

Effects of a training program on the practices of hospital pharmacy residents in the field of prescription analysis

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Abstract

The objective of the research was to evaluate the impact of a training program on pharmacy residents' performance in the field of prescription analysis. A before-and-after study was conducted. The criteria for assessing the level of performance were the type and frequency of interventions. Before the training program, 279 pharmaceutical opinions were given (6.3% of 4458 prescriptions) versus 330 (12.1% of 2731 prescription) after the training program. Findings showed a significant improvement after the training in the fields of non-conformity to guidelines or contra-indication (0.3 vs. 0.9%), untreated indication (0.02 vs. 1.2%), overdosage (2.1 vs. 3.9%), drug interaction (2.2 vs. 3%) improper administration (1.1 vs. 2.1%) and failure to receive drug (0.07 vs. 0.5%). Insufficient analysis persisted for parenteral nutrition, drug interactions and physicochemical incompatibilities. Behaviour may have been a factor in this failure, as residents did not systematically refer to documentary tools. Methods to assess behaviour would be useful as a future research project.

Keywords: Resident, training program, impact, evaluation, performance

Introduction

Previous literature and regulations emphasize that clinical pharmacy, and specifically prescription analysis can contribute to the prevention of therapeutic iatropathology and medication errors. In France, analysis and validation of hospital prescriptions have been mandatory for pharmacists since 1991. However, their development has slowed for social, financial and cultural reasons. Furthermore, a limited number of practitioners are involved in such procedures on a daily basis (Schmitt, 1999).

In 1998, surgeons and anaesthetists of the surgery and liver transplant unit from our institution planned a quality improvement program which included prescription analysis. Considering the emerging data regarding the impact of prescription analysis and clinical pharmacy activities (Leape et al., 1999), this activity was extended to the hepatogastroenterology department in May 1999 and subsequently to the emergency unit in January 2001. Currently, prescription analysis is performed by

pharmacists in seven clinical wards. The training would involve a review of patients' drug therapy with physicians. In addition, the therapeutic appropriateness, including route and mode of administration, therapeutic redundancy, drug–drug interaction, physicochemical drug–drug incompatibility and dose adjustment for patients suffering from kidney or liver failure would be examined. We would then provide any information which would contribute to the appropriate use of drugs. Since the introduction of prescription analysis, pharmacy residents have been integrated into this activity by adopting the practices of the senior practitioner. Residents have become increasingly autonomous but remain under the responsibility of the head pharmacist who continues to assess the performance of residents in order to ensure patients' safety. This led us to examine exactly how residents carry out prescription analysis.

No research has been published previously on assessing residents' performance in the field of

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prescription analysis. Although literature on competency assessment exists in medicine and primary care pharmacy (Calop, Allenet, Calop, & Figari, 2002), none relate to hospital pharmacists and prescription analysis (Goldsmith et al., 2003).

Therefore, the aim of this study was to assess the effect of a prescription analysis training program on residents' performance while practicing prescription validation on clinical wards.

Objectives and training of pharmacy residency

Pharmacy residency training aims to develop a greater professionalism and specialization of the pharmacy student. A specialized pharmacy residency is defined as an organized and directed postgraduate training program that centres on the development of the knowledge, attitudes, and skills needed to provide pharmaceutical care in a specialized area of hospital pharmacy practice. Residency training is aimed at adults aged 25–30. The duration of residency in France is four years divided into eight rotation periods of six months. These rotations can be carried out either in the same or in different hospitals. The residency program includes two half-days per week of academic teaching. Academic credits can be obtained in a large variety of topics including pharmacotherapy, drug distribution chain, pharmacovigilance, clinical trials, clinical pharmacy, clinical pharmacokinetics, nutrition, aseptic drug compounding, medical devices and sterilization and pharmacoconomics.

The assessment of the residency comprises a theoretical and a practical element. The theoretical assessment consists of the formal examination of six academic programs chosen by the student. The practical assessment involves the hospital pharmacy Director's appraisal.

Competences: Definition and assessment

This work raises two important questions: what is competence and how can pharmacy residents be judged or assessed in an objective way? Competence has been described as "an ability equal to the requirements of the task assigned" (Davies, Webb, McRobbie, & Bates, 2002), and an "ability based on work or job outputs" (Mills et al., 2005). Competence is a comprehensive construct, encompassing skills, knowledge, behaviour and other attributes, such as personal traits, motives, values and attitudes. As the aim of the present study was to improve residents' performance while practicing prescription validation, a bibliographic search in the field of competence assessment was conducted. No publications referring to the assessment of residents' performance in the field of prescription analysis in hospitals were found. Therefore, performance was evaluated using proxy criteria: frequency of prescription interventions;

type of problems detected; and, the nature of the interventions. A senior clinical pharmacist served as the performance reference.

Materials and methods

Developing the training program

We performed a before-and-after study: a preliminary survey assessed how residents practiced prescription analysis (Charpiat, Macchi-Andanson, Perquin, Leboucher, & Brandon, 2003). The results allowed the identification of gaps in residents' knowledge and skills. They revealed that residents had little to say concerning information listed in internal documents or in different databases, particularly concerning drug–drug interaction and physicochemical incompatibility. Residents also had little knowledge in the field of parenteral nutrition. These results enabled a training program to be designed. The evolution of residents' practice after the implementation of the program was then assessed.

The training plan was implemented in November 2002. Previously, no formal training program was organized. Pharmacy residents assisted the practitioner and were asked to practice in the same way. The training program took place in three clinical wards: surgery, digestive and liver diseases and the emergency unit.

This training is based on the principle of clinical supervision (Abel, 2004). Each semester, the practitioner explained to pharmacy residents the objectives of prescription analysis and helped residents to develop skills necessary for the validation of prescriptions. During the rounds, residents answered questions concerning prescribed medication. The recommendations of the resident or the practitioner were made to physicians orally or in written form. Residents also attended a weekly staff meeting with pharmacy practitioners, the Head of Pharmacy, and other residents and students. This staff meeting was an opportunity to discuss drug-related problems encountered during the rounds or to highlight relevant literature.

Although the resident does not pass a programme the practitioner regularly performs prescription analyses at least four times a month with each resident. Some of the resident's interventions are supervised and commented on by the practitioner and recorded in a database. This system enables supervisors to provide feedback and advice to the residents on patient management and interventions.

Different tools are at the residents' disposal: two interaction files, one of which lists the interactions not yet reported in the Vidal[®] dictionary (a book similar to the British National Formulary) but extracted from different articles, and the other file lists the interactions from the French Health Products Safety

Agency (AFSSAPS); a file compiling physicochemical incompatibilities (Chauvet et al., 1998); a document itemizing the drugs whose dosage needs to be adjusted in case of kidney failure; the Vidal[®] dictionary (which contains the summary of the products' characteristics) (Vidal, OVP Edition du vidals Paris 2005); access to various databases (for example, Theriaque, 2005; Pubmed, 2005); and, different books such as the *Martindale (2001)*, the *Handbook on injectable drugs (Trissel, 1994)* and *La revue Prescrire* journal. Concerning drug interaction, the lapse of time that exists between year of publication and its integration into the database of the French drug agency was explained to residents and examples were given. For total parenteral nutrition, residents were taught how to calculate energy expenditure and to determine the required amounts of macro and micronutrients as described in two consensus conferences and in the ASPEN recommendations (Anonymous, 1994; Anonymous, 1997; National Advisory Group on Standards and Practice Guidelines for Parenteral Nutrition, 1998).

Evaluating the training program

The study was carried out in three clinical wards: surgery, hepatogastroenterology and emergency unit. Prescription analysis was performed weekly in the two first departments and daily in the emergency unit. The program ran from June 1998 in the surgery unit to the end of 2003. Prescription analysis began later in the other units: May 1999 in the hepatogastroenterology unit and January 2001 in the emergency unit. The survey was carried out over two time periods: Phase 1 (pre-implementation of the training program) ran from June 1998 to October 2002; and Phase 2 (after implementation of the training

program) ran from November 2002 to December 2003.

The criteria for assessing the level of performance of the residents was the type and frequency of interventions performed. Residents' results were compared before and after the training program was set up in November 2002, using the chi square test. A p value < 0.05 was considered significant.

The number and nature of interventions carried out by residents during prescription analysis was also compared with those of a clinical pharmacist, with 15 years of experience. This pharmacist had attended training programs such as those led by the medical journal *La Revue Prescrire* (Broclain et al., 1998). Furthermore, this practitioner met the required criteria necessary to supervise the residents, as described by the American Society of Hospital Pharmacists (ASHP) Accreditation Standards (ASHP Report, 1994).

Each time a pharmaceutical intervention occurred, the intervention date, the patient's name, age and sex, and the type of intervention were recorded in a notebook. "Drug-related problems" were sub-coded into ten categories: non-conformity to guidelines or contra-indication; improper administration; over dosage; drug interaction; drug use without indication; sub therapeutic dosage; untreated indication; drug monitoring; adverse drug reaction; and, failure to receive drug. "Pharmacist's recommendation" was sub-coded into seven categories: dose adjustment; drug switch; drug discontinuation; administration modality optimization; drug monitoring; change of administration route; and, addition of a new drug (Conort et al., 2004). Each intervention recorded in the notebook was then transferred onto an Access spreadsheet created by the SFPC.

Table I. Nature and frequency of pharmaceutical interventions made by the residents before and after the training program.

	Before training program (1998–2002)	After training program (2002–2003)	χ^2 values (p values)
Prescriptions analysed	4458	2731	
Number of interventions (percentage of prescriptions analysed)	279 (6.3%)	330 (12.1%)	74.1 ($p < 0.001$) S
Nature of intervention		Frequency (percentage of prescriptions analysed)	
1 Non conformity to guideline or contra-indication	12 (0.3%)	24 (0.9%)	145.4 ($p < 0.001$) S
2 Untreated indication	1 (0.02%)	34 (1.2%)	52.24 ($p < 0.001$) S
3 Subtherapeutic dosage	2 (0.04%)	4 (0.15%)	2.099 ($p = 0.20$) NS
4 Overdosage	95 (2.1%)	106 (3.9%)	19.09 ($p < 0.001$) S
5 Drug use without indication	16 (0.4%)	6 (0.2%)	1.075 ($p = 0.30$) NS
6 Drug interaction	99 (2.2%)	83 (3%)	4.597 ($p < 0.05$) S
7 Adverse drug reaction	0	0	NA
8 Improper administration	51 (1.1%)	58 (2.1%)	10.88 ($p = 0.001$) S
9 Failure to receive drug	3 (0.07%)	14 (0.5%)	14.23 ($p < 0.001$) S
10 Drug monitoring	0	1 (0.04%)	NA

NA: not applicable; NS: no significant differences; S: significant differences.

Results

A total of 16019 prescriptions were analyzed between 1998 and 2003. Of these, 7189 (44.9%) were analysed by a resident, and 8830 (55.1%) by the practitioner. Ten residents participated in the survey.

The nature and frequency of pharmaceutical interventions made by residents before and after the implementation of the training programme were compared and presented in Table I.

Comparisons between the nature and frequency of pharmaceutical interventions made by the practitioner and residents before and after the program are presented in Table II.

Table I shows 279 interventions were made by residents before the training program (6.3% of the analyzed prescriptions) compared to 330 interventions (12.1%) after the program ($\chi^2 = 74.11$, $p = 0.001$), a significant difference in residents' performances, particularly in the following types of intervention: non-conformity to guidelines or contra-indication; untreated indication; over dosage; drug interaction; improper administration; and, failure to receive drug. Before November 2002, the residents' detection of *improper administration* mainly reflected switching from intravenous to oral step-down therapy. The frequency of residents detecting errors relating to failure to receive drugs were lower compared to those of the practitioner (Table II). After the training program (Phase 2), the frequencies were similar. Nevertheless, it should be noted that the residents were less efficient than the practitioner, even after the training program for errors concerning untreated indication and drug interaction.

Details of the interventions showed that those relating to untreated indication corresponded most of the time to a lack of calcium, magnesium, phosphorus, vitamins, trace elements and lipids for patients treated with parenteral nutrition. Interventions concerning *failure to receive drug* generally corresponded to physicochemical incompatibilities between injectable drugs administered in the same bottle or infusion line. Table II shows that the number of incompatible injectable drugs admixtures detected by the residents was lower than that of the practitioner's. Ten different injectable admixtures were identified by the residents compared to 24 by the practitioner.

Residents detected significantly more overdoses than the practitioner on the whole period (1998–2003). One hundred and eighty-six overdoses (2.1% of the analyzed prescriptions) were detected by the practitioner versus 201 by residents (2.8% of the analyzed prescriptions) ($\chi^2 = 7.99$, $p < 0.01$). Overdoses detected by the practitioner involved 37 different drugs versus 33 for the residents. Descriptions of the interventions indicated that the practitioner intervened nine times on ofloxacin for severe kidney failure with a creatinine clearance below 20 ml/min, compared to

Table II. Nature and frequency of pharmaceutical interventions made by the practitioner and residents before and after the training program.

	Before training program (1998–2002)			After training program (2002–2003)		
	Practitioner	Residents	χ^2 values (p values)	Practitioner	Residents	χ^2 values (p values)
Prescriptions analysed	6035	4458		2795	2731	
Number of interventions (percentage of prescriptions analysed)	535 (8.9%)	279 (6.3%)	24.34 ($p < 0.001$) S	387 (13.8%)	330 (12.1%)	3.80 ($p = 0.05$) NS
Nature of intervention	Frequency (percentage of prescriptions analysed)	Frequency (percentage of prescriptions analysed)	Frequency (percentage of prescriptions analysed)	Frequency (percentage of prescriptions analysed)	Frequency (percentage of prescriptions analysed)	Frequency (percentage of prescriptions analysed)
1 Non conformity to guidelines or contra-indication	24 (0.4%)	12 (0.3%)	1.23 ($p = 0.30$) NS	29 (1%)	24 (0.9%)	0.37 ($p = 0.90$) NS
2 Untreated indication	44 (0.7%)	1 (0.02%)	29.98 ($p < 0.001$) S	55 (2%)	34 (1.2%)	4.55 ($p < 0.05$) S
3 Subtherapeutic dosage	4 (0.07%)	2 (0.04%)	0.20 ($p = 0.90$) NS	1 (0.03%)	4 (0.15%)	1.87 ($p = 0.20$) NS
4 Overdosage	100 (1.7%)	95 (2.1%)	3.16 ($p = 0.10$) NS	86 (3.1%)	106 (3.9%)	2.66 ($p = 0.20$) NS
5 Drug use without indication	22 (0.4%)	16 (0.4%)	0.002 ($p = 0.90$) NS	10 (0.4%)	6 (0.2%)	0.91 ($p = 0.50$) NS
6 Drug interaction	209 (3.5%)	99 (2.2%)	13.89 ($p < 0.001$) S	117 (4.2%)	83 (3%)	5.20 ($p < 0.05$) S
7 Adverse drug reaction	1	0	NA	0	0	NA
8 Improper administration	102 (1.7%)	51 (1.1%)	5.32 ($p = 0.05$) S	66 (2.4%)	58 (2.1%)	0.35 ($p = 0.90$) NS
9 Failure to receive drug	29 (0.5%)	3 (0.07%)	14.4 ($p < 0.001$) S	22 (0.8%)	14 (0.5%)	1.60 ($p = 0.30$) NS

NA: not applicable; NS: no significant differences; S: significant differences.

six times for the residents. On the other hand, for the same drug, the practitioner intervened 27 times for slight to moderate kidney failure versus 42 times for the residents. The performance of residents was equivalent to the practitioner's for *non-conformity to guidelines or counter-indication, drug use without indication and improper administration*.

The category *adverse drug reaction* corresponds to adverse drug effect notifications. This data has not been included in our results as serious adverse drug effects were recorded elsewhere for this period.

Discussion

The objective of this work was to assess the effect of a training program on the performance of pharmacy residents in the field of prescription analysis.

The overall results show that the implementation of a training program improved the residents' efficiency in prescription analysis. However, taking into account the different categories of drug related problems, this improvement was variable from one category to another. Concerning physicochemical incompatibilities between injectable drugs, residents' interventions were non-existent prior to the training program. After the training program, residents intervened more frequently on this type of drug-related problem, learned to control drugs administered by intravenous route more often at the time of prescription analysis, and learned to refer to documents dealing with physicochemical incompatibilities. However, the practitioner intervened on more injectable drug admixtures than residents over the whole period of the study.

It was also noted that residents rarely gave an opinion in the field of parenteral nutrition (TPN). This is surprising as the role of the pharmacist in parenteral nutrition is well documented in literature (Bonaf, 2000). Although residents attended teaching courses in the field of nutrition, academic programs and hospital residency training are not coordinated and residents often do not manage to put into practice the theoretical knowledge acquired. It is likely that pharmacy residents do not use or need this knowledge in everyday practice outside the field of prescription analysis, and that this knowledge is soon forgotten after graduation. The implementation of the new training program appeared to improve residents' interventions in this area (*untreated indication*) but performance remained lower when compared to that of the practitioner.

Some explanations can be offered for this. First, it is possible that residents consider interventions in the field of parenteral nutrition of minor importance compared with overdosage, for example. Second, Lanoir, Chambrier, Colin, Vergnon, and Bouletreau (1996) revealed poor prescription practices and slow improvement (Lanoir et al., 1998) in France in the field of TPN. In our hospital, it has been observed

that physicians frequently do not change their TPN prescriptions after the pharmacist's opinion has been given. It is also possible that residents felt discouraged and decreased their intervention rate. This point could be an area for further research.

Concerning the category *drug interactions*, interactions not yet reported in the Vidal[®] dictionary but drawn from different articles and listed in available tools were absent from the interventions of the residents. For example, the oral anticoagulant-tramadol interaction was not identified by the residents (Scher, Huntington, & Vitillo, 1997; Sabbe, Sims, & Sims, 1998; Chiffolleau et al., 2003). We also observed that residents identified significantly more overdosages than the practitioner. One of the reasons is that residents intervened for all types of kidney failure, from slight to severe types whereas the practitioner intervened only for severe cases. We could speculate about the relevance of some of the opinions given by residents.

This study has several limitations. First, this work assessed a pharmacy residents' training program. This training can be fundamentally questioned since the practitioner had not been trained as a student supervisor and it is not known whether his supervision was sufficiently valid to guarantee the efficiency of the residents' practice. In France, there are few university professors who are involved in both routine clinical pharmacy practice and patient care programmes. Moreover, there are no specific guidelines for pharmacy residents' clinical supervision.

Another limitation of our study was the choice of the criteria to assess the level of performance of the residents (type and frequency of interventions performed). We did not consider qualitative criteria such as behaviour, communication skills and intervention relevance. Nor does our study deal with residents' behaviour with physicians: for example, how comfortable is the resident in discussions with the physician when he detects an inadequate prescription? The mode of social interaction between the pharmacy resident and the prescriber has not been examined. We could have assessed the prescriber's level of acceptance of pharmacy residents' recommendations on drug-related problems (Allenet et al., 2004).

In addition, analysis of how residents practice in their working environment, such as use of additional databases, systematic checks of interaction lists, was not performed. The residents' assessment could be complemented with direct observations of residents' practice in order to estimate how they use the different tools available. The occasional observation of residents and of their way of working shows that they rarely make a bibliographic search to solve a problem. When analyzing prescriptions, they only use the Vidal[®] dictionary. These results and observations lead us to think that it is not the residents' knowledge but their behaviour that is an issue.

A further shortcoming of this study was the comparison of residents' interventions with those of only one practitioner. However, only one practitioner was available during the period of study. In addition, it cannot be guaranteed that all possible interventions were identified. A major intervention may have been missed either by residents or by the practitioner. Moreover, the practitioner's own performance is relative. For example, in the field of interactions, the ability of pharmacists to identify potential drug interactions was studied (Weideman, Berstein, & McKinney, 1999). This study showed that the performance of an experienced pharmacist in the detection of drug interaction is not optimal when compared with that of a computer.

The performance of the ten residents were assessed. Indeed, some will inevitably be better than others, but this aspect was not assessed. Individual performance was not examined and personalized feedback was certainly insufficient. Providing more individual feedback and increasing clinical supervision are probably the priorities to improve residents' performances (Abel et al., 2004). Performance in the field of prescription analysis should be assessed at appropriate intervals and be supported by evidence of practice activities in the form of a portfolio (Aslani et al., 2002; Shankar Ravi, Mishra Shenoy & Partha, 2003).

Another way to improve pharmacy residents' training would be to develop a set of guidelines. The literature search on pharmacy residency showed that very little is known about residents' professional functions and the knowledge necessary to practice in France. Moreover, no published studies were found concerning the assessment of pharmacy residents' abilities in France and there were no guidelines for practitioners to evaluate the residents objectively. It appears necessary to develop a competency grid in the field of prescription analysis. A pilot study investigated junior grade hospital pharmacists' performance across a range of skills, using a previously designed and evaluated competency assessment grid (Goldsmith et al., 2003). One of the aims of the competency grid was to provide clear guidance on what constitutes a competent practitioner and therefore aid judgment of performance. The findings of this pilot study show that the introduction of a competency framework had significant positive effects on the competency of junior grade hospital pharmacists, compared to those obtained by a control group.

Conclusion

The results of this study indicate that the implementation of a new training program improved pharmacy residents' performance in the field of prescription analysis, but that it had limitations. They allowed us to identify shortcomings, especially a lack of opinion concerning the information listed in internal documents

or in different databases (drug interaction and physicochemical incompatibility) and in the field of parenteral nutrition. This work raises important questions such as why the use of available tools is not optimal and how comfortable do residents feel in their exchanges with physicians. Answers will be obtained by studying their behaviour. Such a study opens up perspectives of collaborations with social sciences researchers.

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