TEACHERS' TOPICS

An Anticoagulation Therapy Elective for Third-Year Pharmacy Students

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Objective. To develop an anticoagulation elective course for third-year pharmacy students to enhance their knowledge and skills for providing anticoagulation services.

Design. Content developed for the course focused on standards of care, evaluation of primary literature, clinical application, billing and regulatory issues, written and verbal communication, and patient education. Teaching methods included lectures, discussions, demonstrations, and self-directed learning.

Assessment. Assessment methods included multiple-choice examinations, evaluation of patient cases, student presentations, and a practical examination. Students demonstrated competencies in multiple areas and rated the course favorably. Students who completed the elective reported being more prepared for anticoagulation activities than those who did not. Confidence levels regarding participation in anticoagulation services postgraduation were similar.

Conclusion. The elective provided valuable experience in anticoagulation therapy and increased students' perception of their preparedness related to dealing with anticoagulation issues while on advanced pharmacy practice experiences (APPEs). More exposure to management topics and the logistics of initiating anticoagulation services should be incorporated.

Keywords: anticoagulation, elective, curriculum, pharmacotherapy

INTRODUCTION

Anticoagulants used to treat and prevent thromboembolism are lifesaving therapies but also carry a significant risk of adverse events due to their low-therapeutic index, pharmacokinetic and pharmacodynamic variability, and increased propensity for drug, food, and disease interactions. While the incidence of hemorrhagic events associated with such therapies are relatively low in well-controlled clinical trials, a higher incidence has been observed in routine practice.¹ Anticoagulants account for more drug-related injuries in the hospital setting than any other medication class.² Because of concerns over hemorrhagic complications, warfarin therapy is often underutilized, exposing patients to undue risk of thromboembolism.³

The safe and effective use of anticoagulants is maximized when care is delivered through a systematic and coordinated fashion by knowledgeable and experienced clinicians. Programs that incorporate patient specific dosing, education, intense monitoring, and effective communication between health care providers have been shown to be superior to routine care.¹ The American College

of Chest Physicians advocates the use of anticoagulation management services (AMSs), which have demonstrated lower rates of hemorrhagic and thromboembolic events than other methods of management.⁴ The Joint Commission has recently added anticoagulation safety goals to their list of standards. Hospitals are now required to maintain specific programs and mechanisms with the goal to ensure appropriate anticoagulation monitoring, dosing, and education of both hospital staff members and patients.⁵ Pharmacists have and continue to play a vital and increasing role in the initiation and management of both inpatient and outpatient anticoagulation services.

The current curriculum at Auburn University Harrison School of Pharmacy (AUHSOP) includes several aspects of anticoagulation management. First- and second-year students are exposed to the pathophysiologic and pharmacologic aspects of thromboembolic disease and anticoagulant drug therapy through the Drugs and Disease sequence. Third-year students are given an anticoagulation case with approximately 9 hours of facilitated problem-based learning discussion and an additional 2 hours of clinical skills laboratory devoted to anticoagulation management issues. The difficulty of incorporating all aspects of anticoagulation therapy and adequately addressing the complexities of anticoagulation management in the core curriculum is an unfortunate reality. The need for more

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intense training in the specialized area of anticoagulation to better prepare students for advanced pharmacy practice experiences (APPEs) and clinical practice after graduation was recognized.

In 2007, a 2-credit-hour anticoagulation course elective was developed for third-year pharmacy students at AUHSOP. The aim of the course was to provide students with a working knowledge of both basic and advanced anticoagulation concepts sufficient to enhance their participation in anticoagulation services during their fourth year and provide a foundation for those who would manage and/or establish anticoagulation services in their practices after graduation.

The learning objectives for the course were for the students to be able to:

- (1) Demonstrate appropriate identification and use of anticoagulant references and resources.
- (2) Demonstrate a working knowledge base necessary for the appropriate assessment and treatment of conditions requiring anticoagulant therapy as it relates to indication, drug selection, dosing, duration of therapy, contraindications, interactions, monitoring, prevention, and adverse events.
- (3) Explain the multiple roles/responsibilities of pharmacists in the management of anticoagulant therapy related to policy/protocol development, consultation, education, and management.
- (4) Demonstrate an ability to make evidence-based pharmacotherapeutic decisions (both basic and advanced) regarding anticoagulant

therapy while also considering patient specific factors.

- (5) Identify and manage drug-induced complications related to anticoagulant therapy.
- (6) Recognize and differentiate severity of potential drug-interactions related to anticoagulant therapy with a focus on practical management.
- (7) Communicate accurate patient specific plans effectively in both written and verbal formats.
- (8) Display the skills necessary to effectively communicate advanced and/or controversial anticoagulant issues to physicians and other health care providers.
- (9) Demonstrate general literature evaluation skills through research of advanced or controversial anticoagulant therapeutic issues.
- (10) Provide appropriate patient counseling necessary for safe and effective anticoagulant therapy.

DESIGN

Multiple teaching methods were employed throughout the elective including traditional lectures, group discussions, demonstrations, and self-directed learning activities. The first 9 weeks of the course were composed of 6 traditional lectures, a discussion of medical legal issues, and 2 case-based reviews (Table 1). The lectures covered the following topics: introduction to anticoagulation therapy, hemostasis and thrombosis, heparins and direct thrombin inhibitors, warfarin (2 weeks), and antiplatelet therapy. Although certain assumptions were made

Table 1. Schedules for an Anticoagulation Therapy Elective Course

Week	2008	2009
1	Introduction to anticoagulation therapy	Introduction to anticoagulation therapy
2	Hemostasis and thrombosis	Hemostasis and thrombosis
3	Heparins and Direct thrombin inhibitors	Heparins and Direct thrombin inhibitors
4	Warfarin	Warfarin
5	Warfarin	Case-based review/Examination #1
6	Case-based review/Examination #1	Warfarin
7	Antiplatelets	Antiplatelets
8	Medical-legal issues	Medical-legal issues/Patient education/ Point-of-care testing
9	Case-based review/Examination #2	Case-based review/Examination #2
10	Student Presentations (2)	Student Presentations (2)
11	Patient education/ Point-of-care testing	Student Presentations (1)
12	Student Presentations (2)	Student Presentations (2)
13	Student Presentations (2)	Student Presentations (2)
14	Examination #3	Student Presentations (2)
15	Practical	Examination #3
16		Practical

concerning students' prior knowledge, core concepts necessary to understanding more complex issues and those traditionally more difficult for students to grasp were reviewed. The focus of the introduction to anticoagulation therapy lecture was to introduce students to the importance of anticoagulation management, the pharmacists' role in multiple settings, recommendations and components of AMS, current Joint Commission requirements, and reimbursement issues. The lecture on hemostasis and thrombosis was an in-depth review of normal hemostasis using demographics to provide a visual depiction of clot formation and the mediators involved, factors leading to inappropriate thrombus formation, and a review of the most common disease states encountered with anticoagulation therapy (ie, venous thromboembolism, atrial fibrillation, cerebral vascular accident, valvular heart disease, heart failure, and myocardial infarction). A significant amount of baseline knowledge was assumed for the encountered disease states; thus, more of a review format was used including the presentation and diagnosis of each disease state and current standards of care related to anticoagulation management. The 4 lectures covering drug therapies reviewed basic pharmacology but mainly addressed evidenced-based recommendations, patient-specific dosing considerations, monitoring considerations, and recognition and practical management of complications and interactions, as well as current controversial issues and clinical pearls.

The medical legal session was dedicated to a class discussion of issues in which students were asked to think through the drug distribution and patient care process and identify specific areas where drug errors or avoidable

adverse events could potentially occur. They were then given actual medical legal cases that described an incident with negative outcomes. The students were asked to discuss how the error could have been prevented or what systems could be developed to ensure similar errors were avoided in the future. The 2 case-based review sessions were held during the same class period, immediately before the first 2 examinations. Students were presented with actual scenarios and asked to discuss their assessments and recommendations. The discussions included the management strategies and outcomes for the cases presented.

Group Presentations

Students were required to complete a group presentation covering an advanced therapeutic or controversial issue. These were presented over the following 4 class sessions. Each group consisted of 2 to 3 students. Presentation topics were designated during the first class session (Table 2). Each group was assigned a faculty mentor with experience in anticoagulation management to provide guidance during the preparation of their presentation. Students were required to utilize both primary and tertiary literature and demonstrate an ability to retrieve, analyze, and synthesize available data in addition to demonstrating effective communication skills (both graphic and verbal). The presentations were approximately 45 minutes in length, allowing 10-15 minutes for questions. Two to 3 faculty members, including the group's mentor, were present for the presentation and grading. Grades were assigned based on the accuracy and comprehensiveness of information presented, as well as presentation style

Table 2. Presentation Topics of Pharmacy Students Enrolled in an Anticoagulation Therapy Elective Course

2008	2009
Anticoagulation treatment duration and intensity in idiopathic DVT	Optimal dose with warfarin initiation
Protein C-, S-, and Antithrombin deficiency	Anticoagulation treatment duration and intensity in idiopathic DVT
Antiphospholipid antibody syndrome	Protein C-, S-, and Antithrombin deficiency
Role of low dose vitamin K for INR stabilization and preferred route for treatment of supratherapeutic INRs	Factor V Leiden and Prothrombin mutation
Anticoagulation issues related to placement of IVC filters	Antiphospholipid antibody syndrome
Optimal model of anticoagulation management	Optimal model of anticoagulation management
	Role of low dose vitamin K for INR stabilization and preferred route for treatment of supratherapeutic INRs
	Role of thrombolytics in pulmonary embolism
	Role of warfarin in heart failure
	Role of warfarin in myocardial infarction

Abbreviations: DVT= deep vein thrombosis; INR= international normalized ratio; IVC= inferior vena cava

and ability for students to answer questions. This assignment accounted for 15% of their course grade.

Practical Examination

During a class session, students were provided with a demonstration of an outpatient warfarin visit, including the patient interview and point-of-care monitoring. They were required to discuss the components of patient education for both warfarin and low molecular weight heparin (LMWH) by specifying how they would phrase information and respond to difficult questions from patients. The final component of the course included a practical examination. Students were assessed on their ability to provide comprehensive and effective counseling to a patient new to either warfarin or LMWH therapy, as well as how effectively they handled patient questions. Students were aware of the 2 potential scenarios (warfarin or LMWH) prior to completing the practical examination, which comprised 5% of their course grade. Each student chose a 20-minute time slot to complete the practical. The topic chosen for completion and grading purposes was determined by a coin flip.

Patient Case Assignments

Throughout the course, students were given patient cases to complete outside of class. These were presented as 3 small cases or 1 main case with 2 varying “what if”

scenarios. Cases either reiterated issues covered in class or introduced new topics requiring additional out-of-class research for completion (Table 3). Although students were encouraged to work in groups to stimulate discussion and enhance the learning process, each student was expected to complete the case assignment individually. All cases were discussed the following week at the beginning of the class period. Students were assigned a completion grade (5% of their course grade) based solely on the number of weekly cases completed and then 3 cases were randomly selected for grading, each accounting for 10% of their course grade. Case grades were assigned based on accuracy, completeness, and appropriate documentation style (ie, the subjective, objective, assessment, plan or SOAP format).

EVALUATION AND ASSESSMENT

Thirteen students enrolled and completed the elective during the spring semester of 2008. The course assessments included 3 traditional multiple-choice examinations (2 covering the lecture material and 1 covering the topics presented by the students), the patient cases, their group presentation, and the final practical examination as described above. The average examination scores were 84%, 88%, and 95% (each accounting for 15% of their course grade). For the group presentation, all but one group scored above 80%, with a class average of 87%.

Table 3. Cases/Topics Assessed in an Anticoagulation Therapy Elective Course

Case	2008	2009
1	Inpatient initiation for VTE; LMWH in obesity; dosing of protamine	Inpatient initiation for VTE; LMWH in obesity; correction of HIT mismanagement
2	Evaluation and management of potential GI bleed; management of known warfarin drug interaction; management of unknown warfarin drug interaction	Outpatient warfarin management (initial hospital f/u post inpatient load with elevated INR); LMWH bridging for procedure
3	Medical legal cases (various)	Evaluation and management of potential GI bleed; warfarin management during dental procedure (high risk); warfarin management during dental procedure (low risk)
4	Warfarin management during dental procedure (high risk); warfarin management during dental procedure (low risk); LMWH bridging for procedure	Warfarin maintenance dose adjustments: subtherapeutic INR secondary to hypothyroidism, subtherapeutic INR secondary to missed dose, slightly elevated INR due to unknown cause
5	Outpatient warfarin initiation; dose adjustment with serial INR values	Inpatient warfarin dose adjustment; LMWH dosing in CKD; LMWH bridging with warfarin initiation
6	Warfarin maintenance dose adjustments: slightly subtherapeutic INR secondary to missed dose; subtherapeutic INR secondary to change in amiodarone dosing; significantly subtherapeutic INR with compliance	Outpatient warfarin management: initial hospital f/u post inpatient load with subtherapeutic INR, dose adjustment with serial INR values
7		Management of elevated INR with serial INR values

Abbreviations: VTE = venous thromboembolism; LMWH = low molecular weight heparin; GI= gastrointestinal; INR= international normalized ratio; HIT= heparin induced thrombocytopenia; CKD= chronic kidney disease

The class average for the practical examination was 88%. All 13 students completed each assigned case; however, the grades for each case were highly variable.

Student evaluations conducted at the end of the course in April 2008 were reviewed and found to be positive (Table 4). Students appeared to appreciate the variety of both teaching and assessment methods. They felt the case examples and out-of-class case assignments gave them a better understanding of the material and appreciation for the practical management of various anticoagulation issues. The only suggestions for improvements were additional guidance related to the student presentations. Several students noted they did not fully understand the time commitment for this activity until they began. One student suggested more guest speakers during the course.

Survey

To further evaluate the effectiveness of the course in meeting the objectives, a formal survey instrument was later developed and approved by the Auburn University Investigational Review Board. The survey was distributed electronically to all fourth-year students (both those who completed the elective and those who did not) in January 2009. The survey questions were designed to assess the students' perception of their knowledge and abilities related to the provision of specific anticoagulation management activities encountered during their APPEs. Students identified themselves as having completed the anticoagulation elective as a third-year pharmacy student or not, so comparisons between groups could be made. The students were asked to respond using a 5-point Likert scale to 25 items pertaining to their anticoagulation experiences and their perceptions of pre-

paredness related to providing specific anticoagulation services in multiple settings (1 = extremely prepared; 2 = somewhat prepared; 3 = neutral or unsure; 4 = unprepared; 5 = extremely unprepared). They were also questioned about their present level of confidence in accepting a position after graduation that would require them to participate in and or implement anticoagulation services in varying settings (1 = extremely confident; 2 = somewhat confident; 3 = neutral or unsure; 4 = unconfident; 5 = extremely unconfident). Comparisons between groups (those who took the elective and those who did not) were analyzed by the Mann-Whitney test using SPSS (SPSS Incorporated, Chicago, IL).

Ten of the 13 students enrolled in the elective and 39 students who did not participate in the elective completed the voluntary online survey instrument. Nine of the 10 students who took the elective and 33 of the 39 students who did not, reported completion of at least 1 APPE involving anticoagulation management services. The majority of elective students responded they were either "extremely prepared" or "somewhat prepared" for all areas assessed, with the exception of recommending or implementing adjustments in heparin or LMWH therapy (Table 5). Overall, students who completed the elective felt more prepared than students who did not in all areas regarding anticoagulation therapy except for their preparedness to recognize potential adverse effects. There was a significant difference in favor of degree of preparedness among those who completed the elective with regard to providing warfarin patient education, providing patient education for LMWH use, conducting inpatient anticoagulation assessments, conducting outpatient anticoagulation assessments, recommending warfarin dose adjustments to other health care providers, and implementing adjustments in warfarin therapy. Responses were similar between groups in their comfort with managing adverse events.

Responses were similar between students who completed the elective and those who did not regarding their current level of confidence if asked to accept a position that required participation in or implementation of anticoagulation services (Table 6). Overall, more students responded they were confident in accepting a position that required them to provide rather than implement anticoagulation services. In general, students seemed more confident in providing services in the outpatient setting than the inpatient setting.

DISCUSSION

Although the basics of anticoagulation therapy are covered in our required curriculum, this has traditionally been one of the more difficult topics for students to

Table 4. 2008 Course Evaluation by Third-Year Pharmacy Students Who Completed the Anticoagulation Therapy Elective (n=13), %

	Excellent	Very Good	Good
Course content	69	31	
Organization	70	15	15
Sequencing	62	23	15
Use of class time	77	15	8
Evaluation methods	69	23	8
Enhanced student interest	85	15	
Interest level during class	77	23	
Quantity of information learned	85	15	
Perceived relevance of course	85	15	

No responses of fair, poor, or very poor were given.

Table 5. Comparison of Level of Preparedness for Providing Anticoagulation Services During Advanced Pharmacy Practice Experiences, Between Students Who Completed an Elective Course and Students Who Did Not % (n=42)

	Extremely Prepared		Somewhat Prepared		Neutral or Unsure		Unprepared		Extremely Unprepared	
	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)
Warfarin patient education ^a	89 (8)	45 (15)	11 (1)	49 (16)	0	6 (2)	0	0	0	0
LMWH patient education ^a	56 (5)	9 (3)	44 (4)	79 (26)	0	6 (2)	0	6 (2)	0	0
In-patient assessment ^a	44 (4)	15 (5)	56 (5)	55 (18)	0	24 (8)	0	3 (1)	0	3 (1)
Out-patient assessment ^a	44 (4)	15 (5)	56 (5)	67 (22)	0	12 (4)	0	6 (2)	0	0
Recommending warfarin adjustments ^a	56 (5)	15 (5)	33 (3)	55 (18)	11 (1)	9 (3)	0	21 (7)	0	0
Recommending heparin / LMWH adjustments	11 (1)	3 (1)	44 (4)	36 (12)	44 (4)	18 (6)	0	42 (14)	0	0
Implementing warfarin adjustments ^a	56 (5)	18 (6)	44 (4)	55 (18)	0	12 (4)	0	15 (5)	0	0
Implementing heparin / LMWH adjustments	11 (1)	0	56 (5)	47 (15)	33 (3)	22 (7)	0	31 (10)	0	0
Determining follow-up	22 (2)	15 (5)	56 (5)	67 (22)	22 (2)	9 (3)	0	9 (3)	0	0
Assessing indications	44 (4)	21 (7)	44 (4)	73 (24)	11 (1)	6 (2)	0	0	0	0
Determining goals of therapy	67 (6)	45 (15)	33 (3)	52 (17)	0	3 (1)	0	0	0	0
Determining duration of therapy	33 (3)	24 (8)	44 (4)	58 (19)	22 (2)	12 (4)	0	6 (2)	0	0
Monitoring for adverse effects	67 (6)	55 (18)	22 (2)	45 (15)	11 (1)	0	0	0	0	0
Recognizing adverse effects	44 (4)	51 (17)	44 (4)	49 (16)	11 (1)	0	0	0	0	0
Managing adverse effects	22 (2)	21 (7)	56 (5)	61 (20)	22 (2)	15 (5)	0	3 (1)	0	0
Locating appropriate resources	56 (5)	47 (15)	44 (4)	44 (14)	0	9 (3)	0	0	0	0
Evaluation of primary literature	56 (5)	36 (12)	33 (3)	58 (19)	11 (1)	3 (1)	0	3 (1)	0	0

Abbreviations: EP = elective participants; NP = nonparticipants

^a The level of preparedness was significantly different between elective participants (EP) and nonparticipants (NP) at $p < 0.05$.

master. Because pharmacists are exposed to anticoagulation activities on a routine basis as evident by 86% of students reporting the completion of at least 1 APPE requiring participation in anticoagulation services, an elective with a specific focus on anticoagulation management was thought to be a beneficial and practical addition to our curriculum. Anticoagulation management is already an area with a strong pharmacy presence and as healthcare continues to evolve and focus on patient safety and cost-effective outcomes, pharmacy involvement will most likely continue to increase. It is therefore important to equip our students with the skills necessary to meet those challenges.

The anticoagulation elective employed a variety of teaching and assessment methods that were well received

by students. The course appears to have met one of the main objectives: to better prepare students for the provision of anticoagulation services during their APPEs. Although the level of preparedness was found to be significantly different in only 6 of the 21 areas assessed, the importance of the specific activities in which those taking the elective felt more prepared should be noted. Patient education, assessments of therapy, and warfarin dosage adjustments are all core components of anticoagulation management. The other areas may have failed to reach statistical significance due to the small number of students surveyed or to less focus being given to these topics throughout the elective.

Although the students who participated in the elective felt confident in most areas assessed, future adjustments

Table 6. Comparison of Level of Confidence in Performing Anticoagulation Services Between Students Who Completed an Elective Course and Students Who Did Not

Services Involved in Postgraduate Position	Extremely Confident		Somewhat Confident		Neutral or Unsure		Unconfident		Extremely Unconfident	
	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)	EP % (n)	NP % (n)
Provide inpatient services	44 (4)	45 (15)	56 (5)	55 (18)	0	0	0	0	0	0
Provide outpatient services	56 (5)	55 (18)	44 (4)	45 (15)	0	0	0	0	0	0
Implement inpatient services	22 (2)	33 (11)	33 (3)	33 (11)	33 (3)	33 (11)	11 (1)	0	0	0
Implement outpatient services	33 (3)	36 (12)	33 (3)	36 (12)	22 (2)	27 (9)	11 (1)	0	0	0

Abbreviations: EP= elective participants; NP = nonparticipants

in the course should focus on enhancing the students' understanding related to inpatient management, particularly with the dosing and management of unfractionated heparin (UFH) and LMWH. This could potentially be achieved through additional case examples requiring assessments and dosing adjustments of these particular agents. With only about half of the students surveyed reporting any level of confidence in initiating anticoagulation services, this also should be given more attention. Providing students with additional resources such as business plans that justify pharmacy services or guest speakers who have implemented anticoagulation services may be of benefit. Students' lack of confidence in this area could simply be a reflection of their inexperience.

Although the results of the survey are encouraging, the number of participants was small. Additional data over consecutive years will need to be collected to better assess the true benefits of the elective.

SUMMARY

Anticoagulation therapy is a specialized area requiring highly trained and knowledgeable clinicians to ensure safe and effective therapy for the treatment and prevention of thromboembolism. Forth-year pharmacy students have the opportunity to work in multiple settings that provide pharmacy-managed anticoagulation services. An anticoagulation elective course focusing on advanced therapeutic issues and allowing third-year students addi-

tional exposure to anticoagulant topics better prepared students to care for patients receiving anticoagulation therapy. Focus should continue to be placed on the value of anticoagulation knowledge for students who, as future clinicians, may participate in or initiate anticoagulation services.

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