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THE HIDDEN PLASTIC PATHWAY: MICROPLASTIC MIGRATION FROM ENTERAL AND PARENTERAL NUTRITION SYSTEMS IN INTENSIVE CARE

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Abstract

Enteral and parenteral nutrition are essential for critically ill patients who cannot meet their nutritional needs by ordinary eating. Both routes bring nutrient solutions into contact with containers, connectors, syringes, filters and tubing, many of which contain polymers. These materials may be sources of microscopic plastic particles or chemical constituents that migrate into fluids. This narrative review examines potential pathways of microplastic exposure through nutrition systems in intensive care, summarizes emerging evidence, and identifies practical and research priorities. A study published in 2024 detected microplastics in 43% of 30 tested enteral nutrition formula samples from nine brands; this finding is important but should not be generalized to every product or clinical setting. Research on infusion systems has also highlighted potential particle transfer and major limitations in current detection methods. However, the amount reaching individual patients and the clinical consequences of nutrition-system exposure remain uncertain. Particle shedding must be distinguished from chemical leaching, as each requires different tests. The appropriate response is neither alarm nor dismissal: life-sustaining nutrition should not be delayed, while standardized testing, transparent material information and carefully designed clinical research are needed.

Keywords: microplastics; nanoplastics; enteral nutrition; parenteral nutrition; intensive care; infusion systems; medical devices; contamination; patient safety

1. Introduction

Nutrition is an active part of critical care, supporting recovery, tissue repair and the maintenance of lean body mass. When oral intake is unsafe or inadequate, enteral nutrition (EN) can deliver formula through a feeding tube. When the gastrointestinal route is unsuitable or cannot meet requirements, parenteral nutrition (PN) provides nutrients intravenously. Both approaches depend on a chain of manufactured products, including bags, bottles, connectors, syringes and tubing, that may contain plastic polymers.

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Plastic components have made healthcare more accessible and practical: they are lightweight, flexible, inexpensive and can be manufactured for single use. The relevant question is not whether plastic should simply be removed from clinical care. It is whether microscopic particles or chemical additives can migrate from nutrition products and administration equipment into the fluid, what dose may reach the patient, and whether that exposure has clinical consequences. These questions require separate evidence.

Microplastics are often defined as plastic particles smaller than 5 mm, while the term nanoplastics is used for still smaller particles, although definitions vary. Results across studies can be difficult to compare because laboratories use different sample preparation procedures, lower size limits, polymer-identification techniques and contamination controls. The World Health Organization has emphasized uncertainties in exposure measurement and health-risk assessment [1]. These issues are especially relevant in intensive care, where nutrition may be delivered continuously and patients may already have substantial physiological stress.

2. Review approach

This article is a narrative review of selected peer-reviewed studies and authoritative reports concerning microplastics, enteral formulas, infusion systems, medical-device materials and human-health evidence. It is not a systematic review or meta-analysis, and no new patient data were collected. Numerical findings are attributed to the studies that reported them; no pooled estimate of exposure has been calculated. Because the field is evolving, readers should verify the latest literature before using this review for clinical policy or publication.

3. How might particles enter the pathway?

Potential sources can be considered at three stages: before a product reaches the ward, during preparation, and while the fluid moves through the administration circuit. For EN, contact points may include the formula container, cap, transfer set, feeding bag, syringe, connector and feeding tube. For PN, the pathway can include the nutrient container, compounding equipment, transfer devices, administration set, pump segment, filter and vascular catheter. A plastic component does not automatically release particles; migration may depend on polymer type, manufacturing quality, storage, fluid chemistry, mechanical stress, temperature and contact time.

Two processes should be distinguished. Particle shedding is the release of solid fragments or fibres. Chemical leaching is the transfer of substances such as plasticizers or stabilizers from a material into a fluid. They may occur together, but require different analytical methods. Detecting a chemical additive does not prove that microplastic particles are present, and counting particles does not establish the dose of chemical additives.

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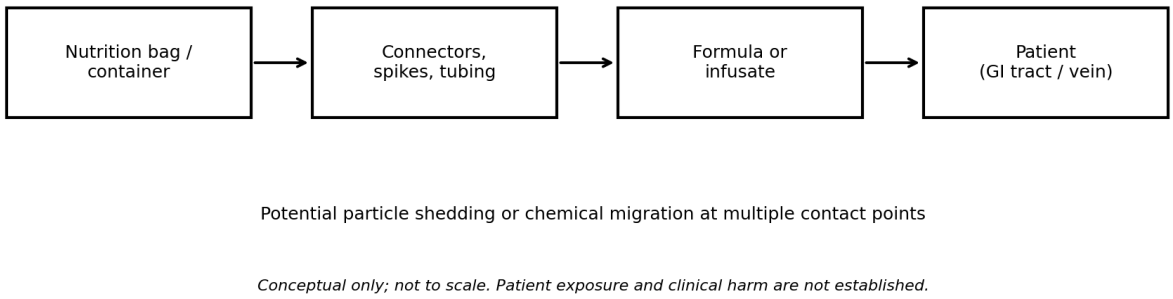

Figure 1. Conceptual pathway for potential particle or chemical migration during nutrition delivery. This schematic is illustrative and does not represent measured exposure.

4. Evidence from enteral nutrition

One directly relevant study by Başaran and colleagues examined 30 samples from nine brands of enteral nutrition formulas. Microplastics were reported in 43% of the tested samples, with polymethyl methacrylate identified as the dominant polymer [2]. The authors also calculated estimated daily intake using their findings and assumed consumption. This study is notable because it investigated a clinical nutrition product rather than relying only on environmental samples.

The result should nevertheless be interpreted in context. Thirty samples cannot represent every formula, production batch, package type, country or handling practice. Particles may potentially be introduced during manufacture, packaging, storage, sampling or laboratory processing, so procedural blanks and appropriate controls are essential. The 43% finding is a result from this particular sample set, not evidence that 43% of all enteral nutrition products worldwide are contaminated.

The administration circuit creates further questions. Bags, connectors and tubing could contribute particles, but evidence tracing a particle from a specific component through the full circuit and into a patient remains limited. EN also differs from ordinary food ingestion: it may be delivered continuously, bypasses oral exposure and passes through a tube whose material varies between products. The additional exposure attributable specifically to bedside equipment is not yet well quantified.

5. Evidence from parenteral nutrition and infusion systems

PN deserves separate attention because the solution enters the bloodstream and bypasses the gastrointestinal barrier. Medical containers and devices have long been studied for chemical leaching, including plasticizers from certain polyvinyl chloride (PVC) materials. The degree of migration depends on the material and fluid; lipid-containing solutions may interact with materials differently

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from aqueous solutions. Chemical leaching is related to, but distinct from, the newer question of microplastic particle transfer [3].

A 2026 review of infusion therapy identifies medical devices and pharmaceutical containers as a potentially overlooked route of particle exposure and highlights weaknesses in testing methods, source attribution and clinical risk assessment [4]. Laboratory experiments can demonstrate particle transfer under selected conditions, but findings depend on circuit design, solution, flow rate, duration, filter, particle-size threshold and analytical method. Experimental transfer does not establish the dose received by every ICU patient or prove a particular clinical outcome.

In-line filters may retain some particles, but performance varies with pore size, particle properties, filter design and compatibility with the prescribed formulation. Filters should be used only in line with product instructions and local protocols. They are not a universal solution, and changes to PN administration must account for nutrient delivery, emulsion stability and device compatibility. Pharmacy, nutrition-support and infection-prevention teams should assess proposed changes together.

6. Potential biological significance

Researchers are studying possible effects of microplastics through cell experiments, animal models, environmental studies and analyses of human samples. Proposed mechanisms include oxidative stress, inflammatory signalling, physical interactions with tissues and effects related to additives or contaminants carried on particle surfaces. A plausible mechanism, however, is not the same as a demonstrated clinical outcome. Dose, size, shape, polymer, surface chemistry and exposure duration may all influence biological behaviour.

It is reasonable to ask whether direct vascular exposure differs from ingestion, since the intestine acts as a partial barrier. Yet the amount and size distribution of particles that may pass through nutrition circuits, their fate in blood and their relationship to outcomes such as inflammation, organ dysfunction or thrombosis have not been adequately established. WHO has likewise highlighted substantial uncertainty in the broader evidence linking microplastic exposure to human health effects [1]. Clinicians should not state that nutrition-system microplastics are known to cause a specific ICU complication.

Table 1. Potential sources, pathways and evidence gaps

Stage / component	Possible concern	Current evidence	Key uncertainty

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Formula or nutrient container	Particles or additives may migrate during manufacture or storage	Direct formula testing exists; one study found particles in 43% of tested EN samples [2]	Representativeness across products, batches and methods
Bags, connectors, syringes and tubing	Shedding from contact surfaces or handling	Plausible; evidence varies by device and test conditions	Contribution of each component during real-world use
PN infusion set and vascular access	Direct delivery of particles or leached chemicals	Infusion-device research is emerging [3,4]	Patient-level dose and clinical significance
Filters and handling	Filters may retain some particles; handling may introduce contamination	Performance is product- and method-dependent	Validated practices that reduce particles without disrupting therapy

7. Current evidence at a glance

The evidence can be viewed in three layers. First, microplastics are widely documented in environmental samples and have been reported in some food, water and biological samples. Second, direct but limited evidence indicates that particles can be present in some enteral formulas and that medical infusion pathways warrant investigation. Third, evidence that exposure specifically attributable to EN or PN systems causes measurable harm in ICU patients remains insufficient. This distinction matters: absence of proof of harm does not establish zero risk, but neither does particle detection prove clinical injury.

Question	Evidence status	Clinical interpretation
Are microplastics present in environmental samples?	Well documented, although measured counts vary by method	Exposure is plausible; comparisons need standardized testing.
Have particles been reported in EN formulas?	Yes, in a limited direct study [2]	A signal for further testing, not a universal prevalence estimate.

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Can medical-device materials release particles or chemicals?	Chemical leaching is established for some materials; particle evidence is developing [3,4]	Material choice and fluid compatibility matter.
Do nutrition-system particles cause specific ICU outcomes?	Not established	Do not delay or withhold clinically indicated nutrition on this evidence alone.

8. Practical clinical and system-level steps

A proportionate response should protect patients without interrupting essential treatment. During procurement, hospitals can request information on polymer composition, extractables and leachables testing, particle testing where available, and compatibility with the intended formula or infusate. Transparent, comparable manufacturer data would be more useful than broad assurances that a product is simply 'medical grade.'

At the bedside, staff should follow established preparation and administration procedures. Avoid unnecessary transfers, avoidable manipulation, damaged equipment and nonvalidated substitutions. Clean handling is also important for research because airborne fibres from clothing, air and work surfaces can contaminate samples. Studies should use procedural blanks, appropriate controls, validated sampling tools and polymer confirmation.

Nutrition delivery must remain central to clinical decisions. Any change to tubing, filters, bags or connectors should consider sterility, infection risk, flow, adsorption of nutrients or medicines, emulsion stability and device instructions. No patient should have clinically indicated EN or PN withheld because of an unquantified microplastic concern. If a facility wishes to review this issue, the first step is a multidisciplinary review involving pharmacy, clinical engineering, infection prevention and nutrition support.

9. Research priorities

The most informative studies would test the entire delivery pathway rather than a formula or device in isolation. Researchers could compare fluid before and after passage through specified components, use unused-device and procedural blanks, identify polymers with spectroscopy, and report particle size and morphology. Test conditions should reflect real flow rates, temperatures, storage periods and administration durations. Particle counts and chemical migration should be reported separately.

Clinical studies should investigate whether measured exposure correlates with biomarkers or patient-centred outcomes while accounting for illness severity, medication use, transfusions and other exposure sources. Neonates and other vulnerable groups deserve attention, with rigorous ethical

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safeguards and contamination-resistant methods. Shared reporting standards and independent replication are necessary before studies can be compared reliably or clinically meaningful thresholds proposed.

10. Conclusion

Enteral and parenteral nutrition are indispensable in intensive care, yet they create repeated contact between nutrient fluids and polymer-based containers and devices. A 2024 study reported microplastics in some tested enteral formula samples, while recent infusion-system literature highlights a need for stronger measurement and risk assessment. The typical dose delivered to ICU patients and any clinical harm specifically caused by these pathways remain uncertain. The appropriate response is neither complacency nor alarm: improve standardized testing, seek transparent device information, maintain careful handling practices and conduct patient-relevant research, while preserving timely access to life-sustaining nutrition.

Limitations

This is a narrative review of selected literature rather than a systematic review with duplicate screening and formal risk-of-bias assessment. Studies use heterogeneous methods and are not directly comparable. Findings may change as further research becomes available.

References

1. World Health Organization. Dietary and inhalation exposure to nano- and microplastic particles and potential implications for human health. Geneva: WHO; 2022. https://www.who.int/publications/i/item/9789240054608

2. Başaran B, Aytan Ü, Şentürk Y. First occurrence and risk assessment of microplastics in enteral nutrition formulas. Food and Chemical Toxicology. 2024;191:114879. doi:10.1016/j.fct.2024.114879.

3. Medical devices as a source of phthalate exposure: A review of current knowledge and alternative solutions. 2023. https://pmc.ncbi.nlm.nih.gov/articles/PMC9837533/

4. von Pawlowski M, Saur L, Röthele J, Pylatiuk C. Microplastic particles and infusion therapy—Evidence, implications, and unanswered questions. Journal of Hazardous Materials Advances. 2026;21:101068. doi:10.1016/j.hazadv.2026.101068.

5. Leslie HA, van Velzen MJM, Brandsma SH, et al. Discovery and quantification of plastic particle pollution in human blood. Environment International. 2022;163:107199. doi:10.1016/j.envint.2022.107199.

ISSN (E): 2992-9148 SJIF 2024 = 5.333 ResearchBib Impact Factor: 10.77 / 2025 VOLUME-4, ISSUE-10

6. Prata JC, da Costa JP, Lopes I, Duarte AC, Rocha-Santos T. Environmental exposure to microplastics: An overview on possible human health effects. Science of the Total Environment. 2020;702:134455. doi:10.1016/j.scitotenv.2019.134455.