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Cost-avoidance associated with implementation of an overnight emergency medicine pharmacist at a Level I Trauma, Comprehensive Stroke Center

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ABSTRACT

Aim: To investigate the cost-avoidance associated with implementation of an overnight emergency medicine pharmacist (EMP) through documented clinical interventions.
Design: Retrospective evaluation of prospectively tracked interventions in a single Level I Trauma, Comprehensive Stroke Center, from November 25, 2020 through March 12, 2021 during expanded emergency medicine service hours (2300–0700).
Interventions: One of 45 clinical patient-care recommendations associated with cost-avoidance were available to be selected and documented by the EMP; more than one intervention was allowed per patient, though one clinical intervention could not be counted as multiple items. Documented services were associated with monetary cost avoidance based upon available literature assessing pharmacy clinical interventions. Differences in time from imaging to systemic thrombolytics and percentage of patients meeting door-to-alteplase benchmarks were compared with and without the availability of EMPs.
Results: Overnight EMPs documented 820 interventions during 107 overnight shifts with a cost avoidance of $612,974. The most common interventions were bedside monitoring ($n = 127$; $50,694), drug information consultation (97; $11,269), and antimicrobial therapy initiation and streamlining (95; $60,101). When categorizing interventions, 378 (46%; $292,484) were input as hands-on care, 216 (26%; $94,899) as individualization of patient care, 135 (17%; $25,897) as administrative and supportive tasks, 84 (10%; $121,746) as adverse drug event prevention, and 7 (1%; $77,964) as resource utilization. All patients ($n = 6$) with an acute ischemic stroke during the evaluation period received systemic thrombolytics ≤45 min in the presence of EMPs compared with 50% receiving thrombolytics ≤45 min without EMPs.
Conclusions: Expanded overnight coverage by EMPs provided clinical bedside pharmacotherapy expertise to critically ill patients otherwise not available prior to study implementation. Clinical interventions were associated with substantial cost-avoidance.

1. Introduction

The positive impact of emergency medicine pharmacists (EMP) on clinical outcomes are well documented [1-3]. EMPs have been shown to improve compliance with advanced cardiovascular life support (ACLS) guidelines, reduce time to sedation and analgesia in rapid sequence intubation (RSI), and decrease time from door-to-alteplase administration for ischemic strokes, among other improved outcomes [1-3]. However, resources often limit hospitals from having full 24-h EMP services [4,5].

The American Society of Health-System Pharmacists (ASHP) Guidelines of Emergency Medicine Services highlight the increased demand for EMP services given their role in patient-centered care, pharmacotherapy consultation and optimization, and medication safety [4]. Although, quantifying the value of EMP services to allocate resources are difficult to establish without a robust method of associating direct sources of revenue or prevention of patient harm. Within the state of

Abbreviations: ACLS, advanced cardiovascular life support; ADE, adverse drug event; AIS, acute ischemic stroke; ASHP, American Society of Health-System Pharmacists; CA, cost avoidance; CPA, collaborative practice agreement; ED, emergency department; EMP, emergency medicine pharmacist; NCCTH, non-contrast computerized tomography head; RSI, rapid sequence intubation; COVID-19, SARS-CoV-2; SD, standard deviation; USD, United States dollar.

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Utah, the Intermountain Medical Center emergency department (ED) has the highest volume of patients with over 80,000 visits each year. During the surge of SARS-CoV-2 (COVID-19) cases in October 2020, expansion to overnight, 24-h pharmacy services was initiated with the anticipated need of treating complex patients and high ED volumes. EMP hours of coverage expanded from the 0700 to 2300 model to full 24-h coverage in anticipation of the community's need.

The goal of this study was to document clinical interventions and associated cost avoidance (CA) by overnight EMPs during expanded hours. Additionally, the median differences from imaging to systemic thrombolytics and percentage of patients meeting door-to-alteplase for acute ischemic stroke benchmarks observed were compared before and after overnight EMP implementation.

2. Methods

2.1. Study design

This was a retrospective, single-center, descriptive analysis from November 25, 2020 through March 12, 2021 (107 days). Patients were included with a documented intervention by an EMP into the REDCap database. Interventions were only documented by EMPs who staffed in the ED during the expanded 2300–0700 h. The documented services were associated with monetary cost avoidance based upon available literature and similar to a previous evaluation of implementation of telecritical care pharmacy services [5-9]. Qualifications of participating EMPs in our study included completion of two years post-graduate pharmacy training and board-certification in emergency medicine and/or critical care. In patients presenting with acute ischemic stroke (AIS), a secondary analysis was performed comparing median time from non-contrast computerized tomography head (NCCTH) to alteplase administration and percentage of patients achieving stroke guideline-recommended benchmarks of door-to-alteplase ≤30 min, ≤ 45 min, and ≤ 60 min [10].

2.2. Data collection

Prior to the initiation of data collection, intervention descriptions, categories, and associated CA were taken from scoping reviews [Appendix A] and built into a standardized REDCap database. There were 45 possible interventions that EMPs were able to select from [6,7]. Interventions were grouped into five categories: hands-on care, adverse drug event (ADE) prevention, individualization of patient care, resource utilization, and administrative and supportive tasks. Hands-on care included active involvement of EMP at bedside, often requiring active medication titration, dosing evaluation, and monitoring of high acuity medications. ADE prevention resulted from intervening on medication reconciliation and through patient chart review. Individualization of patient care was categorized as EMP patient-centered interventions from collecting patient history and real-time clinical data and making interventions. Resource utilization consisted of EMP involvement within medication stewardship, particularly with high-cost medications. Administrative and supportive tasks contained interventions related to drug information consultations and adherence to institutional protocols, such as drug protocol management. Clinical recommendations were retrospectively documented directly into REDCap during the staffed shift, often immediately following the clinical intervention. EMPs were allowed to document more than one intervention per patient, though a single clinical intervention could not be counted in multiple categories of CA. Patients were included into the secondary analysis if they received alteplase for ischemic stroke during the evaluated time periods. Timestamps collected from the EHR for ED presentation, NCCTH scan initiation, and alteplase administration on the medication administration record (MAR) were used for calculations. These are perpetually calculated and everyone reviewed by our Comprehensive Stroke Center clinical program coordinators.

2.3. Study outcomes and statistical analysis

The primary outcome was to quantify documented overnight EMP interventions and their CA. CA associated with each intervention from the scoping reviews were adjusted to the 2021 US Dollar (USD) [11,12]. The secondary outcome was to observe how EMPs may have impacted adherence to recommended benchmark goals for door-to-needle times in patients with AIS. Alteplase administration timing was used for analysis to compare periods without vs with the availability of overnight EMP services. Median time from NCCTH to alteplase administration was reported. Furthermore, percentage of patients achieving door-to-alteplase times of ≤30 min, ≤ 45 min, and ≤ 60 min were assessed to determine adherence to primary and secondary objectives as recommended by the American Heart Association/American Stroke Association [10]. These outcomes were compared over two timeframes of the same duration (107 days) within the prior year (August 3, 2020 – November 18, 2020 & November 25, 2019 – March 12, 2020). These periods were chosen to compare separate time periods of 107 days with and without the COVID-19 pandemic. All data were expressed as descriptive statistics.

3. Results

Over the study period there were 820 interventions documented by overnight EMPs during the expanded hours of 2300–0700 [Table 1]. The CA associated with these interventions was $612,974.31. Hands-on care had the greatest contribution to the CA (47%; $292,484), followed by ADE prevention (20%; $121,746), individualization of patient care (15%; $94,899), resource utilization (13%; $77,946), and administrative and supportive tasks (5%; $25,897) [Table 1]. The top six CA interventions were blood factor stewardship ($n = 10$, $98,918.09), bedside monitoring ($n = 127$; $50,694.34), culture follow-up after discharge ($n = 67$, $47,179.52), medication reconciliation resulting in major ADE prevention ($n = 25$; $86,027.81), antimicrobial streamlining ($n = 95$; $60,101.37), and prevention of unnecessary high-cost medications (n = 2; $77,595), totaling 69% of all interventions and $420,516 in CA.

The most common interventions documented were bedside monitoring ($n = 127$; $50,694), drug information consultation ($n = 97$; $11,269), and antimicrobial therapy and streamlining ($n = 95$; $60,101) [Table 1]. EMPs categorized 378 (47%) of their interventions as hands-on care, 216 (26%) as individualization of patient care, 135 (17%) as administrative and supportive tasks, 84 (10%) as ADE prevention, and 7 (1%) as resource utilization.

Hands on care and individualization of patient combined for 72% of the total interventions during this period [Table 1]. Overnight EMPs documented their participation in emergent cases including 32 strokes, 14 cardiac arrests, 50 RSI or procedural sedations, and 60 rapid response team needs. These accounted for 106 of the 378 interventions (28%) documented as hands-on care. Individualization of patient care was primarily driven by antimicrobial therapy initiation and monitoring, contributing to 95 of the 216 interventions (44%) in the category. This was followed by 49 interventions (23%) initiating nonantimicrobial therapy considered as individualization of patient care.

For the secondary analysis, the median times of NCCTH to alteplase administration were documented and compared to different time periods of the same duration [Table 2]. From November 25, 2020 – March 12, 2021 (2300–0700), the median time (IQR) was 12 min (12, 16) from NCCTH to alteplase administration with the services of EMPs vs 31 min (22, 39) without EMPs. Of the six patients treated with overnight EMP services, two of them had a door-to-alteplase ≤30 min (33%) and the remaining four patients received alteplase within 45 min of presentation (100%). Thus, all patients ($n = 6$) with an acute ischemic stroke during the evaluation period received systemic thrombolytics ≤45 min in the presence of EMPs compared with 50% receiving

Table 1
Emergency medicine pharmacist interventions and cost avoidance from November 25, 2020 through March 12, 2021 during hours of 2300–0700.

Intervention	*N* = 820	Cost Avoidance USD ($612,974.31)
Category 1: Hands-on care, %	**378 (46)**	**$292,484.28 (47)**
Blood factor stewardship	10	$98,918.09
Bedside monitoring	127	$50,694.34
Culture follow-up after ED discharge	67	$47,179.52
Emergency code sepsis participation	15	$24,424.94
Emergency code stroke participation	32	$22,410.86
Emergency code blue participation	14	$22,115.42
Emergency procedural sedation or RSI participation	50	$14,247.25
Rapid response team participation	60	$10,381.14
Medication teaching or discharge education	3	$2112.52
Category 2: ADE prevention, %	**84 (10)**	**$121,746.42 (20)**
Medication reconciliation resulting in major ADE prevention	25	$86,027.81
Medication reconciliation resulting in minor ADE prevention	54	$21,555.07
ADE prevention: Major	4	$13,764.37
ADE prevention: Minor	1	$399.17
Category 3: Individualization of patient care, %	**216 (26)**	**$94,899.42 (15)**
Antimicrobial therapy initiation and streamlining	95	$60,101.37
Anticoagulant therapy management	17	$12,205.47
Pain management	13	$9594.00
Initiation of nonantimicrobial therapy	49	$8477.93
Glycemic and electrolyte management	29	$2675.25
Antimicrobial pharmacokinetic evaluation	8	$1384.15
Management of sedation	3	$276.75
Management of alcohol withdrawal	2	$184.50
Category 4: Resource utilization, %	**7 (1)**	**$77,946.44 (13)**
Prevention of unnecessary high-cost medication	2	$77,595.00
Discontinuation of clinically unwarranted therapy	5	$351.44
Category 5: Administrative and supportive tasks, %	**135 (17)**	**$25,897.75 (5)**
Drug information consultation: toxicology specific	32	$13,954.08
Drug information consultation	97	$11,269.70
Drug protocol management	6	$673.97

ED = emergency department, RSI = rapid sequence intubation, ADE = adverse drug event.

thrombolytics ≤45 min without EMPs. Refer to Table 2 for median DTN times and benchmark percentages.

4. Discussion

Our study is the first to assess EMP interventions, contributions to patient care, and associated CA during expanded overnight (2300–0700) coverage. The cost avoidance from our findings support other studies representing the clinical and financial benefits of EMPs [1-5,9,13,14]. Roman and colleagues evaluated the roles of EMPs outside of traditional pharmacy services [14]. From their systematic analysis, three key roles for EMPs emerged, including care of critically ill patients, antimicrobial stewardship, and home medication evaluation and ordering [14]. EMPs from our study documented 40% of their interventions from high acuity patients (e.g., ischemic/hemorrhagic stroke, cardiac arrests, RSI or procedural sedations, and rapid response participations), in addition to antimicrobial initiation and streamlining. The top two category contributors to the overall CA were hands-on care and ADE prevention, which are consistent with findings from the PHARM-EM study [9]. EMPs are an additional level of patient safety and stewardship for the fast-paced work environment as represented by percentage of interventions under this category [9,13].

For the study period, interventions were associated with a CA of $612,974 over 107 days [Table 1]. The extrapolated CA for the entire year would be $2,090,987. The top six documented interventions that contributed to 69% ($420, 516) of the CA more emphasize the invaluable impact EMPs have on patient-centered care. Overnight EMPs have access to more timely patient-specific information compared to facilities that would otherwise utilize centrally-staffed pharmacists who are not physically present in the ED. EMPs were frequently involved

Table 2
Alteplase Treatment Time Intervals for Patients with Acute Ischemic Stroke.

Timeframe	N	EMP	Median time from NCCTH to alteplase administration, IQR	Door-to-alteplase ≤ 30 min, n/N (%)	Door-to-alteplase ≤ 45 min, n/N (%)	Door-to-alteplase ≤ 60 min, n/N (%)
Nov 25, 2020 – Mar 12, 2021 (2300–0700)	6	Yes	12 min (12, 16)	2/6 (33)	6/6 (100)	6/6 (100)
Study Period						
Aug 3, 2020 – Nov 11, 2020 (2300–0700)	4	No	29 min (22, 46)	0	1/4 (25)	2/4 (50)
Comparator 1						
Nov 25, 2019 – Mar 12, 2020 (2300–0700)	4	No	26 min (16, 46)	1/4 (25)	2/4 (50)	3/4 (75)
Comparator 2						

with bedside monitoring, documented with interventions associated with active titration of vasopressors, sedatives, and antihypertensives. Their availability for bedside patient care inherently provides EMPs more opportunities to intervene and prevent ADEs, including major ADEs that may have led to severe temporary or permanent patient harm, prolonged ED or hospital lengths of stay, or possibly death.

Delays in appropriate antimicrobial therapy have been associated with increased mortality in severe sepsis and septic shock [18]. Antimicrobial initiation and streamlining, characterized as empiric therapy initiation and de-escalation of therapy, highlights the role overnight EMPs have on optimizing patient care. This is also represented by their continued involvement in culture follow up after discharge. Results are still reported overnight, where the EMP evaluated the appropriateness of the discharged patient's therapy. Patients needing a change in therapy had their recommendation documented for the oncoming EMP to evaluate and contact the patient, as appropriate. Blood factor stewardship, which consisted of EMPs evaluating patient parameters and providing recommendations on antithrombotic reversal, in addition to clotting factor administration, led to substantial CA by preventing unnecessary, or optimization of, high-cost medications.

EMPs, alongside other pharmacists, have a unique role as a real-time clinical support resource [1-5,9,13]. Our analysis demonstrates their importance with high acuity patients during hours most hospitals do not have EMP services (2300–0700). During the study period, 14 cardiac arrests and 60 rapid response participations were documented during the overnight hours, totaling 74 patients in an emergent situation with the added clinical resource of a bedside EMP. Furthermore, 50 interventions were related to procedural sedation or RSI. The value of having an EMP available in the emergency department far exceeds the procurement of just medications, as they play a pivotal role in thorough patient and chart review and assessment followed by collaborative discussions on tailored pharmacotherapy recommendations [1-3,9,13]. This is especially vital during the overnight hours when other resources, staff, and specialties may not be immediately available.

Regarding stroke performance metrics, overnight implementation of EMPs yielded a median time of NCCTH to alteplase administration of 12 min, which was roughly a 20-min observed difference compared to the other evaluated time periods without overnight EMP coverage (32 min), though the number of patients available for comparison were small and precluded formal analyses. Aside from procurement and dosing of thrombolytics for ischemic stroke patients, EMPs have an essential role in evaluating inclusion/exclusion criteria, optimizing concomitant therapies such as antihypertensives, addressing relative contraindications, and logistically allowing other healthcare providers to focus on other roles [4,5,12].

There are several limitations of our study. The inherent limitations that come with retrospective, single-center analysis may make it difficult to extrapolate to other facilities in different care settings and with different resource allocation. CA associated with each intervention were based on available literature [5-7]. These calculations and estimates do not provide consistent, objective CA analysis specific for each patient or situation, which may provide under- or over-estimated CA. There are currently no formal cost-analyses available, to our knowledge, that represent the actual cost return and impact of EMPs. This makes it difficult to objectively quantify the value of an EMP when considering individual institution budgets. Interventions were stratified into categories with descriptions based on available scoping reviews [5-7]. However, participating EMPs could interpret the intervention definitions differently or prioritize certain documentations over others. This may contribute to classification bias; an example being EMPs selecting interventions associated with higher CA. To mitigate this, an initial group discussion occurred to review the available CA interventions where examples were reviewed and classified. Due to the fast-paced and busy nature of the ED setting, it is also possible that interventions were performed, but not documented leading to uncaptured data. The amount of time spent per intervention was not recorded. Documenting the time spent for each intervention may provide greater insight on EMP clinical responsibilities and additional datapoints for more robust CA metrics. Lastly, our CA metrics are not directly correlated to more patient-important outcomes such as morbidity, mortality, and patient-level cost of care. These are areas all requiring future research.

5. Conclusion

Expanded overnight coverage with EMPs provided clinical bedside pharmacotherapy expertise to critically ill patients otherwise not available prior to study implementation. The EMP interventions were associated with substantial CA. Further studies are needed to investigate more robust, objective CA analyses and metrics to support clinical pharmacy services.

CRediT authorship contribution statement

Mark H. Nguyen: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation. **Kyle Gordon:** Writing – review & editing, Data curation. **Breyanna Reachi:** Writing – review & editing, Data curation. **Jeremy Bair:** Supervision, Project administration, Data curation. **Stephanie Chauv:** Writing – review & editing, Visualization, Project administration, Formal analysis, Data curation, Conceptualization. **Gabriel V. Fontaine:** Writing – review & editing, Project administration.

Declaration of competing interest

Gabriel V. Fontaine, PharmD, MBA: AstraZeneca, Chiesi, Anticoagulation Forum – consultant, speakers bureau; Marinus Pharmaceuticals – consultant.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2024.05.011.

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Further readings

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