REDDING BIAS IN A RETROSPECTIVE CASE-CONTROL STUDY: AN APPLICATION OF PROPENSITY SCORE MATCHING

Alex Euzevudu,1,2 Jonathan Goldman,3 Anne Waaler4

1. ICON Clinical Research, San Francisco, CA 2. ICON Medical Imaging, San Francisco, CA 3. GE Healthcare, Horten, Norway

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Introduction

• In retrospective studies, where treatment selection is non-random, cases and controls frequently show large imbalances in patient characteristics.
• These important differences in patient characteristics can create substantial bias in treatment comparisons.
• In particular, patients with advanced or unstable disease may receive the most intensive treatment.
• These imbalances may be adjusted for in order to reduce selection bias and accurately estimate the treatment effect.
• While it is possible to match on a small number of key patient characteristics, if there are numerous covariates, exact matching may not be possible.
• One method to reduce treatment selection bias is the use of propensity scores. The propensity scores adjust for potential confounders to estimate the probability of receiving the treatment.
• Once propensity scores are estimated, cases can be matched to one or more individual controls based on the propensity scores.
• This study provides results from the application of propensity score matching that utilizes the nearest-neighbor technique.

Methods

Data Source and Sample Selection

• This study utilized Premier’s Perspective® Comparative Database, the largest hospital service-level database of U.S. data derived from detailed hospital discharge data.
• All adult patients undergoing inpatient echocardiography between Jan. 2003 and Oct. 2005 were identified (n=22,499).
• Of interest is the use of an echocardiography contrast agent with perflutren protein-type A microspheres.
• All adult patients undergoing inpatient echocardiography between Jan. 2003 and Oct. 2005 were included in the analysis.
• We limited the selection of matched controls to four, because selection of more than four controls per case may lead to multiple comparisons.
• We implemented the nearest neighbor matching using a SAS® Users Group International Conference; SAS® Users Group International Conference; SAS® Users Group International Conference; SAS® Users Group International Conference; SAS® Users Group International Conference.
• For each contrast agent patient, we selected four matched control patients with similar propensity scores.
• A stepwise selection process was implemented to choose those variables with the best predictive power.
• This study provides results from the application of propensity score matching that utilizes the nearest-neighbor technique.

Results

Population characteristics

• Baseline patient characteristics by contrast agent use are shown in Table 1.
• Some of the baseline characteristics showed statistically significant differences between cases and controls at the 0.01 level (Table 1), indicating the potential of serious selection bias in treatment choice.
• Specifically, patients receiving the contrast agent were more likely to have chronic obstructive pulmonary disease, cardiac comorbidities, and were more likely to be treated in the ICU or receive mechanical ventilation (Table 1).

Propensity score matching

• Table 2 lists the variables selected by the stepwise selection process for the logistic regression that models the choice between contrast agent vs. non-contrast agent echocardiography.
• By matching on the derived propensity scores, a propensity-matched algorithm identified 4 matched controls for each of the 2,200 cases.
•Achieving a 100% matching rate reduces the bias that can occur when the sickest (or healthiest) patients of one treatment group are eliminated from the analysis.
• After implementing the propensity score matching algorithm, differences in patient characteristics largely disappeared, and the two treatment groups appeared to be balanced (Table 3).
• In particular, differences between the two groups became insignificant for all of the comorbid disease categories, as well as the level of care variables (Table 3).
• After matching, only one variable remained statistically significant: Higher concomitant medication usage among cases (P=0.001). (Note: Table 3)
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Table 1. Baseline Characteristics by Contrast Agent Use Before Matching

Table 2. Baseline Characteristics by Contrast Agent Use After Matching

Table 3. Baseline Characteristics by Contrast Agent Use After Matching

Limitations

• Propensity score matching can only control for observed covariates. Any unobserved patient characteristics that affect both treatment selection and outcome may still create selection bias.
• Despite the large differences in patient characteristics, this patient population had sufficient overlap between the treatment groups to match every case with 4 controls. Not all study populations will yield complete matches.
• When a larger number of cases are eliminated, because the algorithm fails to find a control with a similar propensity score, the validity of the resulting analysis may be questionable.

Conclusion

• Propensity score matching is a useful way to reduce selection bias in retrospective studies, especially when the present study can be affected by large number of covariates.
• Propensity score matching can be easily implemented in SAS® using the greedy matching algorithm.

References


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Presented at the ISPOR 12th Annual European Congress; Paris, France, October 2009

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