

Assessment of Hospital Pharmacists' Knowledge, Attitudes, and Practices Regarding Therapeutic Drug Monitoring in Adana, Türkiye: A Cross-Sectional Study

Emir EMLİK*, Sevgin MEMİLİ**, Nursel SÜRMEİİOĞLU***

Assessment of Hospital Pharmacists' Knowledge, Attitudes, and Practices Regarding Therapeutic Drug Monitoring in Adana, Türkiye: A Cross-Sectional Study

Adana İlindeki Hastane Eczacılarının Terapötik İlaç İzlemine İlişkin Bilgi, Tutum ve Uygulamalarının Değerlendirilmesi: Kesitsel Çalışma

SUMMARY

This study aimed to evaluate the knowledge, attitudes, and practices of hospital pharmacists regarding therapeutic drug monitoring (TDM) in Adana, Türkiye. This cross-sectional descriptive study was conducted using a structured questionnaire developed based on the literature. A total of 84 hospital pharmacists working in public hospitals participated in the study. Data on demographic characteristics, attitudes toward TDM, previous practice experience, and knowledge level were collected. Descriptive statistics, Pearson's chi-square test, and Fisher's exact test were used for data analysis. Although 97.6% of participants stated that TDM is necessary for treatment effectiveness and safety, only 11.9% reported previous TDM practice. The most commonly reported barriers were insufficient hospital or laboratory resources (50.0%) and lack of knowledge (36.5%). Vancomycin was the most frequently monitored drug. Correct response rates for knowledge questions related to vancomycin were low, including pharmacokinetic/pharmacodynamic target index (28.6%), target trough concentration (7.1%), and sampling time (7.1%). The correct response rate for the phenytoin-related question was 19.0% and was significantly higher among pharmacists with previous TDM experience ($p<0.05$). Hospital pharmacists showed high awareness of the importance of TDM; however, practical experience and knowledge levels were limited. Educational gaps and infrastructure limitations appear to be the main barriers to implementation. Strengthening undergraduate and continuing professional education may support the effective use of TDM in clinical pharmacy practice.

Keywords: Therapeutic drug monitoring, hospital pharmacy, clinical pharmacy, pharmacokinetics, pharmacists

ÖZ

Bu çalışma, Adana ilinde görev yapan hastane eczacılarının terapötik ilaç izlemine (Tİİ) yönelik bilgi, tutum ve uygulamalarını değerlendirmeyi amaçlamıştır. Literatüre dayalı olarak geliştirilen yapılandırılmış anket formu kullanılarak kesitsel ve tanımlayıcı bir araştırma yürütülmüştür. Çalışmaya kamu hastanelerinde görev yapan toplam 84 hastane eczacısı dahil edilmiştir. Katılımcıların demografik özellikleri, Tİİ'ye yönelik yaklaşımları, önceki uygulama deneyimleri ve bilgi düzeyleri değerlendirilmiştir. Verilerin analizinde tanımlayıcı istatistikler, Pearson ki-kare testi ve Fisher exact testi kullanılmıştır. Katılımcıların %97,6'sı Tİİ'nin tedavi etkinliği ve güvenliği açısından gerekli olduğunu belirtirken, yalnızca %11,9'u daha önce Tİİ uyguladığını bildirmiştir. Tİİ uygulanmamasının en sık nedenleri hastane veya laboratuvar kaynaklarının yetersizliği (%50,0) ve bilgi eksikliği (%36,5) olarak saptanmıştır. En sık izlenen ilaç vankomisin olmuştur. Vankomisin ile ilişkili bilgi sorularında doğru yanıt oranları düşük bulunmuştur. Bunlar arasında farmakokinetik/farmakodinamik hedef indeks (%28,6), hedef vadi düzeyi (%7,1) ve örneklem zamanı (%7,1) yer almaktadır. Fenitoin ile ilgili soruda doğru yanıt oranı %19,0 olup, daha önce Tİİ uygulayanlarda anlamlı derecede daha yüksek bulunmuştur ($p<0,05$). Hastane eczacılarında Tİİ'nin önemine yönelik farkındalık yüksek olmakla birlikte, uygulama deneyimi ve bilgi düzeyi sınırlıdır. Lisans ve meslek içi eğitimlerin güçlendirilmesi, Tİİ'nin klinik uygulamalarda etkin kullanımını destekleyebilir.

Anahtar Kelimeler: Terapötik ilaç izlemi, hastane eczacılığı, klinik eczacılık, farmakokinetik, eczacı

Received: 29.04.2026

Revised: 06.06.2026

Accepted: 14.06.2026

* ORCID: 0009-0002-4948-3958, Department of Clinical Pharmacy, Faculty of Pharmacy, Çukurova University, Adana, Türkiye

** ORCID: 0009-0000-3480-2296, Department of Clinical Pharmacy, Faculty of Pharmacy, Çukurova University, Adana, Türkiye; Department of Clinical Pharmacy, Faculty of Pharmacy, Hacettepe University, Ankara, Türkiye

*** ORCID: 0000-0001-7758-7100, Department of Clinical Pharmacy, Faculty of Pharmacy, Çukurova University, Adana, Türkiye

INTRODUCTION

Therapeutic drug monitoring (TDM) is an important clinical tool used to optimize drug therapy and improve patient safety. It involves measuring drug concentrations in blood or plasma and interpreting these results according to pharmacokinetic and pharmacodynamic principles. TDM is particularly useful for drugs with a narrow therapeutic range, marked pharmacokinetic variability, or a high risk of toxicity. By considering patient-specific factors such as age, body weight, organ function, and concomitant medications, TDM can support individualized dosing and improve treatment outcomes (Guilhaumou et al., 2019; Heil et al., 2018).

The clinical value of TDM depends not only on measuring drug concentrations but also on the correct interpretation of results. Appropriate sampling time, achievement of steady-state concentration, dose, and the patient's clinical response should all be considered during evaluation. Therefore, TDM is widely regarded as a quality assurance approach to medication management that aims to ensure the right drug is given to the right patient at the right dose (Kang & Lee, 2009; Yilmaz, 2005; Yin et al., 2023).

In recent years, the role of hospital pharmacists has expanded from traditional medication supply services to more patient-centered clinical responsibilities. Hospital pharmacists increasingly contribute to medication safety, dose optimization, adverse effect prevention, and multidisciplinary treatment decisions. TDM is one of the areas in which pharmacists can play an active and valuable role, especially in the management of antimicrobials, antiepileptics, and other high-risk medications (Rosenthal, Austin, & Tsuyuki, 2010).

Despite these benefits, the implementation of TDM in routine clinical practice remains limited in many healthcare settings. Reported barriers include insufficient laboratory facilities, lack of trained personnel, limited institutional support, and inadequate

practical knowledge among healthcare professionals (Abdel Jalil et al., 2023; Albassam, Alghanem, Alawadhi, & Alsulaimani, 2022). In Türkiye, data regarding hospital pharmacists' knowledge, attitudes, and practices related to TDM remain limited. In particular, little is known about pharmacists' previous TDM experience, perceived implementation barriers, knowledge regarding commonly monitored drugs, and use of electronic drug information resources in hospital settings. Therefore, this study aimed to evaluate the knowledge, attitudes, and practices of hospital pharmacists regarding TDM in Adana, Türkiye. By identifying educational and institutional gaps, the findings may help support future strategies to strengthen pharmacists' contribution to clinical pharmacy services.

MATERIALS AND METHODS

Study design and participants

This cross-sectional descriptive study was conducted among hospital pharmacists working in public hospitals in Adana, Türkiye. Data were collected in 2025 through face-to-face administration of a structured questionnaire. Public hospitals located in the central districts of Adana were visited in person, while pharmacists working in hospitals outside the city center were contacted through chief pharmacists to maximize participation. All reachable hospital pharmacists working in public hospitals during the study period were invited to participate, and participation was voluntary.

Questionnaire

Data were collected using a structured questionnaire developed by the researchers based on the relevant literature on therapeutic drug monitoring and hospital pharmacy practice. The questionnaire was designed to assess demographic and professional characteristics, attitudes toward TDM, previous TDM-related experience, perceived implementation barriers, use of electronic drug information resources, and knowledge regarding commonly monitored

drugs. To improve content appropriateness and clarity, the questionnaire was reviewed by experienced academics in clinical pharmacy. The final questionnaire consisted of 20 items. Eight questions assessed demographic and professional characteristics, while twelve questions evaluated knowledge, attitudes, and practices regarding TDM. However, formal psychometric validation, pilot testing, and reliability analyses (e.g., Cronbach's alpha) were not performed. The survey questionnaire is provided in Appendix 1.

Demographic and professional variables included age, sex, university of graduation, academic degree, years of professional experience, institution of employment, and the presence of a clinical pharmacist in the workplace.

TDM-related questions included opinions regarding the role of TDM in treatment, previous experience with TDM, reasons for not performing TDM, drugs commonly monitored, factors considered when determining sampling time, and the use of electronic drug information resources.

Knowledge questions focused on commonly monitored narrow-therapeutic-index drugs, particularly vancomycin and phenytoin, which were selected because they are clinically relevant medications more likely to be encountered in routine TDM practice in hospital settings in Türkiye. Participants were asked about pharmacokinetic/pharmacodynamic parameters used for vancomycin monitoring, target trough and peak concentrations, appropriate sampling times, and clinical parameters considered during phenytoin monitoring.

For questions with multiple correct options, responses were considered correct when at least one correct option was selected without selecting any incorrect option. All other responses were classified as incorrect.

Ethical considerations

The study was approved by the Ethics Committee of Çukurova University, Türkiye (Approval No: 17).

Participation was voluntary and based on informed consent. Responses were collected anonymously, and no personally identifiable data were recorded.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 20.0. Categorical variables were presented as numbers and percentages, while continuous variables were expressed as mean $\pm$ standard deviation. Responses to knowledge questions were classified as correct or incorrect.

Pearson's chi-square test was used for group comparisons, and Fisher's exact test was applied when expected cell counts were not appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 84 hospital pharmacists from 10 public hospitals in Adana, Türkiye, participated in the study. Demographic and professional characteristics of the participants are presented in Table 1. Only 5 participants (6.0%) reported the presence of a clinical pharmacist in their institution.

Table 1. Demographic and professional characteristics of participants (n=84)

Variable	Value
Female, n (%)	58 (69.0)
Male, n (%)	26 (31.0)
Age, mean $\pm$ SD (years)	35.92 $\pm$ 8.13
Professional experience, mean $\pm$ SD (years)	11.88 $\pm$ 8.11
Bachelor's degree, n (%)	75 (89.3)
Master's degree, n (%)	7 (8.3)
Doctoral degree, n (%)	2 (2.4)
Presence of a clinical pharmacist in the institution, n (%)	5 (6.0)

Nearly all participants (n=82, 97.6%) considered TDM necessary for treatment effectiveness and safety. However, only 10 pharmacists (11.9%) reported previous involvement in TDM practice. Reported barriers to implementation mainly included insufficient institutional or laboratory resources, limited knowledge, and increased workload (Table 2.).

Table 2. Reasons for not performing therapeutic drug monitoring among pharmacists without previous TDM experience (n=74)

Reason for not performing therapeutic drug monitoring	n (%)
Insufficient hospital/laboratory resources	37 (50.0)
Lack of knowledge about how and why to perform TDM	27 (36.5)
Increased workload	12 (16.2)
Other	7 (9.5)

Among pharmacists who reported previous TDM experience, vancomycin was the most frequently monitored drug (18.18%, n=8/44 responses). When asked which factors they considered while determining sampling time for TDM, the most common

response was “No opinion” (59.1%, n=52). Regarding the use of electronic drug information resources, 39.3% (n=33) of participants reported that they did not use any database, whereas 17.1% used Medscape and 11.1% used TebRp (Table 3.).

Table 3. Distribution of pharmacists' preferred electronic drug information resources (n=84)

Electronic drug information resource	n (%)
Medscape	20 (17.09)
TebRp	13 (11.11)
UpToDate*	9 (7.69)
RxMediaPharma	7 (5.98)
Vademecum	4 (3.42)
Lexidrug™ (Lexicomp®)	2 (1.71)
Micromedex	1 (0.85)
Sanford Guide*	1 (0.85)
İlacabak	1 (0.85)
ChatGPT	1 (0.85)
PubMed	1 (0.85)

Knowledge regarding vancomycin monitoring was generally limited (Table 4.). For the question assessing the appropriate pharmacokinetic/pharmacodynamic parameter for evaluating vancomycin activity, accepted correct responses were trough concentration or AUC/MIC (area under the concentration–time curve to minimum inhibitory concentration ratio). Although AUC-guided monitoring is prioritized in current international guidelines, trough concentration–based

monitoring was also accepted because it may still be encountered in routine clinical practice in some hospital settings during the transition toward broader implementation of AUC-guided monitoring (Rybak et al., 2020). Only 24 participants (28.6%) answered correctly. Correct response status was not significantly associated with sex, academic degree, professional experience, presence of a clinical pharmacist in the institution, or previous TDM experience ($p>0.05$).

Table 4. Correct response rates for TDM knowledge questions (n=84)

Knowledge item	Correct n (%)
Appropriate parameter for vancomycin monitoring	24 (28.6)
Target trough concentration of vancomycin	6 (7.1)
Appropriate trough sampling time	6 (7.1)
Target peak concentration of vancomycin	8 (9.5)
Appropriate peak sampling time	10 (11.9)
Phenytoin monitoring question	16 (19.0)

For the question regarding the target trough concentration of vancomycin, where the accepted correct response was 15–20 µg/mL, only 6 pharmacists (7.1%) responded correctly. No significant association was found between correct response status and demographic or professional variables ($p>0.05$).

For the question regarding the target peak concentration of vancomycin, where the accepted correct response was 25–50 µg/mL, 8 participants (9.5%) answered correctly. Similarly, 10 pharmacists (11.9%) correctly identified the appropriate timing of peak sample collection. No statistically significant associations were observed for these two questions according to demographic or professional variables ($p>0.05$).

Regarding the appropriate timing of trough sample collection, the accepted correct response was 30 minutes before the next dose after steady-state had been reached. Only 6 pharmacists (7.1%) answered correctly. However, pharmacists with previous TDM experience were significantly more likely to answer correctly than those without previous experience (40.0% vs. 2.7%, $p=0.001$) (Table 5.).

The correct responses to the phenytoin-related question were “I check the patient’s albumin level” and “I consider the patient’s renal function.” Overall, 16 pharmacists (19.0%) answered correctly. Pharmacists with previous TDM experience were significantly more likely to respond correctly than those without previous experience (50.0% [5/10] vs. 14.9% [11/74], $p=0.019$) (Table 5.).

Table 5. Factors associated with correct responses to selected TDM knowledge questions (n=84)

Variable	Vancomycin trough sampling (Correct %)	p	Phenytoin question (Correct %)	p
Male	7.7	1.000	19.2	1.000
Female	6.9		19.0	
Bachelor	6.7	0.505	18.7	0.679
Postgraduate	11.1		22.2	
1–3 years	18.2	0.338	45.5	0.115
4–10 years	8.1		13.5	
11–20 years	4.5		18.2	
≥ 21 years	0.0		14.3	
Clinical pharmacist present	20.0	0.316	20.0	1.000
No clinical pharmacist	6.3		19.0	
Previous TDM yes	40.0	0.001	50.0	0.019
Previous TDM no	2.7		14.9	

Among pharmacists who reported actively monitoring vancomycin (n=8), correct response rates remained variable and generally suboptimal. Four participants (50.0%) correctly identified the appropriate monitoring parameter, whereas only one (12.5%) correctly identified the target trough concentration and one (12.5%) the target peak concentration. Correct responses regarding appropriate sampling time were reported by three participants (37.5%) for trough levels and two (25.0%) for peak levels.

DISCUSSION

According to the findings of this study, the great majority of hospital pharmacists (97.6%) considered TDM to be necessary for treatment effectiveness and safety. However, only 11.9% reported that they had previously performed TDM. This marked difference suggests an important gap between theoretical knowledge and practical implementation. Similar findings have been reported in the literature, where positive attitudes toward TDM were present, but institutional

and educational barriers limited routine practice (Abdel Jalil et al., 2023; Albassam et al., 2022; Rosenthal et al., 2010). These findings suggest that theoretical education alone is not sufficient, and that system-level support is also required. Beyond evaluating pharmacists' perceptions of TDM, the present study provides contextual information regarding previous TDM experience, perceived barriers to implementation, knowledge of commonly monitored drugs, and use of electronic drug information resources in a Turkish hospital setting. These findings may help better identify educational and institutional gaps relevant to strengthening pharmacists' contribution to TDM-related clinical services.

In the present study, the most commonly reported reason for not performing TDM was insufficient hospital or laboratory resources (50.0%), showing that lack of resources is an important barrier to implementation. In addition, 36.5% of participants selected the response "I do not know how or why it should be performed," suggesting limited pharmacokinetic/pharmacodynamic knowledge. This may also reflect limited communication and collaboration between pharmacists and the multidisciplinary clinical team. Similar barriers have been reported in different countries (Abdel Jalil et al., 2023; Albassam et al., 2022; Bragazzi, Mansour, Bonsignore, & Ciliberti, 2020; Chamoun et al., 2020). These results show that both educational and structural barriers should be addressed together. Similar findings have been reported internationally. Studies have shown that pharmacists and healthcare professionals generally recognize the clinical importance of TDM but continue to report barriers such as insufficient institutional support, limited laboratory access, inadequate training, and lack of confidence in interpretation of TDM results (Albassam et al., 2022; Alkhiyami, Higazy, & Saad, 2024; Sharaf et al., 2024). Positive attitudes toward TDM despite modest knowledge levels and educational or institutional challenges affecting implementation have also been reported in previous studies (Alkhiyami et al., 2024). Consistent with these findings, Australian studies have also em-

phasized that implementation of pharmacist-managed TDM services and anti-infective TDM programs may be influenced by institutional infrastructure, assay availability, variability in local practices, and workforce-related barriers (Firman, Tan, Clavarino, Taing, & Whitfield, 2022; Sandaradura et al., 2022). The consistency of these findings across settings suggests that educational and structural barriers to TDM implementation may represent a broader challenge extending beyond local healthcare systems. Although reported less frequently, workload (16.2%) was another factor limiting TDM practice. Previous studies have similarly shown that pharmacists may recognize the value of TDM but avoid routine implementation because of time limitations and insufficient confidence (Abdel Jalil et al., 2023; Rosenthal et al., 2010).

Sampling time is a critical component of TDM because serum drug concentrations can only be interpreted correctly when samples are collected at the appropriate time. Incorrect sampling may lead to inappropriate dose adjustments. Therefore, pharmacokinetic principles should be considered when planning sample collection (Kang & Lee, 2009; Rybak et al., 2020). In this study, 59.1% of participants selected "No opinion" when asked about factors considered while determining sampling time, showing an important educational gap. Regular and standardized training programs may help improve this area. Similarly, 39.3% of participants reported that they did not use any electronic drug information database. This finding suggests that clinical decision-support tools are not widely used among pharmacists. Previous studies have emphasized the value of electronic databases and clinical support systems in improving TDM practice (Firman et al., 2022; Ghaibi, Ipema, & Gabay, 2015).

Responses from participants who reported performing TDM showed that monitored drugs were mostly narrow therapeutic index agents requiring careful dose adjustment. Vancomycin was the most frequently monitored drug (18.18%), followed by

aminoglycosides, meropenem, and digoxin. Vancomycin requires close monitoring because of its narrow therapeutic range, hydrophilic structure, relatively small volume of distribution, and renal elimination, particularly in critically ill patients (Heil et al., 2018; Rybak et al., 2020). However, in the present study, correct response rates for questions related to vancomycin monitoring were low.

Only 28.6% of participants correctly identified the pharmacokinetic/pharmacodynamic parameter used to evaluate vancomycin activity. No significant differences were observed according to sex, academic degree, or professional experience ($p>0.05$), suggesting that knowledge levels were generally low across groups. Current international guidelines prioritize AUC-guided vancomycin monitoring, particularly for serious MRSA infections; however, trough concentration-based monitoring may still be encountered in routine clinical settings because of practical and institutional considerations during the transition toward broader AUC implementation (Rybak et al., 2020). Therefore, both approaches were considered in the present knowledge assessment. Comparable findings from international studies have also highlighted variability in pharmacists' knowledge, confidence, and involvement in TDM-related decision-making, particularly for medications requiring complex pharmacokinetic interpretation (Alkhiyami et al., 2024; Firman et al., 2022; Sharaf et al., 2024). Differences between healthcare settings may partly reflect variability in institutional TDM infrastructure, pharmacist integration into clinical services, and access to continuing professional education. However, participants with 1–3 years of professional experience had relatively higher correct response rates than those with longer experience. Given the cross-sectional nature of the study, this finding should be interpreted cautiously and does not allow conclusions regarding changes in knowledge over time. Multiple factors, including recency of education, institutional practices, or differences in exposure to TDM-related activities, may contribute to this pattern. A similar trend was

observed in responses to the phenytoin-related question. In addition, 50.0% of participants with previous TDM experience answered the phenytoin-related question correctly, whereas the rate was lower among those without TDM experience. This finding may reflect an association between previous TDM experience and higher rates of correct responses; however, causal interpretations cannot be made because of the cross-sectional design. Similar observations have been reported in the literature, where previous TDM experience was associated with improved confidence and competence (Albassam et al., 2022; Sandaradura et al., 2022).

Correct response rates for questions related to vancomycin target trough concentration, trough sampling time, target peak concentration, and peak sampling time were very low (7.1%, 7.1%, 9.5%, and 11.9%, respectively). Only for trough sampling time was a significant difference observed between pharmacists who had previously performed TDM and those who had not (40.0% vs. 2.7%, $p=0.001$). This finding further supports the value of practical experience as a reinforcing factor for theoretical knowledge.

When the eight pharmacists who reported actively monitoring vancomycin were evaluated separately, correct response rates were still limited. Apart from the small subgroup size, this finding may indicate that TDM has not yet become a standardized and systematic practice in Türkiye.

This study has some limitations. Although the study was conducted in a single province, the target population consisted of hospital pharmacists working in public hospitals in Adana, Türkiye. During the study period, approximately 100 hospital pharmacists were working in Adana, and 84 pharmacists participated in the study, representing a substantial proportion of the target population. Nevertheless, the findings may not be generalizable to hospital pharmacists in other regions of Türkiye. Although an effort was made to invite hospital pharmacists working in public hospitals across the study setting, participation

was voluntary and limited to pharmacists reachable during the study period. Therefore, some degree of participation bias cannot be excluded. In addition, although the questionnaire was developed based on the literature and reviewed by experienced academics in clinical pharmacy, formal psychometric validation, pilot testing, and reliability assessment were not performed; therefore, the findings should be interpreted with caution. The knowledge assessment focused primarily on vancomycin and phenytoin, reflecting drugs more commonly encountered in routine TDM practice in hospital settings in Türkiye. Although this approach aimed to reflect practical clinical settings, inclusion of a broader range of monitored medications may have provided a more comprehensive assessment of TDM-related knowledge. Furthermore, some subgroup analyses were based on relatively small numbers of participants, particularly pharmacists with previous TDM experience and institutions with a clinical pharmacist; therefore, subgroup findings should be interpreted cautiously. Larger multicenter studies including different regions of Türkiye may provide stronger and more generalizable findings.

The number of clinical pharmacists in Türkiye is still insufficient for all hospitals. However, even when pharmacists are not physically present in clinical wards, hospital pharmacists who review medication orders electronically may contribute to monitoring narrow therapeutic index drugs and supporting dose management from the pharmacy department. As shown by the present findings, knowledge and awareness gaps may be improved through targeted continuing education. In this way, pharmacists may take a stronger role not only in medication supply and distribution but also as healthcare professionals contributing directly to pharmaceutical care.

CONCLUSION

Therapeutic drug monitoring is an important clinical service for drugs with a narrow therapeutic range. In this study, hospital pharmacists demonstrated

strong awareness of the importance of TDM; however, routine practice, practical experience, and knowledge levels were limited. Vancomycin was the most frequently monitored drug, yet knowledge regarding its monitoring principles remained insufficient.

Hospital pharmacists should be supported through undergraduate and continuing professional education on the practical application of TDM. Practical strategies such as strengthening case-based TDM education during undergraduate pharmacy training, expanding continuing professional education opportunities, improving access to evidence-based clinical decision-support resources, and supporting institutional initiatives that facilitate pharmacist involvement in TDM-related activities may contribute to strengthening TDM implementation in hospital settings. Further multicenter studies from different regions of Türkiye are needed to better evaluate national practice patterns.

AUTHOR CONTRIBUTION STATEMENT

Concept: N.S.; Design: N.S., E.E.; Supervision: N.S.; Resources: N.S.; Data Collection and/ or Processing: E.E.; Analysis and/or Interpretation: N.S., E.E.; Literature Review: E.E., S.M.; Writing the Article: S.M., E.E.; Critical Review: N.S., S.M.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

- Abdel Jalil, M. H., Hijazeen, R., Khaled Abu-Mahfouz, F., Abu Hammour, K., Hasan Matalqah, M., Saleh Khaleel Albadaineh, J., . . . Al-Iede, M. (2023). Vancomycin prescribing and therapeutic drug monitoring: Challenges of real clinical practice. *PLOS ONE*, 18(5), e0285717. doi:10.1371/journal.pone.0285717
- Albassam, A., Alghanem, S. S., Alawadhi, F., & Alsulaimani, Z. (2022). Knowledge, Confidence, and

- Perception Toward Therapeutic Drug Monitoring Among Physicians and Pharmacists in Kuwait. *Therapeutic Drug Monitoring*, 44(4), 511-519. doi:10.1097/ftd.0000000000000966
- Alkhiyami, D. I., Higazy, A. S., & Saad, M. O. (2024). A survey on the knowledge and attitudes of pharmacists towards the application of antimicrobial therapeutic drug monitoring and its challenges in Qatar. *PLOS ONE*, 19(2), e0297699. doi:10.1371/journal.pone.0297699
- Bragazzi, N. L., Mansour, M., Bonsignore, A., & Ciliberti, R. (2020). The Role of Hospital and Community Pharmacists in the Management of COVID-19: Towards an Expanded Definition of the Roles, Responsibilities, and Duties of the Pharmacist. *Pharmacy (Basel)*, 8(3). doi:10.3390/pharmacy8030140
- Chamoun, N., Usta, U., Karaoui, L. R., Salameh, P., Hallit, S., Shuhaiber, P., . . . Iskandar, K. (2020). Current Trends in Hospital Pharmacy Practice in Lebanon. *Hospital pharmacy*, 55(2), 112-118. doi:10.1177/0018578718823733
- Firman, P., Tan, K.-S., Clavarino, A., Taing, M.-W., & Whitfield, K. (2022). Pharmacist-Managed Therapeutic Drug Monitoring Programs within Australian Hospital and Health Services—A National Survey of Current Practice. *Pharmacy*, 10(5), 135. doi:10.3390/pharmacy10050135
- Ghaibi, S., Ipema, H., & Gabay, M. (2015). ASHP guidelines on the pharmacist's role in providing drug information. *American journal of health-system pharmacy : AJHP : official journal of the American Society of Health-System Pharmacists*, 72(7), 573-577. doi:10.2146/sp150002
- Guilhaumou, R., Benaboud, S., Bennis, Y., Dahyot-Fizelier, C., Dailly, E., Gandia, P., . . . Garnier, M. (2019). Optimization of the treatment with beta-lactam antibiotics in critically ill patients-guidelines from the French Society of Pharmacology and Therapeutics (Société Française de Pharmacologie et Thérapeutique-SFPT) and the French Society of Anaesthesia and Intensive Care Medicine (Société Française d'Anesthésie et Réanimation-SFAR). *Critical care (London, England)*, 23(1), 104. doi:10.1186/s13054-019-2378-9
- Hanretty, A. M., & Gallagher, J. C. (2018). Shortened Courses of Antibiotics for Bacterial Infections: A Systematic Review of Randomized Controlled Trials. *Pharmacotherapy*, 38(6), 674-687. doi:10.1002/phar.2118
- Heil, E. L., Claeys, K. C., Mynatt, R. P., Hopkins, T. L., Brade, K., Watt, I., . . . Pogue, J. M. (2018). Making the change to area under the curve-based vancomycin dosing. *American journal of health-system pharmacy : AJHP : official journal of the American Society of Health-System Pharmacists*, 75(24), 1986-1995. doi:10.2146/ajhp180034
- Kang, J. S., & Lee, M. H. (2009). Overview of therapeutic drug monitoring. *The Korean journal of internal medicine*, 24(1), 1-10. doi:10.3904/kjim.2009.24.1.1
- Rosenthal, M., Austin, Z., & Tsuyuki, R. T. (2010). Are Pharmacists the Ultimate Barrier to Pharmacy Practice Change? *Canadian Pharmacists Journal / Revue des Pharmaciens du Canada*, 143(1), 37-42. doi:10.3821/1913-701x-143.1.37
- Rybak, M. J., Le, J., Lodise, T. P., Levine, D. P., Bradley, J. S., Liu, C., . . . Lomaestro, B. (2020). Therapeutic Monitoring of Vancomycin for Serious Methicillin-resistant *Staphylococcus aureus* Infections: A Revised Consensus Guideline and Review by the American Society of Health-system Pharmacists,

- the Infectious Diseases Society of America, the Pediatric Infectious Diseases Society, and the Society of Infectious Diseases Pharmacists. *Clinical Infectious Diseases*, 71(6), 1361-1364. doi:10.1093/cid/ciaa303
- Sandaradura, I., Alfenaar, J.-W., Cotta, M. O., Daveson, K., Day, R. O., Van Hal, S., . . . Imani, S. (2022). Emerging therapeutic drug monitoring of anti-infective agents in Australian hospitals: Availability, performance and barriers to implementation. *British Journal of Clinical Pharmacology*, 88(2), 669-679. doi:10.1111/bcp.14995
- Sharaf, S., Dahlawi, A., Alhajjaji, A., Alqurashi, A., Albarakati, M., Badawi, M., . . . Shamsi, A. (2024). Assessment of Knowledge, Attitude, and Practice of Therapeutic Drug Monitoring Among Hospital Pharmacists in Saudi Arabia. *International Journal of Clinical Practice*, 2024, 11. doi:10.1155/2024/3435718
- Yılmaz, D. (2005). *Yoğun bakım ünitesinde dar terapötik aralıklı ilaçların kan düzeyi izlemi*. (Master's thesis). Hacettepe University, Ankara, Türkiye.
- Yin, T., Liang, H., Huang, Q., Zhou, B., Tang, M., Lou, J., & Xiang, D. (2023). A Survey of Therapeutic Drug Monitoring Status in China. *Therapeutic Drug Monitoring*, 45(2), 151-158. doi:10.1097/ftd.0000000000001060

APPENDIX 1

Survey Questionnaire

Section 1. Sociodemographic Characteristics

1. I voluntarily agree to complete this survey.
 - A) Yes
 - B) No
2. Age: _____
3. Sex: _____
4. University graduated from: _____
5. What is your academic degree?
 - A) Bachelor's degree
 - B) Master's degree
 - C) Doctorate (PhD)
6. What is your duration of professional experience? (Please circle.)
 - 1–3 years
 - 4–6 years
 - 7–10 years
 - 11–15 years
 - 16–20 years
 - 21–25 years
 - 26–30 years
 - More than 30 years
7. Institution where you work: _____
8. Is there a clinical pharmacist in your institution?
 - A) Yes
 - B) No

Section 2. Attitudes and Practices Regarding Therapeutic Drug Monitoring

9. What do you think about the role of therapeutic drug monitoring (TDM) in the treatment process?
- A) I think it is necessary for treatment effectiveness and safety.
 - B) I do not think it contributes to the treatment process.
 - C) No opinion
10. Have you previously performed therapeutic drug monitoring (TDM)?
- A) Yes
 - B) No
 - C) No opinion
11. If your answer is “No”, why do you not perform therapeutic drug monitoring? (You may select more than one option or specify “Other”).
- A) It increases workload.
 - B) I think it is not important in practice.
 - C) I do not know how and why it should be performed.
 - D) Hospital/laboratory resources are insufficient.
 - E) Other: _____
12. If your answer is “Yes”, for which drugs can therapeutic drug monitoring be performed in your institution? (Please circle.)
- Vancomycin
 - Amikacin
 - Gentamicin
 - Meropenem
 - Phenytoin
 - Phenobarbital
 - Valproic acid
 - Digoxin
 - Theophylline
 - Voriconazole
 - Warfarin
 - Cyclosporine
 - Tacrolimus
 - Lithium
 - Linezolid
 - Methotrexate
 - Itraconazole

13. When determining the sampling time for therapeutic drug monitoring, what do you consider? (You may select more than one option.)

- A) Timing does not matter; the sample can be collected at any time.
- B) I determine the sampling time considering the pharmacokinetics of the drug.
- C) I determine the sampling time by consulting guidelines or drug information databases.
- D) No opinion

14. If you use electronic databases as references, which one(s) do you use? (Please circle.)

- Medscape
- Sanford Guide®
- UpToDate®
- Lexidrug™ (Lexicomp®)
- Micromedex
- My undergraduate/postgraduate course notes
- None
- Other: _____

Section 3. Knowledge Regarding Therapeutic Drug Monitoring

15. Which pharmacokinetic/pharmacodynamic index do you use to evaluate vancomycin activity? (You may select more than one option.)

- A) Trough concentration
- B) Peak concentration
- C) AUC/MIC ratio
- D) No opinion

16. What target trough concentration range do you aim for with vancomycin?

- A) 5–10 µg/mL
- B) 15–20 µg/mL
- C) 20–35 µg/mL
- D) 35–50 µg/mL
- E) No opinion

17. When do you collect a sample for evaluating vancomycin trough concentration?

- A) No opinion
- B) It can be collected at any time once steady state is reached.
- C) It does not need to reach steady state; it can be collected during any dosing interval.
- D) It should be collected 30 minutes before the next dose after reaching steady state.
- E) It should be collected 30 minutes after the next dose, after reaching steady state.

18. What target peak concentration range do you aim for with vancomycin?

- A) 10–15 µg/mL
- B) 15–20 µg/mL
- C) 20–25 µg/mL
- D) 25–50 µg/mL
- E) No opinion

19. When do you collect a sample for evaluating vancomycin peak concentration?

- A) No opinion
- B) It can be collected at any time once steady state is reached.
- C) It does not need to reach steady state; it can be collected during any dosing interval.
- D) It should be collected 1 hour after completion of the infusion of the next dose after reaching steady state.
- E) It should be collected 1 hour before completion of the infusion of the next dose after reaching steady state.

20. What do you consider when monitoring phenytoin? (You may select more than one option.)

- A) I evaluate the patient's albumin level.
- B) I consider the patient's renal function.
- C) I consider the patient's hepatic function.
- D) No opinion