

A Structured Approach to Identifying and Addressing Drug Therapy Problems in Neonatal and Pediatric Critically Ill Patients: IN-DEPTH

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Pharmacy students, residents, and new practitioners may feel overwhelmed with patients in the pediatric critical care setting due to the disease states, variation in acuity based on patient factors, and complex medication regimens. The FASTHUG MAIDENS mnemonic is a standardized and validated tool that was developed in 2011 for pharmacists to use when evaluating critically ill adult patients. However, there are no studies evaluating the use of this tool in pediatric critical care setting. This article aims to provide trainees and new practitioners with a new and distinct mnemonic tool, IN-DEPTH, to use when evaluating critically ill pediatric patients and identifying areas for treatment optimization. In addition, this article will provide rationale and examples to enhance the user's understanding of the components and subcomponents of the mnemonic. Ultimately, the goal of the IN-DEPTH mnemonic is to help provide some structure for pharmacy trainees or new practitioners that are less experienced with critical or pediatric care and provide the opportunity to have a meaningful impact in the care of critically ill pediatric patients.

ABBREVIATIONS AAP, American Academy of Pediatrics; ACIP, Advisory Committee on Immunization Practices; APPE, advanced pharmacy practice experience; CICU, cardiac intensive care unit; eGFR, estimated glomerular filtration rate; EMR, electronic medical record; GT, gastrostomy tube; IV, intravenous; IVIG, intravenous immunoglobulin; IWS, iatrogenic withdrawal syndrome; NG, nasogastric; NICU, neonatal intensive care unit; NPO, *nil per os*; PANDEM, prevention and management of pain, agitation, neuromuscular blockade, and delirium in critically ill pediatric patients with consideration of the ICU environment and early mobility; PICU, pediatric intensive care unit; PO, *per os*; RSV, respiratory syncytial virus; TOF, train of four; TPT, transpyloric tube

KEYWORDS critical care; drug-related problems; neonate; pediatrics

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Introduction

Pharmacy practice in pediatric critical care is intricate because of the vast range of patient ages and disease states, variation in acuity based on patient factors, and the complexity of medication regimens. Most students in Doctor of Pharmacy programs lack sufficient didactic or experiential exposure to pediatric pharmacy. Prescott et al¹ noted that Doctor of Pharmacy students only receive on average 21.9 hours of didactic content in the curriculum focused on pediatric patients, and that only 20% of Doctor of Pharmacy students took at least 1 advanced pharmacy practice experience (APPE) rotations. Additionally, Doctor of Pharmacy students also have limited exposure to some of the critical care disease states that may be seen in children and adults.² Pharmacy students, residents, and new practitioners are likely to feel overwhelmed when entering a rotation or new position in the pediatric critical care setting like the

pediatric intensive care unit (ICU) (PICU), neonatal ICU (NICU), or the cardiac ICU (CICU).

Given the limited experience of pharmacy students and residents with both pediatrics and critical care, trainees and new practitioners may struggle with identifying a systematic way to identify and address drug therapy problems. There is a standardized and validated mnemonic tool, FASTHUG MAIDENS (Feeding; Analgesia; Sedation; Thromboembolic prophylaxis; Head of bed elevation; stress Ulcer prophylaxis; Glucose control; Medication reconciliation; Antibiotics/anti-infectives; Indications for medications; Dosing; Electrolytes, hematology, and other laboratory tests; No drug interactions, allergies duplication, or side effects; and Stop dates), that was developed in 2011 for pharmacists to use when evaluating critically ill adult patients.³ Its purpose is to aid trainees and new practitioners in identifying drug-related problems in adult ICUs. The FASTHUG MAIDENS mnemonic could be

applied to pediatric patients. However, the guidance provided along with this tool lacks a comprehensive application to critically ill neonatal and pediatric patients due to additional information needed to assess drug therapy problems (e.g., weight-based dosing, dosage forms, parenteral and enteral nutrition considerations). In addition to this, not all components of the FASTHUG MAIDENS tool are relevant to pediatric patients. For example, the use of thromboembolic prophylaxis in all hospitalized pediatric patients is not routinely recommended whereas, this is a common practice in most hospitalized adult patients. To our knowledge, only one group adapted the FASTHUG BID (Bowel, Indwelling catheter, and Drug de-escalation) mnemonic for application to pediatric critical care, but it is important to note that no studies have explored the application of this mnemonic with pediatric critical care trainees.⁴ Our goal was to develop an adapted mnemonic tool, IN-DEPTH, to assist pharmacy trainees and new practitioners in evaluating critically ill pediatric patients and identifying areas for treatment optimization (Table). This proposed tool could be applied to patients in the PICU, NICU, and/or CICU.

Description of IN-DEPTH components

I – Indications for Medications. There are 2 subcomponents to the “I” in IN-DEPTH. The first is matching indications to medications. Trainees and new practitioners should review the medication list and match each medication to an indication from the active problem list and/or past medical history. An assessment should then be made to determine if deprescribing or initiating new therapy is warranted.

The second subcomponent is performing a medication reconciliation upon transitions of care. Transitions of care can occur upon admission (either from a different facility or home), moving between units in the same institution, and upon discharge (to another facility or home). During the medication reconciliation process, allergies, medications prior to arrival (e.g., dose, route of administration, dosage form), and availability of those medications on the health-system’s formulary should be assessed. An example of using this section cohesively is discontinuing acid suppression agents that were initiated in the PICU in a mechanically ventilated pediatric patient for stress ulcer prophylaxis upon transition to a general medicine floor. The acid suppression therapy would no longer have an indication and could be discontinued during a transition medication reconciliation. Another example would be when a clonidine extemporaneous oral suspension is continued from home, and the dose obtained upon medication reconciliation is mL/dose rather than mcg/dose. In this case, the trainee or new pharmacist should obtain the concentration of the clonidine extemporaneous oral suspension received prior to admission, and if this is different

than the health-system’s formulary extemporaneous oral suspension they would need to determine the mcg/dose that should be ordered.

N – Nutrition. Nutrition requires a large focus in the pediatric critical care arena. As such, there are 3 subcomponents to the “N” section of the mnemonic. The first component is review of enteral nutrition. It is important to determine the diet status such as *nil per os* (NPO), liquids only, or solid foods as tolerated. For infants, the type of enteral liquid feeds (i.e., human milk, formula) should be identified as this could result in the need for additional supplementation of vitamins or iron for some patients receiving human milk. Another consideration would be the route of administration of these enteral feeds such as *per os* (PO) or via a feeding tube [e.g., nasogastric (NG), transpyloric tube (TPT), or gastrostomy tube (GT)]. Trainees and new practitioners should assess the volume and frequency of enteral feeds. This information is important to determine when medication therapy can be switched from intravenous (IV) to enteral routes if the patient is tolerating the enteral nutrition goals for the patient.

The second component is consideration of parenteral nutrition. If enteral nutrition is not an option, the threshold to initiate parenteral nutrition would be dependent upon the age and nutritional status of the patient. If parenteral nutrition is initiated, it is important to identify fluid goals and determine if the patient has central or peripheral IV access, as this would determine the maximum amount of macronutrients (e.g., amino acids and dextrose) added as well as other micronutrients (e.g., potassium). In addition, trainees and new practitioners should assess the concentration of other continuous IV infusions to optimize the volume provided from these medications. This would allow for most of the total fluid goal to be provided with parenteral nutrition to maximize the macronutrient kilocalories for the patient. For more detailed discussion of considerations for enteral and parenteral nutrition in children, trainees may need to be referred to other references for greater understanding.⁵

The third subcomponent with nutrition management is consideration of nutrition monitoring parameters (e.g., glycemic status, electrolytes, triglycerides, alkaline phosphatase, or weight changes). More frequent monitoring of electrolytes and triglycerides may be needed with parenteral nutrition, specifically after adjustments in the formulation are made. It is also important to assess if any medications on the patient’s medication list will alter serum electrolyte concentrations and could be anticipated, prevented, or corrected with adjustments in the parenteral nutrition formulation or addition of enteral electrolyte supplements. At the time of initiation of enteral or parenteral nutrition, risk factors for development of re-feeding syndrome should be assessed (e.g., history of eating disorder, recent large weight loss, cachexia) and a more conservative nutrition plan

Table. The Components of the IN-DEPTH Tool

Letter	Definition	Subcomponent	Description
I	Indications for medications	Matching indications to medications	- Identify problem list - Match medications with each problem - Determine appropriateness of medications - Assess for de-prescribing opportunities - Initiate medications for untreated or partially treated problems/conditions
		Perform medication reconciliation upon transitions of care	- Assess patient allergies - Identify medications and indications for use at each transition of care (e.g., dosage form, dosage regimen, concentration of oral liquids)
N	Nutrition	Assess enteral nutrition	- Determine diet status (NPO, clear liquids, solid foods) - Identify type of enteral feeds (formula, human milk) - Assess route of feeding (PO, NG/OG, TPT, GT) and method of delivery if applicable (continuous versus bolus) - Identify volume and frequency of enteral feeds - Assess for ability to change IV medications to PO if tolerating enteral feeds
		Assess parenteral nutrition	- Identify type of intravenous line access (i.e., central versus peripheral) - Identify patient's fluid goal and amount of fluid available for parenteral nutrition - Assess concentrations of other fluids to maximize fluids available for parenteral nutrition
		Monitor nutrition parameters	<i>Enteral and parenteral nutrition:</i> - Assess for hypo- and hyper-glycemia - Assess if medications affecting electrolytes would be added or discontinued - Assess for re-feeding syndrome when initiating nutrition with malnourished patients <i>Parenteral nutrition:</i> - Assess electrolyte changes to determine adjustments to parenteral nutrition - Periodic monitoring of parenteral nutrition labs (phosphorus, magnesium, triglycerides, direct bilirubin)
D	Dosing, dosage form, and drug interactions	Assess dosage regimen appropriateness	- Check appropriateness of dosing based on age, weight, body surface area for indication - Ensure dosing does not exceed maximum adult dose or pediatric dose for patients ≥ 40 kg - Determine need for hepatic and/or renal adjustment Evaluate the planned duration for non-anti-infectives if applicable
		Assess for dosage form appropriateness	- Assess availability/measurability of medications (i.e., measurable doses) - Determine appropriateness of dosage form
		Screen for drug interactions	- Assess for drug-disease interactions - Assess for drug-drug interactions - Assess for appropriateness of a medication based on age (KIDs list²) - Assess for drug-food interactions (e.g., warfarin, levothyroxine)

(Table cont. on page 699)

Table. The Components of the IN-DEPTH Tool (cont.)			
Letter	Definition	Subcomponent	Description
E	Electrolytes, labs, vital signs, and ins & outs	Review laboratory findings	• Review pertinent labs based on medication list • Determine if laboratory monitoring is necessary • Assess if changes to medications are needed based on labs
		Assess vital signs	• Review vital signs based on medication list • Assess if changes to medications are needed based on vital signs
		Review inputs and outputs	• Determine appropriateness of intravenous maintenance fluids • Identify impact of hidden fluids (volume, type of fluid, need for continuation) • Evaluate outputs (chest tube output, ostomy output, urine output, and stools) • Assess if changes to medications are needed based on inputs and outputs
P	Pain, sedation, neuromuscular blockage, delirium, withdrawal	Pain/sedation (analgo-sedation)	• Assess pain and sedation scores • Determine need for adjustment in analgo-sedation based on pain/sedation scores, laboratory and vital sign changes, and other pertinent patient factors
		Neuromuscular blockade	• Determine if pain and sedation are adequately managed • Asses for train of four monitoring (TOF) for depth of paralysis • Ensure patient on appropriate scheduled eye care to prevent corneal abrasions
		Delirium	• Assess delirium scores • Utilize BRAIN MAPs to determine contributing factors for delirium
		Withdrawal	• Assess iatrogenic withdrawal or neonatal withdrawal scores • Identify use of PRN opioids/benzodiazepines to determine need for initiation or adjustment of therapy
T	Time of anti-infective agents	Evaluate cultures and susceptibilities	• Identify if cultures obtained • Follow-up on cultures for reporting of susceptibilities
		Assess for escalation or de-escalation opportunities	• Track number of anti-infective days • Determine if appropriate to de-escalate or initiate anti-infectives based on culture and susceptibilities or clinical response • Ensure stop dates for anti-infectives are added

(Table cont. on page 700)

be developed if at risk.⁶ Specific electrolytes to monitor for refeeding syndrome include potassium, magnesium, and phosphorus.

D – Dosing, Dosage Form, and Drug Interactions. The “D” in IN-DEPTH has 3 subcomponents. The first component is to assess the dosing regimen appropriateness. There are several factors to consider with evaluating dosing regimens in pediatric patients. The main 2 factors to check when assessing

medication regimen appropriateness in a pediatric patient are age and weight. A vast majority of medications are dosed by age, weight, or a combination of those 2 factors. For neonates and young infants who are growing rapidly, the dose may need to be weight adjusted weekly or every 2 weeks to ensure that weight-based dosing remains in therapeutic range. Another common example would be ensuring weight-based dosing does not exceed maximum adult dosing

Table. The Components of the IN-DEPTH Tool (cont.)			
Letter	Definition	Subcomponent	Description
H	Hospital prophylaxis	Assess immunization status	• Review CDC recommendations and determine if immunizations are up to date or needed during admission • Determine if adjustment in CDC recommended immunization schedule is needed based on medications received and/or disease states • Assess need for RSV prophylaxis
		Ensure appropriate stress ulcer prophylaxis	• Determine appropriateness of stress ulcer prophylaxis • Ensure de-prescribing occurs upon transitions of care (if needed)
		Venous thromboembolism prophylaxis	• Assess need for VTE prophylaxis • Ensure de-prescribing occurs upon transitions of care (if needed)
		Anti-infective prophylaxis	• Determine need for antibiotic prophylaxis • Ensure anti-infective prophylaxis is discontinued if broad spectrum anti-infectives are initiated for treatment of infection
		Bowel regimen	• Determine need for bowel regimen • Screen for medications that could be associated with constipation or diarrhea

CDC, Centers for Disease Control and Prevention; GT, gastrostomy tube; IV, intravenous; NG, nasogastric; OG, orogastric, RSV, respiratory syncytial virus; TPT, transpyloric tube; VTE, venous thromboembolism

with children weighing ≥ 40 kg.⁷ An additional consideration is that some medications like antiarrhythmics (e.g., flecainide, sotalol), hydrocortisone, and chemotherapy (e.g., vincristine) are dosed based on body surface area. Finally for this subcomponent, medications that have need for hepatic and/or renal dosing adjustments should be identified and assessed. Assessing renal function in pediatric patients differs from adults due to rapid changes in glomerular function and muscle composition. Thus, specific equations are needed when calculating estimated glomerular filtration rate (eGFR) in pediatric patients.⁸ There are 2 equations, Schwartz and Bedside Schwartz, which should be utilized based on the age of the patient. The Bedside Schwartz can be used in patients between the ages of 1 to 18 years old. However, it is important to note that it has not been validated in children <1 year of age. Despite this, some institutions may utilize the Bedside Schwartz equation in infants <1 year of age to maintain consistent applications for providers and pharmacists across the continuum of care. Trainees and new practitioners should refer to the preference of their facility as to the preferred method of renal assessment in infants <1 year of age. The final consideration for evaluating the appropriateness of a dosage regimen is to ensure the planned duration of therapy is appropriate for non-maintenance medications. For example, trainees and new practitioners would want to ensure

that patients with asthma exacerbations who require systemic corticosteroids have an appropriate stop date for the medication order based on their clinical condition. Another class that duration of therapy is important is anti-infective therapy; this will be discussed in more detail in the “T” section below.

A second subcomponent would be the consideration of dosage forms. Trainees and new practitioners should ensure that all infants and children who are prescribed an oral suspension/solution should have a measurable dose. Though different definitions of measurable doses have been utilized, a measurable dose would be 0.01 mL/dose for <1 mL oral syringe, 0.1 mL/dose for a 1- to 3-mL oral syringe, and 0.2 mL/dose for >3 - to 10-mL oral syringe.⁹ There are also age and weights that can trigger additional dosing regimen considerations. Although variable and patient-specific, it has been shown that 91% of children between the ages of 6 to 11 years of age can be trained to swallow a tablet or capsule.¹⁰ Therefore, in patients ≥ 6 years of age, an assessment should be made to determine if an oral tablet or capsule could be utilized in place of oral suspension/solution. This could specifically be beneficial when the medication taste is undesirable, or a significant volume of oral liquid is required for the dose.

The third subcomponent to the “D” in IN-DEPTH is to screen for drug interactions, and these include drug-drug, drug-disease, and drug-food interactions.

Drug-drug interactions are perhaps the most straightforward of the 3. Drugs on the medication list should be screened against each other for known interactions or contraindications. If needed, a drug interaction screening tool can be utilized. Drug-disease interactions should be reviewed to identify medications that should be avoided because they could affect response to therapy (e.g., beta blockers in a patient with asthma) or could exacerbate signs or symptoms of a disease (e.g., acetaminophen in a patient with elevated hepatic enzymes). Although not specifically a drug-disease interaction, an additional factor to consider in this section for pediatric patients is the appropriateness of use of an agent based on age of the patient (e.g., valproic acid in children <2 years). The most concise and comprehensive reference of medications to avoid or use with caution in neonates, infants and children is the Key Potentially Inappropriate Drugs in Pediatrics (KIDs) list.¹¹ Drug-food interactions could include medications whose efficacy is affected by consistency in the foods consumed (e.g., warfarin and vitamin K) or medications that bind to multivalent cations (e.g., tetracyclines or fluoroquinolones). The consideration for agents that interact with multivalent cations may be most important to screen in pediatric patients that are on a human milk or formula-based diet due to high calcium content of milk-based products. Another example of a type of drug-food interaction would be agents that are administered on an empty stomach (e.g., levothyroxine). This may be more difficult to achieve in neonates due to their frequent feeding schedule (i.e., every 3–4 hours), but the suggestion can be made to administer between feedings and at the same time daily.

E – Electrolytes, Labs, Vital Signs, and Ins & Outs. There are 3 subcomponents to the “E” in IN-DEPTH. The first component is to review electrolytes and other laboratory findings. Pertinent laboratory findings should be identified and reviewed based on the medication list. For example, if a patient is receiving diuretics, it would be prudent to monitor serum sodium, potassium, and chloride concentrations. It is helpful to develop a list of medications that are associated with significant alterations in serum electrolytes (e.g., amphotericin can cause hypomagnesemia and hypokalemia, and oxcarbazepine and vasopressin can cause hyponatremia). Other laboratory values may need to be trended over time based on the medications being administered. For example, if the patient is receiving antimicrobials, then periodic monitoring of white blood cell count, C-reactive protein, or procalcitonin may be needed. In addition, therapeutic drug monitoring may be required for some medications including vancomycin, aminoglycosides, voriconazole, or phenobarbital. Laboratory values may be different based on patient age. For example, the normal range for serum bicarbonate in infants is lower than older pediatric patients due to inability for infants to reab-

sorb bicarbonate in the proximal tubule in the kidney.¹² In addition, the serum phosphorus range for neonates and infants is generally higher than older pediatric patients as neonates and infants need higher phosphorus concentrations for bone development.⁹ The laboratory values outside the normal ranges based on age may or may not be flagged in the electronic medical record. Some health-system’s electronic medical records (EMR) have age-specific normal ranges reported for certain labs. However, some health-system’s EMRs do not provide these age-specific normal ranges, requiring health care professionals to interpret results based on the age of the patient. In addition to this, trainees and new practitioners should also evaluate trends in laboratory values over time.

The second subcomponent is consideration of vital signs. However, the vital signs in pediatric patients differ compared to adolescents or adults; as a result, other references should be utilized when making therapy management decisions based on vital signs.⁸ Some vital signs that may be important to consider in relation to medication therapy could include avoiding enteral administration of medications or nutrition if tachypneic, review of as needed ibuprofen or acetaminophen use when monitoring temperature, or consideration of agents that could increase (e.g., corticosteroids) or decrease (e.g., opioids) blood pressure or increase (e.g., albuterol) or decrease (e.g., opioids) heart rate.

The last subcomponent of the “E” is to review input and output of fluid. The inputs to consider include maintenance or bolus fluids, fluid from IV medication administration, and nutrition. At this step the appropriateness of IV maintenance fluids should be determined using any validated method such as the Holiday-Segar method.¹² The impact of hidden fluids such as volume needed to administer intermittent medications, flushes of lines, or carrier fluids should also be identified to determine if adjustment in maintenance fluid rate is needed. The outputs to consider include urine, stool, chest tube, and ostomy output. If these outputs are substantial, then a decision may be made to initiate replacement fluids for continued losses. The type of replacement fluid is dependent upon the source of output. For example, chest tube output is rich in protein, so replacement with albumin may be considered. Or, if the patient has severe emesis, a chloride-rich fluid may be selected versus if they have severe diarrhea, a bicarbonate rich fluid may be selected. In addition to assessing if replacement fluids are needed, it is also important to evaluate if any medication is contributing to increased inputs or decreased outputs.

P – Pain, Sedation, Neuromuscular Blockage, Delirium, Withdrawal. There are 4 subcomponents to the “P” in IN-DEPTH, the first of which is analgesedation. The first subcomponent is pain and sedation. They go hand in hand and should be assessed in tandem using their respective scoring tools. The 2022 Society

of Critical Care Medicine's Clinical Practice Guidelines on the prevention and management of pain, agitation, neuromuscular blockade, and delirium in critically ill pediatric patients with consideration of the ICU environment and early mobility (PANDEM) provide recommendations for the assessment and management of pain, sedation, neuromuscular blockade, delirium, and iatrogenic withdrawal syndrome (IWS). They suggested validated assessment tools for assessment of pain that vary based on the age of the patient and the ability to communicate.¹³ In addition, the PANDEM guidelines provide recommendations on validated sedation scores for nursing assessment. Trainees and new practitioners should work with their preceptors or mentors to identify the scoring tools utilized and familiarize themselves with the scoring range, as there is variation on the sedation scoring tools. To assess if a patient is receiving adequate analgesia and sedation, the pain and sedation scores, the number of as needed administrations of analgesic and sedative agents, and vital signs should be reviewed for the previous 24-hour period.¹³ Based on this assessment, an increase or decrease in dose of sedative and analgesic medications can be recommended to optimize this area of therapy for the patient.

The second subcomponent is neuromuscular blockade. Once pain and sedation are optimized, the PANDEM guidelines recommend that train of four (TOF) monitoring can be assessed for patients on neuromuscular blockade therapy to ensure the most appropriate level of paralysis.¹³ It is also recommended to consider drug holidays to determine when neuromuscular blockade agents might be able to be discontinued.¹² Finally, it is imperative to ensure the patient is on appropriately scheduled eye care to prevent corneal abrasions.¹³

The third subcomponent is delirium. The PANDEM guidelines also provide recommendations on validated assessment tools for delirium. Several tools exist, and again it is recommended that learners clarify which type of tool is utilized at the institution. The PANDEM guidelines recommend use of the BRAIN MAPs tool to identify contributing factors that can cause or exacerbate delirium.¹³ Items included on the BRAIN MAPs analysis are drugs that could affect mentation (such as anticholinergics), sleep-wake cycle disturbances (especially in patients that have established sleep patterns at home), and under or over treated analgesation.¹³

The final subcomponent for this section is IWS. The PANDEM guidelines provide recommendations for validated tools for assessment of IWS.¹³ Several tools exist, and again it is recommended that learners clarify which type of tool is utilized at the institution. Most patients with IWS are often initiated on enteral opioids, benzodiazepines, and/or clonidine to prevent manifestations of withdrawal from opioids, benzodiazepines, and dexmedetomidine, respectively. The doses of the

enteral agents can be gradually decreased using a protocolized approach. The IWS scoring can be used to determine if the doses of the enteral agents should be increased, decreased, or remain the same.

T – Time of Anti-infective Agents. The “T” in the acronym has 2 subcomponents, which includes appropriateness of antimicrobial therapy and duration of treatment. The first subcomponent of this section is to evaluate appropriateness of empiric antimicrobial selection and determination if narrowing of therapy is needed based on cultures and susceptibilities. The initial empiric antimicrobial selection can be assessed based on knowledge of the most common organisms associated with a specific infection. Recommendations for narrowing empiric therapy to tailored therapy can be made by monitoring cultures and susceptibilities, and identifying an antibiotic choice based on pathogen identified, location of infection, and appropriateness of agent based on age of patient. An example of selection of an agent based on location of infection would be a first-generation cephalosporin would be appropriate for a susceptible urinary tract infection but would not be appropriate for meningitis due to issues with adequate penetration in the meninges. In addition, an example of selection of an agent based on age of the patient might be avoidance of ceftriaxone for a neonate because of the risk of hyperbilirubinemia and kernicterus.

The second subcomponent is assessment of duration of antimicrobials. This necessitates the need to track the number of days an antimicrobial has been received and determine the planned duration of treatment based on the infection and organism. Ensuring stop dates are included on the medication order, when possible, is also a critical step to ensure that antimicrobials are discontinued in a timely manner and to prevent unnecessary continuation and risk of adverse effects.

H – Hospital Prophylaxis. The last section, “H”, of the IN-DEPTH acronym is for hospital prophylaxis. This section contains 5 subcomponents including assessment of need for immunizations, stress ulcer prophylaxis, venous thromboembolism prophylaxis, anti-infective prophylaxis, and need for implementation of a bowel regimen. The first subcomponent is to assess the immunization status of the patient to identify any missed immunizations and assess for contraindications or precautions to immunization administering. The 2025 American Academy of Pediatrics (AAP) Immunization Schedule includes recommendations for immunizations based on age of the child.¹⁴ In addition, catch-up immunization schedules are provided. Reviewing the AAP recommendations for each patient would be appropriate to determine if immunizations are needed during the admission. Adjustments might be suggested based on medications received or disease states at the time of a due immunization. For example, if a patient received intravenous

immunoglobulin (IVIG) during the hospitalization then some live vaccines will need to be deferred for up to 11 months after the IVIG.¹⁵ Although not a vaccine, respiratory syncytial virus (RSV) prophylaxis is included in the 2025 AAP Immunization Schedule.¹⁴ Assessment of need of RSV prophylaxis should be performed near the time of discharge for patients <8 months of age in their first RSV season or <20 months of age if they have risk factors.¹⁴

The remaining subcomponents of this section will not apply to every pediatric patient, as some are age, therapy, or disease state dependent. For example, assessing the need for venous thromboembolism prophylaxis may be needed for patients with moderate to high risk of venous thromboembolism. For these patients it is important to ensure de-prescribing on transitions of care if able. An example of a therapy dependent prophylaxis would be the need for initiation of a bowel regimen. If agents associated with constipation (e.g., opioids) are initiated, then a scheduled bowel regimen should be considered, and reporting of stools should be assessed daily. An example of prophylaxis that would be dependent on therapy and/or disease state would be stress ulcer prophylaxis. For example, if the patient is initiated on high-dose steroids and/or requires intubation, stress ulcer prophylaxis may be needed. It is important to regularly assess if continuation of stress ulcer prophylaxis is needed based on discontinuation of risk factors, initiation of enteral feeds, or upon transitions of care. Last, determining the need for anti-infective prophylaxis is strictly dependent on disease state. For example, if a patient is chronically immunosuppressed, then antibiotic, antifungal, and/or antiviral prophylaxis may be appropriate and utilized depending on patient-specific factors and their underlying disease state.

Discussion

The IN-DEPTH mnemonic is a novel structured tool for pharmacy trainees and new practitioners to help identify areas in treatment that can be optimized in critically ill pediatric patient populations such as the PICU, NICU, and pediatric CICU. The mnemonic can help alleviate some stress and anxiety from trainees or new practitioners that are not as familiar with critical or pediatric care. We believe this tool will be useful for Doctor of Pharmacy students, pharmacy residents and practitioners who are new to the pediatric critical care arena. It is a structured guide to point out crucial areas of pediatric critical care that should be addressed with every patient encounter. It is also a great resource for preceptors to provide learners when starting on rotation. It will help the learners be able to analyze the patient and develop recommendations that align with the goals of pediatric critical care patient management. We believe studies aiming to validate the IN-DEPTH mnemonic would be beneficial for future use in practice.

If validated and demonstrated to be beneficial for learners and practitioners new to pediatric critical care in their ability to identify areas for treatment optimization, more widespread use of the tool could be encouraged in training settings.

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References

1. Prescott WA Jr, Dahl EM, Hutchinson DJ. Education in pediatrics in US colleges and schools of pharmacy. *Am J Pharm Educ.* 2014;78(3):51.
2. Branan TN, Darley A, Anthony Hawkins W. How critical is it? Integrating critical care into the pharmacy didactic curriculum. *Am J Health Syst Pharm.* 2024;81(18):871–875.
3. Mabasa VH, Malyuk DL, Weatherby EM, Chan A. A standardized, structured approach to identifying drug-related problems in the intensive care unit: FASTHUG-MAIDENS. *Can J Hosp Pharm.* 2011;64(5):366–369.
4. Dehbi S, Benabdelouahab, El Hernoussi Z, et al. Give your pediatric intensive care unit patient at least one fast hug in bed each day. *J Pediatr Crit Care.* 2025;12(2):57–63.
5. Cober MP, Gura KM. Enteral and parenteral nutrition considerations in pediatric patients. *Am J Health Syst Pharm.* 2019;76(19):1492–1510.
6. Da Silva JSV, Seres DS, Sabino K, et al. ASPEN consensus recommendations for refeeding syndrome. *Nutr Clin Pract.* 2020;35(2):178–195.
7. Matson KL, Horton ER, Capino AC; Advocacy Committee for the Pediatric Pharmacy Advocacy Group. Medication dosage in overweight and obese children. *J Pediatr Pharmacol Ther.* 2017;22(1):81–83.
8. Eiland LS, Meyers RS. Caring for and assessing pediatric patients: Aspects to consider as a pharmacy practitioner. *Am J Health Syst Pharm.* 2019;76(19):1463–1471.
9. Zahn SO, Tobison JH, Place AJ, et al. Impact of a process change on prevalence of prescribed unmeasurable liquid doses in a neonatal intensive care unit. *J Pediatr Pharmacol Ther.* 2020;25(2):96–103.

10. Meltzer EO, Welch MJ, Ostrom NK. Pill swallowing ability and training in children 6 to 11 years of age. *Clin Pediatr (Phila)*. 2006;45(8):725–733.
11. McPherson C, Meyers RS, Thackray J, et al. Pediatric Pharmacy Association 2025 KIDs list of key potentially inappropriate drugs in pediatrics. *J Pediatr Pharmacol Ther*. 2025;30(4):422–439.
12. Meyers R. Management of pediatric parenteral fluids. *J Pediatr Pharmacol Ther*. 2024;29(4):346–353.
13. Smith HA, Besunder JB, Betters KA, et al. 2022 Society of Critical Care Medicine clinical practice guidelines on prevention and management of pain, agitation, neuromuscular blockade, and delirium in critically ill pediatric patients with consideration of the ICU environment and early mobility. *Pediatr Crit Care Med*. 2022;23:74–110.
14. American Academy of Pediatrics. 2025 Immunization Schedule. Accessed August 21, 2025. https://downloads.aap.org/AAP/PDF/AAP-Immunization-Schedule.pdf?_gl=1*1pnc0pi*_ga*OTY0MTM4MTQ0LjE3NTI2MDY3NTk.*_ga_FD9D3XZVQQ*cze3NTU4MDE2MDMkbzMkZzEkdDE3NTU4MDE3NTUkaYwJGwwJGgw
15. Kroger A, Bahta L, Long S, Sanchez P. General Best Practice Guidelines for Immunization. Best Practices Guidance of the Advisory Committee on Immunization Practices (ACIP). Accessed August 21, 2025. https://www.cdc.gov/vaccines/hcp/imz-best-practices/?CDC_AAref_Val=https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/index.html