Research Article

Interprof. J. Health Sci. 2025, 23(1): IJHS-0726

Analysis of the Relationship between the Number of Patients Receiving Services and the Amount of Infectious Waste Generated at the University of Phayao Dental Hospital

Paphaon Kheawseema[1] and Somboon Chaiprakarn[2,*]

[1]School of Dentistry, University of Phayao, Muang, Phayao 56000, Thailand
[2]Faculty of Engineering, Science and Technology, Sarasas Suvarnabhumi Institute of Technology, Samut Prakan 10540, Thailand
*Corresponding author: E-mail: somboon.chn@svit.ac.th
Received 19 April 2025; Revised 30 May 2025; Accepted 4 June2025

Abstract: This study aimed to 1) examine the amount of infectious waste generated by each clinic within the Dental Hospital, University of Phayao; 2) investigate the number of patients receiving services at each clinic; and 3) analyze the relationship between the number of patients and the amount of infectious waste produced. A descriptive cross-sectional study design was employed. Data were collected between August 2024 and January 2025 via the HOSxP hospital information system and infectious waste records in accordance with the Department of Health guidelines. Correlation analysis was conducted using Pearson's or Spearman's correlation coefficients, depending on the normality of the data. The results revealed a strong positive correlation between the number of patients and the amount of infectious waste ($r = 0.829$, $p = 0.042$), which was statistically significant. These findings suggest that the amount of infectious waste in dental clinics is influenced not only by the number of patients but also by the nature of the procedures, the types of materials used, and the waste management practices of each clinic. This study provides valuable insights for designing effective infectious waste management systems tailored to the specific context of each clinic. This study also supports the development of efficient, safe, and environmentally friendly waste management practices and highlights the need for further research with larger and more diverse datasets.

Keywords: Infectious waste, Dental clinic, Patient volume

INTRODUCTION

The issue of infectious waste in healthcare facilities is a significant concern that requires effective management, as such waste can impact the health of medical personnel, patients, and the surrounding environment. Dental hospitals are among the healthcare facilities that generate substantial amounts of infectious waste from dental treatment processes. This includes disposable items such as syringes, gauze, and materials contaminated with bodily fluids. If not properly managed, these wastes can contribute to the spread of pathogens and have adverse effects on the environment.

The management of infectious waste in healthcare facilities requires appropriate measures to prevent the contamination of pathogens and toxic substances in water sources and soil. Inadequate waste management may pose serious health risks and cause environmental damage (1). The management of medical waste is a critical issue affecting both public health and the environment. Recent studies have shown that the COVID-19 pandemic has dramatically increased the amount of infectious waste in healthcare facilities, including dental clinics, due to the widespread use of personal protective

equipment (PPE), disposable instruments, and stricter infection control protocols (2–4). The World Health Organization reported a 30% increase in global healthcare waste during the pandemic, highlighting the need for updated, robust waste management strategies (1). This increase is particularly evident in dental clinics, where treatments often require close contact with patients and the use of additional one-way barriers (3, 4). Although many developed countries have regulations governing medical waste, there remains a lack of clear guidelines for identifying what qualifies as infectious waste. This ambiguity often leads to inefficient waste segregation and an increase in the volume of waste requiring costly and environmentally harmful disposal methods, such as incineration. These challenges highlight the need for enhanced education for healthcare personnel and the development of standardized waste segregation systems to promote sustainable waste management in healthcare facilities. Furthermore, additional research is essential, as the growing volume of medical waste tends to correlate with rising global GDP (1). A study by Chartier et al. (5) also highlighted that the management of infectious waste in healthcare facilities with a high number of patients, such as dental hospitals, is particularly important, as the volume of infectious waste tends to increase with the number of patients receiving services (6). However, recent research indicates that not only patient volume but also the type and complexity of dental procedures, as well as the adoption of new infection control measures, significantly influence waste generation (7).

The University of Phayao Dental Hospital provides dental services to the public and students. This generates a large amount of infectious waste that must be effectively disposed of. Recent internal reports indicate that the amount of infectious waste has steadily increased over the past three years due to an increase in patient volume and the expansion of the scope of dental procedures. The clinic currently faces challenges such as non-compliance with waste segregation regulations, inadequate staff training in waste management, and limited waste disposal infrastructure. These issues highlight the urgent need for a comprehensive assessment of infectious waste generation patterns and disposal methods in order to implement targeted interventions. However, detailed data on the relationship between patient volume and waste generation at the hospital level are lacking. This is a critical knowledge gap that this study aims to fill (8).

Each dental clinic at the University of Phayao Dental Hospital specializes in providing different types of treatments, which can affect the amount and type of infectious waste generated. For example, dental surgery clinics primarily perform restorative treatments such as fillings and crown preparations, which typically involve the use of disposable materials such as gloves, cotton rolls, and suction tubes. Surgical procedures performed at oral surgery clinics typically generate large amounts of infectious waste due to the use of surgical drapes, sutures, and disposable instruments. Diagnostic clinics such as orthodontics and oral radiology typically generate less infectious waste because their procedures are less invasive and make greater use of reusable equipment. Understanding these differences in procedures helps explain why the amount of waste generated varies between clinics, beyond simply the number of patients treated.

The objective of this research was to study the amount of infectious waste and the number of patients in each clinic, as well as to analyze the relationship between these two variables. The findings support the design of an infectious waste management system that is appropriate for the specific service characteristics of each type of dental clinic.

METHODS

Study Design and Setting

A descriptive cross-sectional study design was used to analyze the patient population and hospital-level infectious waste data from August 2024 to January 2025. Patient data were retrieved from the hospital information system HOSxP, while the amount of infectious waste was recorded using a standardized waste collection form maintained by each clinic. The analysis focused on investigating the relationship between the number of patients treated in each dental clinic and the amount of infectious waste generated.

Data Collection

The data were recorded via the Infectious Waste Volume Recording Form, in accordance with the Department of Health's announcement (9). The HOSxP hospital information management system was utilized to retrieve data on patient services and procedures during the specified period. Data on the volume and types of infectious waste were collected from dental clinics at the University of Phayao Dental Hospital. Patient service and procedural data retrieved from the HOSxP system were used to analyze the relationship between dental procedures and the volume of infectious waste generated.

Specific Procedures for Measuring and Recording Infectious Waste Volumes:

In each clinic, infectious waste was collected daily and segregated according to the Department of Health guidelines. Waste was placed in designated color-coded containers or bags (typically red or yellow) labeled for infectious waste. At the end of each working day, trained staff weighed the total infectious waste generated in each clinic using a calibrated digital scale with an accuracy of ±0.01 kg. The measured weight was recorded on a standardized Infectious Waste Volume Recording Form, which included fields for the date, clinic name, type of waste, and total weight (in kilograms). Each form was reviewed and signed by the responsible staff member and verified by a supervisor. Monthly, the forms were compiled and cross-checked with central waste management records to ensure accuracy and completeness.

The waste volume data was then aggregated by clinic and by month for analysis. To ensure consistency, all weighing and recording procedures followed a standard operating protocol, and staff received regular training on waste segregation, weighing, and documentation practices. Any discrepancies or missing data were investigated and resolved before analysis.

Data Quality Control

To ensure the accuracy and completeness of the data collected from various sources, regular reviews were performed by hospital staff and the research team. Hospital staff were responsible for initial data entry and routine checks at each clinic, while the research team performed regular audits to cross-check the integrity of the data.

As part of the double check (parallel validation), two independent reviewers from the research team checked the consistency and accuracy of the recorded data separately. Any deviations found were discussed and resolved through consultation, with reference to the original records where appropriate. This approach helped to minimize errors in data collection and analysis.

For clinics whose data did not pass the normality test (Shapiro–Wilk test), non-parametric statistical methods were applied to analyze the data. Specifically, Spearman's rank correlation coefficient was used instead of Pearson's correlation to assess relationships involving non-normally distributed variables. This ensured appropriate handling of data distribution characteristics and valid statistical inference.

Normality testing was performed via the Shapiro–Wilk test for each clinic:

Clinics that did not pass the normality test include prosthodontics, endodontics, operative dentistry, and orthodontics.

Clinics that passed the normality test (p value > 0.05) included pediatric dentistry, general dentistry, oral and maxillofacial surgery, periodontology, specialized dentistry, and prosthodontics.

Interpretation

Correlation Coefficient (r):

- The value of r ranges from -1 to 1
- $r > 0$: Positive correlation (as the number of patients increases, the amount of infectious waste increases).
- $r < 0$: Negative correlation (as the number of patients increases, the amount of infectious waste decreases).
- $r = 0$: No correlation

Interpretation of the value of r (10):

- 0.00-0.19: Very weak correlation
- 0.20-0.39: Weak correlation
- 0.40-0.59: Moderate correlation
- 0.60-0.79: Strong correlation
- 0.80-1.00: Very strong correlation

Statistical Analysis

Inferential statistics, specifically correlation analysis, were used to examine the relationship between two variables: the number of patients receiving services and the amount of infectious waste generated. Descriptive statistics were used in this study. The level of statistical significance was set at $p < 0.05$.

Ethical Approval

This study was approved by the University of Phayao Human Ethics Committee (Reference No. HREC-UP-HSST 1.1/038/67) on August 20, 2024. It adhered to the ethical principles outlined in the Declaration of Helsinki and the International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines. No personal data were collected, and all information related to patient identification was anonymized. The analyses were conducted using aggregated data.

RESULTS

The data indicate substantial variation in patient volume across clinics and months, with special, operative dentistry, and periodontology clinics serving the highest number of patients, suggesting differing patterns of service demand and utilization within the hospital, as shown in Table 1.

The volume of infectious waste varied across clinics and months, with oral surgery and the Special Clinic being the primary contributors. These variations likely reflect differences in the nature and frequency of dental procedures performed in each clinic, as shown in Table 2.

Although several clinics exhibited strong correlations between patient volume and infectious waste generation, only the Operative Dentistry Clinic showed a statistically significant relationship. These findings suggest that the relationship between service volume and waste generation may vary by clinic type and procedural intensity, warranting further investigation, as shown in Table 3.

Table 1. The number of patients (people) at each clinic from August 2024–January 2025 at the University of Phayao Dental Hospital.

Clinic	Patients (people)						$\overline{X}$
	Aug-2024	Sep-2024	Oct-2024	Nov-2024	Dec-2024	Jan-2025	
1. Prosthodontics	77	34	29	20	13	21	32.33
2. Pediatric	0	0	20	29	20	27	16.00
3. Oral Radiology	2	7	2	5	0	2	3.00
4. Oral Surgery	38	46	33	82	53	51	50.50
5. Periodontology	20	19	69	105	101	107	70.17
6. Special	313	347	345	245	211	269	288.33
7. Endodontics	21	25	19	24	30	60	29.83
8. Occlusion	0	5	2	3	0	1	1.83
9. Operative dentistry	39	46	94	225	128	133	110.83
10. Orthodontics	18	16	11	2	3	9	9.83

Table 2. The volume of infectious waste in each clinic from August 2024–January 2025 at the University of Phayao Dental Hospital.

Clinic	Infectious Waste (kg)						$\overline{X}$
	Aug-2024	Sep-2024	Oct-2024	Nov-2024	Dec-2024	Jan-2025	
1. Prosthodontics	0.00	0.00	0.00	9.50	20.10	27.10	9.45
2. Pediatric	0.00	1.50	0.00	0.00	0.00	13.30	2.47
3. Oral Radiology	0.00	28.00	0.00	0.00	0.00	0.00	4.67
4. Oral surgery	30.25	12.31	8.8	25.4	15.50	17.50	18.29
5. Periodontology	4.00	11.4	7.90	11.60	27.60	37.90	16.73
6. Special	0.00	8.00	43.20	28.20	0.00	0.00	13.23
7. Endodontics	0.00	6.50	11.50	0.00	0.00	0.00	3.00
8. Occlusion	0.00	2.50	0.00	0.00	0.00	0.00	0.42
9. Operative dentistry	0.00	4.60	7.20	12.20	28.40	28.60	13.50
10. Orthodontics	0.00	0.00	0.00	0.00	26.00	26.30	8.72

Note:
- 0.00 indicates that there was no waste generated in that month.
- NA indicates that there was no data reported for that month.

Table 3. Results of the correlation analysis between the number of patients receiving services and the volume of infectious waste generated.

Clinic	**r**	***p-value***	**Interpretation**
1. Prosthodontic	-0.759	0.080	Strong negative correlation, *not statistically significant* ($p > 0.05$)
2. Pediatric	0.017	0.947	Very weak correlation, *not statistically significant*
3. Oral Radiology	0.696	0.125	Strong positive correlation, *not statistically significant*
4. Oral Surgery	0.189	0.719	Weak positive correlation, *not statistically significant*
5. Periodontology	0.680	0.137	Strong positive correlation, *not statistically significant*
6. Special Clinic	0.333	0.519	Weak positive correlation, *not statistically significant*
7. Endodontics	-0.507	0.305	Moderate negative correlation, *not statistically significant*
8. Occlusion	0.696	0.125	Strong positive correlation, *not statistically significant*
9. Operative Dentistry	0.829	0.042*	Very strong positive correlation, *statistically significant* ($p < 0.05$)
10. Orthodontics	-0.372	0.468	Weak negative correlation, *not statistically significant*

[a] Pearson's correlation, [b] Spearman's correlation * Statistical significance (p value < 0.05)

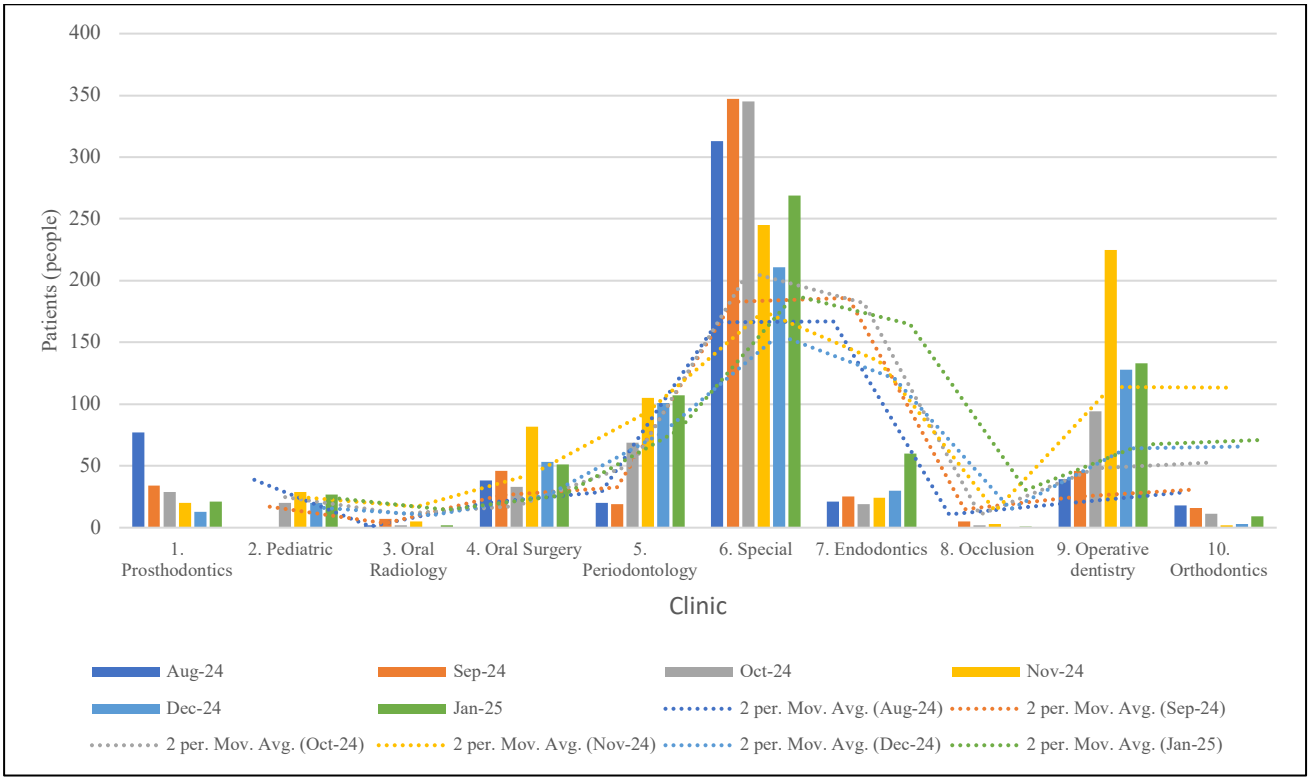

Figure 1. The number of patients (people) at each clinic from August 2024–January 2025 at the University of Phayao Dental Hospital

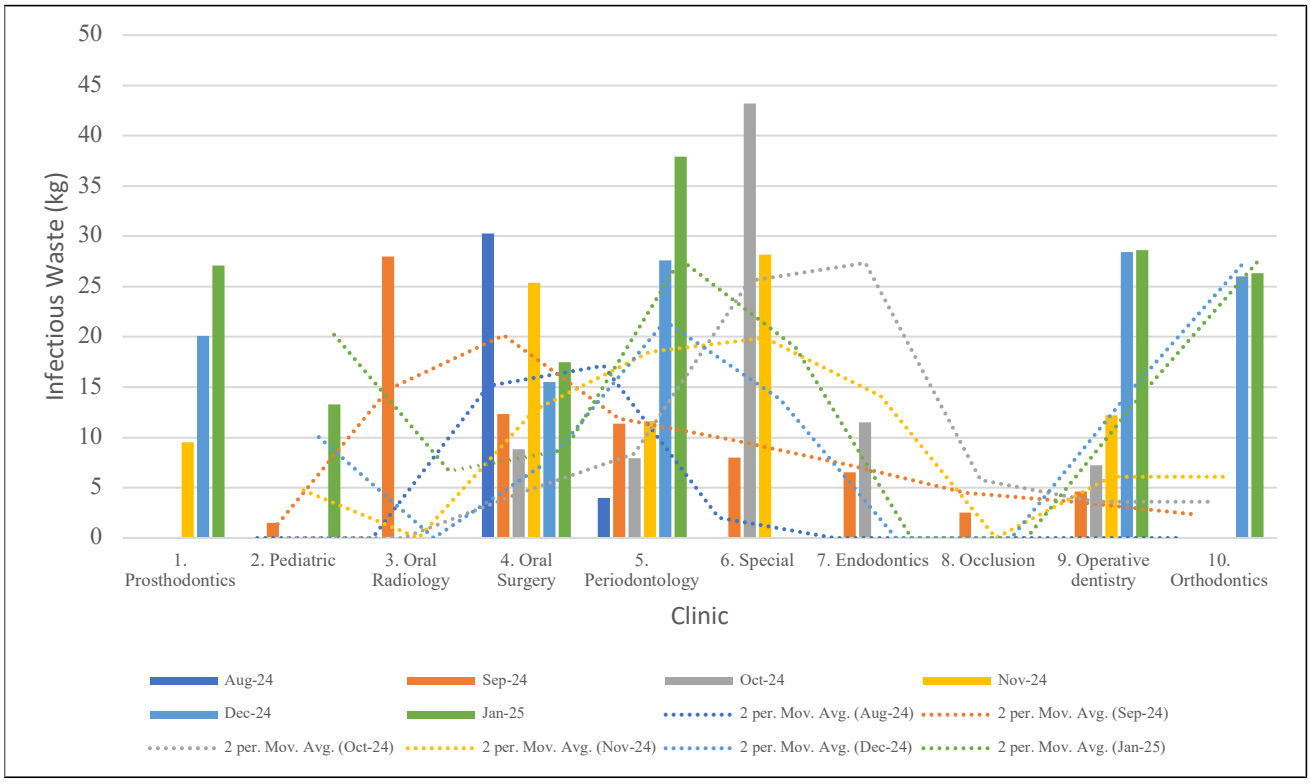

Figure 2. The volume of infectious waste in each clinic from August 2024–January 2025 at the University of Phayao Dental Hospital

The correlation analysis revealed that the operation dentistry clinic was the only clinic with a statistically significant positive relationship between the number of patients and the volume of infectious waste generated (r = 0.829, p = 0.042). For all other clinics, the correlations, although varying in strength, were not statistically significant. These findings suggest that patient volume may influence waste generation in specific clinics, with the Operative Dentistry Clinic being a notable exception.

Figure 1 illustrates the number of patients attending each clinic at the University of Phayao Dental Hospital from August 2024 to January 2025. The data show that the special clinic consistently received the highest patient volume across all months, peaking in October 2024. The "Operative Dentistry" clinic also presented a relatively high number of patients, particularly in November 2024. In contrast, the "oral radiology" and "orthodontics" clinics had the lowest number of patients throughout the observed period.

Figure 2 presents the volume of infectious waste generated by each clinic at the University of Phayao Dental Hospital from August 2024 to January 2025. The data revealed that the highest levels of infectious waste were produced in the Oral Surgery, Periodontology, and Special clinics, with a noticeable peak in the Oral Surgery clinic in January 2025. In contrast, the Oral Radiology and Orthodontics clinics generated the least amount of infectious waste throughout the study period.

Figure 3 illustrates the correlation coefficients (r) between the number of patients and the volume of infectious waste generated in each clinic at the University of Phayao Dental Hospital. The results show that the strength and direction of the correlation vary across clinics.

Operative Dentistry stands out with the highest positive correlation (r = 0.829), indicating that an increase in patient numbers is strongly associated with an increase in infectious waste in this clinic. Oral Radiology and Occlusion clinics also show strong positive correlations (r = 0.696 for both), followed closely by Periodontology (r = 0.68), suggesting similar trends.

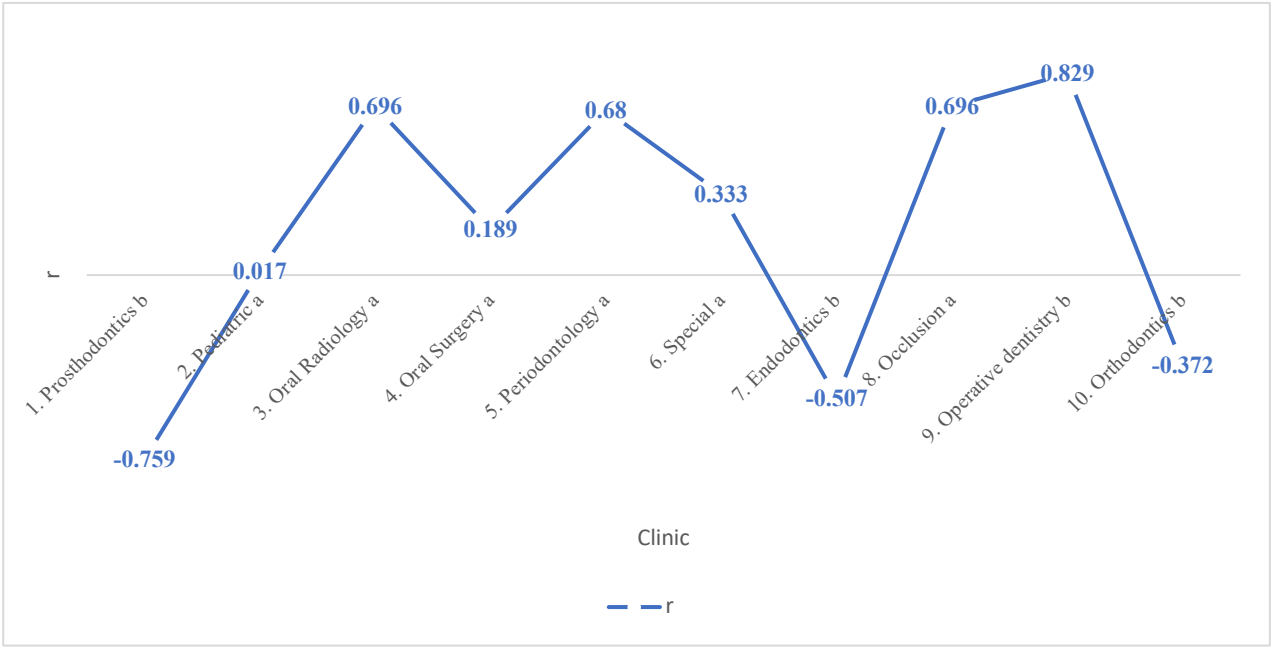

Figure 3. The results of the correlation analysis between the number of patients receiving services and the volume of infectious waste generated

Special and Oral Surgery clinics display moderate positive correlations (r = 0.333 and r = 0.189, respectively), while the Pediatric clinic shows almost no correlation (r = 0.017), indicating little relationship between patient volume and infectious waste in that department.

Conversely, Prosthodontics, Endodontics, and Orthodontics clinics exhibit negative correlations (r = -0.759, -0.507, and -0.372, respectively), suggesting that in these clinics, an increase in patient numbers may be associated with a decrease in infectious waste, or that other factors may influence waste generation.

These findings highlight the need for tailored waste management strategies in each clinic. Clinics with strong positive correlations may require more robust protocols to manage increased waste volumes as patient numbers rise, while clinics with negative or weak correlations may benefit from a review of their waste generation processes to identify underlying causes and optimize resource use.

DISCUSSION

The study revealed clear variations in both the number of patients and the volume of infectious waste across different clinics at the University of Phayao Dental Hospital. Clinics that primarily provided treatment or operative procedures tended to generate higher volumes of infectious waste than those focused on diagnostic or specialized services did (11, 12).

In examining the relationship between patient volume and infectious waste generation, only the Operative Dentistry Clinic demonstrated a statistically significant positive correlation. While some other clinics showed moderate to strong correlations, these correlations were not statistically significant.

These findings indicate that patient volume alone cannot reliably predict the amount of infectious waste generated, as the type of services provided plays a crucial role. Therefore, the development of infectious waste management systems should be tailored to the specific nature of services and the operational context of each clinic to ensure appropriateness and effectiveness in infection control (11, 12).

Across most clinics, there are monthly variations in waste volume, with January 2025 showing a marked increase in several departments, particularly in Oral Surgery and Periodontology. The linear trend lines for each month indicate an overall declining trend in infectious waste volume over time, despite occasional spikes in specific months and clinics.

These findings suggest a need for targeted waste management strategies, particularly in clinics with consistently high waste volumes, to enhance sustainability and infection control practices within the dental hospital setting (13).

The research findings indicate that the relationship between the number of patients receiving services and the volume of infectious waste varies across different dental clinics. Only the operative dentistry clinic showed a very strong positive correlation with statistical significance, which aligns with the nature of the procedures that often involve a large quantity of disposable materials, such as gauze, gloves, and syringes, resulting in an increase in waste volume with the number of patients. Most clinics demonstrated fluctuations in patient volume from month to month, with visible trends represented by linear regression lines for each time point. A general upward trend can be observed in several clinics, suggesting a gradual increase in patient attendance over time. Notably, compared with those in previous months, there was a slight decline in patient numbers in some clinics, such as "special" and "operative dentistry" clinics, in January 2025. Overall, the data suggest that certain clinics, particularly "special" and "operative dentistry" clinics, are in greater demand, which may indicate the need for resource reallocation or service expansion to accommodate patient needs.

These results are consistent with the research of Sukmak et al. (2024) (14) and Lim et al. (2024) (15), which indicated that the type of procedures and service delivery models significantly affect the volume of infectious waste. Clinics focused on treatment and surgery tend to generate more waste than clinics focused on diagnostics, such as orthodontic or endodontic clinics. Furthermore, the research by Silva and de Souza (2024) (11) highlighted that the diversity of services in dental clinics affects both the volume of waste and waste management approaches.

Moreover, Silva, M. F., & de Souza, M. T. (2024) (11) reported that although the number of patients did not increase during the COVID-19 period, the volume of waste increased due to stricter infection control measures, such as the use of PPE similar practices (e.g., enhanced PPE use, additional disposable materials) were implemented at the University of Phayao Dental Hospital during the study period. Kaposi et al. (12) reported that departments such as surgery, anesthesia, emergency, and critical care patients, which use large amounts of single-use materials such as PPE, diapers, and medical plastic equipment, are significant sources of hazardous medical waste. This highlights that the type of service and the nature of medical procedures have a substantial influence on the volume of waste generated.

Importantly, when comparing these findings to recent international standards and guidelines, such as those from the World Health Organization (WHO, 2022) and the Centers for Disease Control and Prevention (CDC, 2023), it is clear that best practices for dental waste management emphasize not only the safe segregation, storage, and disposal of infectious waste but also the minimization of waste generation at the source. The WHO's "Global analysis of health care waste in the context of COVID-19" (2022) recommends that dental clinics implement comprehensive waste management plans that include staff training, clear signage, and the use of color-coded containers for different types of waste. The CDC (2023) also highlights the importance of periodic audits and continuous quality improvement in dental waste management systems.

Our findings support these international recommendations, particularly the need for tailored waste management strategies based on the specific service profiles of each clinic. For example, clinics with high volumes of surgical or restorative procedures should prioritize the use of reusable instruments where possible, adopt minimally invasive techniques to reduce waste, and ensure strict adherence to segregation protocols. Conversely, clinics with lower patient volumes or those focused on consultations and follow-ups may benefit more from targeted staff education and regular waste audits to prevent unnecessary disposal of non-infectious materials as infectious waste (16, 17).

Additionally, recent European and North American guidelines (18, 19) recommend the integration of environmentally sustainable practices, such as the use of biodegradable materials, recycling programs for dental plastics, and the adoption of digital impressions to reduce the use of alginate and other single-use impression materials. These strategies are particularly relevant for clinics with high volumes of prosthodontic and orthodontic procedures, as identified in our study.

Additionally, factors related to infection rates and infection control measures, especially during the COVID-19 period, were found to contribute to an increase in waste volume, even though the number of patients did not significantly change. Therefore, while the number of patients is one factor, it cannot be used as an accurate indicator of infectious waste volume without considering the type of services and management systems within each clinic. The findings of this study reflect the need to design a waste management system that is tailored to the specific context of each service unit. Our results underscore the importance of aligning local dental waste management practices with current international standards, including ongoing staff education, investment in sustainable materials, and robust monitoring systems, to ensure both safety and environmental responsibility.

Practical Implications for Dental Hospital Administrators and Policy Makers:

The findings of this study present several significant practical implications for dental hospital administrators and policy makers. These insights can inform evidence-based decision-making in areas such as resource allocation, workforce planning, and the implementation of quality improvement initiatives. By understanding the factors identified in this study, administrators can develop more effective operational strategies, while policy makers can design targeted policies that address specific challenges in dental healthcare delivery. Finally, these implications contribute to the enhancement of patient care, staff efficiency, and overall system sustainability within dental hospital settings.

Data-Driven Resource Allocation and Planning:

The observed variation in infectious waste generation across different clinics highlights the need for targeted resource allocation. Administrators can use clinic-specific waste data to better forecast supply needs (such as waste containers, PPE, and disposal services), optimize waste collection schedules, and allocate staff for waste management more efficiently. This approach not only helps control costs but also ensures that high-waste clinics receive adequate support for infection control and environmental safety.

Tailored Waste Management Strategies:

Policy makers should recognize that a "one-size-fits-all" approach is ineffective. Waste management protocols should be tailored to the specific clinical activities and waste profiles of each department. For example, clinics with high volumes of surgical or restorative procedures may require more frequent waste removal and stricter segregation practices, while clinics focused on consultations may benefit from staff education to minimize unnecessary disposal of non-infectious materials as infectious waste.

Compliance with International Standards:

By benchmarking against current international guidelines (e.g., WHO, CDC, ADA), administrators can ensure that local practices meet global standards for safety and sustainability. This includes implementing color-coded waste segregation, regular staff training, and periodic audits. Adopting these standards can also facilitate accreditation and improve the hospital's reputation for quality and environmental responsibility.

Investment in Sustainable Practices:

The study's findings support investment in environmentally friendly waste management solutions, such as the use of reusable instruments, biodegradable materials, and digital technologies (e.g., digital impressions to reduce alginate waste). Policy makers should consider incentives or regulations that encourage clinics to adopt these innovations, which can reduce both environmental impact and long-term operational costs.

Continuous Monitoring and Quality Improvement:

Establishing a robust system for ongoing monitoring, documentation, and analysis of infectious waste at the clinic level will enable administrators to identify trends, respond to emerging issues, and implement quality improvement initiatives. This proactive approach can also support compliance with regulatory requirements and prepare the institution for future public health challenges.

Staff Engagement and Training:

Regular training and engagement of clinical and support staff in waste segregation, minimization, and safe disposal are essential for effective implementation of waste management policies. Administrators should foster a safety culture that empowers staff to identify inefficiencies and suggest improvements.

Policy Development and Advocacy:

Policy makers can use the evidence from this study to advocate for updated national or regional guidelines that reflect the realities of dental practice. This can include setting clear definitions of infectious waste, establishing minimum standards for waste handling, and supporting research into innovative waste reduction technologies.

Although this study did not directly measure the types of procedures, materials used, or waste management practices, it is reasonable to interpret that these factors may influence the amount of infectious waste generated in dental clinics. Variations in clinical activities and management protocols likely contribute to differences in waste volume beyond patient numbers alone. Future studies should include these variables to better understand their impact. These observations suggest that the differences in infectious waste generation among clinics at the University of Phayao Dental Hospital may be plausibly explained by variations in the types of procedures performed, the materials used, and the infection control measures implemented. For example, clinics

such as Oral Surgery and Special Clinics, which frequently perform surgical or intensive treatment procedures, consistently produced higher waste volumes—even when their patient numbers were similar to those of other clinics. In contrast, clinics focused primarily on diagnostic or less invasive procedures, such as Oral Radiology and Orthodontics, generated much less infectious waste. This pattern supports the interpretation that procedural intensity and the use of single-use materials, as well as stricter infection control protocols, likely contributed to the observed differences in waste generation, beyond patient volume alone.

Limitations

This study has several limitations that should be acknowledged. First, the research employed a retrospective, descriptive cross-sectional design, which relies on existing records and may be subject to data entry errors or incomplete reporting. The accuracy of infectious waste volume measurements depended on the consistency and diligence of staff in each clinic, and there may have been variations in waste segregation and weighing practices. Additionally, the study was conducted at a single dental hospital over a six-month period, which may limit the generalizability of the findings to other settings or longer timeframes. The sample size, particularly the number of clinics and months observed, may not capture all seasonal or operational variations in waste generation. Furthermore, the study did not account for other potential factors influencing waste production, such as changes in infection control protocols, staff turnover, or the introduction of new materials and technologies during the study period. Finally, the study could not distinguish between zero values and missing data in some instances, which may have affected the interpretation of certain results.

Future research should consider multi-center studies with prospective data collection, standardized waste measurement protocols, and the inclusion of additional variables to provide a more comprehensive understanding of infectious waste generation in dental healthcare settings.

CONCLUSION

Based on these findings, the following actionable recommendations are proposed to improve infectious waste management in dental hospital settings,

1. Implement Clinic-Specific Waste Monitoring: Establish a regular system for recording and analyzing infectious waste generation at the clinic level. This will enable administrators to identify high-waste areas and adjust resource allocation, waste collection schedules, and staff assignments accordingly.
2. Tailor Waste Management Protocols for Clinical Activities: Develop and enforce waste segregation and disposal protocols that reflect the types of procedures performed in each clinic. For example, clinics with high volumes of restorative or surgical procedures should prioritize strict segregation and frequent waste removal, while clinics focused on consultations should emphasize minimizing unnecessary disposal of non-infectious materials.
3. Enhance Staff Training and Engagement: Provide ongoing education and training for dental staff on proper waste segregation, minimization, and safe disposal practices. Encourage staff participation in identifying inefficiencies and suggesting improvements to current waste management systems.
4. Adopt Sustainable and Innovative Practices: Invest in environmentally friendly solutions, such as reusable instruments where appropriate, biodegradable materials, and digital technologies (e.g., digital impressions to reduce alginate waste). Evaluate the cost-effectiveness and feasibility of these innovations before widespread adoption.
5. Benchmark Against International Standards: Align local waste management policies with up-to-date international guidelines (e.g., WHO, CDC, ADA) to ensure safety, compliance, and environmental sustainability. Regular audits and quality improvement initiatives should be incorporated into routine practice.
6. Support Policy Development and Continuous Improvement: Use evidence from ongoing waste monitoring to inform hospital policy, update protocols, and advocate for national or regional guidelines that reflect the realities of dental practice.

In summary, a data-driven, clinic-specific, and sustainable approach to infectious waste management is essential for ensuring safety, regulatory compliance, and environmental responsibility in dental hospitals. Future research should explore the effectiveness of these interventions and expand to include diverse clinical settings.

RECOMMENDATIONS

Short-term Strategies

1. Implement standardized waste recording and monitoring: Establish a consistent system for daily recording and analysis of infectious waste at the clinic level to promptly identify high-waste areas and adjust resource allocation as needed.
2. Enhance staff training and awareness: Conduct regular training sessions for all dental staff on proper waste segregation, minimization, and safe disposal practices to ensure compliance and reduce errors.
3. Optimize waste segregation and collection: Reinforce the use of color-coded containers and clear signage to improve waste segregation and facilitate efficient collection and disposal.
4. Immediate audit and feedback: Perform periodic audits of waste management practices and provide immediate feedback to staff for continuous improvement.

Long-term Strategies

1. Develop clinic-specific waste management protocols: Create and implement tailored waste management guidelines for each clinic based on the types of procedures and waste generated.
2. Invest in sustainable technologies and materials: Encourage the adoption of reusable instruments, biodegradable materials, and digital solutions (such as digital impressions) to reduce single-use waste in the long run.
3. Integrate international standards: Align hospital waste management policies with up-to-date international guidelines (e.g., WHO, CDC, ADA) and pursue relevant certifications or accreditations.
4. Establish a continuous quality improvement system: Set up a long-term monitoring and evaluation framework to track progress, assess the effectiveness of interventions, and adapt strategies as needed.
5. Policy development and advocacy: Use study findings to inform hospital and national policy, advocate for updated regulations, and support research into innovative waste reduction approaches.

Suggestions for further study

1. To gain a more comprehensive understanding of the elements influencing infectious waste generation, additional factors, such as the types of materials used, the frequency of procedures, and clinical management practices, should be investigated.
2. The data collection period should be extended, or monthly data should be analyzed over the course of an entire year to identify clearer trends and assess the impact of seasonal changes or special circumstances, such as disease outbreaks.
3. Comparative studies between hospitals or dental clinics in different regions should be conducted to explore the similarities and differences in factors influencing infectious waste generation and develop a more universally applicable waste management model.
4. The costs and impacts of the infectious waste management system, considering environmental, economic, and safety factors, are evaluated to assess the efficiency and sustainability of the current system.

ACKNOWLEDGMENTS

This research would not have been completed without the support of the University of Phayao Dental Hospital, which provided the information and facilities for conducting the study. In addition, the researcher would like to express gratitude to the research team for their full support and encouragement throughout the research process.

REFERENCES

1. Windfeld ES, Brooks MS. Medical waste management – A review. Waste Manag.

2015;48:575–85. https://doi.org/10.1016/j.jenvman.2015.08.013
2. World Health Organization. Global analysis of health care waste in the context of COVID-19: status, impacts and recommendations. Geneva: WHO; 2022. Available from: https://www.who.int/publications/i/item/9789240039612
3. CareQuest Institute for Oral Health, Organization for Safety, Asepsis and Prevention (OSAP). Best practices for infection control in dental clinics during the COVID-19 pandemic. 2020. Available from: https://www.carequest.org/system/files/CareQuest-Institute-OSAP-best-practices-for-infection-control-in-dental-clinics-during-the-covid-19-pandemic.pdf
4. The Open Dentistry Journal. COVID-19 in dental practice: transmission risk, infection control challenges, and the implications for dental care. Open Dent J. 2020;14:348–54. Available from: https://opendentistryjournal.com/VOLUME/14/PAGE/348/FULLTEXT/
5. Chartier Y, Emmanuel JR, Pieper U, Prüss A. Health-care waste management. Geneva: World Health Organization; 2014.
6. World Health Organization. Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care (Internet). Geneva: World Health Organization; 2018 (cited 2025 Apr 18). Available from: https://www.who.int
7. Deana NF, Seiffert A, Aravena-Rivas Y, Alonso-Coello P, Muñoz-Millán P, Espinoza-Espinoza G, et al. Recommendations for safe dental care: A systematic review of clinical practice guidelines in the first year of the COVID-19 pandemic. Int J Environ Res Public Health. 2021;18(19):10059. https://doi.org/10.3390/ijerph181910059
8. Mahjoub MMO, Soliman MC. Dental waste management strategies in dental clinics: exploring the relationship between cost efficiency, environmental impact, and regulatory compliance. Int J Multidiscip Res Growth Eval. 2025;6(3):769–776.
9. Department of Health, Ministry of Public Health. Guidelines for the Management of Infectious Waste in Healthcare Facilities B.E. 2566 (2023) (Internet). Nonthaburi: Department of Health; 2023 (cited 2025 Apr 19). Available from: https://laws.anamai.moph.go.th/th/notification-of-the-department-of-health/download/?did=208426&id=89657&reload=
10. Mukaka MM. A guide to appropriate use of correlation coefficient in medical research. Malawi Med J. 2012;24(3):69–71.
11. de Sousa ATR, Pataca LCM, Maia CC, Vimieiro GV, Gonçalves MF, Mol MPG. Waste management from dental clinics: a case study in Belo Horizonte, Brazil. Waste Manag. 2024;189:177–84. https://doi.org/10.1016/j.wasman.2024.08.027
12. Kaposi A, Nagy A, Gomori G, et al. Analysis of healthcare waste and factors affecting the amount of hazardous healthcare waste in a university hospital. J Mater Cycles Waste Manag. 2024;26:1169–80. https://doi.org/10.1007/s10163-024-01890-1
13. Waste Managed. Dental waste disposal guide (Internet). Waste Managed; 2024 (cited 2025 May 29). Available from: https://www.wastemanaged.co.uk/our-news/dental/dental-waste-disposal-guide/
14. Sukmak K, Bunjongsiri K. The capacity for infectious waste management in Thailand under normal circumstances and during the COVID-19 pandemic. Dis Control J. 2024;50(3):451–462. https://doi.org/10.14456/dcj.2024.36
15. Lim O, Chua WY, Wong A, Ling RR, Chan HC, Quek SC, Wu S, Somani J. The environmental impact and sustainability of infection control practices: a systematic scoping review. Antimicrob Resist Infect Control. 2024;13(1):156. https://doi.org/10.1186/s13756-024-01507-0
16. World Health Organization. Global analysis of health care waste in the context of COVID-19: status, impacts and recommendations. Geneva: WHO; 2022. Available from: https://www.who.int/publications/i/item/9789240039612
17. Centers for Disease Control and Prevention. Best practices for environmental infection prevention and control in dental settings. Atlanta: CDC; 2023. Available from: https://www.cdc.gov/dental-infection-control/hcp/dental-ipc-faqs/cleaning-disinfecting-environmental-surface.html

18. European Centre for Disease Prevention and Control. Considerations for infection prevention and control practices in the context of COVID-19 in healthcare settings. Stockholm: ECDC; 2022. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/Considerations%20for%20IPC%20respiratory%20viral%20infections%20in%20HC%20settings.pdf
19. American Dental Association. Best management practices for amalgam waste. Chicago: ADA; 2023. Available from: https://www.ada.org/-/media/project/ada-organization/ada/ada-org/files/resources/library/oral-health-topics/topics_amalgamwaste_brochure.pdf