**Application Development to Facilitate Multi-Criteria Decision Analysis to Treatments for Patent Ductus Arteriosus (PDA)**

**Introduction**

The average rate of preterm birth in high-income countries is 9%, and 12% in low-income countries[[1]](#footnote-1). The costs associated with the care of preterm infants are significant; vary with national context; and, are primarily associated with neonatal morbidities. Among the complications afflicting neonates is Patent Ductus Arteriosus (PDA), a common cardiovascular diagnosis, affecting between 20-60% of preterm infants[[2]](#footnote-2). Despite the prevalence of PDA, there is significant discordance amongst clinicians on appropriate treatment. Disagreement ranges from whether pharmacological treatment for PDA is effective, and not potentially harmful to the neonate; to what pharmacological intervention is most effective (assuming the former apprehension is resolved).

The Stochastic Multi-criteria Acceptability Analysis (SMAA) technique is a suitable means to evaluate how treatment decisions for hemodynamically significant PDA differ across decision maker preference sets and baseline event rates. The SMAA approach is a form of Multi-Criteria Decision Analysis (MCDA), used as a tool for decision support in a variety of contexts including healthcare[[3]](#footnote-3). The majority of MCDA approaches rely on the input of preference data for non-commensurate criteria. The decision support information generated from MCDA models is a weight associated with a particular preference. There are a number of applications in healthcare of MCDA decision support tools, particularly those that allow for partial or ‘preference free’ input, such as an SMAA approach that analyzes the preferences that provide a given alternative its ranking (e.g., most preferred, or 3rd rank)[[4]](#footnote-4),[[5]](#footnote-5).

In this paper we describe the re-analysis of a recently published Bayesian network meta-analysis (NMA) of pharmacological treatments for PDA (CITE). The work represents a new approach to providing decision support. The re-analysis of the NMA is conducted through an SMAA which uses ordinal preference constraints (e.g. mortality is more important than necrotizing enterocolitis). A Monte-Carlo simulation is built in R which models the preference model of the SMAA. Finally, the R model was transformed into a web-ready application using Shiny. The final application represents a tool which clinicians can utilize to analyze individual preferences against common practices in the treatment of PDA.

**Method**

*Baseline Data: The Network Meta-Analysis (NMA)*

The NMA was undertaken (need fill in information here)

*The Re-Analysis of the NMA to Develop the Stochastic Multi-criteria Acceptability Analysis (SMAA)*

A Stochastic Multi-criteria Acceptability Analysis (SMAA) tool to support decision making based on performance across multiple outcomes which differ in their importance for decision making. Ordinal or Cardinal criteria can be utilized in the developed of an SMAA tool. We developed the SMAA tool in this study using ordinal preference constraints (e.g. mortality is more important than necrotizing enterocolitis) from two clinicians (SM, MCY) as well as a “preference free” model. Sensitivity to baseline rates was explored through increasing or decreasing single event rates +/- 2-10%. Monte-Carlo methods were used for parameter estimation in NMA and integration over the feasible weight space given preference constraints with 30,000 iterations used for both. Outcomes included first rank acceptability (FRA), the vector of central weights required to have an a priori preference for one treatment over another, and a confidence factor (CF) reflecting certainty in decisions. All analysis is conducted in R.

The use of R as a programming tool lends itself well to a Bayesian approach to creating a analytic framework. Bayesian approaches rely on prior information, or *prior distributions*, which are incorporated with new information to formulate probabilities for an outcome. Bayesian inference allows for the incorporation of new information to further inform outcome probabilities.

**Results of the Re-Analysis and SMAA**

Clinicians differed in outcome rankings, which influenced treatment recommendations and their uncertainty (SM: highest FRA = oral acetaminophen (0.50), CF = 0.66; MCY: highest FRA = IV ibuprofen standard dose (0.31), CF = 0.33). Central weights for the preference free model suggests that oral acetaminophen is preferred when weights across outcomes are generally equal, while IV ibuprofen requires heavier weights on intraventricular hemorrhage and oliguria. Variations in baseline rates have a similar effect on recommendations.

More detail needed

**Development of Shiny Application**

An application based on the R model was developed using Shiny. Shiny allows for the development of an interactive, web-accessible application which can allow researchers and clinicians and researchers to enter inputs, manipulate and visualize the data, and view the results. The structure for the R code is important, in that it integrates user input into to the model to generate outputs consistent with the method of Bayes Theorum, rather than applying the formulae derived from modeled data to the new inputs.

**Discussion**

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2. Dice, J. E., & Bhatia, J. (2007). Patent ductus arteriosus: an overview. *The Journal of Pediatric Pharmacology and Therapeutics*, *12*(3), 138-146. [↑](#footnote-ref-2)
3. Marsh, K., IJzerman, M., Thokala, P., Baltussen, R., Boysen, M., Kaló, Z., ... & Devlin, N. (2016). Multiple criteria decision analysis for health care decision making—emerging good practices: report 2 of the ISPOR MCDA Emerging Good Practices Task Force. *Value in health*, *19*(2), 125-137. [↑](#footnote-ref-3)
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5. Lahdelma, R., Salminen, P., 2002. Pseudo-criteria versus linear utility function in stochastic multi-criteria acceptability analysis. *European Journal of Operational Research* 141 (2), 454–469. [↑](#footnote-ref-5)