta los efectos beneficiosos del método sobre la salud. Se recomienda su implantación en otros establecimientos sanitarios.

Palabras clave Desarrollo infantil; nacimiento prematuro; Nicaragua.