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Customized Parenteral Therapies for the Pediatrics and Geriatrics

Mr. Vaibhav Mahadeo Shriram[1], Ms. Rutuja Dnyandev Pawar[2]

[1,2]Student, B Pharmacy, Dr. Babasaheb Aambedkar Technological University Lonere Raigad

Abstract

Making safe and effective parenteral therapies for children and older adults is important due to their body responses. These two age groups have distinct physiological conditions, from immature organs in infants to declining kidney and liver function in the elderly—that mainly affect how drugs behave in the body. As a result, off-the-shelf formulations often fall short, either risking toxicity or failing to deliver the intended therapeutic effect. This growing field has pushed researchers and clinicians to design more customized solutions for these various populations. In pediatric care, rapid growth, varying body composition, and an evolving immune system make standard drug dosing unpredictable. Meanwhile, older adults commonly face multiple chronic conditions, take more medications, and process drugs more slowly—all factors that demand precise and cautious dosing strategies. Both groups benefit from formulations that are not just age-appropriate but also easier to administer, better tolerated, and more adaptable to their clinical realities. This review highlights recent innovations in parenteral drug delivery customized to the needs of pediatric and geriatric patients. It examines formulation techniques such as controlled release systems, nano-sized carriers, solvent-free preparations, and the appropriate selection of excipients that reduce adverse reactions. Apart from formulation, the article also looks at the practical side of care, including dose customization, drug compatibility, sterility standards, and the critical role of monitoring therapeutic levels. The review also describes regulatory perspectives, age-specific trial designs, and how real-world clinical data is reforming the development of injectable drugs. Advances in biotechnology and personalized medicine are creating exciting possibilities for therapies that truly fit the individual—not just their diagnosis, but their age, metabolism, and treatment setting. In core, this article emphasizes the importance of moving away from one-size-fits-all approaches. With smarter formulations and a deeper understanding of patient-specific needs with their physiological conditions. We can significantly improve outcomes and safety for the youngest and oldest members of our healthcare system.

Introduction:

The term parenteral comes from the Greek words para (meaning “beside” or “outside”) and enteron (meaning “intestine”), and it was introduced to describe a route of drug administration that bypasses the digestive system . According to the United States Pharmacopeia (USP) 24 and National Formulary 19, parenteral drug delivery systems (PDDS) refer to formulations designed to be administered through routes other than the gastrointestinal tract, typically by penetrating the skin or other external body barriers. This allows the active pharmaceutical ingredient (API) to be administered directly into the bloodstream, tissues, organs, or specific sites. In modern clinical practice, especially in hospitals, sterile injectable formulations play a important role in patient care. One of the main challenges of parenteral delivery is that it’s an penetrative method. Despite advancements in penetration alternatives such as transdermal patches,

pulmonary inhalation, and nasal sprays, parenteral delivery remains the only effectively route for many drugs specially protein and peptide based therapies. These molecules often degrade or are poorly absorbed when administered through the digestive system or mucosal membranes.

Sustained-release parenteral systems have been developed to enhance the duration of drug action at the target site. These systems offer multiple advantages:

1. They reduce the frequency of dosing
2. Provide more consistent therapeutic effects.
3. Lower the likelihood of side effect
4. enhance patient adherence.

A key benefit, especially for patients who require frequent injections, is the reduced discomfort and pain associated with less frequent dosing.

From a cost perspective, sustained-release parenteral therapies can significantly reduce the overall cost of treatment. Because these systems require fewer administrations and less frequent clinical interventions, they can lower healthcare costs. They also tend to use smaller total doses of medication compared to multiple single injections—an important advantage when dealing with high-cost drugs like therapeutic proteins. In certain cases, delivering medication through a sustained-release parenteral system can significantly enhance its therapeutic effectiveness, whether the treatment goal is systemic or localized. For instance, doxorubicin—an anticancer drug—when encapsulated in PEGylated liposomes (Stealth, Alza Corp), has shown improved anti-tumor activity. This improvement is largely due to the prolonged circulation time of the drug in the bloodstream, which increases its accumulation within solid tumors (Gabizon, 1992). A particularly effective method involves placing a long-acting drug formulation directly at the site where it's needed. These "depot injections" allow for high local drug concentrations with minimal systemic exposure, reducing potential toxicity. A notable example is the use of biodegradable polymer implants that release carmustine directly at the tumor site in the brain, which has proven valuable in the treatment of brain cancer.

Advantages of parenteral drug delivery system

- Provides drug and nutritional options for patients unable to use oral therapy.
- Circumvents absorption limitation of the gastrointestinal tract .
- Rapid onset of action.
- 100% Bioavailability.
- Prolong duration of action.
- Localised delivery
- Helpful in local anaesthesia.

Disadvantages of parenteral drug delivery system

- Impossible to drug removal when once it is administered.
- Risk of infection
- Pain at the site of action.
- Special person is required for the administration of parenteral.
- High cost

Anatomy of pediatric and geriatric

The human body changes a lot as we grow—from the moment we're born, through adulthood, and into old age. These changes don't just affect how we look, but also how our bodies work inside. Children, adults, and older adults have very different anatomical structures and body functions. Let's explore how these age groups compare in terms of their body systems and why this matters, especially in healthcare.

System	Children	Adults	Elderly
Bones & Body Structure	Soft, flexible bones with growth plates; head is large compared to body	Fully developed, hard, and dense bones; balanced structure	Bones thin and weaken; more prone to fractures and height loss
Muscles & Movement	Muscles are growing; coordination improves through play	Peak muscle strength and coordination	Muscle mass declines (sarcopenia); slower, weaker movement
Heart & Circulation	Fast heart rate; small heart; low blood pressure	Efficient heartbeat and stable blood pressure	Stiff blood vessels, higher BP; risk of heart disease and stroke increases
Breathing & Lungs	Breathe faster due to smaller lungs; airways more sensitive	Breathing is steady; lungs work efficiently	Decreased lung capacity; shallow breathing and higher infection risk
Brain & Nerves	Brain develops rapidly; quick learning; reflexes turn into control	Full cognitive function; sharp coordination and memory	Slower reflexes, memory issues may appear; risk of dementia
Digestion & Nutrients	Sensitive system; transitioning from milk to solids	Efficient digestion of a wide variety of foods	Slower digestion; less acid and saliva; prone to constipation, low appetite
Kidneys & Urine	Immature kidneys; frequent urination; dehydration risk	Fully functional kidneys; balanced fluid-waste control	Kidney function declines; more dehydration, UTIs, or incontinence

Understanding the Challenges in Pediatric and Geriatric Parenteral Drug Therapy

Delivering medications through the parenteral route—such as intravenous (IV), intramuscular (IM), or subcutaneous injections—is common when patients can't take oral drugs or when rapid action is needed. However, this method comes with significant hurdles when used in two highly sensitive populations: children and the elderly. Unlike healthy adults, children and older adults have very different body functions, drug-processing abilities, and care needs. This makes formulating and giving parenteral drugs to them quite complex. In this section, we'll explore these challenges in detail, supported by real case studies, and also highlight how healthcare teams are working to make things safer and more effective.

Challenges in Children (Pediatrics)

1. Children Aren't Just Mini Adults

Children, especially newborns and infants, have developing organs that don't work the same as in adults. Their livers and kidneys—organs that help process and remove drugs—are still maturing, which means medications can stay in their system longer or work differently than expected. Immature liver enzymes affect how drugs are broken down. Underdeveloped kidneys lead to slower elimination of medications. More body water in babies means water-soluble drugs distribute differently. These changes often require dose adjustments and careful monitoring.

2. Difficulty in Dosing Accurately

Doses for children are usually based on weight or body surface area. But children grow quickly, and even small weight changes can affect the amount of drug they need. This makes it easy to miscalculate, especially when drugs come in concentrations designed for adults. Pediatric doses often need to be diluted or divided. Small errors can lead to overdose or underdose.

3. **Limited Drug Testing in Children**

Many medications aren't tested in children before being approved. As a result, doctors often have to use drugs "off-label"—that is, outside the officially approved instructions. This increases the risk of side effects or poor effectiveness.

4. Challenges with IV Access

Getting a vein in small babies or toddlers is tough. Their veins are tiny and fragile. In emergencies or when repeated injections are needed, doctors might use central lines (a special type of IV), which carry higher risks of infection and complications.

5. Drug Compatibility and Mixing

In hospitals, several drugs may be given at the same time through one IV line. Some combinations are not safe when mixed and may cause harmful reactions or reduce effectiveness. In pediatrics, due to lack of data, compatibility remains a guessing game in many cases.

Case Study 1: Newborn Treated for Infection

Background: A 7-day-old baby weighing 2.8 kg was diagnosed with a serious bloodstream infection. The doctors started IV antibiotics of ampicillin and gentamicin.

Problem: Gentamicin, while effective, can harm the kidneys. Because the baby's kidneys were immature, the drug wasn't cleared properly, causing its levels in the blood to rise too high. On top of that, the IV line kept failing due to the baby's small veins.

Solution: The healthcare team placed a longer-lasting IV line (PICC line) and adjusted the drug dose based on kidney function and blood levels. A pharmacist specializing in pediatrics helped optimize the treatment, avoiding further complications.

Challenges in the Elderly (Geriatrics)

1. **The Body Slows Down with Age**

- As people age, their body's ability to process drugs changes:
- Liver function drops, slowing how drugs are broken down.
- Kidneys filter less efficiently, leading to drug build-up.
- Body fat increases, changing how fat-loving drugs are stored.

2. **Multiple Medications (Polypharmacy)**

Many elderly patients are on five or more medications at once. This increases the chances of drug interactions, unexpected side effects, and confusion with dosing schedules. Some drug combinations can be dangerous, especially when given by IV.

3. **Changed Drug Effects (Pharmacodynamics)**

Older adults may respond to drugs more strongly or more weakly. For example, sedatives or painkillers can cause extreme sleepiness or confusion even at low doses. Blood pressure medications can cause severe drops. Anticoagulants may increase bleeding risks, even at safe doses.

4. **Frailty and Chronic Illnesses**

Older patients often have multiple health conditions—like diabetes, kidney problems, or heart disease—that complicate drug therapy. A drug that's safe for one illness may worsen another.

5. **Communication and Self-Care Issues**

Cognitive decline, memory loss, or physical disability can make it hard for elderly patients to express side effects or manage home care after discharge. This makes them more dependent on caregivers.

Case Study 2: Elderly Woman with Pneumonia

Background: An 83-year-old woman, weighing 45 kg, was admitted with pneumonia. Doctors started IV antibiotics, fluids, and painkillers.

Problem: Within a day, she became confused and disoriented. Investigation showed that the IV fluids were too fast, worsening her low sodium levels. Also, the paracetamol dose—normal for adults—was too high for her small size and borderline kidney function, putting her at risk of liver damage.

Solution: Doctors slowed down the IV fluids, adjusted the electrolyte balance, and switched the paracetamol to oral form at a lower dose. A geriatric team monitored her mental status and recovery closely.

Common Challenges Across Both Groups

1. **Inadequate Age-Specific Formulations**

   Many parenteral drugs are designed for adults. In both children and elderly, doses often need to be adjusted or diluted. This creates risks of: Inaccurate dosing Contamination during preparation Drug instability

2. **Infection Risk from IV Access**

   Both groups have weaker immune systems. IV lines, if not managed carefully, can lead to serious infections like bloodstream infections or local abscesses.

3. Parenteral Nutrition Complications

Sometimes, patients cannot eat or digest food and need IV nutrition (TPN). While lifesaving, TPN must be precisely balanced to avoid problems like: Electrolyte imbalance, Liver strain, Blood sugar swings. Children need TPN for growth, and the elderly often need it due to swallowing difficulties or severe illness.

New Approaches to Improve Safety

1. Ready-to-Use Drug Kits

Pre-filled syringes and bags that come in age-specific doses reduce preparation errors. They also minimize infection risks.

2. Smart Infusion Devices

Modern infusion pumps can be programmed to deliver exact doses based on a patient's age and weight. Alerts help prevent over- or under-dosing.

3. Innovative Drug Carriers

New drug delivery systems—like nanoparticles or liposomes—help target drugs more precisely and reduce side effects. These are especially useful in cancer treatment or long-term pain management.

4. Computerized Monitoring Systems

Hospitals are now using software that alerts healthcare staff about possible drug interactions or wrong doses, especially when the patient is very young or old.

Improving Care Through Teamwork and Policy

1. Age-Specific Guidelines

Global health organizations have started publishing separate drug guidelines for children and the elderly. These help doctors choose safe and effective treatments. WHO and FDA support pediatric trials. The Beers Criteria guides drug use in older adults.

2. Interdisciplinary Teamwork

Bringing together pediatricians, geriatricians, nurses, and pharmacists ensures that drug therapy is safe, especially when high-risk or complex parenteral regimens are used.

3. Caregiver Education

Parents of young children and caregivers of older adults play a big role in recognizing early signs of drug side effects, line infections, or dosage issues. Teaching them what to look for can prevent complications.

Clinical Considerations and Dosing Customization in Pediatric and Geriatric Parenteral Therapy

Providing safe and effective parenteral drug therapy for pediatric and geriatric patients requires a high level of clinical awareness and customization. These populations are more vulnerable to adverse effects, dosing errors, and drug-related complications due to their unique physiological conditions. To optimize outcomes, clinicians must tailor treatment using several tools and strategies, starting with Therapeutic Drug Monitoring (TDM). TDM plays a critical role in guiding dosage adjustments by measuring drug concentrations in the bloodstream at set intervals. This is especially important for drugs with narrow therapeutic windows—such as aminoglycosides, vancomycin, or certain anticonvulsants—where slight deviations can lead to toxicity or therapeutic failure. In both children and the elderly, unpredictable absorption, metabolism, or excretion patterns make TDM essential for maintaining effective and safe drug levels throughout treatment. For pediatric patients, weight-based and body surface area (BSA)-based dosing is a standard approach. Unlike adults, children require highly individualized dosing calculations because their metabolic rates, enzyme activity, and organ maturity vary widely with age and development.

For example, a neonate's immature liver may metabolize a drug far differently than that of a toddler. BSA-based dosing is particularly useful for oncology drugs and intensive care treatments, where precise titration is necessary to minimize harm while ensuring efficacy. In contrast, renal and hepatic dose adjustments are especially relevant in the geriatric population. As people age, kidney filtration and liver metabolism often slow down, impacting how drugs are cleared from the body. Without proper dose adjustments, this can lead to drug accumulation and toxicity. Tools like the Cockcroft-Gault formula help estimate renal function and guide clinicians in selecting the right dose for drugs primarily eliminated by the kidneys. Liver function tests and clinical scoring systems (like the Child-Pugh score) aid in adjusting doses for hepatically metabolized medications. Another growing area of precision in dosing is the application of personalized pharmacogenomics—the study of how genes influence an individual's response to drugs. Certain genetic markers can predict whether a patient will metabolize a drug too quickly, too slowly, or not at all. For instance, variations in the CYP450 enzyme family can affect the metabolism of many common medications. In pediatric oncology or geriatric psychiatry, where side effects can be particularly harmful, incorporating pharmacogenomic data helps clinicians choose the right drug and dose from the beginning, reducing trial-and-error and enhancing patient safety. In summary, clinical decisions around parenteral drug dosing must be individualized, especially when caring for children and older adults. With tools like TDM, weight/BSA-based calculations, organ function assessments, and pharmacogenomics, healthcare providers can move beyond generalized protocols toward more personalized, age-appropriate therapy. This patient-centered approach is key to achieving better outcomes and reducing risks in these sensitive populations.

Emerging Technologies and Future Directions in Parenteral Drug Delivery for Pediatrics and Geriatrics

The landscape of parenteral drug delivery is undergoing a technological transformation. As healthcare shifts toward personalized, data-driven, and patient-centric approaches, new technologies are emerging that promise to reshape how injectable therapies are designed, administered, and monitored—particularly for vulnerable populations such as children and older adults. These innovations address long-standing challenges in dosing accuracy, administration ease, patient compliance, and outcome monitoring. Among the most promising developments are AI-powered dose prediction systems, 3D-printed injectables and delivery devices, smart injectors and wearable drug delivery systems, and the integration of real-world data with digital health tools.

AI-Based Dose Prediction Tools

Artificial intelligence (AI) is increasingly being used to support decision-making in clinical settings, particularly in complex dosing scenarios. Traditional dosing models rely on weight, age, kidney/liver function, and pharmacokinetics, but even these can fall short in pediatric and geriatric care due to wide variability in physiology and drug response. AI-powered systems are capable of analyzing vast datasets—from patient electronic health records (EHRs), clinical trial data, and real-world treatment responses—to predict optimal dosing for individual patients. For pediatric patients, where small errors can have serious consequences, AI can provide precision by learning from past cases to suggest the safest and most effective starting dose. For the elderly, who often take multiple medications and may have fluctuating organ function, AI tools can help predict drug-drug interactions, cumulative toxicities, and time-specific dosing needs. These tools do not replace clinical judgment but serve as powerful decision-support systems that

enhance safety and personalization. One example is AI platforms that integrate TDM (Therapeutic Drug Monitoring) with real-time clinical data to offer adaptive dosing in intensive care or oncology settings. As machine learning algorithms continue to evolve, these systems may eventually offer predictive warnings for adverse drug reactions before they occur.

3D-Printed Injectables and Devices

Three-dimensional (3D) printing is no longer just for prototyping gadgets or creating prosthetics—it is now entering the realm of personalized drug delivery. In parenteral therapy, 3D printing can be used to create customized injectables, tailored implants, or patient-specific infusion devices. This has enormous potential in pediatrics, where body size, drug tolerance, and medical needs vary significantly from one child to another. For instance, 3D-printed injectable depots—designed to slowly release a drug over time—can be made in child-specific doses and shapes that accommodate different rates of metabolism and treatment duration. Similarly, in geriatric care, biodegradable implants or slow-release injectables can reduce the need for repeated hospital visits, which can be physically and emotionally taxing. Moreover, 3D printing allows for on-demand manufacturing, reducing wait times and enabling point-of-care drug production in hospitals or pharmacies. The possibility of combining multiple drugs into a single injection or implant through precise layering also opens up new pathways for managing polypharmacy in elderly patients.

Smart Injectors and Wearable Drug Delivery Systems

Another major advancement is the development of smart injectors and wearable drug delivery devices. These systems go beyond simple injections—they incorporate sensors, microprocessors, and wireless technology to monitor, control, and optimize the administration of injectable drugs in real time. For pediatric patients, smart injectors offer a less intimidating and more controlled experience. Devices that adjust injection speed or minimize pain through microneedle arrays are being tested to improve compliance and reduce injection trauma. In the case of chronic diseases such as juvenile arthritis or diabetes, these wearables can allow children to receive regular doses at home without constant hospital visits. For older adults, wearable devices that provide automated, continuous, or programmable drug delivery—similar to insulin pumps—can be lifesaving. These tools can be programmed to deliver doses based on time, blood glucose level, or even biometric data. Some advanced versions also send alerts to caregivers or healthcare providers if a dose is missed or if side effects are detected. Companies are now developing closed-loop systems where the drug delivery device is linked to real-time physiological data, adjusting dosing dynamically. For example, a wearable patch could detect inflammation levels in real time and release anti-inflammatory medication accordingly. Such technologies could significantly reduce medication errors and improve therapeutic consistency.

Integration of Real-World Data and Digital Health

The integration of real-world data (RWD) with digital health platforms is also playing a critical role in transforming parenteral drug therapy. RWD includes information gathered from sources outside traditional clinical trials, such as patient monitoring devices, wearable sensors, EHRs, and even mobile health apps. This data helps researchers and clinicians understand how treatments perform in everyday settings, across diverse populations. In pediatrics, this can be especially useful in tracking treatment outcomes for rare diseases or monitoring adverse reactions to newly approved biologics. Parents can log symptoms, side

effects, or behavioral changes via smartphone apps, which are then shared with providers in real-time, allowing for timely interventions and dose adjustments. In geriatrics, digital tools that monitor medication schedules, hydration levels, mobility, and cognitive changes can be linked with parenteral therapy schedules. These insights help healthcare providers assess how well a patient is responding to treatment and whether modifications are needed. Digital pillboxes, reminders, and patient dashboards also promote adherence, which is often a challenge among elderly individuals living alone or with cognitive impairments. Additionally, the growing use of telemedicine has expanded access to personalized parenteral therapy consultations. Patients can now receive treatment planning, follow-up, and even device training from home, making care more convenient and continuous. The future of parenteral drug delivery in pediatric and geriatric care lies at the intersection of technology, personalization, and connectivity. AI-based dosing, 3D-printed injectables, smart delivery systems, and data-driven healthcare platforms are not just concepts—they are rapidly becoming realities that promise to improve safety, precision, and patient comfort. For pediatric patients, these innovations reduce fear, enable accurate dosing, and make therapy more adaptable to developmental needs. For older adults, they offer autonomy, reduce hospital dependency, and enhance monitoring of complex medication regimens. As these technologies evolve, collaboration between clinicians, engineers, regulators, and patients will be key to ensuring they are safe, accessible, and effective. Embracing this next generation of parenteral therapies can lead us toward a more responsive and inclusive healthcare system—one that truly meets the needs of patients at every stage of life.

Case Studies and Clinical Examples in Customized Parenteral Therapy

Customized parenteral therapy has shown remarkable potential in improving outcomes for patients at both ends of the age spectrum—children and the elderly. Clinical case studies help bring theory into practice, offering real-world insights into how tailored dosing, formulations, and administration methods can make a difference. These examples also provide valuable lessons on what can go wrong when customization is neglected.

1. Successful Customized Parenteral Therapy in Children

Case Example: Vancomycin Dosing in a Neonate

A premature infant born at 30 weeks of gestation was admitted to the NICU with suspected sepsis. Blood cultures were positive for Staphylococcus aureus, and vancomycin therapy was initiated. Standard adult dosing adjusted by weight would have risked toxicity due to the infant's immature kidneys and underdeveloped metabolism. Instead, a customized vancomycin dosing regimen was created using Therapeutic Drug Monitoring (TDM) and pharmacokinetic modeling specific to neonates. Serum drug levels were monitored daily, and doses were adjusted accordingly. After five days of tailored treatment, the infection cleared, and the infant showed no signs of renal distress or drug toxicity. This case highlights the importance of age-specific pharmacokinetics and how regular monitoring can guide dose optimization in neonates.

Case Example: Total Parenteral Nutrition (TPN) in a Pediatric Oncology Patient

A 6-year-old child undergoing chemotherapy for leukemia developed mucositis, making oral nutrition impossible. A customized total parenteral nutrition (TPN) formula was created, considering weight, growth requirements, electrolyte balance, and chemotherapy-induced nutrient losses. The infusion was delivered through a central line using a programmable pump, and the formula was adjusted weekly based on metabolic labs.

Over four weeks, the child maintained weight, showed signs of tissue recovery, and avoided common TPN-related complications such as liver toxicity or infections. The case emphasizes the value of personalized nutrition support in maintaining therapy tolerance and improving recovery in young cancer patients.

2. Optimized Parenteral Therapies in Frail Elderly Patients

Case Example: Antibiotic Therapy in an Elderly Patient with Renal Impairment

An 84-year-old woman with chronic kidney disease (CKD Stage 4) presented with a urinary tract infection that had progressed to urosepsis. IV gentamicin was initially considered, but due to her frail condition and reduced renal clearance, the risk of nephrotoxicity was high. A decision was made to use a lower, renal-adjusted dose of ceftriaxone, and kidney function was closely monitored through creatinine clearance levels.

The patient responded well, and the Infection resolved without worsening renal function. This case demonstrates how dose individualization based on organ function can help avoid complications in geriatric care.

Case Example: Injectable Anticoagulant in a Bedridden Elderly Patient

A 79-year-old man recovering from hip surgery was prescribed enoxaparin injections to prevent deep vein thrombosis (DVT). However, he also had a low body weight and signs of early-stage dementia, which posed risks for bruising and non-adherence. The care team chose to use a lower prophylactic dose of enoxaparin and switched to a prefilled safety syringe with a retractable needle to prevent accidental injury. The patient completed the ’ourse without bleeding complications or missed doses, thanks to simplified administration and caregiver training. This example illustrates how device innovation and dose adaptation can improve compliance and safety in the elderly.

Case Example: Overdose of Morphine in a Pediatric ICU Patient

A 4-year-old admitted to the pediatric ICU for post-surgical pain received morphine via IV infusion. The dose had been calculated based on standard mg/kg ratios but was not adjusted for the child’s lower-than-average body surface area. A programming error in the infusion pump further increased the dose delivered. Within an hour, the child exhibited respiratory depression and required emergency ventilation.

The Incident led to a hospital-wide review of pediatric infusion protocols, resulting in the integration of double-check systems and smart pump alerts. This case is a stark reminder of the importance of cross-verification and device safety features in pediatric dosing.

Case Example: Inappropriate Polypharmacy in a Geriatric Patient

A 90-year-old woman with advanced Alzheimer’s disease was admitted with confusion and frequent falls. She had been receiving parenteral iron, antibiotics, a sedative, and a diuretic, prescribed by multiple specialists. No one had coordinated the therapy, and she experienced hypotension, electrolyte imbalance, and delirium. After hospitalization, her treatment was reviewed by a geriatric pharmacist, and several unnecessary drugs were discontinued. Her symptoms improved, and she was discharged with a simplified care plan. This case underscores the risks of fragmented care and lack of personalized review in the elderly, especially when using multiple parenteral therapies.

Conclusion:

These real-world cases reflect the core value of customized parenteral therapy treating the patient, not just the disease. Whether it’s a fragile newborn fighting sepsis or an elderly patient managing multiple comorbidities, personalization in drug type, dose, delivery device, and monitoring can greatly improve

outcomes. Successful cases highlight the benefits of therapeutic drug monitoring, dose calculation based on organ function, simplified administration tools, and team-based care coordination.

On the flip side, adverse events teach us the critical importance of oversight, training, and technology-assisted safeguards. As healthcare continues to evolve, these lessons should guide future practice, with a strong focus on individual needs, real-time adjustments, and multidisciplinary collaboration.

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