NICU Cost Model Evaluation of Kangaroo Care

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Introduction

Kangaroo Care has become an expected practice with positive health outcomes for neonatal infants. This paper evaluates the impact of the cost and benefits of kangaroo care. Sensitivity cases, on likely factors in infant care, help quantify the impact in an effort to support hospital staff decision making. The cost model variables relate to documented kangaroo care impacts as published in respected journal articles.

Methodology

A spreadsheet based cost model was developed after Comert[1] and the year-long evaluation of a state-run Neonatal Intensive Care Unit (NICU) in Istanbul (supporting 211 neonatal infants). Annual budget data includes fixed (Operating Expense) and running (personnel, intervention, …) cost parameters. The paper also included separate hospital care data (average days in hospital, intervention frequency, intervention duration, …) for two different age groups (33-37GW & 28-32GW).

Budget Parameters

- Operating Costs (lease, electricity, admin/IT/HR/finance, …)
- Running Costs
  - Intervention Cost
  - Personnel Cost
  - Ancillary Cost
  - Consumable Cost
  - Drug Cost
  - Laboratory / Investigational Cost

Using the data and cost information, an annual budget model was built with specific care and cost variables which can be modified to derive and evaluate alternative scenarios. The variables selected align with published data on kangaroo care barriers and enablers [2] and kangaroo care impacts on infants [3,4,5].

Additional Computations / Adjustments

- To improve the applicability to Australian evaluation, an overarching, proportional adjustment was made to change the base-case average daily NICU infant cost to $5000/day.
- Intervention, drug and lab costs were all attributed to infants requiring intervention. Personnel, ancillary and consumable costs were apportioned proportionally to infant count. Operating cost was apportioned based on the total number of infants*days.

- The average increase in hospital time due to intervention was provided (4.5 days). To build the model an assumption had to be made to compute average intervention days for each infant age/GW group. 4 and 5 days were chosen as estimate of the intervention days for the older and younger groups, respectively.

The methodology for evaluation is a two-part process. First a base budget/cost dataset is computed using representative, overall figures. Second, a revised annual forecast is computed and built using the average daily infant cost for each of the two age groups, with and without intervention.

Key Parameters for modifying the revised forecast are:

- Personnel Cost Adjustment – This percent increase (or decrease) variable was included to allow for adjustments due to increased staff and parent training time. This was noted as a key enabler in Chan, et.al. [2].
- Age group variables and Base-Case values from Comert et al[1]

Variables	Group 1 (33-37 GW)	Group 2 (28-32 GW)
Number of infants	115	96
Average Days in Hospital for each age group	12.04 days	15.58 days
Percent of age group with intervention (# infants)	20.2% (23 infants)	70% (67 infants)
Extra days in hospital if intervention was required	4	5

Table 1 – Key variables which can be modified in the model and Base-Case values

The model is built to make data more available on kangaroo care impact with modifications to the model easily incorporated.

Results

Single variable sensitivities were chosen as the first level of evaluation. In these cases, specific questions could be asked, evaluated and answered. Total Annual Cost is going to be the key metric for evaluation and decision making in this paper. The model also computes a number of other metrics for each age group and for those with and without intervention. Examples for each age group, with and without intervention, include average days in hospital, total cost per infant and daily cost per infant. This additional level of detail is useful for specific implementation alternatives.

After having an understanding of the single variable sensitivities, more complex multiple variable analyses can be performed. In these cases additional thought is required to insure the integrity of the overall evaluation.

Differences between the Base-Case and the sensitivity case can be used to evaluate decision policy. Capital outlay for equipment may (or may not) be offset by cost savings. It is this thought process that will be covered in the discussion section.

Single Variable Sensitivities

The following table details a variety of single variable sensitivities impacting either Group 1 (33-37GW), Group 2 (28-32GW) or both Group 1 and 2 age groups. The difference in total annual cost as compared to the base case is also computed

Scenario	Total Annual Cost (in $000)		Difference from base case cost (in $000) (positive numbers are savings)	
Base Case	**$14,393**		**$0**	
Case A 1 less intervention day per infant	Group 1 (33-37 GW)	Group 2 (28-32 GW)	Group 1 (33-37 GW)	Group 2 (28-32 GW)
	$14,368	**$14,370**	**$25**	**$23**
	Both Group 1 & 2		Both Group 1 & 2	
	$14,345		**$48**	
Case B 5% less intervention per age group	Group 1 (33-37 GW)	Group 2 (28-32 GW)	Group 1 (33-37 GW)	Group 2 (28-32 GW)
	$14,295	**$14,306**	**$98**	**$87**
	Both Group 1 & 2		Both Group 1 & 2	
	$14,203		**$190**	
Case C 1 less average day stay in hospital per age group	Group 1 (33-37 GW)	Group 2 (28-32 GW)	Group 1 (33-37 GW)	Group 2 (28-32 GW)
	$14,193	**$14,132**	**$200**	**$261**
	Both Group 1 & 2		Both Group 1 & 2	
	$13,933		**$460**	
Case D-1 1% more personnel costs	**$14,407**		**-$14**	
Case D-2 2.5% more personnel costs	**$14,427**		**-$34**	

Table 2 – Total cost impact from single variable variations and difference compared to the base case

Impacts from changes in single variables show the potential for an overall positive cost impact of kangaroo care. For example, if kangaroo care improvements lead to 5% less intervention in both age groups (Case B), the total annual cost would be reduced from $14.393MM to $14.203MM for a savings of $190,000. Alternatively, if 2.5% more staff time were required for parent training and monitoring, total annual cost would rise to$14,427MM, an increase of $34,000.

Multiple Variable Sensitivities

The following table details a variety of multiple variable sensitivities impacting either Group 1 (33-37GW), Group 2 (28-32GW) or both Group 1 and 2 age groups. The difference in total annual cost as compared to the base case is also computed.

Scenario	Total Cost (in $000)		Difference from base case cost (in $000) (positive numbers are savings)	
Base Case	**$14,393**		**$0**	
Case D 1 less average day AND 2% more personnel cost per age group	Group 1 (33-37 GW)	Group 2 (28-32 GW)	Group 1 (33-37 GW)	Group 2 (28-32 GW)
	$14,226	**$14,166**	**$167**	**$227**
	Both Group 1 & 2		Both Group 1 & 2	
	$13,965		**$428**	
Case E 5% Intervention AND 1 less intervention day per age group	Group 1 (33-37 GW)	Group 2 (28-32 GW)	Group 1 (33-37 GW)	Group 2 (28-32 GW)
	$14,275	**$14,280**	**$118**	**$113**
	Both Group 1 & 2		Both Group 1 & 2	
	$14,162		**$231**	

Table 3 – Total cost impact from multiple variable variations and difference compared to the base case

The use of variations on multiple parameters is powerful, if logical variations can be envisioned. Two examples are presented.

Case D – in this scenario kangaroo care results in one less average day for each group combined with this is a 2.5% uplift in personnel costs associated with the extra parent and staff training required. In this case the extra training cost is more than offset by the reduced days in hospital. In the case where it was applied and effective on both age groups, total annual costs would drop to $13.965MM resulting in an overall savings of $428,000.

Case E – in this scenario kangaroo care results in both a lower intervention rate and for those in intervention, the stay is one day shorter In the case where it was applied and effective on both age groups, total annual costs would drop to $14.162MM resulting in an overall savings of $231,000.`

These multiple variable scenarios illustrate how logically linked cost variables and health impact evaluations could occur. This thought process and the resulting data will help decision makers set policy regarding outcome-based care. This will be illustrated further in the discussion section.

Discussion

Having a robust computational model of NICU costs with meaningful variables that represent logical cases is a powerful tool for decision makers. To illustrate this point with an example, one can compare potential savings (or losses) to the cost for equipment to implement kangaroo care. Effective kangaroo care can be applied through the use of the evidence-based product Kangaroo Zak from Nurtured By Design.

- Kangaroo Zak – soft, strapless, stretchy and breathable wrap that covers the parent's torso and closes on the side with a zipper. Kangaroo Zak is ergonomically designed specifically to facilitate prolonged, effective and safe sessions on kangaroo care in post-partum and NICU – approximate hospital cost less than $99 each

To evaluate the cost effectiveness of a decision to begin kangaroo care, an implementation case is made.

> Implementation Case – Kangaroo care using the Kangaroo Zak is implemented only on the younger, Group 2 infants (count 96). If this results in 5% less intervention (a decrease from 75% to 70%), then an overall annual savings, before expenditure, of $87,000 (see Case B, Table 2) is obtained. Kangaroo care implementation for Group 2 would cost approximately $9,500 ($99 * 96 infants), resulting in an overall cost savings of $77,500. The return on investment (ROI) for this scenario is 816% (benefit / cost), which would almost certainly meet hospital budget-planning / economic investment criteria.

In addition, kangaroo care implementation results in 5% less intervention, meaning that 5 infants progress well enough to not require any intervention. In this scenario, the optimum cost and infant health decision is to implement kangaroo care, using the Kangaroo Zak, for all Group 2 infants.

At this point it is worth noting that Russell et al[3] documented significantly higher benefits from kangaroo care implementation using Kangaroo Zak we have modelled in this paper. The effectiveness seen in the Russell study can also be evaluated in the cost model. However, we have shown that the optimum decision policy is to implement kangaroo care using Kangaroo Zak and additional benefits would only strengthen the decision recommendation.

Review of the single and multiple variable sensitivity studies provide initial evidence that improvements in infant heath care, even with additional staff cost, are good decisions from both cost and outcome perspectives.

Additional work using the cost model could be undertaken to model specific hospital details, model specific health outcomes or model trial implementation results.

Conclusion

A robust cost model was developed to assess the cost and health outcome impact of kangaroo care implementation. Published evidence supporting effective implementation is strong. The cost model allows decision makers to evaluate different implementation strategies. In this paper, several single and multiple variable sensitivities were computed. These cases document a range of outcomes. An understanding of implementation costs and modelled cost saving provides robust evidence for decision making. In almost all cases illustrated in this paper, the optimum decision policy is to implement effective, evidence based kangaroo care.

References

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