**TAGRA ACUTE MLC SUBGROUP Tuesday 15th March 2016**

**ADDENDUM TO ‘INDICATOR SELECTION RESULTS – PART 2’**

**Alternative ‘best’ index options**

In section 4 of paper TAMLC43, the ‘top’ 1, 2, 3 and 4 indicators were identified. They were the combinations of variables that had the highest R2 in regressions in which each variable was included *separately* – i.e. in multiple regressions.

In the NRAC formula, the indicators of need are transformed into a ‘needs index’ (as the sum of the Z-scores of the indicators). When the index options were transformed into an index in this way and regressions carried out, in section 5 of the paper, it was noted (Table 9) that the current Acute MLC index – which consists of two variables, LLTI and All-cause SMR – sometimes produced higher R2 than the ‘best’ 2 variables identified in section 4. Clearly, the best variables in a multiple regression do not necessarily form the best combined *index*.

Because of this, we have now repeated the analysis of section 4 to choose the top 4, but based on indexes formed of combinations of variables, rather than keeping the variables separate. The resulting ‘alternative’ top 4s are shown in Table 16.

*Table 16: Top 4 indicators derived by regression analysis on indexes*

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Common top 4** | **Whole Acute top 4** | **Cancer specific top 4** |
| **Top 1****Top 2****Top 3****Top 4** | LLTI LLTI, General healthLLTI, HRI, DNALLTI, HRI, DNA, Unpaid care | LLTI LLTI, General healthLLTI, HRI, DNALLTI, HRI, DNA, Unpaid care | Cancer SMRCancer SMR, HRICancer SMR, HRI, All-cause SMRCancer SMR, HRI, All-cause SMR, Living alone ≥ 70 |
|  | **Heart specific top 4** | **Digestive specific top 4** | **Injury specific top 4** |
| **Top 1****Top 2****Top 3****Top 4** | LLTI LLTI, General healthLLTI, HRI, DNALLTI, HRI, DNA, General health | LLTI LLTI, General healthLLTI, HRI, DNAGeneral health, HRI, DNA, Unpaid care | LLTI DNA, HRILLTI, HRI, DNALLTI, DNA, HRI, General health |
|  | **Other specific top 4** | **Respiratory specific top 4** | **Outpatients specific top 4** |
| **Top 1****Top 2****Top 3****Top 4** | LLTI LLTI, HRILLTI, HRI, DNALLTI, HRI, DNA, Unpaid care | General health General health, LLTIGeneral health, HRI, DNAGeneral health, HRI, DNA, LLTI | LLTILLTI, Unpaid careGeneral health, HRI, Unpaid careUnpaid care, General health, LLTI, HRI |

There are some changes from the top 4s listed in Table 7. Particularly, in the top 2s, HRI is now often replaced with General health; and in the top 4s, Ethnicity is often replaced with Unpaid care.

All common and specific index options now turn out to be subsets of a group of five variables – LLTI, General health, HRI, DNA, and Unpaid care – with the exception of Cancer which still has two further variables (Cancer SMR, Living alone ≥70) in its specific sets.

Table 17 shows the R2 values for these alternative index options.

*Table 17: Adjusted R2 for the top 1, 2, 3 and 4 variables combined into an index, in comparison with the current reference model*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Whole Acute** | **Cancer** | **Heart** | **Digestive** | **Injury** | **Other** | **Respiratory** | **Outpatients** |
| R2 using common top 4 index  | 66.0% | 10.5% | 22.7% | 41.4% | 28.5% | 51.0% | 40.7% | 52.8% |
| R2 using specific top 4 index | 66.0% | 14.2% | 23.3% | 41.5% | 30.1% | 51.0% | 41.5% | 53.1% |
| R2 using common top 3 index | 64.9% | 10.6% | 22.7% | 40.6% | 30.1% | 50.2% | 40.1% | 50.5% |
| R2 using specific top 3 index | 64.9% | 14.5% | 22.7% | 40.6% | 30.1% | 50.2% | 40.8% | 52.9% |
| R2 using common top 2 index | 60.8% | 9.6% | 21.8% | 39.6% | 26.7% | 46.2% | 39.3% | 51.1% |
| R2 using specific top 2 index | 60.8% | 15.1% | 21.8% | 39.6% | 27.2% | 47.3% | 39.3% | 53.0% |
| R2 using common top 1 index | 60.8% | 9.7% | 21.6% | 39.3% | 26.8% | 46.7% | 38.2% | 51.1% |
| R2 using specific top 1 index | 60.8% | 15.3% | 21.6% | 39.3% | 26.8% | 46.7% | 38.5% | 51.1% |
| ***Reference model*** | ***59.6%*** | ***10.9%*** | ***21.0%*** | ***38.6%*** | ***26.0%*** | ***45.1%*** | ***38.2%*** | ***49.3%*** |

Comparing Table 17 with Table 9, the overall picture is quite similar, but there are a couple of noticeable changes.

Firstly, in most cases the R2 for the top 2 is now slightly better than for the reference model – which indicates that General health tends to perform slightly better as a 2nd variable than both HRI and All-cause SMR, in a combined index.

Secondly, the R2 does now increase as the 4th variable is added, in most cases; particularly for cases where the 4th variable has been changed from Ethnicity to Unpaid care as this has increased the R2 quite substantially. For Outpatients, changing Ethnicity to HRI in the top 3 also led to a large improvement.

It is still the case that the specific index options for Cancer produce higher R2 than the common index options. Again, there are no big R2 gains in using the specific options for any other diagnostic groups; this is not surprising considering the overlap in the variable sets.

Table 18 shows the RSS obtained from comparing predictions using these alternative index options with the 2014/15 cost ratios.

*Table 18: RSS obtained from comparing predictions derived from the top 1, 2, 3 and 4 variables from the restricted sets with the 2014/15 cost ratios. Lower values indicate the predictions are closer to the observed values.*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Whole Acute** | **Cancer** | **Heart** | **Digestive** | **Injury** | **Other** | **Respiratory** | **Outpatients** |
| RSS using common top 4 index | 349 | 3473 | 4056 | 2158 | 2881 | 799 | 3449 | 409 |
| RSS using specific top 4 index | 349 | 3516 | 4029 | 2153 | 2868 | 799 | 3419 | 419 |
| RSS using common top 3 index | 354 | 3472 | 4045 | 2197 | 2875 | 811 | 3454 | 412 |
| RSS using specific top 3 index | 354 | 3542 | 4045 | 2197 | 2875 | 811 | 3443 | 427 |
| RSS using common top 2 index | 350 | 3460 | 4011 | 2147 | 2870 | 815 | 3470 | 417 |
| RSS using specific top 2 index | 350 | 3580 | 4011 | 2147 | 2934 | 865 | 3502 | 416 |
| RSS using common top 1 index | 355 | 3467 | 4015 | 2160 | 2861 | 821 | 3499 | 417 |
| RSS using specific top 1 index | 355 | 3554 | 4015 | 2160 | 2861 | 821 | 3501 | 417 |
| ***RSS using reference model*** | ***368*** | ***3471*** | ***4028*** | ***2203*** | ***2868*** | ***840*** | ***3547*** | ***422*** |

In Table 10, the reference model outperformed the ‘common’ 2-variable index consisting of LLTI + HRI. In Table 18 this is no longer the case – the alternative common index, LLTI + General health, outperforms the reference model for all diagnostic groups except Injury where the RSS values are almost equal.

As before, specific-index predictions for Cancer are worse than the common-index predictions – in opposition to the R2 results. For no other diagnostic groups are there consistent or sizeable differences in RSS between the specific and the common indexes.

The conclusions from this analysis are:

* The indicators that perform best in a combined *index* are generally not the same as the indicators that perform best as separate variables in a multiple regression.
* Allowing the variables to differ between diagnostic groups has not produced radically different index options, so does not seem worth the added complexity. There are no noticeable improvements in the predictive power using specific indexes. We would still recommend the ‘common’ approach.
* RSS seems to favour a 2-indicator model overall, but not strongly.
* If 2 indicators were to be used, then using LLTI + General health results in a consistently better-performing index than LLTI + HRI. This would also avoid the potential ‘perverse incentive’ identified for HRI in section 6.1 of the paper.
* The best-performing 3-indicator model is still [LLTI, HRI, DNA].
* If 4 indicators were to be used, then [LLTI, HRI, DNA, Unpaid care] performs much better as an index than [LLTI, HRI, DNA, Ethnicity].

**Other alternatives**

The paper identified potential issues around perverse incentives with some of the variables; particularly DNA, but also HRI to a lesser extent. With HRI there is also the potential for better explanation of past costs than prediction of future costs, since HRI is very closely linked to cost.

The common top 3 and top 4 in Table 16 both contain DNA and HRI. Because the Subgroup may wish to exclude either or both of these, we have briefly explored the performance of some other possible 3- and 4-indicator models, drawing from the same set of five indicators and also All-cause SMR <75. Table 19 shows the R2 for these other alternatives, using the Whole Acute cost ratios.

 *Table 19: Adjusted R2 for other alternative index options using 3 and 4 variables*

|  |  |
| --- | --- |
|  | **Whole Acute R2** |
| **Common top 4 index [LLTI, HRI, DNA, Unpaid care]** | **66.0%** |
| Alternative 1 [LLTI, HRI, General health, Unpaid care] | 64.7% |
| Alternative 2 [LLTI, All-cause SMR <75, General health, Unpaid care] | 62.3% |
| **Common top 3 index [LLTI, HRI, DNA]** | **64.9%** |
| Alternative 1 [LLTI, HRI, General health] | 64.2% |
| Alternative 2 [LLTI, HRI, Unpaid care] | 62.6% |
| Alternative 3 [LLTI, HRI, All-cause SMR <75] | 62.1% |
| Alternative 4 [LLTI, Unpaid care, All-cause SMR <75] | 61.3% |
| Alternative 5 [LLTI, General health, All-cause SMR <75] | 61.2% |
| **Common top 2 index [LLTI, General health]** | **60.8%** |
| **Reference model [LLTI, All-cause SMR <75]** | **59.6%** |
| **Common top 1 index [LLTI]** | **60.8%** |

Based on these values, we can conclude:

* There are a few 3-indicator models without DNA that offer an improvement over the best 2-indicator model. Of these, [LLTI, General health, HRI] appears to be the best, with an R2 that is almost as high as [LLTI, HRI, DNA].
* Adding Unpaid care to this model produces a reasonable alternative 4-indicator model but the gain in R2 is very slight.
* There are also a couple of 3-indicator options that exclude both DNA and HRI and that still offer a (slight) improvement in R2 over two indicators: [LLTI, Unpaid care, All-cause SMR <75] and [LLTI, General health, All-cause SMR <75].
* The best 2-indicator model offers no real improvement in R2 over a single indicator (although the predictive power *is* slightly better, in Table 18).