Examining the reliability of ICD discharge coding in the Red Cross War Memorial Children's Hospital administrative database

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Declaration

I, Adriaan Daniels, hereby declare that the work on which this research project is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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List of Abbreviations

CI: Confidence interval

eCCR: Electronic Continuity of Care Record

EMR: Electronic Medical Record

EP: Expert physician

HF: Heart failure

HIS: Hospital Information System

HIV: Human immunodeficiency virus

ICD: International Classification of Diseases

IQR: Interquartile range

MI: Myocardial infarction

PI: Principal investigator

RCWMCH: Red Cross War Memorial Children's Hospital

SD: Standard deviation

UCT: University of Cape Town

WHO: World Health Organisation

Chapter 1: Introduction and Literature Review

1.1 Background

The International Classification of Diseases (ICD) is used to translate diagnoses of diseases and other health problems from words into an alphanumeric code, which permits easy storage, retrieval and analysis of the data[1]. In addition to assigning codes for specific diagnoses for each patient contact with health services it also provides coding for a wide variety of signs, symptoms, complaints or social circumstances that may stand in place of a formal diagnosis on a health record or chart[1]. These may offer equally important statistical and contextual information and broaden the scope and practical applicability of the classification system.

The use of discharge codes within hospital administrative data has expanded to a variety of applications beyond the classification of mortality, morbidity and procedures for statistical purposes. These applications may include using ICD coded data as the basis for hospital reimbursement protocols; allocation of resources; outcomes monitoring; quality of care assessment; clinical, epidemiological and health service research[2]. Harnessing the potential of this wealth of information is extremely attractive given the cost-saving benefits over other forms of data collection; this is especially true for resource-limited settings.

Despite the valuable utility of discharge coding in hospital administrative databases, there has been growing concern regarding the reliability of the information contained therein. Previous studies have reported that collected patient data such as discharge diagnoses are plagued with inaccuracies as a result of numerous errors along the path

from admission to discharge[2-5]. Studies assessing agreement between medical chart and administrative databases for specific diseases routinely report poor correlation and advise caution when using these databases in isolation for research purposes.

1.2 Objectives

This study aims to examine the reliability of the ICD discharge coding in the Red Cross War Memorial Children's Hospital (RCWMCH) administrative database. The primary objectives of the literature review were to:

1. Illustrate the wide array of uses and the benefits of accurate collection and coding of hospital patient discharge data.
2. Describe the potential consequences of using inaccurate discharge data.
3. Define the extent and identify patterns of hospital administrative database coding errors with a focus on local and/or developing world data where available.
4. Define the potential sources of error in collecting and coding for discharge data and to identify recommendations for solutions.

1.3 Literature search strategy

A literature search was initially performed in June 2015 and again in September 2016 using the Pubmed search engine (http://www.ncbi.nlm.nih.gov/pubmed). The following search terms were used:

Search 1: (quality or accuracy or reliability or validity or error) and (discharge and coding)

Search 2: (discharge and coding) and (electronic or computerized) and (hospital and information and system)

Search 3: (Reliability or Validity or Error or Fidelity) and (Discharge and Coding) and (International and Classification and Diseases)

Search 4: "Hospital Information Systems"[Mesh] AND "International Classification of Diseases"[Mesh] AND ("humans"[MeSH Terms] AND English[lang])

The results of the search were limited to human studies that were published in English.

No age limitations were assigned to the search and we deliberately did not include the words 'paediatric' or 'pediatric' to avoid limiting the results of the search.

Inclusion and exclusion criteria

The selection of relevant articles for inclusion was based on the full text review and how the information related specifically to our research.

Inclusion criteria

- The main criterion for inclusion was articles commenting on or assessing validity of discharge diagnosis coding in hospital administrative databases especially those able to identify patterns and reasons for error and recommend solutions.

- Articles focused on providing a broader description and understanding of the ICD discharge coding system and hospital administrative databases in general were also included.
- While local and paediatric articles were prioritised it became clear that South African or any developing nation research on the topic was almost non-existent with very few paediatric studies in any setting. Regardless of setting and patient age-range, articles were included as many essentially mirrored our own aims and objectives and/or contained relevant findings, key points and core information essential to understanding the topic and laying the foundation for our own work.
- Any study designs were considered and the included research consisted mostly of retrospective audits comparing administrative discharge data with a reference 'gold standard' (i.e. medical record review, disease registries, special investigation results or a combination of all), systematic reviews, some prospective studies and also some qualitative review articles.

Exclusion criteria

- Articles not involving specifically electronic/computerised administrative data were excluded,
- Studies focused primarily on non-diagnostic discharge coding such as procedure, place of occurrence or external cause of injury coding.
- Studies assessing validity of non-ICD coding systems or involving only ICD versions prior to version 8 were excluded.
- Retrospective reviews/audits with small sample numbers and considered to be inadequately powered to reach significant conclusions were also excluded.

- Articles focused on assessing validity of specific injury and/or surgical conditions were excluded as our study is based entirely in a non-injured (medical) population of patients.
- Articles published prior to the year 2000 (more than 15 years old) were excluded unless they were considered to be seminal work and/or included significant viewpoints or initial descriptions not addressed in more recent articles.
- Some selected full text articles were unavailable and could not be retrieved. However, based on the abstract review of the unavailable full text articles, they were unlikely to offer any unique information or viewpoints that were not addressed in the other selected articles and their exclusion would have little to no impact on the literature review.

1.4 Results

The search returned a total of 454 articles. Using four search strings resulted in a fair amount of overlap in results and after duplicate articles were removed, 379 articles were left for review.

All abstracts were read and 38 articles were selected for full text review. Full text articles were primarily retrieved using the *Endnote* citation manager 'Find Full Text' function and also via the University of Cape Town (UCT) library electronic database using the study outsource link. The inclusion and exclusion criteria were applied and as noted above, the unavailable full text references not considered to be vital as well as those published prior to the year 2000 were excluded from the review.

To broaden the search strategy, additional articles and online resources were sourced and reviewed based on colleague recommendations (i.e. project supervisor and co-supervisor) as well as reference list screening of previously fully reviewed articles. Of the 55 articles reviewed in full text, 30 were selected and referenced in the review.

The literature search yielded no African studies and only two studies were from developing nations, neither of which looked specifically at paediatric populations. Twenty-five studies included data only from developed nations (9 from Canada, 9 from the United States of America, 2 from Europe, 4 from Australia and 1 from Asia).

The data were collected from 1961 – 2012. Seven studies looked at only paediatric population data, seven studies looked at only adult data, one study excluded children younger than 12 years old and another excluded children younger than 16 years old. The rest of the studies looked at all age-group sample populations and nearly all the studies included data from tertiary academic hospitals.

The paediatric studies included six cross-sectional studies retrospectively comparing hospital administrative discharge data with a reference 'gold standard' to assess overall agreement and/or to measure statistical validity (i.e. sensitivity, specificity, positive predictive value and negative predictive value) of administrative discharge coding for different conditions[4, 6-10]. Outcomes for agreement and validity mostly varied from poor to moderate with only one showing excellent validity (91% sensitivity and 100% specificity)[8] despite all being conducted in well-resourced developed nation settings. We also included one case-control study primarily focused on developing a method of improving accuracy when using administrative discharge

data to identify patients with community-acquired pneumonia[11]. This study assessed the accuracy of 12 different ICD-9 based coding algorithms for identifying community acquired pneumonia admissions from administrative data and compared each method with a 'gold standard' medical chart review of the same sample. Some algorithms were able to achieve very high overall accuracy (≈ 90% specificity and sensitivity) in identifying cases demonstrating a creative method of optimising these databases for accurate case finding.

Studies using mostly adult sample data were included as they still provided valuable and applicable insight into the topic; illustrated important trends and many mirrored our own study objectives and design in assessing discharge data validity. They have also highlighted the need for more paediatric research on this important topic. Of the all age group (n=7) and adult only (n=7) studies referenced, most had similar study objectives to the majority of the paediatric studies assessing agreement and statistical validity. Three studies recruited their samples prospectively for comparison against other linked data sources[3, 12, 13] and the rest were retrospective reviews of sample data[5, 14-22]. The results revealed significant variability in accuracy from poor to excellent with further variability patterns emerging between different geographic settings and diagnoses. A number of studies, particularly those from Canada, did manage to demonstrate a very high degree of validity within their administrative databases reflecting their highly organised infrastructure focused on maintaining robust and consistent administrative data[13, 18, 19, 22].

Among the adult focused studies were the only two developing nation articles (1 from Asia and 1 from Sri Lanka) referenced in this review[16, 21]. These studies both assessed

validity of administrative cause of death discharge diagnosis and revealed poor to, at best, moderate validity of administrative data. This was notably poorer than the majority of developed nation studies and illustrates an important limitation of many studies with regard to their results not being generalisable across different regions.

A study assessing whether certain clinical coder characteristics may predispose to a higher risk for coding error[23] and another assessing the validity of an optimised ICD based coding algorithm for identifying sepsis-related admissions from administrative data[14] were included. These studies focused their attention on identifying a potential source of error in discharge data and identifying a tool for optimising the potential of discharge data for case finding respectively.

We included four systematic reviews all of which assessed data from both adult and paediatric populations. Three of the reviews were part of a series by a Canadian team looking at validity of discharge coding for Acute Stroke[24], Myocardial Infarction (MI)[25] and Heart Failure (HF)[26]. The Acute Stroke review reported good overall validity (≥ 82% sensitivity and ≥ 95% specificity) included only 2 articles from developing nations (the same 2 articles noted earlier which reported very poor coding validity). The MI review also reported good overall validity (≥ 86% sensitivity and specificity) in contrast to the HF review that showed a surprisingly poorer sensitivity of 75.3% equating to almost one quarter of HF cases not being captured in administrative data. Neither of these latter two studies included any developing world data skewing the generalisability, however, the variability in accuracy between the diagnoses is noteworthy. The final systematic review included research assessing overall discharge coding accuracy only in British hospitals (England, Scotland and

Wales)[27]. This review reported overall median diagnostic accuracy at 80.3% but with considerable variation in accuracy rates between studies.

The remaining articles were mainly literature and clinical reviews or editorials on the subject of discharge coding and hospital administrative databases[2, 28-30]. We also referenced some manuals and guidelines as well as online resources in the final write-up of this review[1, 31, 32].

Core information and key discussion points were identified during the review and described in more detail referencing the appropriate literature.

1.5 Discussion

Disease classification and coding

The International Classification of Diseases (ICD) is the world's most widely used system of disease classification (nosology)[2, 31]. The first edition, ICD-1, was published in 1893 listing 179 causes of death and has since evolved and been revised numerous times to include not only 'cause of death'/mortality codes but also morbidity and procedure codes[2]. The World Health Organization (WHO) was entrusted with the ICD in 1948 and has since then continued with regular revisions and improvements[31]. The current version, ICD-10 came into use in 1994 among WHO member states and now includes over 21800 total codes and has introduced alphanumeric codes for the first time with the greatest specificity of all ICD revisions to date. ICD is currently under revision again with ICD-11 planned for release in 2017[31].

Our research focuses specifically on the use of ICD diagnostic coding in hospital administrative databases and therefore a basic understanding of ICD diagnostic coding assignment protocol is essential.

The ICD consists of three volumes; the 'Tabular List' that contains an alphanumeric listing of diseases, external causes, reasons for encounter, and other health conditions in 22 chapters; the 'Instruction Manual' that contains an introduction to the classification, explains conventions of ICD, and gives instructions on coding death certificates, hospital medical records and other forms of health information; and the 'Alphabetical Index' of the diseases and conditions that have codes in the Tabular List[31]. These 3 volumes are designed to be used together to code as specifically and accurately as possible.

ICD allows for a very specific degree of diagnostic coding with up to 5 'characters' in a diagnostic code. The first letter refers to the chapter in which the code is contained and the subsequent two, three or four numbers refer to a related group of diseases then specific disease within that group. The more characters included, the more specific the diagnostic code is for the condition (e.g. A03 for *Shigellosi*s vs. A03.1 for *Shigellosis due to Shigella flexneri*). Coding to the maximum level of specificity is not always possible as the appropriate information may not always be available for each case. However, ICD-10 guidelines dictate that diagnoses should be coded to the highest level of specificity possible, as this will dramatically improve the quality and usefulness of the derived data[32]. A systematic review of coding in Great Britain noted generally good accuracy up to the third character level of the ICD-10 diagnostic code with a significant drop thereafter suggesting that most errors occur from the fourth

character level of specificity[27].

At discharge, patients should have diagnostic coding recorded for all conditions that affected them during their admission or episode of care. This should include a single 'main diagnosis' and all the 'secondary diagnoses' if present[31]. A variable number of secondary diagnoses are allowed to be entered depending on the administrative database software being used. At RCWMCH, 5 secondary diagnoses are allowed for in the Clinicom® software, however, some software packages allow for many more to be entered.

One study highlighted the considerable international variation that exists regarding the definition of the 'main diagnosis'. Some countries primarily employ a 'reason for admission' rule as the basis while other countries opt for a 'resource use' rule[28]. The implications of this international variation and confusion regarding the definition are considerable and can impact the quality of data and it's comparability across different settings[28].

In South Africa, the 'main condition' is defined as the condition, diagnosed at the end of the episode of healthcare, primarily responsible for the patient's need for treatment or investigation. It is the 'main condition treated'. If there is more than one 'main condition treated', then the most clinically severe or life-threatening condition should be selected. If this cannot be established then the condition held most responsible for the greatest use of resources should be selected. The coder should revert to the default rule that allows the selection of the first condition recorded by the responsible clinician in circumstances where there is more than one 'main condition' treated and

no information is available to determine which of the conditions is the most severe or life threatening, or which one is responsible for the greatest use of resources. If no diagnosis was made, the main symptom, abnormal finding or problem should be selected as the 'main condition'[32].

Secondary diagnoses are interpreted as additional conditions that affect patient care or may co-exist with the main condition in terms of requiring any combination of clinical evaluation, therapeutic treatment, diagnostic procedures, extended length of hospital stay, increased nursing care and/or monitoring[32].

Poor data validity may result due to incorrectly coding diagnoses as the 'main condition' instead of a 'secondary condition' and vice versa. Another issue resulting in poor validity is the failure to code for all the secondary diagnoses completely.

It is of vital importance that coding is done according to these standardised guidelines as variance in their understanding and application within in a single institution or across multiple institutions will have a significant effect on the quality and comparability of the data. The WHO has made guidelines, instruction manuals and also online tutorial and training content available to aid in promoting accurate coding. Customised national guidelines based on the WHO ICD guidelines are also available to help standardise coding practices at a national level. In many developed world settings resources are such that dedicated and specifically trained coding staff can be employed on a permanent basis to abstract diagnostic information from medical records and code them into the administrative databases according to standardised coding guidelines. While clinician input is encouraged to improve coding accuracy,

in less resourced settings the entire coding process can often fall solely upon the already overburdened most junior medical staff and/or minimally trained ward clerks.

Potential for use and benefits of discharge data within vast administrative databases

A study by Schoenman et al., looked specifically at the wide range of uses for hospital discharge data by conducting an expansive literature review, telephone interviews and discussing findings with data experts[29].

The most relevant headings are as follows:

1. *Public Safety and Injury Surveillance and Prevention*

   Inpatient data is often used to track data such as injury rates, patient characteristics, outcomes of specific injuries and to develop injury prevention programs or motivate for changing of legislation (e.g. motorcycle helmet laws, seat belt laws etc.)[29].

2. *Public Health, Disease Surveillance, and Disease Registries*

   This relates to using data to aid in disease surveillance and prevention, economic burden-of-illness studies, public health reporting, and tracking the effect of environmental conditions on health[29].

3. *Community Health Assessments and Health Planning*

   Using discharge data as part of larger community health assessment projects, generating community-level counts of hospitalizations for specific conditions

or subpopulations[29]. This kind of analysis can be useful in identifying 'hot spots' or areas in need of improved and/or specific interventions such as improved primary care facilities, family planning facilities or improved emergency medical services to name a few.

4. *Quality Assessment and Performance Improvement*

   This involves using data related to health care quality for 'benchmarking' applications allowing hospitals to gauge their own performance and implement quality improvement activities to address deficiencies[29]. Benchmarking analysis outcomes are sometimes publicly reported to aid consumers in making an informed decision in selecting hospitals although this is more applicable to developed world or private sector settings.

5. *Health Services and Health Policy Research Applications*

   Discharge data is widely used in research, where the goal is to establish a foundation of knowledge for health services or health policy. These applications include research of the effect of health care financing and delivery systems on hospital use, costs, or outcomes; racial and geographic variations in use and outcomes and more clinically orientated research such as what procedures/interventions and practices produce the best clinical outcomes[29].

Discharge data clearly has enormous potential and also offers significant cost advantages over data collection from prospective studies, surveys, registries or medical chart abstraction. The data is routinely collected, readily available and often spans over long time periods, which makes it suitable to monitor trends or assess the

impact of policy and practice changes. Given the vast array of applications and advantages (especially the inherent cost saving), optimising this data source is particularly suited to resource-limited settings such as South Africa.

Coding accuracy and sources of error

Coding accuracy refers to how accurately the ICD coding reflects the patient's underlying condition. As a result of the expanded use of administrative data, coding accuracy has been the subject of increased attention and scrutiny[2]. When dealing with extremely large volumes of data such as those contained in administrative databases, deficiencies and errors at various levels of the coding process can quickly lead to the DRIP syndrome (data rich information poor)[5]. The issue of accuracy is further complicated by the fact that there is no consensus on what constitutes an acceptable level of accuracy and also that different degrees of accuracy may be acceptable for different applications[27]. Accuracy assessments have found administrative databases to have several problems with quality. In a seminal paper by O'Malley et al[2], the issue of ICD coding accuracy and the numerous opportunities for error during the coding process are specifically addressed. Error sources are broadly subdivided into two categories:

1. *Errors along the 'patient trajectory'*

   This group includes error sources as a patient progresses through the health care system. These mainly involve errors relating to reaching an accurate diagnosis. Errors may result from poor communication between the patient and the clinician; the clinician's overall skillset and ability to order and interpret the appropriate tests and procedures; the quality/availability of the tests and

procedures; and changes to the admission diagnosis and/or the addition of new diagnoses and complications during their admission[2]. In a prospective study using actors as non-complex 'standardised patients' and examining error sources in administrative data, Peabody et al showed inaccuracy in 43 per cent of the administrative diagnostic coding data of which physician diagnostic error alone accounted for 13 percent[3]. This level of inaccuracy resulted despite these being simple cases in an outpatient setting not requiring any tests and/or procedures to confirm the diagnosis or introduce confusion.

Certain diagnoses may inherently represent a larger potential for error than others. This may be due their broad and non-specific case definitions; no laboratory or imaging tests being available for their confirmation; the perception that certain diagnoses may be unimportant; constantly changing criteria for their diagnosis and also rarity or complexity[2]. Evidence for variability in validity across different diagnosis has been shown in a number of studies[4, 9, 11, 12, 14, 15, 17, 24-26]. In a series of systematic reviews by McCormick et al, HF validity was found to have significantly poorer sensitivity in administrative data than acute stroke and myocardial infarction[24-26]. This was thought to be in large part due to the absence of a single accepted 'gold standard' to diagnose HF and that a definitive diagnosis of HF can often be challenging [26]. Sepsis is another poorly defined and complex condition and two studies demonstrated notably poorer validity and significant undercoding of sepsis in administrative databases compared with other conditions[14, 17]. A study by Howard et al demonstrated extremely poor sensitivity for identification of acute respiratory distress syndrome from both medical record

review (47 per cent) and diagnostic coding data (6 per cent) versus prospective clinical screening by experts using up to date clinical guidelines[12]. In a study assessing administrative database accuracy for obesity, sensitivity was found to be extremely poor at 7,75 per cent[15]. A number of reasons were put forth for the poor capture of obesity, many of which relate to obesity being poorly recognised as a disease despite it representing a highly prevalent global health concern and a leading preventable cause of morbidity and mortality[15].

A large-scale study assessing paediatric emergency department discharge diagnosis data validity showed poor to moderate agreement with medical records with significant variance by diagnosis[4]. Another paediatric study showed very poor accuracy of diagnostic coding for malformations in newborn infants due to poor understanding of what constitutes a malformation as opposed to a normal variant or minor physical feature[9].

2. *Errors along the 'paper trail'*

Assuming the clinician makes the correct diagnosis, a range of opportunities for error still exists which could result in inaccurate diagnostic information appearing in the administrative dataset. This group involves errors in the creation of the medical record and the process of accurately coding the information contained therein. The accuracy of discharge data can be significantly influence by how completely, meticulously, unambiguously and neatly the clinician records his findings, test results, admitting and discharge diagnoses. The transcription and coding of the medical chart information into the administrative database in turn depends on the quality of the clinician notes, the training and experience of the coder, the adherence to a standardised coding

manual and the availability and practice of thorough quality control at the health facility[2].

Quality assessments of administrative data mostly assess this group of error sources as many of them use medical records as the 'reference standard', which assumes that the clinician diagnoses are correct.

In a study assessing medical chart documentation quality in a highly evolved and resourced setting, only 42,6 per cent of reviewed charts were rated as well documented with a variance from 14,6 to 87,5 per cent across 17 hospitals[5]. The well-documented charts also showed better agreement with administrative data than the poorly documented charts. Furthermore, high chart documentation quality was more strongly associated with the hospital the physician worked at than any other factor. This reflects variability at the various health care facilities in the culture of training, mentoring and stressing the importance of chart documentation. Another study assessed the enormous financial implication of poor discharge coding and highlighted the globally institutionalised trend of discharge documentation being completed (often poorly) by the most junior medical staff (e.g. interns) as leading cause of error along the paper trail[17]. Nelson et al highlighted this point as well in a study assessing the use of hospital discharge data as a surveillance tool for childhood diarrhoeal disease[10].

In the prospective study mentioned earlier by Peabody et al, poor clinician documentation alone resulted in 30 per cent of the administrative discharge

data being inaccurate even when the correct diagnosis was reached[3]. This study demonstrates a high degree of inaccuracy even before taking later error sources along the paper trail into account (e.g. final coding of diagnoses, data entry into administrative database).

Errors during the actual process of code assignment have also been shown to account for a large degree of data inaccuracy. In a study looking at administrative data error, it was demonstrated that 35 per cent of errors could be directly attributed to errors at the level of coding and the study also demonstrated considerable inconsistency in coding practice amongst the coders[33].

Conversely, Hennessy et al., examined the relationship between coding validity and variables such as health record coders' characteristics (e.g. employment status, experience, etc.) and disease complexity in a highly resourced setting with regard to administrative data capturing infrastructure[23]. The study demonstrated robust validity in the administrative data and also remarkable consistency amongst the coders. They attributed this to the fact that they employ dedicated coders who undergo 2 years of training in an accredited college program that incorporates work experience. Furthermore, all coders in the 4 major hospitals are managed under a single Health Records Department and rotate between hospitals ensuring a high degree of consistency. A similar explanation was suggested for good validity in a data validity study conducted in Switzerland[18]. This degree of coding infrastructure is, however, a luxury rarely available to facilities in developing countries.

The adequacy of training the coders receive directly impacts on how accurately and consistently coders are able to process vast amounts of information and assign the correct codes[2]. Continuing education of coders is also important as coding classifications may change or be updated and studies have demonstrated a drop off in quality followed by a trend towards improvement after introducing a new ICD version and this is thought to represent a 'learning curve' period[18, 20].

1.6 Conclusion

The literature review has highlighted the enormous potential for using discharge coding within hospital administrative data in a variety of applications beyond simply classifying disease, morbidity and mortality. However, it has also been shown to have a variety of issues with regard to accuracy and the literature has revealed considerable variability in validity across different settings and diagnoses. Attaining accuracy in the administrative data can be especially challenging given the considerable opportunity for errors at different points along the *patient trajectory* and *paper trail*. The implications of inaccurate administrative discharge data may include management decisions and resource allocation being based on flawed data and similarly, questionable conclusions being reached for research based on this data.

A number of recommendations have been put forward to help improve data quality and studies reporting good administrative data validity have often already integrated these strategies into their infrastructure. The employment of dedicated and adequately trained coding staff as well as periodic auditing of data quality stand out as important

interventions for attaining a high level of discharge data quality[2, 18, 23]. Implementing these strategies requires resources, good leadership commitment and foresight at many levels of a healthcare system.

The literature review has also shown a striking paucity of data from developing nations and paediatric populations. The few developing nation studies available revealed validity that was notably poorer than those reported in developed nation studies and this is in keeping with the idea that better resources, commitment and organisation are strongly associated with better administrative data validity[16, 21]. However, some studies from developed nations also revealed poor validity suggesting that, without a comprehensive effort across many levels, consistently robust and accurate administrative data can be difficult to achieve, even in well-resourced settings[3, 4, 7, 14, 15, 17].

Our research aims to serve as a starting point to simultaneously address this research gap in developing nations and for paediatric populations. We hope that our baseline assessment of the current state of administrative discharge diagnostic data validity at RCWMCH and will serve as a platform for more research and improved commitment to improving and optimising the use of this valuable resource.

Recommended solutions to improve coding accuracy

Many studies list some standard recommendations for improvement of discharge coding accuracy and generally address the different points of potential error as described above. Other studies offer more novel methods of either improving data

accuracy and/or optimising the databases for specific applications. The most relevant recommendations are as follows:

1. Teaching health informatics to students at medical school and teaching hospitals[5, 16]
2. Providing physicians and medical record coders with continuing training and education on the use and importance of health informatics[5, 12, 16]
3. Requiring discharge summaries to be typed to improve legibility[5]
4. Introduction of a more simplified online discharge summary application[17]
5. Ensuring senior medical staff members be involved in supervising discharge summaries (e.g. through regular ward discharge summary meetings)[17]
6. Employment of adequately trained dedicated coders who employ standardised guidelines to promote accuracy and consistency[2, 18, 23]
7. Data linkage between administrative discharge databases and other healthcare databases such as laboratory results, imaging results, pharmacy or even an electronic health record where available[5, 6, 10, 29, 30]
8. The use of ICD based coding algorithms or case definitions to optimise the use of administrative databases for accurately identifying groups of patients with specific conditions[11, 14]
9. Regular local and national audits of to assess reliability of discharge data[10, 16, 21, 29]

Ultimately, success through implementation of these strategies will require strong and visionary leadership and a sustained commitment towards improvement with

cooperation and participation at many levels and across all healthcare related organisations [29, 30].

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Chapter 2: Publication-Ready Manuscript

EXAMINING THE RELIABILITY OF ICD DISCHARGE CODING IN THE RED CROSS WAR MEMORIAL CHILDREN'S HOSPITAL ADMINISTRATIVE DATABASE

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2.1 Abstract

Background

Discharge diagnostic data from hospital administrative databases are often used to inform decisions relating to a variety of vital applications. These may include the allocation of resources, quality of care assessments, clinical research and for the formulation of healthcare policy to name a few. Having accurately coded and reliably captured discharge data for patients is of paramount importance for any hospital and health system to function efficiently.

Objectives

1. Retrospectively examine the reliability of the ICD discharge coding in the Red Cross War Memorial Children's Hospital (RCWMCH) administrative database for primary and secondary discharge diagnoses.
2. Formulate recommendations for improvement to the current system.

Methods

This study was a retrospective folder review of 450 patient admissions to the short stay and general paediatric wards at the RCWMCH between 1 August 2013 and 1 September 2014. International Classification of Diseases version 10 (ICD-10) discharge coding was completed for each admission by the principal investigator and compared with the corresponding admission data captured for each patient within the Clinicom® Health Information System. Agreement comparison was done to both four-character and three-character ICD-10 code specificity.

Results

Of the initial 450 randomly selected folders, 396 (88%) were analysed during the folder review process. The median number of total diagnoses (primary diagnosis plus secondary diagnoses) coded by the principal investigator (PI) folder review was 3 with a distribution of 1 to 10 (IQR 2 - 4). The median number of total diagnoses coded in Clinicom® was 1 with a distribution of 1 to 3 (IQR 1 - 1). Agreement of primary diagnosis coding to four characters was 26.3% with slight improvement to 34.3% when assessed to three characters. Agreement for secondary diagnoses to four characters was 14.9% and 27.7% when assessed to three characters.

Conclusion

Reliability of administrative discharge data from RCWMCH is poor. Inadequacies with regard to the employment of dedicated and/or adequately trained coding personnel may be significant contributors to the problem.

Keywords

ICD-10, Agreement, Administrative Data, Clinicom

2.2 Background

Administrative discharge data contain vast amounts of patient information and have enormous potential for use in a variety of applications beyond simply classifying morbidity, mortality and procedures for statistical purposes. These may include applying the data for use in hospital reimbursement protocols; allocation of resources; outcomes monitoring; quality of care assessment; clinical, epidemiological and health service research to name a few[1]. Harnessing the potential of this wealth of information is extremely attractive given the cost-saving benefits over other forms of data collection; this is especially true for resource-limited settings.

Diagnoses and other clinical information obtained during the course of paediatric admissions are recorded in various data sources including the patient medical record and an electronic administrative database. At discharge, patients have diagnostic coding recorded for all conditions that affected them during their admission or episode of care. This should include a single 'main or primary diagnosis' and all the 'secondary diagnoses' if present[2].

At RCWMCH all patients should ideally have their primary diagnosis, secondary diagnoses, procedures and other data updated on discharge paperwork by ward medical staff. Clerical staff should follow standardised guidelines[3] to enter discharge diagnoses, assign the appropriate diagnostic code for each diagnosis and enter other routinely collected information into a computerised hospital information system (HIS) application, Clinicom®, to form an administrative data set. Discharge diagnoses are coded using the International Classification of Diseases version 10 (ICD-10)[4], the most widely used classification of diseases.

ICD-10 allows for a very specific degree of diagnostic coding with up to five 'characters' to make up an alphanumeric diagnostic code. The first letter refers to the chapter in which the code is contained and the subsequent two, three or four numbers refer to a related group of diseases then specific disease within that group. The more characters included, the more specific the diagnostic code is for the condition (e.g. A03 [three characters] for *Shigellosi*s vs. A03.1 [four characters] for *Shigellosis due to Shigella flexneri*). Coding to the maximum level of specificity is not always possible as the appropriate diagnostic information may not always be available/documented for each case. However, ICD-10 guidelines dictate that diagnoses should be coded to the highest level of specificity possible, as this will dramatically improve the quality and usefulness of the derived data[5]. A systematic review of coding in Great Britain noted generally good accuracy up to the third character level of the ICD-10 diagnostic code with a significant drop thereafter suggesting that most errors occur from the fourth character level of specificity[6]. Diagnostic coding at RCWMCH is done using ICD-10 to a maximum of four characters.

Previous studies have reported that collected patient data such as discharge diagnoses are plagued with inaccuracies as a result of numerous errors along the path from admission to discharge[1, 7-9]. Studies assessing agreement between medical chart and administrative databases for specific diseases routinely report poor correlation and advise caution when using these databases in isolation for research purposes. The vast majority of the published research is based in the developed world and many of these have reported poor reliability in administrative discharge data[7, 8]. This is concerning for far less resourced state health facilities such as those in South Africa where

adequately trained and dedicated coders are rarely employed and where little to no published data exists specifically assessing hospital administrative data reliability.

In our study we examined the reliability of the discharge ICD coding in the RCWMCH administrative database. Unreliable data could significantly affect the quality of the administrative datasets and therefore all data and statistics abstracted from it.

Objectives

The primary objective of the study was to:

1. Retrospectively examine the reliability of the ICD discharge coding in the RCWMCH administrative database for primary and secondary discharge diagnoses.

Secondary objectives:

1. Formulate recommendations for improvement to the current system.

2.3 Methods

Study design

A retrospective folder review of patient medical records and data captured within the Clinicom® Health Information System.

Study site

RCWMCH in Cape Town, South Africa. RCWMCH is a dedicated referral children's

hospital with 290 inpatient beds and caters for about 18 500 inpatient and 260 000 outpatient visits per year. The patients come from a wide variety of demographic and socio-economic backgrounds although most are dependent on state services. The hospital houses Trauma and Medical Emergency Units, both of which have short stay in-patient wards. The range of paediatric tertiary services includes an intensive care unit, general paediatric and surgical wards as well as medical and surgical subspecialty wards.

Study population and patient selection

Patients admitted and treated in the short stay ward and general paediatric wards at the RCWMCH between 1 August 2013 and 31 July 2014.

Inclusion criteria

- Patients discharged from the medical short stay ward.
- Patients discharged from the general paediatric wards.
- Patients belonging to the above two groups whose discharge information was captured and recorded in the Clinicom® HIS.

Exclusion criteria

- Patients discharged from the rehydration ward subdivision of the short stay ward. Including patients discharged from this ward would unfairly bias toward correct coding of the primary diagnosis in the Clinicom® system as this ward is almost exclusively used for treating diarrhoeal disease thereby making the primary diagnosis ICD-10 code a given.

- Patients discharged from any other part of the hospital other than the medical short stay and general paediatric wards were also excluded.

Definitions

Primary or main diagnosis:

> 'In South Africa, the 'main condition' is defined as the condition, diagnosed at the end of the episode of healthcare, primarily responsible for the patient's need for treatment or investigation. It is the 'main condition treated'. If there is more than one 'main condition treated', then the most clinically severe or life-threatening condition should be selected[5].'

Secondary diagnosis:

> 'Secondary diagnoses are interpreted as additional conditions that affect patient care or may co-exist with the main condition in terms of requiring any combination of clinical evaluation, therapeutic treatment, diagnostic procedures, extended length of hospital stay, increased nursing care and/or monitoring. This includes any comorbidity that the patient may have. There may be multiple secondary diagnoses per patient[5].'

Total diagnoses: The sum of the primary diagnosis and all secondary diagnoses present during a health care encounter/hospital admission.

Diagnostic codes: The alphanumeric codes given for all primary and secondary diagnoses as per ICD-10.

Hospital Information System (HIS): An electronic, computerised information system designed to help hospitals manage and process all aspects of their daily operations in a more organised, integrated and efficient manner. Clinicom® is one of the several HIS software packages available.

Administrative data: Data routinely generated at every encounter with the health care system such as epidemiological/demographic data, a diagnosis, a procedure, an

admission to hospital, etc. Administrative databases often constitute large volumes of data and are most often collected and stored within electronic Hospital Information Systems.

Data collection

We randomly selected 450 folders from the total 7535 discharged patients entered into the Clinicom® HIS for the short stay and general paediatric wards during the 12-month period between 1 August 2013 and 31 July 2014. Sample size norms for reliability studies such as this are not well established. We estimated that at least 400 folders would allow reasonable precision in the assessment of reliability of ICD coding. To randomly select our folders, we assigned the 7535 eligible folder numbers from the Clinicom® HIS a sequential code (1, 2, 3, 4, etc.) and then randomly selected 450 folders within this code, using an electronic random number generator. The patient folders were drawn from the medical records department, reviewed by the principal investigator (PI) and data variables extracted and captured on a data sheet (appendix 1 – data collection sheet) and then into an electronic spreadsheet (Microsoft Excel®).

The data collected included patient clinical information: primary discharge diagnosis and up to 8 secondary diagnoses, length of stay as well as epidemiological data including age-in-months and sex. The PI assigned an appropriate ICD-10 code for each folder's primary and secondary diagnoses to 4-character specificity (wherever possible). ICD-10 coding was completed as per the South African ICD-10 coding standards[5] using an online version of the WHO ICD-10 version: 2010[3], the ICD version in use at RCWMCH during the time of the study population admissions.

The data collection and abstraction from the medical records was based on the clinical notes of the responsible clinician and not the opinion of the PI. The aim of the study was not to assess the validity of the clinical diagnoses made by the responsible clinicians but rather to assess the agreement between the medical records and the administrative database.

The chart review and data collection took between 15 to 30 minutes per chart and a binary opinion (i.e. easy or difficult) of whether the folder was easy or 'difficult to code' for was entered for each folder.

An expert physician (EP) investigator, one of the study investigators, reviewed a randomly selected sample of 20 folders (5%) for quality control and to assess PI-EP agreement with the EP as the reference standard. The EP followed the same chart abstraction procedure as the PI. We recognise that the EP may be subject to errors as well. However, as an experienced consultant paediatrician and head of department of ambulatory and emergency services at RCWMCH, we believed that the EP reviewing a medical folder retrospectively would be more likely to arrive at the correct diagnosis (and appropriate ICD-10 code) intended by the managing paediatric doctor at RCWMCH compared with clerical staff with far less or even no formal background in paediatrics or medicine.

To avoid bias during the folder review and data abstraction process, the PI and EP were blinded to the reciprocal patients' diagnostic coding and other relevant data recorded in the Clinicom® system and also to each other's diagnostic coding.

The data abstracted and ICD coding done by the PI was regarded as the reference/gold standard for the study. The reciprocal data/coding for each folder was abstracted from the Clinicom® administrative dataset into the Microsoft Excel® spreadsheet to create the second dataset for comparison with the PI dataset.

Statistical analysis

Continuous data were summarised using medians and interquartile range (IQR) while proportions were depicted using percentages and 95% confidence intervals (CIs) as appropriate.

For initial comparison we described the number of diagnoses per patient for the PI abstracted data and for the administrative database using conventional descriptive methods (mean and standard deviation (±SD) or median [interquartile range, IQR]) or proportions: e.g. total diagnoses, total secondary diagnoses.

Reliability of Clinicom® recording was assessed by calculating proportions of agreement between Clinicom® generated and PI generated diagnostic records at both 4 and 3-character levels. Agreement was calculated similarly for primary diagnoses, secondary diagnoses and for *any* diagnoses (at least one similar diagnosis irrespective of whether diagnosis is secondary or primary) with PI generated diagnostic records as gold standard. The *any* diagnosis assessment was used to disregard the ordering of diagnosis and to assess to what degree at least one of the PI total diagnoses was listed in amongst the total diagnoses for each patient in the administrative dataset. Agreement here would suggest at least some thread of commonality between the two

datasets.

For quality control a similar analysis was carried out comparing EP and PI abstracted data in a small sample of the data using the EP as the reference/gold standard.

All data were analysed in STATA® 13.0 (Statacorp LP, College Station, Texas, USA).

2.4 Results

Of the initial 450 randomly selected folders from 1 August 2013 and 1 September 2014, 396 (88%) were analysed during the folder review process. Thirty-three (7.3%) were excluded as the folders could not be located, twelve (2.7%) were excluded due to missing relevant notes within the folder, eight (1.8%) were excluded as no ICD discharge diagnoses codes were entered into Clinicom® for them and one (0.2%) was excluded as the patient was admitted to a surgical ward and not to the short stay ward or general medical ward.

Two hundred and eighty-three (71%) patients in the sample were admitted and discharged from the short stay ward and 113 (29%) were admitted and discharged from the general medical wards (see figure 1). Twenty-eight (7%) folders were marked as ‘difficult to code’ by the PI.

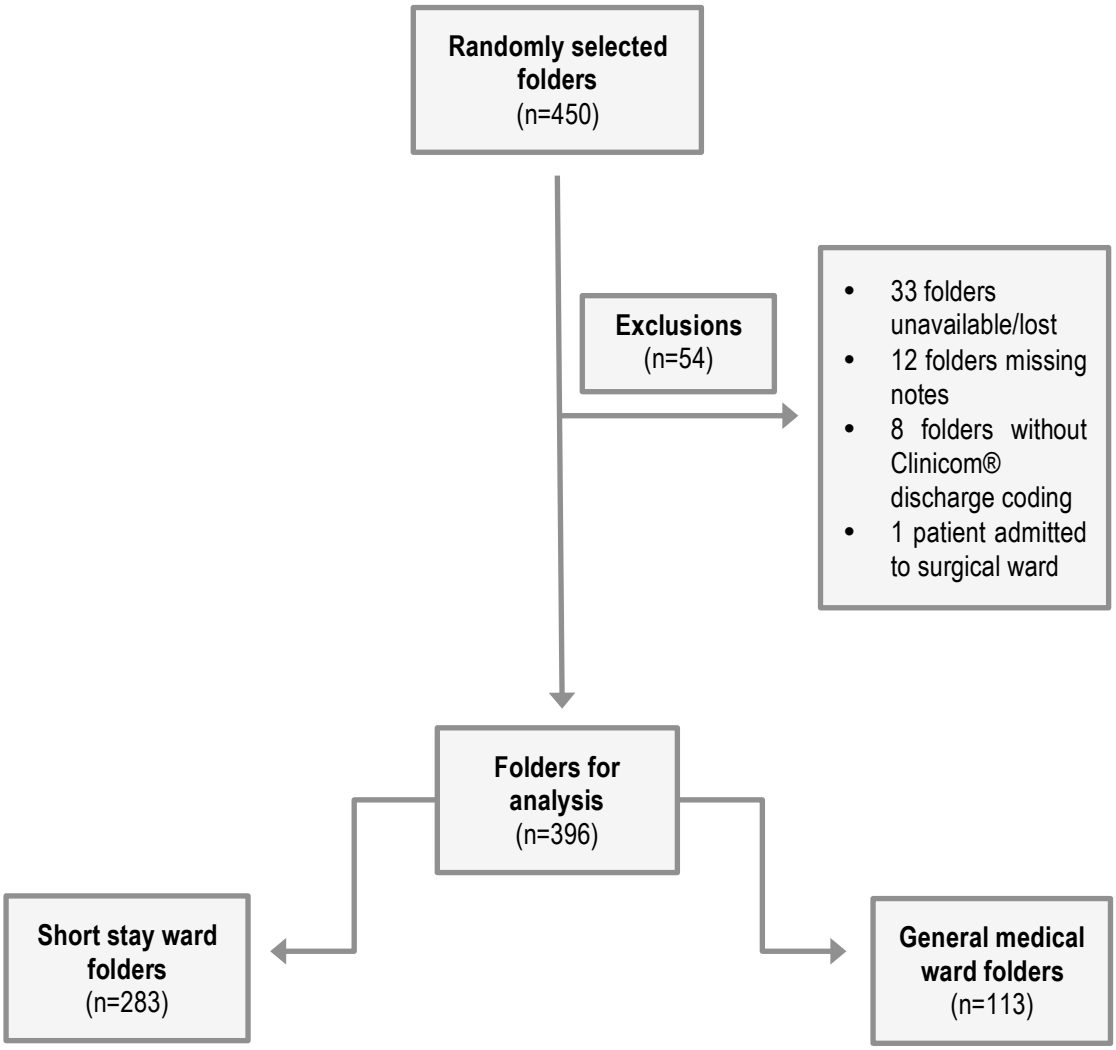

Figure 1: Flow diagram showing enrolment, losses and analysis

The study included 213 male patients (54%) and 183 female patients (46%). The age distribution was 6 days to 15.4 years with median age of 13.6 (interquartile range [IQR] 4.6 – 38.7) months.

The first assessment of reliability was done by examining completeness of coding by comparing the total diagnoses coded per discharge in Clinicom® data with the PI

folder review. The median number of total diagnoses (primary diagnosis plus secondary diagnoses) coded by the PI folder review was 3 with a distribution of 1 to 10 (IQR 2 – 4) (see figure 2). The median number of total diagnoses coded in Clinicom® was 1 with a distribution of 1 to 3 (IQR 1 - 1).

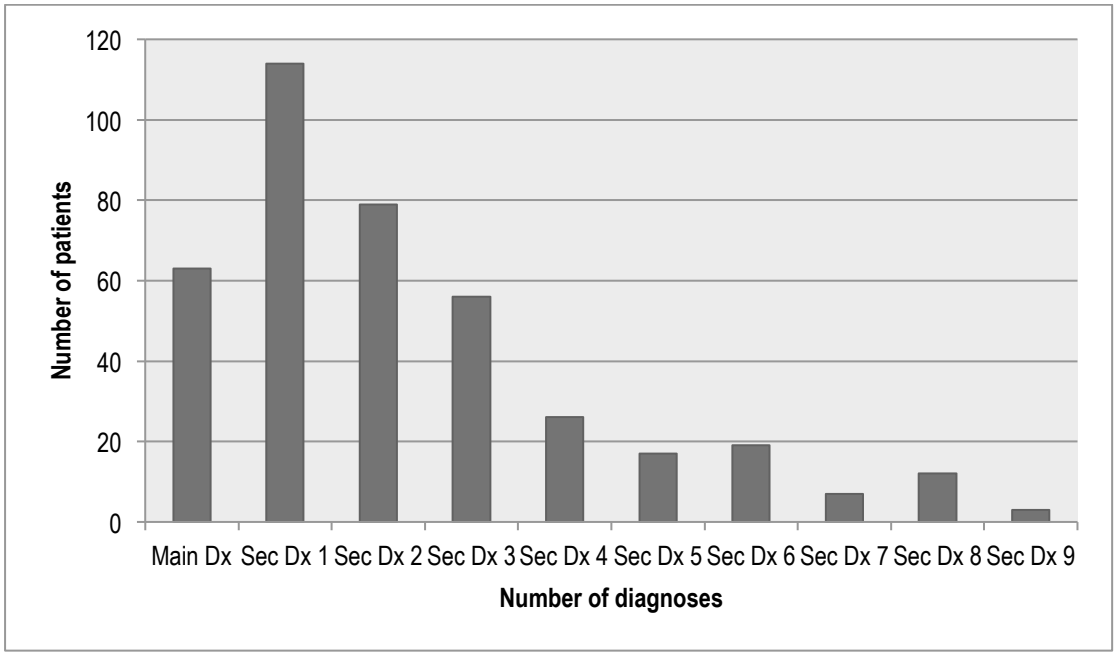

Figure 2: Distribution of principal investigator coded total diagnoses. Main Dx – Main diagnosis. Sec Dx 1-9 – Secondary diagnosis 1-9.

We assessed diagnosis agreement between the PI chart review and the Clinicom® electronic administrative data to 4-character and also to 3-character specificity. We included an assessment to 3-characters, as we believed that disagreement at only the fourth character level may represent a much less clinically significant disagreement and could still provide some useful information for various applications.

Agreement of primary diagnosis coding to four characters was 26.3% and showed slight improvement to 34.3% when assessed to three characters (table 1). Agreement for secondary diagnoses to four characters was 14.9% and 27.7% when assessed to

three characters. The poor secondary diagnoses agreement was to be expected given the undercoding of diagnoses noted from the completeness examination. No significant difference in agreement was observed between the general medicine wards and the short stay wards.

Ward	Primary diagnosis 4-character coding		Total	Primary diagnosis 3-character coding		Total
	Non-Agreement	Agreement		Non-Agreement	Agreement	
General Medical	82 (72.57)	31 (27.43)	113	75 (66.37)	38 (33.63)	113
Short Stay	210 (74.20)	73 (25.80)	283	185 (65.66)	98 (34.63)	283
Total	292 (73.74)	104 (26.26)	396	260 (65.66)	136 (34.34)	396

Table 1: Clinicom® vs. principal investigator agreement of primary diagnoses to 3 and 4 characters stratified to short stay and general wards. Presented in absolute numbers with percentages in brackets.

Agreement for at least one similar diagnosis to four characters was 27.5% and 36.4% for three characters (table 2). Again, no significant difference in agreement was observed between the general medicine wards and the short stay wards.

Ward	Any diagnosis 4-character coding		Total	Any diagnosis 3-character coding		Total
	Non-Agreement	Agreement		Non-Agreement	Agreement	
General Medical	80 (70.80)	33 (29.20)	113	72 (63.72)	41 (36.28)	113
Short Stay	207 (73.14)	76 (26.86)	283	180 (63.60)	103 (36.40)	283
Total	287 (72.47)	109 (27.53)	396	252 (63.64)	144 (36.36)	396

Table 2: Clinicom® vs. principal investigator agreement for at least one diagnosis to 3 and 4 characters stratified to short stay and general wards. Presented in absolute numbers with percentages in brackets.

For each folder we made a subjective 'yes' or 'no' comment on whether we thought that the discharge diagnoses were 'difficult to code'. Difficulty may have been due to one or more of a number of reasons (e.g. multiple diagnoses, rare or complex diagnoses, poorly recorded medical notes etc.). The analysis was repeated with the exclusion of the cases marked as 'difficult to code' by the PI. The agreement showed little overall improvement and was in some cases even poorer.

Agreement of primary diagnosis coding to four characters was 27.2% and 35.6% when assessed to three characters (table 3). Agreement for secondary diagnoses to four characters was 14.6% and 26.8% when assessed to three characters.

Ward	**Primary diagnosis 4-character coding**		**Total**	**Primary diagnosis 3-character coding**		**Total**
	Non-Agreement	Agreement		Non-Agreement	Agreement	
General Medical	71 (71.72)	28 (28.28)	99	64 (64.65)	35 (35.35)	99
Short Stay	197 (73.23)	72 (26.77)	269	173 (64.31)	96 (35.69)	269
Total	268 (72.83)	100 (27.17)	368	237 (64.40)	131 (35.60)	368

Table 3: Clinicom® *vs. principal investigator agreement of primary diagnoses to 3 and 4 characters stratified to short stay and general wards excluding 'difficult to code folders. Presented in absolute numbers with percentages in brackets.*

Agreement for at least one similar diagnosis to four characters was 28.3% and 37.2% for three characters (table 4).

Ward	Any diagnosis 4-character coding		Total	Any diagnosis 3-character coding		Total
	Non-Agreement	Agreement		Non-Agreement	Agreement	
General Medical	69 (69.70)	30 (30.30)	99	61 (61.62)	38 (38.38)	99
Short Stay	195 (72.49)	74 (27.51)	269	170 (63.20)	99 (36.80)	269
Total	264 (71.74)	104 (28.26)	368	231 (62.77)	137 (37.23)	368

Table 4: Clinicom® vs. principal investigator agreement for at least one diagnosis to 3 and 4 characters stratified to short stay and general wards excluding 'difficult to code folders. Presented in absolute numbers with percentages in brackets.

Quality Control

The median number of total diagnoses (primary diagnosis plus secondary diagnoses) coded by the PI folder review was 3 with a distribution of 1 to 9 (IQR 2 – 4.5). The median number of total diagnoses coded by the EP folder review (n=20) was 3.5 with a distribution of 1 to 10 (IQR 2 - 5).

Agreement of primary diagnosis coding to four characters was 45% and showed slight improvement to 65% when assessed to three characters (see table 5). Agreement for secondary diagnoses to four characters was 70% and 75% when assessed to three characters.

Primary diagnosis 4-character coding		Total	Primary diagnosis 3-character coding		Total
Non-Agreement	Agreement		Non-Agreement	Agreement	
11 (55)	9 (45)	20	7 (35)	13 (65)	20

Table 5: Principal investigator vs. expert physician agreement of primary diagnoses to 3 and 4 characters. Presented in absolute numbers with percentages in brackets.

Agreement for at least one similar diagnosis to four characters was 95% and 100% for three characters (see table 6).

Any diagnosis 4-character coding		Total	Any diagnosis 3-character coding		Total
Non-Agreement	Agreement		Non-Agreement	Agreement	
1 (5)	19 (95)	20	0	20 (100)	20

Table 6: Principal investigator vs. expert physician agreement for at least one diagnosis to 3 and 4 characters. Presented in absolute numbers with percentages in brackets.

2.5 Discussion

Our study demonstrates extremely limited agreement between discharge diagnostic coding abstracted from the medical records and those present in the hospital administrative database, Clinicom® at a South African public children's hospital. Using diagnostic data from this administrative database as the source material for administrative purposes or research may bring about questions regarding completeness and to what extent the administrative data accurately reflects the medical records.

The study highlights two fundamental issues regarding the quality of the administrative discharge data:

1. The overall undercoding of diagnoses with limited secondary diagnoses recorded per patient in the administrative data compared with the medical chart review.
2. The overall poor agreement between the administrative data ICD-10 coding compared with the medical chart review.

The first issue regarding the undercoding of diagnoses is perhaps the most striking as even before the assessing of agreement it immediately demonstrates the incompleteness and therefore inherent poor reliability present in the discharge data. Previous studies have shown the phenomenon of undercoding in administrative data; however, this has mostly been in relation to *specific* diagnoses such as heart failure, sepsis, respiratory distress syndrome or obesity being under coded[10-16]. This is perhaps less surprising as these diagnoses are exceptional in that they either lack an acceptable gold standard for diagnoses, are poorly defined, inherently complex to diagnose or are simply poorly recognised as a *disease* as is often the case with obesity for example.

Our study on the other hand has shown overall undercoding in the administrative data throughout the whole sample. The median number of total diagnoses coded by the PI folder review was 3 with a distribution of 1 to 10 (IQR 2 - 4). The median number of total diagnoses coded in Clinicom® was 1 with a distribution of 1 to 3 (IQR 1 - 1). The maximum number of total diagnoses for any patient was three in Clinicom® versus ten in the PI folder review. Furthermore, in the PI folder review, 140 patients (35.4%) still had at least four total diagnoses and 84 (21.2%) had at least five. Only from eight or more total diagnoses did the number drop below 10 per cent of the sample. This illustrates a significant discrepancy in completeness of diagnostic coding between Clinicom® and the PI folder review. It is worth noting that the PI-EP quality control comparison showed very similar numbers of total diagnoses with similar distributions as well as comparable IQR's.

The second issue highlighted was the poor diagnostic code agreement between the PI folder review and the administrative data. Primary diagnosis agreement to four

characters was only 26.3% and when limited to three characters showed only marginal improvement to 34.3%. A previous systematic review of discharge coding accuracy showed a significant improvement as high as 39 per cent in some studies when agreement analyses was limited to three characters suggesting that a high proportion or errors occur at the fourth character[6]. These numbers are well in excess of the 8% improvement noted in our study and as the systematic review was limited to hospitals in Great Britain, it serves as another example of the limited generalisability of developed nation studies in this context. Even poorer agreement for secondary diagnoses was to be expected given the undercoding noted in the initial analyses. A more significant improvement was noted here when limiting analyses from four to three characters (14.6% and 26.8% respectively).

The best agreement results were noted when assessing for 'at least one similar diagnosis', and even these were still remarkably poor at 28.3 and 37.2 per cent for four- and three-character agreement respectively. This analysis is perhaps the most telling given that it was poor at both three- and four-character assessment despite the fact that it essentially disregarded ordering between primary and secondary diagnoses and was therefore the most 'forgiving' of the analyses. Ordering of diagnoses in a population with a high burden of complex medical issues (e.g. HIV, malnutrition and poverty-related illnesses) can be particularly challenging with regard to singling out one of many significant diagnoses as the *primary diagnosis*. This difficulty in ordering was also likely at play in the PE-PI quality control analysis for primary diagnoses, which yielded the lowest agreement of all our quality control analysis. However, when assessing for at least one similar diagnosis, the agreement was near perfect at 95 and 100 per cent for four and three characters respectively. There is no

clear consensus on what constitutes an acceptable level of agreement for discharge coding reliability in the administrative data. However, of all our quality control results, these were certainly adequate as a benchmark for comparison.

Finally, when stratifying the various agreement analyses to short stay and general wards, no significant difference was noted in the results suggesting that the poor coding reliability is likely to be widespread across different wards in the hospital.
There are several possible explanations for these results, which may include some of the following:

1. The lack of dedicated and adequately trained expert coding staff.
2. Inadequate training of current staff (medical and non-medical) responsible for diagnostic coding.
3. Poor clinician medical chart documentation.
4. Lack of training and/or poor usability of the administrative data software package (i.e. Clinicom®).
5. The inherent limitations of the ICD-10 coding system regarding the disconnect between the rigid ICD diagnostic descriptors and local clinical concepts/terminology[17].
6. A culture of unimportance attached to discharge coding amongst busy medical and non-medical staff.
7. The lack of a direct financial incentive for complete and accurate discharge coding in government funded state hospitals such as RCWMCH which is contrary to private healthcare and many first world healthcare systems where

optimised and accurate discharge coding, which is used to calculate billing, equates to significant revenue for hospitals[11].

8. Lack of regular complete administrative data auditing.

While it may be that many of these reasons were responsible in the present study to varying degrees and that many of them were related, however, the lack of adequately trained and dedicated clerical coding staff should be considered as a significant contributor to the poor results. Previous studies showing good administrative data validity and consistency have suggested the dedicated expert coders employed in these settings as the primary reason for their good results[1, 18, 19]. The results also echo those noted in the few other developing nation studies available which have reported administrative data to be significantly poorer than those in developed nation studies[20, 21].

Limitations

Our study has several limitations. Firstly, as a single-site study at a teaching paediatric hospital our sample was not a representative sample of all hospitals in the country and also because administrative data quality may vary across hospitals and countries, generalisability of our findings to other settings is limited. However, we believe that despite this limitation, our study has value in highlighting the phenomenon of poor discharge coding reliability in similar settings and in raising awareness and caution when considering the use of these data for important applications.

Secondly, we used medical record data as the source material for our PI reference standard to evaluate only the reliability of ICD-10 administrative data. Our study was

not powered to assess the validity of the administrative diagnostic data (i.e. whether the condition was truly present in a patient or not). The validity depends much more strongly on the clinical acumen of treating medical practitioners and the quality of their documentation.

Thirdly, we used only one individual principal investigator who had no formal training in discharge coding to abstract and code the data from each chart. As part of quality control an expert physician abstracted data from a sample of the medical records and EP-PI agreement examined. Disagreements in the quality control were discussed and common pitfalls were considered in the final coding process.

Finally, confirming the primary source of the error responsible for the poor administrative data reliability is technically difficult in a retrospective folder review and our study could not adequately address this. Studies have shown a clear link between poorly documented medical notes and poor administrative data discharge record reliability[1, 9]. We made a subjective comment regarding coding difficulty for each folder although we had not specified whether difficulty was due to poor documentation or case complexity. However, administrative data reliability remained equally poor even when re-analysed with the challenging folders excluded. Furthermore, even if error in ICD-10 diagnostic coding was disregarded, the overall administrative data coding was still uniformly sparse and under-coded versus the PI folder abstraction. The PI-EP comparison showed similar detail and completeness in diagnostic coding with high median total diagnoses per patient with good overall agreement which improved when ordering was disregarded and was near perfect to a 3-character specificity. Given these points, while medical note documentation may be

a contributing factor, it seems unlikely to be the prime source of poor reliability in our study.

The clerical staff at RCWMCH do not review the medical notes when coding into Clinicom®. This is partly because it would be far too laborious and time-consuming a task given the staff constraints and more importantly because many do not have medical backgrounds or adequate training in diagnostic coding. They rely on the admission sheets (short stay) and/or ward admission books for a diagnosis and also discharge summaries when available. The admission sheets and books generally include a presumptive primary diagnosis and little in the way of secondary diagnoses and the discharge summaries may be variable in their quality. We recommend further research geared toward confirming the primary sources of error contributing to the poor data reliability.

Recommendations

If resources where unlimited a wide array of interventions could be easily implemented which would likely have a significantly positive impact on the quality of administrative data. Good literature and evidence exists to advise and guide interventions that have been shown to improve results. However, the reality of limited resources in our setting dictates that the key to improvement lies in implementing cost effective measures that collectively have a positive impact on data quality.

1. *Improvement to discharge summary preparation*

   The most junior medical staff members (e.g. interns, junior medical officers) are often responsible for preparing discharge summaries. They do, however,

have a background in clinical medicine and are more familiar with medical terminology terms than non-medical ward staff. This will strengthen their ability to understand the documentation and code more accurately. Junior medical staff members have usually been involved in the management of these patients, which provides further insight into each case. We would encourage that discharge summaries be typed to improve legibility and that ICD discharge codes be included with each discharge diagnosis list in the summary by using the WHO ICD-10 coding books or online applications available as we have for our study. This improvement to the discharge summaries should help the non-medical ward clerk staff to enter reliable data *at discharge* into the hospital information system.

2. *Senior staff involvement*

   We would also encourage senior staff (e.g. senior registrars, consultants, nurse unit managers) to become more actively involved in supervising discharge summaries. This may include activities such as regular discharge summary meetings, consultants being responsible for the final sign-off of each discharge summary and also providing consistent encouragement to all ward staff on the importance of discharge preparation and discharge coding.

3. *Auditing*

   Regular auditing of discharge coding reliability is recommended to assess baseline reliability and track the impact of interventions. These auditing interventions are ideal projects for junior medical staff to embark upon and can be assigned regularly on a rotating basis. The audits will add valuable content to their respective curriculum vitaes and will further improve their understanding on health informatics and the importance of reliable

administrative data.

4. *Practical health informatics training*

   Some consideration should be given to including some elements on health informatics in the curriculum for medical students at medical school and teaching hospitals[9, 20]. Providing access and facilitating and completion of the free WHO ICD online training course[22] for junior medical staff as well as non-medical ward clerk staff is also recommended.

More costly recommendations include the following:

1. *Employing dedicated and adequately trained coding staff*

   This intervention has the most evidence for sustainable success after implementation. As a starting point, managers and policy-makers could also consider investing in education and training packages for any of their current staff that are responsible for discharge coding.

2. *Employing dedicated case managers*

   The inclusion of dedicated case managers for departments with a high burden of complex patients will help streamline and improve not only the quality of discharge preparation (and electronic documentation) but also the overall co-ordination of care during admission and post discharge, especially for those patients who have challenging multi-disciplinary needs.

3. *Electronic Medical Record*

   The investment in a high quality and fully realized Electronic Medical Record (EMR) (e.g. Epic), which combines clinical note documentation, investigation ordering, results viewing, medication prescription, discharge documentation and more into a single integrated software package. Unfortunately, these

packages are often extremely expensive to implement and are out of reach for most state funded health facilities for the foreseeable future. In the meantime, where the technology exists, we could encourage and support the 2017 implementation of the web-based electronic Continuity of Care Records (eCCR) project by the local provincial Department of Health as a first step toward a paperless future.

Finally, we encourage additional research that includes larger samples and varying health care facilities to help in obtaining a more complete picture on the state of ICD discharge coding quality.

2.6 Conclusions

Our study has demonstrated poor agreement between discharge diagnostic coding in the hospital electronic administrative database and those abstracted directly from medical folders for paediatric general medical and short-stay ward admissions at RCWMCH. These results should caution against the use of administrative discharge data as an information resource for any administrative or research purposes. We have suggested possible explanations for the poor reliability and have made several recommendations to improve the quality of discharge coding in administrative data. We have also encouraged regular assessments and audits of discharge coding across various medical departments and healthcare facilities in similar resource limited settings to assess baseline quality, increase awareness and track trends and response to interventions.

2.7 List of Abbreviations

CI: Confidence interval

eCCR: Electronic Continuity of Care Record

EMR: Electronic Medical Record

EP: Expert physician

HF: Heart failure

HIS: Hospital Information System

HIV: Human immunodeficiency virus

ICD: International Classification of Diseases

IQR: Interquartile range

MI: Myocardial infarction

PI: Principal investigator

RCWMCH: Red Cross War Memorial Children's Hospital

SD: Standard deviation

UCT: University of Cape Town

WHO: World Health Organisation

2.8 Declarations

Ethics approval and consent to participate

Ethical approval to conduct this study was obtained from the Human Research Ethics Committee (HREC REF: 021/2017) and the RCWMCH Administration who further provided consent on the patients' behalf, as this was a retrospective folder review. The study was also conducted in accordance with the Declaration of Helsinki, 2013. No identifying data were used in our password-protected electronic database.

Consent for publication

Not applicable.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors wish to declare no conflicts of interest.

Funding

Nil

Authors' contributions

AD performed the data collection and was the primary contributor in writing the manuscript. HB contributed editing and supervision to the writing of the manuscript

as well as performing data collection for the quality control section. RM was the primary contributor to the statistical analysis of the data and also contributed to the writing of the manuscript. LM contributed editing and supervision to the writing of the manuscript.

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Finally, thanks to all my colleagues for their hard work, passion and team spirit.

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Appendices

Appendix 1: Folder Review Data Collection Sheet

Patient Identifiers				
Medical Record Number				
Gender	Male		Female	
Date of Birth/Age				
	Diagnosis		**ICD-10**	
Primary Diagnosis				
Secondary Diagnosis 1				
Secondary Diagnosis 2				
Secondary Diagnosis 3				
Secondary Diagnosis 4				
Secondary Diagnosis 5				
Secondary Diagnosis 6				
Secondary Diagnosis 7				
Secondary Diagnosis 8				
Secondary Diagnosis 9				
Total Secondary Diagnoses				
Total Diagnoses				
Additional Information				
Coding Difficulty	Not difficult		Difficult	
HIV Status (admission)	Positive	Negative	Exposed	Unknown
HIV Status (discharge)	Positive	Negative	Exposed	Unknown
HIV Tested	Yes		No	
Length Of Stay (Days)				

Some of the appendices were removed to avoid exposing authorities' signature

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI),and Declaration of Helsinki (2013) guidelines.
The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC:021/2017

Appendix 4: BMC Paediatrics Submission Guidelines

Research article

Criteria

Research articles should report on original primary research, but may report on systematic reviews of published research provided they adhere to the appropriate reporting guidelines which are detailed in our editorial policies. Please note that non-commissioned pooled analyses of selected published research will not be considered.

BMC Pediatrics strongly encourages that all datasets on which the conclusions of the paper rely should be available to readers. We encourage authors to ensure that their datasets are either deposited in publicly available repositories (where available and appropriate) or presented in the main manuscript or additional supporting files whenever possible. Please see Springer Nature's information on recommended repositories. Where a widely established research community expectation for data archiving in public repositories exists, submission to a community-endorsed, public repository is mandatory. A list of data where deposition is required, with the appropriate repositories, can be found on the Editorial Policies Page.

Preparing your manuscript

The information below details the section headings that you should include in your manuscript and what information should be within each section.

Please note that your manuscript must include a 'Declarations' section including all of the subheadings (please see below for more information).

Title page

The title page should:

- present a title that includes, if appropriate, the study design e.g.:
    - "A versus B in the treatment of C: a randomized controlled trial", "X is a risk factor for Y: a case control study", "What is the impact of factor X on subject Y: A systematic review"
    - or for non-clinical or non-research studies a description of what the article reports
- list the full names, institutional addresses and email addresses for all authors
    - if a collaboration group should be listed as an author, please list the Group name as an author. If you would like the names of the individual members of the Group to be searchable through their individual PubMed records, please include this information in the "Acknowledgements" section in accordance with the instructions below
- indicate the corresponding author

Abstract

The Abstract should not exceed 350 words. Please minimize the use of abbreviations and do not cite references in the abstract. Reports of randomized controlled trials should follow the CONSORT extension for abstracts. The abstract must include the following separate sections:

- **Background:** the context and purpose of the study
- **Methods:** how the study was performed and statistical tests used
- **Results:** the main findings
- **Conclusions:** brief summary and potential implications
- **Trial registration:** If your article reports the results of a health care intervention on human participants, it must be registered in an appropriate registry and the registration number and date of registration should be in stated in this section. If it was not registered prospectively (before enrollment of the first participant), you should include the words 'retrospectively registered'. See our editorial policies for more information on trial registration

Keywords

Three to ten keywords representing the main content of the article.

Background

The Background section should explain the background to the study, its aims, a summary of the existing literature and why this study was necessary or its contribution to the field.

Methods

The methods section should include:

- the aim, design and setting of the study
- the characteristics of participants or description of materials
- a clear description of all processes, interventions and comparisons. Generic drug names should generally be used. When proprietary brands are used in research, include the brand names in parentheses
- the type of statistical analysis used, including a power calculation if appropriate

Results

This should include the findings of the study including, if appropriate, results of statistical analysis which must be included either in the text or as tables and figures.

Discussion

This section should discuss the implications of the findings in context of existing research and highlight limitations of the study.

Conclusions

This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study reported.

List of abbreviations

If abbreviations are used in the text they should be defined in the text at first use, and a list of abbreviations should be provided.

Declarations

All manuscripts must contain the following sections under the heading 'Declarations':

- Ethics approval and consent to participate
- Consent for publication
- Availability of data and material
- Competing interests
- Funding
- Authors' contributions
- Acknowledgements
- Authors' information (optional)

Please see below for details on the information to be included in these sections.

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable' for that section.

Ethics approval and consent to participate

Manuscripts reporting studies involving human participants, human data or human tissue must:

- include a statement on ethics approval and consent (even where the need for approval was waived)
- include the name of the ethics committee that approved the study and the committee's reference number if appropriate

Studies involving animals must include a statement on ethics approval.

See our editorial policies for more information.

If your manuscript does not report on or involve the use of any animal or human data or tissue, please state "Not applicable" in this section.

Consent for publication

If your manuscript contains any individual person's data in any form (including individual details, images or videos), consent for publication must be obtained from that person, or in the case of children, their parent or legal guardian. All presentations of case reports must have consent for publication.

You can use your institutional consent form or our consent form if you prefer. You should not send the form to us on submission, but we may request to see a copy at any stage (including after publication).

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If your manuscript does not contain data from any individual person, please state "Not applicable" in this section.

Availability of data and materials

All manuscripts must include an 'Availability of data and materials' statement. Data availability statements should include information on where data supporting the results reported in the article can be found including, where applicable, hyperlinks to publicly archived datasets analysed or generated during the study. By data we mean the minimal dataset that would be necessary to interpret, replicate and build upon the findings reported in the article. We recognise it is not always possible to share research data publicly, for instance when individual privacy could be compromised, and in such instances data availability should still be stated in the manuscript along with any conditions for access.

Data availability statements can take one of the following forms (or a combination of more than one if required for multiple datasets):

- The datasets generated and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS]
- The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
- All data generated or analysed during this study are included in this published article [and its supplementary information files].
- The datasets generated and/or analysed during the current study are not publicly available due [REASON WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.
- Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.
- The data that support the findings of this study are available from [third party name] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [third party name].

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Hao Z, AghaKouchak A, Nakhjiri N, Farahmand A. Global integrated drought monitoring and prediction system (GIDMaPS) data sets. figshare. 2014. http://dx.doi.org/10.6084/m9.figshare.853801

With the corresponding text in the Availability of data and materials statement:

The datasets generated during and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS].[Reference number]

Competing interests

All financial and non-financial competing interests must be declared in this section.

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Please use the authors initials to refer to each author's competing interests in this section.

If you do not have any competing interests, please state "The authors declare that they have no competing interests" in this section.

Funding

All sources of funding for the research reported should be declared. The role of the funding body in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript should be declared.

Authors' contributions

The individual contributions of authors to the manuscript should be specified in this section. Guidance and criteria for authorship can be found in our editorial policies.

Please use initials to refer to each author's contribution in this section, for example: "FC analyzed and interpreted the patient data regarding the hematological disease and the transplant. RH performed the histological examination of the kidney, and was a major contributor in writing the manuscript. All authors read and approved the final manuscript."

Acknowledgements

Please acknowledge anyone who contributed towards the article who does not meet the criteria for authorship including anyone who provided professional writing services or materials.

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Endnotes

Endnotes should be designated within the text using a superscript lowercase letter and all notes (along with their corresponding letter) should be included in the Endnotes section. Please format this section in a paragraph rather than a list.

References

All references, including URLs, must be numbered consecutively, in square brackets, in the order in which they are cited in the text, followed by any in tables or legends. The reference numbers must be finalized and the reference list fully formatted before submission.

Examples of the BioMed Central reference style are shown below. Please ensure that the reference style is followed precisely.

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Web links and URLs: All web links and URLs, including links to the authors' own websites, should be given a reference number and included in the reference list rather than within the text of the manuscript. They should be provided in full, including both the title of the site and the URL, as well as the date the site was accessed, in the following format: The Mouse Tumor Biology Database. http://tumor.informatics.jax.org/mtbwi/index.do. Accessed 20 May 2013. If an author or group of authors can clearly be associated with a web link (e.g. for blogs) they should be included in the reference.

Example reference style:

Article within a journal
Smith JJ. The world of science. Am J Sci. 1999;36:234-5.

Article within a journal (no page numbers)
Rohrmann S, Overvad K, Bueno-de-Mesquita HB, Jakobsen MU, Egeberg R, Tjønneland A, et al. Meat consumption and mortality - results from the European Prospective Investigation into Cancer and Nutrition. BMC Med. 2013;11:63.

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Slifka MK, Whitton JL. Clinical implications of dysregulated cytokine production. Dig J Mol Med. 2000; doi:10.1007/s801090000086.

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