Randomized Controlled Trial on Kangaroo Mother Care in Bogotá: Cost-utility analysis

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Presented at

IX International Conference on Kangaroo Mother Care

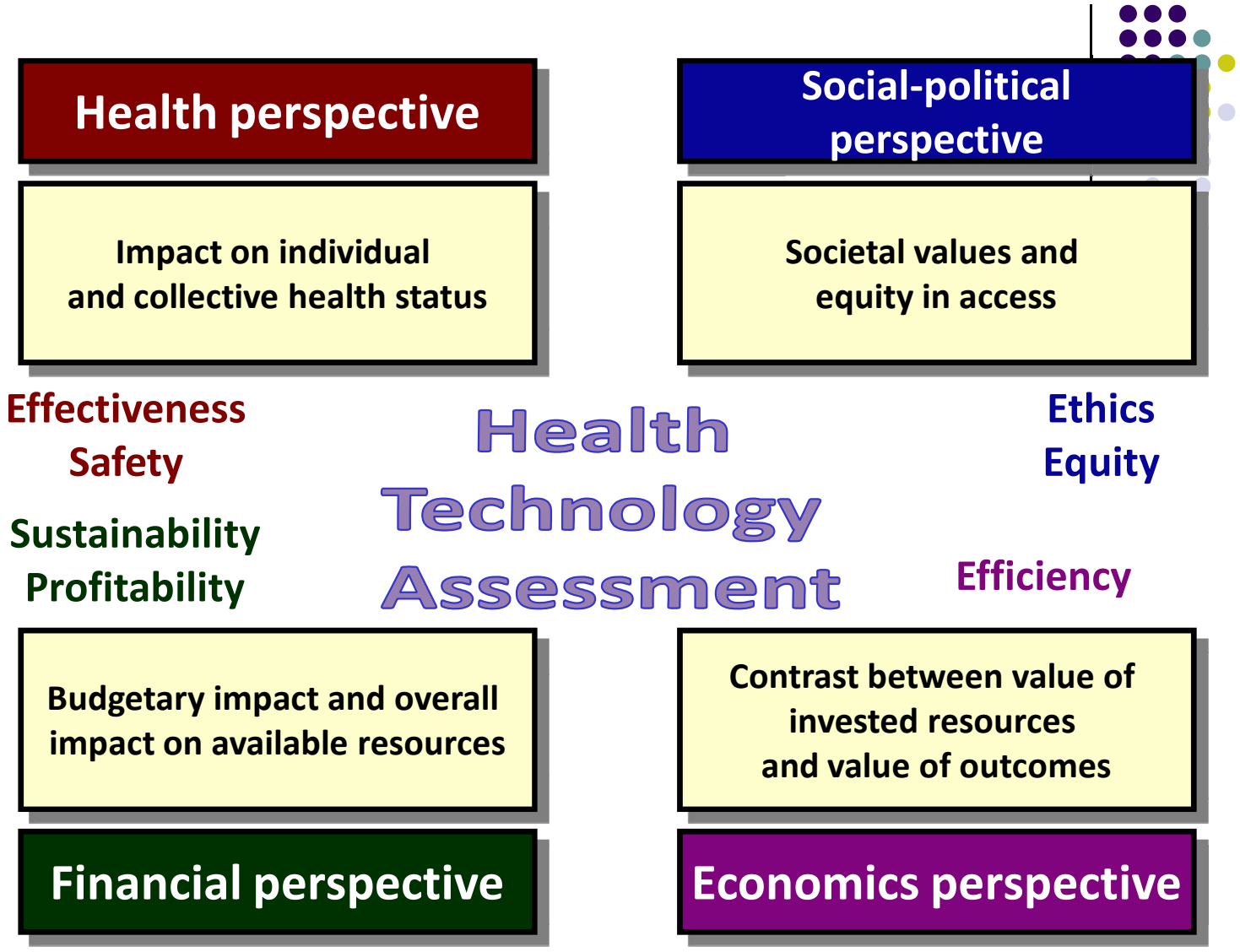
22, 23, 24 and 25 November 2012, Ahmedabad - Gujarat - India

Supported by : National Neonatology Forum, India
National Neonatology Forum Gujarat State Chapter
Prumukhswami Medical College, Karamsad, Gujarat

Chairperson: Dr. Shashi N Vani

Organizing Secretaries: Dr. Ashish Mehta, Dr. Nikhil Kharod, Dr. Somashekhar Nimbalkar

RATIONALE


Health perspective
Social-political perspective
Impact on individual and collective health status
Societal values and equity in access
Effectiveness
Safety
Sustainability
Profitability
Health Technology Assessment
Ethics
Equity
Efficiency
Budgetary impact and overall impact on available resources
Contrast between value of invested resources and value of outcomes
Financial perspective
Economics perspective

Decision Making in resources allocation in Health Care

- Available resources for providing health care are limited
- Health needs are potentially unlimited
- What health needs should be satisfied?
- Criteria:
  - Social,
  - Technical,
  - Political,
  - Personal (each individual)
  - ***and Economical***

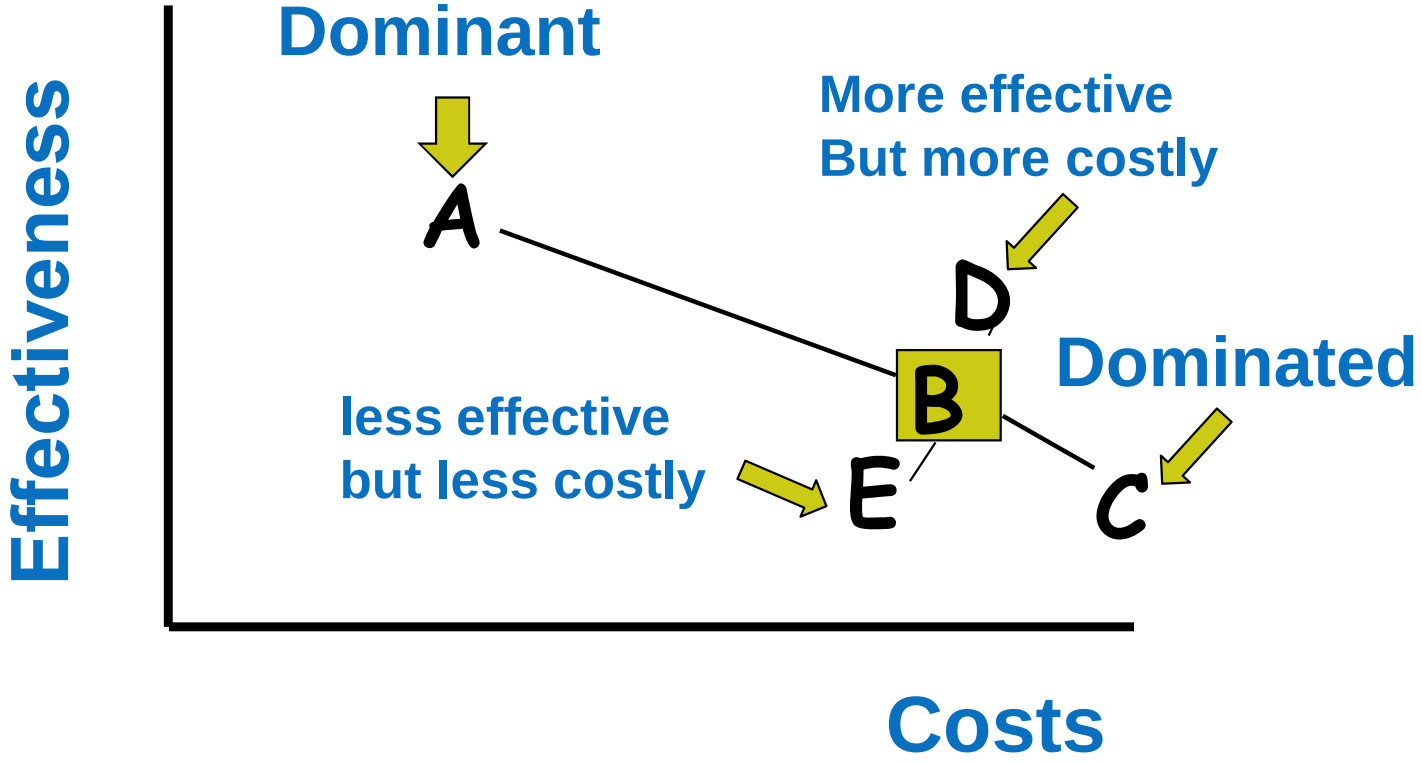
Economic evaluation of health care interventions

- Any type of economic evaluation includes:
  - Identifying,
  - Quantifying,
  - Valuing
  - and Comparing
- Cost and benefits of the considered alternatives

Cost-utility analysis

- Assumptions:
  - Different outcomes, measured in different units-dimensions and converted to a common “artificial” unit (*Utility*)
  - When not only duration but quality of life needs to be taken into account (QUALYs)
  - Cost may be different
- Incremental Cost-utility ratio
  - Costs (B-A)/Utility(B-A)

Interpretation of Cost-effectiveness or cost-utility ratios



Methods

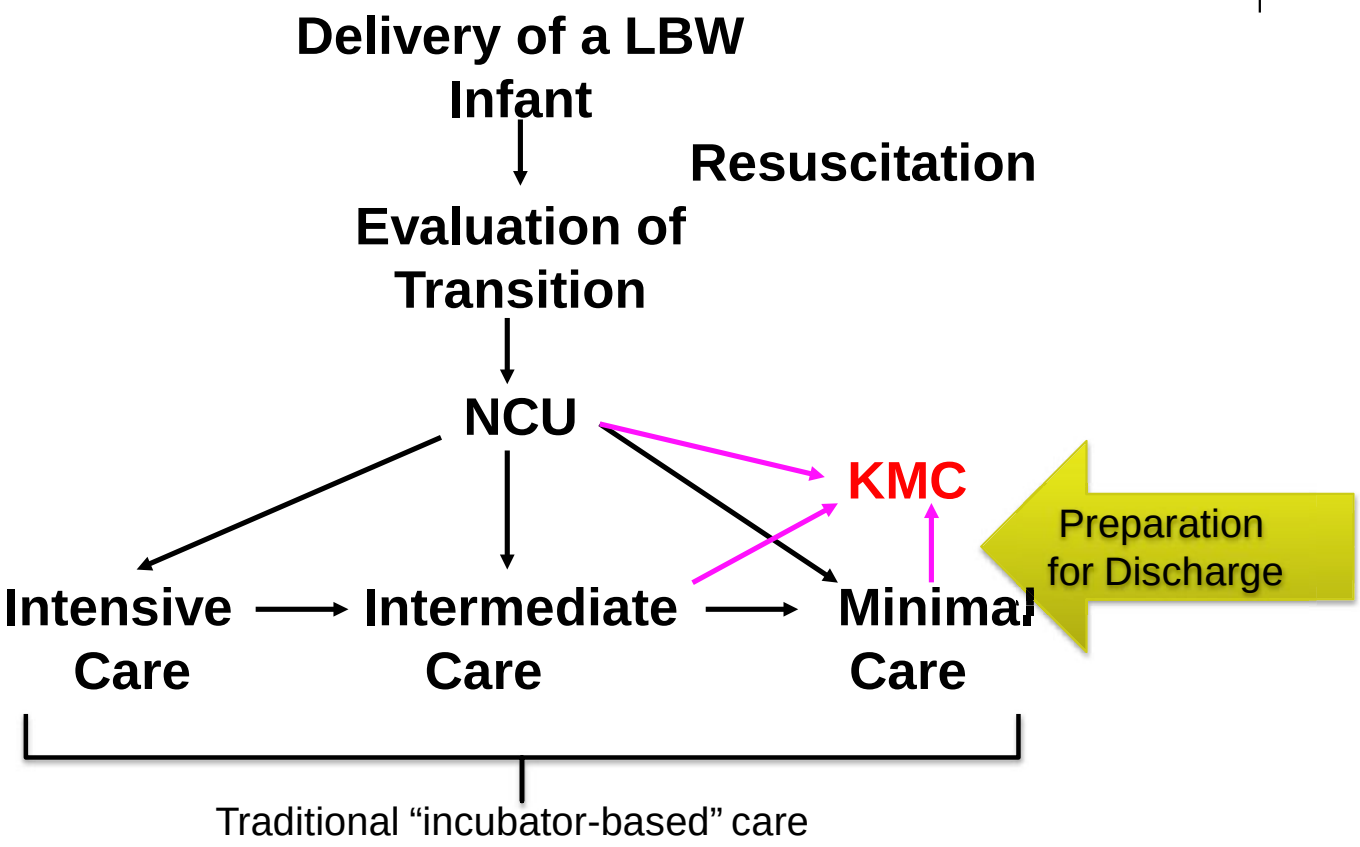
Strategy

- Cost-utility analysis based on results of a RCT comparing KMC and traditional care for LBW and premature infants under 2000 g at birth, carried out between 1994 and 1996
- Cost estimation based on resource consumption during the RCT
- Resource consumption associated with hospital stay updated by micro-costing

Strategy

- Valuation of resources using National Price Listing (2011).
- Utilities estimated by clinical experts formal consensus:
  - Multi-attribute utility function
  - Discrete health states: direct ordering and analog scoring
  - Modified Delphi (nominal groups)

What are the interventions being compared?



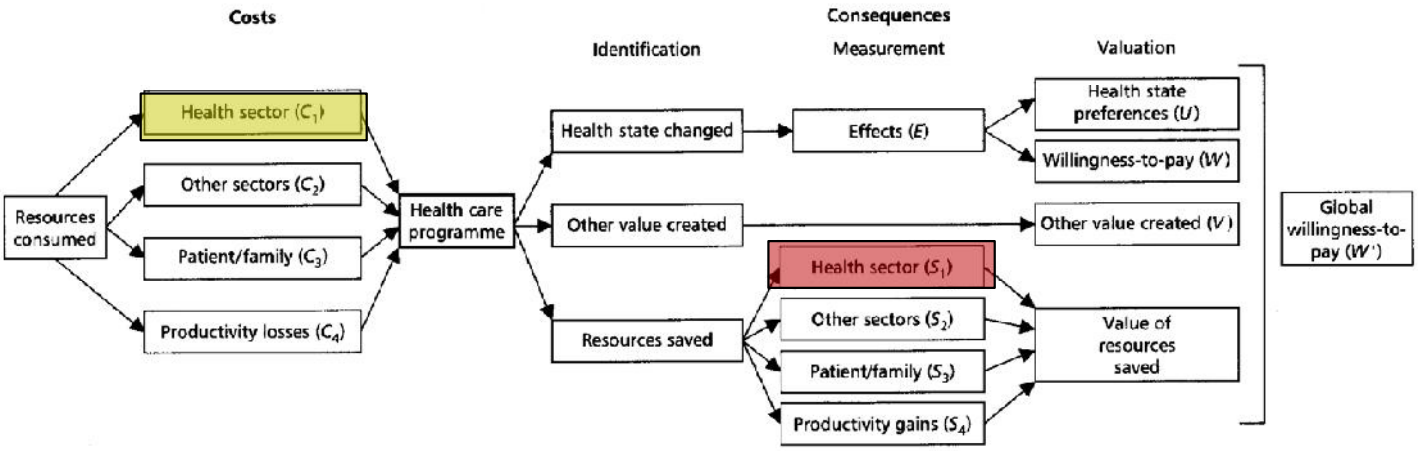
Analysis assumptions

- Scenario: Bogotá, tertiary care neonatal unit, ambulatory KMC clinic
- Perspective: Social Security System (SSS)
  - Pays for hospital bills
  - Pays for ambulatory care
  - Pays for maternity leave
- Time horizon: from eligibility to KMC to one year of corrected age
- Subjects: preterm and LBW infants under 2000 g at birth

Analysis assumptions

- Costs in Colombian pesos 2011
  - exchange rate col$ 1850 per US$ at July 2011
- No discount applied

What costs are being addressed ?



Direct medical costs of hospital stay vs. ambulatory care

Savings from early discharge from hospital

Analysis assumptions

- Outcomes estimated from results of the 1994-1997 RCT conducted in Bogotá (Pediatrics, 1997; 100:682-688. Pediatrics 2001;108:1072-9.) :
  - Discrete health states at one year of corrected age
  - Mortality, morbidity, breast feeding, growth development, neurological status

Analysis assumptions

- Cost in KMC group:
  - KMC program admits >100 infants/month
  - Direct medical costs of in hospital stay from eligibility to actual discharge
  - Cost of not-avoided morbidity (i.e. nosocomial infections, primary hospitalization)
  - Daily outpatient visits until appropriate weight gain
  - Weekly visits until term
  - Hospital readmissions during first year
  - Cost of ambulatory care of infectious morbidity
  - Other cots non differential

Analysis assumptions

- Costs in control group
  - Cost of hospital stay per day from eligibility to discharge:
  - Incubator day, crib day
    - Two medical visits per day
    - Average medication and testing use from eligibility to discharge
  - Cost of not-avoided morbidity (i.e. nosocomial infections)
  - Hospital readmissions during first year
  - Cost of ambulatory care of infectious morbidity
  - Other costs non differential

Study population

- 746 subjects were enrolled in the study. 693 had complete information until death (30 subjects) of being alive at 1 year of corrected age.
- Inclusion criteria: weigth at birth under 2000 g. Surviving early adaptation. Being eligible for KMC after stabilization. Free from lethat of major malformations.

Estimation of utility

- Two systems employed.
  - Multi-attribute utility function (additive)
  - Direct ordering and scoring

Multi-attribute utility function

- Study outcomes were categorized as:
  - Disease-related
    - Mortality (dead-alive)
    - Morbidity (Infection: severe, mild-moderated, absent)
  - Health related
    - Somatic growth (4 patterns)
    - Psychomotor (Griffits score)
    - Neuromotor (Normal-abnormal)
    - Head perimeter (normal abnormal)
    - Breast feeding up to 3 months (appropriate, inapropriate)

Multi-attribute utility function

- Additive multiattribute function:
  - Each attribute represents one dimension (e.g. somatic growth is one dimension)
  - The multi-attribute utility for an individual is the weighted average of each uni-dimensional utility
  - Weights for each dimension assigned by experts consensus (Swing weighting method)
  - Preferences (scores) for each outcome in each dimension
  - Computing the MAUF for each study participant

Multi-attribute utility function

$$V_i \times < \left[\begin{array}{l} w_{IC} u_{IC}(x_{ICi}) + w_{SI} u_{SI}(x_{SIi}) \\ + w_{DP} u_{DP}(x_{DPi}) \\ + w_{DN} u_{DN}(x_{DNi}) + w_{LM} u_{LM}(x_{LMi}) \\ + w_{PC} u_{PC}(x_{PCi}) \end{array} \right]$$

Direct scoring of discrete health states

- Experts rank by consensus the outcome variables:
  - Disease-related
    - Mortality
    - Infection: severe, mild-moderated, absent)
  - Health related
    - Somatic growth (4 patterns)
    - Psychomotor (Griffits score)
    - Neuromotor (Normal-abnormal)
    - Head perimeter (normal abnormal)
    - Breast feeding up to 3 months (appropriate, inapropriate)

Direct scoring of discrete health states

- All covariable patterns – combinations- (taking into account the assigned ranks) of outcomes are listed, and reduced to significant discrete health states
- Anchor states (“perfect” health 1, death or worse than dead, 0)
- Scoring of states by experts (upwards and downwards)
- Nominal group consensus technique

Número del Estado	Desarrollo Psicomotor - Griffiths	Desarrollo Neuromotor - INFANIB	Perímetro Cefálico	Índice de Crecimiento	Lactancia Materna	Frecuencia y Severidad de la Infección
1	Satisfactorio	Normal	Superior_-2σ	Normal	Adecuada	Sin Infección - Leve
2	Satisfactorio	Normal	Superior_-2σ	Normal	Adecuada	Severa
2	Satisfactorio	Normal	Superior_-2σ	Normal	Inadecuada	Sin Infección - Leve
3	Satisfactorio	Normal	Superior_-2σ	Normal	Inadecuada	Severa
3	Satisfactorio	Normal	Superior_-2σ	Anormal	Adecuada	Sin Infección - Leve
3	Satisfactorio	Normal	Superior_-2σ	Anormal	Inadecuada	Sin Infección - Leve
3	Satisfactorio	Normal	Superior_-2σ	Anormal	Inadecuada	Severa
4	Satisfactorio	Normal	Inferior_-2σ	Normal	Adecuada	Sin Infección - Leve
4	Satisfactorio	Normal	Inferior_-2σ	Normal	Inadecuada	Sin Infección - Leve
5	Satisfactorio	Normal	Inferior_-2σ	Anormal	Adecuada	Sin Infección - Leve
5	Satisfactorio	Normal	Inferior_-2σ	Anormal	Inadecuada	Sin Infección - Leve
5	Satisfactorio	Normal	Inferior_-2σ	Anormal	Inadecuada	Severa
6	Satisfactorio	No_Normal	Superior_-2σ	Normal	Adecuada	Sin Infección - Leve
6	Satisfactorio	No_Normal	Superior_-2σ	Anormal	Adecuada	Sin
6	No_Satisfactorio	Normal	Superior_-2σ	Normal	Adecuada	Sin Infección - Leve
6	No_Satisfactorio	Normal	Superior_-2σ	Normal	Inadecuada	Sin Infección - Leve
6	No_Satisfactorio	Normal	Superior_-2σ	Anormal	Inadecuada	Sin
7	Satisfactorio	No_Normal	Inferior_-2σ	Anormal	Inadecuada	Severa
7	No_Satisfactorio	Normal	Superior_-2σ	Anormal	Adecuada	Sin
7	No_Satisfactorio	Normal	Superior_-2σ	Anormal	Adecuada	Severa
7	No_Satisfactorio	Normal	Superior_-2σ	Anormal	Inadecuada	Severa
7	No_Satisfactorio	Normal	Inferior_-2σ	Normal	Adecuada	Sin
7	No_Satisfactorio	Normal	Inferior_-2σ	Normal	Inadecuada	_Leve
7	No_Satisfactorio	Normal	Inferior_-2σ	Anormal	Inadecuada	Sin
8	No_Satisfactorio	No_Normal	Superior_-2σ	Normal	Adecuada	Sin
8	No_Satisfactorio	No_Normal	Superior_-2σ	Normal	Inadecuada	Sin Infección - Leve
8	No_Satisfactorio	No_Normal	Superior_-2σ	Anormal	Inadecuada	Sin
9	No_Satisfactorio	No_Normal	Superior_-2σ	Anormal	Adecuada	Severa
9	No_Satisfactorio	No_Normal	Inferior_-2σ	Normal	Adecuada	Sin Infección - Leve
9	No_Satisfactorio	No_Normal	Inferior_-2σ	Normal	Inadecuada	Sin
9	No_Satisfactorio	No_Normal	Inferior_-2σ	Anormal	Adecuada	Severa
10	No_Satisfactorio	No_Normal	Inferior_-2σ	Anormal	Inadecuada	Severa
10	Fallecidos					

Costs estimation

- Resource use was recorded in the RCT in terms of health care episodes:
  - visits,
  - days of hospital stay in different levels of complexity (intensive, intermediate or minimal neonatal care, general pediatric Ward, pediatric intensive care),
  - visits due to infectious episodes requiring ambulatory courses of antibiotics,
  - re-admissions to hospital.

Costs estimation

- Costs of hospital stay (average cost per day)
  - Valuation of resource use during hospital stay
  - Convenience sample of 57 preterm infants less that 2000 g cared for at Hospital Universitario San Ignacio in Bogotá during 2011
    - Primary neonatal hospitalization
    - Neonatal and pediatric readmissions (infectious episodes)
  - Micro-costing was used for identifying average resource use per hospital-day (detailed billing records).

Costs estimation

- Valuation of used resources
  - Standard pricing lists from the Colombian Ministry of Health (ISS+30%).
  - When data were not available, average purchasing cost from San Ignacio Hospital records (2011) was employed.
  - Ambulatory KMC resource use and valuation came from detailed cost-structure files kept by the “Programa Madre Canguro Integral” run by Fundación Canguro at San Ignacio Hospital during 2011.

Costs estimation

- Included costs
  - Differential costs for producing the interventions (health sector costs, the so-called “direct medical costs”)
  - Cost of treatment of not avoided complications and disease events (so-called “induced costs”).
- Not included costs
  - Costs attributable to unrelated health events (e.g. inguinal hernia, hip dysplasia, etc.)
  - Out of the pocket family expenses
  - Productivity losses

Incremental Costs-utility ratios (ICUR)

- Difference in utility between KMC and control
- Difference in cost between KMC and control
- ICUR $(Cost_{KMC}-Cost_{C})/(U_{KMC}-U_{C})$
- Utilities: weights for QALYs (Quality Adjusted Life Years)
  - Utility X 1 year (survivors)
  - Utility X age at death

Uncertainty and sensitivity analysis

- Sampling uncertainty : 95% confidence intervals around the point estimate of the ICUR, using the Fieller theorem (Glick, et. al. 2011).
- Effects of variation in estimating utilities were assessed by one-way sensitivity analysis employing two different procedures for deriving utilities
- Variability in cost estimation was assumed as part of sampling uncertainty.

RESULTS

Effective sample

- 746 participants in the RCT
- 592 subjects with complete information
  - Up to 1 year of corrected age (survivors)
  - Up to time of dead (demises)
- No differences in baseline variables
  - Between the 746 recruited infants and the 592 evaluable at one year
  - Between KMC and control infants among the 592 subjects

Multiattribute Utility weights

Attribute	Growth Index	Infection	Griffiths Score	Infanib result	Breast feeding	Head Perimeter
Weight	0,15	0,12	0,21	0,20	0,14	0,17
Ranking	*4*	*6*	*1*	*2*	*5*	*3*

Multi-attribute Utility scoring

Variables	Health States	Score
Growth Index (Waterloo)	Normal W H	100
	Low W Normal H	79.375
	Normal W Low H	43.125
	Low W H	0
Infection	No infection	100
	mild	73.75
	Severa	0
Griffiths Score	Appropriate	100
	Borderline	58.75
	Low	0

Multi-attribute Utility Function (equation)

$$U_i(x_{ICi}, x_{SIi}, x_{DPi}, x_{DNi}, x_{LMc}, x_{PCi}) =$$

$$V_i \times \begin{bmatrix} 0.154 * u_{IC}(x_{ICi}) \\ +0.119 * u_{SI}(x_{SIi}) \\ +0.215 * u_{DP}(x_{DPi}) \\ +0.197 * u_{DN}(x_{DNi}) \\ +0.141 * u_{LM}(x_{LMi}) \\ +0.174 * u_{PC}(x_{PCi}) \end{bmatrix}$$

Utilities (QALYs)

- Baseline analysis: Multi-attribute Utility Function
  - Total average Utility: 0.84 QALYs per infant
  - KMC: 0.876 QALY per infant
  - Control 0.809 QALY per infant.
  - This difference is statistically significant ($p < 0.001$).

Utilities (QALYs)

- Alternative analysis: Utility function

$$\bar{U} = Fr_1 u_1 + Fr_2 u_2 +$$
$$Fr_3 u_3 + Fr_4 u_4 +$$
$$Fr_5 u_5 + Fr_6 u_6$$
$$+ Fr_7 u_7 + Fr_8 u_8$$
$$+ Fr_9 u_9 + Fr_{10} u_{10}$$

Utilities (QALYs)

- Alternative analysis: Direct ranking and scoring
  - Total average Utility: 0.82 QALYs per infant
  - KMC: 0.846 QALY per infant
  - Control 0.78 QALY per infant.
  - This difference is statistically significant ($p < 0.001$).

Costs

- Average differential costs per infant:
  - KMC infant Col$ 2’810,531
  - Control infant Col$ 2’997,643
  - Difference not statistically significant (p=0.12).

Costs-utility

- Incremental Cost-Utility Ratio (ICUR) (based on utilities from MAUF)

$$ICUR = \frac{\text{Col\$ } 2810531\text{-Col\$ } 2997643}{0.876 \text{ QALY}\text{-}0.809 \text{ QALY}}$$

$$ICUR = -\$2783236 \text{ per QALY}$$

- Fiellers 95%CI Col$ -14’333,117 to Col$ +8’838,754, per QUALY.

Interpretation

- KMC is not only cost-useful but cost-saving (DOMINANT)
- Uncertainty evaluation: due to sampling variation, KMC can be clearly dominant and cost-saving: saving more that Col$ 14 million per additional gained QALY. On the other side of the 95%CI, KMC is not dominant and one could be expending a bit less that Col$ 9 million in order to gain an additional QALY.

Interpretation

- The upper limit is clearly under the willingness to pay threshold for Colombia: Col$36’000,000 per gained QALY
- In summary KMC very efficient: is at least cost-useful or in the best case-scenario is dominant

Interpretation

- Costs structures are local and results can not be extrapolated
- Nevertheless, they give an idea of the likely direction of economic consequences of using KMC in many other settings

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Thank you