

RUG-IV Inversions and Smoothing

Stepwise Systems
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Hierarchical Classification and Inversions

RUG-IV is a hierarchical classification model that was developed using a step-by-step top-down approach. First the characteristics of the most expensive residents were analyzed and qualifiers were identified that would classify as many of these residents as possible into a top clinical category (Rehabilitation and Extensive Services category) based on provision of both rehabilitation therapy services and extensive care services. The remaining unclassified residents were then analyzed to find the next most expensive clinical category (Rehabilitation) based on the provision of rehabilitation therapy services. This process continued, classifying the remaining most expensive residents in subsequent clinical categories—Extensive Services, High Special Care, Low Special Care, Clinically Complex, Behavior and Cognitive Problems, and finally Reduced Physical Function.

Such a hierarchical classification model is often easier to understand than alternative models that assign a numeric score to each resident based on statistical regression analysis. Also, the hierarchical model divides residents into meaningful categories that make clinical sense.

When a hierarchical classification model is used for payment, rate “inversions” can occur. A rate inversion occurs when a resident who qualifies for a higher category also qualifies for a lower category with a higher rate. Consider an example of such a hierarchy inversion from the currently used RUG-III hierarchical model. The high rehabilitation/extensive with high ADL group (RHX) has a lower payment rate than the medium rehabilitation with high ADL group (RMX). All residents who qualify for RHX also qualify for RMX and would receive a higher rate for a lower level of rehabilitation. A facility would receive increased revenue for decreasing rehabilitation services. From a payment perspective, this type of problem can be resolved by using an “index maximizing” classification. With index maximizing, all categories, for which a resident qualifies, are determined and the resident is classified in the category with the highest payment rate. With index maximizing, the higher rate for RMX is achieved without reducing rehabilitation services. While such index maximizing solves the payment rate problem, it leads to confusing classification—a resident receiving a high level of rehabilitation services is classified in a medium rehabilitation category.

A RUG-IV inversion example involves the ultra-high rehabilitation/extensive high ADL group (RUX) which has a lower staff time than the ultra-high rehabilitation/extensive low ADL group (RUL). However, a lower ADL (less dependent) resident should be less expensive in terms of staff time than the corresponding higher ADL resident. This inversion occurs largely because the two groups are very small (there are only 5 residents

in RUX and 2 in RUL). Many of the inversions in RUG-IV are due to small group sizes, and often in groups involving very expensive residents.

Other inversions in RUG-IV occurred with regard to groups that are split based on provision of restorative nursing. A split based on restorative nursing was felt to be important in the Behavior/Cognitive and Reduced Physical Function groups to provide an incentive encouraging such services in the long-term care population. However, the actual impact of restorative nursing was weak and splits based on these services resulted in inversions. These inversions could also be handled with index maximizing. In general, most inversions in RUG-IV were due to small group sizes and a weak restorative nursing effect. In these cases, the group staff time means are highly variable and inverted means probably do not reflect true differences in resident care needs.

While inversions can be handled by index maximizing, an alternative solution is to “smooth” the group staff times involved in inversions by averaging across groups. Such smoothing avoids rate inversions while maintaining meaningful hierarchical classification. Additionally, averaging across groups reduces the high variability that can be associated with small cell sizes. A simple type of smoothing can involve calculating an overall weighted staff time mean across 2 groups (e.g., RUX and RUL) and then applying that mean to both groups. Similar smoothing was used to adjust the original RUG-III group staff times to minimize inversions.

RUG-IV Smoothing

With RUG-IV, our approach has been to develop several different smoothing techniques to minimize inversions with regard to nursing staff time. Steps in smoothing RUG-IV nursing times were as follows:

1. **Weighted average.** A few pairs of inverted adjacent groups were smoothed by assigning the weighted average for the two groups to each group.
2. **Ratio smoothing.** A few groups were smoothed by making the groups conform to general ratios with regard to the clinical categories directly above and below.
3. **Extensive add-on.** The Rehabilitation/Extensive groups were smoothed by determining the average staff time added when a Rehabilitation resident also receives extensive services. This average Extensive “add-on” was then added to the staff time mean of a Rehabilitation group to obtain the smoothed staff time mean of the corresponding Rehabilitation/Extensive group.
4. **Depression offsets.** The Clinically Complex groups are split on the basis of depression. The average percent increase in staff time attributable to depression was determined for these groups. The means for a depression group and the corresponding non-depression group were then “offset” using this percentage, such that the difference between the two groups corresponded to that percentage, while the weighted average of the two groups did not change. A similar depression offset was applied to the High and Low Special Care groups.

5. **Restorative nursing offset.** The Behavior/Cognitive and Reduced Physical Function groups are split on the basis restorative nursing services. The average percent of staff time attributable to restorative nursing was determined for these groups. The means for a restorative nursing group and the corresponding group without restorative nursing were then “offset” using this percentage, such that the difference between the two groups corresponded to that percentage, while the weighted average of the two groups did not change.

Each of these RUG-IV smoothing steps are discussed in more detail below.

Weighted Average

Two sets of groups were smoothed with this method. Both sets involved Rehabilitation groups where a higher ADL had a lower staff time. The staff time means for both RUB and RUC were set to the weighted average of the two groups. The staff time means for RVA and RVB were set to the weighted average of the two groups.

Ratio Smoothing

This method was used three times. The staff time mean of the combined CC group (CC1 and CC2) was set so that the ratios of that mean to the lower combined PC group and the upper combined LC group were the same as the weighted average ratios for CB to PB and LB and for CD to PD and LD¹. In other words, the standard relationship among the Low Special Care, Clinically Complex, and Reduced Physical Function groups for ADL levels B and D was determined and this standard relationship was used to smooth the CC group mean.

The exact same method was use to smooth the combined CE group (CE1 and CE2) mean, based on the standard relationship among the Low Special Care, Clinically Complex, and Reduced Physical Function groups for ADL levels B and D.

A similar method was used to smooth the combined LD group (LD1 and LD2) mean, but this was based on the standard relationship among the High Special Care, Low Special Care and Clinically Complex groups for ADL levels B C, and E.

Extensive Add-On

The means for all of the Rehabilitation/Extensive groups were smoothed using an add-on approach. A regression analysis was performed to determine the average increase in staff time for a Rehabilitation/Extensive resident versus a resident in the corresponding Rehabilitation group. Adding extensive services to rehabilitation therapy was found to increase staff time by 168 wage weighted minutes. Note that this estimate is for all

¹ The form of these ratios is $(C - P) / (L - P)$. This is the proportion of the P to L difference represented by the P to C difference.

Rehabilitation/Extensive residents and avoids the small sample sizes for the individual Rehabilitation/Extensive group means. The smoothed mean for each Rehabilitation/Extensive group (e.g., RUX) was then calculated as the mean for the corresponding Rehabilitation group (e.g., RUC) plus 168.

Depression Offsets

The means for the Clinical Complex groups were smoothed based upon a depression offset. A regression analysis was performed to determine the average percent increase in staff time attributable to depression for these groups. The finding was that a depressed resident required about 12% more staff time. The means for a depression group and the corresponding non-depression group were then “offset” using this percentage, such that the difference between the two groups corresponded to 12%, while the weighted average of the two groups did not change.

The means for the High and Low Special Care groups were also smoothed with a similar offset. A regression analysis was performed to determine the average percent increase in staff time attributable to depression across all High and Low Special Care groups. The finding was that a depressed resident required about 25% more staff time. The means for a depression group and the corresponding non-depression group were then “offset” using this percentage, such that the difference between the two groups corresponded to 25%, while the weighted average of the two groups did not change.

Restorative Nursing Offset

The means for the Behavior/Cognitive and Reduced Physical Function groups were smoothed using a restorative nursing offset. A regression analysis was performed to determine the average percent increase in staff time attributable to restorative across all Behavior/Cognitive and Reduced Physical Function groups. The finding was that a resident receiving restorative nursing required about 7% more staff time. The means for a restorative nursing group and the corresponding group without restorative nursing were then “offset” using this percentage, such that the difference between the two groups corresponded to 7%, while the weighted average of the two groups did not change.

Inversions after Smoothing

The following three sets of inversions remained for the Medicare Part A urban rates after all smoothing:

1. RHL, RML, and RLX versus ES3. These inversions will have little impact because RHL, RML, and RHX are rare groups, and many residents in these groups will not also qualify for SE3.
2. RLB and RLA versus several lower groups. These two are also rare groups and will have little impact.

3. LD1 and CD1 versus PD2. While these groups are not rare, the rate differences are small and there will be little impact.

The overall fiscal impact of all of these inversions on Medicare SNF Part A payments has been estimated as a 0.1% increase.

Impact of Smoothing on RUG-IV Nursing Cost Prediction

Although smoothing of nursing staff time was used for many RUG groups, there was little loss of predictability as measured by the percentage of nursing cost variance explained by the model. RUG-IV accounted for 38.5% of the nursing cost variance before smoothing and 37.5% after smoothing. This is a very modest reduction.