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Title: The Total Effect of Hemoglobin on Medical Cost for Hemodialysis Patients: An Application of the Structural Equation Model.

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Abstract:

Anemia treatment in ESRD patients has been associated with improved clinical and economic outcomes. The direct result of anemia treatment is the increase of hemoglobin (Hb) level. Some research has shown that the increase of Hb has been associated with significantly reduced medical expenditures. To date, most economic analyses have been based on linear regression models (LRM), which produce only the direct effects of Hb on medical cost after adjusting for other variables. However, it is likely that higher Hb may affect other medical conditions that influence cost, i.e. it also has indirect association with cost.

We modeled the effect of Hb on medical cost and the relations among Hb and the other factors simultaneously for 1998, 1999, and 2000 incident hemodialysis patients with a Structural Equation Model (SEM). The logarithm of per patient per month cost was used as the measure of medical cost.

The SEM gives both the direct and indirect effects of Hb on medical cost. The indirect effect of Hb in this analysis is the effect of Hb on cost through a common factor of hospitalizations, number of transfusions, and number of vascular accesses in the follow-up period. The direct effect is the effect that cannot be explained by the above effect. The results show that the effect of Hb from SEM is almost double the effect from the LRM, which does not consider the interrelationship between the independent predictors on cost: increasing 1 unit of Hb is associated with a decrease of 13.8% ($\exp[0.129]-1$) of medical cost (SEM), while it decreases only 8.3% according to the LRM for 1998. The R-square from SEM also almost doubles the R-square from LRM.

In future analyses, we should consider both the direct and indirect effects, if the latter exists, and the correlations of the factors. Otherwise, the result may be misleading. Caution is needed to interpret effects from a model without incorporating the correlations.

Year	Direct Effect	Indirect Effect	Total Effect	Regression Effect
1998	0.012	0.117	0.129	0.080
1999	0.024	0.090	0.114	0.075
2000	0.027	0.084	0.114	0.072