

# Impact of pharmacy validation in a computerized physician order entry context

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## Abstract

**Background.** Computerised physician order entry offers a potential means of reducing prescribing errors, and can also increase the feasibility of pharmacy validation as a secondary filter for eliminating errors. The impacts of these two benefits have never been evaluated in combination.

**Objective.** To describe (i) the pharmacists' interventions during validation of drug prescriptions on a computerized physician order entry system, (ii) the impact of these interventions on the prescribing process and (iii) the extent to which computerized physician order entry was responsible for the identified errors.

**Method.** Prospective collection of all medication order lines during five days in a tertiary care university hospital using computerized physician order entry for drug prescription. All orders were reviewed by a pharmacist. We described the frequency of pharmacy alerts and their short-term impact on the correction of potential prescribing errors (modification of the prescription). An independent committee reviewed their type and link with the computerized physician order entry system.

**Results.** About 399 (11%) prescription order lines, corresponding to 222 (52%) patients, required a pharmacy alert during the study period. Among the 81 pharmacy alerts targeted to the prescriber, 21 [26% (IC95% = 17–37%)] resulted in a modification of the prescription. Among the 95 potential prescribing error, the independent review committee judged 16 (17%) as potentially life-threatening and attributed 47 (49%) to the use of computerized physician order entry system (unit error, no use of typical order prespecified, prescription inconsistency or other).

**Conclusion.** Pharmacy validation produced only a moderate short-term impact on the reduction of potential prescribing errors. However, pharmacy validation may also provide ongoing benefits by identifying necessary improvements in the computerized physician order entry system. Those improvements would allow pharmacists to concentrate on the most relevant interventions.

**Keywords:** medical record systems, prescriptions, pharmacists, medical errors, CPOE, computerized provider order entry

Adverse drug events are associated with increases in the duration of hospital stay, additional costs and mortality [1] and have been recognized as a safety priority [2, 3]. Medication errors account for a large proportion (20 to 28%) of adverse drug events and are preventable [4, 5]. Dean *et al.* [6] described prescribing errors as 'clinically significant meaningful prescribing errors occurring when, as a result of a prescribing decision or prescribing writing process, there is an unintentional significant (1) reduction in the probability of treatment being timely and effective or (2) increase in the risk of harm when compared with generally accepted practice.' Most medication errors do not result in an adverse drug event. However, medication

errors occur in 5% of prescriptions, mostly due to prescribing errors [4, 5, 7].

Computerized physician order entry (CPOE) and the review by pharmacists of all prescriptions (referred to hereafter as 'pharmacy validation') have been put forward for reducing prescribing errors. Some studies that use time series to evaluate the effects of CPOE with different levels of clinical decision support systems have shown a decrease of more than 50% in non-intercepted serious medication errors (potential or actual) [1, 8–10] or a decrease of more than 33% in prescribing errors in an emergency department [11]. However, the effect of CPOE on clinical outcomes (mortality rates, adverse drug events, or length of stay)

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remains questionable [9, 12–16]. Other studies have qualitatively analysed the possible side effects of the integration of CPOE into a patient care information system, including the induction of specific prescribing errors due to a lack of flexibility of the system, and over-completeness or fragmentation of the information relating to prescriptions [17, 18].

By reviewing the prescriptions, pharmacists can identify errors, thereby reducing the frequency of medication errors [19]. Pharmacists participating in medical rounds can prevent 66 to 80% of adverse drug events [20, 21], decrease drug costs by 41% [22] or be associated with a low frequency of medication errors [23]. Pharmacy validation is mandatory in France [24] but often hardly feasible, given the small number of hospital pharmacists, the large number of prescriptions and the compulsory feedback to the prescriber. CPOE offers a potential means of reducing prescribing errors and can also increase the feasibility of pharmacy validation as a secondary filter for eliminating errors. The impacts of these two benefits have never been evaluated in combination.

In this study, we aimed to describe (i) the pharmacists' interventions during the validation of computerized drug prescriptions, (ii) the impact of these interventions on the prescribing process and (iii) the extent to which CPOE was responsible for the errors identified by the pharmacists.

## Methods

### Sites and subjects

In France, the physician is entirely responsible for the writing of prescriptions, including specification of the brand name of the drug (rather than its international denomination), infusion time and solution for reconstitution of intravenous medication. In this context, pharmacy validation is implemented in a different way, as the pharmacist must alert the prescriber (in cases of unavailability or non-conformity with best practice) but cannot modify the prescription directly (with the exception of replacing one drug with another having the same international denomination). Nurses should administer exactly what is written on the prescribing order.

Georges Pompidou European Hospital (HEGP) is a French tertiary care university hospital. A patient information system, integrating an electronic patient record and a CPOE (Dx-Care, Medasys™) is implemented throughout the hospital since its inception (year 2000). The hospital information system currently collates prescriptions and results of biological tests and imaging procedures. Eight hundred computers, both laptops and fixed posts, are used to in care procedures (in care departments and medical offices). The Dx-Care® program is at the centre of care delivery. It is used by doctors, pharmacists and nurses:

- to prescribe laboratory examinations and imaging tests for a patient,
- to visualize the results of laboratory tests,
- to establish and to consult nursing schedules,
- to archive a structured observation,
- to prescribe drugs,
- to validate prescriptions (pharmacists).

The drug prescription facility is available in 10 departments and has been used for 2 to 3 years. This study focuses on these 10 departments: two surgical and eight medical wards, 210 beds, 25% of the hospital's beds. Forty-two residents, fellows or staff physicians are in charge of these patients and may write prescription of drugs for them. Medical students cannot prescribe.

For each patient, the software displays a screen with all the prescription order lines, one for each drug. The physician must click on an order line to display a new window with all the prescription order line details: drug name (from a pull-down menu), dose, unit (from a multiple choice list), frequency, reconstitution process, route and an optional annotation field. This window cannot be closed if a non-optional field is empty. Various types of prescription aid are available: information about reconstitution processes for intravenous drugs, typical orders prespecified by pharmacists for intravenous drugs and an integrated drug–drug interaction system. The only automatic decision support is alert, concerning maximum dose for oral drugs. Physicians and pharmacists have access to the patient's administrative and clinical data, biological results, images, nursing transmissions notes, vital signs, appointments and all reports.

All prescriptions are reviewed for interactive validation by pharmacists. Nights and weekends prescriptions are reviewed on the next day if unexpired. Four pharmacists (two senior pharmacists and two residents), assisted by two part-time pharmacy students, perform these validations.

The results of the pharmacy validation can be accessed by the prescribers and/or the nurses (depending on the pharmacist's choice) via a symbol inserted in front of a given prescription order line: 'accepted', 'refused' or 'availability problem'.

The 'accepted' symbol indicates that the pharmacist agrees with the prescription, unless a comment is added relating to good practice, which may or may not suggest a modification of the prescription line.

The 'refused' symbol indicates that the pharmacist disagrees with the prescription, having identified a potentially severe prescribing error suggesting modification of the prescription. This symbol is always associated with a comment.

There are two kinds of 'availability problem': 'substitution', where a new prescribing order is required before the nurse can deliver the suggested drug because the molecule is not the same as that initially requested by the doctor, and 'equivalence' in which a new prescribing order is not required because the molecule suggested is the same, but simply has a different brand name.

Any comment added by the pharmacist is considered a 'pharmacy alert'. The physician may click on the symbol to visualize the pharmacist's comment, but is not obliged to take that comment into account. We define as potential prescribing errors, all lines with a 'refused' symbol or an 'accepted' symbol associated with a comment from the pharmacist (i.e. all pharmacy alerts other than availability problems).

### Design of the study protocol

In this prospective quantitative and qualitative study, we aimed to describe the prevalence and impact of pharmacy

alerts. To describe prevalence, we collected data on discontinuous rather than a block of time to avoid counting twice the same alert: we included all medication order lines validated by the hospital's pharmacy on three Mondays (7, 14 and 21 March 2005). For any given day, the pharmacy alert on a prescribing line may be 'new' or 'previous', in cases in which the alert was posted on a previous day but may still be useful if the physician has not yet modified his/her order. We described the impact of pharmacy alerts by including all

'new' pharmacy alerts on the three Mondays plus all 'new' pharmacy alerts on two Wednesdays (9 and 16 March 2005) to increase the number of alerts investigated, as follow-up can only be done on new alerts.

### Data collection

*The pharmacist's record.* For each potential prescribing error identified as part of their routine work, the pharmacists

**Table 1** Description and example of potential prescribing errors

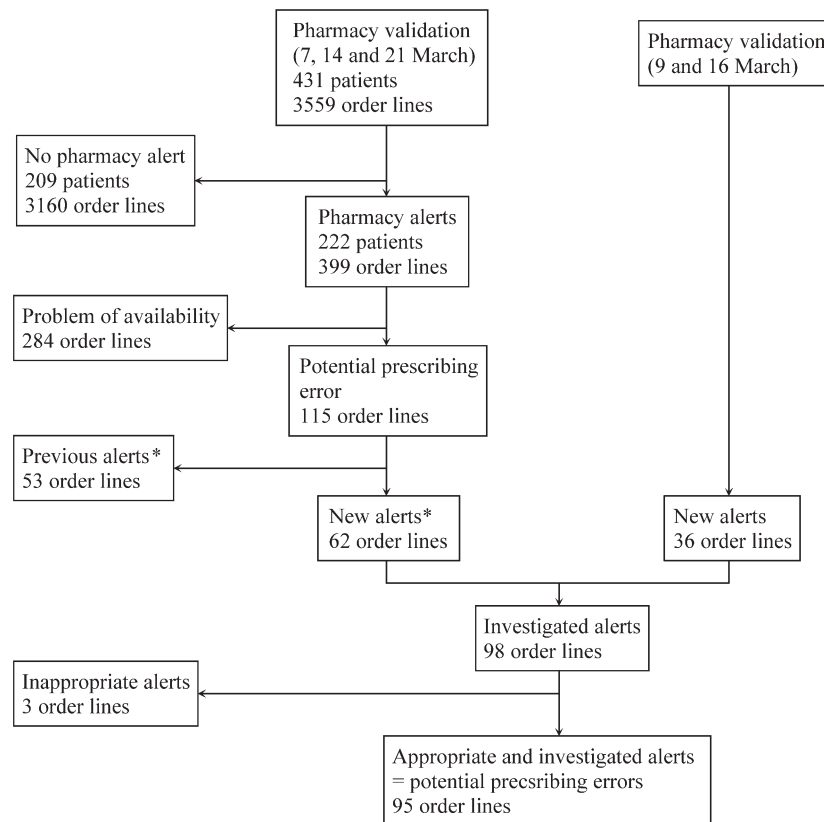
Classification	Advice or correction about:	Example
<i>Type</i>		
Treatment adaptation	A potential interaction with current drug regimen Non-adaptation to biological or pharmacological follow-up according to official recommendations or specific protocols A patient known disease that is a contra-indication to the treatment	Treatment by Acenocoumarol non-adapted to patient INR
Incomplete order	An improper or missing indication for reconstitution or injection (bolus, infusion, according to the French law requirements Lack of readability of the prescription	Only written: 'Amikacin 500 mg.' Need to add: 'dilution in 200 mL of G5%, infusion time: 30 minutes.'
Wrong route or unit	An improper unit or route	Warfarin at 5 mg per os: 10 pill at 6:00 pm; instead of 10 mg
Dose	An improper dose by day or by each drug intake	Macrogol: 6 sachets a day. Whereas the usual dose is 2 sachets a day
Drug omission/duplication	A drug omitted by the prescriber Two or more drug in the same therapeutic class prescribed simultaneously or the same drug prescribed twice	Potassium omitted for a patient with hypokalaemia
<i>CPOE-related</i>		
Unit error	Choice of an improper unit facilitated by a design flaw (users might inadvertently choose the wrong unit)	Enoxaparin 4000 UI in syringe of 0.4 ml: 3500 syringes at 8:00 am and 6:00 pm; instead of 3500 UI
No use of typical orders prespecified	No use of typical order available in the system with all required indication for reconstitution or injection (bolus, infusion, etc) resulting in an improper or missing indication.	Only written: 'Amikacin 500 mg.' Need to add: 'dilution in 200 mL of G5%, infusion time: 30 minutes.'
Prescription inconsistency	Facilitated by design flaw, inconsistency between the title given to the perfusion order and its details components	Title of perfusion is 'Vit B1 and B6 in 1000 mL of glucose at 5%'. KCl 2 g is only mentioned in the details components
Other	Duplication of a drug order, dose error or choice of an improper route facilitated by design flaw	Levothyroxin prescribed twice for the same patient
<i>Potential severity</i>		
None, purely preventive		Creatinine clearance is 397 mmol/l, adverse events of morphine have to be monitored closely
Significant or serious		Only written: 'Amikacin 500 mg.' Need to add: 'dilution in 200 mL of G5%, infusion time: 30 minutes.'
Life-threatening		Warfarin at 5 mg per os: 10 pill at 6:00 pm; instead of 10 mg

printed a copy of the whole prescription, including their own intervention (symbol and text comment) and specifying the person targeted (prescriber and/or the nurse). Potential prescribing errors were classified by the pharmacists using a classification adapted from published classifications [1, 7, 10, 19, 25, 26]. Our type classification included five categories (Table 1). A training session was organized before the study, and each pharmacist was provided with a handout including examples and definitions of the categories (available on request).

*Independent review committee.* An independent multidisciplinary committee of three physicians (cardiology, clinical immunology, internal medicine) and one pharmacist not taking part in the validation process retrospectively reviewed all the investigated alerts to rate the more subjective items. The committee had access to the whole prescription but was blind to the impact of the alert, the ward, the names of the prescriber and of the patient. Following guidelines, the committee rated (i) the potential severity on a three-category scale (none, purely preventive; serious or significant and life-threatening) adapted from previous publications [5, 7, 26] and (ii) the possible implication of the CPOE system in the error. An error was identified by the committee as related to

the use of CPOE if it occurs more easily than would have occurred in the traditional medication ordering system. Sub-categories are described in Table 1. Each of the reviewers rated all the alerts individually, and discrepancies in assessment were then resolved by consensus between all reviewers.

*Impact investigation.* The impact of all ‘new’ pharmacy alerts targeted to the prescriber was investigated by two researchers, a physician and a pharmacist (C.E. and S.V.). We first recorded whether the prescription order line was modified in the CPOE system before the next administration of the drug. Then, for all non-modified orders, the reasons for non-compliance with the pharmacist’s advice were investigated by semi-structured interviews with the prescriber. The various possible answers were indicated in a multiple choice form: (i) ‘It’s an omission, I haven’t seen it yet’, (ii) ‘I think my order is clear enough for the nurse’, (iii) ‘Due to disease progression, biology or a specific context, it wasn’t required’, (iv) ‘I disagree with the pharmacist’s advice’ and (v) ‘other, explanation’. We also investigated whether an adverse drug event, defined as an injury resulting from the use of a drug [5], had occurred following the potential prescribing error.



**Figure 1** Study flow chart. To describe the ‘prevalence’ of pharmacy alerts, all medication order lines validated by the hospital’s pharmacy on three Mondays (7, 14 and 21 March 2005) were included. To describe the ‘impact’ of pharmacy alerts, we only followed up ‘new’ pharmacy alerts on these three Mondays. We added all ‘new’ pharmacy alerts on two Wednesdays (9 and 16 March 2005) in order to increase the number of alerts investigated. Asterisk denotes that a previous alert is an alert posted by pharmacist on a previous day but still active if the physician has not yet modified his/her order and that a new alert is an alert posted by pharmacist on a day of the study (7, 9, 14, 16 or 21 March 2005).

## Analysis

Data were recorded and analysed with Microsoft Access and Excel. Results are presented as frequency, percentage and confidence intervals, as appropriate. Some qualitative examples are given to illustrate the impact of pharmacy alerts and possible future improvement in CPOE.

## Results

The prevalence of pharmacy alert is 399 on 3559 prescription order lines (11%), corresponding to 222/431 (52%) patients (Fig. 1). Pharmacy alerts were issued for availability problems (284 lines; 8% of all lines) or potential prescribing errors (115 lines; 3% of all lines). Only a quarter of the availability problems involved substitution (71; 2% of all lines), and most availability problems were therefore resolved without the need for a new prescription from the physician (193; 6% of all lines). Of the 115 order lines with potential prescribing errors, 62 corresponded to new alerts. We further evaluated these 62 new alerts along with 36 other new pharmacy alerts collected on the two Wednesdays (9 and 16 March).

We followed up and the committee revised these 98 alerts. Three of these were considered inappropriate and excluded. The most common type of potential prescribing errors concerned incomplete order [34 errors (36%)] and treatment

**Table 2** Characteristics of the 95<sup>a</sup> investigated and appropriate pharmacy alerts (potential prescribing error)

Total <i>n</i> (%)	95
<i>Graded by pharmacists</i>	
Type	
Incomplete order	34 (36)
Treatment adaptation	31 (33)
Wrong route or unit	14 (15)
Dose	11 (12)
Drug omission/duplication	5 (5)
Target: physician	81 (85)
<i>Graded by review committee</i>	
Potential severity	
None, purely preventive	31 (33)
Significant or serious	48 (50)
Life-threatening	16 (17)
CPOE-related	47 (49)
Unit error	14 (15)
No use of typical orders prespecified	17 (18)
Prescription inconsistency	8 (8)
Other	8 (8)

Not assessable: when there is no next administration of the treatment (prescription finished anyway, patient dead or discharge). <sup>a</sup>95 = 98 (investigated alerts) – 3 (inappropriate alerts).

**Table 3** Impact of the 81<sup>a</sup> pharmacy alerts to the physician

<i>n</i> (row %)	Medication order modified	Medication order not modified	Not assessable
<i>Potential severity</i>			
None, purely preventive	9 (31)	16 (55)	4 (14)
Significant or serious	6 (17)	25 (69)	5 (14)
Life-threatening	6 (38)	8 (50)	2 (12)
<i>Type</i>			
Treatment adaptation	10 (32)	15 (58)	3 (10)
Incomplete order	4 (17)	15 (66)	4 (17)
Wrong route or unit	6 (43)	6 (43)	2 (14)
Dose	0 (0)	9 (82)	2 (18)
Drug omission/duplication	1 (20)	4 (80)	0 (0)
Total	21 (26)	49 (60)	11 (14)

<sup>a</sup>81 = 84 (investigated alerts targeted at the physician) – 3 (inappropriate alerts).

adaptation [31 errors (33%)]. Most pharmacy alerts concerned significant or serious potential prescribing errors, 48 (50%), but 16 (17%) were considered potentially life-threatening. Conversely, 31 (33%) had no potential severity and were purely preventive (Table 2).

Among the 81 pharmacy alerts targeted at the physician, 21 [26% (95% CI = 17–37)] resulted in modification by the prescriber. No tendency was observed between the rate of modification and the potential severity of the error: pharmacy alerts with potential life-threatening prescribing errors resulted in a larger number of prescription modifications [38% (15–65%) of modifications] than did significant or serious errors [17% (6–33%) of modifications], but the latter did not result in more modifications than purely

**Table 4** Involvement of CPOE in the 95<sup>a</sup> investigated and appropriate pharmacy alerts (potential prescribing error)

<i>n</i> (row %)	CPOE-related	not CPOE-related
<i>Potential severity</i>		
None, purely preventive	0 (0)	31 (100)
Significant or serious	33 (69)	15 (31)
Life-threatening	14 (88)	2 (12)
<i>Type</i>		
Treatment adaptation	1 (3)	30 (97)
Incomplete order	26 (76)	8 (24)
Wrong route or unit	14 (100)	0 (0)
Dose	4 (36)	7 (64)
Drug omission/duplication	2 (40)	3 (60)
Total	47 (49)	48 (51)

<sup>a</sup>95 = 98 (investigated alerts) – 3 (inappropriate alerts).



**Table 5** Examples of potential prescribing errors or availability problem and their interpretations with possible future improvements of CPOE

Example	Classification	Interpretation	Improvements
The prescription was: 'previscan <sup>TM</sup> (fluindione) 20 mg (0-0-1)'. The pharmacy alert and comment were: 'specific vigilance, INR low at 1.9 today: dose adjustment recommended: increase.' The prescription was modified by the physician.	Potential medication error Type: treatment adaptation Potential severity: none, purely preventive CPOE-relation: no	The prescriber cannot easily access laboratory results while prescribing oral anticoagulant treatment (several windows change and clicks).	Pharmacy comment replaced by a specific clinical decision support system displaying the history of INR results and suggesting a dose adjustment.
The prescription was: 'Innohep <sup>TM</sup> (tinzaparin sodium) 18,000 IU (0-0-1 IU)'. The pharmacy alert and comment were: '1 syringe and not 1 International Unit by day.' The prescription was not modified by the physician. Hopefully, the nurse administered one syringe and not one unit.	Potential medication error Type: wrong route or unit Potential severity: life-threatening CPOE relation: unit error	While prescribing, the physician has to specify the unit of prescription, but the syringe is selected by default. This is probably an omission error. It may be difficult for the prescriber to modify the prescription subsequently with the software.	Dose range limits Improvements to CPOE, making it easier to modify the prescription.
The prescription was: 'Amiklin <sup>TM</sup> (amikacin) 500 mg'. The pharmacy alert and comment addressed to the physician only were: 'Please use prerecorded reconstitution process for intravenous drug', and for the physician and the nurse: 'dilution in 200 mL of 5% G or 0.9% NaCl, infusion time: 30 minutes'. The prescription was not modified by the physician. When questioned about this, the prescriber argued: 'I think my order is clear enough for the nurse'.	Potential medication error Type: incomplete order Potential severity: significant or serious CPOE relation: no use of typical order prespecified	Pre-recorded prescription with the correct reconstitution process was not used.	Mandatory prerecorded reconstitution process for intravenous drugs in the software.
The prescription was: 'Forlax <sup>TM</sup> (macrogol) (2-2-2)'. The pharmacy alert and comment were: 'too high dose, usual dose is 2 per day and the patient had a bowel movement yesterday', the prescription was not modified by the physician. When questioned, the prescriber said 'I didn't know how to view the pharmacy alert'. Hopefully for the patient, the nurse did not administer all 6 sachets.	Potential medication error Type: dose Potential severity: none purely preventive CPOE relation: no	Lack of knowledge or information for the prescriber about software use.	Software training
'Levothyrox <sup>TM</sup> (Levothyroxin) 100 µg (175 µg at 8:00 am)' was prescribed twice for the same patient. The pharmacy alert and comment were: 'prescription order line duplicated'.	Potential medication error Type: drug omission/duplication	Duplication of order line facilitated by fragmentation of the complete patient chart.	Better screen readability

(continued)

Table 5 *Continued*

Example	Classification	Interpretation	Improvements
The prescription was not modified by the physician. When questioned about this, the physician argued: 'I think my order is clear enough for the nurse'. The nurse administered the drug once.	Potential severity: significant or serious CPOE relation: other		
The prescription was: 'Tahor <sup>TM</sup> (atorvastatin) 40 mg (0-0-1)'. The pharmacy alert and comment were: 'we propose a substitution with Zocor <sup>TM</sup> (simvastatin) or Vasten <sup>TM</sup> (pravastatin), the only statins available in the hospital'. The prescription was not modified by the physician, because the patient had brought his own usual treatment (Tahor <sup>TM</sup> ) with him to the hospital.	Availability problem: drug substitution	The prescriber is not aware of drug availability while prescribing.	Automatic substitutions proposed by the software. Possibility of indicating 'patient's own treatment'.

preventive alerts with no potential severity [31% (15–51% of modifications)] (Table 3).

A total of 47 (49%) potential prescribing errors were attributed to the use of CPOE, including all 'wrong route/unit' or 'prescription inconsistency' errors. These potential prescribing errors were judged to have a greater potential severity than the others (Table 4).

None of the prescription order lines requiring a pharmacy alert resulted in an actual adverse drug event.

Reasons for non-compliance with the pharmacist's advice were investigated for the 49 pharmacy alerts that did not result in any modification of the prescription. One prescriber could not be interviewed. The three most frequent answers were: 'I think my order is clear enough for the nurse' (12 answers; 24%); 'Due to disease progression, biology or a specific context, it wasn't required' (11; 22%) and 'It's an omission, I haven't seen it yet' (8; 16%). The 'other explanation' answer was chosen in 16 cases: in five cases (10%), the explanation was difficult modifying the prescription with the software, and in four cases (8%), the prescriber did not know how to view the text comment of the pharmacy alert.

Examples of the most frequent prescribing errors and typical pharmacy alerts are given in Table 5.

## Discussion

We found that 11% of prescription order lines, corresponding to 50% of the patients, required pharmacy intervention. Of the 95 potential prescribing errors investigated, 67% were considered significant, serious or life-threatening by an independent review committee. However, the impact of the pharmacy intervention was questionable, as only 22 prescription order lines (23%) were modified by the physician in response

to the alert provided by the pharmacist. It was estimated that 50% of these errors were related to CPOE use.

The frequency of prescribing errors in this study is similar to previous reports [4, 7], and we observed no adverse drug event, which is not surprising, given the frequency of such events (1%) and the limited number of prescribing errors investigated ( $n = 98$ ).

Few studies had investigated the impact of pharmacy validation in a CPOE context. Leape *et al.* [20] reported a high level of acceptance by physicians of the prescription changes made by a pharmacist when that pharmacist was integrated as a full member of the team, caring for the patient. This context is different from that studied here, in which the pharmacist does not take part in medical rounds and gives advice through the CPOE system. In the study reported by Lustig [19], the pharmacist was not physically present but called the physician directly if an error arose on a daily per patient order: the reported rate of non-modification was only 12.5%.

Half the potential prescribing errors were estimated to be attributable to the use of CPOE but as longer our study is not a comparative one, we are not able to state if more or less errors would have occurred without CPOE system. As in Koppel study [18], errors were most frequently due to human-machine interface flaws. Many physicians explained that they had not yet seen the pharmacist's comment, they found it difficult to modify the order with the software or they did not know how to view the pharmacist's comment.

Our study has various limitations. First, 'prescribing error' is defined differently in different studies [27]. The definition of 'potential prescribing error' is even more problematic. We chose to use the definition developed by Dean *et al.* with a panel of experts for prescribing errors [6]. We derived our classification for the types of potential prescribing errors from published classifications [1, 7, 10, 19, 25, 26]. High

levels of inter-individual and intra-individual reproducibility were ensured, but not evaluated, by training pharmacists, using a distinct set of prescriptions, and each pharmacist was provided with a handout with type definitions and examples. For subjective items, like potential severity and attribution to CPOE, we used a system of independent, retrospective rating by four experts not involved in and blind to follow-up. But, despite guidelines were provided, the agreement between the four experts was low (not quantified) and discrepancies could only be resolved by a consensus meeting with the experts and the investigators.

Our study may underestimate the impact of pharmacy validation: the absence of prescription modification does not necessarily indicate an absence of impact on the prevention of prescribing error, as the nurse may have modified drug administration unofficially after having seen the pharmacy alert. On the other hand, the impact may have been overestimated: the physician may in some cases have modified his prescription independently of the pharmacy alert, by adjusting for a biological result, for example.

Improvement of CPOE requires the tracking and elimination of errors [18]. Pharmacy validation also seems to be a useful way of identifying potential errors, due or not to the use of CPOE, which could be prevented by improvements of CPOE. Ergonomic improvements are required as a matter of priority, to make pharmacy comments more accessible, thereby possibly increasing their impact. The development of other prescription aids in the CPOE system, for drug-dose adjustment and availability problems, may prevent some prescribing errors and would allow pharmacists to concentrate on the most relevant interventions.

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