**APPENDIX C: Sensitivity Analysis**

1. ***Use of Alternative Instruments for the Musculoskeletal and Connective Tissue Group (MDC 08)***

The Sargan-Hansen test of overidentifying restrictions in the mortality model yielded a p-value of 0.079 for MDC 08, failing to reject the null hypothesis of exogeneous instruments at 5% significance level but rejecting it at the 10% level (Appendix B). Due to this ambiguous result, we conducted sensitivity analysis using a different instrumental variable in estimating the mortality model for this group. Namely, we used a dummy variable indicating the distance between the index ACH and the nearest LTCH is less than 0.25 miles along with the distance between the index ACH and the nearest LTCH as instruments. Diagnostic tests provided support for the validity of these instruments, both in terms of relevance and exogeneity (Appendix B). The results obtained using the new instruments are presented in Table C1. They yield findings that are qualitatively similar to the ones obtained for the Musculoskeletal and Connective Tissue Group using the original set of instruments.

**Table C1: Sensitivity Analysis Using Different Instruments: Marginal Effect of LTCH on Probability of 365-day Mortality**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Baseline Model |  | Interaction with Organ Failure | | |  | Interaction with ICU/CCU | | |
| Condition Group | Model without interactions  (A) |  | Multiple organ failure  (B1) | No multiple organ failure  (B2) | Difference in Marginal Effects (B3) |  | ICU/CCU>=3 (C1) | ICU/CCU<3 (C2) | Difference in Marginal Effects (C3) |
| MDC=08 Musculoskeletal & Connective Tissue | -0.017 |  | -0.094 | 0.000 | -0.094 |  | -0.108 | 0.011 | -0.118 |
| N = 1,675,862 | P=0.075 |  | P<0.001 | P=0.997 | P<0.001 |  | P<0.001 | P=0.412 | P<0.001 |

Notes: P-values are in parentheses. Marginal LTCH effect is calculated as the average of individual marginal effects that are computed for each observation using the results of the two-stage residual inclusion regression and the individual observation’s covariate values, while varying LTCH indicator between 0 and 1. The baseline model includes the LTCH transfer indicator, patient-level controls and index ACH-level controls listed in Appendix A as explanatory variables. The model with interaction with organ failure includes an interaction term between LTCH transfer indicator and a multiple organ failure indicator as an additional explanatory variable. The model with interaction with ICU/CCU includes an interaction term between LTCH transfer indicator and indicator for minimum 3-day ICU/CCU stay as an additional explanatory variable. Columns B1 and C1 present marginal effect of LTCH on the outcome among patients with multiple organ failure and minimum 3-day ICU/CCU stay, respectively. Columns B2 and C2 present the marginal effect of LTCH among other patients. Columns B3 and C3 present the differential treatment effect between patients with and without the specified characteristics.

1. ***Excluding Cases with Low Propensity to Transfer to an LTCH***

The incidence of LTCH transfer among patients without prolonged mechanical ventilation is very low, raising a concern regarding the comparability of our comparison group to LTCH cases. To examine the robustness of our findings to an alternative approach to developing a comparison group, we conducted a sensitivity analysis, excluding from our study sample those with relatively low predicted probability of LTCH transfer. Specifically, we first estimated the probability of LTCH transfer based on a model of demographic and clinical patient characteristics. Then, we excluded from our analysis dataset those cases with a predicted probability that is less than the 5th percentile of LTCH patients’ predicted LTCH transfer probability distribution within a given MS-DRG. The implementation of this criterion led to the exclusion of up to 5% of the treatment group (LTCH cases) and up to 29.7% of the control group (non-LTCH cases) from the analysis dataset (Table C2).

Table C3 presents the estimation results of the mortality model, and Table C4 presents the estimation results of the Medicare payment model. The sensitivity analysis results are similar to our findings reported in the paper for many of the MDCs. In the baseline mortality model, the estimate for the marginal LTCH effect remains insignificant in 4 MDCs and becomes statistically insignificant in the Digestive category, which had a negative and statistically significant estimate of LTCH effect in our main model. For patients with three or more days in an ICU/CCU and multiple organ failure, the LTCH care **is associated with** lower 365-day mortality (P<0.05) in 4 MDCs and 2 MDCs, respectively. These results are similar to our main findings with the exception that the **marginal** LTCH effect for patient**s** with multiple organ failure is not statistically significant in Musculoskeletal & Connective Tissue Category. We found our payment model estimates to be robust to the changes in the analysis sample implemented in the sensitivity analysis.

**Table C2: Number of Observations Excluded Due to Low Propensity for LTCH Transfer**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Non-LTCH Cases Excluded | | LTCH Cases Excluded | | Sample Size | |
|  | Count | Percent of non-LTCH Cases | Count | Percent of LTCH Cases | Before Excluding Cases with Low LTCH Transfer Propensity | After  Excluding Cases with Low LTCH Transfer Propensity |
| MDC=04 Respiratory | 256,263 | 15.5 | 859 | 4.9 | 1,675,862 | 1,418,740 |
|  |  |  |  |  |  |  |
| MDC=05 Circulatory | 723,714 | 25.9 | 731 | 4.8 | 2,805,553 | 2,081,108 |
|  |  |  |  |  |  |  |
| MDC=06 Digestive | 394,233 | 29.7 | 466 | 4.8 | 1,336,060 | 941,361 |
|  |  |  |  |  |  |  |
| MDC=08 Musculoskeletal & Connective Tissue | 467,343 | 27.4 | 425 | 4.6 | 1,717,671 | 1,249,903 |
|  |  |  |  |  |  |  |
| MDC=18 Infectious & Parasitic DDs | 115,972 | 20.7 | 960 | 5.0 | 579,335 | 462,403 |

**Table C3. Sensitivity Analysis Results: Marginal Effect of LTCH on Probability of 365-day Mortality**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Baseline Model |  | Interaction with Organ Failure | | |  | Interaction with ICU/CCU | | |
| Condition Group | Model without interactions  (A) |  | Multiple organ failure  (B1) | No multiple organ failure  (B2) | Difference in Marginal Effects (B3) |  | ICU/CCU>=3 (C1) | ICU/CCU<3 (C2) | Difference in Marginal Effects (C3) |
| MDC=04 Respiratory | -0.005 |  | -0.104 | 0.11 | -0.214 |  | -0.126 | 0.116 | -0.242 |
| N = 1,418,740 | P=0.864 |  | P=0.001 | P=0.003 | P<0.001 |  | P<0.001 | P=0.018 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=05 Circulatory | -0.006 |  | -0.068 | 0.068 | -0.135 |  | -0.068 | 0.036 | -0.104 |
| N = 2,081,108 | P=0.689 |  | P=0.006 | P=0.003 | P<0.001 |  | P<0.001 | P=0.246 | P=0.002 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=06 Digestive | -0.011 |  | -0.004 | -0.017 | 0.013 |  | 0.020 | -0.149 | 0.169 |
| N = 941,361 | P=0.464 |  | P=0.889 | P=0.326 | P=0.634 |  | P=0.332 | P<0.001 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=08 Musculoskeletal & Connective | 0.007 |  | -0.042 | 0.025 | -0.067 |  | -0.082 | 0.041 | -0.123 |
| Tissue N = 1,249,903 | P=0.541 |  | P=0.149 | P=0.070 | P=0.020 |  | P<0.001 | P=0.011 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=18 Infectious & Parasitic DDs | -0.007 |  | -0.004 | -0.010 | 0.005 |  | -0.090 | 0.130 | -0.220 |
| N = 462,403 | P=0.705 |  | P=0.850 | P=0.627 | P=0.806 |  | P<0.001 | P<0.001 | P<0.001 |

Notes: P-values are in parentheses. Marginal LTCH effect is calculated as the average of individual marginal effects that are computed for each observation using the results of the two-stage residual inclusion regression and the individual observation’s covariate values, while varying LTCH indicator between 0 and 1. The baseline model includes the LTCH transfer indicator, patient-level controls and index ACH-level controls listed in Appendix A as explanatory variables. The model with interaction with organ failure includes an interaction term between LTCH transfer indicator and a multiple organ failure indicator as an additional explanatory variable. The model with interaction with ICU/CCU includes an interaction term between LTCH transfer indicator and indicator for minimum 3-day ICU/CCU stay as an additional explanatory variable. Columns B1 and C1 present marginal effect of LTCH on the outcome among patients with multiple organ failure and minimum 3-day ICU/CCU stay, respectively. Columns B2 and C2 present the marginal effect of LTCH among other patients. Columns B3 and C3 present the differential treatment effect between patients with and without the specified characteristics.

**Table C4. Sensitivity Analysis Results: Marginal Effect of LTCH on Total Payment for 180-Day Episode**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Baseline Model |  | Interaction with Organ Failure | | |  | Interaction with ICU/CCU | | |
| Condition Group | Model without interactions  (A) |  | Multiple organ failure  (B1) | No multiple organ failure  (B2) | Difference in Marginal Effects (B3) |  | ICU/CCU>=3 (C1) | ICU/CCU<3 (C2) | Difference in Marginal Effects (C3) |
| MDC=04 Respiratory | 17,068 |  | 2,062 | 46,853 | -44,791 |  | 11,121 | 31,490 | -20,369 |
| N = 1,418,740 | P<0.001 |  | P=0.288 | P<0.001 | P<0.001 |  | P<0.001 | P<0.001 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=05 Circulatory | -5,637 |  | -18,720 | 21,673 | -40,393 |  | -7,877 | -1,733 | -6,145 |
| N = 2,081,108 | P<0.001 |  | P<0.001 | P<0.001 | P<0.001 |  | P<0.001 | P=0.318 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=06 Digestive | -3,493 |  | -19,749 | 8,012 | -27,761 |  | -3,123 | -6,072 | 2,949 |
| N = 941,361 | P<0.001 |  | P<0.001 | P<0.001 | P<0.001 |  | P=0.026 | P<0.001 | P=0.070 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=08 Musculoskeletal & Connective | 3,337 |  | -13,742 | 11,904 | -25,647 |  | -6,533 | 10,317 | -16,850 |
| Tissue N = 1,249,903 | P=0.010 |  | P<0.001 | P<0.001 | P<0.001 |  | P=0.001 | P<0.001 | P<0.001 |
|  |  |  |  |  |  |  |  |  |  |
| MDC=18 Infectious & Parasitic DDs | 18,828 |  | 2,891 | 39,944 | -37,052 |  | 16,866 | 27,124 | -10,258 |
| N = 462,403 | P<0.001 |  | P=0.172 | P<0.001 | P<0.001 |  | P<0.001 | P<0.001 | P=0.010 |

Notes: P-values are in parentheses. Marginal LTCH effect is calculated as the average of individual marginal effects that are computed for each observation using the results of the two-stage residual inclusion regression and the individual observation’s covariate values, while varying LTCH indicator between 0 and 1. The baseline model includes the LTCH transfer indicator, patient-level controls and index ACH-level controls listed in Appendix A as explanatory variables. The model with interaction with organ failure includes an interaction term between LTCH transfer indicator and a multiple organ failure indicator as an additional explanatory variable. The model with interaction with ICU/CCU includes an interaction term between LTCH transfer indicator and indicator for minimum 3-day ICU/CCU stay as an additional explanatory variable. Columns B1 and C1 present marginal effect of LTCH on the outcome among patients with multiple organ failure and minimum 3-day ICU/CCU stay, respectively. Columns B2 and C2 present the marginal effect of LTCH among other patients. Columns B3 and C3 present the differential treatment effect between patients with and without the specified characteristics.