Effect of discharge letter-linked diagnosis registration on data quality

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Abstract

Objective. Diagnostic data are essential for the assessment of medical practice: they are needed for retrieval of clinical cases and describing co-morbidity and complications. In most Western countries, diagnosis registration in hospital information systems is based mainly on completing forms after patient discharge. As this registration plays no role in patient care, data quality is usually unsatisfactory. To improve data quality, we redesigned the process of diagnosis registration at a paediatric department, and now paediatricians provide diagnoses with codes in a separate registration heading of the discharge letter. We compared the quality of this discharge letter-linked diagnosis registration with the quality of the previous form-based registration.

Design. Retrospective study with blinded before and after measurement. Re-abstracted diagnosis descriptions of the text of discharge letters were taken as gold standard.

Setting. A paediatric department in an academic medical centre.

Study participants. From each registration period, 60 admissions were selected randomly. Mean age of the patients was 4.5 (SD = 5.5) and 5.2 (SD = 5.2) years for the old and new situation respectively. Mean length of stay was 8.8 (SD = 11.0) and 7.2 (SD = 12.4) days.

Intervention. Discharge letter-linked diagnosis registration.

Main outcome measures. Completeness and accuracy, both at three-digit level of ICD-9-CM.

Results. Completeness of form-based diagnosis registration was 51% (95% CI, 44–58%) and of discharge letter-linked diagnosis registration 54% (95% CI, 47–60%). Accuracy was 65% (95% CI, 58–72%) and 67% (95% CI, 60–74%) respectively.

Conclusions. The discharge letter-linked diagnosis registration does not provide a better basis for assessment of medical practice than the form-based diagnosis registration.

Keywords: abstracting and indexing, data collection, diagnosis, patient discharge, paediatrics, quality assurance

An important method of improving quality of care within hospitals is assessment of medical care for patient groups [1]. When using a hospital information system (HIS) for assessment [2–4] the recorded diagnostic data must be of high quality [5,6] in order to retrieve cases [7–11] and describe co-morbidity and complications [5,12–17]. Diagnostic data form the framework within which the care provided can be assessed.

Important aspects of diagnostic data quality are completeness and accuracy. Completeness is the proportion of true diagnoses that are recorded; accuracy is the proportion of recorded diagnoses that are true. When retrieving cases, incompleteness leads to false negatives and inaccuracy leads to false positives. Specificity and timeliness also determine usefulness of diagnostic data for assessment. Specificity is the proportion of accurately recorded diagnoses that contain all available diagnostic information and timeliness is the time interval between recognizing and recording diagnoses.

Stimulated by the institution of the Dutch Quality of Health Care Institutions Act [18], paediatricians of the Academic Medical Center (AMC), Amsterdam, decided to assess their medical practice using routinely collected patient data [19]. The AMC is a university hospital and the paediatric department consists of 155 beds. A general feeling of unease arose among the paediatricians about current diagnostic data quality. As in most Western hospitals, collecting diagnostic data in the AMC is based on forms, completed by physicians, after patient discharge. Subsequently, medical record coders...
encode the diagnosis descriptions according to ICD-9-CM and record codes in HIS. The paediatricians stated that this procedure negatively influences data quality. First, the diagnostic data do not play a role in daily patient care. This leads to a situation in which completing discharge-forms is not given high priority. Second, medical record coders are unaware of additional diagnostic facts that might influence selection of appropriate codes.

Studies in several countries show that completeness of routinely collected diagnostic data in hospitals varies from 0.50 to 0.90 [10,11,20–38] and accuracy from 0.30 to 0.95 [9–11,20–26,28–33,35–52]. These results depend on study design, registration use and registration process.

Because of differences in study design, comparability is limited. Some studies use a disease-specific registry as gold standard [20,22,28–30,32], other studies use medical records, re-abstracted or not. Some studies are limited to one disease [20,22,28,29,31,33,36,37,39,42–45,52] whereas others take a broader domain. Differences are also found in setting, limitation of diagnostic categories, and operational definition of completeness and accuracy. It seems that a disease-specific registration as gold standard [20,22,28–30,32] and a limitation to severe diseases and principal diagnosis [24] lead to better diagnostic data quality. When diagnostic data are used for financial compensation, data quality is higher than without this use, but problems still remain [53,54].

Notable is that ‘principal diagnosis’, ‘secondary diagnosis’, ‘complications’ and ‘nature of injury’ are recorded, but no study mentions ‘reason for admission’. However, for assessment of medical practice ‘reason for admission’ is of particular importance because medical activities should also be judged from this perspective.

Some studies were limited to the measurement of accuracy [11,39,42,44]. In these studies, cases were retrieved based on specific ICD-9-CM codes and then compared with the gold standard. In this sort of study completeness cannot be measured. However, accuracy without completeness is of no use in assessing data quality. Specificity is almost never measured or is implicitly part of accuracy [41]. Timeliness is never measured.

Many studies conclude that form-based diagnostic discharge data should not be used, or should be used with great caution, for quality of care measurement. Several suggestions have been formulated on how to improve data quality, such as systematic audit of data quality [20,24,41,42], information feedback to physicians [21] and education of physicians [20,22,42]. However, few intervention studies comparing different registration procedures have been performed. Yeoh [38] implemented physician encoding at a paediatric department. Accuracy increased from 0.54 to 0.85. Hohnloser [27] implemented computer-based registration in daily care process at an intensive/critical care unit; here, completeness increased from 0.48 to 0.82. However, the method was not fully appropriate as no gold standard was used: numbers of codes were compared with numbers of diagnoses in the discharge summary.

To improve data quality at the paediatric department of the AMC, we redesigned diagnosis registration. After implementation in routine practice we tested our hypothesis that integration of diagnosis registration with communication about patients, combined with physician encoding, improves completeness, accuracy, specificity and timeliness of diagnostic data.

Methods

An intervention study was performed with blinded before and after measurement.

Intervention

The old situation is described in the introduction and reported graphically in Figure 1a. The new situation is reported in Figure 1b. In this situation paediatricians themselves encode diagnoses. After discharge, standardized descriptions of diagnoses with codes are reported in a medical registration heading at the bottom of the discharge letter. This letter plays an important role in communication between paediatrician and general practitioner. Besides ‘principal diagnosis’, ‘secondary diagnosis’, ‘complications’ and ‘nature of injury’, ‘reason for admission’ is recorded. The letter with this heading is checked by one medical record coder and one supervisor. In order to support paediatricians, a paediatric diagnosis booklet has been developed in close consultation with the paediatricians. This booklet has an alphabetical list of selected and further specified ICD-9-CM codes with descriptions. Six digits are available for a code. This means that compared with ICD-9-CM, one to three digits are available for local extensions.

In two meetings, paediatricians and residents were instructed. During the first months after introduction, regular deliberations between medical record coder and paediatricians took place. Furthermore, electronic versions of the letters were made available on the Intranet. Consequently the new registration facilitates patient information retrieval in case of readmission. A mechanism was implemented to remind paediatricians to write discharge letters within 6 weeks, which is policy in the AMC. Participating specialties were general paediatrics and seven paediatric subspecialties (Table 1). The new registration started on February 1, 1995. Up to the time of writing approximately 7000 discharge letters in the new style have been produced.

Case selection

We estimated both completeness and accuracy in the old situation to be 0.65. In order to use data for medical practice assessment we judged that completeness and accuracy should be at least 0.90. With a power of 0.80 52 cases per group would be needed to demonstrate this meaningful difference [55]. We randomly selected 60 admissions with discharge dates between September and December 1994 (sample ’94) and 60 admissions with discharge dates between September and December 1995 (sample ’95) with electronic versions of the discharge letter. By choosing ‘September to December’ for both registrations, seasonal influences were avoided.
The sampling frame consisted of admissions with only one responsibility period for which one of the participating subspecialties bore responsibility. A responsibility period is a period during which one medical specialty carries the principal responsibility for medical care. Registration of diagnoses takes place after every period of responsibility.

**Data collection**

For each case selected the following data were collected: patient's age and sex, length of stay, number of words in discharge letter, whether the letter was written by pediatrician or resident, responsible subspecialty, admission day and diagnosis codes in HIS with category indication.

**Gold standard**

The text of the discharge letter was basis for the gold standard. In the electronic versions of the letters of 1995 we antedated all dates by 1 year and removed the medical registration heading for blinding. One paediatrician marked parts of the text referring to relevant diagnoses. The paediatrician also stated to what category (reason for admission, principal diagnosis, secondary diagnosis, or complication) each diagnosis belonged. Rules for diagnosis marking were formulated (Figure 2).

One blinded expert medical record coder checked whether every diagnosis had been recorded in HIS and whether diagnosis code in HIS could be recognized in the corresponding letter. Rules were formulated for the expert coder (Figure 3): first he coded the marked diagnosis descriptions twice – once according to the list of locally extended codes available in 1994 and once according to the list available in 1995. HIS codes were already presented on the evaluation forms. Then, for every admission the coder matched, at the 3-digit level of ICD-9-CM, his own codes with HIS codes. Alternative codes could be correct. If there was a match, the coder checked whether the match was also true at 6-digit level of ICD-9-CM and whether diagnostic category was correctly indicated in HIS.

**Measures**

We made operational and formalized quality aspects described in the Introduction as follows: **Completeness** is the proportion of marked diagnoses in discharge letters that, at 3-digit level of ICD-9-CM, are coded in the corresponding admission records of HIS.

\[
\text{Completeness (cat)} = \frac{\sum_{i=1}^{n} |D_{\text{cat}}(i) \cap D_{\text{cat}}(i)|}{|D_{\text{cat}}(i)|}
\]

where:

\text{ALL\_CATEGORIES=\{reason\_for\_admission, principal\_diagnosis, secondary\_diagnosis, complication\}}

\text{cat \subseteq ALL\_CATEGORIES}

Figure 1  (a) Form-based diagnosis registration. (b) Discharge letter-linked diagnosis registration.
1. Read letter.
2. Read letter again and mark relevant diagnoses.
3. Indicate per diagnosis whether it is reason_for_admission, principal_diagnosis, secondary_diagnosis or complication.
4. The following definitions and procedures apply:
   **Reason_for_admission:** Diagnosis, symptom, sign or injury that, at admission day, was considered as reason_for_admission.
   **Procedure:** Code one diagnosis as reason_for_admission with ‘R’. If more than one reason_for_admission, indicate also most important. Reason_for_admission may also be principal_diagnosis.
   **Principal_diagnosis:** Diagnosis that, at discharge, is most important reason for treatment.
   **Procedure:** Code one diagnosis as principal_diagnosis with ‘P’. It is allowed that a diagnosis is reason_for_admission (‘R’) and principal_diagnosis (‘P’).
   **Secondary_diagnosis:** Every relevant diagnosis other than reason_for_admission, principal_diagnosis or complication.
   **Procedure:** Code up to five diagnoses as secondary_diagnosis with ‘S’. If more than five secondary diagnoses, indicate five most important.
   **Complication:** Diagnosis that developed as result of hospital stay or received treatment.
   **Procedure:** Code up to three diagnoses as complication with ‘C’. If more than three complications, indicate three most important. Handle definition strictly. In case of doubt choose secondary_diagnosis.

Figure 2 Rules for diagnosis marking by paediatrician.

1. Read letter.
2. Code every marked diagnosis description as specifically as possible: once according to the list of locally extended codes available in 1994, and once according to the list available in 1995.
3. Check correctness of HIS codes by comparing them with your own codes at 3-digit level of ICD-9-CM. If correct, tick the appropriate HIS code on evaluation form. Alternative codes may also be correct!
4. If answer in 3 is true, check specificity of every code in HIS at 4- to 6-digit level: for 1994 and for 1995.
5. Check whether faults have been made at 4- to 6-digit level.
6. Check whether HIS code was classified in the correct category.
7. If HIS codes on evaluation form not ticked but letter consists of diagnostic information compatible with code, mark relevant text and copy text to evaluation form: repeat rules 2 to 6.

Figure 3 Rules for checking diagnoses by expert medical record coder.

\[ D_i(\text{cat}) := \text{set of diagnosis codes obtained by re-coding the marked diagnosis descriptions that belong to cat in discharge letter of admission } i \text{, e.g. } D_i(\text{reason_for_admission}) \text{ is the set of diagnosis codes obtained by re-coding the marked reason for admission descriptions of admission } i \]  

\[ C_i := \text{set of diagnosis codes in HIS record of admission } i \]  

\[ \ell : \text{function that returns a set of 3-digit level ICD-9-CM codes, e.g. } \ell(\{786.010, 490.000\}) = \{786, 490\} \]  

\|S\| := \text{number of elements in set } S, \text{ e.g. } |\{786.010, 490.000\}| = 2 \]  

**Accuracy** in the proportion of diagnosis codes in HIS that, at 3-digit level of ICD-9-CM, have matching diagnosis descriptions in corresponding discharge letters.  

\[ \text{Accuracy}(\text{cat}) = \sum_{i=1}^{w} \frac{\|D_i(\text{cat})\cap \ell(C_i(\text{cat}))\|}{|C_i(\text{cat})|} \]  

where:  

\[ D_i := \text{set of diagnosis codes obtained by re-coding marked diagnosis descriptions in discharge letter of admission } i \]  

\[ C_i := \text{set of diagnosis codes that belong to cat in HIS record of admission } i, \text{ e.g. } C_i(\text{reason_for_admission}) \text{ is the set of reason for admission codes in HIS record of admission } i \]  

\[ C_i(\text{ALL_CATEGORIES}) := \text{set of all diagnosis codes in HIS record of admission } i \]  

**Specificity** is the proportion of accurate HIS codes that contain, as far as possible with the local 6-digit codes, all additional diagnostic information in text of corresponding discharge letters.
### Table 1 Patient and admission characteristics of selected cases

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample ’94 ($n=60$)</th>
<th>Sample ’95 ($n=60$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years ± SD)</td>
<td>4.5 ± 5.5</td>
<td>5.2 ± 5.2</td>
</tr>
<tr>
<td>Sex: male/female</td>
<td>30/30</td>
<td>37/23</td>
</tr>
<tr>
<td>Mean length of stay (days ± SD)</td>
<td>8.8 ± 11.0</td>
<td>7.2 ± 12.4</td>
</tr>
<tr>
<td>Mean number of words/letter (± SD)</td>
<td>528.4 ± 289.0</td>
<td>472.8 ± 199.9</td>
</tr>
<tr>
<td>Number of letters written by (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paediatrician</td>
<td>2 (3)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Resident</td>
<td>58 (97)</td>
<td>56 (93)</td>
</tr>
<tr>
<td>Number in subspeciality (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General paediatrics</td>
<td>38 (63)</td>
<td>37 (62)</td>
</tr>
<tr>
<td>Paediatric gastro-enterology</td>
<td>7 (12)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Paediatric nephrology</td>
<td>6 (10)</td>
<td>8 (13)</td>
</tr>
<tr>
<td>Paediatric hematology and immunology</td>
<td>4 (6)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Paediatric pulmonology</td>
<td>4 (6)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Paediatric metabolic disorders</td>
<td>1 (2)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Paediatric cardiology</td>
<td>0 (0)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Paediatric endocrinology</td>
<td>0 (0)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Number of admissions per day (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>6 (10)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Sunday</td>
<td>1 (2)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Monday</td>
<td>9 (15)</td>
<td>7 (12)</td>
</tr>
<tr>
<td>Tuesday</td>
<td>12 (20)</td>
<td>15 (25)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>11 (18)</td>
<td>10 (17)</td>
</tr>
<tr>
<td>Thursday</td>
<td>14 (23)</td>
<td>11 (18)</td>
</tr>
<tr>
<td>Friday</td>
<td>7 (12)</td>
<td>9 (15)</td>
</tr>
</tbody>
</table>

**Statistical analysis**

To compare patient and admission characteristics, we used $z$- and $t$-tests with continuity correction for dichotomous variables and continuous variables, respectively. The $z$-test was also used to compare results of both registrations. The $\chi^2$ test was used to compare both groups with regard to day of admission and treating specialty. The Mann–Whitney test was used to compare age and length of stay.

**Results**

**Case selection**

From participating specialties, 512 patients were discharged from September to December 1994. Of these admissions, 470 (92%) had one responsibility period with a mean of 2.57 (SD ± 0.98) diagnoses in HIS. To select 60 admissions with electronic discharge letters, we had to retrieve randomly 173 admissions. From September to December 1995, the participating specialties discharged 582 patients. Of these admissions, 535 (92%) had one responsibility period with a mean of 2.87 (SD ± 1.29) diagnoses in HIS. To select 60 admissions, 173 admissions.
Table 2 Number of diagnoses in discharge letters and HIS

<table>
<thead>
<tr>
<th>Diagnostic category</th>
<th>Number of diagnoses (mean)</th>
<th>Sample '94 (n = 60)</th>
<th>Sample '95 (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Letters</td>
<td>HIS</td>
<td>Letters</td>
</tr>
<tr>
<td>All categories</td>
<td>209 (3.48)</td>
<td>165 (2.75)</td>
<td>221 (3.68)</td>
</tr>
<tr>
<td>Reason for admission</td>
<td>60 (1.00)</td>
<td>60 (1.00)</td>
<td>60 (1.00)</td>
</tr>
<tr>
<td>Principal diagnosis</td>
<td>60 (1.00)</td>
<td>60 (1.00)</td>
<td>60 (1.00)</td>
</tr>
<tr>
<td>Secondary diagnosis</td>
<td>89 (1.48)</td>
<td>45 (0.75)</td>
<td>101 (1.68)</td>
</tr>
</tbody>
</table>

Table 3 Completeness of diagnosis registrations

<table>
<thead>
<tr>
<th>Diagnostic category in discharge letter</th>
<th>Completeness diagnosis registration (95% CI)</th>
<th>Sample '94 (n = 60)</th>
<th>Sample '95 (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Form-based)</td>
<td>(Discharge letter-linked)</td>
</tr>
<tr>
<td>All categories</td>
<td>107/209 = 0.51 (0.44–0.58)</td>
<td>119/221 = 0.54 (0.47–0.60)</td>
<td></td>
</tr>
<tr>
<td>Reason for admission</td>
<td>35/60 = 0.58 (0.45–0.71)</td>
<td>34/60 = 0.57 (0.43–0.69)</td>
<td></td>
</tr>
<tr>
<td>Principal diagnosis</td>
<td>37/60 = 0.62 (0.48–0.74)</td>
<td>40/60 = 0.67 (0.53–0.78)</td>
<td></td>
</tr>
<tr>
<td>Secondary diagnosis</td>
<td>35/89 = 0.39 (0.29–0.50)</td>
<td>45/101 = 0.45 (0.35–0.54)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 Accuracy of diagnosis registrations

<table>
<thead>
<tr>
<th>Diagnostic category in HIS</th>
<th>Accuracy diagnosis registration (95% CI)</th>
<th>Sample '94 (n = 60)</th>
<th>Sample '95 (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Form-based)</td>
<td>(Discharge letter-linked)</td>
<td></td>
</tr>
<tr>
<td>All categories</td>
<td>107/165 = 0.65 (0.58–0.72)</td>
<td>119/177 = 0.67 (0.60–0.74)</td>
<td></td>
</tr>
<tr>
<td>Reason for admission</td>
<td>35/60 = 0.58 (0.45–0.71)</td>
<td>36/60 = 0.60 (0.47–0.72)</td>
<td></td>
</tr>
<tr>
<td>Principal diagnosis</td>
<td>41/60 = 0.68 (0.55–0.80)</td>
<td>43/60 = 0.72 (0.59–0.83)</td>
<td></td>
</tr>
<tr>
<td>Secondary diagnosis</td>
<td>31/45 = 0.69 (0.53–0.82)</td>
<td>40/57 = 0.70 (0.57–0.82)</td>
<td></td>
</tr>
</tbody>
</table>

admissions with electronic discharge letters, we retrieved randomly 92 admissions.

Patient and admission characteristics

Table 1 shows patient and admission characteristics of the samples. There were no statistically significant differences.

Number of diagnoses in discharge letter and HIS

Table 2 shows the number of marked diagnoses in discharge letters and the number of diagnoses in HIS. Initially, the re-abstractor marked 117 and 104 reasons for admission for sample '94 and sample '95 respectively. However, per admission only the most important reason for admission was taken into account. For both samples, the number of diagnoses in discharge letters was higher than the number in HIS. The difference is explained by the difference in number of secondary diagnoses.

Completeness

Completeness of the two methods of diagnosis registration is presented in Table 3. In the definition used, category indication in the discharge letter and category indication in the HIS are not necessarily the same. If we make this a requirement, the proportions in Table 3 are 0.03 to 0.10 lower. There are no statistically significant differences in completeness between the two methods of registration. Notable is that completeness of 'secondary diagnoses' is lower than completeness of 'reason for admission and principal diagnoses'.

In only 27% (95% CI, 16–40) of the admissions, all marked discharge letter diagnoses were recorded in HIS. This is true for the old and the new method of registration.

Accuracy

Accuracy of diagnosis registrations is given in Table 4. Also in this definition category indication of a diagnosis code in
Table 5  Analysis of inaccurate codes

<table>
<thead>
<tr>
<th>Nature of inaccuracy</th>
<th>Number of inaccurate codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Code from correct chapter of ICD-9-CM, but not consistent with patient’s disease, e.g. acute bronchitis, viral (466.0) instead of viral pneumonia, unspecified (480.9)</td>
<td>17</td>
</tr>
<tr>
<td>2. Code related to patient’s disease, but not justifying patient’s problem, e.g. respiratory malfunction arising from mental factors (306.1) instead of hyperventilation (786.01)</td>
<td>8</td>
</tr>
<tr>
<td>3. Incorrect double recording of code as ‘reason for admission’ and ‘principal diagnosis’</td>
<td>16</td>
</tr>
<tr>
<td>4. Incorrect double recording of code as ‘secondary diagnosis’ and ‘complication’</td>
<td>2</td>
</tr>
<tr>
<td>5. Unnecessary code, e.g. functional digestive disorders, not elsewhere classified (564), while in history slight constipation irrelevant for admission</td>
<td>4</td>
</tr>
<tr>
<td>6. No relationship between code and admission</td>
<td>11</td>
</tr>
<tr>
<td>7. Diagnosis information received too late (special code for this)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
</tr>
</tbody>
</table>

HIS and category indication of corresponding diagnosis in the letter are not necessarily the same. If this demand is made, proportions in Table 4 are 0.03 to 0.09 lower. There are no statistically significant differences between the registrations.

In the form-based as well as in the discharge letter-linked diagnosis registration 58 inaccurate codes were found (Table 5). From perspective of accuracy it is conceivable to denote nature of inaccuracy ‘3’ to ‘5’ (Table 5) as not inaccurate. This leads to overall accuracy of 0.78 (95% CI, 0.72–0.85) for form-based and 0.77 (95% CI, 0.71–0.83) for discharge letter-linked registration. It does not lead to increased completeness. It appeared that most inaccuracies stem from hasty and imprecise completion of the form (in the old situation) or medical registration heading (in the new situation) by paediatricians.

With regard to the form-based diagnosis registration, in 32% (95% CI, 20–45) of the admissions, all diagnosis codes in HIS match with diagnosis descriptions in discharge letters. For discharge letter-linked registration this is 40% (95% CI, 28–54).

Specificity

In Table 6 specificity of both registrations is presented. The form-based registration has higher rates, albeit not statistically significant. Specificity was assessed against possibilities of the list of locally extended codes at the moment of use. For example, a patient had laryngo-tracheo-bronchitis: in 1994, code 490.000 (bronchitis, inclusive tracheobronchitis not otherwise specified) was specific at 6-digit level. In 1995, code 490.002 (laryngo-tracheo-bronchitis) was added to the list. This means that in 1995, code 490.000 was not specific for the patient.

Timeliness

Time interval between discharge and recording diagnosis codes in HIS are presented in Figure 4. The proportion of admissions for which it is true that diagnoses are recorded within 6 weeks after discharge (our definition of timeliness) are 0.47 (95% CI, 0.34–0.60) and 0.53 (95% CI, 0.40–0.66) for form-based and letter-linked registration respectively. However, after 24 weeks all letters were written in the old situation and only 87% in the new situation. This unexpected result can be explained as follows. Before February 1995 letters were either produced soon after discharge or not at all. From February 1995 letters that were not produced soon after discharge, were, due to the reminders, still written after a relatively long interval.

Discussion

Diagnostic data of high quality are essential for the assessment of medical practice. To improve data quality in a hospital information system, we redesigned diagnosis registration at a paediatric department. We compared quality of the discharge letter-linked diagnosis registration to quality of the previous form-based registration. We performed a retrospective study with blinded before and after measurement. Diagnostic information in the text of the discharge letter was taken as gold standard after separate and independent abstraction. At the 3-digit level of ICD-9-CM, completeness of the discharge letter-linked diagnosis registration was 54% (95% CI, 47–60) and accuracy 67% (60–74). This was similar to the previous form-based registration.
Table 6: Specificity of diagnosis registrations

<table>
<thead>
<tr>
<th>Diagnostic category</th>
<th>Specificity diagnosis registration (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample '94 (n=60)</td>
</tr>
<tr>
<td></td>
<td>(Form-based)</td>
</tr>
<tr>
<td>All categories</td>
<td>101/107 = 0.94 (0.88–0.98)</td>
</tr>
<tr>
<td>Reason for admission</td>
<td>32/35 = 0.91 (0.77–0.98)</td>
</tr>
<tr>
<td>Principal diagnosis</td>
<td>40/41 = 0.96 (0.87–1.00)</td>
</tr>
<tr>
<td>Secondary diagnosis</td>
<td>29/31 = 0.94 (0.79–0.99)</td>
</tr>
</tbody>
</table>

Figure 4: Time interval between discharge and recording diagnostic codes.

Study design

For each of the two observation periods 60 admissions were selected, each of the two samples having approximately 200 diagnoses. It is clear that no meaningful improvement occurred.

The selection procedure may have introduced selection bias. In order to identify 60 appropriate cases, far more admissions had to be retrieved from the form-based registration than from the discharge letter-linked registration. In the period of the form-based registration more often a letter was not written after discharge than in the period of the discharge letter-linked registration. However, comparison of both samples on important patient and admission characteristics revealed no relevant differences.

We measured quality of both registrations in cases for which there was an electronic discharge letter available. Quality of both registrations in cases where there were no electronic discharge letters remains unknown, but we think that it is more likely to be worse than better. As the proportion of available discharge letters increased, the overall diagnostic data quality in the new situation is likely to be improved.

We constructed a gold standard by re-abstracting diagnoses descriptions from the text of discharge letters. Because this re-abstracting process is more thorough than routine abstracting process, re-abstracted diagnoses are assumed to be correct [56]. A prerequisite is strict control on re-abstracting, as registration quality is wholly dependent upon validity of the re-abstracted data. We did this by formulating rules for the paediatrician who re-abstracted the diagnoses.

Whether text of discharge letters is a good basis for a gold standard can be discussed. In The Netherlands, the discharge letter is an important tool in communication between medical specialist and the general practitioner, whereas the general practitioner has a pivotal role in patient care. At the department where this study was performed, discharge letter quality has received much attention for many years. The letter gives a complete outline of the admission and has a fixed structure. Apart from the medical registration heading there are no differences between letters of both periods. An advantage of using the discharge letter as the gold standard, over using the paper medical record, is that electronic version of the discharge letter provides opportunities for blinding.

We found no other studies in the literature in which two methods of diagnosis registration were compared and re-abstractor and reviewer were blinded for registration method. Inter-coder variability is a well-known phenomenon [49, 50]. We assumed that the expert reviewer was capable of assessing whether an alternative code was acceptable or not. The rules we made for the review process supported this. It is unlikely that the Hawthorne effect played a role in the study. Paediatricians were not told that the registrations would be evaluated. Moreover, in the included periods no extra attention was given to registration process.

The criterion of matching at 3-digit level of ICD-9-CM is rather crude. An inaccurately recorded code and a true code may both belong to the same group of diseases – e.g., recorded code is 462xxx (acute pharyngitis), but true code is 466xxx (acute bronchitis); both belong to ‘acute respiratory infections’. But it can also mean that recorded and true code belong to completely different groups of diseases, e.g., recorded code is 462xxx, but true code is 458xxx (hypotension). In Table 5 we provide information on the degree of inaccuracy.

Consequences for assessment of medical practice

Patient retrieval based on diagnostic information in HIS will result in false positive and false negative cases. In order to remove irrelevant cases, verification based on medical records or discharge letters is necessary. Afterwards, re-abstracting diagnoses from medical records or discharge letters is important to obtain a valid idea of patients’ diseases. These
verification and re-abstracting activities are time consuming.

In patient retrieval there is typically a trade-off between precision (the proportion of retrieved patients that are relevant) and recall (the proportion of relevant patients retrieved) [57]. Precision is a function of registration accuracy and choice of codes by which patients are retrieved. Recall is a function of registration completeness and choice of codes by which patients are retrieved. When only one disease-specific code is used to retrieve patients, precision will be relatively high and recall will be relatively low. The use of more, disease-related, codes will lead to decreased precision and increased recall.

It is likely that severe cases of a disease are more often coded than mild cases. This means that retrieved patients may not represent the whole group.

**Improving diagnostic data**

In HIS, per admission one ‘reason for admission’ can and must be recorded. During the re-abstracting process it appeared that often more than one reason for admission is relevant, e.g. a complex of signs and symptoms or a list of differential diagnoses. We therefore advocate the possibility to record more than one reason for admission.

Our hypothesis that linking diagnosis registration to the discharge letter would improve registration quality could not be demonstrated. The promise of these data to have a valuable but insufficient condition for high quality data [58].

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**References**


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