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Do we need a pharmacist in the ICU?

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On the surface, the answer to the question of the title of this editorial seemed to be a rhetorical and obvious yes. This is not because two pharmacists are involved in authoring this editorial, but because there is a substantial amount of literature—arguably more than which exists for any other clinical team member in the ICU and likely more than some of the standard-of-care interventions (such as mechanical ventilation)—which linked the presence of a pharmacist in an ICU to improved patient outcomes.

Since the beginning of ICU clinical pharmacy services in the 1960s [1], the practice has matured along with the subspecialty of critical care medicine into one that has been considered by the Society of Critical Care Medicine (SCCM) as essential [2]. In fact, within the SCCM guidelines for best practice model and ICU staffing [2], pharmacist presence was considered as best practice supported by grade C evidence, the highest level of all recommendations in that document. A summary of the studies evaluating the impact of having a dedicated

pharmacist in the ICU is shown in Table 1 [3–15]. In general, these studies show reductions in drug prescribing errors, adverse drug events, and costs, with no worsening and typically improvement in clinical outcomes such as ICU length of stay and mortality. A large survey of US hospitals conducted in 2004 compared costs and clinical outcomes in ICUs with at least a part-time dedicated pharmacist to those without this resource. It showed improved costs and clinical outcomes (shorter ICU lengths of stay and lower hospital mortality) particularly in patients with infections [5] and thromboembolic diseases [6]. In a landmark paper, Leape and colleagues [3] clearly demonstrated that presence of pharmacists in a medical ICU reduced medication errors and cost. These benefits appear generalizable since the studies have been conducted in a variety of ICUs (e.g., medical, surgical, neurosurgical, cardiac, and pediatric) using different physician staffing models (e.g., open vs closed ICU), and date back to the early 1990s [13]. The majority of the studies have been conducted in North America, but similar beneficial results have been published from studies conducted in Asia [4, 8, 9], the Middle East [10], and Europe [11]. Provision of drug information, clarifying and correcting medication orders, identifying drug interactions as well as actual or potential adverse drug events, and recommending alternative therapies account for greater than 90 % of ICU pharmacists' activities [3, 4, 8, 13, 14]. The studies indicate that a large majority, and in most studies almost all, of pharmacists' recommendations are accepted by the physicians [3, 4, 13–15]. These significant improvements in patient care afforded by the presence of dedicated pharmacists are clearly viewed as important by medical colleagues, as shown by a recent survey [16].

In addition to the clear benefits for the patients, ICU pharmacists can play a multitude of other roles [17] such as education of other team members, leadership or administrative roles in critical care committees, and in

Table 1 Evidence summarizing the clinical and economic outcomes of pharmacists' impact in the ICU

References	Setting/type of ICU	Time and duration of study	Pharmacist interventions	Clinical outcomes	Pharmacoeconomic outcomes
<p>Comparative studies with contemporary controls</p> <p>Leape et al. [3] (USA)</p>	<p>17-bed MICU (intervention) vs 15-bed CCU (control), academic</p>	<p>6 month pre-intervention (Feb-Jul 1993) vs 9.2 month post-intervention (Oct 1994-Jul 7 1995)</p>	<p>–Presence of a dedicated ICU pharmacist (including during rounds) in post-intervention period only in intervention MICU</p> <p>–398 pharmacist interventions (mean 1.4/day or 2/weekday): 45 % clarification or correction of order, 25 % provision of drug information, 12 % recommendation of alternative therapy, 4 % identification of drug interaction, 2 % identification of drug allergy, 2 % identification of ADE, 10 % other</p> <p>–99 % drug ordering recommendations accepted by physicians</p>	<p>66 % decrease in all ADEs and preventable ADEs due to prescribing errors compared to pre-intervention period ($p < 0.001$) and post-intervention control CCU ($p < 0.001$) where rates remained unchanged</p>	
<p>Saokaew et al. [4] (Thailand)</p>	<p>Similar intervention and control 20-bed MICUs</p>	<p>Mar 2005 (33 days)</p>	<p>–Presence of a dedicated ICU pharmacist (including during rounds) in intervention but not control MICU</p> <p>–127 pharmacist interventions (mean 3.8/day or 5.1/weekday): 50 % clarification or correction of order, 21 % provision of drug information, 18 % recommendation of alternative or supplemental therapy, 8 % identification of drug interactions, 3 % others</p> <p>–98 % of recommendations accepted by physicians</p>	<p>1 day increase in ICU length of stay ($p = 0.99$)</p>	<p>14 % decrease in estimated medication costs ($p = 0.14$)</p>

Table 1 continued

References	Setting/type of ICU	Time and duration of study	Pharmacist interventions	Clinical outcomes	Pharmacoeconomic outcomes
MacLaren et al. [5, 6] (USA)	382/3238 (11.8 % response rate) academic and non-academic hospitals encompassing 1034 ICUs: 25 % general, 16 % med, 6 % resp, 16 % surgical, 13 % CVICU, 7 % trauma, 6 % neurosurg 4 % neonatal, 3 % pediatric, 2 % burn	2004 National Hospital Survey	ICUs with at least a partial dedicated ICU pharmacist compared to ICUs with no dedicated ICU pharmacist	<p><i>Patients with infections:</i></p> <ul style="list-style-type: none"> –Lower hospital mortality for nosocomial-acquired infections (14.6 vs 18.1 %, $p < 0.001$), community-acquired infections (11.4 vs 13.3 %, $p = 0.008$), and sepsis (18.5 vs 19.4 %, $p = 0.008$) –ca. 1 day shorter ICU lengths of stay ($p < 0.001$) <p><i>Patients with thromboembolic events:</i></p> <ul style="list-style-type: none"> –Lower hospital mortality overall (7.6 vs 10.4 %, $p < 0.001$) –ca. 1 day shorter ICU length of stay overall ($p < 0.001$) –Less patients with bleeding complications (5.9 vs 8.8 %, $p < 0.001$), or requiring transfusions per patient with bleeding complications (10.2 vs 14.2 %, $p < 0.001$) or blood units per patient transfused (3.1 vs 6.8, $p = 0.006$) –Lower hospital mortality in patients with bleeding complications (5.8 vs 7.6 %, $p < 0.001$) 	<p><i>Patients with infections:</i></p> <ul style="list-style-type: none"> –11 % Lower overall Medicare charges ($p < 0.001$) <p><i>Patients with thromboembolic events:</i></p> <ul style="list-style-type: none"> –8 % lower overall Medicare charges ($p < 0.001$) –22 % lower overall Medicare charges per patient with bleeding complications ($p < 0.001$)
Comparative studies with historical controls Weant et al. [7] (USA)	Neurosurgery service including open-model neurosurgical ICU, academic	27 month pre-intervention (Jul 2003–Sep 2005) vs 27 month post-intervention (Oct 2005–Dec 2007)	Presence of dedicated neurosurgery service pharmacist (including during rounds) in post-intervention period	<ul style="list-style-type: none"> –0.2 % decrease in hospital mortality (8.53 vs 8.75 %, $p = 0.93$); 1.4 % decrease in early (within 2 days of admission) hospital mortality (1.95 vs 3.34 %, $p = 0.06$) –1.3 day decrease in hospital length of stay ($p = 0.003$) and 1.8 day increase in ICU length of stay ($p = n/a$) –4 % decrease in 30 days hospital readmission rate (7 % vs 11 %, $p < 0.001$) 	<ul style="list-style-type: none"> 33 % decrease in pharmacy and intravenous medication costs ($p = n/a$) and 1 % decrease in overall hospital costs ($p = n/a$)

Table 1 continued

References	Setting/type of ICU	Time and duration of study	Pharmacist interventions	Clinical outcomes	Pharmacoeconomic outcomes
Jiang et al. [8] (China)	33-bed MSICU, academic	3 month pre-intervention (Dec 2010–Mar 2011) vs 3 month post-intervention (Mar 2011–Jun 2011)	–Presence of a dedicated ICU pharmacist (including during rounds) in post-intervention period only –232 pharmacist interventions (mean 2.5/day or 3.6/weekday) (62.5 % initiated by pharmacist); 36 % dose adjustments; 28 % recommendation of alternative therapy; 16 % identification of ADE; 11 % provision of drug information; 6 % identification of drug interaction or contraindication; 3 % other –87 % of recommendations accepted by physicians	–0.2 day increase in ICU length of stay ($p = 0.14$) –73 % decrease in medication errors per patient decreases in wrong dose, interval or duration, unnecessary drug use, lack of use of needed drugs, inappropriate drug selection, repeated drug use, and drug–drug interactions	12 % decrease in medication cost per patient ($p = 0.095$)
Jiang et al. [9] (China)	33-bed MSICU, academic	1 year pre-intervention (Sep 2010–Aug 2011) vs 1 year post-intervention (Sep 2011–Aug 2012)	Dosing adjustments performed by pharmacists in septic patients requiring CRRT only in the post-intervention period	–No significant decrease in mortality (48 vs 53 %, $p = 0.56$) –3 day decrease in ICU length of stay ($p = 0.037$) –73 % decrease in antimicrobial dosing errors ($p < 0.001$) –58 % decrease in all ADEs ($p = 0.048$), and 80 % decrease in preventable ADEs ($p = 0.018$)	–26 % decrease in ICU antimicrobial costs/patient ($p = 0.046$) –26 % decrease in overall ICU costs/patient ($p = 0.038$)
Aljbouri et al. [10] (Jordan)	General ICU	10 month pre-intervention (Aug 2009–May 2010) vs 10 month post-intervention (Jun 2010–Mar 2011)	Presence of a dedicated ICU pharmacist in post-intervention period only		–42 % decrease in antimicrobial costs ($p \leq 0.01$) –30 % decrease in vasoactive medication costs ($p \leq 0.01$) Estimated cost of €3 per monitored patient-day compared favorably to estimated cost saving of €26–40 per monitored patient-day based on reduction in preventable ADEs
Klopotowska et al. [11] (Holland)	Closed-model 28-bed MSICU, academic	3 week pre-intervention (Oct 2005) and 8 month post-intervention (Oct 2005–Jun 2006)	–Presence of a dedicated ICU pharmacist in post-intervention period only –659 pharmacist recommendations (mean 2.6/day or 3.7/weekday) –74 % of recommendations accepted by physicians	–0.6 day increase in ICU length of stay ($p = 0.92$) –67 % decrease in prescribing errors ($p < 0.001$) –75 % decrease in preventable ADEs ($p = 0.25$)	

Table 1 continued

References	Setting/type of ICU	Time and duration of study	Pharmacist interventions	Clinical outcomes	Pharmacoeconomic outcomes
Devlin et al. [12] (Canada)	Closed-model 15-bed MSICU, academic	50 consecutive ventilated patients pre-intervention (Feb–May 1995) vs 50 consecutive ventilated patients post-intervention (Nov 1995–Feb 1996)	Introduction of pharmacist-initiated and implemented ICU sedation guidelines in the intervention period	0.6 day decrease in ICU length of stay ($p = ns$)	74 % decrease in sedation drug costs ($p = 0.08$)
Prospective observational study					
Montazeri and Cook [13] (Canada)	Closed-model 15-bed MSICU, academic	3 months (Jun–Sep 1990)	–Presence of dedicated ICU pharmacist including during rounds –575 pharmacist interventions (mean 11/working day): 43 % provision of drug information, 45 % pharmacist-initiated therapeutic consultation [19 % dose adjustments, 22 % recommendation of alternative therapy, 2 % identification of actual or potential ADE, 2 % other], 4 % clarification of order, 8 % other –95 % of pharmacist-initiated therapeutic consultation recommendations accepted by physicians		\$10,000 CAD estimated cost savings over 3 months (estimated cost savings to pharmacist salary ratio of 4:1)
Retrospective observational studies					
Kopp et al. [14] (USA)	Open-model 16-bed MSICU, academic	4.5 months (mid-Oct 2003–Feb 2004)	–Presence of dedicated ICU pharmacist –129 pharmacist interventions (mean 1/day or 1.3/weekday) (39 % during rounds and 40 % during chart review); 19 % clarification or correction of order, 40 % provision of drug information, 26 % recommendation of alternative therapy, 7 % identification of drug interaction, 1 % identification of drug allergy, 5 % identification of ADE, 2 % other –98 % acceptance rate of interventions by physicians		\$205,919–280,421 USD estimated cost savings over 4.5 months

Table 1 continued

References	Setting/type of ICU	Time and duration of study	Pharmacist interventions	Clinical outcomes	Pharmacoeconomic outcomes
Moffett et al. [15] (USA)	Pediatric cardiac ICU, academic	3 months (Jan–Mar 2006)	–77 medications required dose adjustment for renal dysfunction, 96 % of which were recommended by pharmacists –100 % of pharmacist dosing recommendations accepted by physicians		\$12,000 USD cost savings over 3 months due to pharmacist renal dosing interventions
ADE adverse drug event, CAD Canadian dollars, CCU coronary care unit, CRRT continuous renal replacement therapy, CVICU cardiovascular intensive care unit, ICU, intensive care unit, med medical, MICU medical intensive care unit, MSICU medical-surgical intensive care unit, n/a not available, ns not (statistically) significant (i.e., $p > 0.05$), neurosurg neurosurgical, resp respiratory, USD United States dollars					

scholarly work and research. The extent to which these are seen in individual ICUs is variable, as outlined by a recent survey [18]. As an example, in one of the studies listed in Table 1 [12], the development and implementation of sedation guidelines were initiated and led by the ICU pharmacist. However, the bulk of the activities still involve provision of pharmaceutical care where a patient's drug-related issues (e.g., wrong dose, wrong drug, interactions, and adverse reactions) are identified, prevented, and resolved with pharmacists making recommendations that are accepted by the physicians a majority of the times.

Upon closer examination of the published data, it appears that while pharmacists in the ICU are clearly essential and beneficial for the patients and the team, not all ICUs have a pharmacist, and even in ICUs that do have such a dedicated person, he or she is only present for part of the day. In a recent survey conducted in the USA, only 62.2 % of 382 ICU respondents had clinical pharmacy services [18]. Similarly, Leblanc and colleagues [19] reported that only 74.4 % of 168 international ICU pharmacists who responded were routinely attending rounds, one of the key activities demonstrated to be of benefit to the patient. This contradiction (clear evidence of need but yet not universally available) is likely due to several reasons. First and foremost are likely financial barriers. Despite the fact that ICU pharmacists have been demonstrated to provide cost-effective care and cost savings in many facets of care, some hospital administrators may still not (however erroneously) see the clear return on investment. Studies estimate that costs saved in terms of direct drug costs and avoidance of preventable adverse drug events compared to the pharmacist cost is a multiple of at least 4 [11, 13]. Second, critical care training is not common in pharmacy training curricula, and thus the specialized training required to be a competent ICU pharmacist must be obtained either “on the job” or in a formal manner through a limited number of residency/fellowship-type training programs. In a recent survey, this type of residency/fellowship was only available in 16.2 % of the US hospitals with ICU pharmacy services [18]. Finally, much like the care gaps that exist for many well established evidence-based therapies, it may be that the uptake process to move towards this best practice requires time.

While the spread of this knowledge needed to close the gap is happening, as evidenced by the international nature of the publications supporting the role of a pharmacist, further efforts are still needed [18]. Perhaps the next time an editorial of this topic is authored for the journal, the title will not be “Do we need a pharmacist in the ICU?” but rather “Do we have enough pharmacists in the ICU?”

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