THE ELECTRONIC PRESCRIPTION AND PHARMACISTS: TOWARDS BETTER PATIENT CARE

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This study shows the profile of potential errors due to computerization and how these errors evolve with the human-machine interface in a high critical care unit.

The study was conducted in the neurovascular department at Toulouse University Hospital, France for one year. Computerization was performed using the Orbis® software (AGFA Society). We compare medication errors with or without computerization by pharmaceutical analysis according to the French Standard for Clinical Pharmacy.

4048 prescriptions were analyzed: 1550 handwritten prescriptions, and 2498 computerized physician order entry. A pharmacist intervened in 6.97% of cases before computerization and 25.3% after ($p < 0.001$). Untreated indications decreased significantly with computerization ($p < 0.001$) and unsuitable modes of administration of medications increased significantly with computerization ($p = 0.034$). Among the errors, 13.3% were generated by the use of a computer. The proportion of CPOE errors decreased over time during 6 months.

This work shows that pharmacists and physicians have to take particular care at the beginning of computerization. The criticality of the transition from handwritten to computerized prescriptions seems to make accompaniment by a pharmaceutist necessary.

**Key words**: computerization, CPOE errors, pharmaceutical interventions.
INTRODUCTION

Pharmaceutical analysis is a step in the management of therapeutic drug to patients in hospital. It has been applied in France since 1991. The development of computerized physician order entry (CPOE) facilitates this analysis and has led to decrease in medication errors. Computerization can also meet requirements established by the competent authorities: good practice contract, certification, etc. According to Bates et al., non-intercepted medication errors have decreased by 55%, from 10.7 events per 1000 to 4.86 events per 1000 (p = 0.01) with computerization [1]. A similar decrease is also reported by Shulman et al. with 6.7% before and 4.8% after computerization (p < 0.04) [2].

Can computerization be considered as a really secure process overall? The transition to computerization is punctuated by improvements and setbacks. The biggest benefits are the absence of retranscription (free of handwriting identification problems, less subject to errors associated with similar drug names), pharmaceutical analysis online, and drug administration traceability. With computerization, prescriptions in France better respect the bylaw of March, 31 1999 [3], are more secure and, are always readable.

However, computerization might generate new consequences: increased working time, changes in human relationships and new categories of medication errors [4,5]. Despite these difficulties, several publications show that CPOE decreases the frequency prescription errors [6],[7].

The aim of this study is to evaluate the impact of computerization on the pharmaceutical analysis activity and the conformity of prescriptions [3].

MATERIALS AND METHODS

This retrospective study was conducted in the Neurovascular Care Unit (a total of 26 beds) of the Neurosciences Department at Toulouse University Hospital from May 2012 to May 2013. Patients, in this ward, presented ischemic or hemorrhagic stroke or had been admitted for investigations concerning vascular neurological diseases.

Legibility, completeness of prescription

The French Medicines and Sterile Medical Devices Commission (COMEDIMS) carried out an audit based on a methodology created by the National Agency to Support Performance (ANAP). ANAP initiated a project to develop a method for helping healthcare and medico-social institutions to assess the contribution of information systems [8]. Fifteen orders, established on a single day, were analyzed before and after computerization.

Software

Computerization was performed using the Orbis® software (AGFA Society). Physicians and pharmacists received about 3 hours’ training in the use of the tool. At the start of
computerization, support (by people competent in the use of the software) was organized for 15 days.

**Pharmaceutical Interventions**

During the prescription analysis within the care unit, the pharmacist was on hand to detect any abnormalities occurring in the prescription process, and any risk or error that could affect the patient. Such anomalies are called Pharmaceutical Interventions (PIs). The PIs identified by Conort et al. [8] are: 1- unsuitable route or administration of medication, 2- non respect of recommendations or contraindications, 3- over dosage, 4- under dosage, 5- inappropriate treatment, 6- untreated indication, 7- adverse effects, 8- monitoring, 9- treatment not received, 10- interactions.

Prescribing physicians were contacted to confirm their prescriptions. The medical prescription was corrected in case of error and the pharmacist marked the PI as accepted, not accepted or other when the patient discharge to the ward.

We report medication errors according to the dictionary of medication errors of the French Society of Clinical Pharmacy [9] for a period of one year (six months before and six months after computerization). Handwritten prescriptions were analyzed from May to November 2012, then, when computerization was established in November 2012, all prescriptions in Orbis® were reviewed for interactive analysis until May 2013.

**Statistical analysis**

Qualitative variables and proportions were compared by the Fisher exact test or the Chi²-squared test as appropriate (theoretical numbers < or > 5 respectively). Results were considered as significant if p < 0.05. All statistical tests were performed with R software approved by INSERM online [10].

**RESULTS**

During the 1-year study period, 4048 prescriptions were analyzed, corresponding to 1550 handwritten prescriptions and 2498 CPOE. Among the 4048 prescriptions, 740 (18.3 %) were the object of intervention by a pharmacist: 108 PI before computerization (6.97%) and 632 PI after (25.3%) (p < 0.001) (Figure 1). Computerization induced a significant increase in the number of accessible prescriptions.
Legibility, completeness of prescription

One hundred percent of the computerized prescriptions were in compliance with French laws, except as regards the presence of the patient’s weight and height. Results are reported in Table 1.

<table>
<thead>
<tr>
<th>medical prescription</th>
<th>conformity rate before computerization (%)</th>
<th>conformity rate after computerization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of the care unit</td>
<td>93.33</td>
<td>100</td>
</tr>
<tr>
<td>Complete and legible name of prescriber noted</td>
<td>66.67</td>
<td>100</td>
</tr>
<tr>
<td>Presence of prescriber’s signature</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Weight</td>
<td>86.67</td>
<td>46.67</td>
</tr>
<tr>
<td>Height</td>
<td>86.67</td>
<td>13.33</td>
</tr>
<tr>
<td>Presence of prescription date</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Presence of prescription time</td>
<td>13.33</td>
<td>100</td>
</tr>
<tr>
<td>Name of drug</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Galenic form</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Mode of administration</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Dosage</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Treatment period</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1: Criteria of legibility and completeness for conformity of medical prescriptions according to French law of March 31, 1999, with conformity rates before and after computerization

Figure 1. Impact of computerization on Pharmaceutical Interventions (PIs): measured by number of PIs / number of prescriptions analyzed
Description of Pharmaceutical Interventions

PI types are summarized in Table 2 for handwritten prescriptions and CPOE.

<table>
<thead>
<tr>
<th>Error types according to French Society of Clinical Pharmacy</th>
<th>PI before computerization n (%) (N=108)</th>
<th>PI after computerization n (%) (N= 548)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuitable route or administration of medication</td>
<td>32 (29.6)</td>
<td>222 (40.5)</td>
<td>0.034</td>
</tr>
<tr>
<td>non respect of recommendations or contraindications</td>
<td>21 (19.4)</td>
<td>114 (20.8)</td>
<td>0.75</td>
</tr>
<tr>
<td>overdosage</td>
<td>11 (10.2)</td>
<td>61 (11.1)</td>
<td>0.77</td>
</tr>
<tr>
<td>under dosage</td>
<td>3 (2.8)</td>
<td>29 (5.3)</td>
<td>0.26</td>
</tr>
<tr>
<td>inappropriate treatment</td>
<td>4 (3.7)</td>
<td>28 (5.1)</td>
<td>0.53</td>
</tr>
<tr>
<td>untreated indication</td>
<td>17 (15.7)</td>
<td>25 (4.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>adverse effects</td>
<td>4 (3.7)</td>
<td>20 (3.7)</td>
<td>&gt; 0.99</td>
</tr>
<tr>
<td>monitoring</td>
<td>7 (6.5)</td>
<td>19 (3.5)</td>
<td>0.17</td>
</tr>
<tr>
<td>unreceived treatment</td>
<td>6 (5.6)</td>
<td>17 (3.1)</td>
<td>0.24</td>
</tr>
<tr>
<td>Interactions</td>
<td>3 (2.8)</td>
<td>13 (2.4)</td>
<td>0.73</td>
</tr>
<tr>
<td>CPOE errors</td>
<td>0</td>
<td>84 (13.3)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Evolution and comparison of categories of error in prescribing medication. Pharmaceutical interventions before (May to November 2012) and after (November 2012 to May 2013) computerization

PIs regarding non-respect of recommendations or contraindications, overdosages, under dosages, inappropriate treatment, adverse effects, monitoring, not received treatments and interactions were not significantly different before and after computerization. In contrast, untreated indication decreased with computerization (p<0.001). Unsuitable route or administration of medications increased significantly with computerization (p = 0.034).

Computerized physician order entry errors

Over the six month period, a new category of PI appeared: 13.3% of errors were generated by the use of computer. Among PIs due to CPOE errors, we essentially found duplicate orders (the same drug was prescribed twice), unit errors (the drug dose was in tablets instead of in milligrams for example), the use of free text, and parameterization flaws (error in the prescription of the drug to be administered in continuous or discontinuous mode).

We can observe (Figure 2) a decrease in the proportion of CPOE PI from November to April. The interventions of the pharmacists for CPOE errors differed significantly according to the month: 28.6% of the total PIs in November, 22% in December, 13.8% in January, 20.9% in February, 15.5% in March and 6.3% in April (p = 0.0089). An increase was observed in February (20.9%) with arrival of a new resident physician, but the decrease resumed as he became accustomed to the system. Graph profiles (Figure 2) declined from November 2012
to January 2013 and from February 2013 to April 2013 at a rate that seems to be the same for both periods.

Acceptance rate

In the period without computerization, 84 (78 %) of all recommended interventions were accepted by the medical staff. 14 % were not accepted and 8 % were noted as « other ».

After computerization, 445 (70 %) were accepted, 17 % were not accepted and 13 % were noted as « other ». This acceptance rate was not significantly different from the previous one (data not shown, p = 0.117).

DISCUSSION/ CONCLUSION

This study shows an increase in the number of prescriptions analyzed after computerization. Computerized analysis is more recurrent because it is done throughout the day whenever a prescription is changed, unlike the analysis of handwritten prescriptions which is performed by the pharmacist once a day.

Besides this quantitative aspect, computerization improves the quality of prescriptions. There are obvious advantages to computerized prescriptions, such as improved legibility with the use of blocking filters and the existence of a therapeutic informations. The decreased
compliance concerning the recording of the patient’s weight and height can be explained by the fact that the nurse has to perform a new computer operation (not necessary on paper) and this task is only very rarely performed by the prescribing physician. This loss in legibility may be a barrier to pharmaceutical analysis if pharmacists do not visit the care unit.

Compliance with this requirement facilitates the analysis of the order by the pharmacist. It should be noted that working methods may differ among clinical pharmacists and the detection of medication problems and recommendations could depend strongly on the experience of the pharmacist. The increase in the rate of pharmaceutical interventions (6.7% against 25.3%) may be explained by the simplicity offered by computerized access to patient data and the availability of good practice guidelines online. Another explanation may be the strengthening of the pharmaceutical team in the unit at the time when computerization was brought in.

However, the implementation of the software generated new interventions. These CPOE errors tended to decrease as staff learned to use the software. In this study, we observed variations in CPOE errors. The main explanation was that the junior medical staff changed during the study, which affected the results. According to Koppel et al. errors are most frequently due to flaws in the human-machine interface [11]. To reduce these CPOE errors, pharmaceutical team set up standardized protocols using computerized systems in the aim of making practitioners’ prescriptions more reliable. The most frequently occurring errors in drug parameters were corrected. This work of standardization should also reduce the time physicians spend on prescription. Computerization is not a finalized process. The learning of the computer system associated with higher alertness seem fundamental to its success.

With the increase of PI, a decrease in the acceptance rate was expected, but, in fact, no significant difference was found in the rates before and after computerization. The acceptance rate of the pharmaceutical interventions was similar to those reported in other studies [12-14]. This high rate was probably due to the presence of the pharmacist in the care unit at the time of the interventions. The pharmacist’s presence at the patient’s bedside is fundamental for optimal order analysis [15]. Leape et al. found that pharmacists could prevent 66 % to 80 % of adverse drug events [16], and also reported a high level of acceptance by physicians when the pharmacist was integrated as a full member of the team.

In conclusion, this work shows that pharmacists and physicians have to be particularly careful at the beginning of a computerized project. After three months, the rate of CPOE errors in our study decreased. This shows that the pharmaceutical work was effective and apparently reproducible over several months. After the initial learning period for users, this tool was beneficial because it made data more accessible for the pharmacist. As a result, the pharmaceutical team could be more determined in prescription analysis and reduce the prescription of potentially inappropriate medication. The critical nature of the transition from handwritten orders to computerized prescriptions seems to require a pharmaceutical accompaniment. CPOE analysis by the pharmacist and the daily tracking of errors help to improve the computer tool [17].

**STUDY LIMITATIONS**

One limitation is the retrospective character of the study but the main drawback is undoubtedly its monocentric nature. Working with a single center limits extrapolation of the
results to a larger population. We can also report an information bias regarding analysis of the order by different pharmacists (three). The number of samples may have been too low due to the short study period (six months before and after computerization).
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