Prescribing practice in a Swiss primary and secondary acute care hospital

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Summary

Questions under study: Little is known about the prescribing behaviour of physicians in hospitals. This analysis, using data based on Computerised Physician Order Entry (CPOE), was performed to evaluate prescription patterns, to analyse possible over-prescribing of drugs and to assess the compliance with therapy-guidelines.

Methods: Within a 12 month period, 68 133 prescriptions in three departments were analysed with respect to drug class, duration of therapy, dosage, administration route, patient’s age, patient’s length of stay and number of prescriptions per patient.

Results: On average, each patient received 12 drugs. A steady increase in the number of prescribed drugs can be seen between the age of 20 and 85. The median duration of intravenously administered antibiotics was 4.0 days, the median duration of antibiotic therapy was 9.5 days.

Discussion: On average, patients were taking 5 drugs on a regular basis on admission to hospital. This number was doubled during the hospital stay where patients were prescribed 12 drugs on average. On discharge 6 drugs were prescribed and thus a reasonable reduction was made. Surgical and Internal Medicine wards were using very similar drug classes. Concerning the use of low-molecular-weight heparin, guidelines were widely adhered to whereas proton-pump-inhibitors were prescribed too often and the duration of intravenous antibiotic therapy tended to be too long.

Key words: prescribing pattern; hospitalized patients; acute care hospital; computerized physician order entry CPOE; therapy duration; drug therapy; electronic prescription; medication error

Introduction

In Swiss Healthcare – like in many other healthcare systems – more and more efforts are being made to improve quality, reduce errors and optimise processes in modern patient care. Physicians and nurses are getting accustomed to new electronic tools supporting their daily work. Introducing computerised support is a move towards e-healthcare. The implementation of new electronic tools can support work and offers the opportunity to monitor health professionals’ behaviour and decisions.

Prescription and administration of drugs are the most frequent interventions in healthcare over all. Only little is known about the prescribing practices of hospital physicians. Since only a small portion of hospitals worldwide, as in Switzerland, use computerised support during drug prescription (Computerised Physician Order Entry CPOE) and due to the fact that analysis of handwritten prescriptions is time consuming and difficult to perform, the only information currently available on how Swiss physicians prescribe their drugs is based on data of drug consumption in a particular hospital or in Switzerland in general.

As our wards have been using CPOE for more than 3 years (the first starting in 2002, the last in spring 2005) enough data are available to report a reasonable sample of prescriptions based on our daily work.

There are many reasons for introducing CPOE. According to the literature, about 5% of inpatients suffer from medication errors, many of them caused by incorrect or unclear prescriptions [1]. As demonstrated by several studies, the introduction of CPOE leads to a decrease in medication error rates of as much as 55–80% [2] and furthermore, process optimisation is gained for physicians as well as for nurses [3]. Being the first step in modern medication handling, CPOE also offers an opportunity to check the prescription itself, eg, evaluation of drug-drug-interactions and known allergies, proposals of adapted dose regimens during...
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Materials and methods

Patients and prescriptions

Within a 12 month period, beginning on August 1st 2004 and ending on July 31st 2005, all drug-prescriptions of inpatients were included in the analysis if the drugs were not prescribed as-needed. Given the fact that within the last 3 years all our wards had introduced CPOE into their daily practice, we could analyse the prescriptions in every department. Within our departments we do not subdivide wards with respect to medical specialities: a typical internal-medicine ward covers all possible medical patients as does a surgical ward. The distribution of certain pathologies is assumed to be random amongst the wards within a department. Based on this situation, all prescriptions in every ward were included although 1 surgical and 1 gynaecological ward introduced CPOE during the analysis period (whereas 3 surgical wards and 5 internal medicine wards were already performing CPOE prior to the first day of the examination period).

Exclusion criteria

All prescriptions starting prior to the first day of the study period or not ending before the last day of the study period were excluded as it was not possible to calculate the therapy duration. Furthermore all prescriptions on an as-needed basis were excluded, as well as prescriptions ordered by non-physicians, eg, based on telephone orders or based on drug-removals in the automated medication dispensing system Pyxis® used throughout the hospital. This automated drug dispensing system normally receives all prescriptions from the electronic patient record (EPR) Phoenix®. In case of emergency or in absence of a CPOE, nurses are allowed to remove a drug based on eg, phone-orders by the physician in charge, leading to an automatically generated prescription in the EPR which must then be counter-signed by a physician. As most of these removals without previous prescription are not subsequently used regularly, all of these prescriptions were excluded from the analysis leading to data based on direct prescribing only.

Patients in obstetrics and the intensive care unit ICU were not analysed as CPOE is not performed in these units yet.

Data collection

Based on SQL (structured query language), all available data of prescribed drugs with the above mentioned restrictions were analysed with respect to drug classification, dosage, duration (interval between start and stop date), patient age, length of stay, prescribing physician and department. In addition the medication on admission was compared to the medication on discharge. There were fewer patients analysed than effectively treated in this time period because not every patient was hospitalised on a ward using CPOE and because the length of stay was limited to be above 24 hours.

Diagnoses and guidelines

Data storage of prescriptions and structured diagnoses codes (based on International Classification of Diseases, 10th revision, ICD-10) are made in separate software systems. For this reason a direct match between specific patients’ prescriptions and the correlated ICD-10 code was not made within this study. The same sample of patients analysed for prescribing behaviour was however analysed according to ICD-10 codes. This leads to a limitation on general statements on medication frequency in certain clinical situations. Prescribing behaviour is thus not broken down to specific diagnoses. General guidelines for prevention of venous thromboembolism [4, 5], for prevention of stress ulcers [6] and articles on therapy duration of antibiotics [7–9] were used to compare the results as well as possible with current guidelines.

Results

68 133 prescriptions in a total of 5366 patients were analysed. 93% of internal medicine patients, 62% of surgical patients and 16% of gynaecological patients were analysed. As shown in table 1, median patient age in internal medicine, surgery and gynaecology was 76 years (interquartile range IQR 63–83), 63 years (IQR 46–76) and 51 years (IQR 39–65) respectively; median length of stay was considerably higher in internal medicine inpatients than in surgical inpatients (8 vs. 5 days). Overall, median patient age was 70 (IQR 54–80) years. Table 2 shows the distribution of analysed prescriptions and their origin with regard to the departments. The median number of prescriptions per patient was 12 (IQR 7–17). The median number of prescriptions per patient was 13 (IQR 8–18) in internal medicine inpatients as compared to 10 (IQR 7–15) in surgical inpatients. As mentioned above only 375 gynaecological patients were included: the median number of prescriptions per gynaecological patient was 10 (IQR 5–14). 98% of all analysed patients received orally administered drugs whereas 94% received parenterally administered drugs. Only 16% received drugs for inhalation.

For internal medicine inpatients, the number of drugs patients took on a regular basis on admis-
In general, the number of drugs prescribed on discharge was higher than on admission. Out of 2654 internal medicine patients taking at least one drug on a regular basis on admission, the average number of drugs taken was 5 (IQR 3–8). The number of drugs on discharge was 6 (IQR 4–8). When drugs are included that were to be taken for a limited number of days only, the number of prescribed drugs was 6 (IQR 4–9) as well, and including drugs on an as-needed basis the amount was 7 (IQR 5–10).

Table 3a (Internal Medicine) and 3b (Surgery) show the top 25 drug groups used within the hospital. By far the most prescriptions are made for intravenous fluids or colloids, analgesics (including opiates), low molecular weight heparins, acid suppressing agents, laxatives, diuretics and antihypertensive agents followed by antibiotics and sedatives.

Concerning therapy duration, only a few drugs are of interest. Table 4 shows the median duration of orally administered antibiotics and of intravenous formulations. Over the different antibiotic classes a median duration of 4.0 days (interquartile range IQR 3–5) for an intravenous application and 4.0 days (IQR 2–7) for the oral regimen was observed, resulting in a median total duration of 9.5 days in all patients over all antibiotics regardless of indication and antibiotic in question. No difference was seen between internal medicine or surgical patients. The maximal duration of intravenous formulations frequently reach 30 days in patients with severe infections (e.g., endocarditis, osteomyelitis, hepatic abscess). The results shown in table 4 represent all prescriptions of these drugs; the orally administered drugs are not exclusively correlated with a prior parenteral formulation.

Analysing ICD-10 codes of patients with risk factors concerning venous thromboembolism or gastrointestinal bleeding showed the following results: a total of 731 internal medicine patients with a main diagnosis (ICD-10) of acute respiratory disease (number analysed: 275), congestive heart failure (224, coronary syndromes not included), patients bedridden due to acute neurological disease (152) and those with severe infection (80) were identified, representing 29% of all patients hospitalised within this period. In the same period, 68% of internal medicine patients and 89% of surgical patients receive low molecular weight heparins LMWH for prophylactic reasons (1720 Internal medicine patients, 2256 surgical patients, in total 3976 out of 5366 patients, data not shown in tables).

Analysing the ICD-10 codes concerning the main diagnosis and major stress factors like ICU-care, myocardial infarction, major surgery or se-
vere infections, 850 (14%) patients were identified as being reasonable candidates for prophylactic proton pump inhibitor PPI. In fact 66% of all patients (3564 out of 5366, 1450 internal patients, 2114 surgical patients) received a proton-pump inhibitor for prophylactic reasons (patients with therapeutic use of PPI not included).

### Discussion

Modern drug therapy is defined by many factors including evidence based medicine, guidelines, increasing data on drug-drug-interactions and enzymatic inductions but also increased quality requirements, increased economic pressure on hospitals (especially publicly funded) and new tools to manage medication processes. One of the cornerstones of up-to-date medication-processing is computerized physician order entry CPOE. Several studies have proven the effectiveness of CPOE as compared to traditional paper based orders, not only concerning medication safety but also concerning drug management and process optimisation. Furthermore, CPOE offers the fundamental possibility to analyse current prescribing pattern and to modify prescription itself eg, raising the possibility for expert systems and decision support tools.

Only little is known about the prescribing practices in Swiss hospitals and we do not know if we sufficiently follow therapy guidelines or whether we could improve our prescribing behaviour for equal benefit in patient safety and cost-effectiveness.

A total of 68133 prescriptions for 5366 inpatients, ordered in our hospital within a 12 month period were analysed. The median number of prescribed drugs per patient was 12 (interquartile range IQR 7–17), median patient age regardless of the department where the patients were hospitalised was 70 years (IQR 54–80). Due to the fact that most internal medicine patients are older (median age 76 versus 63 years in surgical), present nearly always as an urgency or emergency and not as planned admissions and by the nature of internal medicine itself, the median number of prescribed drugs is higher in internal medicine patients than in surgical patients (13 versus 10). Between the age groups 20–25 years and 85–90 years there can be seen a constantly increasing median number of prescriptions from 6 to 16 (figure 1), of 0.5 prescription per age-class (5 years) on average.
Apart from the top 5 drug classes, on internal medicine wards diuretics, aspirin-like drugs and ACE-inhibitors are widely used whereas in surgical departments sedatives, hypnotics and laxatives are used more frequently (table 3).

As antibiotics are one of the more expensive drug classes and the risks associated with intravenous application is higher than with oral administration (infection, side effects), there is special interest in the drug-duration and application of antibiotics. Of course the indication for antibiotic treatment and the choice of antimicrobial agent has a great influence on the appropriate duration. Depending on the diagnosis, most guidelines assume that a switch from intravenous to oral antibiotic therapy should in general be possible within 3 days or less [10, 11]. In our setting, the median duration of intravenous application of antibiotics was 4.0 days. As our results are not related to specific diagnoses (further work will be done) and therapies of long duration (eg, endocarditis) are included, the switch from intravenous to oral admin-

<table>
<thead>
<tr>
<th>Table 3b</th>
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<tbody>
<tr>
<td>Top 25 drugs prescribed for 3174 Surgery/Gynaecology patients with number of prescriptions, most frequent trade names (*) and IT code (Index Therapeudicus). As a patient normally receives more than one prescription for each drug class, the total amount of prescriptions exceeds the number of patients analysed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of prescriptions</th>
<th>Most frequent used products by generic names</th>
<th>IT code</th>
</tr>
</thead>
<tbody>
<tr>
<td>5600</td>
<td>Paracetamol</td>
<td>01.01.10</td>
</tr>
<tr>
<td>4336</td>
<td>Saline 0.9%, ringer-lactate, glucose 5%</td>
<td>05.03.20</td>
</tr>
<tr>
<td>2958</td>
<td>Nadroparin</td>
<td>06.03.30</td>
</tr>
<tr>
<td>2836</td>
<td>Morphine, Fentanyl, Phenidin</td>
<td>01.01.30</td>
</tr>
<tr>
<td>2476</td>
<td>Esomeprazol, Omeprazol</td>
<td>04.99.00</td>
</tr>
<tr>
<td>2111</td>
<td>Ondansetron</td>
<td>01.09.00</td>
</tr>
<tr>
<td>1871</td>
<td>Zolpidem, Midazolam, Triazolam</td>
<td>01.03.10</td>
</tr>
<tr>
<td>1137</td>
<td>Sodium-picosulfate, Sodium-dihydrogenophosphate</td>
<td>04.08.11</td>
</tr>
<tr>
<td>930</td>
<td>Amoxicillin, Cotrimoxazol, Piperacillin Tazobactam</td>
<td>08.01.93</td>
</tr>
<tr>
<td>858</td>
<td>Lorazepam</td>
<td>01.04.10</td>
</tr>
<tr>
<td>792</td>
<td>Ciprofloxacin, Moxifloxacin</td>
<td>08.01.80</td>
</tr>
<tr>
<td>623</td>
<td>Quinapril, Valsartan</td>
<td>02.07.10</td>
</tr>
<tr>
<td>601</td>
<td>Tresamid, Furosemid</td>
<td>05.01.00</td>
</tr>
<tr>
<td>467</td>
<td>Scopolaminbutylbromid</td>
<td>04.02.00</td>
</tr>
<tr>
<td>449</td>
<td>Acetylsaliclyc acid</td>
<td>06.03.20</td>
</tr>
<tr>
<td>432</td>
<td>Sodiumchloride+Potassiumchloride</td>
<td>05.03.30</td>
</tr>
<tr>
<td>428</td>
<td>Valerian extract</td>
<td>01.04.20</td>
</tr>
<tr>
<td>394</td>
<td>Bisoprolol, Metoprolol</td>
<td>02.03.00</td>
</tr>
<tr>
<td>378</td>
<td>Laxatives</td>
<td>04.08.15</td>
</tr>
<tr>
<td>362</td>
<td>Diclofenac, Desketoprofen</td>
<td>07.10.10</td>
</tr>
<tr>
<td>338</td>
<td>Atorvastatin</td>
<td>07.12.00</td>
</tr>
<tr>
<td>318</td>
<td>Feldopin, Amlodipin</td>
<td>02.06.10</td>
</tr>
<tr>
<td>291</td>
<td>Salbutamol, Irrapropriumbromide</td>
<td>03.04.10</td>
</tr>
<tr>
<td>289</td>
<td>Hydroxyethyl starch</td>
<td>06.01.23</td>
</tr>
<tr>
<td>240</td>
<td>Irbesartan + HCT</td>
<td>02.07.20</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Table 4</th>
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<tbody>
<tr>
<td>Median therapy duration in days (IQR interquartile range), formulation and amount prescribed of antimicrobials used within the period analysed. Administration route, median and maximal/minimal duration are indicated. Order by total numbers of analysed prescriptions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generic name</th>
<th>Formulation</th>
<th>Number of analysed prescriptions</th>
<th>Median duration in days (IQR)</th>
<th>Max (days)</th>
<th>Min (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin/Clavulanate i.v.</td>
<td>intravenous</td>
<td>587</td>
<td>3 (2–4)</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>Ciprofloxacin p.o.</td>
<td>oral</td>
<td>472</td>
<td>4 (2–6)</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Amoxicillin/Clavulanate p.o.</td>
<td>oral</td>
<td>421</td>
<td>5 (2–8)</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>Piperacillin/Tazobactam</td>
<td>Intravenous</td>
<td>363</td>
<td>4 (3–7)</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Cefepime</td>
<td>intravenous</td>
<td>348</td>
<td>4 (3–6)</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>Metronidazol i.v.</td>
<td>intravenous</td>
<td>198</td>
<td>4 (2–5)</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Fluconazol p.o.</td>
<td>oral</td>
<td>110</td>
<td>5 (3–8)</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>Metronidazol p.o.</td>
<td>oral</td>
<td>110</td>
<td>4 (3–7)</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Montifloxacin</td>
<td>oral</td>
<td>104</td>
<td>5 (3–8)</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Ciprofloxacin i.v.</td>
<td>intravenous</td>
<td>99</td>
<td>2 (2–4)</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Ceftriaxon</td>
<td>intravenous</td>
<td>68</td>
<td>4 (2–6)</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Co-Trimoxazol/Sulfobactam</td>
<td>oral</td>
<td>23</td>
<td>4 (3–5)</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Amikacin</td>
<td>intravenous</td>
<td>7</td>
<td>5 (2–6)</td>
<td>14</td>
<td>2</td>
</tr>
</tbody>
</table>
The age classes 0–20 years and less than 21–50 and 91–100 class in the groups of 21–30, 31–40, 41–50, 51–60, 61–70, 71–80, 81–90 years, on >300 prescriptions per age class between 61 and 90 years, on >1000 prescriptions per age class in all patients. The total number of 68 133 prescriptions were analysed concerning age-groups with 5-year-interval. Data are based on >1000 prescriptions per age class between 61 and 90 years, on >300 prescriptions per age class in the groups of 21–50 and 91–100 years and less than 200 prescriptions in the age classes 0–20 and >100 years.

There are only few guidelines and recommendations available on the prophylactic use of acid-suppressing agents in general and especially on PPI. Most recommendations include just a subset of intensive care unit ICU patients and by far not all acutely ill and hospitalised patients [6, 9]. Furthermore, most studies were done with non-PPI drugs like sucralfate, histamine H2 receptor antagonists or pirenzepine and in addition, the majority of recently published prospective studies and a meta-analysis have been unable to demonstrate a reduction in clinically important bleeding with pharmacological agents even in the postoperative period [14]. As most inpatients and especially ICU patients suffer from several stress factors, the prophylactic use of PPI continues to be debated and most often depends on institution-specific guidelines. Analysing the ICD-10 codes concerning the main diagnosis and major stress factors like ICU-care, myocardial infarction or severe infections only about 850 (14%) patients could be identified as being reasonable candidates for prophylactic PPI. As the main diagnosis was most often not the only reason for the choice of prophylaxis, these 14% were definitely not the only patients considered for prophylaxis. In fact, 66% of all patients received a proton-pump inhibitor for prophylactic reasons (patients with therapeutic use of PPI not included). A reduction of drug therapy with PPI for prophylactic reasons should be made for both patient-safety and economic reasons.

In the department of internal medicine, we analysed the number of regular drugs on admission and the number prescribed to patients on discharge. On average, patients took 5 drugs on a regular basis on admission, as compared to 14 drugs during the hospitalisation and to 6 drugs on discharge. In summary, despite the fact that the number of drugs was more than doubled during the acute care of the inpatient, at discharge nearly the same number of prescribed drugs was achieved as on admission reflecting at least a good management of drug prescription regarding the number of prescribed drugs. Furthermore, electronic tools can assist in the switch to the outpatient setting by comparing drug prescription on admission and on discharge and to coordinate with the drugs commonly used by the patients’ family physician.

The study has several limitations. First it is a retrospective data analysis, no interventions could be tested. Second, not all departments had equal numbers of patients included. Especially in gynaecology, only 16% of patients were analysed and therefore (despite the fact that even these results show strong similarity to surgical patients) no arguments are given concerning gynaecological patients. On the other hand, nearly all internal medicine patients and most surgical patients could be analysed and, given the fact that all wards care for various patients, no differences between wards should be present emphasising the validity of results. Third, prescriptions were not broken down to diagnoses and therefore only global interpretation can be made concerning diagnosis-related prescribing behaviour.

CPOE not only is a powerful instrument in controlling prescribing-errors, it also gives the unique possibility for analysing prescription practices within a hospital and assisting with the prescribing process. As only limited data on prescribing patterns in Swiss hospitals are available, this
summary gives an overview on the current situation in a medium sized Swiss acute care hospital. In times of growing economic pressure on public funded hospitals and with regard to optimal patient care, these data are the basis for adapting or changing prescribing patterns. As shown above, two drug classes in particular (PPI and to a lesser extent LMWH) are prone to overuse in inpatients whereas the duration of antibiotic therapy for example, could possibly be improved and the reduction of prescribed drugs at hospital discharge compared to the hospitalisation period seems to be well done. More analysis has to be done to improve the medication process – especially diagnosis-related medication behaviour – and in the future, decision support models will give additional possibilities to assist and interfere with drug prescribing.

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