A prospective evaluation of inter-rater agreement of routine medical records audits at a large general hospital in São Paulo, Brazil.

Ana Carolina Cintra Nunes Mafra*,1,2, João Luiz Miraglia1, Fernando Antonio Basile Colugnati3, Gilberto Soares Lourenço Padilha4, Renata Rafaela Santos Tadeucci1,2, Ederson Almeida1, Mario Maia Bracco1,2,4

1Hospital Israelita Albert Einstein, São Paulo, Brasil
2Hospital Municipal Dr. Moysés Deutsch – M’Boi Mirim, São Paulo, Brasil
3Universidade Federal de Juiz de Fora, School of Medicine, Juiz de Fora, Brasil
4Centro de Estudos e Pesquisas Dr. João Amorim – CEJAM, São Paulo, Brasil

*Corresponding author
Avenida Brigadeiro Faria Lima, 1188, Jardim Paulistano, São Paulo – SP, Brasil CEP 01451-001; e-mail: ana.mafra@einstein.br; telephone number: 55 11 2151-0906.

Word count: 2.111
ABSTRACT

Objectives To evaluate the inter-rater agreement (IRA) among members of the Patient’s Health Record Review Board (PHRRB), in routine auditing of medical records, and the impact of periodic discussions of results with raters.

Design: Prospective longitudinal study conducted between July of 2015 and April of 2016.

Setting: Hospital Municipal Dr. Moysés Deutsch, a large public hospital in São Paulo.

Participants: The PHRRB was composed of 12 physicians, 9 nurses and 3 physiotherapists, who audited medical records, monthly, with the number of raters changing throughout the study.

Interventions: It was carried out PHRRB meetings in order to reach a consensus on criteria that the members have to rate in the auditing process. It was created a review chart that raters should verify the registry of patient’s secondary diagnosis, chief complaint, history of presenting complaint, past medical history, medication history, physical exam and diagnostic testing. It was obtained the IRA every three months.

Measures: The Gwet’s AC1 coefficient and Proportion of Agreement (PA) were calculated to evaluate the IRA for each item over time.

Results: The study included 1884 items from 239 records with an overall full agreement among raters of 71.2%. A significant IRA increase by 16.5% (OR=1.17; 95% CI=1.03—1.32; p=0.014) was found in the routine PHRRB auditing, with no significant differences between the PA and the Gwet’s AC1, that showed a similar evolution over time. The PA decreased by 27.1% when at least one of the raters was absent from the review meeting (OR=0.73; 95% CI=0.53—1.00; p=0.048).

Conclusions: Medical record quality has been associated with the quality of care and could be optimized and improved by targeted interventions. The PA and the Gwet’s...
AC1 are suitable agreement coefficients that are feasible to be incorporated in the routine of PHRRB evaluation process.

Keywords: Inter-rater agreement; Longitudinal agreement; medical quality register; audit; Gwet’s AC1.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Implementation of a scientific method in a routine task of data generation of a PHRRB.
- Prospective longitudinal design evaluating inter-rater agreement over time and associated factors.
- Agreement comparisons among more than two simultaneous raters.
- Relatively short follow-up.
- Results are not generalizable to other health facilities.

INTRODUCTION

Adequate medical recordkeeping is an essential part of good health professional practice that makes it possible to evaluate and improve the quality of health care. In addition, medical records should also be used as a learning tool, far beyond the medical management of patients, but also improving the coordination and continuity of care and supporting decision making, avoiding adverse events that can compromise patient safety, mainly in hospitals.  

Auditing patient's medical records is a practice that aims to ensure the quality of patient care throughout reliable information registered by health professionals during patient visits or admissions in healthcare units. The Brazilian Medical Council establishes that patients’ records review commissions is mandatory for health services, since 2002.
However, the reliability of the auditing processes is a matter closely related to the inter-rater agreement (IRA) when different raters assign the same precise value for each item being observed\(^4,5\). Some review studies assessing adverse events have been shown to suffer from poor to moderate inter-rater reliability (IRR)\(^6,7\). In addition, IRR is rarely described or discussed in research papers based on data abstracted from medical records and there are no standard methods for assessing IRR\(^8\). Moreover, time constraints and work overload are frequent situations faced by health staff to perform tasks involving data management resulting in low data quality that can affect managerial decision-making. Therefore, the evaluation of suitable methods for data abstraction from this source is essential\(^9\).

When such studies employ multiple raters it is important to have a strategy to document adequate levels of agreement between them, and the Cohen’s Kappa coefficient (\(\kappa\)) is a well-known measure\(^{10}\). However, it is affected by the skewed distributions of categories (the prevalence paradox) and by the degree to which raters disagree (the bias problem)\(^{11,12}\).

Kilem Li Gwet proposed a new agreement coefficient to fix those limitations and which can be used with any number of raters requiring a simple categorical rating system\(^{13,14}\). The objective of this study was to evaluate the IRA of routine audits of medical records and the impact of periodic discussions among raters, to refine auditing criteria, in a large general hospital as part of an intervention to improve the quality of the medical records related to essential content. In addition, the study also aimed to compare the estimates of the percent agreement (PA) to the Gwet’s agreement coefficient (AC1) and to identify possible factors associated with the PA.

**METHODS**
Population and setting

This was a prospective longitudinal study conducted between July of 2015 and April of 2016 at the Hospital Municipal Dr. Moysés Deutsch (HMMD), a large public general hospital (300 beds) located in the southern zone in the city of São Paulo, Brazil, an impoverished region encompassing approximately 600,000 inhabitants. The present study was part of a larger intervention aimed at improving the quality of patient care throughout a tailored integration strategies among health facilities in its Regional Health Care Network, that used a Lean Six Sigma methodology to get improvements of data quality registered in the medical records, with potential benefits to the patients, to decision-making actions and processes, and to obtain scientific quality over these data for research purposes, as published elsewhere.15

Audit of medical records and review meetings

The HMMD maintains a routine auditing process that includes 13% of all medical records of patients discharged in the previous month, carried out by the Patient’s Medical Record Review Board (PMRRB), that was composed by 24 nominated health professionals from several HMMD staff, medical, nurses and multi-professional staff coordinators, or delegated by them, from all clinical departments, 12 physicians, 9 nurses and 3 physiotherapists. It is a time-costly procedure because competes with the patient-care tasks among these professionals. As a consequence, is common that the audits have happened isolated by each PMRRB member without any criteria alignment, to rate the items in the audit chart, which compromise the whole quality of the auditing process. However, the patient’s medical charts were selected in a non-aleatory way, lacking representativeness over the results achieved, compromising the accuracy and generalizability of these data.
The planned intervention has used the Lean-6-Sigma methodology, that is largely utilized to aggregate values in several HMMD quality improvement processes, that is part of the environment culture among the professionals. The proposed actions included at least one team-leader from each HMMD clinical department, preferably its coordinator, which increased the PMRRB components, reducing the total medical charts to be reviewed by each member. It was refined the audit chart by all members through discussions about the relevance of the information that should be registered by their health teams, answering the question: ‘Which information cannot be missed in the patient’s medical record?’ The chosen items were then discussed, to define the criteria that should be rated as adequate, inadequate, incomplete, or not applicable (Table 1). Finally, the patient’s medical records have become selected randomly, weighed by the discharge proportion of each department.

**Table 1: Audited items.**

| Audited items                  | Options to rate                                      |
|--------------------------------|------------------------------------------------------|
| Secondary diagnosis            | Adequate or inadequate                               |
| Chief complaint                | Not applicable, adequate or inadequate               |
| History of presenting complaint| Not applicable, adequate or inadequate               |
| Past medical history           | Not applicable, adequate or inadequate               |
| Medication history             | Not applicable, adequate or inadequate               |
| Complete medical history       | Not applicable, adequate, inadequate or incomplete   |
| Physical exam                  | Adequate or inadequate                               |
| Diagnostic testing             | Not applicable, adequate or inadequate               |

The number of raters varying throughout the study as shown in Table 2.
Every three months during the study period, and in addition to the routine audits, five to six medical records were randomly allocated to the same two or three independent raters of the same professional category in order to evaluate the IRA. The study also included review meetings conducted every three months to align assessment criteria based on the results of the IRA evaluation and the auditing processes.

Table 2: Number of audited medical records and of raters over time.

| Audit period       | Number of medical records for IRA | Number of raters |
|--------------------|-----------------------------------|------------------|
| 1. 2015 July       | 54                                | 18               |
| 2. 2015 October    | 45                                | 19               |
| 3. 2016 January    | 84                                | 21               |
| 4. 2016 April      | 56                                | 16               |

Statistical methods

The Gwet’s AC1 and PA were calculated to evaluate the IRA for each item over time and were compared through line graphs including 95% confidence intervals (CIs). The Gwet’s AC1 95% CIs were calculated, while the PA were modelled by generalized estimating equations (GEE), without an intercept. The agreement measures were interpreted following the categories proposed by Altman.

Logistic GEE was used to model the PA of all raters along the time, using the value of 1 to full agreement and of 0 to some disagreement, and combining all items for each item individually. The analyses employed an exchangeable working correlation matrix and items in a single medical record were considered to be correlated. The model included as independent variables: professional category, review meeting attendance, and time.
(audits 1 to 4). A forward stepwise approach was used to variable selection employing a p-value lesser than or equal to 0.200 in the unadjusted model, and lesser than or equal to 0.050 in the multiple model.

The analyses were performed with the R software version 3.2.2\textsuperscript{19} with geepack\textsuperscript{20}.

**Ethics approval**

The study was approved by the research ethics committee of the São Paulo Municipal Health Department, and the partners’ institutions (26981514.3.0000.0086).\textsuperscript{21}

**RESULTS**

The study included 1884 items from 239 records with an overall full agreement among raters of 71.2%. The estimated mean PA was found to be larger than the Gwet’s AC1 for all audited items (Figure 1), however, these differences were not statistically significant and the evolution of the two agreement coefficients was similar throughout the study period. Although a positive trend was found in the agreement of almost all items, their CIs did not indicate any statistically significant changing over time. In addition, the coefficients measurements got closer as the agreement got greater. During the study period, the greatest agreement was “chief complaint”, while the lowest one was “secondary diagnosis”.

The logistic GEE model that included all items (Table 3) found a statistically significant increase of 17% over time for the PA, but when at least one of the raters was absent...
from the review meeting, the PA decreased by 27%. Physiotherapists and physicians showed higher PA when compared to nurses. In the analysis by item, there was a non-significant positive trend to higher PA for History of presenting complaint while physicians presented a significantly higher PA over time when compared to nurses for “secondary diagnosis”, “medication history”, and “diagnostic testing”. Physiotherapists presented a significantly higher PA over time when compared to nurses for “medication history”. Finally, when at least one of the raters was absent from the review meeting the PA decreased by 60.5% for “diagnostic testing” (Table 4).

Table 3: Estimated odds ratios (OR) for percent agreement. N=1884 items from 239 records.

|                          | ORa (95% CI) | p value | ORb (95% CI) | p value |
|--------------------------|--------------|---------|--------------|---------|
| Time (audits 1 to 4)     | 1.20 (1.06–1.35) | 0.004   | 1.17 (1.03–1.32) | 0.014   |
| Absent from meeting (Yes)| 0.82 (0.60–1.11) | 0.195   | 0.73 (0.53–1.00) | 0.048   |
| Professional category (physiotherapists) | 1.49 (0.99–2.26) | 0.058   | 1.66 (1.10–2.51) | 0.016   |
| Professional category (physicians) | 1.45 (1.08–1.93) | 0.013   | 1.44 (1.07–1.93) | 0.015   |

*aEstimates obtained by the unadjusted models.
*bEstimates obtained by the multiple models.

Table 4: Estimated odds ratios (OR) of percent agreement by item. N= 239 records.

|                          | OR (95% CI) | p value |
|--------------------------|------------|---------|
| Secondary diagnosis      |            |         |
|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.02 (0.80–1.30) | 0.878   |
| Absent from meeting (Yes)      | 0.65 (0.35–1.23) | 0.187   |
| Prof. category (physiotherapists) | 1.74 (0.72–4.22) | 0.221   |
| Prof. category (physicians)    | 1.82 (1.00–3.29) | 0.048   |

**Chief complaint**

|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.20 (0.80–1.80) | 0.370   |
| Absent from meeting (Yes)      | 0.71 (0.26–1.95) | 0.507   |
| Prof. category (physiotherapists) | 1.22 (0.29–5.16) | 0.786   |
| Prof. category (physicians)    | 0.74 (0.30–1.83) | 0.519   |

**History of presenting complaint**

|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.31 (0.99–1.74) | 0.056   |
| Absent from meeting (Yes)      | 0.58 (0.28–1.19) | 0.138   |
| Prof. category (physiotherapists) | 1.78 (0.68–4.61) | 0.238   |
| Prof. category (physicians)    | 1.56 (0.81–3.01) | 0.182   |

**Past medical history**

|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.14 (0.86–1.51) | 0.375   |
| Absent from meeting (Yes)      | 0.70 (0.34–1.44) | 0.334   |
| Prof. category (physiotherapists) | 1.12 (0.43–2.91) | 0.817   |
| Prof. category (physicians)    | 1.35 (0.69–2.63) | 0.378   |

**Medication history**

|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.25 (0.96–1.62) | 0.099   |
| Absent from meeting (Yes)      | 0.83 (0.44–1.57) | 0.569   |
| Prof. category (physiotherapists) | 4.25 (1.53–11.77) | 0.005   |
| Prof. category (physicians)    | 1.87 (1.02–3.41) | 0.041   |

**Complete medical history**

|                                | OR (95% CI)     | p value |
|--------------------------------|-----------------|---------|
| Time (audits 1 to 4)           | 1.22 (0.95–1.57) | 0.118   |
|                                            | OR (95% CI)     | p value |
|-------------------------------------------|-----------------|---------|
| Absent from meeting (Yes)                 | 0.74 (0.38–1.42) | 0.359   |
| Prof. category (physiotherapists)         | 1.15 (0.47–2.82) | 0.753   |
| Prof. category (physicians)               | 0.96 (0.52–1.76) | 0.893   |
| **Physical exam**                         |                 |         |
| Time (audits 1 to 4)                      | 1.07 (0.82–1.39) | 0.616   |
| Absent from meeting (Yes)                 | 1.32 (0.68–2.58) | 0.410   |
| Prof. category (physiotherapists)         | 2.59 (0.70–9.57) | 0.154   |
| Prof. category (physicians)               | 1.02 (0.54–1.91) | 0.950   |
| **Diagnostic testing**                    |                 |         |
| Time (audits 1 to 4)                      | 1.23 (0.91–1.66) | 0.175   |
| Absent from meeting (Yes)                 | 0.39 (0.18–0.89) | 0.024   |
| Prof. category (physiotherapists)         | 1.52 (0.59–3.92) | 0.387   |
| Prof. category (physicians)               | 3.11 (1.53–6.30) | 0.002   |

Prof.: professional.

**DISCUSSION**

A significant increase in the IRA among PHRRB members was found along the time in routine medical record auditing processes when periodic evaluations of the agreement were performed and discussed by them. On the other hand, but supporting this finding, the absence of a member in a review meeting had a negative impact in the PA. In addition, the PA and the Gwet’s AC1 were comparable and presented a similar evolution over time. Complete medical history was a composite of chief complaint, history of complaint, past medical history, and medication history. It was considered complete whether all of them were complete, too. Thus, it showed a positive evolution in both PA and Gwet AC1 over time from moderate to substantial according to
Altman’s categories. Only the IRA of secondary diagnosis has remained moderate. These findings can indicate raters learning curve regarding the positive evolution of some variables across agreement ranges. Nevertheless, the degree of agreement is arbitrary making it impossible to define an acceptable level. Thus, the interpretation of these IRA values is in accordance with the main study objective, i.e., the rater’s concordance in a particular category.

The greater IRA among physicians and physiotherapists, when compared to nurses, can reflect some inconsistency over the evaluations that can be attributed by rater’s selection, training, and accountability, that could be influenced by a misunderstanding about rating the Complete History item.

The strategy applied for the IRA was feasible to be carried out in this real-world scenario, aggregating value to the auditing process, providing more accurate information that can be used by health leadership. The use of PA and Gwet’s AC1 for that purpose was successful because they demand a relatively small sample of PMRs to be audited by each rater, and can provide two data consistency measures. Both of the used indices have reached acceptable levels of agreement, according to study purposes.

Following and evaluating the progress of the agreement among raters of PMRs allows setting up goals and identifying associated factors to improve the audit processes, but previously proposed models worked with continuous variables or with the Kappa coefficient, so the use of PA and Gwet AC1 made it possible to model the agreement of more than two raters over time.

The increased IRA highlights the need for more careful planning and evaluation of medical record audits since this activity is closely related to health care quality and patient safety improvements efforts.
Since the present study was conducted under real-world conditions and included different health providers as raters, this intervention has the potential to be applicable in other similar settings, taking into consideration that it was carried out in only one hospital that has a culture of evidence-based improvement interventions, during a short-term follow-up. Furthermore, the literature on the quality of medical records keeping and IRA or IRR is scarce what is reflected by the fact that no reviews on the subject could be identified making the results of this study relevant to improve the body of knowledge, in the era of data-driven institutions and big data from patient’s health records.

Finally, this study did not include an evaluation of the impact in the quality of medical records what should be the final goal of any routine audit, and therefore should be evaluated in future studies.

ACKNOWLEDGEMENTS

We thank all the MRRC members who conducted the audit records and support the process, the members of the archiving sector as well as the hospital leadership.

COMPETING INTERESTS STATEMENT

None declared.

FUNDING STATEMENT

This work was funded by the Brazilian Ministry of Health and São Paulo State Research Foundation (FAPESP) through Research Program for the Unified Health System-PPSUS grant 2012/51228-9.
DATA SHARING STATEMENT

The dataset is available to researchers who want to explore the data. To request, please send an email to ana.mafra@einstein.br.

AUTHOR’S CONTRIBUTION

ACCNM conceptualized the study design, drafted the initial manuscript, carried out the random sampling, the statistical analysis, and revised the manuscript. RRST and EA elaborated and operationalized the intervention, contributed to the study design and reviewed the manuscript. FABC contributed to the study design and reviewed the manuscript. JLM and GP contributed to the interpretation of data for the work and revised the manuscript critically for important intellectual content. MMB elaborated the study design, operationalized the intervention, drafted and revised the manuscript. All authors approved the final manuscript as submitted.

REFERENCES

1. Pirkle CM, Dumont A, Zunzunegui M-V. Medical recordkeeping, essential but overlooked aspect of quality of care in resource-limited settings. *International Journal for Quality in Health Care*. 2012;24(6):564–7. doi: 10.1093/intqhc/mzs034.

2. Zegers M, de Bruijne MC, Spreeuwenberg P, Wagner C, Groenewegen PP, van der Wal G. Quality of patient record keeping: an indicator of the quality of care? *BMJ Quality & Safety*. 2011;20(4):314–8. doi: 10.1136/bmjqs.2009.038976.

3. Conselho Federal de Medicina. Resolução nº 1638. Diário Oficial União nº 153, seção 1, 09/08/2002, p. 184-5. Available:
15

4. Gisev N, Bell JS, Chen TF. Interrater agreement and interrater reliability: Key concepts, approaches, and applications. *Research in Social and Administrative Pharmacy*. 2013; 9:330-338. doi: 10.1016/j.sapharm.2012.04.004.

5. Bajpai S, Bajpai R, Chaturvedi HK. Evaluation of Inter-Rater Agreement and Inter-Rater Reliability for Observational Data: An Overview of Concepts and Methods. *Journal of the Indian Academy of Applied Psychology*. 2015, 41 (3): 20-27.

6. Lilford R, Edwards A, Girling A, Hofer T, Di Tanna GL, Petty J, et al. Inter-rater reliability of case-note audit: a systematic review. *J Health Serv Res Policy*. 2007; 12(3):173–80. doi: 10.1258/135581907781543012

7. Thomas EJ, Lipsitz SR, Studdert DM, Brennan TA. The reliability of medical record review for estimating adverse event rates. *Ann Intern Med*. 2002; 136(11):812–6. doi: 10.7326/0003-4819-136-11-200206040-00009

8. Yawn BP, Wollan P. Interrater Reliability: Completing the Methods Description in Medical Records Review Studies. *Am J Epidemiol*. 2005; 161(10):974–7. doi: 10.1093/aje/kwi122

9. Liddy C, Wiens M, Hogg W. Methods to achieve high interrater reliability in data collection from primary care medical records. *Ann Fam Med* 2011; 9:57-62. doi: 10.1370/afm.1195

10. Cohen J. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*. 1960; 20(1):37–46. doi: 10.1177/001316446002000104
Zec S, Soriani N, Comoretto R, Baldi I. High Agreement and High Prevalence: The Paradox of Cohen’s Kappa. *The Open Nursing Journal*. 2017, 11, (Suppl-1, M5) 211-218. doi: 10.2174/1874434601711010211

Eugenio BD, Glass M. The Kappa Statistic: A Second Look. *Computational Linguistics*. 2004;30(1):95–101. doi: 10.1162/089120104773633402

Wongpakaran N, Wongpakaran T, Wedding D, Gwet KL. A comparison of Cohen’s Kappa and Gwet’s AC1 when calculating inter-rater reliability coefficients: a study conducted with personality disorder samples. *BMC Medical Research Methodology*. 2013; 13:61. doi:10.1186/1471-2288-13-61.

Gwet KL. Handbook of inter-rater reliability: the definitive guide to measuring the extent of agreement among raters. 4. ed. Gaithersburg, MD: Advanced Analytics, LLC; 2014.

Bracco MM, Mafra ACCN, Abdo AH, Colunagni FAB, Dalla MDB, Demarzo MMP, et al. Implementation of integration strategies between primary care units and a regional general hospital in Brazil to update and connect health care professionals: a quasi-experimental study protocol. *BMC Health Serv Res* 2016; 16:380. doi: 10.1186/s12913-016-1626-9

Prentice RL, Zhao LP. Estimating equations for parameters in means and covariances of multivariate discrete and continuous responses. *Biometrics* 1991;47(3):825–39. doi: 10.2307/2532642

Liang K-Y, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika* 1986;73(1):13–22. doi: 10.1093/biomet/73.1.13

Altman DG. Practical statistics for medical research. 1st ed. London: Chapman and Hall; 1991
19. R Core Team (2019). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna. Austria. Available: http://www.R-project.org/. [Accessed 30 Dec 2019].

20. Højgaard S, Halekoh U, Yan J. The R Package geepack for Generalized Estimating Equations. *Journal of Statistical Software* 2005; 15:2. doi: 10.18637/jss.v015.i02.

21. PlataformaBrasil. Available: http://aplicacao.saude.gov.br/plataformabrasil/login.jsf. [Accessed 15 Apr 2019].

22. Walter SD, Eliasziw M, Donner A. Sample size and optimal designs for reliability studies. *Stat Med.* 1998;17(1):101–10. doi:10.1002/(SICI)1097-0258(19980115)17:1<101::AID-SIM727>3.0.CO;2-E.

23. Stemler, SE. A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. *Practical Assessment, Research & Evaluation.* 2004, 9:4.

24. Hill EG, Slate EH. A semi-parametric Bayesian model of inter- and intra-examiner agreement for periodontal probing depth. *Ann Appl Stat.* 2014;8(1):331–51. doi: 10.1214/13-AOAS688

25. Williamson JM, Lipsitz SR, Manatunga AK. Modeling kappa for measuring dependent categorical agreement data. *Biostatistics* 2000;1(2):191–202. doi: 10.1093/biostatistics/1.2.191.

---

**Figure 1**: Estimated percent agreement (PA) and Gwet’s AC1 with respective 95% confidence intervals (CIs), by audited item, throughout the study period.
