Trabajo Fin de Máster

Economic impact about the implementation of a pharmaceutical attention program in one Emergency Department

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Resumen

Introducción: Los problemas relacionados con la medicación (PRM) son eventos o circunstancias involucrados en la farmacoterapia que interfieren real o potencialmente con los resultados de salud deseados. Mejorar la seguridad de los medicamentos tiene un gran potencial y las intervenciones por parte de los farmacéuticos clínicos pueden expandirse como un mecanismo para mejorar los resultados en la seguridad de los medicamentos, así como el uso de recursos sanitarios. Los servicios de urgencias (SU) representan el dispositivo sanitario que atiende a más pacientes tras la atención primaria y la atención ambulatoria y son un entorno con un riesgo especialmente alto para desarrollar PRM.

Objetivo: El objetivo de este estudio es realizar un análisis del impacto económico de la implementación de un programa de atención farmacéutica (PAP) en el SU.

Material y métodos: Estudio retrospectivo, observacional, unicéntrico, que incluyó todos los PRM detectados prospectivamente, en un hospital de tercer nivel, tras la implantación de un PAP en urgencias durante 30 meses. El PAP consistió en la revisión diaria de las prescripciones médicas de los pacientes atendidos en urgencias.

Resultados: se detectaron un total de 3.082 PRM. La potencial reducción de costes durante el periodo de estudio ascendió a 742.779 USD, mientras que el coste de incluir un farmacéutico clínico en el SU fue de únicamente 18.000 €. Se realizó un subanálisis sobre la terapia anticoagulante y se observó una reducción significativa de los eventos adversos por medicamentos (OR 3,62 IC95 (1,92-6,85), p<0,001 para la aparición de eventos adversos cuando no se aceptó la intervención farmacéutica), lo que supuso una potencial reducción de los costes de 179.641,90 USD.

Conclusión: la implementación de PAP en un SU es una iniciativa que puede optimizar la utilización de recursos sanitarios. Existe la necesidad de desarrollar estudios prospectivos y ensayos clínicos controlados aleatorizados para disponer de evidencia de alta calidad sobre la implementación de este tipo de programas.

Palabras clave: problemas relacionados con la medicación (PRM), urgencias, programa de atención farmacéutica, efectos adversos, evitación de costes.

Abstract

Introduction: Drug Related Problems (DRP) are events or circumstances involved in pharmacotherapy that actually or potentially interfere with desired health outcomes. Improving medication safety has a great potential and that interventions to leverage clinical pharmacists can be expanded as a mechanism to improve medication safety outcomes and also health care resources. Emergency departments (ED) represent the health device that treats more patients after primary care and ambulatory care and are an environment with a particularly high risk to develop DRP.

Objective: The objective of this study is to perform an analysis of the economic impact about the implementation of a pharmaceutical attention program (PAP) at the ED.

Material and methods: One center, observational, retrospective study that included all the DRP detected prospectively, in a tertiary hospital after the implementation of a PAP in the ED during 30 months. PAP consisted on a daily review of medical prescriptions of patients attended at ED.

Results: a total of 3,082 DRP were detected. The potential cost avoidance during the study period rose to 742,779 USD, while the cost of including a clinical pharmacist at the ED was only 18,000 €. A sub analysis about anticoagulant therapy was performed, and a significant reduction of adverse drug events was observed (OR 3.62 IC95 (1.92-6.85), $p<0.001$ for apparition of adverse events when the pharmaceutical intervention was not accepted), meaning a cost avoidance of 179,641.90 USD.

Conclusion: the implementation of PAP in an ED us a cost avoiding initiative. There is a need for developing prospective studies and randomized controlled clinical trials in order to dispose of high quality evidence about the implementation of these kind of programs.

Keywords: drug-related problems (DRP), emergency department, pharmaceutical attention program, adverse events, cost avoiding.

Contents

Introduction

Drug Related Problems (DRP) are events or circumstances involved in pharmacotherapy that actually or potentially interfere with desired health outcomes (1). These have been associated with an increase in morbidity and mortality, so their early detection is essential in order to increase safety in the use of medication (2,3). Moreover, DRP and medication errors (ME) have been also related with a longer hospital stay and increased cost of hospitalization (3,4). Factors such as age, number of concomitant drugs and comorbidities have been associated to DRP and ME developing (5).

In fact, the "ADE prevention Study" (6) was one of the first prospective studies that estimated that 6.5% of inpatients had suffered an adverse event, and about 28% of that were related to DRP and ME. This result estimated an annual cost of 2.8 million dollars for a 700-bed hospital.

Also, in the OECD Health Working Paper called "The economics of medication safety" (7), authors refer that one of every 5 patients experience medication-related harms during hospitalization. That means that, among the costs from avoidable admissions and the prolonged length of stay of patients derived from preventable medication related problems, costs over 54 billion dollars annually in OECD countries. They conclude that improving medication safety has a great potential and that interventions to leverage clinical pharmacists can be expanded as a mechanism to improve medication safety outcomes (7).

Emergency departments (ED) represent the health device that treats more patients after primary care and ambulatory care (8). Besides that, diversity of professionals that are working on ED, patients' clinical variability (high number of comorbidities, polypharmacy, elder age) and the elevated care pressure, transforms ED into an environment with a particularly high risk to develop DRP and ME (9).

DRP can be avoided or minimized by introducing alerts in the computerized electronic prescription systems (10), that is, through preventive actions. However, these processes could be optimized through the integration of a health professional specialized in the drug, such a clinical pharmacist (CP).

Recent experiences have demonstrated that the introduction of a CP at ED resulted in better health outcomes for patients and fewer DRP and ME (11–15).

Objective and hypothesis

The objective of this study is to perform an analysis of the economic impact about the implementation of a pharmaceutical attention program (PAP) at the ED. The hypothesis of this study is that the implementation of a PAP at the ED results in a cost avoiding initiative and useful to improve patients' outcomes.

Material and methods

Study design

One center, observational, retrospective study that included all the DRP detected prospectively, in a tertiary hospital after the implementation of a PAP in the ED between July 2020 - December 2022 (30 months).

The study took place in a tertiary university hospital that provides 431 beds and receives around 40,000 emergency patients/year.

Setting and patient population

PAP consisted on a daily review of medical prescriptions of patients attended at ED. Computerized physician order entry (CPOE) is operational for ED patients. This CPOE incorporates a pharmacy warning system (PWS) that generates drug alerts based on demographic, drug and laboratory test data. Both CPOE and PWS have been described previously (10). Due the available time destinated to that PAP, prescriptions were only reviewed once a day and from Monday-Friday; once a DRP was detected a recommendation was made, and could be accepted or not by physicians.

Data collection

All data was prospectively collected; data collected: demographic (sex, age), physician specialty, medical or surgical service, DRP detected (following an adaptation of the Pharmaceutical Care Network Europe Classification v.9.01 (PCNE) (16), grouping DRP in the following: incorrect dose or frequency, adjustment due to physiological alteration such as renal or hepatic insufficiency, obesity or low weight, prescription error derived from CPOE use, interactions, indication, administration, effectiveness, duplicity, analytical alteration, drug not included in the formulary and others), drug involved on the DRP according to the Anatomical Therapeutic Chemical Classification System (ATC) (17). DRP were also categorized and monetized following a previous published study about critical care and ED interventions performed by pharmacists (18), where the authors propose a cost avoidance per intervention depending on the severity and relevance of it.

Sub analysis

Since anticoagulant agents are classified as a risk medication (19), which means that have a higher probability of causing serious or even fatal harm to patients, and their right management is crucial for preventing both comorbidities and adverse events, we performed a sub analysis studying the incidence of adverse events in those patients presenting a DRP where an anticoagulant was involved.

Statistical analysis

Absolute and relative frequencies were used for categorical variables, while mean and standard deviation for quantitative variables. A univariate analysis of the data was performed to determine the possible relationship between acceptance of the pharmaceutical intervention and presence of adverse event in the sub analysis of anticoagulant DRP. p-values lower than 0.05 were considered statistically significant. To compile all data and to perform the statistical analysis Microsoft® Excel v.16 was used and SPSS 25.0 statistical package (IBM Corp. New York. United States) were used, respectively.

Results

A total of 3,082 DRP were detected in 98,776 patients who received at least one drug (3.1%) during the study period. Half of them (51.1%) were detected in men, with a mean age of 72.8 (16.4) years. Three fourths (72%) corresponded to medical specialties. The main specialties where a DRP was detected were Medical Emergencies 1175 (38.1%), General Surgery 305 (9.9%), Traumatology 293 (9.5%), Cardiology 204 (6.6%), Pneumology 185 (6.0%), Vascular Surgery 143 (4.6%), Infectious Diseases 137 (4.4%) and Digestology 123(4.0%).

The most common involved drugs were: J01 (antibacterials for systemic use): 662 (21.5%); B01 (antithrombotics): 352 (11.4%); R03 (drugs for airway obstruction); S01 (ophthalmology): 178 (5.8%); A02 (drugs for gastric secretion): 157 (5.1%); H03 (thyroid therapy): 142 (4.6%); J05 (antivirals for systemic use): 129 (4.2%). Among the 3,082 detected DRP, those representing more than a 10% were: 554 (18%) incorrect dosing (554 (18%), adjustment due to pathophysiological alteration (renal and hepatic failure, obesity, low weight (533 (17.3%)), CPOE prescription error (439 (14.2%)), interactions 373 (12.1%) and related to indication (372 (12.1%)). Rest of the information about DRP detected is available at table 1.

The result of the pharmaceutical intervention (accepted/not accepted) was evaluable in the 88.5% (2,728/3,082) of the detected DRP, presenting an acceptance of 76% (2,066/2,728).

Following the Hammond classification (18), we found 382 (12,40%) DRP related to section 1: adverse drug event prevention, 86 (2,80%) in section 2: resource utilization, 1,462 (47,4%) in section 3: individualization of patient care, 20 (0,7%) in section 4: prophylaxis, none on section 5: hand-on-care and 713 (23,1%) in section 6: administrative and supportive tasks. According to that classification, a total of $ 742,779 USD (876,479.25 €) was potentially avoided. On the other hand, 419 (13,6%) could not be classified following Hammond criteria (those were related to prescription errors derived from CPOE use). However, since not all interventions could be evaluated and not all of them were accepted (2,066/2,728), the actual potential cost avoided would be $ 526,950.77 USD (621,801.90 €). The main intervention was the one related to dose adjustment: no continuous renal replacement therapy (1,165 (37,80%), which belongs to section 3: individualization of patient care), followed by therapeutic interchange (390 (12,70%) which belongs to section 6: administrative and supportive tasks) and drug information consultation (323 (10,50%) which also belongs to section 6: administrative and supportive tasks). DRP interventions following Hammond classification and cost avoidance detailed in table 2.

The salary destined into hire a CP who can develop this PAP was a total sum of 18.000 €. Euro-dollar divisa was 1,18 USD per euro in 2018. Taking into account only the evaluable interventions and also those that were accepted (2,066/2,728), represents a potential cost avoidance of $526,950.77 USD. Purchasing 2018 divisa (since the cost avoidance is calculated by 2018), that would represent a potential cost avoidance of 621,801.90 €. If the reference is 2019 divisa (since the amount of money destined to the PAP was approved in 2019), that would represent a potential cost avoidance of 584,915.36 €. Both scenarios show that potential cost avoidance of the PAP exceed the cost of a CP. Also, since the PAP last for 30 months, the avoidance per month would be 20,726.73 € (€ divisa 2018) and 248,720.76 €/year. Details showed in table 3.

Between antithrombotic DRP problems (352 (11.4 %), which include antiplatelet therapy and anticoagulation therapy, 296 were related to anticoagulation therapy. Almost half of the DRP detected were adjustments for renal function (127 (43.1%)), followed by 60 (20.3%) incorrect dose, 45 (15.2%) analytical abnormalities, 24 (8.1%) prescription errors related to CPOE, 16 (5.4 %) duplicate prescriptions, 16 (5.4%) indication errors, 5 (1.7%) interactions and 3 (1.0%) others.

A total of 45 (15.2%) patients presented an adverse event related to the anticoagulation therapy (AERAC) (42 (93.3%) were hemorrhages (22 (48.9%) bruising, 11 (24.4%) gastrointestinal bleeding, 4 (8.9%) hematuria, 2 (4.4%) epistaxis/hemoptysis and 3 (6.7%) other locations), 2 (4.4%) thrombocytopenia and 1 (2.2%) and thromboembolism associated with peripheral insertion central catheter. A higher proportion of AERAC was identified in those patients who the pharmaceutical intervention was not accepted front those patients who the pharmaceutical intervention was accepted (31.5% vs 13.0%), resulting in an OR of 3.62 IC95 (1.92-6.85), $p<0.001$) after performing a univariate analysis.

These results show a relative reduction of the risk (RRR) to develop an adverse event related to anticoagulant therapy of 58.7% and an absolute reduction risk (RAR) of 18.5%, which means that for every 5,40 pharmaceutical interventions on anticoagulant therapy, one adverse event is avoided (NNT=5.40) cost avoidance for anticoagulant therapy management has a value of $ 683.78 USD (806.86€). Moreover, categorizing anticoagulant therapy adverse events as major adverse events (due its repercussion and risk medication characteristics), the prevention of each one has a value of $ 3,277.25 USD (3,867.16 €). With this information we can assume that regarding only anticoagulant DRP, the PAP represented a cost avoidance of $ 179,593.30 USD (211,920.37 €): 54.8 major adverse drug events avoided in a total of 296 DRP. Details described in table 4.

Discussion

This study shows de high potential cost avoidance that represents the implantation of a PAP in an ED. While the cost of a pharmacist dedicated to this area seems to be low, the correct management and potential adverse events avoidance overtake the expenditure on it. Moreover, this avoidance derivates from a slight intervention, since the PAP implemented consisted in a non-full-time dedication from the pharmacist. Moreover, the PAP implementation with a full-time pharmacist would represent a cost avoidance higher than 200.000 € since a full-time pharmacist salary is around 50.000 €/year and the estimated avoided cost/year in this study rises to 248,720.76$/year.

Other published experiences support these results; a similar study performed by Rech et.al (20) showed that pharmacist involvement in an ED setting resulted in a significant cost avoidance, predominantly in the area of hands-on patient care and also in ADE prevention. Our results show no cost avoidance on the hand-on patient care section since our program stills no contempt bed-side actions and is limited on a remote drug prescription review only.

On the other hand, our results are in consonance regarding ADE prevention, since more than the half of our potential cost avoidance is related to this section. Moreover, Rech et. al highlight that the most frequent type of intervention was those related with patient individual care, which was the most frequent type of intervention performed in our study, representing half of the interventions (47.3%).

Another study published by Bankes et. al (21) evaluated a medication safety system that consisted on a technology developed to identify and prioritizes patients whom medication should be reviewed. Their objective was to demonstrate that the implementation of that system was associated to health care resource utilization and better health outcomes. They observed a reduction on both costs and better health outcomes such as less mortality, hospital admissions and revisits to the ED. Unlike the study performed by Bankes et. al, our study is designed to calculate the potential cost avoidance and not the actual cost reduction; nevertheless, our results are in line with the one previously reported since we have also explored health outcomes such as adverse events derived from anticoagulant therapy. As they observed a significant reduction on mortality and complications, also observed a reduction of adverse events in those patients who the pharmaceutical intervention was

accepted, witnessing a reduction from 31.5% of adverse events to a 13% (and an OR of 3.62). This has been also directly correlated with a cost avoidance of $179,641.90.

Even though there is data available about drug-related admissions to ED and their potential impact (22–24), there is a lack of evidence on results about the economic impact of pharmacist interventions in ED. However, as we've seen, in the recent years this has been a hot topic that tries to elucidate data about the implementation of PAP in ED. In fact, there's a published protocol of a systematic review and meta-analysis about randomized and controlled clinical trials that has as objective evaluate pharmacists interventions and their impact on clinical and economic outcomes (25). The present study pretends to reveal some new evidence about that topic.

Although the benefit of the implantation of a PAP it is clear, there's a need to standardize or have a disposition of better measurable items in order to perform a more precise cost analysis of these kind of initiatives. The proposal from Hammond et al (18) is one of the only references about the potential cost avoidance, not only in ED but in critically ill patients, which is one of the main limitations: even several patients admitted at the ED are in a critically ill situation, we also find patients in less severe situations and the repercussion of DRP could vary. Moreover, this proposal is elaborated from a review of several publications referenced from a wide time window, then the costs, medical procedures, type of medication is expected to be heterogeneous. For these reasons, a more approachable and standardized values are needed.

Additionally, it should be noticed that depending on the kind of hospital, range of patients and diseases attended, and activities performed, calculated cost can oscillate. For instance, in a work elaborated by Saito et. al (15), detected that ME could decrease from a 90.5% to a 9.5% with the physical presence of a pharmacist at the ED: since our PAP did not include by the time a physical pharmacist, and all DRP were detected remotely (review of medical orders from pharmacy), it is expected that a lower number of interventions can be performed. As we've seen in our results, there are a high number of categorized activities or interventions that can be performed by pharmacist, that have not been done in our program, such as hand-on bed section. On the other hand, we can observe that in our setting, almost one fourth of the interventions could not be classified in any of the Hammond sections.

Even adverse drug events prevention is not one of the most frequent interventions, represents the one with more cost avoidance. This could be related with the results observed in the anticoagulant sub analysis, where the pharmaceutical intervention has an influential role. The significant reduction of hemorrhages and adverse events related with blood coagulation suppose a reduction of admission days, complications, morbidity and, subsequently, a reduction of costs. In fact, during the last years, evidence about the benefits of anticoagulant stewardship programs have been released (26–28). These results could be interesting to focus the resources and kind of interventions performed by the PAP in those activities with more potential benefits, both clinical and economic.

A recent study published by Goulas et. al(14) which objective was to analyze discrepancies between physicians' medication list and pharmacists' medication list, showed that the 93.1% of patients had at least one ME, and that 23.1% of the ADE could have not been detected if the pharmaceutical intervention would have not existed. As we found in our study, some of the prevented adverse events related are due omission of the usual patients' medication.

This study has some limitations: the first, is that is a one center study and results should be carefully taken when extrapolated. Also, besides from anticoagulants, health results could not be evaluated, then the avoidance derived from medical errors is hard to estimate, since standardized interventions and proposed cost avoidance could be over or underestimated. Moreover, we did not conduct a register about all conciliated patients, nor drug information consults performed during the study period, then a potential higher cost avoidance could be displayed. Nevertheless, this study has some strengths: the high number of interventions and the long study period provide us consistent evidence about DRP in our setting. Additionally, since the PAP was performed by a single pharmacist, there is no possible bias regarding the interventions and their classification.

Conclusion

The implementation of a PAP in an ED could be a cost avoiding initiative, since the potential expenses evaded surpass the budget dedicated to a clinical pharmacist hiring. Focusing on those risk medication with higher probability of induce several adverse events, such anticoagulants, could be a good strategy to optimize the PAP. Nevertheless, there is a need for developing more prospective studies and randomized controlled clinical trials, and also standardize indicators and kind of measures, in order to reveal high quality evidence about the implementation of these kind of programs.

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Table 1. Descriptive table: characteristics of drug-related problem (DRP) detected at the emergency department.

Variable	N	%
Total of DRP detected	3,082	100
Sex		
Male	1,575	51.1
Female	1,507	48.9
Age (years), mean (SD)	72.8	16.4
Drug-related problem (DRP) detected		
Incorrect dosing	554	18.0
Adjustment due to physiological alteration	533	17.3
CPEO prescription error	439	14.2
Interactions	373	12.1
Indication	372	12.1
Drug not included in formulary	196	6.4
Incorrect frequency	189	6.1
Administration	173	5.6
Effectivity	77	2.5
Duplicity	72	2.3
Analytical alteration	58	1.9
Others	46	1.5
Specialties*		
Medical emergencies	1,175	38.1
General Surgery	305	9.9
Traumatology	293	9.5
Cardiology	204	6.6
Pneumology	185	6.0
Vascular surgery	143	4.6
Infectious disease	137	4.4
Digestology	123	4.0
Internal medicine	91	2.9
Oncology	86	2.8
Psiquiatry	69	2.2
Urology	60	1.9
Neurology	38	1.2
Gynecology	25	0.8
Hematology	24	0.8
ATC group involved#		
J01: antibacterial for systemic use	662	21.5
B01: antithrombotic agents	351	11.4
R03: drugs for obstructive airway diseases	266	8.6
S01: ophtalmologicals	178	5.8

A02: drugs for acid related disorders	157	5.1
H03: thyroid therapy	142	4.6
C10: lipid modifying agents	139	4.5
J05: antivirals for systemic use	129	4.2
A12: mineral supplements	109	3.5
B03: antianemic preparations	82	2.7
N02: analgesics	81	2.6
N03: antiepileptics	68	2.2
C01: cardiac therapy	67	2.2
N06: psychoanaleptics	56	1.8
M01: antiinflamatory and antirheumatic products, non-steroids	53	1.7
N05: psycholeptics	51	1.7
C09: agents acting on the renin-angiotensin system	38	1.2
A10: drug in diabetes	36	1.1
G04: urologicals	35	1.1
N04: anti-parkinson drugs	33	1.1
Acceptation of pharmaceutical intervention		
Evaluable	2,728	88.5
Accepted (among evaluable)	2,066	76.0

*Specialties present in > 20 DRP; # ATC groups present in > 10% of DRP.

Table 2. DRP following Hammond criteria and cost avoidance.

Hammond criteria	**Section**	**Cost avoidance per criteria ($2018USD)**	**DRP following Hammond criteria, N(%)**	**Total cost avoidance (Number of DRP x cost avoidance) $2018USD**	**Total cost avoidance (Number of DRP x cost avoidance) 2018€ ***
Major ADE prevention	Section 1: adverse drug event prevention	3,277.25	40 (1.3)	131,090	154,686.20
Minor ADE prevention		380,16	75 (2.4)	28,512	33,644.16
Medication reconciliation resulting in major ADE prevention		3,277.25	54 (1.8)	176,971.5	208,826.37
Medication reconciliation resulting in minor ADE prevention		380.16	199 (6.5)	75,651.8	89,269.12
Recommended laboratory monitoring		380.16	14 (0.5)	5,322.2	6,280.20
Preventing unecessary labs and/or tests	Section 2: resource utilization	cost of test avoided	-	0	0
Prevention of inappropriate screening of heparin induced thrombocytopenia		778.93	-	0	0
Medication route: intravenous to oral conversion		Medication cost	11 (0.4)	< 100 $	< 100 €
Medication route: hypertensive crisis management		19,897.16	-	0	0
Medication route: resolving shock management		73.02	-	0	0
Discontinuation of clinically unwarranted therapy		66.94	75 (2.4)	5,020.5	5,924.20
Prevention of unnecessary high-cost medication		Medication cost	-	0	0
Dosage adjustment: continous renal replacement therapy	Section 3: individualization of patient care	2,492.03	-	0	0
Dosage adjustment: no continous renal replacement therapy		163.78	1,165 (37.4)	190,803.7	225,148.37
Antimicrobial therapy initiation and streamlining		602.52	63 (2.1)	37,958.8	44,791.38
Anticoagulant therapy management		683.78	125 (4.1)	8,597.5	10,145.05
Initiation of nonantimicrobial therapy		164.78	38 (1.2)	6,261.6	7,388.70

Antimicrobial pharmacokinetic evaluation		164.28	71 (2.3)	11,699.4	13,805.30
Total parenteral nutrition management		65.34	-	0	0
Change venous thromboembolism prophylaxis to most appropriate agent	Section 4: prophylaxis	82.11	-	0	0
Initiation of venous thromboembolism prophylaxis		1,618.84	7 (0.2)	11,331.9	13,371.64
Initiation of stress ulcer prophylaxis		55.45	13 (0.4)	720.9	851.84
Initiation of ventilator-associated pneumonia prophylaxis with chlorhexidine		633.26	-	0	0
Bedside monitoring	Section 5: hands-on care	380.16	-	0	0
emergency code blue participation		1,504.45	-	0	0
Rapid response team participation		164.78	-	0	0
Emergency code stroke participation		666.99	-	0	0
Emergency code sepsis participation		1,550.79	-	0	0
Blood factor stewardship		9,420.77	-	0	0
Emergency procedural sedation or rapid sequence intubation participation		271.38	-	0	0
Medication teaching or discharge education		670.64	-	0	0
Culture follow-up after emergency department discharge		670.64	-	0	0
Drug information consultation	Section 6: Administrative and supportive tasks	110.65	323 (10.5)	35,740.0	42,173.20
Drug information consultation: toxicology specific		415.30	-	0	0
Patient own medication evaluation		380.16	-	0	0
Therapeutic interchange		oral: 18.21; non oral 103.64	390 (12.7); oral 273 and non-oral 117	17,097.2	20,174.70 €
Pharmacist provided drug protocol management pursuant		106.98	-	0	0

to collaborative practive agreement					
Rejection of a restricted medication		385.10	-	0	0
Resume					
Hammond section	**DRP, N(%)**		**Cost avoided ($2018USD)**		**Total cost avoidance (2018€)***
Section 1: adverse drug event prevention	382 (12.4)		417,547.50		492,706.05
Section 2: resource utilization	86 (2.8)		5,020.50		5,924,20
Section 3: individualization of patient care	1462 (47.3)		255,321.00		301,278.80
Section 4: prophylaxis	20 (0.6)		12,052.80		14,222.30
Section 5: hands-on care	0 (0)		0		0
Section 6: Administrative and supportive tasks	713 (23.1)		52,837.20		62,347.90
Non classified	419 (13.6)		-		-
Total cost avoided			742,779		876,479.25

*Calculated using Dollar-euro divisa of 1,18 (available in 2018).

Table 3. Description of cost avoidance.

Description	$	€ 2018*	€ 2019[#]
Total potential cost avoidance[α]	742,779.00	876,479.25	824,506.90
Estimated cost avoidance[ϕ]	526,950.77	621,801.90	584,915.36
Estimated cost avoidance/month[ξ]	20,726.73	24,457.54	23,006.67
Estimated cost avoidance/year	248,720.76	293,490.50	276,080.04
Description	€	€*	€[#]
Pharmacist salary invested on the Project	18,000	-	-
Full-time pharmacist salary/year	50,000	-	-
Potential cost avoidance of the study[Ψ]	-	603,801.90	566,915.36
Potential cost avoidance with a full-time pharmacist/year	-	243,490.50	226,080.04

*Euro-dollar divisa 2018: 1,18.

#Euro-dollar divisa 2019: 1,11.

[α] Sum of all interventions classified following Hammond reference detailed in table 2.

[ϕ] Sum of all evaluable and accepted interventions: a total of 3,082, which 2,728 were evaluable and 2,066 accepted.

[ξ] The study period is 30 months.

[Ψ] Difference between total estimated cost avoided and investment (pharmacist salary).

Table 4. Anticoagulant therapy management avoiding cost

	Intervention accepted	Intervention non accepted	OR	P
Adverse events related to anticoagulant therapy	13.0%	31.5%	3.62 IC95 (1.92-6.85)	<0.001
Relative reduction risk (RRR)	58.7%			
Absolute reduction risk (RAR)	18.5%			
NNT	5.40			
Number of ADE prevented*	54.8			
Major ADE prevention cost	3,277.25$		3,867.16€	
Anticoagulant therapy ADE avoided cost[#]	179,593.30$		211,920.37€	

*Calculated from the 296 DRP detected and a NNT of 5.4

#Calculated from the number of ADE prevented and the cost of ADE prevention

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