Using GENMOD to Analyze Correlated Data on Military Health System Beneficiaries Receiving Inpatient Behavioral Health Care in South Carolina Health Care Systems

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Abstract
The SAS procedure, GENMOD, was used to analyze a large, correlated dataset of Military Health Care (MHS) system beneficiaries who received inpatient behavioral health (BH) care in South Carolina (SC) Health Care Systems from 2005 to 2014. BH was defined by Major Diagnostic Code (MDC) 19 (mental disorders and diseases) and 20, alcohol/drug use. MDCs are formed by dividing all possible principal diagnoses from the International Classification Diagnostic (ICD-9) codes into 25 mutually exclusive diagnostic categories. The sample included a total of 6,783 BH hospitalizations and 4,827 unique military service members, veterans, and their adult and child dependents who had MHS insurance coverage. Most of BH hospitalization (mental health or substance abuse) was the dependent variable; and gender, race, age group, and discharge year were predictors. Gender was significant with both independent correlation ($p = .0001$) and exchangeable structure ($p = .0003$). However, age was significant using the independent correlation ($p = .0160$), but non-significant using the exchangeable structure correlation ($p = .0584$).

Results
Table 1 shows descriptive statistics for BH group, gender, race, age group, and discharge year. Approximately eighty three percent of MHS hospitalizations had a primary diagnosis of mental health, 77.98% white, 60.21% female, 31.01% were for 30-59 year olds, and 63.78% received inpatient BH care between 2005 and 2014.

Table 2 displays descriptive statistics of age and age by BH group. Overall, the average age of MHS patients was 42.25 years. The average age for MHS beneficiaries with mental health diagnoses was 40.71 years compared to 49.97 years for those with substance abuse diagnoses.

Table 3 shows estimates for GEE analysis from GENMOD procedures with different correlation structures and BH hospitalization as the dichotomous outcome (mental health/substance abuse). Gender was significant for both the independent correlation ($p = .0001$) and exchangeable structure ($p = .0003$).

However, age was significant for the independent correlation ($p = .0160$), but non-significant for the exchangeable correlation structure ($p = .0584$). Discharge year and race were significant in both the independent correlation and exchangeable structure models. The unstructured correlation structure was examined, but the model did not converge.

Conclusions
GENMOD is a powerful SAS procedure for analyzing generalized linear models such as generalized estimating equations when the data are correlated. This study indicated that, when adjustments for correlated data are not made, results may differ. It is also prudent to examine different correlation structures and distributions when the outcome is dichotomous. SAS is one of the most powerful statistical programs for the analysis of large, correlated datasets.

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