Utilizing the Peer Group Method with Case Studies to Teach Pharmacokinetics[1]

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In clinical pharmacokinetics the student must integrate information from pharmaceutics, pharmacokinetics, biopharmaceutics, medicinal chemistry, pharmacology, physiology, pathophysiology, and therapeutics to decide how to maximize a patient's drug therapy while minimizing untoward effects. It is no longer enough to plug numbers into a memorized formula to get a correct answer, but that correct answer must be part of a practical, effective treatment plan. For students who are accustomed to taking multiple choice tests that are directly based on lecture material, clinical decision making is not always an easy or welcomed process.

Several of my colleagues teaching in the pharmacy administration discipline at various schools or colleges of pharmacy had discussed with me the concept of peer group teaching methods and the eventual success they had achieved with this method in courses using a case study format. I decided to employ this method to "teach" pharmacokinetics.

Initially, I was concerned that this method of teaching would require too much class time. I found, though, that the students benefitted from this approach to learning. They were first exposed to the information in a traditional lecture. This initial exposure provided the students with an introduction to and some familiarity with the subject and a foundation for their own work. Next, the case studies required the students to research the subject further and provided them time to "digest" the information in a group, encouraging the open discussion of principles and perspectives on that particular drug therapy. Discussing and defending one's ideas among members of a group is important in establishing confidence. The final step required that the students formulate their ideas in an organized way and present these ideas for the class to learn. These two final steps gave the students a way to build confidence in their knowledge and skills and a less-threatening forum than the traditional lecture-test format for "testing" this knowledge . Traditional tests generally require students to recognize, recall, regurgitate and sometimes apply what they have been taught, memorized and hopefully learned. The peer group method allows students to learn information traditionally, research the topic further, discuss the information, then apply this learning in a manner that builds confidence in their own knowledge.

[1] Manuscript based on a submission to the Council of Faculties Innovations in Teaching Competition.

METHOD

The 110 students in the class were randomly assigned and divided into 11 groups, consisting of 10 students each. The eleven groups were assigned two sets of eleven case studies. Each group was responsible for presenting two case studies. The presentation consisted of an oral portion and a written portion. Each group presented the case study with the corresponding number of their group, (*e.g.,* Group I presents Case I, etc.). Each group was expected to review all of the case studies so that they could understand and participate during the presentations.

The case studies (Appendix A) were designed to require utilization of the didactic pharmacokinetic information presented previously in the course, background knowledge from previous course work and the identification of specific material related to the drug and patient. Students were instructed that the oral and written reports should include the following information:

1. a description of the patient
2. a description of the condition being treated
3. the drug being monitored and why that particular drug is indicated for the above patient and condition
4. the pharmacokinetic parameters for this particular patient and drug (either estimated or calculated and why)
5. recommendations for this patient including dose and interval, length of therapy and monitoring parameters
6. summary of references and methods used to reach conclusions

The group members were expected to come to class prepared. Adequate preparation required an understanding of background information, the particular subject being covered and specific information (calculations and background research) about the case study. To assure this, the students provided peer evaluations of themselves and other members of their group based on preparation and contribution to the group. The peer evaluation was worth a total of 50 points. The Peer Evaluation Factor [PEF] was determined by dividing the total number of points received by the possible total of 50, and therefore had a range of 0 - 0.1. Each person in the group was expected to be responsible for a portion of the oral or written presentation, and noted their particular contribution on the evaluation form.

The written reports were to be typed. The written reports were then available for the class to copy at the conclusion of the course. The students found that the typed reports made an excellent resource for their upcoming clinical rotations.

Students were expected to use audiovisual aids such as overheads during the oral presentations. The oral presentations were to be approximately 10 minutes in length. Because each class member had copies of the other case studies being presented and had worked through the cases with their respective groups, the class and the professor were expected and encouraged to ask questions of the presenter and other group members. The oral presentations allowed the entire class to understand the problem-solving process employed by each group, and learn the appropriate handling of the special problem or consideration represented by each case study.

The groups were provided four hours of class time to work on the case studies. The group presentations took place in 120 minute blocks on two different extended class days. The grade for the case-study component of the class was determined by:

Peer evaluation factor [PEF]	possible 0 - 1.0
Faculty grade [FG]	possible 0 - 100%
Case study Grade = PEF x FG	possible 0 - 100%

By determining the grade in this manner the faculty grade assigned for the collective group's effort in producing the written and oral report was attenuated by the peer group's evaluation of a particular student's contribution to the group process. The case-study component for the course was the equivalent of one test in calculating the final grade for the course.

Course Grade:	
Test I	100%
Test II	100%
Test III	100%
Case Study	100%
Final Grade	Mean

To assist the students in understanding the reason for the case study, group activity format, they were provided the following objectives and desired outcomes for this method of learning/teaching:

Working in the assigned groups to provide the oral and written report for the case studies the student will:

1. learn to effectively communicate and work with a team or group in evaluating and determining appropriate treatment for a patient
2. collect, synthesize and interpret the relevant information to describe the patient to be treated
   a. identify and list the appropriate information needed to establish a patient-specific solution
   b. understand why each piece of information is needed
   c. identify sources of information
   d. compare the patient information collected with the medication prescribed and the indications to determine if any drug-related problem exists
3. identify the condition being treated, the appropriate treatment and monitoring
   a. rank the condition(s) according to severity and risk to the patient
   b. identify appropriate pharmacotherapeutic. treatment of the condition
   c. identify the desired outcome for the patient
4. identify the drug being monitored and the reason it is indicated for the above patient and condition
   a. determine whether the treatment is appropriate or optimal considering the benefit and risk to the patient
   b. identify any possible drug-related problems for this patient with this condition on this medication
5. determine the pharmacokinetic parameters for the patient and the drug (estimated or calculate and why)
   a. identify which pharmacokinetic parameters are needed to determine dosing for this patient
   b. identify appropriate sources of information for pharmacokinetic estimates if needed
   c. calculate the pharmacokinetic parameters for this patient using the correct formulas
   d. evaluate this patient's pharmacokinetic parameters

from calculations based on information provided in the case study
   e. identify reasons that this patient may or may not differ from the average
6. make appropriate treatment recommendations for this patient including dose and interval, length of therapy and monitoring parameters
   a. explore options in therapy if appropriate
   b. identify appropriate monitoring
   c. recommend dosage regimens which optimize compliance and efficacy while minimizing toxicity
7. identify references which are useful and available for therapeutic drug monitoring decision making
8. present the problem and solution in a written and oral format that can be easily understood by other members of the health care team and/or the patient

The form used for the peer evaluations also included questions concerning the case-study, group learning process. For evaluation of the learning method and the process the students were asked to respond to the following questions:

1. As a participant in your group's case study discussions, what was the most positive outcome for you personally?
2. If you could redo your contribution to your group's case study discussions, how would it be different, or would your contribution be the same?
3. Compare the case study approach of learning with the traditional lecture/test format. Which do you prefer and why?
4. What changes in the case study part of the course would you recommend for next year's class?

RESULTS

Following are the results of the learning method and process evaluations.

1. *What was the most positive outcome for you personally?*

Getting to find a practical application for all of these equations.	68
Understanding why it is important to study all of the biopharmaceutics too	33
Getting to work with classmates who I didn't really know	45
Finding out I understood a lot more about the subject than I thought I did	54
Knowing sources for correct information	48

2. *If you could redo your contribution to your group's case study discussions, how would it be different, or would your contribution be the same?*

Same	65
Come to group sessions more prepared	37
Participate in the oral presentation	9

3. *Compare the case study approach of learning drug specific pharmacokinetics with the traditional lecture/test format. Which do you prefer and why?*

Lecture for basics followed by cases for application	110

Reasons:

I finally was able to use the equations for a purpose
It's fun figuring out how all of this information fits together
It helped me understand a lot more about therapeutics
I understand drug interactions better now

4. *What changes in the case study part of the course would you recommend for next year's class?*

Smaller groups	45
More case studies	43

Since instituting the case-study component of the class, the faculty who precept students on clerkships, two semesters after the students have completed this class, have noticed a marked increase in the students' ability to make pharmacokinetic recommendations and solve pharmacokinetic problems.

All students take biopharmaceutics/pharmacokinetics during the Spring semester of their second professional year. Twenty-nine of the BS Pharmacy students who took this class in Spring 1992, took the PharmD Clinical Pharmacokinetics course as an elective, just to learn more. The same trend continued in 1993.

DISCUSSION

During the first part of the course the students were exposed to the fundamental theory and principles of biopharmaceutics, pharmacokinetics and drug dosing. The case studies which followed were designed to require the utilization of the didacticbiopharmaceutic/pharmacokinetic information presented in the course and background knowledge from previous course work; identification of the appropriate use of medications; and the understanding of specific patient conditions. The student then must integrate and apply these principles to achieve the proper dosing and monitoring of patients taking medications.

The case studies focused on the commonly monitored drugs [aminoglycosides (gentamicin, amikacin, tobramycin), vancomycin, theophylline, digoxin, salicylate and lithium] given by the common routes of administration [continuous IV infusion, intermittent IV bolus, intermittent short-term IV infusion, and orally]. The students encountered various scenarios including patients of different ages (pediatric and geriatric), certain common chronic conditions (CHF and CF) and certain acute scenarios (trauma). The students determined the pharmacokinetic parameters for the particular drug in their patient, the appropriate maintenance and loading dose, if necessary, and appropriate monitoring parameters. Two set of representative case studies are included in Appendix A.

SUMMARY

The use of peer group teaching in the biopharmaceutics/pharmacokinetics course enabled the students to learn to interpret, analyze, research and solve problems related the drug dosing by applying their knowledge and utilizing the collective expertise of the peer group as well as the resource material. The 110 students in the class were assigned to 11 groups. The groups were given case studies to present appropriate responses or solutions to. To assure preparation and participation, the students graded themselves and the other group members according to specific criteria. The Peer Evaluation Factor (PEF) and the Faculty Grade (FG) were used to determine the grade for the case study. The

case study grade was counted the equivalent of one test in determining the final grade for the course. The case studies were designed to utilize the theoretical principles presented earlier in the course, background knowledge from previous course work and the evaluation of a specific drug, drug formulation, and/or patient condition. The groups prepared oral and written reports, which enabled the class to understand the problem-solving processes utilized in each case. Working in the group allowed the students to begin to understand and experience the interaction with other health-care practitioners, including the synergistic effect group dynamics can have on problem solving.

Am. J. Pharm. Educ., **58**,73-77(1994); received 1/10/94.

APPENDIX A. CASE STUDIES

Set I

Case I
A 17 yo male, SE (65 kg), is hospitalized with an acute asthmatic attack. For the first few days he receives aminophylline at the rate of 62 mg/hr; a steady-state plasma theophylline concentration of 12 mg/L is achieved. The patient tolerates this aminophylline dose without adverse effects, and his pulmonary function is improved. Patient SE is then switched from IV aminophylline to oral theophylline and remains in the hospital for 2 additional days while receiving oral therapy. Suggest an oral dosage regimen for SE. How should SE be followed?

Case II
LR**,** a 25 yo female, is a chronic asthmatic and has been taking theophylline 200 mg every six hours for at least a year. LR weighs 60 kg. The last time a theophylline level was checked was when she was discharged from the hospital on her current dose of theophylline. The theophylline level on the second day of oral therapy was 12 mg/L. LR has developed stress ulcers, resulting from law school studies. She was placed on cimetidine 300 mg tid two weeks ago. You are the pharmacist in the HMO where she is seen. She has called you complaining of feeling very jittery, and nervous. She can't get to sleep at night and is restless when she does fall asleep. You ask her to come in to the clinic for a theophylline level and it is reported to be 18 mg/L.

What are your recommendations? How and why have LR's theophylline pharmacokinetics changed?

Case III
You are the critical care pharmacist in TCHA's NICU unit. The neonatologists do not prescribe continuous aminophylline infusions for neonates. aminophylline. However, many of the neonates are placed on theophylline for "As and Bs" (apnea and bradycardia). It is frequently hard to give neonates oral doses of theophylline at first. How do you recommend giving the theophylline? The first child you have to recommend a dose for is a 2.0 kg 35 week gestational age neonate with As and Bs. What dose do you recommend?

Case IV
BJ is a 65 yo male recently diagnosed with CHF. He weighs 85 kg and is 5'10" tall. You are the clinical pharmacist in the Family Practice Center and the physician asks you to recommend an oral digoxin dosing regimen for BJ. What recommendations would you make and how would you follow this patient? Should you give BJ a loading dose? If so, how would you give it?

Case V
LR is a 75 yo female who has taken digoxin 0.125 mg by mouth every day for the last 5 years. She was prescribed this dose for CHF. She recently has had some problems with irregular heart beats and her physician has prescribed quinidine 200 mg three times daily. About a week after LR begins taking quinidine, she calls you complaining that her heart is beating funny and that she feels nauseated. What are your recommendations to LR and why? Would you recommend any changes in her drug therapy?

Case VI
TS is a 1 yo in the Special Care Nursery. She has recently developed heart failure secondary to a viral infection. Following surgery she was placed on Digoxin 15 ug bid IV. The physicians are attempting to stabilize her and convert her to oral dosing to send her home. TS weighs 18 kg and her digoxin level 2 weeks into therapy on the IV dose is 1.0 ng/ml. What oral dose of digoxin would you recommend and why? How would you follow TS?

Case VII
HR is a 20 yo male with a history of generalized tonic-clonic seizures. He was prescribed phenytoin 300 mg (capsules) daily several years ago and has been stable on that dose. The last time his blood level was checked it was 12 mg/L. HR recently (2 weeks ago) was prescribed cimetidine for an ulcer he developed. He has been complaining of being very sleepy and feels uncoordinated. His family says his speech is even slurred. What recommendations would you make to HR's physician? When the physician checks HR's phenytoin level after your phone call it is 21 mg/L. What do you recommend for him to do?

Case VIII
BC is an 18 yo (80 kg) who was in a three wheeler accident. He received a severe injury to the head. He has been placed on phenytoin 200 mg (suspension) twice daily. He receives the medicine down his GT. He has been on the phenytoin for 1 week with a level of 12 mg/L. He seems to be fighting the respirator so the PICU physician places BC on phenobarbital 100 mg bid to sedate him. Three days later BC has a seizure on EEC The physician asks you what happened? What do you recommend doing? You decided to take a phenytoin level and it was 6 mg/L. Why has BC's situation changed so? What do you recommend?

Case IX
RP is a 3 yo child with hydrocephalus. She has been receiving phenytoin 20 mg bid, and phenobarbital 15 mg bid, both IV, for several weeks. Over the course of the last few weeks she has not been able to take much of anything by mouth. Her body weight has decreased from 25 to 20 kg. Her phenytoin level was 12 mg/L about 2 weeks into therapy. Lately she seems more sedated though. What could be happening? What should you do? You took another blood level and it's now 13 mg/L. Can you make any recommendations?

Case X
You are the clinical pharmacist in a sports medicine clinic. One of the common requests you receive is for the anti-inflammatory dose of aspirin. Today you specifically must recommend an anti-inflammatory dose for a Birmingham Fire lineman who is.6'8" tall and weighs a mere 280 lb. He just had arthroscopic surgery on his knee, and is not looking forward to any discomfort. Besides he wants to be able to play again this season. What dose do you recommend and why? Are there any special recommendations you would make to him?

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SET II

Case I
TM has been hospitalized for a ruptured duodenal diverticulum that was surgically repaired. Prior to surgery, you are asked to begin this patient on Gentamicin. TM is 5'1", weighs 65 kg and his serum creatinine is 1.3 mg/dL.

Recommend an appropriate Gentamicin maintenance dose, including the most appropriate dosing interval for TM after choos-

ing an appropriate therapeutic range. What pharmacokinetic parameter estimates are you using for TM and why? How should you monitor TM?

Case II
JT is a 26 yo female who has been hospitalized with a severe UTI. She is immediately started on Gentamicin 80 mg every 8 hours (0800,1600, 2400). Levels at the third dose were the following:

Trough drawn at 0730: 1.5 mg/L
Peak drawn at 0930: 4.5 mg/L

JT weighs 75 kg, is 5'2" tall and has a history of chronic UTI.

Would you recommend any dosage changes for JT? If so, on what are you basing this decision? How do JT's pharmacokinetic parameters compare to other 26 yo's? Can you speculate why?

Case III
LM is a 21 yo male who has cystic fibrosis. He has chronic respiratory infections and is currently receiving tobramycin along with several other medications. The physicians phone you because they cannot achieve therapeutic levels for LM with "normal" doses. LM is currently receiving Tobramycin 80 mg every 8 hours (0800,1600,2400). LM weighs 60 kg and is 5'9" tall. The following levels are drawn around his 1600 dose on the third day of therapy.

Trough drawn at 1530: 0.3 mg/L
Peak drawn at 1730: 3.1 mg/L

What dosage changes would you recommend for LM? How do LM's pharmacokinetic parameters compare with those of a "normal" 21 yo male? Why?

Case IV
PR is a 2 day old neonate who has blood cultures positive for an organism sensitive to tobramycin but resistant to gentamicin. The resident in NICU has asked you to recommend a Tobramycin dose for PR. What pharmacokinetic parameter estimates will you use to calculate PR's dose? How should you monitor this neonate?

Case V
LK is a 19 yo female who has been admitted to your hospital following complications after an abortion performed in a clinic with less than sterile conditions. The ER physician has begun Amikacin 300 mg every 8 hours. When LK gets to PICU, the attending draws amikacin levels with the 5th dose. The level which are reported are:

Trough drawn at 2330: 5 mg/L
Dose given at 2400 - 0100
Peak drawn at 0200: 35 mg/L

LK weighs 40 kg and is 5'3" tall. Will you recommend any changes in LK's therapy? On what will you base your decision? How do the pharmacokinetic parameters calculate for LK compare to "normal"? Why?

Case VI
TS is a 17 yo male admitted to the hospital with a gun shot wound to the abdomen. He will undergo extensive surgery. The admitting physician has asked you to recommend an Amikacin dose for TS. TS weighs 95 kg, is 6'4" tall, and is a body builder. Apparently he was shot during a robbery attempt at the convenience store where he works evenings. On what pharmacokinetic parameters will you base your dosage recommendations? What are your recommendations? How will you continue to follow TS?

Case VII
SM is a 43 yo male admitted to the hospital for a right colectomy because of colon cancer. Initially he has normal renal function. Postoperatively the patient develops a wound infection which is treated by surgical drainage as well as IV cephalosporin. Culture of the wound fluid reveals Staphylococcus Aureus which is found to be resistant to methicillin. The surgeon wishes to start SM on Vancomycin. SM weighs 63 kg and is 5'11" tall. Recommend a dosing regimen to achieve appropriate therapy. What is the therapeutic range you are using to calculate your dose? Why? What pharmacokinetic parameters are you using to estimate the dose? Why did you chose those?

Case VIII
A 24 yo female patient, JH (72 kg), is admitted to the hospital after sustaining multiple traumatic injuries in a motor vehicle accident. Her recovery is complicated by the onset of acute renal failure 1 week after admission. During the second week, she experiences a spiking fever: gram-positive bacilli which are resistant to methicillin but susceptible to vancomycin are cultured from her blood. The physician begins a course of Vancomycin of 1000 mg every 12 hours. The following levels are drawn at the fifth dose:

Trough drawn at 0730: 10.5 mg/L
Dose given 0800 -1000
Peak drawn at 1100: 20 mg/L

Would you recommend any change in her dose? Why? How do JH's pharmacokinetic parameters compare to those of a "normal" 24 yo female and why?

Case IX
A 14 yo male patient JA (52 kg) is presented to the hospital emergency room in status asthmaticus. He has a history of asthma. To resolve the status asthmaticus, JA receives epinephrine, IV fluids, oxygen, and beta agonists by inhalation. The ER physician also wants to begin an aminophylline infusion and asks you to recommend the infusion rate. A stat admit theophylline level is 2 mg/L. Recommend an aminophylline infusion rate for JA. On what pharmacokinetic parameters do you base this recommendation and why? The physician also realizes he should give JA a loading dose of aminophylline and asks you to calculate it for him. What do you recommend and why? How should you monitor JA?

Case X
A 63 yo female patient KZ (73 kg) has chronic lung disease but is admitted tot the hospital for an elective surgical procedure. Postoperatively, her ventilation is not adequate, so she is placed on a mechanical ventilator. In addition, it is believed that she will benefit from IV infusion of aminophylline at 40 mg/hr immediately after an IV loading dose of aminophylline administer over 30 minutes. 24 hours into therapy KZ's steady state concentration of theophylline is determined to be 9 mg/L. The attending physician wishes to increase her theophylline level to 14 mg/L so that he can attempt to wean her from the respirator. What infusion rate do you recommend? What are the pharmacokinetic parameter you calculate for KZ? How do they compare to normal? You learn during your conversation with KZ's daughter that she has smoked two packs of cigarettes a day for as long as the daughter can remember. Does this play any part in KZ's theophylline therapy?