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Reducing Clinical Waste in Flexible Cystoscopy: A Prospective Quality Improvement Study

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Abstract

Aims

Flexible cystoscopy is a very common procedure that relies heavily on single-use consumables, resulting in significant procedural waste. This study aimed to evaluate whether a targeted waste-segregation intervention could reduce clinical waste generation during flexible cystoscopy without compromising clinical practice.

Methods

A prospective audit of 50 consecutive diagnostic flexible cystoscopies performed at a tertiary urology centre was undertaken. Twenty-five procedures were evaluated before intervention, followed by structured contamination-based waste segregation training for clinical staff and a re-audit of 25 post-intervention procedures. Total procedural waste was weighed in grams, and individual disposable items were classified as clinical or domestic waste to determine segregation accuracy. The annual environmental and financial impact was modelled using institutional procedural volume, disposal costs, and a standard CO_2 conversion factor.

Results

Mean waste weight decreased from 994.4 g pre-intervention to 472.4 g post-intervention, representing a 52.5% reduction. Segregation accuracy improved from 0% to 53%, with 17 of 32 routinely used, non-contaminated items correctly diverted into domestic waste post-intervention. For a service performing 2,000 cystoscopies annually, this equates to approximately 1,044 kg less clinical waste, 1,138 kg lower CO_2 emissions and an estimated disposal cost saving of €1,930.

Discussion

Behaviour-focused segregation training halved total waste generated during flexible cystoscopy and deliver measurable environmental and financial benefits without altering

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consumables, workflow or infection control practice. This represents a scalable, low-cost sustainability strategy for outpatient urology.

Introduction

Managing clinical waste is a significant challenge in healthcare, with associated financial and environmental impacts [1,2]. Flexible cystoscopy is a common outpatient urological procedure, with a wide range of waste from disposable materials such as gloves, drapes and sterile packaging[3]. In practice, a portion of this could be directed to clinical waste streams rather than being recycled or placed in domestic waste. Evidence from the Green Healthcare Programme suggests that acute hospitals could save more than €7,000 annually through improved segregation and recycling practices[4]. Further, clinical waste incineration is highly carbon intensive, generating approximately 1.09 kg of carbon dioxide for every kilogram of waste incinerated[1]. Improving waste management in flexible cystoscopy suites therefore represents a practical and immediate opportunity to reduce both environmental impact and healthcare costs.

Similar patterns have been reported across a range of healthcare settings, where a large proportion of waste classified as clinical was shown to be non-contaminated and suitable for domestic or recyclable disposal without compromising infection control standards[5]. However, uncertainty around waste classification, habitual use of clinical bins, and workflow pressures often result in unnecessary disposal of clean items as clinical waste[6]. Interventions that target these behaviours, particularly through staff education, contamination-based segregation, and clearer disposal pathways, have been associated with reductions in waste of 20–70% in surgical settings[7]. Despite this growing evidence base, flexible cystoscopy has not been widely examined from a sustainability perspective.

This study aimed to quantify the waste generated during routine diagnostic flexible cystoscopy and to assess how this waste is managed in everyday clinical practice. We examined segregation accuracy before and after a structured education intervention, focusing on contamination-based disposal. The study also considered the environmental and financial implications of improving waste management within a high-volume cystoscopy service.

Methods

A prospective quality improvement audit was conducted in the flexible cystoscopy suite of a tertiary urology department. Fifty consecutive flexible cystoscopies were analysed during November 2024 using the Ambu aScope 5 Cysto HD cystoscope. The first 25 procedures

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were evaluated under existing waste disposal practices, and after implementation of a sustainability-focused intervention, the next 25 procedures were monitored in the same way. All procedures were diagnostic during the audit period. Permission to carry out the study was obtained from the local hospital audit committee.

The intervention was the adoption of best-practice waste segregation standards defined by the EPA Green Healthcare best practice guideline for waste reduction[8]. A single structured educational session was provided to nursing and clinical personnel, delivered within the cystoscopy suite. The teaching emphasised correct categorisation of contaminated and non-contaminated material, appropriate use of domestic waste bins for non-infectious items, and the avoidance of unnecessary disposal into the clinical waste bins. No changes were made to clinical workflow, equipment usage, or infection control precautions.

For each cystoscopy, all non-sharp disposable material was weighed immediately after the procedure using a calibrated digital scale. Item-level segregation accuracy was also assessed. Each consumable used during cystoscopy was classified according to contamination status as either clinical waste or domestic/landfill waste. These classifications were entered prospectively into a structured spreadsheet, enabling comparison of disposal behaviour before and after the intervention.

The primary outcome was the difference in total waste weight between the pre- and post-intervention cohorts. The secondary outcome was segregation accuracy, defined as the proportion of uncontaminated items correctly diverted away from the clinical waste stream after the intervention. Exploratory outcomes included environmental and financial impact projections based on changes in waste disposal.

Carbon emissions were estimated using a standard conversion factor of 1.09 kg of CO_2 produced per kilogram of clinical waste incinerated[1]. Financial savings were modelled using a national disposal rate of €2,125 per tonne of clinical waste[4]. Annual projections were calculated using an average activity level of approximately 2,000 flexible cystoscopies per year.

Continuous data from the two cohorts were analysed as non-paired distributions. Mean values were calculated for both groups, and differences in waste weight were assessed using appropriate statistical testing with a significance threshold of $p < 0.05$. Segregation outcomes were described using absolute counts and proportional accuracy. All statistical analyses and figure generation were performed using Python 3.10 (SciPy ecosystem).

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Results

Procedural Waste Weight

Fifty consecutive diagnostic cystoscopies were analysed, with 25 procedures in each cohort. Total waste weight decreased significantly following implementation of the segregation protocol ($p < 0.0000002$). The mean waste weight fell from 994.4 g in the pre-intervention cohort to 472.4 g in the post-intervention cohort (Table 1), representing an absolute reduction of 522 g per case and a relative reduction of 52.5%. Individual procedure weights ranged from 780 to 1,090 g pre-intervention and from 340 to 620 g post-intervention. The reduction in mean procedural waste is illustrated in Figure 1.

Segregation Accuracy

A detailed review of individual waste items showed a clear and meaningful change in how waste was disposed of after the intervention. Prior to implementation, all routinely used consumables were discarded as clinical waste (32 items). Following the intervention, only 15 items remained in the clinical waste stream, while 17 non-contaminated items were correctly redirected to domestic waste (Table 2), corresponding to a segregation accuracy of approximately 53%. The items most diverted included glove wrappers, sterile packaging and empty saline bags. In contrast, genuinely contaminated items such as drapes, swabs, and used syringes continued to be disposed of appropriately as clinical waste. Overall, these findings demonstrate a shift away from default disposal into clinical waste towards more accurate, contamination-based segregation following staff training.

Environmental and Financial Impact

The observed reduction in clinical waste corresponds to considerable environmental benefit. Based on an average reduction of 522 g of clinical waste per cystoscopy, an institution performing approximately 2,000 procedures annually would avoid incineration of 1,044 kg of waste (Table 3). Applying a conversion factor of 1.09 kg of CO_2 per kilogram of clinical waste incinerated, this equates to an estimated reduction of 1,138 kg of CO_2 emissions per year. Financial modelling based on the national disposal cost of €2,125 per tonne of clinical waste suggests an annual saving of approximately €2,418.25 for the cystoscopy service (Table 3). These estimates are conservative, as recycling pathways were not available within the cystoscopy suite, and non-contaminated materials that might ordinarily be recycled were instead diverted into household waste.

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Discussion

This prospective audit shows that a simple behaviour change, supported by clear and practical waste-segregation guidance, can lead to a meaningful reduction in waste during diagnostic flexible cystoscopy. After performing an educational session for cystoscopy suite personnel, the amount of clinical waste generated per procedure fell by over 50%, and correct segregation improved from 0% to 53%. This was a cost-effective and impactful intervention. These findings illustrate that much of the waste produced during cystoscopy is clean, non-contaminated packaging that does not need to be treated as clinical waste. Our results support existing sustainability evidence that improving how waste is sorted can have a great impact on reducing procedural waste.

The degree of waste reduction observed is comparable to findings from perioperative research. Prior studies in operating theatres have demonstrated that 40-70% of materials classified as clinical waste are non-contaminated and suitable for domestic or recyclable disposal [9]. Interventions focusing on staff education, waste auditing, and contamination-based disposal have been shown to reduce the volume of medical waste by 20-60% without compromising sterility or safety[10]. Our findings show that the same principle applies to flexible cystoscopy.

Although endoscopy has received increasing attention in sustainability research, most studies have focused on high-volume therapeutic gastrointestinal endoscopy, where disposable plastics and packaging constitute a significant environmental burden[11,12]. An evaluation of sustainability practices in gynaecology similarly observed that most disposables categorised as healthcare risk waste were not contaminated and could be diverted to domestic or recyclable streams without compromising infection precautions[13]. Comparable evidence in urology is limited. To our knowledge, this is one of the first studies to quantify waste generation in flexible cystoscopy and demonstrate modifiable waste reduction through practice change.

A key insight from current healthcare sustainability literature is that the environmental impact of medical activity is not determined solely by the material composition of consumables, but by how these materials are handled, segregated, and disposed of[14]. Factors such as staff awareness, bin positioning, and familiarity with waste categories strongly influence disposal pathways. Multiple studies in surgical and anaesthetic settings have shown that defaulting to clinical waste bins is common[15]. Before the intervention, this pattern was clearly evident, with all disposable items routinely placed into the clinical waste stream regardless of whether they were contaminated. The improvement seen after education shows that accurate waste segregation is achievable when staff are given clear guidance and simple prompts within their workflow.

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The environmental benefit demonstrated is consistent with current carbon accounting in healthcare. Incineration of clinical waste contributes greatly to healthcare emissions because of its high energy requirement, with approximately 1.09 kg of CO_2 generated per kilogram of incinerated material[1]. Previous life-cycle assessments of operating room waste have estimated that between 5–15% of hospital carbon emissions arise from regulated medical waste streams[16]. By diverting an estimated one tonne of clinical waste per year, our findings translate into a reduction of over one tonne of CO_2 emissions annually for a single outpatient procedure room. When scaled nationally across hospitals performing cystoscopy, the potential cumulative environmental benefit is substantial.

Current literature shows that introducing effective recycling and waste-segregation practices can lead to meaningful cost reductions [17]. Multiple quality improvement programmes in surgical environments have demonstrated that improved waste segregation can reduce annual cost without altering equipment or compromising sterility[17,18]. The estimated annual savings of approximately €1,930 from cystoscopy alone may seem modest in isolation, but it becomes more significant when expanded to other similar procedure rooms nationally. This finding is consistent with recent studies that describe waste stewardship as a cost-neutral or cost-saving approach to improving sustainability in healthcare[19,20].

Limitations of this study include its single-centre design, short follow-up period, and reliance on domestic rather than recyclable disposal pathways. Previous studies suggest that segregation accuracy may decline over time without ongoing reinforcement, periodic auditing, or clear visual cues at the point of disposal[20,21]. Future research should examine scalability and long-term sustainability of behaviour change with regards to recycling.

This prospective audit highlights an opportunity to reduce avoidable waste during diagnostic flexible cystoscopy through simple changes in how waste is managed. A straightforward education-based intervention reduced total waste by more than 50% and improved segregation accuracy from 0% to 53%, with associated reductions in carbon emissions and disposal costs. These findings show that sustainability improvements in outpatient urology can be achieved without changing equipment or disrupting clinical workflow, by embedding contamination-based waste segregation into routine practice.

Declarations of Conflicts of Interest:
None declared.

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Tables and Figure Legends:

Table 1. Procedural waste

	Pre intervention	Post intervention
Mean (g)	999.4	472.4
Median (g), IRQ	1020, IQR 50	480, IQR 90
Range	780-1090	340-620

Summary statistics for procedural waste weight before and after intervention. Values represent mean, median with interquartile range (IQR), and full observed range for 25 consecutive diagnostic cystoscopies per cohort.

Table 2. Item level waste segregation counts

	Pre intervention	Post intervention
Clinical Waste	32	15
Household Waste	0	17

Item-level waste segregation before and after intervention. Counts represent the number of disposable items classified into clinical waste versus household (domestic) waste streams during a single diagnostic cystoscopy session. Post-intervention data demonstrate improved

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segregation accuracy, with a shift from exclusive clinical waste disposal to 53% correct diversion of non-contaminated items into the household waste stream.

Table 3. Annual environmental and financial impact projections

Outcome	Estimated value
Annual waste reduction	1044kg
Estimated CO_2 reduction	1138kg
Estimated annual cost saving	€2,418

Estimated annual waste, environmental, and financial impact associated with implementation of contamination-based waste segregation in a high-volume cystoscopy service. Projections are based on observed per-procedure waste reductions applied to 2,000 procedures annually.

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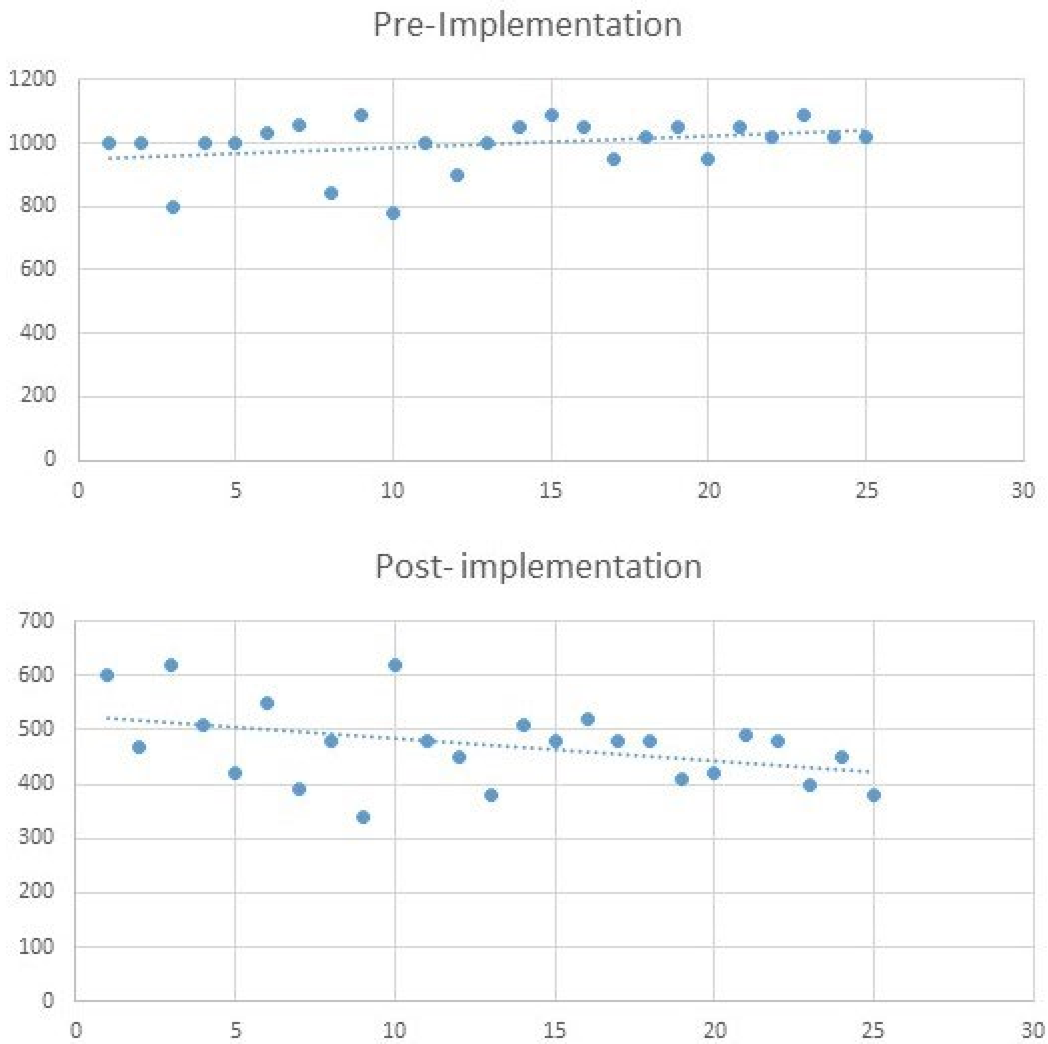
Figure 1



Total procedural waste weight for consecutive diagnostic flexible cystoscopies collected before (top) and after (bottom) implementation of contamination-based waste segregation guidelines. Each point represents a single procedure (n = 25 per cohort). The dotted regression lines demonstrate negligible change in waste generation under routine disposal practices before the intervention and a clear downward trend following staff education and protocol implementation. These findings illustrate improved segregation behaviour and reduced total waste production over time.