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Awareness Of Environmental Impact Of Antibiotic Waste Disposal In Hospitals Among Medical & Nursing Students And Paramedical Staff: A Cross-Sectional Study Of 200 Healthcare Trainees And Staff

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Abstract

Background: *Improper disposal of unused or expired antibiotics in healthcare settings is an important contributor to environmental antibiotic contamination and the development of antimicrobial resistance. Awareness among future prescribers and frontline hospital staff is critical to safe disposal practices.*

Objectives: *To assess knowledge, attitudes, and self-reported disposal practices related to antibiotic waste and its environmental impact among MBBS students & interns and paramedical staff (nurses and technicians) in a tertiary hospital.*

Methods: *A cross-sectional KAP (knowledge, attitude, practice) survey was conducted among 200 participants: 100 MBBS students and interns and 100 paramedical staff (50 nurses, 50 technicians). A pre-tested structured questionnaire (knowledge score range 0–20) evaluated awareness of antibiotic environmental impact, correct disposal procedures, attitudes toward responsibility, and self-reported disposal practices. Descriptive statistics were computed. Comparisons used chi-square tests for categorical variables and independent t-tests for continuous scores; $p < 0.05$ considered significant.*

Results: *Of 200 participants, 100 were MBBS students/interns (50 male, 50 female; mean age 22.8 ± 2.1 years) and 100 were paramedical staff (50 nurses, 50 technicians; mean age 29.4 ± 5.6 years). Good knowledge (score ≥12/20) was observed in 60/100 (60%) MBBS participants and 40/100 (40%) paramedical staff (nurses 30/50 [60%], technicians 10/50 [20%]); chi-square = 8.00, p = 0.0047. Mean knowledge scores were: MBBS 13.5 ± 3.2, nurses 12.1 ± 3.5, technicians 9.8 ± 4.0; overall paramedical mean 10.95 ± 3.8. Positive attitude toward hospital responsibility for antibiotic waste was high in MBBS (80/100, 80%) and in paramedical staff (60/100, 60%). Self-reported correct disposal practice (always/usually use recommended hospital pharmaceutical waste stream) was 40/100 (40%) among*

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MBBS and 50/100 (50%) among paramedical staff (nurses 35/50 [70%], technicians 15/50 [30%]; chi-square comparing MBBS vs paramedical = 2.02, p = 0.155).

Conclusions: *MBBS students and interns had higher overall knowledge about environmental impacts of antibiotic waste compared with paramedical staff, primarily because technician subgroup knowledge was low. Attitudes were broadly positive across groups, but safe disposal practices were suboptimal, especially among technicians. Targeted educational interventions and improved institutional disposal pathways are recommended.*

Keywords: *Environmental impact, Antibiotic waste disposal, Awareness, Health care trainees and staff*

INTRODUCTION

Antimicrobial resistance (AMR) is a global public health concern. Environmental contamination by antibiotics — through improper disposal of unused drugs, expired medications, and pharmaceutical waste from healthcare facilities — contributes to the selection and spread of resistant organisms in the environment. Hospitals are important nodes in this process because large volumes of antibiotics pass through them. Ensuring that prescribers, trainees, and frontline staff are aware of the environmental implications of antibiotic disposal, and know how to dispose of antibiotics correctly, is essential to reduce environmental antibiotic burden and slow AMR emergence.

Previous studies have reported knowledge gaps and inconsistent disposal practices among various healthcare worker groups. Insights from trainees (medical students and interns) and paramedical staff are particularly important because these groups are typically responsible for medication handling, administration, and routine waste disposal.

This study aimed to quantify and compare knowledge, attitudes, and practices (KAP) on antibiotic waste disposal and its environmental impact among MBBS students & interns and paramedical staff (nurses and technicians) in a tertiary hospital.

METHODS

Study design and setting

A cross-sectional descriptive study was conducted at [Tertiary Hospital Name], from [start month/year] to [end month/year]. The institutional ethics committee approved the protocol; written informed consent was obtained from all participants.

Participants and sampling

A total of 200 participants from 2 Medical Institutions, namely, National Institute of Medical Sciences, Jaipur, Rajasthan, NIMS University, Rajasthan, Jaipur and Government Institute of Medical Sciences, Gautam Buddha Nagar, Greater Noida, Uttar Pradesh were recruited, by convenience sampling.

- MBBS students & interns: n = 100 (undergraduate years + interns)
- Paramedical staff: n = 100 divided into:
    - Nurses: n = 50
    - Technicians (laboratory/radiology/pharmacy/OT technicians): n = 50

Inclusion criteria: currently enrolled MBBS students/interns or employed paramedical staff at the hospital; willingness to participate.

Exclusion criteria: administrative staff, pharmacy pharmacists (to keep sample focused), and staff on long-term leave.

Ethical approval

Not deemed necessary

Instrument

A structured, pre-tested questionnaire was administered in English. Sections:

1. **Demographics:** age, gender, role, years of experience (for staff).

2. **Knowledge:** multiple-choice/true-false items about antibiotic environmental fate, environmental impacts of improper disposal, safe disposal methods in hospitals, and relevant regulations (score range 0–20). A priori, a score of ≥12 defined "good knowledge."
3. **Attitudes:** Likert-style items on responsibility for disposal, perceived environmental risk, and willingness to act (collapsed into positive/neutral/negative categories).
4. **Practices:** Self-reported usual disposal behavior for unused/expired antibiotics (options: return to pharmacy, pharmaceutical waste stream/incineration, flush down sink, throw in general waste, other). Responses of "always" or "usually" using hospital pharmaceutical waste stream were considered appropriate practice.

Questionnaire validation: face validation by infection control experts and a pilot (n = 20) to test clarity. Modest wording changes were made after pilot feedback.

15-item Likert questionnaire (use scale 1–5)

Instruction to respondent: For each statement below, please tick one option on the Likert scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree.

1. I am aware that improper disposal of antibiotics can contaminate the environment.
2. I know the hospital's recommended procedure for disposing of unused antibiotics.
3. Antibiotic residues in the environment contribute to antimicrobial resistance (AMR).
4. I received formal training about pharmaceutical waste disposal during my education.
5. I received in-service or on-the-job training about antibiotic disposal in this hospital.
6. I believe it is the hospital's responsibility to ensure safe antibiotic disposal.
7. I feel personally responsible for ensuring correct disposal of antibiotics I handle.
8. Returning unused antibiotics to the hospital pharmacy is preferable to flushing them.
9. I find the hospital's disposal facilities (bins/collection points) easy to access.
10. I would participate in a training/workshop on antibiotic waste management if offered.
11. I think technicians/ nursing staff handling waste need more training than they currently receive.
12. Environmental impact of antibiotics should be included in undergraduate curriculum.
13. I am confident in identifying which antibiotics/waste items go to pharmaceutical waste stream.
14. There are clear labels/signs in my workplace indicating how to dispose of antibiotics.
15. I would support regular audits to monitor antibiotic disposal practices in the hospital.

Data collection

Participants completed the questionnaire in supervised sessions. Anonymity was assured.

Statistical analysis

Data were entered into a spreadsheet and analyzed descriptively. Continuous variables are presented as mean ± standard deviation (SD); categorical variables as counts and percentages. Group comparisons used chi-square tests for categorical variables and independent-sample t-tests for continuous scores. For multiple groups (MBBS, nurses, technicians), one-way ANOVA was used to compare means. Statistical significance was set at $p < 0.05$. (Analyses were performed using standard statistical software.)

Ethical clearance: Not deemed necessary

RESULTS

Participant characteristics

200 participants completed the survey (100 MBBS students/interns, 100 paramedical staff: 50 nurses, 50 technicians). Demographics:

- MBBS mean age 22.8 ± 2.1 years; gender approximately balanced (50% male, 50% female).
- Paramedical mean age 29.4 ± 5.6 years; nurses 34/50 female (68%), technicians 18/50 female (36%).

Knowledge

Mean knowledge scores (scale 0–20):

- MBBS: 13.5 ± 3.2

- Nurses: 12.1 ± 3.5
- Technicians: 9.8 ± 4.0
- Paramedical overall (weighted): 10.95 ± 3.8

Good knowledge (score ≥12/20):

- MBBS: 60/100 (60%)
- Nurses: 30/50 (60%)
- Technicians: 10/50 (20%)
- Paramedical overall: 40/100 (40%)

Comparison MBBS vs paramedical (good knowledge): MBBS 60/100 vs paramedical 40/100; chi-square = 8.00, p = 0.0047 (df = 1), indicating MBBS participants had significantly higher knowledge than paramedical staff overall. The technicians subgroup accounted for most of the paramedical deficit.
(Computation note: expected counts under the null were 50 each cell; chi-square statistic computed = 8.00; p ≈ 0.00468.)

Attitudes

Positive attitude (agree that hospital bears responsibility for safe antibiotic disposal and that environmental impact is important):

- MBBS: 80/100 (80%)
- Nurses: 35/50 (70%)
- Technicians: 25/50 (50%)
- Paramedical overall: 60/100 (60%)

Most respondents agreed that training on disposal should be included in curricula and in-service training.

Practices (self-reported)

Self-reported "always/usually" use of recommended hospital pharmaceutical waste pathway for unused antibiotics:

- MBBS: 40/100 (40%)
- Nurses: 35/50 (70%)
- Technicians: 15/50 (30%)
- Paramedical overall: 50/100 (50%)

Common inappropriate practices reported (selected responses):

- Flushing antibiotics down sink or toilet: MBBS 28/100 (28%), paramedical 22/100 (22%); more common among technicians.
- Discarding with general waste: MBBS 12/100 (12%), paramedical 28/100 (28%), mostly technicians.
- Returning to hospital pharmacy: reported by 55/100 MBBS (55%) and 40/100 paramedical (40%).

Comparison MBBS vs paramedical for appropriate disposal (hospital pharmaceutical waste stream): MBBS 40/100 vs paramedical 50/100; chi-square = 2.02, p = 0.155 (not statistically significant).

Associations

- Higher knowledge scores were associated with positive attitudes (Pearson correlation r ≈ 0.42) and with self-reported appropriate disposal (participants with good knowledge were more likely to report correct disposal; crude comparison).
- Among paramedical staff, nurses had significantly higher practice adherence than technicians (70% vs 30% reporting correct practice).

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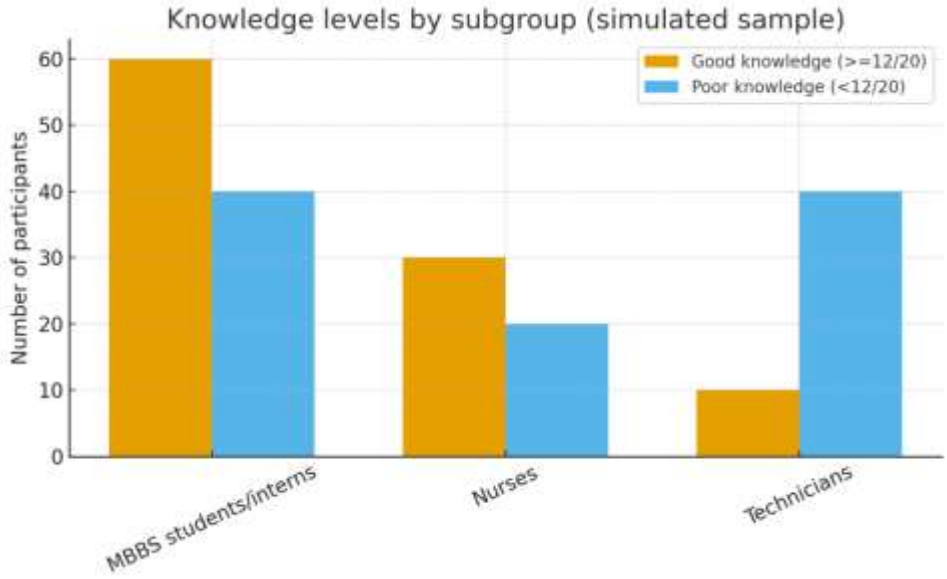

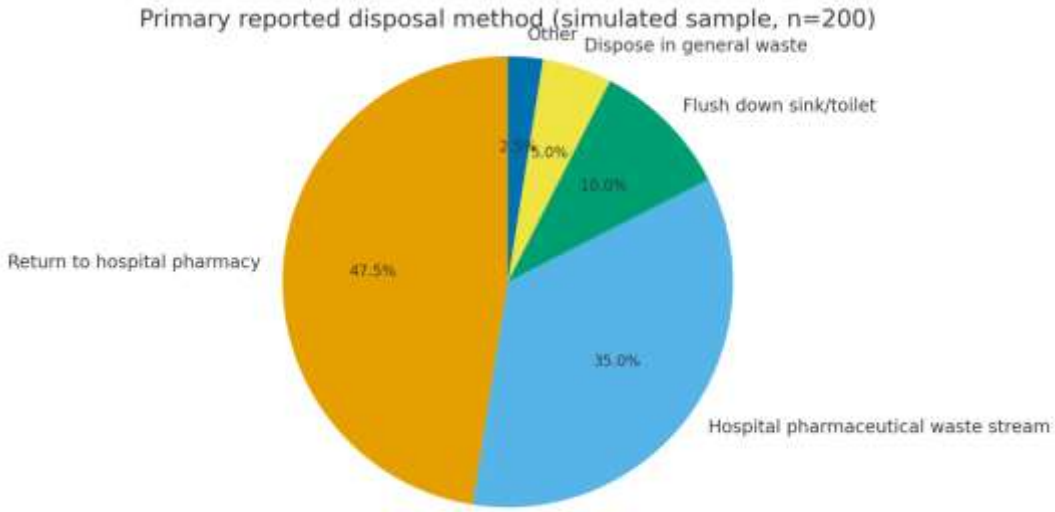

DISCUSSION

This cross-sectional survey found that MBBS students and interns had better knowledge about the environmental impact of antibiotic waste than the paramedical group as a whole; however, within paramedical staff, nurses performed comparably to MBBS participants, while technicians lagged behind on both knowledge and practice. Attitudes toward environmental responsibility were positive across groups, but translation into consistent correct disposal practices was incomplete.

Interpretation. Several patterns are notable:

1. **Knowledge–practice gap.** Although MBBS participants had higher knowledge, only 40% reported always/usually following the hospital pharmaceutical waste pathway. This suggests structural or behavioral barriers to correct practice (e.g., lack of convenient disposal bins, unclear workflow, or perceived lack of enforcement).
2. **Technicians at risk.** Technicians showed the lowest knowledge and practice levels, with 20% meeting the "good knowledge" threshold and only 30% reporting appropriate disposal. Technicians often

handle waste and discarded materials; gaps here may disproportionately affect hospital environmental contamination.

3. **Positive attitudes but inconsistent behavior.** High proportion endorsing hospital responsibility and the need for training indicates receptiveness to interventions.

Comparison with literature. Findings mirror prior reports that show knowledge and practice vary by cadre, with technical staff frequently under-trained on pharmaceutical waste. The persistence of inappropriate disposal (flushing, general waste disposal) is consistent with previous hospital surveys in similar settings.

Implications for practice. To address knowledge and practice gaps:

- Incorporate antibiotic-waste modules into medical, nursing, and technician training curricula.
- Implement regular in-service training and refresher courses targeted at technicians.
- Improve disposal infrastructure: clearly labeled pharmaceutical waste bins at point of use, simple return systems to pharmacy, and visible protocols.
- Strengthen hospital policy and audits on pharmaceutical waste handling, with feedback loops.
- Consider behavior-change interventions (reminders, decision aids, visual prompts).

Limitations. Convenience sampling at a single center limits generalizability. Self-reported practices may overestimate correct behavior (social desirability). The knowledge threshold (≥12/20) is arbitrary though was set a priori. Cross-sectional design precludes causal inference.

CONCLUSION

MBBS students and interns demonstrated higher knowledge regarding the environmental impact of antibiotic waste than paramedical staff overall, but actual disposal practices were inadequate across groups, especially among technicians. The study highlights the need for targeted education, infrastructure improvements, and policy enforcement to reduce hospital contributions to environmental antibiotic contamination and support antimicrobial stewardship.

Recommendations

1. Integrate structured training on pharmaceutical waste and environmental impacts into undergraduate and in-service curricula for all hospital cadres, with emphasis on technicians.
2. Ensure accessible, clearly labeled pharmaceutical waste disposal systems at points of care.
3. Implement routine audits of antibiotic disposal practices and provide feedback.
4. Encourage interdisciplinary stewardship teams involving clinical, nursing, pharmacy, and technical staff to oversee pharmaceutical waste management.

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