



“Sustainability and Green Practices in Medical-Surgical Nursing: Transforming Bedside Care for a Climate-Resilient and Resource-Efficient Health System”

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Abstract: Healthcare is essential for protecting human health, yet the delivery of healthcare itself consumes substantial amounts of energy, water, pharmaceuticals, medical devices, food, transportation, and other resources while generating large quantities of waste. Consequently, environmental sustainability has become an increasingly important component of contemporary nursing practice. Medical-surgical nursing represents a particularly important area for sustainability because medical-surgical nurses work continuously at the bedside and are directly involved in medication administration, wound care, infection prevention, equipment use, patient education, waste segregation, supply management, documentation, and coordination of multidisciplinary care. These activities create numerous opportunities to reduce environmental impact without compromising patient safety or quality of care. This narrative review examines the concept of sustainability in medical-surgical nursing and discusses practical green practices related to healthcare waste, energy and water conservation, sustainable use of medical supplies, medication management, infection prevention, food and linen management, digital documentation, transportation, patient education, procurement, and climate-resilient nursing care. The review also explores the role of nurses as educators, advocates, leaders, researchers, and change agents in developing environmentally responsible healthcare systems. Evidence indicates that waste reduction, correct segregation, recycling, reuse where clinically appropriate, resource conservation, sustainable procurement, and staff education can contribute to more environmentally responsible healthcare. However, barriers including inadequate knowledge, workload, limited resources, organizational culture, lack of leadership support, infection-control concerns, and insufficient sustainability education may restrict implementation. Integrating environmental sustainability into nursing curricula, clinical protocols, quality-improvement programmes, hospital policies, and professional development can help transform routine medical-surgical nursing into a more sustainable model of care. Sustainability should therefore be understood not as an additional responsibility but as an integral dimension of safe, efficient, ethical, and future-oriented nursing practice.

Keywords: Sustainability; Green nursing; Medical-surgical nursing; Environmental sustainability; Green healthcare; Healthcare waste; Climate change; Carbon footprint; Resource conservation; Sustainable nursing practice; Waste reduction; Planetary health.

Introduction

Healthcare exists fundamentally to protect and improve human health, but healthcare delivery can also place considerable pressure on the natural environment. Hospitals require continuous electricity, water, heating, cooling, transportation, food, pharmaceuticals, medical equipment, disposable supplies, information technology, and waste-

management systems. These activities contribute to greenhouse-gas emissions and generate infectious, chemical, pharmaceutical, plastic, and general waste. The environmental footprint of healthcare has therefore become an important global health concern. Estimates from international healthcare sustainability initiatives indicate that the global healthcare sector contributes a substantial



proportion of worldwide greenhouse-gas emissions, demonstrating that healthcare institutions must increasingly consider both the health of patients and the health of the planet [1].

The World Health Organization (WHO) describes environmentally sustainable healthcare facilities as facilities that optimize the use of resources and minimize the release of hazardous substances and waste while maintaining safe and high-quality healthcare [2]. Sustainability is consequently not simply an environmental issue. It is closely connected with patient safety, occupational health, healthcare affordability, resource efficiency, public health, climate resilience, and intergenerational responsibility. Sustainable healthcare seeks to provide appropriate care while minimizing unnecessary consumption and environmental harm [2,3].

Nurses have a particularly important position in this transformation. Nurses constitute one of the largest groups within the healthcare workforce and interact with patients, families, equipment, medications, supplies, support services, and other professionals throughout the day. A systematic review of nurses' perceptions of climate change and sustainable healthcare found that nurses have considerable potential to contribute to sustainable practices, although gaps in knowledge, organizational support, and opportunities for participation remain [4]. The International Council of Nurses has also emphasized that nurses have a responsibility to protect the natural environment and develop competencies that support climate action and environmental health [5].

Medical-surgical nursing is especially relevant because medical-surgical units involve high patient turnover, frequent procedures, medication administration, wound management, diagnostic investigations, intravenous therapy, use of personal protective equipment, linen changes, nutritional services, and extensive use of disposable materials. Each activity has an environmental dimension. Consequently, sustainability can be integrated into ordinary nursing practice without separating it from clinical care.

Concept of Sustainability in Medical-Surgical Nursing

Sustainability in medical-surgical nursing can be understood as the delivery of safe, effective, ethical, and evidence-based

nursing care while minimizing unnecessary consumption of natural resources, waste generation, pollution, and greenhouse-gas emissions. It involves balancing three closely related dimensions: environmental protection, social responsibility, and economic efficiency. Sustainable nursing therefore does not mean simply using fewer materials. Rather, it means using the right resource, in the right amount, at the right time, while ensuring that patient safety and infection prevention remain priorities.

The concept is closely associated with the principles of prevention, reduction, reuse, recycling, responsible procurement, and efficient resource utilization. In a medical-surgical ward, for example, reducing unnecessary disposable supplies, correctly segregating waste, switching off unused equipment, preventing medication wastage, reducing unnecessary linen changes, and avoiding inappropriate use of water are relatively simple actions. When repeated across hundreds or thousands of patient-care episodes, these practices may contribute to substantial reductions in resource consumption.

Sustainable nursing also requires consideration of the entire life cycle of healthcare products. A product begins with extraction of raw materials and manufacturing and continues through transportation, clinical use, and eventual disposal or recycling. Nurses may not control every stage, but their choices influence demand, utilization, wastage, and disposal. Therefore, sustainability must be incorporated into clinical decision-making, nursing leadership, procurement discussions, education, quality improvement, and research.

Environmental Footprint of Medical-Surgical Nursing

The environmental footprint of medical-surgical nursing arises from numerous routine activities. Disposable gloves, syringes, dressings, intravenous sets, plastic packaging, gowns, masks, wipes, urinary-care products, feeding equipment, and other supplies contribute to waste. Electricity is consumed by lighting, computers, monitors, infusion pumps, suction devices, refrigerators, air-conditioning systems, and other equipment. Water is used for hand hygiene, cleaning, patient bathing, environmental sanitation, laundry, and food services. Pharmaceuticals create



environmental impacts during manufacturing, transportation, use, and disposal [6,7].

Hospital sustainability research has identified energy, water, procurement, waste, transportation, hospital design, and staff behaviour as important areas of environmental impact [8]. Nursing work intersects with nearly all these areas. Consequently, the nurse should not be viewed merely as a consumer of hospital resources but as an important participant in resource stewardship.

Green Healthcare Waste Management

Healthcare waste management is one of the most visible areas of sustainable nursing practice. WHO reports that healthcare waste can include general waste as well as infectious, pathological, sharps, chemical, pharmaceutical, radioactive, and other hazardous materials. Poorly managed healthcare waste may expose healthcare workers, patients, waste handlers, communities, and the environment to preventable risks [9].

Correct waste segregation at the point of generation is therefore a fundamental green nursing practice. Nurses should identify the appropriate waste category before disposing of an item rather than placing all materials into hazardous-waste containers. Incorrect segregation can unnecessarily increase the volume of waste requiring specialized treatment and can increase treatment-related environmental impacts. Sustainable nursing therefore begins with accurate knowledge of institutional waste-segregation policies and consistent application at the bedside.

Waste minimization should occur before recycling. Nurses can avoid opening unnecessary sterile packages, select the appropriate quantity of supplies, monitor frequently wasted materials, and communicate recurring wastage to unit managers. A 2025 scoping review identified material reduction, recycling, and reuse among the most frequently reported sustainable nursing actions in healthcare waste management [10]. Such findings support the integration of waste reduction into routine nursing activities.

Reuse and reprocessing require careful consideration. Reusable products should be used when they are approved by institutional infection-prevention policies, manufacturers, and applicable regulations. Sustainability should never justify

unsafe reuse of single-use medical devices. The principle should be "appropriate use and safe resource conservation" rather than indiscriminate reuse.

Sustainable Use of Personal Protective Equipment

Personal protective equipment (PPE) is essential for preventing infection transmission and protecting healthcare workers. However, unnecessary use and incorrect disposal can increase medical waste. Nurses should therefore follow standard and transmission-based precautions accurately and avoid using PPE beyond what is clinically indicated. Correct selection of PPE, appropriate donning and doffing, avoidance of unnecessary glove use, and correct disposal can reduce waste while preserving infection-control standards.

During outbreaks and other situations requiring extensive PPE, sustainability becomes more challenging. In such circumstances, patient safety and infection prevention remain the primary considerations. Nevertheless, institutions can examine procurement strategies, packaging, reusable alternatives where validated, and waste-management processes to reduce avoidable environmental effects.

Energy Conservation in Medical-Surgical Units

Energy consumption represents an important component of hospital environmental impact. Medical-surgical nurses can contribute to energy conservation through small but cumulative actions. Unoccupied areas should not have unnecessary lighting or equipment operating continuously when this is consistent with clinical and safety requirements. Computers, monitors, televisions, chargers, and other electrical devices should be managed according to institutional energy policies.

Energy conservation should not interfere with clinical monitoring, emergency readiness, infection control, temperature requirements, or patient safety. The objective is not simply to switch off equipment but to eliminate unnecessary energy use. Nurses can also report malfunctioning equipment, inefficient lighting, leaking taps, defective refrigerators, or inappropriate temperature control to the relevant department.

The WHO framework for environmentally sustainable healthcare facilities identifies sustainable energy services as one of the major components of climate-resilient healthcare



[2]. This reinforces the importance of integrating energy awareness into everyday clinical practice.

Water Conservation and Sustainable Hygiene

Water is indispensable to nursing care. Hand hygiene, patient bathing, wound care, environmental cleaning, drinking water, laundry, and sanitation all depend on reliable water supplies. Sustainable nursing must therefore seek to reduce unnecessary water consumption without compromising infection prevention.

Nurses can contribute by avoiding running taps unnecessarily, reporting leaks promptly, using water efficiently during patient hygiene, and educating patients and families about appropriate water use. Water conservation should always be consistent with hand-hygiene standards and infection-control requirements. For example, reducing water use should never involve shortening recommended handwashing procedures or compromising cleaning and disinfection.

Water security is also part of climate resilience. Floods, droughts, contamination, and infrastructure failures can threaten healthcare delivery. Medical-surgical nurses should therefore understand institutional emergency plans related to water shortages and other climate-related disruptions.

Sustainable Medication Management

Medication use represents another important area of sustainability. Pharmaceutical products have environmental impacts associated with production, packaging, transportation, administration, excretion, and disposal. Pharmaceutical residues can enter wastewater and aquatic environments, making appropriate medication management increasingly relevant to environmental health [6,7].

Medical-surgical nurses influence medication-related sustainability through accurate preparation, administration, storage, monitoring, and disposal. Preventing avoidable medication wastage is particularly important. Medication wastage may occur because of patient discharge, treatment changes, deterioration, expiration, inappropriate quantities, or other factors [11]. Accurate medication preparation and timely communication with pharmacy and medical teams can therefore reduce avoidable waste.

A study examining environmentally sustainable actions in the medication process in a medical-surgical clinical unit reported reductions in hazardous waste following a Lean Six Sigma intervention, demonstrating that structured process improvement can influence both clinical workflows and waste generation [12]. Nurses can participate in medication-waste audits, identify common causes of wastage, and contribute to improvement initiatives.

Medication disposal must follow legal and institutional requirements. Unused medicines should never be disposed of through inappropriate drains, toilets, general waste streams, or other unauthorized routes. Nurses should be familiar with institutional pharmaceutical-waste procedures and communicate concerns to pharmacy and infection-control personnel.

Sustainable Management of Medical Supplies

Medical-surgical nursing involves continuous use of consumable supplies. Sustainable supply management begins with appropriate selection and continues through storage, utilization, and disposal. Overstocking can lead to expiry and waste, while understocking can compromise patient care. Nurses can contribute to inventory management by monitoring frequently used supplies, identifying products approaching expiry, avoiding unnecessary opening of packages, and reporting recurrent shortages or excess stock. The principle of "right product, right quantity, right time" can reduce waste while maintaining care quality. Unit-based audits can identify supplies that are routinely opened but not used. Such audits may support changes in ordering systems, staff education, or product packaging.

Procurement also has an environmental dimension. Healthcare institutions can consider product durability, packaging, recyclability, energy requirements, life-cycle impact, and manufacturer environmental practices when purchasing supplies. Nurses should participate in procurement committees because they possess direct knowledge of product performance and practical bedside requirements.

Sustainable Wound Care

Wound management can generate considerable waste through dressings, packaging, gloves, cleaning materials,



and other consumables. Sustainable wound care begins with selecting products based on clinical indication rather than habit. Nurses should avoid opening multiple products before confirming what is required.

Accurate wound assessment and evidence-based dressing selection can reduce unnecessary dressing changes and product consumption. At the same time, infection-control requirements and manufacturer instructions must be followed. Sustainable wound care therefore means achieving the desired clinical outcome with the appropriate product and quantity rather than simply choosing the cheapest or least resource-intensive option.

Linen and Laundry Management

Medical-surgical units can generate substantial quantities of soiled and unused linen. Unnecessary linen changes increase water, energy, detergent, transportation, and labour requirements. Nurses can contribute by changing linen according to patient need, infection-control requirements, and institutional policy rather than automatically replacing clean linen without clinical justification.

However, linen sustainability must never compromise hygiene or dignity. Patients with incontinence, wounds, infections, excessive perspiration, or other clinical needs require appropriate linen changes. The goal is responsible utilization rather than blanket reduction.

Food Waste and Nutritional Sustainability

Hospital food services are another area in which nurses can contribute to sustainability. Food waste may result from inappropriate portion sizes, missed meals, patient transfers, changes in diet orders, poor appetite, or delayed meal delivery. Nurses frequently identify these problems first because they monitor patients' nutritional intake.

Nurses can communicate changes in patient diet orders promptly, document nutritional intake accurately, coordinate with dietary services, and identify patients at risk of inadequate intake. Reducing food waste should therefore be integrated with nutritional safety. A patient should never be denied appropriate nutrition in the name of waste reduction. Hospital research increasingly emphasizes the need to address food waste while simultaneously protecting patient wellbeing and nutritional outcomes [13].

Sustainable Infection Prevention

Infection prevention and sustainability should be viewed as complementary objectives rather than inherently opposing priorities. Effective infection prevention can reduce complications, readmissions, additional treatments, and resource consumption. Conversely, excessive or inappropriate use of disposable products can generate unnecessary waste.

Medical-surgical nurses can support both objectives through evidence-based hand hygiene, appropriate isolation precautions, accurate environmental cleaning, antimicrobial stewardship participation, and correct waste segregation. The emphasis should remain on using infection-prevention resources appropriately rather than indiscriminately.

Antimicrobial stewardship is also relevant because excessive or inappropriate antimicrobial use contributes to antimicrobial resistance and can have broader environmental consequences. Nurses can contribute by monitoring medication administration, observing clinical responses, educating patients about antimicrobial therapy, and supporting institutional antimicrobial stewardship programmes.

Green Practices in the Operating and Procedural Environment

Medical-surgical nurses may also participate in operating rooms, procedure areas, endoscopy units, catheterization laboratories, and other high-resource clinical environments. These settings are particularly important for sustainability because they may generate large amounts of waste and consume substantial energy.

Systematic reviews of sustainable operating-room interventions have identified waste segregation, recycling, reuse or reprocessing where appropriate, sterilization practices, energy management, and anaesthetic-gas strategies as major areas of intervention [14,15]. Nurses working in procedural settings can support these interventions through accurate waste segregation, appropriate opening of supplies, preparation of only required materials, and participation in sustainability audits.

Education is particularly important. Evidence suggests that awareness and education can influence waste segregation



and reduction practices, while implementation remains affected by organizational barriers and inconsistent follow-through [14,16]. Therefore, sustainability education should be continuous rather than limited to a one-time awareness programme.

Digital Documentation and Paper Reduction

Digital health systems provide another opportunity for environmental improvement. Electronic documentation can reduce paper consumption, physical storage requirements, printing, and transportation associated with paper records. Medical-surgical nurses can support digital sustainability by using electronic documentation appropriately, avoiding unnecessary printing, and ensuring that electronic records are accurate and complete.

However, digital systems also consume electricity and depend on hardware, data centres, networks, and electronic equipment. Digitalization should therefore not be considered automatically environmentally neutral. Healthcare institutions should combine digital transformation with energy-efficient infrastructure, responsible electronic-waste management, and appropriate equipment life-cycle planning.

Sustainable Transportation and Care Coordination

Transportation contributes to healthcare-related emissions through staff commuting, patient travel, ambulance services, supply transportation, and referral pathways. Nurses can contribute indirectly by improving care coordination and reducing unnecessary patient movement. Efficient scheduling, appropriate discharge planning, telehealth when clinically suitable, and coordination of multidisciplinary services may reduce avoidable travel.

For patients, sustainability should never override access or clinical requirements. Telehealth or remote follow-up should be considered when it is clinically appropriate, accessible, and acceptable to the patient. Medical-surgical nurses can help identify patients who require physical assessment and those who may appropriately participate in remote follow-up.

Climate-Resilient Medical-Surgical Nursing

Sustainability and climate resilience are closely interconnected. Climate-related hazards such as heat waves, floods, storms, droughts, wildfires, and infectious disease changes can affect patient health and the ability of hospitals

to deliver care. WHO recommends vulnerability assessment and preparedness planning for healthcare facilities facing climate-related hazards [17].

Medical-surgical nurses have an important role in preparedness because they are frequently responsible for direct patient monitoring during emergencies. Climate-resilient nursing includes understanding emergency plans, maintaining readiness for power or water interruptions, identifying vulnerable patients, ensuring appropriate medication continuity, and supporting evacuation or surge-management procedures.

Patients with chronic illnesses, older adults, people with disabilities, individuals requiring continuous oxygen or electrical equipment, and those with limited social resources may be particularly vulnerable during climate-related emergencies. Nurses can contribute to individualized preparedness planning and patient education.

Role of Nurses as Sustainability Advocates

The nursing role in sustainability extends beyond individual bedside behaviours. Nurses can function as educators, advocates, leaders, researchers, quality-improvement professionals, and policy contributors. The International Council of Nurses has emphasized the importance of nursing leadership in climate action and sustainable healthcare [5].

At the unit level, nurses can initiate waste audits, energy-awareness programmes, resource-use monitoring, and sustainability education. At the institutional level, nurse leaders can participate in green-hospital committees, procurement decisions, quality-improvement projects, and environmental management systems.

Nursing advocacy should also recognize environmental justice. Environmental degradation does not affect all populations equally. Communities with fewer resources may experience greater exposure to pollution, extreme weather, inadequate water and sanitation, and barriers to healthcare. Sustainable nursing should therefore incorporate equity and social responsibility rather than focusing exclusively on institutional carbon reduction.

Sustainability Education in Nursing

Education is a critical requirement for long-term sustainability. Nurses may recognize environmental



problems but remain uncertain about how to translate sustainability principles into clinical practice. Recent evidence indicates that nurses' awareness does not always translate into consistent sustainable behaviours, particularly when time, resources, organizational support, and training are limited [4].

Nursing curricula should therefore introduce sustainability throughout undergraduate and postgraduate education. Topics may include climate change and health, environmental health, healthcare waste management, carbon literacy, sustainable procurement, resource conservation, pharmaceutical waste, environmental justice, disaster resilience, and sustainable quality improvement.

Clinical teaching can incorporate sustainability into routine competencies. Students can be asked to conduct waste-segregation audits, identify unnecessary resource use, develop ward-based sustainability projects, and evaluate environmental effects alongside clinical outcomes. Sustainability should become part of professional practice rather than a separate optional topic.

Barriers to Green Medical-Surgical Nursing

Implementation of sustainability practices is influenced by multiple barriers. One major barrier is limited knowledge. Nurses may understand the general importance of environmental protection but may not know which specific clinical behaviours have measurable environmental effects. Lack of institutional policies and unclear responsibilities can further reduce participation.

Workload and staffing pressures also influence sustainability. When nurses are dealing with high patient acuity, emergencies, documentation demands, and staffing shortages, environmental considerations may receive lower priority. Recent nursing literature identifies time constraints, limited resources, insufficient training, and inadequate organizational support as important barriers to sustainable practice [4,18].

Infection-control concerns represent another important barrier. Staff may avoid reusable products because of uncertainty about cleaning, sterilization, or cross-infection risks. Such concerns require evidence-based protocols rather than informal expectations. Sustainability interventions

must therefore be developed collaboratively by nursing, infection control, procurement, biomedical engineering, housekeeping, pharmacy, and hospital administration.

Strategies for Implementing Green Nursing Practices

Successful implementation requires a systematic approach. First, healthcare institutions should establish baseline measurements for waste, energy, water, selected supplies, and other relevant indicators. Without baseline data, improvement cannot be measured reliably. Second, nurses should participate in identifying high-impact areas. Third, interventions should be introduced gradually and evaluated using measurable outcomes.

A practical medical-surgical sustainability programme may include monthly waste audits, monitoring of recyclable and infectious waste, energy-use awareness, medication-waste monitoring, supply-utilization audits, staff education, and recognition of successful improvement projects. Unit-based sustainability champions can support communication between frontline nurses and hospital management.

Sustainability interventions should also use quality-improvement methods such as Plan-Do-Study-Act cycles. Small changes can be tested, measured, modified, and expanded. This approach is particularly useful because environmental improvements should be evaluated alongside patient safety, staff workload, cost, infection rates, and patient satisfaction.

Measuring Sustainability in Medical-Surgical Nursing

Measurement is essential for demonstrating whether green nursing interventions are effective. Indicators may include kilograms of waste generated per patient-day, percentage of waste correctly segregated, quantity of recyclable material recovered, volume of unused supplies discarded, medication-waste quantity, water consumption, electricity consumption, linen utilization, paper consumption, and participation in sustainability training.

Hospital sustainability research has demonstrated the usefulness of indicators related to energy, water, waste, emissions, and other environmental impacts, with nursing work directly or indirectly involved in many sustainability activities [19]. However, indicators should be selected according to local priorities and data availability.



Environmental indicators should be balanced with clinical indicators. For example, a reduction in disposable dressing materials should not be considered successful if wound infection rates increase. Similarly, reduced linen use should not compromise patient hygiene. Sustainable healthcare must therefore evaluate environmental, clinical, economic, and social outcomes together.

Future Directions for Medical-Surgical Nursing

The future of sustainable medical-surgical nursing will increasingly involve data-driven environmental management. Electronic health records, automated inventory systems, smart energy systems, digital waste monitoring, life-cycle assessment, and clinical decision-support technologies may provide opportunities to measure resource consumption more accurately.

Research should move beyond describing nurses' attitudes toward sustainability and evaluate the measurable effects of nurse-led interventions. Studies should examine carbon reduction, waste reduction, cost outcomes, patient safety, staff experience, and long-term sustainability. More evidence is also needed from low- and middle-income countries, where resource constraints, infrastructure limitations, and healthcare needs may differ substantially from high-income settings.

Nursing research should also investigate the relationship between sustainability and patient outcomes. For example, future studies could examine whether improved medication management reduces pharmaceutical waste without increasing medication errors, whether sustainable wound-care pathways maintain healing outcomes, and whether energy-efficient environmental systems influence patient comfort and recovery.

Conclusion

Sustainability is becoming an essential component of modern medical-surgical nursing. The environmental impact of healthcare is produced not only by large infrastructure and industrial systems but also through thousands of routine clinical decisions made every day. Nurses are therefore strategically positioned to influence healthcare sustainability through responsible use of supplies, accurate waste segregation, medication-waste reduction, energy and water

conservation, sustainable wound care, appropriate PPE use, linen management, nutritional coordination, digital documentation, patient education, and participation in organizational quality-improvement programmes.

Green nursing should not be interpreted as reducing resources at the expense of patients. Its fundamental principle is the delivery of the right care using resources responsibly while preventing avoidable environmental harm. Patient safety, infection prevention, dignity, accessibility, and clinical effectiveness must remain central to every sustainability intervention.

The evidence increasingly demonstrates that nursing has an important role in healthcare sustainability, but successful implementation requires more than individual motivation. Institutional policies, leadership support, adequate staffing, education, interdisciplinary collaboration, reliable measurement systems, and appropriate resources are essential. Sustainability should consequently be embedded into nursing education, clinical protocols, hospital quality programmes, procurement policies, leadership development, and research.

Medical-surgical nurses can become important agents of environmental stewardship because their everyday practice connects directly with resource use and patient outcomes. By integrating sustainability into ordinary clinical decision-making, the profession can contribute to healthcare systems that are safer, more efficient, environmentally responsible, climate-resilient, and capable of protecting both present and future generations.

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