Inter-Rater Reliability Assessment and Electronic Collaborative Stage Data Collection in Ontario, Canada

Bob Li, Mary Jane King, Gemma Lee, Eric Holowaty, Marta Yurcan, Jillian Ross, Kamini Milnes, Rami Rahal

Cancer Care Ontario, Canada

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Better cancer services every step of the way
CS is the new standard in Ontario for cancer staging beginning with 2007 cases

- CS is replacing TNM reporting to align with pan-Canadian guidelines

Schematic Diagram of Relationships of Inputs and Outputs for Collaborative Staging v1 to TNM System

- Other input items always used: Histology
- Other input items occasionally used: Age, Grade, Behavior

- CS Tumour Size (TS)
- CS Extension (Ext)
- CS TS/Ext Evaluation Method
- CS Lymph Nodes
- Regional Nodes Positive
- Regional Nodes Exam
- CS Reg Nodes Evaluation Method
- CS Mets at DX
- CS Mets Evaluation Method
- CS Site Specific Factors 1-6

AJCC T
AJCC N
AJCC M
AJCC Stage Group
CS implementation in Ontario led by CCO with all acute care hospitals

- A provincial initiative that aims to improve the quality & completeness of cancer staging data in Ontario

- CS data collection system
  - CCO trained analysts
  - Remote access to hospital records
  - Registry Plus™ software developed by CDC

- CS data collection initiated in 71 non-Cancer Centre hospitals for top 4 disease sites from 2007 forward
  - 14 Cancer Centres to start with 2010 diagnosis year
Robust data quality program implemented to ensure CS data is of high quality

- Providing extensive ongoing training of centralized CCO analysts with support from the Public Health Agency of Canada

- Comprehensive array of DQ measures implemented to assess and monitor multiple dimensions of data quality
  - Reliability
  - Timeliness
  - Completeness
  - Validity
  - Usability

- Bi-annual reporting of stage data with chart level reporting for all staged cases is being provided to all participating hospitals
Comprehensive inter-rater reliability assessment undertaken

- Measures the degree to which the same stage result can be obtained through re-abstraction process among CS analysts
- Assesses stage data quality for the dimension of reliability
- High inter-rater reliability assures data users that there has been consistent application of CS data collection system rules by CS analysts
Process for Assessing Inter-rater Reliability (IRR)

1. Chose reliability indices/measures
2. Established an acceptable level of reliability
3. Tested selected reliability indices with a small subgroup of cases
4. Determined sample size of cases and randomly selected charts for IRR study
5. Calculated reliability results for 5 CS analysts involved in IRR study
6. Analyzed results and identified opportunity for improvement in CS abstraction
Indices selected to assess inter-rater reliability

<table>
<thead>
<tr>
<th>Index</th>
<th>Multiple coders</th>
<th>Metric</th>
<th>Chance agreement</th>
<th>Agreement/correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage agreement</td>
<td>N</td>
<td>Nominal</td>
<td>N</td>
<td>Agreement</td>
</tr>
<tr>
<td>Scott’s Pi</td>
<td>N</td>
<td>Nominal</td>
<td>Y</td>
<td>Agreement</td>
</tr>
<tr>
<td>Cohen's kappa</td>
<td>Y</td>
<td>Nominal</td>
<td>Y</td>
<td>Agreement</td>
</tr>
<tr>
<td>Krippendorff’s Alpha</td>
<td>Y</td>
<td>Nominal, Ordinal, Interval, Ratio</td>
<td>Y</td>
<td>Both</td>
</tr>
<tr>
<td>Perreault’s Pi</td>
<td>N</td>
<td>Nominal</td>
<td>Y</td>
<td>Agreement</td>
</tr>
<tr>
<td>Spearman’s Rho</td>
<td>Y</td>
<td>Ordinal</td>
<td>N</td>
<td>Correlation</td>
</tr>
<tr>
<td>Pearson’s r</td>
<td>Y</td>
<td>Interval</td>
<td>N</td>
<td>Correlation</td>
</tr>
</tbody>
</table>

Two indices used to measure inter-rater reliability

- Modified Percent Agreement
- Krippendorff's alpha
Modified Percent Agreement

- Percent Agreement = \( \frac{O_a}{O_a + O_d} \) * 100
  - Where \( O_a \) is observed agreement; \( O_d \) is observed disagreement
- Percent agreement = Number of agreements of group stage scores divided by the number of total decisions (agreements + disagreements)
  - Modified agreement is assumed when three or more of the five analysts produce the same stage value for a case.
- Advantages - easy to calculate even with multiple analysts; provides information at analyst level
- Limitations - does not consider agreement due to chance; therefore Krippendorf’s alpha is also used to mitigate this issue
Krippendorff Alpha

- Krippendorff’s Alpha is expressed as:

\[ \alpha = 1 - \frac{D_o}{D_e} \]

Where

- \( D_o = \text{disagreement, observed} \)
- \( D_e = \text{disagreement, expected by chance} \)

- Advantages - can apply to multiple metrics, multiple coders; Considers agreement by chance, and for missing data

- Limitations - complex calculation, does not provide information at analyst level, more conservative measure relatively
**Inter Rater Reliability Assessment:**
Defining acceptable level of reliability

<table>
<thead>
<tr>
<th>Value</th>
<th>Level of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=0</td>
<td>none</td>
</tr>
<tr>
<td>0.01-0.20</td>
<td>poor</td>
</tr>
<tr>
<td>0.21-0.40</td>
<td>slight</td>
</tr>
<tr>
<td>0.41-0.60</td>
<td>fair</td>
</tr>
<tr>
<td>0.61-0.80</td>
<td>good</td>
</tr>
<tr>
<td>0.81-0.92</td>
<td>very good</td>
</tr>
<tr>
<td>0.93-1.00</td>
<td>excellent</td>
</tr>
</tbody>
</table>
Inter Rater Reliability Assessment: Sample Size Determination

An approximation to the sample size will be determined by following formula (Douglas G. Bonett, 2002)

\[
n = 8Z_{\alpha/2}^2 \left\{ \left( 1 - \hat{\rho}_1 \right)^2 (1 + (k - 1)\hat{\rho}_1)^2 \right\} / \left\{ k(k - 1)w^2 \right\} + 1
\]

- Where
  - \( Z_{\alpha/2}^2 \) is the point on a standard normal distribution exceeded with probability \( \alpha/2 \)
  - \( \hat{\rho}_i \) is Intra-class correlation coefficient
  - \( W \) is desired width obtained by setting \( w = 2Z_{\alpha/2} \left( \text{var} \hat{\rho}_1 \right)^{1/2} \)
  - \( K \) is number of CS analysts
Inter Rater Reliability Assessment: Sample Size

- **Assumptions:**
  - Two-way random effects model was used in the analysis.
  - $\alpha=0.05$, two-sided;
  - power=0.80;
  - $\rho_i$ is Intra-class correlation coefficient, it was from pilot study and is 0.70
  - $W=0.20$;
  - $K=5$

- **Final total sample size for four disease sites is 198**

- **Random cases selected from hospitals and coded by five raters:** 49 colorectal cancers (CRC), 49 lung cancers, 48 breast cancers and 52 prostate cancers.
## Results: Percent Agreement on Derived AJCC Group Stage Diagnosis

<table>
<thead>
<tr>
<th>Site</th>
<th>Coder 1</th>
<th>Coder 2</th>
<th>Coder 3</th>
<th>Coder 4</th>
<th>Coder 5</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREAST</td>
<td>91.3</td>
<td>65.2</td>
<td>97.8</td>
<td>84.8</td>
<td>91.3</td>
<td>86.1</td>
</tr>
<tr>
<td>CRC</td>
<td>98</td>
<td>92.2</td>
<td>96.1</td>
<td>88.2</td>
<td>92.2</td>
<td>93.3</td>
</tr>
<tr>
<td>LUNG</td>
<td>86.5</td>
<td>88.5</td>
<td>92.3</td>
<td>86.5</td>
<td>88.5</td>
<td>88.5</td>
</tr>
<tr>
<td>PROSTATE</td>
<td>94.2</td>
<td>88.5</td>
<td>94.2</td>
<td>96.2</td>
<td>94.2</td>
<td>93.5</td>
</tr>
<tr>
<td>Total</td>
<td>92.5</td>
<td>84.1</td>
<td>95</td>
<td>89.1</td>
<td>91.5</td>
<td>90.4</td>
</tr>
</tbody>
</table>
## Results: Krippendoffoff Alpha

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Diagnosis Site</th>
<th>Alpha</th>
<th>CI 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario one:</strong> no any exclusion, data as nominal</td>
<td>CRC</td>
<td>0.85</td>
<td>0.82--0.89</td>
</tr>
<tr>
<td></td>
<td>LUNG</td>
<td>0.69</td>
<td>0.63--0.74</td>
</tr>
<tr>
<td></td>
<td>BREAST</td>
<td>0.69</td>
<td>0.64--0.73</td>
</tr>
<tr>
<td></td>
<td>PROSTATE</td>
<td>0.79</td>
<td>0.74--0.84</td>
</tr>
<tr>
<td></td>
<td><strong>All four diagnosis</strong></td>
<td>0.8</td>
<td>0.78--0.82</td>
</tr>
<tr>
<td><strong>Scenario two:</strong> stage unknown as missing, data as nominal</td>
<td>CRC</td>
<td>0.92</td>
<td>0.89--0.94</td>
</tr>
<tr>
<td></td>
<td>LUNG</td>
<td>0.76</td>
<td>0.71--0.80</td>
</tr>
<tr>
<td></td>
<td>BREAST</td>
<td>0.89</td>
<td>0.85--0.93</td>
</tr>
<tr>
<td></td>
<td>PROSTATE</td>
<td>0.91</td>
<td>0.86--0.95</td>
</tr>
<tr>
<td></td>
<td><strong>All four diagnosis</strong></td>
<td>0.89</td>
<td>0.88--0.91</td>
</tr>
<tr>
<td><strong>Scenario three:</strong> stage unknown as missing, stage value was truncated as ordinal (0,1,2,3,4)</td>
<td>CRC</td>
<td>0.98</td>
<td>0.96--0.99</td>
</tr>
<tr>
<td></td>
<td>LUNG</td>
<td>0.88</td>
<td>0.84--0.91</td>
</tr>
<tr>
<td></td>
<td>BREAST</td>
<td>0.95</td>
<td>0.94--0.97</td>
</tr>
<tr>
<td></td>
<td>PROSTATE</td>
<td>0.94</td>
<td>0.90--0.98</td>
</tr>
<tr>
<td></td>
<td><strong>All four diagnosis</strong></td>
<td>0.96</td>
<td>0.95--0.97</td>
</tr>
</tbody>
</table>
Findings

- “Good” or “Very Good” level of reliability was found in the abstraction of CS data
- Opportunities to improve CS data collection processes were identified and implemented
  - Provided additional education on application of rules to assign Stage Unknown for breast and lung cancer cases (esp for one CS analyst)
  - Introduced tools to monitor participation of CS analysts in education and training (and processes for follow-up if sessions are not attended)
  - Created better access to training materials and resources for CS analysts to apply in daily practice
Next steps:

- Establishing process for performing inter-rater reliability (IRR) assessment on regular basis
- Reviewing whether future assessments should consider options for a gold standard based audit i.e., comparison of physician staging
Questions?

bob.li@cancercare.on.ca