






Original article

Clinical pharmacokinetics: perceptions of Libyan hospital pharmacists about how it was taught and how it is applied

Mawada S. Gajam^{1*}  , Saadoun O. Elmezughi² , Abdurrauf M. Gusbi¹, Abdurrahim A. Elouzi¹, Ebtisam A. Benomran³ and Mahmud H. Arhima⁴

¹Department of Pharmaceutics, Faculty of Pharmacy, University of Tripoli, Tripoli, Libya

²Department of Pharmacology and Biochemistry, Faculty of Pharmacy, University of Zawia, Zawia, Libya

³Department of Nursing Basics, Faculty of Nursing, University of Tripoli, Tripoli, Libya

⁴Department of Pharmacology, Faculty of Medicine, University of Tripoli, Tripoli, Libya

*Author to whom correspondence should be addressed

Received: 14-08-2022, **Accepted:** 31-08-2022, **Revised:** 10-09-2022, **Published:** 30-09-2022

Copyright © 2022 Gajam et al. This is an open access article distributed under the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

HOW TO CITE THIS

Gajam et al. (2022) Clinical pharmacokinetics: perceptions of Libyan hospital pharmacists about how it was taught and how it is applied. *Mediterr J Pharm Pharm Sci.* 2 (3): 39 - 45. <https://doi.org/10.5281/zenodo.7115181>

Keywords: Clinical pharmacokinetic, perception, pharmacist, Libya, undergraduate program

Abstract: The application of clinical pharmacokinetic is the responsibility of all pharmacists providing pharmaceutical care. An appropriately applied clinical pharmacokinetic is expected to result in improved patient outcomes: decreased mortality, reduced length of treatment, reduced length of hospital stays and cost-savings. Data on the extend of pharmacokinetic application in Libyan hospitals remain scarce but available subjective evidence suggests that services related to clinical pharmacokinetic are mostly provided and performed by professionals other than clinical pharmacists. To explore the training background and perceptions of pharmacists on the pharmacokinetic course contents they received during their undergraduate pharmacy programs. Also, to determine the attitudes and barriers experienced by the pharmacists when applying pharmacokinetic principles in their current practice. This is a cross-sectional, descriptive study that was conducted between July 2018 and November 2019 using a self-administered survey. The study targeted hospital pharmacists practicing in different hospitals in Libya. A total of 104 pharmacists completed the questionnaire and submitted it back. The majority of participants learned pharmacokinetic courses as a mandatory course during undergraduate courses 81.0% with 37.0% selecting that course was taught as a separate course or courses. Around 80.0% of the participants agreed or strongly agreed that pharmacokinetic courses received in undergraduate studies are useful in pharmacy practice with over 75.0% of the participants agreeing or strongly agreeing on relevance of those course to their current clinical practice. About 40.0% of the participants described their current skills in allowing optimal patient care as can be better. Different barriers were highlighted by the participants to allow sufficient clinical pharmacokinetic practice including lack of sufficient information, lack of awareness of pharmacists' role and skills in applying clinical pharmacokinetic by other pharmacists and by other health care providers. Thus, this study shows that most practicing pharmacists showed a positive attitude of current pharmacokinetic practice and to the impact of their undergraduate studies on their successful practice. However, they have clearly addressed the room for improvement.

Introduction

Clinical pharmacokinetics (PK) is defined by the American Society of Health-System Pharmacists as the process of applying PK principles to determine the dosage regimens of specific drug products for specific patients to maximize the therapeutic outcomes and minimize toxicity [1, 2]. Pharmaceutical care is a vast developing field in the area of pharmacy and constitutes various areas and necessitates skills and knowledge to be adequately applied, and in this context the application of clinical PK is the responsibility of all pharmaceutical care providers [3]. In order to adequately apply clinical PK, a deep understanding and knowledge about absorption, distribution, metabolism and excretion profile of specific drugs in specific diseases and patient populations is crucial [2]. An appropriately applied clinical PK is expected to result in improved patient outcomes: reduced length of treatment, reduced length of hospital stay (LOHS), decreased morbidity, decreased adverse effects of drug therapy and cost-savings [4 - 7].

Therapeutic drug monitoring (TDM) as a core service related to provision of clinical PK was revealed to positively affect patient care. It has been reported that pharmacist being part of TDM services for antiepileptic drugs resulted in significant improvement in appropriateness of TDM use and substantial reduction in unnecessary costs [8, 9]. It is also suggested by another study that pharmacist led TDM services had a positive impact on optimizing the initial dosing of vancomycin, amikacin and gentamicin [9]. Pharmacist initiated TDM services have been assessed with aminoglycosides dosing and resulted in increase in the likelihood of obtaining adequate peak concentrations, decreased the number and mean total doses administered and minimized changes in serum creatinine from baseline [10, 11]. TDMs and individualized dosing with theophylline dosing is found to achieve serum concentrations being in therapeutic range and thus resulted in a rapid clinical improvement and resulted in lesser adverse events in comparison with conventional administration of the medication [10 - 12].

Pharmacists play a fundamental role in ensuring appropriate and cost effective utilization of TDM while providing pharmaceutical care [6, 7]. Pharmacists are expected to use their knowledge and skills in identifying and managing arising issues related to TDMs which could be due to different reasons including drug interactions, non-adherence to prescribed medication and patient specific factors [1, 2]. Researches have shown that despite the valuable role pharmacists can play in optimizing clinical PK services, many pharmacists find it challenging to apply their PK knowledge and skills in clinical practice [13]. Different reasons are suggested to be related to this challenge; including lack of confidence; lack of sufficient training and lack of skills required to apply knowledge gained in undergraduate studies [14]. Lately, and in parallel to the Middle Eastern countries, pharmacy practice in Libya is undergoing a modest improvement in patient care and clinical practice. Different factors could be attributed to this improvement including the acceptance and demand on clinical pharmacy as practice instead of having the pharmacist role restricted to dispensing medications, also the improvement of the clinical pharmacy discipline in studies and in practice made pharmacist role approaching patient centeredness more than before [15, 16]. Data on the extend of PK application in Libyan hospitals remain scarce but available subjective evidence suggests that services related to clinical PK are mostly provided and performed by professionals other than clinical pharmacists or pharmacists in general. Therefore, it is important to assess the pharmacist's perceptions on their education and skills and how this affects the clinical practice they are expected to apply [17]. An important start issue from the researcher's point of view is to start the assessment process by relating the knowledge and skills gained in the undergraduate studies to what is actually applied in the existing clinical field. This is expected to guide the improvement process in future to be started from what is taught and then reflected in what is applied. To the best of our knowledge, no previous studies aimed to assess the attitudes and practice of hospital pharmacists in Libya in this field have been published. An

evaluation of the attitudes, practices and barriers are needed to understand current situation and to aid in bridging the gaps in the practice [13]. Thus, the study aims to explore the training background and perceptions of pharmacists in Libya on the PK course contents they received during their undergraduate pharmacy programs; determine attitudes of, and the barriers experienced by, the pharmacists when applying PK principles in current practice.

Materials and methods

This is a cross-sectional, descriptive study that was conducted between July 2018 and Nov 2019 using a self-designed survey (see below). The study targeted hospital pharmacists practicing in several hospitals in Libya. These hospitals are: Tripoli Central Hospital, Jalaa Maternity Hospital, Tajuraa Heart Hospital, Khadra Hospital, Abu-Setta Thoracic Diseases and Surgery Hospital, Metiga Hospital and Zawia Kidney Hospital. Pharmacists were included in the study if they were working as hospital pharmacist in clinical setting at mentioned hospitals in Libya for at least three years. This study is an extension of a previously conducted study in another country entitled clinical pharmacokinetics: perceptions of hospital pharmacists in Qatar about how it was taught and how it is applied [17]. The questionnaire of the original study was developed after a thorough literature review of similar instruments evaluating attitudes and practices of healthcare providers in different aspects [18 - 20]. Irrelevant fields and answering options were modified to suit pharmacists practicing in Libya.

Questionnaire consisted of three main categories other than demographics and professional characteristics. Categories were classified to assess: PK contents learned in undergraduate curriculum (four multiple choice items); 2 perception towards the PK contents and instructions received in the undergraduate curriculum (five items measured on a five-point Likert scale; strongly agree to strongly disagree); 3 application of PK in current clinical practice (six items assessing relevance of the PK courses received and the barriers faced towards application in practice). One open-ended question was

included to assess perceived barriers in PK application. Face and content validation were performed in the initial study with three experts in the clinical pharmacy field and expert in questionnaire development. Questionnaire was also reviewed and evaluated by clinical pharmacy specialist in Libya. Questionnaire was randomly distributed to hospital pharmacists practicing in different hospitals in Libya through a contact person in each hospital to facilitate distribution and collection of questionnaires.

Statistical analysis: Data were analyzed by IBM Statistical Package for Social Sciences (IBM SPSS Software) version 22. Descriptive and inferential statistics were applied for the data analyses. All the categorical variables were expressed as frequencies and percentages. The influence of respondents' professional and demographic factors on perception towards PK teaching and practice were tested using the Chi square and Fisher's Exact tests. The level of significance was set as $p > 0.05$.

Results

Demographics and professional characteristics of the participants: A total of 104 pharmacists completed the questionnaire and submitted it back. Female participants constituted of 77.8% of the whole study population with a majority of participant being at age range of 20 - 30 years old (44.4%) and a bachelor's degree holders of 77.8%. More than 96.0% of the participants received their degree in Libya but had a variable range of experience of 59.0% had more than five years of experience. 66.0% of the participants received no pharmacy related training after graduation **Table 1**.

Undergraduate pharmacokinetic courses: The majority of the participants learned PK courses as a mandatory course during undergraduate courses (81.0%) with 37.0% selecting that course was taught as a separate course/ courses. With regards to number of PK courses received in undergraduate studies (48.0%) of the participants had the course as single course with remaining participants being taught the course through two or more courses. Less than half of participants (29.6%) described their PK course as being directed towards clinical application of PK principles.

Table 1: Demographics and professional data of hospital pharmacists in Libya

Characteristic	Frequency (%)
Gender	
Male	23 (22.1%)
Female	81 (77.8%)
Age in years	
20 - 30	46 (44.2%)
31 - 40	31 (29.8%)
41 - 50	23 (22.1%)
> 50	04 (03.8%)
Highest academic degree	
B Sci	81 (77.8%)
M Sci	19 (18.26%)
Pharm D	00.0
Ph D	04 (03.8%)
Others	00
Country of graduation	
Libya	100 (96.1%)
Others	04 (03.9%)
Years of experience as hospital pharmacist	
< 5 years	42.6 (40.9%)
6 - 10 years	15.4 (14.8%)
11 - 15 years	23.0 (22.2%)
> 15 years	23.0 (22.2%)

Table 2: Hospital pharmacists' perception towards pharmacokinetics contents and their applicability to clinical practice

Perception Item	%	%	%	%	%
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The undergraduate PK courses I received were useful to my current practice	44.4	37	7.4	7.4	3.8
The undergraduate PK courses I received were relevant to my current practice	40.7	33.3	18.5	3.7	3.8
The method used to teach PK courses at my pharmacy undergraduate studies were effective	29.6	29.6	7.4	22.2	11.2
The content of the PK courses I received at my pharmacy undergraduate studies was adequate	22.2	11.1	25.9	37	3.8
The depth of the PK courses taught at the undergraduate pharmacy studies was appropriate to prepare me for my future clinical roles	22.2	18.5	25.9	29.6	3.8

Perceptions and opinions of participants towards PK course taught during undergraduate studies:

As shown in **Table 2**, around 81.4% of the participants agreed or strongly agreed that PK courses received in undergraduate studies are useful in pharmacy practice with over 74.0% of the participants agreeing or strongly agreeing on relevance of those course to their current clinical practice. With regards to teaching methods and approaches, almost 60.0% of the participants agreed or strongly agreed about effectiveness of

such methods. More than half of the participants did not agree on the sufficiency of PK courses in undergraduate studies (66.7%) nor on the capability of such courses to prepare student for clinical pharmacy practice (59.2%).

Application of PK in current clinical practice: In **Table 3**, hospital pharmacists described their utilization of the PK knowledge gained through undergraduate pharmacy degree programs in their current practice as: Used most of the times (15.0%); used many times (22.0%) and used occasionally (26.0%).

Table 3: Utilization of pharmacokinetic knowledge gained through undergraduate pharmacy program

Extent of utilization	Frequency (%)
Used most of the times	15.6 (15.0%)
Used many times	22.88 (22.0%)
Used occasionally	27.04 (26.0%)
Used rarely	36.4 (35.0%)
Not used at all	02.08 (02.0%)

Perceived barriers and practice: Different barriers were highlighted by the participants to allow sufficient clinical PK practice including lack of sufficient information, lack of awareness of pharmacists' role and skills in applying clinical PK by other pharmacists and by other health care providers, as well as, lack of courses and education provided to enhance the skills and optimize the practice of hospital pharmacists.

Discussion

Although the majority of pharmacists in this study have highlighted the importance and relevance of their undergraduate PK courses to their current practice, yet a large portion of the sample did not feel that knowledge and skills received are sufficient and capable to prepare them for clinical practice. Respondents have also identified several barriers rendering them unable to provide full and sufficient pharmacy practice service. Having the required equipment for a valid and beneficial PK services is crucial for an outstanding practice [21 - 26]. Thus, addressing the concerns and barriers to the implementation of this service is warranted.

Our cohort of pharmacists also pointed the need for curriculum improvement and given most of the cohort sample belongs to graduates from Libyan universities following similar curriculums and teaching methods this highlights the need for a true review of the currently taught curriculum. Years of experience had an influence on some selections, as pharmacists who are fresh graduates (< 5 years) had more positive attitudes and pointed relevance of undergraduate studies to their current practice. This study showed similar findings to a previously conducted study by the author but in different country (Qatar) at a period showing a new and evolving role of clinical pharmacy and clinical PK [15]. The previously conducted study highlighted barriers from the point of view of practicing pharmacists and concluded that certain gaps need to be filled for optimal application of clinical PK. One of the most important gaps is making the scientific material taught in the undergraduate curriculum clinical and patient oriented, filled of true applications and when possible, a live simulations and clinical practice visits during undergraduate studies [27, 28]. To our knowledge, this is the first study evaluating perceptions of

hospital pharmacists in Libya. The study targeted pharmacists practicing in wide range of hospitals in Libya for pharmacists who are exposed to the same or highly similar curriculum making it reflective of research objective. This study is a starting point in the assessment of the influence of PK courses taught by Libyan universities on current practice. Further assessments and studies should be conducted for a comprehensive image before implementing changes, especially from the point of view on academicians and using objective measures to assess the current curriculum and how to improve it. Other published studies evaluating clinical pharmacokinetics teaching and application have been reviewed. A study entitled design and delivery of clinical pharmacokinetics in colleges and schools of pharmacy concluded that teaching

methods have evolved in a noticeable manner in comparison to 2003 [29, 30]. Another recent study published in 2020 aimed at evaluating the impact of development in pharmacy education on pharmacy practice, concluded that new evolvement in pharmacy education had positively affected the pharmacy practice in hospital and community settings [31].

Conclusion: Most practicing pharmacists showed a positive attitude of their current PK practice and to the impact of their undergraduate studies on their successful practice. However, they have clearly addressed the room for improvement. This study can be used to guide future efforts to improve current curriculum and to make it more practical and relevant to current practice.

Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.

Author contributions: EAO & MNSS conceived, designed, performed the analysis of data and drafting and revised the final version of the manuscript. MNEE collected the data. Both authors approved the final version of the manuscript and agreed to be accountable for its contents.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethical issues: Including plagiarism, informed consent, data fabrication or falsification and double publication or submission have completely been observed by authors.

Author declarations: The authors confirm that all relevant ethical guidelines have been followed and any necessary IRB and/or ethics committee approvals have been obtained.

References

1. American Society of Health-System Pharmacists (1998) ASHP statement on the pharmacist's role in clinical pharmacokinetic monitoring. *American Journal of Hospital Pharmacy*. 55 (16): 1726-1727. doi: 10.1093/ajhp/55.16.1726.
2. Dhillon S, Gill K (2006) Basic pharmacokinetics. *Clinical Pharmacokinetics*. Pharmaceutical press. London, UK. ISBN: 978 0 85369 571 4.
3. Ratanajamit C, Kaewpiba P, Sethawacharavanich S, Faroongsarng D (2009) Effect of pharmacist participation in the health care team on therapeutic drug monitoring utilization for antiepileptic drugs. *Journal of Medical Association of Thailand*. 92 (11): 1500-1507. PMID: 19938743.
4. Cies JJ, Varlotta L (2013) Clinical pharmacist impact on care, length of stay, and cost in pediatric cystic fibrosis (CF) patients. *Pediatric Pulmonology*. 48 (12): 1190-1194. doi: 10.1002/ppul.22745.
5. Ensom MH, Davis GA, Cropp CD, Ensom RJ (1998) Clinical pharmacokinetics in the 21st century. Does the evidence support definitive outcomes? *Clinical Pharmacokinetics*. 34 (4): 265-279. doi: 10.2165/00003088-199834040-00001.
6. Touw DJ, Neef C, Thomson AH, Vinks AA (2005) Cost-effectiveness of therapeutic drug monitoring: a systematic review. *Therapeutic Drug Monitoring*. 27 (1): 10-17. doi: 10.1097/00007691-200502000-00004.
7. Vozeh S (1987) Cost-effectiveness of therapeutic drug monitoring. *Clinical Pharmacokinetics*. 13 (3): 131-140. doi.org/10.2165/00003088-198713030-00001.
8. Murphy R, Chionglo M, Dupuis LL (2007) Impact of a pharmacist initiated therapeutic drug monitoring consult service for children treated with gentamicin. *Canadian Journal of Hospital Pharmacy*. 60 (3): 162-168. doi.org/10.4212/cjhp.v60i3.170.
9. Shenfield GM (1998) Therapeutic drug monitoring beyond 2000. *British Journal of Clinical Pharmacology*. 46 (2): 93-94. doi: 10.1046/j.1365-2125.1998.00771.x.

10. Hurley SF, Dziukas LJ, McNeil JJ, Brignell MJ (1986) A randomized controlled clinical trial of pharmacokinetic theophylline dosing. *The American Review of Respiratory Disease*. 134 (6): 1219-1224. doi: 10.1164/arrd.1986.134.5.1219.
11. Karcirova I, Grundmann M (2017) TDM of aminoglycoside antibiotics and vancomycin as an indicator of the quality of medical care: results of the 7-years monitoring. *Clinical Therapeutics*. 39 (8): e83. doi: 10.1016/j.clinthera.2017.05.256.
12. Lehmann CR, Leonard RG (1982) Effect of theophylline pharmacokinetic monitoring service on cost and quality of care. *American Journal of Hospital Pharmacy*. 39 (10): 1656-1662. doi.org/10.1093/ajhp/39.10.1656.
13. Hamzah A, Ab-Rahman AF (2008) Evaluation of blood sampling times and indications for therapeutic drug monitoring services. *Malaysian Journal of Pharmaceutical Sciences*. 6 (1): 1-11.
14. Jones D (2009) Therapeutic drug monitoring: a vital pharmacy role. *British Journal of Clinical Pharmacy*. (3/1/2015).
15. Kheir N, Awaisu A, Gad H, Elazzay S, Jibril F, Gajam M (2015) Clinical pharmacokinetics: perceptions of hospital pharmacists in Qatar about how it was taught and how it is applied. *International Journal of Clinical Pharmacy*. 37 (6): 1180-1187. doi: 10.1007/s11096-015-0183-3.
16. Kheir N, Fahey M (2011) Pharmacy practice in Qatar: challenges and opportunities. *Southern of Medical Review*. 4 (2): 92-96. doi: 10.5655/smr.v4i2.1007.
17. Zaidan M, Singh R, Wazaify M, Tahaine L (2011) Physicians' perceptions, expectations, and experience with pharmacists at Hamad Medical Corporation in Qatar. *Journal of Multidisciplinary Healthcare*. 4: 85-90. doi: 10.2147/JMDH.S14326.
18. Murphy JE, Slack MK, Campbell S (1996) National survey of hospital based pharmacokinetic services. *American Journal of Health System Pharmacy*. 53 (23): 2840-2847. doi.org/10.1093/ajhp/53.23.2840.
19. Boynton PM, Greenhalgh T (2004) Selecting, designing, and developing your questionnaire. *British Medical Journal*. 328 (7451): 1312-1315. doi.org/10.1136/bmj.328.7451.1312.
20. Saw SM, Ng TP (2001) The design and assessment of questionnaires in clinical research. *Singapore Medical Journal*. 42 (3): 131-135. PMID: 11405568.
21. Aldaz A, Ferriols R, Aumente D, Calvo MV, Farre MR, García B, Marqués R, Mas P, Porta B, Outeda M, Soy D, Grupo PK-gen de la Sociedad Española de Farmacia Hospitalaria (2011) Pharmacokinetic monitoring of antiepileptic drugs. *Farmacia Hospitalaria*. 35 (6): 326-339. doi: 10.1016/j.farma.2010.10.005.
22. Naik GS, Kodagali R, Mathew BS, Thomas M, Prabha R, Mathew V, et al. (2015) Therapeutic drug monitoring of levetiracetam and lamotrigine: is there a need? *Therapeutic Drug Monitoring*. 37 (4): 437-444. doi: 10.1097/FTD.0000000000000158.
23. Patsalos PN, Berry DJ, Bourgeois BF, Cloyd JC, Glauser TA, Johannessen SI, Leppik IE, Tomson T, Percuca E (2008) Antiepileptic drugs-best practice guidelines for therapeutic drug monitoring: a position paper by the subcommission on therapeutic drug monitoring, ILAE commission on therapeutic. *Epilepsia*. 49 (7): 1239-1276. doi: 10.1111/j.1528-1167.2008.01561.x.
24. Stepanova D, Beran RG (2015) The benefits of antiepileptic drug (AED) blood level monitoring to complement clinical management of people with epilepsy. *Epilepsy Behavior*. 42: 7-9. doi: 10.1016/j.yebeh.2014.09.069.
25. Duhme DW, Greenbaltt DJ, Koch-Weser J (1974) Reduction of digoxin toxicity associated with measurement of serum levels. A report from the Boston Collaborative Drug Surveillance Program. *Annals of Internal Medicine*. 80 (4): 516-519. doi: 10.7326/0003-4819-80-4-516.
26. Horn JR, Christensen DB, de Blaquiére PA (1985) Evaluation of a digoxin pharmacokinetic monitoring service in a community hospital. *Drug Intelligence and Clinical Pharmacy*. 19 (1): 45-52. doi: 10.1177/106002808501900112.
27. Spruill WJ, Wade WE (2003) Curricular and content survey of clinical pharmacokinetics courses. *American Journal of Pharmaceutical Education*. 67 (2): 1-11. doi: 10.5688/AJ670247.
28. Brackett CC, Reuning RH (1999) Teaching pharmacokinetics using a student-centered, modified mastery-based approach. *American Journal of Pharmaceutical Education*. 63: 272-277.
29. Kruger J, Dunning D (1999) Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*. 77 (6): 1121-1134. doi.org/10.1037/0022-3514.77.6.1121.
30. Hughes GJ, Lee R, Sideras V (2018) Design and delivery of clinical pharmacokinetics in colleges and schools of pharmacy. *American Journal of Pharmaceutical Education*. 82 (9): 6430. doi.org/10.5688/ajpe6430.
31. Azzopardi LM, Serracino-Inglott A (2020) Clinical pharmacy education and practice evolvement in Malta. *Journal of the American College of Clinical Pharmacy*. 3(5): 973-979. doi.org/10.1002/jac5.1280.