U.S. Department of Veterans Affairs
Veterans Health Administration
Pharmacy Benefits Management (PBM) Services
Clinical Pharmacy Practice Office (CPPO)

Evidence Bibliography: Clinical Pharmacy Practice in Emergency Medicine

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The following collection of publications and resources contributes to the growing literature of pharmacist impact on care in the emergency department setting. Positions statements and documented practice models are included, which highlight the value of pharmacists in this setting. Citations noted with an asterisk (*) have been authored by Veterans Affairs (VA) or other federally employed pharmacists.

- Systematic Review/Summary
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Systematic Review and Healthcare Landscape

1. Ortmann MJ, Johnson EG, Jarrell DH, Bilhimer M, Hayes BD, Mishler A, Pugliese RS, Roberson TA, Slocum G, Smith AP, Yabut K, Zimmerman DE. ASHP Guidelines on Emergency Medicine Pharmacist Services. Am J Health Syst Pharm. 2021 Jan 22;78(3):261-275.

   Framework reference to guide hospitals, pharmacy department:

   1. Patient Care: providing real time medication information to providers directly improving patient care through appropriate mediation selection and the prescribing process.
   2. Resuscitation: improved safety from decreased preventable adverse medication events and expedited time to medication administration. Pharmacists assist in dosing in acute events.
   3. Mediation therapy monitoring: can improve patient clinical outcomes by monitoring for effectiveness and safety
   4. Medication reconciliation: many barriers to obtaining an accurate medication history in the ED. Pharmacists could assist in obtaining an accurate medication history or develop protocols to identity ED patients who would benefit from a medication history.
   5. Interdisciplinary education: formal didactic to on-the-spot education via huddles or at bedside to pharmacists, medical residents, and nursing staff

   - **Summary**: A systemic literature search was conducted by a group of EM clinical pharmacy specialist experts identified by ASHP to create a peer consensus.

2. Stoffel JM, Baum RA, Dugan AJ, Bailey AM. Variability in training, practice, and prioritization of services among emergency medicine pharmacists. *Am J Health Syst Pharm*. 2019; 76:S21-S27.
   - **Design:** Electronic survey-based research
   - **Practices:** Pharmacists participated in traumas, cared for boarded patients, and performed scholarly activities.
   - **Outcomes:** Pharmacists practicing in an academic emergency department (ED) reported participating in traumas, care for boarded patients, and performing scholarly activities more frequently and medication reconciliations less frequently than those in a community ED.
   - **Summary:** Institution and ED demographics as well as pharmacist level of training can affect the frequency/ variability of services provided in the ED setting.

3. Roman C, Edwards G, Dooley M, Mitra B. Roles of the emergency medicine pharmacist: A systematic review. *Am J Health Syst Pharm*. 2018; 75(11):796-806.
   - **Design:** Systematic literature review
   - **Practices:** Six reported studies evaluated EM pharmacist involvement in the care of critically ill patients, 5 studies evaluated antimicrobial stewardship (AMS) activities via pharmacist review of positive cultures, 2 studies assessed pharmacist involvement in generating orders for nurse-administered home medications and 2 reviewed publications focused on EM pharmacist involvement in management of healthcare-associated pneumonia and dosing of phenytoin.
   - **Outcomes:** A systematic review of the literature revealed 3 key emerging areas of practice for the EM pharmacist that are associated with positive patient outcomes; management of critically ill patients, AMS roles, and ordering of home medications in the ED.
   - **Summary:** A diverse range of positive patient outcomes was identified. Management of critically ill patients, AMS roles, and ordering of home medications in the ED were associated with positive patient outcomes.

4. Roman C, Edwards G, Dooley M, et al. Roles of the emergency medicine pharmacist: A systemic review. *Am J Health Syst Pharm*. 2018;75(11):796-806.
   - **Summary:** Emergency department (ED)-based clinical pharmacy is a rapidly growing practice area that has gained support in several countries globally, particularly over the last 5-10 years. A systematic literature search covering the period 1995-2016 was conducted to characterize emerging EM pharmacist roles and the impact on patient outcomes. Six databases were searched for research publications on pharmacist participation in patient care in a general ED or trauma center that documented interventions by ED-based pharmacists; 15 results satisfied the inclusion criteria. Six reported studies evaluated EM pharmacist involvement in the care of critically ill patients, 5 studies evaluated antimicrobial stewardship (AMS) activities via pharmacist review of positive cultures, 2 studies assessed pharmacist involvement in generating orders for nurse-administered home medications and 2 reviewed publications focused on EM pharmacist involvement in management of healthcare-associated pneumonia and dosing of phenytoin. A diverse range of positive patient outcomes was identified. The included studies were assessed to be of low quality.

5. Thomas MC, Acquisto NM, Shirk MB, Patanwala AE. A national survey of emergency pharmacy practice in the United States. *Am J Health Syst Pharm*. 2016;73(6):386-94.
   - **Design:** Electronic national survey
   - **Practices:** To characterize pharmacy practice in the emergency department (ED) setting, an electronic survey was sent to approximately 400 members of the American Society of Health-System Pharmacists' Emergency Medicine Connect group and the American College of Clinical Pharmacy's Emergency Medicine Practice and Research Network.
   - **Outcomes:** One hundred eighty-seven survey responses were retained with majority of the respondents from community hospitals (59.6%) or academic medical centers (36.1%). Pharmacist's presence in the ED of more than eight hours a day on weekdays and weekends was the most reported (68.7%); 49.4% of respondents reported that their institutions provided more than eight hours of coverage daily. Nearly one in three institutions (34.8%) provided no weekend ED staffing. The distribution of ED pharmacist activities includes clinical (25%), emergency response (15%), order processing (15%), medication reconciliation and history-taking (10%), teaching (10%), and administrative (5%).
   - **Summary:** Pharmacists practicing in the ED from academic and community institutions perform a variety of clinical, educational and administrative activities.

6. *Kessler C, Ward MJ, McNaughton CD. Reducing Adverse Drug Events: The Need to Rethink Outpatient Prescribing. *JAMA*. 2016; 316(20):2092-2093.
   - **Summary:** In the Emergency Department (ED) setting, concerns regarding adverse drug events (ADEs) due to prescribed medications are often not fully addressed, likely due to the limited scope and time with patients and barriers to communication between physicians in the ED and a patient's primary care team. Medication changes in the ED typically occur during brief discussions and generally without the input or medical records from the patient's primary care or specialty care clinicians. Within large, integrated healthcare systems such as the Veterans Health Administration (VHA), communication between ED physicians and other clinicians is more feasible. Identifying, addressing, and preventing ADEs will require a systematic redesign of how medications are prescribed, monitored, and discontinued, especially chronic medications. Increased integration and use of ED-based pharmacists is a potential solution that may address these needs and could build on existing team-based, inpatient hospital models. Integrated health care systems can help pioneer improved care coordination and transition of care models.

7. *Owenby RK, Brown JN, Kemp DW. Evaluation of pharmacy services in emergency departments of Veterans Affairs Medical Centers. *Am J Health Syst Pharm*. 2015; 72:S110-4.
   - **Design:** Cross-sectional survey study
   - **Practices:** The most common pharmacy services provided included medication reconciliation, patient education/ counseling, pharmacotherapy recommendations, ED staff education, precepting activities, adverse drug reaction (ADR) reporting, and ensuring formulary compliance. In addition, pharmacists made interventions that prevented ADRs and were able to reduce costs.
   - **Outcomes:** ED pharmacy services were more frequently reported in VA facilities compared with a national sample of non-VA facilities. Despite the high prevalence and variety of dedicated

pharmacy services provided to the ED, documentation of these services remains an area in need of improvement.
- **Summary:** Pharmacists provide a wide range of services to the ED however documenting theses services remains an area in need of improvement.

8. Acquisto NM, Hays DP. Emergency medicine pharmacy: Still a new clinical frontier. *Am J Health Syst Pharm*. 2015; 72(23):2092-6.
   - **Design:** Electronic national survey
   - **Practices:** Pharmacists practicing in the ED reported involvement in a variety of activities and were asked to estimate the percentage of a typical day dedicated to those activities. On average, clinical activities (e.g., pharmacotherapy consults, drug information, toxicology recommendations, patient education, microbiology culture review) consumed 25% of a pharmacist's time (IQR, 15–40%), followed by emergency response activities, such as participating in responses to medical cardiopulmonary and trauma resuscitation emergencies (15%; IQR, 10–20%); order processing (15%; IQR, 5–25%); medication reconciliation (10%; IQR, 5–25%); teaching (10%; IQR, 5–15%); and administrative activities (5%; IQR, 0–10%).
   - **Outcomes:** A total of 187 pharmacists completed the survey. Large majorities of respondents were from community hospitals (60.4%) or academic institutions (35.4%). Overall, the median number of pharmacists practicing in the ED was 2.0.
   - **Summary:** These results showed that pharmacists practicing in academic and community EDs perform a variety of clinical, educational, and administrative activities.

9. Jacknin G, Nakamura T, Smally AJ, et al. Using pharmacists to optimize patient outcomes and costs in the ED. *Am J Emerg Med*. 2014; 32(6):673-677.
   - **Summary:** This article reviews the benefits a pharmacist in the ED. Areas of benefit include medical errors in general, by process, by severity, in geriatric populations, and in education also includes medication history, value added activities (i.e., medication reconciliation, real-time consultation, response to urgent alerts such as trauma, stroke, medical, and MI, can be a second check to dosing, ability to prepare medications bedside, obtaining medications not immediately available in the ED, assistance in antibiotic dosing, counseling, protocol development, management of inventory including drug shortages, and committee involvement). Other issues addressed include regulatory standards established by TJC, barriers to implementation of an ED pharmacist, and acceptance in the ED. The ED pharmacist plays an essential part of the ED. Literature supports the cost of the position while also adding an extra safeguard for patient safety.

10. Eppert HD, Reznek AJ; American Society of Health-System Pharmacists. ASHP guidelines on emergency medicine pharmacist services. *Am J Health Syst Pharm*. 2011; 68(23):e81-95.
    - **Design:** ASHP guidelines
    - **Practices:** Pharmacists were involved with essential patient care roles such as optimizing meds, participating in direct patient care rounds, performing medication order reviews, MTM, obtaining medication histories, med reconciliation, participating in procedures that utilize high-risk medications, resuscitation, medication procurement and preparation, provision of drug information, documentation, ensuring medication and patient safety, and performing essential administrative and quality improvement tasks.
    - **Outcomes:** The central role of the emergency medicine pharmacists (EMPs) is to improve patient outcomes by improving patient safety, preventing medication errors, and providing optimized pharmacotherapy regimens and therapeutic outcomes through participation in direct patient care

activities and quality-improvement initiatives in the ED. In addition, EMPs can provide education to members of the pharmacy department and other health care providers, as well as patients and their caregivers, and EMPs may participate in research and scholarly activities in the ED

- **Summary:** The first descriptions of pharmacy services provided in the ED appeared in the 1970s. EMPs today, provide many vital services within the ED. The central role of EMPs is to improve patient outcomes by preventing medication errors, optimizing pharmacotherapy regimens, and improving patient safety through direct patient care activities and quality improvement initiatives in the ED.

11. Elenbaas RM, Waeckerle JF, McNabney WK. The clinical pharmacist in emergency medicine. *Am J Hosp Pharm*. 1977; 34(8):843-6.
    - **Design:** An evaluation of physicians and nurse's attitudes towards pharmacist involvement in the ED.
    - **Practices:** 14-item questionnaire was administered to physicians and nurses.
    - **Outcomes:** All respondents felt the pharmacist was an important component of the department and a benefit to its patient care and educational programs. Eighty-seven percent of the physicians stated the pharmacist is capable of offering primary care to certain patients once diagnosis has been made; 95% felt the role of the pharmacist is transferrable to other emergency room facilities and 83% were willing to have their patients charged for his services.

Position Statements and Practice Models

12. Morgan SR, Acquisto NM, Coralic Z, et al. Clinical pharmacy services in the emergency department. *Am J Emerg Med*. 2018; 36(10):1727-1732.
    - **Summary**: The emergency department (ED) is a fast-paced, high-risk, and often overburdened work environment. Formal policy statements from several notable organizations, including the American College of Emergency Physicians (ACEP) and the American Society of Health-System Pharmacists (ASHP), have recognized the importance of clinical pharmacists in the emergency medicine (EM) setting. EM clinical pharmacists work alongside emergency physicians and nurses at the bedside to optimize pharmacotherapy, improve patient safety, increase efficiency and cost-effectiveness of care, facilitate antibiotic stewardship, educate patients and clinicians, and contribute to scholarly efforts. This paper examines the history of EM clinical pharmacists and associated training programs, the diverse responsibilities and roles of EM clinical pharmacists, their impact on clinical and financial outcomes, and proposes a conceptual model for EM clinical pharmacist integration into ED patient care. Finally, barriers to implementing EM clinical pharmacy programs and limitations are considered.

13. Farmer BM, Hayes BD, Rao R, Farrell N, Nelson L. The Role of Clinical Pharmacists in the Emergency Department. *J Med Toxicol*. 2018; 14(1):114-116.
    - **Summary**: The ED is a unique setting with a diverse and complex patient population presenting around the clock with urgent and emergent needs. Emergency physicians readily utilize and value the presence of ED pharmacists to aid in this care. We support 24-h staffing of emergency departments with dedicated ED pharmacists as part of the clinical care team. American College of Medical Toxicology (ACMT) also supports studies to further define the impact and value of pharmacists in the ED and other areas of ED expansion such as urgent care and observation units.

14. Cobaugh DJ, Schneider SM. Pharmacists in the emergency department: encouraging and discouraging findings. *Am J Health Syst Pharm*. 2016; 73(6):357.
    - **Summary:** The American Society of Health-System Pharmacists (ASHP) developed policies and resources that support the increased engagement of pharmacists in the ED setting. In 2015, the American College of Emergency Physicians adopted this policy statement which recognized pharmacists' values and supported dedicated roles of pharmacists within the ED. While there have been national organizations advocating for the inclusion of pharmacists in the ED, the 2015 ASHP national survey only found 21.8% of respondents were pharmacists assigned to the ED and smaller hospitals were less likely to have dedicated ED pharmacy services. Given the high risks associated with medication use in the ED, hospitals should ensure that pharmacists are active members on the ED team during peak patient care hours seven days a week.

15. *Aldridge VE, Park HK, Bounthavong M, Morreale AP. Implementing a comprehensive, 24-hour emergency department pharmacy program. *Am J Health Syst Pharm*. 2009; 66(21):1943-7.
    - **Design:** A 24-hour emergency department pharmacy program (EDPP) was created at the Veterans Affairs San Diego Healthcare System to address deficiencies identified by the pharmacy service within the ED, including medication tracking, documentation of doses administered, and formulary management. Activities of pharmacists were tracked and documented.
    - **Practices:** The most common practices were interventions that resulted in the prevention of serious patient harm, prevention or management of adverse drug events, and dose or frequency adjustments of a medication orders.
    - **Outcomes:** During the initial six-month implementation period, the ED pharmacists recorded 9,568 interventions. Safety and cost avoidance of their activities were monitored. The EDPP improved the quality of patient care, decreased medication errors and patient wait times, improved the medication reconciliation process, enhanced formulary management, ensured prospective medication order review, and increased overall patient safety, as evidenced by the documented interventions and staff satisfaction survey. The projected cost savings for the medical center during the first year of EDPP implementation was calculated as $1,691,185. The ED staff survey revealed that the program enhanced the level of quality patient care. Staff members reported high levels of satisfaction with the EDPP and 93% considered the ED pharmacist an integral part of the ED team.
    - **Summary:** A tertiary care teaching hospital successfully implemented a 24-hour, comprehensive ED pharmacy service that enhanced the efficiency and delivery of patient care and resulted in significant cost savings.

16. Requirements for Provider-based Off campus Emergency Departments and Hospitals that Specialize in the Provision of Emergency Services [Internet]. Baltimore: Centers for Medicare and Medicaid Services; c2020 [updated 2008 Jan 11; cited 2020 Aug 31]. Available from: https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/downloads/SCletter08-08.pdf.
    - **Summary:** The Centers for Medicare and Medicaid Services acknowledges that the growth in the demand for hospital emergency services has resulted in hospitals expanding their emergency department services to off-site locations. Providers who are based in off-site hospital EDs are permitted and must demonstrate compliance with the hospital Conditions of Participation (CoPs).

17. Kasuya A, Bauman JL, Curtis RA, Duarte B, Hutchinson RA. Clinical pharmacy on-call program in the emergency department. *Am J Emerg Med*. 1986;4(5):464-467.

- **Design:** A retrospective review of completed report forms evaluating the first two years of a pharmacy residency on call program at the University of Chicago Illinois.
- **Practices:** The emergency service is staffed by a clinical pharmacy faculty member and or a clinical pharmacy resident on weekdays from 7am until 5 pm. This regular staffing is complemented by the on-call program. On call hours for the ED area are from 5 pm until 7 am the following day, and weekends and holidays from 7am until 7 am the following day.
- **Outcomes:** Over the two years, clinical pharmacy residents completed 3.1 consultations per 14-hour call period. Greater than 90% of the clinical pharmacy recommendations were accepted and completely followed by physician cohorts. The consultations were usually solicited by medical residents and required a mean of 100 minutes per consult.

Healthcare Landscape

18. Treu CN, Llamzon JL, Acquisto NM, Lazar JD. The impact of an emergency medicine clinical pharmacist on nursing satisfaction. *Int J Clin Pharm*. 2019; 41(6):1618-1624.
    - **Design:** Prospective survey study evaluated nursing satisfaction prior to initiation of an emergency medicine clinical pharmacist and one year after implementation. A total of 52 surveys were returned with 22 (36.7) in the pre-intervention group compared to 30 (50%) in the post-intervention group.
    - **Practices:** The survey assessed three areas of pharmacy: general pharmacy, pharmacy information technology, and emergency medicine clinical pharmacy services.
    - **Outcomes:** All general pharmacy questions were improved at one year with timely resolution of pharmacy related issues, medication procurement, and satisfaction with pharmacy services achieving statistical significance. Pharmacy information technology questions were significantly improved in terms of automated medication dispensing system inventory, prevention and resolution of medication stock outs, and ease of medication removal compared to baseline. The addition of an emergency medicine clinical pharmacist increases nursing satisfaction with central pharmacy and pharmacy technology services.

19. Fairbanks RJ, Hildebrand JM, Kolstee KE, Schneider SM, Shah MN. Medical and nursing staff highly value clinical pharmacists in the emergency department. *Emerg Med J*. 2007; 24(10):716-8.
    1. **Design:** Descriptive survey study
    2. **Practices:** Attend to trauma resuscitations, order review, consults, patient education, selection of antibiotic, selection of medication, DDI consult, medication in pregnancy consult, toxicology consult, cost avoidance, etc.
    3. **Outcomes:** 99% of respondents felt the Emergency Department Pharmacist (Eph) improves quality of care, 96% feel they are an integral part of the team, and 93% had consulted the EPh at least a few times during their last five shifts. Staff felt that the EPh should be available for consults, attend resuscitations, and check orders.
    4. **Summary:** This study reinforced the value of many specific duties of the EPh program and found that doctors and nurses overwhelmingly favor the presence of an EPh in the ED, frequently seek their advice, and feel they improve quality of care. Respondents (nurses/doctors, etc.) felt that high risk and rarely used medications should be checked by a pharmacist when possible.

Pharmacist Interventions

20. Bakey KH, Nguyen CN. Impact of a Pharmacist Intervention in the Emergency Department on the Appropriateness of Direct Oral Anticoagulants Prescribed in Venous Thromboembolism Patients [published online ahead of print, 2021 Mar 19]. *J Pharm Pract*. 2021;8971900211000704.
    - **Design**: Retrospective cohort study
    - **Practices**: An order-set was developed specifically for ED providers to use in patients diagnosed with an acute VTE, which would then alert the ED pharmacist. The pharmacist would evaluate the patient for DOAC eligibility and potential direct discharge. After chart review, patient interview, and discussion with the ordering provider, the pharmacist would leave a progress note in the EHR with recommendation. The pharmacist provided a comprehensive counseling session which also tailored to patients' specific needs. Written discharge instructions were provided.
    - **Outcomes**: A total of 58 patients were evaluated. Of these patients, 14 had a pharmacist directly involved with their care in the ED while 44 patients did not. Of the 44 patients without pharmacist involvement, 56.8% presented to the ED outside the time frame of the service. The rate of medication errors was lower when a pharmacist was involved, 7.1% (n=1), compared to when a pharmacist was not involved, 36.4% (n=16), (p=0.046). When a pharmacist was not involved, the 2 most common types of errors were lower than recommended dosing (n=5) and patients not receiving an anticoagulation prescription at discharge (n=5). Summary: The results of this study show a significant improvement in anticoagulation related medication errors occurred when a pharmacist was involved in an ED visit for patients with an acute VTE diagnosis. These results provide valuable support for the role of pharmacists in anticoagulation management in VTE patients during an ED visit.

21. *Moss JM, Bryan WE, Wilkerson LM, Jackson GL, Owenby RK, Van Houtven C, Stevens MB, Powers JS, Vaughan CP, Hung WW, Hwang U, Markland AD, McGwin G, Hastings SN. Impact of Clinical Pharmacy Specialists on the Design and Implementation of a Quality Improvement Initiative to Decrease Inappropriate Medications in a Veterans Affairs Emergency Department. *J Manag Care Spec Pharm.* 2016;22(1):74-80.
    - **Design:** Ongoing multi-site quality improvement project
    - **Practices:** Academic detailing performed by a physician-CPS pair, medication alert messages identifying medications as PIMs in the computerized patient record system, and automated reports describing the frequency and type of PIMs prescribed by each ED provider
    - **Outcomes:** 73 ED providers received the academic detailing. The ED facility experienced a relative reduction of 47.5% in the rate of PIM prescribing over the observation period.
    - **Summary:** This QI project resulted in a meaningful decrease in potentially inappropriate medication (PIM) prescribing in older ED adults. CPS contributions to QI can extend beyond pharmacotherapy and provider education to also include information technology tools using formulary management expertise.

22. Cesarz JL, Steffenhagen AL, Svenson J, Hamedani AG. Emergency department discharge prescription interventions by emergency medicine pharmacists. *Ann Emerg Med*. 2013;61(2):209-14.e1.
    - **Design:** Prospective observational study in the ED of an academic medical center that serves both adults and children was conducted to evaluate the rates and details of interventions associated with an ED pharmacist review of discharge prescriptions for patients discharged from the ED. Providers satisfaction with such services was also evaluated.
    - **Practices:** To improve the discharge prescription process, ED pharmacist reviewed electronic medical prescriptions generated by the emergency physicians to prevent errors and optimize

medication therapy in patients discharged from the ED. This process could be bypassed if the ED pharmacist was performing time sensitive medication related services.

- **Outcomes:** Most discharge prescriptions reviewed by the ED pharmacist were for adults (602, 89.3%). The pharmacist intervened on 68 prescriptions, an intervention rate of 10.1% with a majority of interventions in pediatric prescriptions (23.6%). The number of interventions categorized as error prevention and optimization of medication therapy was similar (54% and 46% respectively). More than 95% of survey respondents believed ED pharmacist improved patient safety, optimized medication regimens, and improved patient satisfaction.

23. Miranda TM, Petriccione S, Ferracini FT, Borges Filho WM. Interventions performed by the clinical pharmacist in the emergency department. *Einstein* (Sao Paulo). 2012; 10(1):74-8.
    - **Design:** Retrospective study conducted at the Morumbi Emergency Department of Hospital Israelita Albert Einstein evaluating the role and importance of the clinical pharmacist through number of interventions.
    - **Practices:** ED pharmacist were present from 1000-1900 M-F. The pharmacist made interventions based on incorrect indication, dose, frequency, and route of administration including switching to appropriate formulation appropriate for administration through a tube. The pharmacist also reviewed medical prescriptions pediatrics and neonates and monitored anticoagulants and hypoglycemic agents.
    - **Outcomes:** During a time period of 1 year, 3.452 prescriptions were evaluated, and 1,238 interventions were made. The most frequent interventions made were related to dosage (35%), dilution (9.77%), and route of administration (8.48).

Primary Care

24. Stewart B, Brody A, Krishnan AC, Brown SK, Levy PD. An Unmet Need Meets an Untapped Resource: Pharmacist-Led Pathways for Hypertension Management for Emergency Department Patients. *Curr Hypertens Rep.* 2019; 21(8):61.
    - **Summary:** Recent meta-analyses demonstrate an advantage associated with pharmacist-physician collaborative models compared to traditional physician-only care in achieving blood pressure control. The utilization of pharmacist-led follow up in hypertension (HTN) management is highly effective and novel programs, such as a pharmacist-driven transitional care clinic (TCC) uses a collaborative practice agreement with ED physicians to improve HTN management. To be the most effective, policy advocacy is needed to expand pharmacist prescriptive authority and develop incentives for implementation.

Antimicrobial Stewardship

25. Payne-Cardona M, San Luis VA, Aazami R, et al. Pharmacist driven antibiotic redosing in the emergency department. *Am J Emerg Med*. 2021;50:160-166.
    - **Design**: Pre-post, quasi-experimental study
    - **Practices**: The study objective is to determine whether expanded emergency medicine (EM) pharmacist scope of practice can reduce the frequency of major delays in subsequent antibiotic administration in patients boarded in the emergency department (ED). The EM pharmacist workflow include review of last administration, renal function, cultures, and provider documentation for assessment and plan. After reviewing appropriateness, the EM pharmacist

would use the expanded scope of practice to reorder doses and notify EM physicians for confirmation of continuation.

- **Outcomes**: Of the second dose antibiotics administered in ED boarding patients, major delays occurred in 13% of the intervention group and 48% of the control group (p<0.01). Among the major delays, the intervention group displayed a significant decrease in the amount of 6-h (39% vs 13%) and 8-h (60% vs 8%) interval antibiotic delays, compared to the historical control group. A statistically significant lower incidence of in-hospital mortality was observed in the intervention group (3% vs 11%, p = 0.02). In the intervention group, 97% of patients received subsequent antibiotic doses while boarded in the ED, compared to 65% in the control group (<0.01).
- **Summary**: Implementation of an expanded EM pharmacist scope of practice was associated with a significant reduction in frequency of major delays of second antibiotic doses, as well as a reduction in overall hospital mortality of septic patients boarded in the ED.

26. Kooda K, Canterbury E, Bellolio F. Impact of Pharmacist-Led Antimicrobial Stewardship on Appropriate Antibiotic Prescribing in the Emergency Department: A Systematic Review and Meta-Analysis [published online ahead of print, 2022 Jan 13]. Ann Emerg Med. 2022; S0196-0644(21)01500-6.
    - **Design:** Systematic review and meta-analysis
    - **Practices:** The impact of pharmacist presence or pharmacist-led antimicrobial stewardship interventions on appropriate prescribing of antibiotics in the ED was evaluated. Interventions included pharmacist-led culture review in 7 studies, pharmacist presence in 7 studies, pharmacist-directed clinical algorithms and clinician education in 7 studies, and prospective antibiotic review in 1 study. No RCTs. All types of infections were included in 10 studies.
    - **Outcomes:** Analysis of 22 studies involving 5,791 patients found pharmacist intervention to be associated with a higher rate of appropriate antibiotic prescribing, particularly for patients with pneumonia or UTI (22 studies; odds ratio [OR], 3.47; 95% confidence interval [CI] 2.39 to 5.03), particularly among patients with pneumonia (5 studies; OR, 3.74; 95% CI 2.14 to 6.54) or urinary tract infection (4 studies; OR, 1.76; 95% CI 1.24 to 2.50). Time to appropriate antibiotic was shorter with pharmacist intervention (mean difference, 18.9 hours; 95% CI 11.9 to 25.9; P<.001). Studies were retrospective, observational, with a before-and-after design, and had a moderate risk of bias.
    - **Summary:** Pharmacist presence and pharmacist-led antimicrobial stewardship interventions appear to be effective for the appropriate prescribing of antibiotics in adult patients presenting to EDs with a variety of infectious syndromes.

27. Shealy SC, Alexander C, Hardison TG, Magagnoli J, Justo JA, Derrick C, Kohn J, Winders HR, Privette T, Al-Hasan MN, Bookstaver PB. Pharmacist-Driven Culture and Sexually Transmitted Infection Testing Follow-Up Program in the Emergency Department. Pharmacy (Basel). 2020 Apr 23;8(2):72.
    - **Design:** Single-center, pre- and post-implementation cohort study examining the impact of a pharmacist-driven culture and rapid diagnostic technology (RDT) follow-up program in the emergency department (ED).
    - **Practices:** One-hundred-and-twenty-seven patients were included, 64 in the pre-implementation group and 63 in the post-implementation group.
    - **Outcomes:** There was a 36.3% reduction in the meantime to culture/RDT data review in the post-implementation group (75.2 h vs. 47.9 h, p < 0.001). There was a significant reduction in fluoroquinolone prescribing in the post-implementation group (18.1% vs. 5.4%, p = 0.036).
    - **Summary:** Introduction of a pharmacist culture and RDT follow-up program in the ED reduced time to data review, time to outpatient intervention and outpatient follow-up of fluoroquinolone prescribing.

28. Ibarra F Jr. Emergency medicine clinical pharmacist's impact on ordering of vancomycin loading doses. *Am J Emerg Med*. 2020 Apr;38(4):823-826.
    - **Design:** Retrospective pre-post intervention study conducted at an academic level 1 trauma center on adult patients who were ordered vancomycin and a broad spectrum antimicrobial at the same time within 12 hours of arriving to the emergency department.
    - **Practices:** the emergency medicine clinical pharmacist (EMCP) lectured physicians and pharmacists on appropriate vancomycin loading doses, posted flyers in the ED physician' work rooms, and uploaded handouts to the department of pharmacy's website.
    - **Outcomes:** Thirty and 31 orders from the pre- and post-intervention study periods were included in data analysis, respectively. Appropriate vancomycin orders prescribed significantly increased from 2 (6.7%) to 11 (35%) following the intervention ($p < 0.05$). There was a statistically significant increase in the number of appropriate vancomycin loading dose prescribed by emergency department physicians following EMCP intervention. This study highlights the importance of ED clinical pharmacists and encourages institutions to develop, expand and maintain EMCP positions.

29. Kulwicki BD, Brandt KL, Wolf LM, Weise AJ, Dumkow LE. Impact of an emergency medicine pharmacist on empiric antibiotic prescribing for pneumonia and intra-abdominal infections. *Am J Emerg Med*. 2019; 37(5):839-844.
    - **Design:** Retrospective cohort study evaluated adult patients admitted with community-acquired pneumonia (CAP) or community-acquired pneumonia and intra-abdominal infections (CA-IAI) to compare guideline-concordant empiric antibiotic prescribing when an emergency medicine pharmacist (EMP) was present versus absent.
    - **Outcomes:** A total of 320 patients were included in the study with 185 in the EMP intervention arm and 135 in the no-EMP intervention arm. Overall empiric antibiotic prescribing was more likely to be guideline-concordant when an EMP was present (78% vs. 61%, p=0.001) for both CAP (95% vs. 79%, p=0.005) and CA-IAI subgroups (62% vs. 44%, p=0.025).
    - **Conclusion:** The presence of an EMP significantly improved guideline-concordant empiric antibiotic prescribing for CAP and CA-IAI in both an early and established ASP.

30. Fay LN, Wolf LM, Brandt KL, DeYoung GR, Anderson AM, Egwuatu NE, Dumkow LE. Pharmacist-led antimicrobial stewardship program in an urgent care setting. *Am J Health Syst Pharm.* 2019; 76(3):175-181.
    - **Design:** Retrospective quasi-experimental study aimed to determine the impact of implementing a pharmacist-led antimicrobial stewardship program in the urgent care (UC) setting. The primary outcome was to compare guideline-concordant antibiotic prescribing between pre-ASP and post-ASP groups.
    - **Practices:** A collaborative practice agreement was implemented, to allow pharmacist-led UC culture follow-up via stewardship-focused protocol. UC patients with positive urine or wound cultures following discharge were evaluated.
    - **Outcomes:** A total of 300 patients were included in the study (pre-ASP, n = 150; post-ASP, n = 150). Total guideline-concordant prescribing significantly improved for all diagnoses in the post-ASP group (pre-ASP, 41.3% versus post-ASP 53.3%, p = 0.037). Guideline-concordant antibiotic selection improved in the post-ASP group (pre-ASP, 51% versus post-ASP, 68%, p = 0.01). A pharmacist-led urgent care ASP was associated with significantly improved guideline-concordant antimicrobial prescribing.

31. Waters CD, Bitton BJ, Torosyan A, Myers KP. Clinical Pharmacist Management of Bacteremia in a Community Hospital Emergency Department. *Ann Pharmacother*. 2017; 51(6):465-472.
    - **Design:** Retrospective cohort study that evaluated pharmacist involvement in the management of bacteremia in the ED led to an increase in appropriate treatment of bacteremia and improved patient outcomes. Two cohorts included physician managed (107 patients) and those that were pharmacist managed (138 patients).
    - **Practices:** Clinical pharmacy services were implemented in the ED at the study institution, and pharmacists in the ED have been responsible for blood culture review and treatment optimization for ED patients.
    - **Outcomes**: In the physician-managed cohort, 50 of 107 (47%) patients were treated appropriately compared with 131 of 138 (95%) patients in the pharmacist-managed cohort (P<0.0001). Pharmacist involvement in the management of bacteremia in the ED was associated with higher rates of appropriate treatment and a corresponding decrease in the rates of attributable 90-day admission or readmission to the hospital or ED.

32. Bishop BM. Antimicrobial Stewardship in the Emergency Department: Challenges, Opportunities, and a Call to Action for Pharmacists. *J Pharm Pract*. 2016; 29(6):556-563.
    - **Summary:** Implementing antimicrobial stewardship programs (ASPs) in the emergency department (ED) is fraught with challenges including diagnostic uncertainty, distractions secondary to patient or clinician turnover, or concerns with patient satisfaction. This review article services as a call to action for pharmacists working in ASP and in ED settings.

33. Davis LC, Covey RB, Weston JS, Hu BB, Laine GA. Pharmacist-driven antimicrobial optimization in the emergency department. *Am J Health Syst Pharm*. 2016;73(5 Suppl 1):S49-S56.
    - **Design:** Retrospective chart review study evaluated pharmacist-driven antimicrobial optimization service in the non-trauma emergency department (Ed) of a teaching hospital.
    - **Practices:** ED clinical pharmacists performed several interventions for antimicrobial optimization.
    - **Outcomes**: Pharmacists intervened on 24 of 30 (80%0 cultures where an intervention was indicated resulting in a 30% increase in interventions for inappropriate therapy (p=0.01). Pharmacist-driven antimicrobial stewardship program resulted in a 30% absolute increase in interventions for inappropriate therapy as compared to the nursing-driven model.

34. Moussavi K, Nikitenko V. Pharmacist impact on time to antibiotic administration in patients with sepsis in an ED. *Am J Emerg Med*. 2016;34(11):2117-2121.
    - **Design:** Retrospective review evaluated if the physical presence of a clinical pharmacist in the emergency department (ED) would decrease antibiotic order to administration time in adult patients with sepsis or septic shock.
    - **Outcomes:** A total of 186 patients (92 patients when an ED pharmacist was present and 94 patients when an ED pharmacist was absent) were included in the study. When a pharmacist was present, patients received antibiotics sooner (median 0.61 vs 0.88 hour, P=.001), Surviving Sepsis Campaign goals for antibiotic administration time were more likely to be met (88% vs 72%, P=.0097), and initial antibiotics were appropriate more often (97% vs 81%, P=.0008).
    - **Conclusion:** Physical presence of a clinical pharmacist in the ED decreased time to administration and increased appropriateness of intravenous antibiotics for patients with sepsis or septic shock.

35. Miller K, McGraw MA, Tomsey A, et al. Pharmacist addition to the post-ED visit review of discharge antimicrobial regimens. *Am J Emerg Med*. 2014;32(10):1270-1274.

- **Design:** Retrospective observational cohort study to evaluate whether pharmacist addition to the post visit review of discharged adult emergency department (ED) visits' prescriptions/cultures would reduce the prevalence of revised antimicrobial regimen inappropriateness. In the pre-pharmacist cohort, there were 411 positive ED discharge cultures. In the post-pharmacist cohort, there were 459 positive ED discharge cultures.
- **Practices:** Pharmacists from this institution to join the review of cultures and prescribed discharge antimicrobials during the second study period. During this subsequent study period, the pharmacist in the review process would make recommendations for antimicrobial prescription revision/initiation based on culture result and their professional knowledge in consultation with the reviewing nurse and an emergency physician working that day.
- **Outcomes:** In this single-center study, pharmacist addition to the post visit review of discharged adult ED patients' prescriptions/cultures reduced the prevalence of revised antimicrobial regimen inappropriateness.

36. DeFrates SR, Weant KA, Seamon JP, et al. Emergency pharmacist impact on health care-associated pneumonia empiric therapy. *J Pharm Pract*. 2013;26(2):125-130.
    - **Design:** Retrospective chart review of adult patients with HCAP who presented to an academic medical center ED from September 1, 2008 through June 30, 2010 was conducted to evaluate adherence of empiric antibiotic therapy to guideline recommendations. The control group included patients who presented outside of the ED pharmacist hours (2300-1300) and the treatment group included patients who presented withing the ED pharmacist hours (1300-2300).
    - **Practices:** The pharmacist coverage in ED was from 1300-2300. Pharmacist have the knowledge and skills required to evaluate patients for risk factors associated with HCP and to assist in initiating antimicrobial therapy at potential pathogens in an efficient manner.
    - **Outcomes:** The 81 patients presenting with the pharmacist's hours were more likely than the 70 patients outside of this window to receive guideline adherent empiric antibiotics (49.38% vs 25.7%, P=0.05). Although not statistically significant, patients in the treatment group were more likely to receive antibiotics faster and at more appropriate doses.

37. Baker SN, Acquisto NM, Ashley ED, et al. Pharmacist-managed antimicrobial stewardship program for patients discharged from the emergency department. *J Pharm Pract*. 2012;25(2):190-194.
    - **Design:** A retrospective case-control study of patients discharged from the ED of a university teaching hospital with subsequent positive cultures was conducted to determine whether integration of antimicrobial stewardship responsibilities into practice of the ED pharmacist can improve outcomes.
    - **Practices:** ED pharmacist managed antimicrobial stewardship program was initiated to assist in the routine screening of culture reports and follow up. ED pharmacist was also involved in education regarding appropriate empiric antimicrobial selection consisting of didactic lectures and preparation of clinical resources to be used when the pharmacist was not there.
    - **Outcomes:** Pre and post implementation groups were compared. There was a statistically significant reduction in time to positive culture review (2 vs. 3 days, P=0.0001) and time to PCP or patient notification (2 vs 3 days, P=0.01) in the post compared to the pre implementation group respectively. No difference was seen in the appropriateness of therapy.

38. Randolph TC, Parker A, Meyer L, et al. Effect of a pharmacist-managed culture review process on antimicrobial therapy in an emergency department. *Am J Health Syst Pharm*. 2011;68(10):916-919.

- **Design:** Medical records at Carolinas Medical Center were retrospectively reviewed to evaluate the rates of antimicrobial regimen modifications before and after implementation of a pharmacist-managed ED culture review procedure.
- **Practices:** The ED pharmacist reviewed culture samples drawn in the ED as well as selected empiric antibiotics. The pharmacist is responsible for ensuring timing, selection, and dosing concurs with clinical indicators of community acquired pneumonia and surgical prophylaxis set forth by the Centers for Medicaid and Medicare Services and TJC and contacting and counseling the patient.

- **Outcomes:** In the 12 months after implementation, pharmacist initiated antimicrobial regimen modifications in about 15% of cases and had statistically significant reductions in readmissions to the ED for treatment failure, noncompliance due to cost, noncompliance for any other reason, and allergy to medication (all P<0.001).

Medication Errors and Reconciliation

39. Castillo J, Campbell MJ, Sokn E, Spinner M, Lam SW, Meldon S, Podolsky S. Discharge prescription optimization by emergency medicine pharmacists in an academic emergency department in the United States. Int J Clin Pharm. 2020 Oct 29.
    - **Design:** Single-centered study at an academic medical center's emergency department (ED) that evaluated the clinical significant of emergency medicine (EM) pharmacist interventions completed during review of ED discharge prescriptions.
    - **Practices:** Two independent reviewers rated the clinical significance of interventions. High risk criteria were proposed a priori and included in a multivariable logistic regression analysis to identify variables independently associated with pharmacist intervention.
    - **Outcomes:** A total of 3107 prescriptions for 1648 patients were reviewed. Interventions occurred for 7.3% of patients with 29% of interventions rated as significant. The intervention rate was higher in patients with at least 1 high risk criteria versus those without (9.6% vs. 3.7%, $p < 0.0001$). Pharmacist review of discharge prescriptions resulted in clinically significant interventions but did not impact readmission rates. An incremental increase in the number of discharge prescriptions was associated with pharmacist intervention.

40. Pevnick JM, Nguyen C, Jackevicius CA, Palmer KA, Shane R, Cook-Wiens G, Rogatko A, Bear M, Rosen O, Seki D, Doyle B, Desai A, Bell DS. Improving admission medication reconciliation with pharmacists or pharmacy technicians in the emergency department: a randomized controlled trial. *BMJ Qual Saf*. 2018;27(7):512-520.
    - **Design:** Three-arm Randomized controlled trial
    - **Practices:** Three intervention arms including pharmacists, pharmacy technicians and a controlled group obtained initial admission medication histories (AMHs) for 306 inpatients. The primary outcome was severity weighted mean AMH error score.
    - **Outcomes:** Analysis was limited to 278 patients. Pharmacists, pharmacy technicians, and usual care arms had a Mean $\pm$ standard deviation (SD) AMH errors per patient of 1.4 ± 1.9, 1.5 ± 2.1, and 8.0 ± 5.6, respectively ($p<0.0001$). Mean $\pm$ SD severity weighted AMH error scores were 4.1 ± 6.8, 4.1 ± 7.0, and 23.0 ± 16.1, respectively. Pharmacists and pharmacy technicians reduced AMH errors and resultant admission medication orders (AMOs) by over 80%.

41. Pérez-Moreno MA, Rodríguez-Camacho JM, Calderón-Hernanz B, Comas-Díaz B, Tarradas-Torras J. Clinical relevance of pharmacist intervention in an emergency department. *Emerg Med J.* 2017; 34(8):495-501.
    - **Design:** Observational prospective six-month study at a 400-bed hospital recorded interventions carried out by clinical pharmacists.
    - **Practices:** Pharmacist intervention in the process of medication reconciliation or another activity in the ED setting.
    - **Outcomes:** Pharmacists reviewed pharmacotherapy history and medication orders for 2,984 patients. A total of 991 interventions were recorded in 557 patients with 67.2% of errors occurring during medication reconciliation. Medication errors were considered severe in 57.2% of cases and 64.9% of pharmacist intervention were considered relevant. About 10.9% of the drugs were on the High-Alert Medications Institute for Safe Medication Practices (ISMP) list. The severity of the medication error and the clinical significance of the pharmacist intervention were correlated (p<0.001). Clinical pharmacists identified and intervened on a high number of severe medication errors.

42. Ernst AA, Weiss SJ, Sullivan A, Sarangarm D, Rankin S, Fees M, Sarangarm P. On-site pharmacists in the ED improve medical errors. *Am J Emerg Med*. 2012;30(5):717-25.
    - **Design:** Cross-sectional cohort study
    - **Practices:** This study was conducted over a 3-month period at a level 1 trauma center with an emergency medicine residency. This cross-sectional cohort study compared a prospective analysis of patients during the time (10 hour/day) with pharmacists present for resuscitations and traumas (PPs) and a retrospective review of the time on the same days (14 hours/day) with pharmacists absent (PAs).
    - **Outcomes:** Over the 3-month period, 694 patients were included. A total of 242 presented during PP times and 452 during PA times. There were 5 (3%) patients with errors recorded during PP times and 137 (30%) with errors recorded during PA times (difference, 27%; 95% CI, 23-32). Controlling for age, race, sex, and disposition, medical errors were 13.5 times more likely during PA than during PP times (adjusted odds ratio, 13.5; 95% CI, 5.7-31.9).
    - **Summary:** With pharmacists absent, over 13 times more errors were recorded in the ED than with pharmacists present. On-site ED pharmacists may be beneficial in reducing medical errors.

43. Ernst AA, Weiss SJ, Sullivan A, et al. On-site pharmacists in the ED improve medical errors. *Am J Emerg Med*. 2012;30(5):717-25.
    - **Design:** Cross-sectional cohort study comparing errors in the ED for resuscitations and traumas conducted as a prospective analysis of patients during the time (10 hour/day) with a pharmacist present (PP) and a retrospective review of the time on the same days (14 hour/day) when pharmacist was absent (PA).
    - **Practices:** Pharmacist were present for 10 hours/day and attended all major trauma and resuscitations. Pharmacist were involved with collecting data prospectively with assistance from pharmacy students during the hours of 3 pm to 1 am.
    - **Outcomes:** 694 patients were included in the analysis with 242 and 452 in the PP and PA groups respectively. There were 6 (3%) patients with errors recorded during PP times and 137 (30%) with errors during PA times (difference 27%; 95% CI 23-32), resulting in an error rate of 13.5 times more during PA times.

44. Jellinek SP, Cohen V, Fancher LB, et al. Pharmacist improves timely administration of medications to boarded patients in the emergency department. *J Emerg Nurs*. 2010; 36(2):105-110.

- **Design:** This was a prospective observational study assessing the variations in timely administration of medications based on differences in nursing staff assignments (ED nurses who are responsible for boarded patients and ED patients and inpatient) and to determine whether a pharmacist's interventions can improve this variation in timely administration of medications to boarded patients in the ED of a 705 bed teaching hospital.
- **Practices:** Pharmacy services in the ED are provided by the clinical pharmacy manager, pharmacy residents, interns, and staff pharmacist. Medication orders for boarded patients are verified by staff pharmacist and pharmacy resident. ED pharmacist actively participates with nurses to ensure medication administration to boarded patients from 0800-2300.
- **Outcomes:** A total of 79 patients were included in the study, resulting in 266 mediation administration opportunities (ED,146; inpatient, 120). Inpatient nurses administered medications in a timely manner at a significantly greater rate than ED nurses (83.3% vs 63.7% P<0.0001) with the largest difference observed in the evening hours (P=0.02). Pharmacist interventions were successful in both the ED and inpatient nurses.

45. Ratz Y, Shafir I, Berkovitch S, et al. The importance of the pharmacist in reporting adverse drug reactions in the emergency department. *J Clin Pharmacol*. 2010; 50(10):1217-1221.
    - **Design:** Study to assess the influence of a pharmacist present in the emergency department (ED) on increasing diagnosis and reporting rate of ADRs in a tertiary hospital in Israel. The study included all patients admitted to the internal medicine section of the ED during the study period.
    - **Practices:** The pharmacist was responsible for screening all charts to identify patients who may have and ADR and interviewing the patient.
    - **Outcomes:** During the intervention period, 61 patients were interviewed by the pharmacist. Of these, 30 (49%) were identified with a suspected ADR. Of the identified ADRs, 6.6% were found to be highly probable, 47% were probable, 47% were possible, and none were categorized as doubtful. Twelve (40%) were life threatening.

46. Rothschild JM, Churchill W, Erickson A, et al. Medication errors recovered by emergency department pharmacists. *Ann Emerg Med*. 2010;55(6):513-521.
    - **Design:** Prospective cross-section observation study of pharmacist who recovered medication errors (defined as potential, mitigated, or ameliorated adverse drug events) in 4 academic EDs (trauma level I centers).
    - **Practices:** ED pharmacist were responsible for prospective medication order review, medication reconciliation, participation in resuscitations, providing clinical consultation to ED staff for patient specific recommendations, review protocol/guideline adherence, participation in rounds, dispense or prepare medications, screen for allergies and drug interactions, therapeutic drug monitoring, and care for boarded patients daily.
    - **Outcomes:** There were 226 observation sessions spanning 787 hours of observed pharmacist reviewing 17,320 medications ordered or administered in to 6,471 patients. 504 recovered medication errors, or 7.8/100 patients and 2.9/100 medications. Most of the recovered medication errors were potential (90.3%), followed by mitigated (3.9%), and ameliorated (0.2%).

47. De Winter S, Spriet I, Indevuyst C, et al. Pharmacist- versus physician-acquired medication history: a prospective study at the emergency department. *Qual Saf Health Care*. 2010;19(5):371-375.
    - **Design:** Prospective study conducted at the ED of a tertiary care teaching hospital to compare medication histories obtained by the pharmacist and physician and identify characteristics contributing to discrepancies from patients planned to be hospitalized.

- **Practices:** Clinical pharmacist and a well-trained pharmacy technician obtained medication histories using a structured form in the ED independent from the physician acquired ones from 0830-1700 during the week.
- **Outcomes:** Over the course of the study period, 3,594 medication histories were acquired by pharmacy staff. Of those, 59% of medication histories recorded by physicians were different resulting in 5,963 discrepancies were identified. Most common type of error was omission of a drug (61%).
- **Conclusion:** Medication history acquisition in the ED is often incomplete and pharmacist are especially suited to acquire and supervise accurate medication histories.

48. Vasileff HM, Whitten LE, Pink JA, et al. The effect on medication errors of pharmacists charting medication in an emergency department. *Pharm World Sci*. 2009; 31(3):373-379.
    - **Design:** A prospective study conducted in patients at risk of a medication misadventure (60 years or older, taking four or more regular medications, having 3 or more clinical co morbidities and or had at least one previous hospital admission in the previous 3 months) in the ED of a South Australian teaching hospital to assess the frequency and clinical significance of medication errors
    - **Practices:** Pharmacist was responsible for conducting medication reconciliation in patients who had their medications already prescribed by the doctor (usual care) and in patients who had not had not been seen by the doctor and had their medications prescribed (pharmacist medication charting arm)
    - **Outcomes:** In the usual care arm, 75.6% of patients had one or more unintentional discrepancies compared to 3.3% in the pharmacist arm and resulted in an average of 2.35 missed doses compared to 0.24 in the usual care and pharmacist arms respectively. In addition, 1.04 incorrect doses were administered in the usual care arm compared to none in the pharmacist arms. These differences were statistically significant and deemed clinically significant.

49. Brown JN, Barnes CL, Beasley B, et al. Effect of pharmacists on medication errors in an emergency department. *Am J Health Syst Pharm*. 2008; 65(4):330-333.
    - **Design:** A retrospective chart review in patients admitted to the ED of a large rural hospital to determine the frequency of medication errors in an emergency department before (control group) and after (intervention group) an ED pharmacist was assigned to review medications orders and evaluate the physicians acceptance of the pharmacists recommendations.
    - **Practices:** ED pharmacist were responsible for checking orders.
    - **Outcomes:** A total of 37 and 14 medications errors were identified for the control and intervention groups respectively. The rate of errors was 16.09 per 100 medication orders in the control group and 5.38 per 100 orders for the intervention group. The ED pharmacist made 183 recommendations and 98.6% were accepted
    - **Conclusion:** The rate of medication errors decreased significantly when pharmacist prospectively reviewed the medication order.

50. Hayes BD, Donovan JL, Smith BS, Hartman CA. Pharmacist-conducted medication reconciliation in an emergency department. *Am J Health Syst Pharm*. 2007; 64(16):1720-1723.
    - **Design:** Eight-week pilot study in the ED of a tertiary care hospital was conducted to evaluate the effect of pharmacist conducted medication reconciliation on compliance with a hospitals medication reconciliation policy using the hospital approved form.
    - **Practices:** Pharmacy services provided to the ED are limited to the centralized review of medication orders. During the study one pharmacist worked in the ED to facilitate the safe and accurate transfer of medication histories for admitted patients. During the first 4 weeks

pharmacist retrospectively reviewed charts and the next 4 weeks prospectively conducted medication reconciliation.

- **Outcomes:** The hospital-approved medication form was used for 78% of patients in the control group and 100% of patients in the study group. The mean number of errors and percentage of forms containing at least one error was significantly higher in the control group than in the study group (p=0.001) for both comparisons. Allergy documentation was recorded for 62 in the control group compared to all 60 in the study group (p=0.001).

51. Carter MK, Alin DM, Scott LA, Grayer D. Pharmacist-acquired medication histories in a university hospital emergency department. *Am J Health Syst Pharm*. 2006; 63(24):2500-2503.
    - **Design:** A prospective study evaluating the discrepancies between medication histories taken by ED providers (physicians, nurses, and medical students) and medication histories taken by clinical pharmacist in a tertiary teaching facility over a 3-month period.
    - **Practices:** On the arrival of the patient, ED providers completed a medication history. Those patients to be admitted through the ED were interviewed by the clinical pharmacist and then compared to the medication history taken by the ED provider.
    - **Outcomes:** 252 histories were included in the study. The clinical pharmacist identified 1096 home medications compared to 817 home medications documented by ED providers resulting in 78% incomplete regimens. Pharmacist also reported more allergies and obtained more immunization histories.

Opioid Stewardship

52. Acquisto NM, Coralic Z. In the midst of an opioid epidemic: Pharmacists on the frontline of substance use disorder treatment. Am J Health Syst Pharm. 2021 Feb 8;78(4):277-278.
    - **Summary:** In 2018, the National Dialogue for Healthcare Innovation outlined an action roadmap developed at the Opioid Crisis Solutions Summit. The key areas highlighted include improving healthcare system approaches to pain management and opioid misuse, expanding access to SUD treatment and behavioral health services, improving care coordination through data access and analytics, and developing payment systems supporting coordination and quality of care. Furthermore, the roadmap stressed the importance and expertise of pharmacist participation on care teams and in opioid stewardship programs to achieve these goals.

53. Acquisto NM, Schulte RF, Sarnoski-Roberts S, et al. Effect of pharmacist-led task force to reduce opioid prescribing in the emergency department. *Am J Health Syst Pharm*. 2019;76(22):1853-1861.
    - **Design:** Observational study conducted at a large tertiary care center, evaluated selected opioid use outcomes before and after implementation of an ED opioid reduction program by a pharmacist-led interdisciplinary task force.
    - **Practices:** Pharmacist-led interdisciplinary opioid reduction task force which included pharmacists, physicians, and nurses.
    - **Outcomes:** From January 2017 to January 2018, ED opioid orders were reduced by 63.5%. Over the entire study period, there were significant decreases in both opioid orders (β, -78.4; 95% confidence interval [CI], -88.0 to -68.9; R2, 0.93; $p < 0.0001$) and ED discharge prescriptions (β, -24.4; 95% CI, -27.9 to -20.9; R2, 0.90; $p < 0.001$). A clinical pharmacist-led opioid reduction

program in the ED was demonstrated to have positive results, with a more than 50% reduction in both ED opioid orders and discharge prescriptions.

Acute Care

54. Barbour J, Hushen P, Newman GC, Vidal J. Impact of an emergency medicine pharmacist on door to needle alteplase time and patient outcomes in acute ischemic stroke. *Am J Emerg Med*. 2022;51:358-362.
    - **Design**: Single-center retrospective cohort study
    - **Practices**: During a stroke alert, the emergency medicine pharmacist (EMP) participates in screening for contraindications to alteplase, assists with blood pressure management, and facilitates administration of any necessary medications. This includes dosing and preparation of alteplase at bedside.
    - **Outcomes**: Of the 164 patients included, 31 had an EMP at bedside (EMP group) and 133 did not (No EMP group). The median door-to-needle (DTN) time was significantly shorter at 35 min EMP [interquartile range (IQR) 29–44] vs 42 min No EMP [IQR 34–55]; $p = 0.003$. The number of cases achieving a DTN time of 30 min or less was significantly higher when an EMP was involved (35.5% vs.16.5%; p = 0.018) as well as the number of patients receiving alteplase within 45 min (80.7% vs. 57.1%; p = 0.015). NIHSS scores at discharge were lower in the EMP group (2 [IQR 0–5] vs. 4 [IQR 0–8.25]; p = 0.049).
    - **Summary**: Patients with an EMP as part of their stroke response team had significantly lower DTN times and significantly higher cases meeting goal DTN times This is evidence of the benefit of including an emergency medicine pharmacist on the stroke response team. Expansion of the hours of pharmacist coverage has the potential to reach more patients and ultimately improve the care of patients with acute ischemic stroke.

55. Masic D, Hidalgo DC, Kuhrau S, et al. Pharmacist Presence Decreases Time to Prothrombin Complex Concentrate in Emergency Department Patients with Life-Threatening Bleeding and Urgent Procedures. *J Emerg Med*. 2019; 57(5):620-628.
    - **Design:** Retrospective cohort study included patients receiving 4F-PCC for life-threatening bleeding or urgent procedure in the emergency department (ED) from 2014 to 2018.
    - **Practices**: Patients with pharmacists at bedside (PharmD group) were compared with physician teams alone (control group). The primary outcome was time from ED presentation to 4F-PCC administration.
    - **Outcomes**: Of 252 patients evaluated, 116 patients (46%) were included (n = 50 PharmD group; n = 66 control group). Most patients presented on warfarin (68.1%), and of the life-threatening bleeds (94%), intracranial hemorrhage was most common (67.2%). The median time to 4F-PCC administration was significantly shorter in the PharmD group (66.5 vs. 206.5 min, p < 0.001). Pharmacist at bedside was the only factor independently associated with reduction in time to 4F-PCC (β coefficient -163.5 min, 95% confidence interval -249.4 to -77.7). Although there was no difference in hemostasis or mortality, patients in the PharmD group had a shorter intensive care unit length of stay (LOS) (2 vs. 5 days, p < 0.01) and hospital LOS (5.5 vs. 8 days, p = 0.02). A pharmacist at the bedside of patients who present to the ED with life-threatening bleeding or need for emergent procedure decreased time to 4F-PCC administration by 140 min, even after

accounting for confounders. Faster time to 4F-PCC was associated with significantly shorter intensive care unit and hospital LOS.

56. Robey-Gavin E, Abuakar L. Impact of Clinical Pharmacists on Initiation of Postintubation Analgesia in the Emergency Department. *J Emerg Med*. 2016;50(2):308-314.
    - **Design:** Retrospective cohort study compared the rate of initiation of postintubation analgesia in the ED before and after intervention by pharmacists specialized in emergency medicine.
    - **Practices:** The primary endpoint was overall frequency of analgesia initiation with subset analysis of rapid sequence intubation (RSI) during the ED pharmacist (EDP) duty hours.
    - **Outcomes:** The overall rate of postintubation analgesia increased after pharmacist intervention, from 20% to 49% (p = 0.005). Analgesia initiation during EDP hours was 50% and 85% in the pre- and postintervention groups, respectively. Analgesic use after RSI in the ED significantly increased after the implementation of ED pharmacy services. This may suggest the increase may be related to direct pharmacist involvement in postintubation management.

57. Gosser RA, Arndt RF, Schaafsma K, et al. Pharmacist Impact on Ischemic Stroke Care in the Emergency Department. *J Emerg Med*. 2016;50(1):187-193.
    - **Design:** Retrospective study that compare the accuracy of rtPA dosing, mean door-to-rtPA time, and identification of contraindications to rtPA therapy when a pharmacist was present vs. absent in 105 patients who received rtPA for acute ischemic stroke in the ED at a comprehensive stroke center.
    - **Practices:** ED pharmacists staffed daily and were available for consult from 1000 to 1830 hours. Pharmacist involvement was defined as encounters with documentation in the notes, order entry and/or automating dispensing cabinet override.
    - **Outcomes:** The median door-to-rtPA time when a pharmacist was present was statistically significantly shorter than when a pharmacist was absent (69.5 vs. 89.5 min; p = 0.0027). When a pharmacist was present, a door-to-rtPA time of < 60 min was achieved 29.9% of the time, as compared with 15.8% in the pharmacist-absent group (p = 0.1087). Pharmacist involvement on stroke teams may have a beneficial effect on door-to-rtPA time and patient care in the ED.

58. Montgomery K, Hall AB, Keriazes G. Pharmacist's impact on acute pain management during trauma resuscitation. *J Trauma Nurs*. 2015;22(2):87-90.
    - **Design:** Retrospective chart review to evaluate pharmacist impact on door-to-pain medication time as a member of the trauma team compared with when no pharmacist is present. The study was conducted at a community hospital with a level II trauma center.
    - **Practices:** The ED pharmacist participates in all trauma alerts during their scheduled hours. ED pharmacists participate in trauma resuscitation and act as a medication resource for the trauma team members and facilitates the timely administration of analgesics. In addition to the dedicated ED pharmacist, pharmacy residents may also attend trauma alerts while on their emergency medicine clinical rotation.
    - **Outcomes:** In this study, pharmacist participation during trauma resuscitation decreased mean time to administration of first pain medication by 4 minutes. There was a 2.4-point reduction with a pharmacist versus 2.7 without a pharmacist, using a 0 to 10 numeric pain rating scale. The participation of a clinical pharmacist during trauma resuscitation significantly decreased the time to first analgesic administration in trauma patients.

59. Brancaccio A, Giuliano C, McNorton K, et al. Impact of a phenytoin loading dose program in the emergency department. *Am J Health Syst Pharm*. 2014;71(21):1862-1869.

- **Design:** Single-center, observational, preimplementation-postimplementation study conducted in the ED of a 722-bed academic hospital to evaluate a combined pharmacist and physician directed phenytoin loading dose program. Adult patients who received a phenytoin loading dose in the ED were included.
- **Practices:** The ED pharmacist provided clinical services 40 hours per week. Pharmacist provided education to the ED prescribers and nursing on how to optimize the phenytoin loading dose and proper use of the developed electronic order set. Pharmacy students assisted the pharmacist in providing education.
- **Outcomes:** There was no difference in proportion of optimal phenytoin loading doses between preimplementation and postpollination. When stratified into pharmacist and prescriber groups, the rate of optimal phenytoin doses increased by 64% and was statistically significant p=0.007) while the rate in the prescriber group remained unchanged (p=0.91). The number of appropriate serum phenytoin concentrations significantly improved in the postimplementation group (p=0.025). Rates of adverse drug reactions and recurrence of seizures did not differ.

60. Patanwala AE, Thomas MC, Casanova TJ, Thomas R. Pharmacists' role in procedural sedation and analgesia in the emergency department. *Am J Health Syst Pharm*. 2012 Aug 1;69(15):1336-42.
    - **Summary:** This article reviews the pharmacist role during procedural sedation and analgesia (PSA) in the ED. Roles include preprocedural evaluation, assisting in the pharmacologic plan and selection of appropriate agents, coordination and implementation of the pharmacologic plan, obtainment of the appropriate supplies, monitoring, and administration of PSA agents. The pharmacist has an important role on the PSA team and can contribute to improved patient safety, development and implementation of the pharmacologic plan, and administration of PSA agents.

61. Acquisto NM, Hays DP, Fairbanks RJ, et al. The outcomes of emergency pharmacist participation during acute myocardial infarction. *J Emerg Med*. 2012;42(4):371-378.
    - **Design:** A retrospective observational cohort study of ED patients with STEMI requiring urgent cardiac catheterization was conducted to evaluate if a clinical ED pharmacist is associated with a decreased door/diagnosis-to-cardiac catheterization laboratory (CLL) time and decreased door-to-balloon time.
    - **Practices:** The ED pharmacist has been involved in AMI patients since 2000 at this university teaching hospital. Pharmacist is present for all possible STEMI evaluation or responds to all overhead AMI team activation calls if they are in the ED or elsewhere in the hospital.
    - **Outcomes:** ED pharmacist decreased the median door/diagnosis-to- CCL time and door-to-balloon time by a mean of 13.1 minutes and 11.5 minutes respectively. When ED pharmacist was present, patients were more likely to achieve a door/diagnosis-to-CLC time of ≤30 minutes and ≤45 minutes and a door-to-balloon time ≤90 minutes.
    - **Conclusion:** Presence of a dedicated ED clinical pharmacist during STEMI presentation is independently associated with a decrease in door/diagnosis-to-CCL and door-balloon-time. This trial supports role of ED pharmacist and suggest pharmacist may be able to impact other time dependent emergencies.

62. Marraffa JM, Cohen V, Howland MA. Antidotes for toxicological emergencies: a practical review. *Am J Health Syst Pharm.* 2012; 69(3):199-212.
    - **Summary:** This article reviews toxicological emergencies and the pharmacist role in ensuring readily availability and proper use of appropriate therapies. Pharmacist can assist by recognizing signs and symptoms of various types of toxic exposures, guiding emergency staff on appropriate use of antidotes and supportive therapies, helping to ensure appropriate monitoring of patients

for antidote response and adverse effects, and managing the procurement and stocking of antidotes to ensure their timely availability. Pharmacist can play a key role in reducing poisoning and overdose injuries and deaths and guiding emergency personnel on proper storage selection and use of antidotal therapies.

63. Scarponcini TR, Edwards CJ, Rudis MI, Jasiak KD, Hays DP. The role of the emergency pharmacist in trauma resuscitation. *J Pharm Pract.* 2011; 24(2):146-59.
    - **Summary:** This article reviews the pharmacist role on the ED trauma team. The pharmacist role includes assessing pharmacotherapy and opportunities in the primary survey (i.e., airway and role in rapid sequence induction (RSI)), premedication for RSI including sedation and paralytics, post intubation sedation and analgesia, and the secondary survey and assessment of antibiotics, tetanus prophylaxis, analgesia, mannitol or concentrated sodium chloride for intracranial pressure, and methylprednisolone for spinal cord injury. The ED pharmacist is an active member of the trauma resuscitation multidisciplinary team and has been shown to reduce medication errors and an providing additional layer of safety. The ED pharmacist successfully integrates pharmaceutical care into the ED and demonstrating the benefits to physicians is critical for expanding pharmacy services.

64. Hampton JP. Rapid-sequence intubation and the role of the emergency department pharmacist. *Am J Health Syst Pharm*. 2011;68(14):1320-1330.
    - **Summary:** This article reviews of the ED pharmacist role in rapid sequence intubation. Pharmacist can play a role in pretreatment including identification of patients requiring pretreatment and the appropriate agents and dose, in paralysis with induction and selection of appropriate induction and paralytic agents and doses, and postintubation management with selection of appropriate agents and doses to maintain sedation and analgesia. ED pharmacist can assist in appropriate sedative and neuromuscular blocker during the pretreatment and paralysis with induction steps of RSI.

Cost Avoidance

65. Rech MA, Adams W, Smetana KS, et al. PHarmacist Avoidance or Reductions in Medical Costs in Patients Presenting the EMergency Department: PHARM-EM Study. *Crit Care Explor*. 2021;3(4):e0406.

    - **Design**: Multicenter, prospective, observational study
    - **Practices**: A comprehensive, evidence-based framework for categorizing and monetizing cost avoidance (CA) interventions by critical care and emergency medicine pharmacists was developed. This framework contained 38 interventions associated with CA that pharmacists can perform in the ICU and ED settings. Each intervention category was grouped into one of six intervention sections: Adverse drug event (ADE) prevention, resource utilization, individualization of patient care, prophylaxis, hands-on care, and administrative and supportive tasks. All clinical interventions made by participating pharmacists were recorded in Research Electronic Data Capture. All participants received training on appropriate documentation of interventions and were encouraged to enter these data in real time to provide the most accurate accounting of intervention.

- **Outcomes**: The primary outcomes were the quantity, type, and acceptance of interventions provided by and the potential CA generated from clinical pharmacists practicing in ED settings. Eighty-eight emergency medicine pharmacists at 49 centers performed 13,984 accepted interventions during 917 shifts. This included interventions that were accepted on 8,602 patients and generated $7,531,862 of cost avoidance. The quantity of accepted interventions and cost avoidance generated in six established categories were as follows: adverse drug event prevention (1,631 interventions; $2,225,049 cost avoidance), resource utilization (628; $310,582), individualization of patient care (6,122; $1,787,170), prophylaxis (24; $22,804), hands-on care (3,533; $2,836,811), and administrative/supportive tasks (2,046; $342,881). The most frequent interventions were dosage adjustments in patients not receiving continuous renal replacement therapy (CRRT; accepted interventions 2,207; percentage of accepted interventions: 15.8%), initiation of nonantimicrobial therapy (1,705; 12.2%), antimicrobial therapy initiation and streamlining (1,375; 9.8%), and bedside monitoring (1,207; 8.6%). Mean cost avoidance was $538.61 per intervention, $875.60 per patient, and $8,213.59 per emergency medicine pharmacist shift. The annualized cost avoidance from an emergency medicine pharmacist was $1,971,262. The monetary cost avoidance to pharmacist salary ratio was between $1.4:1 and $10.6:1.
- **Summary**: Pharmacist involvement in the care of patients presenting to the ED results in significant avoidance of healthcare costs, particularly in the areas of hands-on patient care and ADE prevention.

66. Lada P, Delgado G Jr. Documentation of pharmacists' interventions in an emergency department and associated cost avoidance. *Am J Health Syst Pharm*. 2007; 64(1):63-8.
    - **Design:** Prospective analysis. All pharmacists working in the ED prospectively documented the pharmacist interventions that were accepted by physicians and nursing staff and entered a spreadsheet on a weekly basis.
    - **Practices:** Intervention categories included the provision of drug information; recommendations for dosage adjustment, formulary interchange, initiation of medications, alternative drug therapy, discontinuation of drug therapy, changes in medication therapy due to allergy notification, drug therapy duplication prevention, or changes in the route of drug administration; questions from nursing staff; order clarifications; drug compatibility issues; patient information; toxicology; and drug interaction identification.
    - **Outcomes:** 2150 pharmacist interventions were documented. Pharmacists participated in the care of 1042 patients triaged to the resuscitation area of the ED. Cost avoidance was determined to be 1,029,776 dollars (September 1, 2003 to December 31, 2003).
    - **Summary:** The most documented interventions made by pharmacists involved in the care of patients visiting the ED included provision of drug information, dosage adjustment recommendations, responses to questions from nursing staff, formulary interchanges, and suggestions regarding initiation of drug therapy. The potential cost avoidance attributable to the pharmacist interventions during the study period was over $1 million.