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Article

# Internal Processes and Good Practices of Medical Equipment Donation Actors

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## Abstract

The health sector of many low-and middle-income countries relies on international donations of medical equipment, and while these donations are most of the time made in good faith, a lack of functionality due to the absence of training, poor health technology management and defective health infrastructure are clear constraints to their use. Depending on the accounts, between 40 and 70% of the medical equipment donations do not function when reaching their destination. While the WHO estimates that 95% of medical equipment in low-and middle-income countries is imported and 80% of it is funded by international donors or foreign governments, it is essential to better understand why medical equipment are so often not functional. The purpose of this research is to better inform the internal processes of medical equipment donors and to give recommendations to improve medical equipment donations. A survey was conducted to three international medical humanitarian organizations and to nine medical surplus recovery organizations in that regard. The literature review showed that guidelines and good practices on medical equipment donations exist and are quite thorough. They include the need to execute a full assessment of the recipient healthcare facility and of the human resources. The survey results show that the assessment prior to the medical equipment donation is not executed systematically, while all medical equipment donors should execute an assessment of the healthcare infrastructure and of the human resources available in the recipient facility.

**Keywords:** medical equipment; biomedical; donation; humanitarian aid; medical surplus recovery; healthcare facility; low- and middle-income country

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## 1. Introduction

In 2015, the United Nations launched the Sustainable Development Goals (SDGs), a global framework comprising 17 ambitious targets to be achieved by 2030. Among these, good health and well-being stands out, alongside other health-related determinants such as clean water, sanitation, and reduced inequalities. Despite international efforts, stark disparities persist between high-income countries (HICs) and low- and middle-income countries (LMICs) in terms of health outcomes and life expectancy, largely influenced by geopolitical conflicts and unequal access to resources.

Medical equipment plays a vital role in healthcare delivery, from diagnosis to treatment. Defined by the World Health Organization (WHO) as tools used to prevent, diagnose, or treat illness (WHO Atlas, 2017:6), these devices are unevenly distributed across the globe. For instance, France had nearly ten times more MRI machines than Yemen in 2013, and over fifty times more radiotherapy units (WHO, 2016) while the populations of both countries are comparable. Indeed, in France, the population count is 68 millions and, in Yemen, it is of 40 millions. Advanced medical technologies remain largely inaccessible in LMICs, often limited to private facilities serving a wealthy minority.

To address this imbalance, international actors have turned to medical equipment donation (MED), particularly through Medical Surplus Recovery Organizations (MSROs) and International Medical Humanitarian Organizations (IMHOs). These groups aim to repurpose unused medical supplies from HICs and deliver them to LMICs. For example, Medical Bridges, a leading MSRO, estimates that Americans discard \$9 billion worth of medical supplies annually (Porterfield, 2016).

However, the effectiveness of such donations is questionable. Studies reveal that up to 38.3% of donated equipment in LMICs is non-functional (Perry et al, 2011:719), compared to less than 1% in HICs (Howitt et al., 2012). Other reports suggest even higher rates of dysfunction, with WHO estimating that 70% of equipment in sub-Saharan Africa is out of service (WHO, 2000:10).

Given that 95% of medical equipment in LMICs is imported and 80% funded by international donors, a critical examination of MED practices is essential (Marks et al., 2019: 2). The phenomenon of “medical equipment graveyards,” where unusable devices accumulate, highlights the need for more sustainable and effective donation strategies.

This research aims to identify the key characteristics of MSROs and IMHOs involved in MED, and to propose recommendations for improving the process. It seeks to understand the challenges, assess current practices through a global survey, and develop a toolkit for monitoring and evaluating the sustainability of donated equipment. The study is structured into five parts, after the introduction, beginning with a literature review, followed by methodology, results, discussion and conclusion.

## 2. Literature Review

This chapter reviews medical equipment donation (MED) to low- and middle-income countries (LMICs), critically assessing effectiveness, actors, opportunities, challenges, governance, and the study’s contribution.

### 2.1. MED Landscape and Actors

MED is delivered by two primary actor groups. International medical humanitarian organizations (IMHOs) operate mainly in emergencies and protracted crises, providing staff support, consumables, and new medical equipment purchased externally; they undertake periodic monitoring and collect recipient feedback. Medical Surplus Recovery Organizations (MSROs) recover reusable supplies from high-income countries (HICs) to donate to LMICs; formal accreditation and emerging best-practice guidelines exist, yet evidence shows frequent non-adherence. Donated items often include near-expiry consumables and broken equipment (Marks et al., 2019), and while some recycled devices can perform well, much donated material risks becoming unusable.

### 2.2. Opportunities and Rationale

MED leverages large volumes of potentially reusable supplies discarded in HIC healthcare systems, promising rapid resource transfers and immediate service gains in under-resourced facilities. When matched to needs and maintained, donated equipment can fill critical gaps and support health service continuity during crises (Fitzgerald, 2016).

### 2.3. Key Challenges

#### 2.3.1. Appropriate Technology Mismatch

Most devices are designed for HIC contexts with stable power, reliable water, robust supply chains, and skilled staff (Howitt et al., 2012: 509). LMIC healthcare facilities frequently lack these conditions, causing donated devices to be unusable or unsafe. The concentration of device manufacturers in HICs exacerbates design misalignment with austere environments (Diaconu et al., 2017:1).

#### 2.3.2. Environmental and Infrastructural Constraints:

Irregular electricity, water shortages (Petkova et al., 2010), and limited consumables undermine medical equipment function and longevity.

### 2.3.3. Human Resources and Maintenance

Severe shortages of biomedical engineers (BMEs) and trained technicians hinder procurement decisions, installation, maintenance, and repair. WHO guidance emphasizes BMEs' essential role across selection, integration, monitoring, training, and lifecycle management, but many African countries report negligible BME capacity.

### 2.3.4. Monitoring and Quality Control Failures

Donor practices often lack rigorous pre-donation site assessments, ongoing monitoring, and accountability mechanisms, leading to high rates of non-functional equipment and "equipment graveyards."

## 2.4. *Examples of Positive Adaptation*

Some device categories have been successfully redesigned for LMIC realities. Anesthesia equipment evolved into robust models (e.g., machines operating without reliable power or gas supplies) informed by field data; improvements included UPS integration and active scavenging (Beringer et al, 2008). Such iterative, context-driven design demonstrates feasibility for other essential technologies.

## 2.5. *Research Gap and Contribution*

Existing evidence highlights prevalence of dysfunctional donated equipment but is uneven and often anecdotal. This review frames the need for systematic investigation into MED actors' practices, appropriateness criteria, and in-country sustainability. The study aims to inform improved donor processes, context-appropriate design adoption, and strengthened BME capacity to enhance MED effectiveness and alignment with universal health coverage goals.

## 2.6. *Equitable Partnership Between Donor and Recipient Organizations*

Equitable partnerships are essential but rare; donors and recipients should establish bilateral, transparent relationships to plan donations collaboratively. Partnership coordinators, local clinical leads, biomedical engineering departments, suppliers, and health ministries must be consulted to produce a formal, agreed donation plan and memorandum of understanding that clarifies contributions and avoids surprises during implementation.

## 2.7. *Existing Guidelines*

A wide range of guidance exists: 33 medical equipment donation guidelines were identified from governments, WHO, World Bank, professional bodies, NGOs, church associations, and public-private partnerships. Key global references include WHO's Guidelines for Healthcare Equipment Donation and follow-up considerations, NGO guides (e.g., THET, Humatem), church association guidance, and sector-specific standards from groups like PQMD and the MedSurplus Alliance. Common consensus across guidelines prescribes five core steps for effective MED: planning, sourcing, operationalizing, feedback, and evaluation.

## 2.8. *Opportunities Related to Medical Equipment Donations*

MED offers tangible opportunities in resource-constrained settings. Donated, second-hand, or low-cost equipment can sustain or improve patient care where political instability, poverty, and limited government engagement constrain service delivery. Technology is central to modern surgical and general healthcare, and donations can fill immediate gaps when matched to need. However, four critical issues determine optimal technology use in LMICs: problematic donations, procurement mismatches between governments and NGOs, consumables supply challenges, and long-term

maintenance. Additional barriers include insufficient training for health practitioners in device use and servicing, and the need for robust post-donation monitoring and evaluation.

### *2.9. Challenges Related to Medical Equipment Donation*

Persistent challenges undermine MED effectiveness. Well-intentioned donations can be inappropriate, ineffective, or dangerous when poorly planned or insufficiently coordinated with recipients, potentially imposing burdens on fragile systems. Power imbalances between donors and recipients can suppress critique, making unsuitable donations culturally difficult to reject and perpetuating perceptions of MED as dumping obsolete equipment. Structural inequalities may be reinforced when top-down donation models fail to address underlying causes of poor health systems.

A deeper problem is design and manufacturing concentration: the global market is dominated by companies headquartered in high-income countries, whose products are typically engineered for resource-rich settings. Device designers often lack detailed understanding of LMIC infrastructure constraints—intermittent power, limited water, sparse maintenance capacity—resulting in technologies unsuited to austere environments. Long-term improvement requires not only better donation practices but also exploration of local manufacturing and context-driven design to create equipment appropriate for LMIC conditions and to rebalance dependency on imports.

### *2.10. Management of Medical Equipment Donation*

The literature frames effective management of medical equipment donation (MED) as essential for LMIC health systems and highlights WHO's 2011 guidance (WHO, 2011) as the authoritative framework for practice. WHO's technical guidance outlines ten best-practice areas: recipient engagement at every stage, meeting end-user and patient needs, regulatory and policy alignment, consideration of local equipment markets, integration with existing procurement systems, attention to public health priorities, inclusion of facility-level input in national coordination, provision for installation/service/supplies, recognition of local environmental and human-resource constraints, and clear communication. The guidance also addresses special considerations for used, refurbished, laboratory, and imaging equipment.

The literature stresses that although many LMIC health sectors rely heavily on donated devices, poor planning and coordination frequently produce negative outcomes (WHO, 2011:7). Successful donations require two-way communication and empowered recipients who can review and refuse unsuitable offers to prevent inappropriate transfers and build local device-management capacity.

### *2.11. Research Gaps*

Key research gaps persist across MED literature. Scholars and sector actors call for expanded empirical study on donation quality, appropriateness, in-country sustainability, and global visibility (Compton et al, 2018). The evidence base is limited and often anecdotal, prompting calls for systematic investigation to strengthen donation systems, support health system resilience, and improve development outcomes.

### *2.12. Contribution of this Research*

This research contributes by combining a critical literature review with primary data from an online global survey of Medical Surplus Recovery Organizations (MSROs) and International Medical Humanitarian Organizations (IMHOs). The study maps current MED practices, policies, and monitoring approaches and evaluates how well donor practices align with published best practices. It aims to identify the defining characteristics of donor organizations, uncover processes that must be implemented to ensure equipment suitability and sustainability, and develop a set of good-practice indicators for monitoring and evaluation.

The literature review reiterates earlier chapter findings: IMHOs and MSROs are the dominant donor types with distinct operational modes; IMSOs often procure and supply new equipment in

crisis settings while MSROs recover surplus items from HICs for redistribution. Core challenges persist, including misfit technologies designed for resource-rich contexts, scarce biomedical engineering capacity in many LMICs, supply-chain and consumables fragility, and limited post-donation monitoring. Power asymmetries and cultural norms can inhibit recipient feedback and enable the transfer of obsolete or inappropriate equipment, reinforcing dependency on imports and limiting local manufacturing or context-driven design.

The next stage of the research applies a survey methodology to compare donor organizations' practices against these documented best practices and gaps, seeking actionable recommendations to improve MED planning, sourcing, operationalization, monitoring, and evaluation.

### 3. Methodology

This chapter explains the mixed-methods approach used to study medical equipment donation (MED) to low- and middle-income countries, combining a critical literature review with primary data from an online survey of Medical Surplus Recovery Organizations (MSROs) and International Medical Humanitarian Organizations (IMHOs). The survey sought to map donor practices, policies, site-assessment processes, monitoring, and barriers to sustainable donation.

#### 3.1. Study Overview

The study adopts a survey research design delivered online to a purposive sample of organizations engaged in MED. The quantitative survey aligns with a positivist orientation while the policy and practice analysis incorporates qualitative interpretation to generate recommendations. The researcher declares positionality as a biomedical engineer with five years' experience working for IMHOs in LMIC settings; this background informed topic selection and interpretation and framed the researcher's awareness of potential donor-side bias.

#### 3.2. Literature Review

The literature review phase used university library databases and targeted keywords (e.g., "medical equipment," "donation," "health technology," "low-income country," and "medical surplus recovery organization") to establish existing knowledge, identify gaps, and shape the survey instrument. Gaps identified in the literature motivated the primary research component.

#### 3.3. Survey Research Design

Given the global distribution of target organizations and COVID-19 constraints, an online survey was chosen for feasibility and reach. A purposive, non-probability sample of thirty-one eligible organizations was compiled from WHO listings and supplemented by major European humanitarian actors and federations representing MSROs. Two federations were engaged to reach constituent members.

The questionnaire was structured into five thematic sections: types of donated equipment; pre-donation site assessment; donation modalities; local market assessment and training; and monitoring and evaluation. Questions were developed from literature-identified gaps and best-practice frameworks.

The instrument underwent piloting with two humanitarian medical equipment specialists, the research supervisor, and lay family members to test clarity, flow, and completion time. Feedback led to revisions; the final survey was designed for completion within 30 minutes and incorporated online best-practice features such as a welcome page, progress indicator, and concise invitation messaging.

To maximize response rates given the small target population, recruitment included preliminary phone calls and tailored invitation emails to identify the appropriate expert contact within each organization. The survey launch included an information sheet explaining purpose and data protection; the field period was initially two weeks and later extended by two weeks to improve participation.

The methodology aims to produce empirical evidence on current donor practices and to compare these with documented best practices, informing recommendations to improve the appropriateness, sustainability, and monitoring of MED initiatives in LMIC contexts.

### 3.4. Ethical Considerations and Limitations

The research was classified as low risk by the School of Arts, Language and Culture Research Ethics Committee and registered under number 2021-10466-17975. Ethical safeguards included a participant information sheet, and an informed-consent mechanism embedded in the online survey; participants had to provide consent before taking part. Documentation of the ethics approval is included in the project annexes.

The study design carries several important limitations. A purposive, non-probability sampling approach targeted a defined set of Medical Surplus Recovery Organizations (MSROs) and International Medical Humanitarian Organizations (IMHOs), which constrains the external validity and generalizability of findings. Different researchers could reasonably have selected alternative samples, producing divergent results. The relatively small sample size and the possibility of non-response bias (organizations electing not to participate) further limit representativeness and the reliability of quantitative inferences.

Methodological constraints also include the sole reliance on an online survey instrument for primary data collection, which can restrict depth of insight compared with mixed methods designs incorporating interviews or field observation. The survey's structure and question framing may reflect the researcher's positionality and technical background, introducing potential bias in how items were asked and interpreted. Finally, the literature review that informed the survey was not conducted as a systematic review, which may have left some evidence or perspectives underrepresented when designing the questionnaire and contextualizing results.

Despite these limitations, the study's ethical oversight, targeted sampling, and transparent descriptive analysis provide a defensible exploratory snapshot of current MED practices among the sampled donor organizations. The combination of literature synthesis and primary survey data is positioned to identify trends, gaps, and good-practice signals that can inform further, more robust research. Follow-up studies using probabilistic sampling, mixed methods (qualitative interviews, case studies), and a systematic literature review would strengthen causal inference, improve representativeness, and deepen understanding of the processes that govern appropriateness, sustainability, and impact of medical equipment donations in low- and middle-income contexts.

## 4. Results

The chapter reports findings from an online survey of organizations involved in medical equipment donation to low- and middle-income countries, summarizing respondent identity, response rate, and data-collection procedures.

### 4.1. Survey Results

#### 4.1.1. Response Rate

Out of the 28 valid organizations contacted—identified primarily from a WHO list and supplemented by major European IMHOs—twelve completed the questionnaire, yielding a 42.9% response rate. Non-responses included twelve organizations that did not answer calls or emails and four that initially engaged but did not complete the survey for reasons such as time constraints or survey overload. Two entries from the initial list were later found to be duplicates and one organization was out of scope because it shifted focus to training rather than donations. Two other organizations indicated they rarely handle medical equipment and were therefore ineligible. The final respondent group of twelve is considered an acceptable dataset given pandemic-era constraint.

#### 4.1.2. Data Collection Process

Initial contact occurred before the survey launch and the questionnaire link was emailed on 7 April 2021 with an intended closing date of 21 April 2021. The invitation package included a participant information sheet and survey preview. Follow-up reminders were sent on 22 April, 27 April, and 1 May 2021 to improve participation. The survey instrument and supporting materials are documented in annexes. The recruitment approach combined direct phone outreach to identify appropriate subject-matter contacts with email distribution to ensure targeted respondents received the survey.

#### 4.2. Respondent Organizations

Seven organizations consented to be named in the research. These included one association of Medical Surplus Recovery Organizations, four MSROs, and two International Medical Humanitarian Organizations:

- Association of MSROs: Medical Surplus Alliance
- MSROs: Remedy; Healthcare Relief; MedWish International; Humatem
- IMHOs: World Health Organization; International Committee of the Red Cross

Five responding organizations chose to remain anonymous and withheld organizational identification from the published report.

#### 4.3. Interpretation

The achieved response rate provides a manageable, informative sample given the small and specialized population of MED actors and the operational challenges encountered during 2020–2021. The mixture of MSROs, their representative association, and major IMHOs among respondents ensures representation of the key donor categories targeted by the study. The combination of named and anonymous respondents preserves confidentiality when requested while still allowing cross-sector insights.

#### 4.4. General Overview of Results

All respondent organizations are HIC-based donors; one MSRO (Remedy) supplies only within the USA for onward shipment by partners. Donation triggers vary: eight organizations (66.7%) donate following a recipient request; Remedy donates based on surplus; MedWish requires a US partner linked to an LMIC actor; the ICRC donates only after thorough internal assessment.

Most organizations accept or request a broad range of equipment for operating theatres, emergency departments, and laboratories, plus instruments and furniture. Some MSROs exclude disposable supplies while others include them.

#### 4.5. Pre-Donation Partnerships and Agreements

Half (6/12) use extensive Memoranda of Understanding (MoUs) with partner facilities; some use succinct agreements or membership forms; a few have no formal agreement. Approaches differ by organization type and relationship depth, and documentation practices vary across MSROs and IMHOs.

#### 4.6. Assessment Practices Prior to Donation

Nine organizations (81.8%) conduct some form of assessment; two do not.

Assessment methods: four organizations perform field visits (including the ICRC and WHO), while five rely on remote methods such as email, phone calls, or online forms. Human resources checks are inconsistent: 44.4% of assessors do not evaluate end-users' clinical skills; 44.4% do not verify staff responsible for equipment disinfection; one-third do not check for an on-site biomedical technician.

Infrastructure checks are partial: two MSROs perform no environmental checks; roughly half verify electricity availability; only a minority (MSA, Humatem, ICRC and one other) verify electricity, water, and building structure comprehensively.

#### *4.7. Donation Policies, Quality Assurance, Consumables, Budget Transparency and Sustainability*

All IMHOs have written donation policies; only 4 of 9 MSROs provided policies, varying greatly in detail and length.

MSROs donate refurbished equipment while IMHOs procure and donate new equipment.

IMHOs require CE/FDA approvals and ISO 13485; 44.4% of MSROs test and repair all items, one tests samples, and others place responsibility on recipients.

MHOs supply consumables for up to one year; only 4 MSROs supply limited consumables. No organizations provided dedicated repair kits, though some supply spare-part references.

None of the respondents require or receive recipient facility budget information for consumables or spare parts, leaving donors unable to confirm whether facilities can sustain equipment upkeep and operation.

#### *4.8. Local Market Assessment and Distributor Information*

Two of three IMHOs consistently assess local markets for service providers and spare parts and share contact details with recipients; the ICRC does this only where a trained biomedical engineer is present.

Only one MSRO (Humatem) consistently assesses and shares local dealer contacts; two others sometimes assess but do not pass on contact details. Most MSROs do not systematically evaluate or communicate local service capacity.

#### *4.9. Training Provision*

Seven of twelve organizations (58%) provide no training at all.

One IMHO regularly organizes biomedical technician training.

Four organizations (ICRC, Humatem, MSA, and another MSRO) offer training opportunistically, depending on needs and available resources.

#### *4.10. Monitoring and Evaluation*

Only Humatem conducts systematic post-donation monitoring, maintaining updated inventories, regular reports, and a computerized maintenance system.

The remaining eleven organizations conduct no structured follow-up after delivery; their engagement typically ends with shipment.

#### *4.11. Monitoring Indicators*

Humatem is the sole organization tracking specific maintenance and training metrics, including in-house vs outsourced preventive maintenance, numbers of technicians trained, and numbers of medical users trained.

#### *4.12. Key Findings*

About two-thirds of donors use MoUs with recipient partners, but fewer than half perform field visits before donation; two organizations perform no pre-donation assessment.

Human-resource assessments are inconsistent: roughly half evaluate user abilities, two-thirds check for biomedical technician presence, but many do not verify disinfection practices or staff capacity.

Infrastructure checks are uneven: two organizations perform no infrastructure checks, while only about one-third consistently verify electricity, water, and structural conditions.

Policy and sustainability gaps persist: all IMHOs have written MED policies but fewer than half of MSROs do; only some donors supply consumables (typically for six months to one year); none request recipient budgets for consumables or spare parts.

Overall, donor engagement frequently stops at delivery, with limited market-linkage, training, or monitoring, undermining long-term usability and sustainability of donated equipment.

## 5. Discussion

### 5.1. Literature and Survey Synthesis

In the literature it was made clear that IMHOs and MSROs operate differently; IMHOs maintain longer field presence while MSROs typically operate from HICs and rely on partners in recipient countries. Major challenges in MED include equipment designs unsuited to austere LMIC environments, unreliable utilities, shortages of trained clinical and biomedical engineering staff, fragile consumables and spare-part supply chains, and weak monitoring systems. The literature also highlights scarce empirical research on MED practices and outcomes.

#### 5.1.1. Agreements and Assessments

The answers from the survey showed that IMHOs were more likely than MSROs to use formal MoUs, perform field visits, maintain written MED policies, and assess infrastructure and staff capacity. MSROs more commonly used remote assessments and often distributed refurbished equipment. Nearly all organizations responded to recipient requests rather than donor surplus, aligning with WHO guidance, but practice quality varied.

About half of respondents used detailed MoUs, while a minority operated without written agreements. Lack of formal agreements raises practical and ethical concerns.

Fewer than half of donors conducted field visits; two organizations conducted no pre-donation assessment. Many donors failed to comprehensively assess user skills, disinfection practices, availability of biomedical technicians, electricity, water, and structural suitability. Partial or absent assessments risk inappropriate donations that cannot be sustained locally.

#### 5.1.2. Quality and Sustainability

IMHOs donated new equipment and required regulatory/quality certifications; MSROs primarily donated refurbished items with variable testing and repair regimes.

IMHOs typically provided up to a year of consumables while MSROs were inconsistent. No organizations routinely provided repair kits, and none required recipient budget transparency for ongoing consumables and maintenance, leaving long-term affordability unverified.

Only one MSRO implemented systematic post-donation monitoring and tracked maintenance and training indicators. Most donor engagement ended at delivery. Training provision was limited. Most organizations offered no training or only ad hoc support. Few donors consistently assessed or linked recipients with local service providers or spare-part suppliers.

The dominant pattern is donor-driven delivery with insufficient assessment, capacity-building, market linkage, and follow-up, which undermines equipment utility and sustainability. Addressing these gaps requires stronger pre-donation assessments, formalized partnership agreements, explicit requirements for consumables and spare-part planning, investment in local biomedical engineering capacity, routine training, and robust post-donation monitoring tied to clear indicators.

This study found heterogeneity in formal MED governance. Among eleven respondents reporting on policy, all IMHOs maintained detailed, written medical equipment donation (MED) policies; four of nine MSROs lacked any documented MED guidance despite MED being core to their operations. WHO and ICRC policies are comprehensive, covering pre-donation onsite assessment, needs alignment, procurement quality assurance, and the role of biomedical engineering. Exemplars among MSROs include Humatem's project-file-based policy and the Medical Surplus Alliance's

publicly available MSRO Code of Conduct, both providing operational checklists and M&E elements that could inform weaker MSRO practices.

MSROs primarily distribute refurbished equipment and are responsible for restoring items to manufacturers' specifications, yet practices vary: some MSROs test and repair all items, one tests only samples, and one places testing responsibility on recipients. Such variability risks delivering nonfunctional equipment.

Consumable provisioning is uneven: seven organizations supply 6–12 months' consumables, while five (all MSROs) supply none. No donor routinely includes repair kits; a few provide spare-part references only. Absence of spare parts and repair tools contravenes WHO recommendations and heightens the likelihood of equipment abandonment when failures occur.

### 5.1.3. Local Market Assessment and Local Trainings

Assessment of local market capacity is inconsistent. Fewer than half of respondents evaluate recipients' ability to procure spare parts and consumables; only three routinely identify and share local dealer contacts. IMHOs more consistently communicate local supplier details, whereas most MSROs do not. The ICRC delegates such activity to contexts with in-country biomedical engineering capacity. These gaps impede local supply-chain continuity and increase dependence on external support.

Training for clinical users and biomedical technicians is infrequent. Seven of twelve organizations never organize user or technical training; one IMHO consistently provides technician training; a small subset (ICRC, Humatem, MSA and one MSRO) offer training contingent on need and resources. WHO guidance specifies donor responsibility to ensure user and maintenance training; failure to provide it undermines safe, effective device use and long-term sustainability.

### 5.1.4. Post Donation Monitoring

Post-donation monitoring is rare. Only one respondent reported systematic follow-up using an electronic maintenance-management system and indicators. The remainder terminate engagement at delivery. This lack of M&E obstructs feedback loops needed to detect high failure rates, adjust sourcing or refurbishment practices, and measure longer-term impact. The absence of routine recipient budget disclosure for consumables and spare parts further prevents donors from assessing financial sustainability of device operation.

## 5.2. Implications and Recommendations

Findings indicate a donor-driven model that insufficiently addresses operational sustainability. Key implications are:

- 1) Inconsistent policy adoption among MSROs leaves quality-control gaps
- 2) Variable testing and the routine omission of consumables and repair kits jeopardize device longevity
- 3) Poor linkage to local dealers and sparse training limit in-country capacity for maintenance and safe use
- 4) Lack of systematic M&E prevents organizations from learning and improving practice.

Recommended priorities for donors include adopting comprehensive MED policies, guided by WHO and the Partnership for Quality Medical Donation examples, (PQMD, 2019) standardizing testing and spare-part provisioning, mandating pre-donation assessment of infrastructure and workforce, establishing local supply-chain linkages, delivering user and technician training, and implementing routine post-donation monitoring with defined indicators to track functionality, maintenance activity and capacity building.

### 5.3. Limitations

This study has methodological and scope limitations that constrain generalizability and depth. The literature review was not systematic and therefore may have missed relevant publications; the MED evidence base is also relatively sparse. The sampling strategy used purposive selection from WHO lists and a small set of European IMHOs, so findings cannot be extrapolated to the full population of donors. Out of the 28 organizations contacted, 12 responded, producing potential nonresponse bias. The primary data derive from a primarily closed-question online survey rather than in-depth semi-structured interviews; recipient facilities were not surveyed, leaving a critical perspective absent. Time constraints limited participant recruitment and the survey field period, further restricting sample size and depth.

To address these limitations and improve MED practice, the study advances actionable recommendations structured across the donation lifecycle. Prior to donation, donors and solicitors should formalize partnerships in written agreements (MoUs or simpler contracts) that define responsibilities, transport costs, acceptance criteria, and contingency plans. Comprehensive pre-donation assessments of facility infrastructure (electricity, water, structural integrity) and human resources (clinical users, biomedical technicians, disinfection capacity) are essential; where onsite visits are infeasible, remote assessments must be exhaustive. All donor organizations, including MSROs, should adopt explicit MED policies aligned with WHO guidance that require needs verification, recipient involvement, quality assurances, and identification of additional operating costs.

### 5.4. Recommendations

Donors should routinely supply consumables and spare parts sufficient for initial operation and should assess local dealer availability so recipients can procure ongoing supplies and service locally. Inclusion of repair toolkits and spare-part references would facilitate repair and extend equipment lifespan. Donors must also ensure user and technical training for clinical staff and biomedical technicians; when internal capacity is limited, donors should partner with local dealers or expert organizations to deliver training.

After donation, systematic monitoring and bilateral feedback loops are vital. Donors should perform follow-up visits or remote monitoring and record outcome indicators to detect failures and iterate practices.

### 5.5. Indicators

Recommended indicators include equipment functionality status (percentage out of service), in-house versus outsourced preventive maintenance, number of technicians trained, and number of clinical users trained. Tracking full-time equivalent biomedical engineering capacity at recipient facilities further informs sustainability needs.

### 5.6. Discussion Conclusion

Broader structural reforms complement operational changes: strengthening local manufacturing and encouraging technology transfer can reduce dependency on imports and improve access to locally maintainable devices. Implementing these measures—standardized policies, rigorous assessments, consumable provisioning, training, local market linkage, and routine monitoring with defined indicators—would significantly improve the appropriateness, durability, and health impact of medical equipment donations to LMICs.

## 6. Conclusion

This study combined a literature review with a targeted online survey of international medical humanitarian organizations (IMHOs) and medical surplus recovery organizations (MSROs) to evaluate practices for medical equipment donation (MED) to low- and middle-income countries

(LMICs). Findings identify persistent gaps in pre-donation assessment, policy coverage, consumable and spare-parts provisioning, training, and post-donation monitoring that limit the suitability and sustainability of donated equipment.

Survey results indicate substantial heterogeneity across donor types. IMHOs more consistently maintain formal MED policies, conduct field assessments, require regulatory quality standards, and supply consumables; MSROs more often redistribute refurbished devices, rely on remote assessments, and vary widely in quality-assurance protocols. Most donors act on recipient requests, aligning with WHO guidance, yet execution of recommended practices is uneven. Only a minority of organizations systematically verifies facility infrastructure, user and technician capacity, local supplier availability, or budget allocations for ongoing operation and maintenance.

The research demonstrates that robust pre-donation assessment materially influences the likelihood of sustained device use. Field visits are preferable; when visits are infeasible, structured remote assessments must comprehensively document electricity, water, structural readiness, clinical user competence, and biomedical engineering capacity. Addressing identified gaps prior to shipment permits joint mitigation strategies such as training, local procurement planning, inclusion of consumables, or provision of spare parts and toolkits tailored to recipient context.

Post-donation monitoring and bilateral feedback are essential yet rare. Routine follow-up that tracks device functionality, maintenance actions, and training outcomes will create learning loops that improve subsequent donations and reduce equipment attrition. Simple, standardized indicators—equipment operational status, in-house versus outsourced preventive maintenance, numbers of technicians trained, and numbers of clinical users trained—provide actionable metrics to inform donor decisions and measure impact.

Longer-term improvements require structural shifts in production and support. Expanding local manufacture, technology transfer, and in-country service capacity will improve device appropriateness and access to spare parts and technical support. Donor organizations should adopt comprehensive MED policies aligned with WHO guidance, standardize refurbishment and testing practices, ensure consumable and spare-part provisioning, mandate pre-donation assessments, deliver user and maintenance training, and implement systematic post-donation monitoring.

Limitations of this study include a non-systematic literature review, purposive sampling, a modest response rate, and reliance on a predominantly closed online survey focused on donors rather than recipients. Despite these constraints, the study identifies clear, practicable measures that donors can implement to increase the clinical utility, durability, and health impact of medical equipment donations to LMICs.

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