Evaluation of hospital infectious waste management in Bandung region

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\textbf{Abstract.} Hospital infectious waste (HIW) has become an important issue as it possesses potential health risk and damage to the environment. HIW, if not handled in a proper way, could be a potential source of diseases such as HIV, hepatitis B&C, and other bacterial diseases that cause serious threat to human health. Therefore, an extra attention is needed for its safe and proper disposal. The sustainable management of infectious waste requires a holistic approach to monitor and evaluate the implementation of hospital infectious waste handling. Based upon sample assessment, a brief overview of current implementation of hospital infectious waste management (HIWM) in Bandung region is provided. The assessment included a 50-point check list referring to the standard Environmental Protection Agency (EPA) Guideline. The assessment of HIW management was conducted in seven hospitals. In general hospitals in Bandung region conform 57 from 100\% assessment score. This is a proof that HIWM was still conducted improperly in Bandung region. Private hospitals provide better score (68\%) compared to government-owned hospitals (41\%) whereas accredited hospitals provide a higher score (61\%) compared to hospitals with non-accreditation (22\%). In addition, specific hospitals provide better compliance performance (74\%) compared to general hospitals (50\%). Hospitals with health worker status provided a better score (68\%) than hospitals with non-outsourcing health worker status (30\%). Kruskal-Wallis test showed that the value of Asymp.\,sig 0.000 < 0.05, significant differences were found for evaluation of HIWM between 7 hospitals. In Bandung region, the HIW management was still conducted improperly; this study provides baseline data for further research into risk assessment of HIW management.

1. Introduction
The handling of infectious waste in developing countries has many challenges; the lack of awareness of health workers and the consideration of financial budget issues become the main problem in healthcare facilities, including hospitals. Hospital is the largest producer of infectious waste when compared to other types of health facilities. Birpinar \textit{et al} \textsuperscript{1} and WHO \textsuperscript{2} concluded that hospital infectious waste can be generated at up to 2.2 tons/day. Over the last decade, safe handling of infectious waste constitutes a major problem of the health sector internationally. Based on Caniato \textit{et al} \textsuperscript{3}, healthcare waste management including infectious waste management practices varies greatly from country to country according to socio-economic conditions, regulation, and level of education. According to Lega \textit{et al} \textsuperscript{4} positive correlations have been found between clinical and economic performance. Recent studies highlighted the importance of management in healthcare sector. The problem is further escalated by the...
occurrence of new infectious diseases and the lack of appropriate infrastructure for the safe management of infectious waste. Thereby, comprising a public health risk and often resulting in environmental degradation through the release of pollutants due to the unsafe waste management practices. Based on Bdour et al [5], 26% of infectious waste consists of sharp and pathological wastes. In developing countries mismanagement of infectious waste is still conducted. There is no specific regulation or guidelines for segregation or classification of infectious waste [6]. This present study on infectious waste handling from seven hospitals was conducted in order to quantify the percentage of conformity with the EPA standard.

In developing countries such as Indonesia, sometimes budget issue is the reason for the misconduct of infectious waste handling. According to Government Regulation No. 44/2009, based on services, hospitals are divided into general hospital and specific hospital, meanwhile based on management, hospitals are divided into public hospital and private hospital. General hospital is a hospital in which patients with many different types of ailments are given care, or a military hospital usually located in a communication zone that gives treatment to all kinds of cases. Specific hospital is a hospital in which patients with specific type of ailments are given care, for example the hospital that specialized in eye care. Public hospital is a hospital with government ownership and private hospital is a hospital with non-government ownership. Hospital accreditation has been defined as “A self-assessment and external peer assessment process used by health care organizations to accurately assess their level of performance in relation to established standards and to implement ways to continuously improve”.

Very few studies have been conducted on infectious waste in Indonesia, especially in Bandung region, which related to the assessment of HIW handling. The objectives of this study were directed towards: (1) conducting a survey of available procedures, techniques and methods of HIW handling; and (2) identifying the important characteristics and their possible influences of misconduct in the handling of HIW. The data of current study were collected from 7 hospitals in Bandung.

2. Methods

2.1. Setting of hospital establishment

Table 1 summarizes the composition of the selected hospitals. The hospitals were grouped into two categories based on the nature of their services, namely 5 general hospitals and 2 specific hospitals.

| Hospital Code | Hospital Services | Type/Number of beds | Accreditation level | Owner / Management | Cleaning Services Status |
|---------------|-------------------|---------------------|---------------------|--------------------|------------------------|
| A             | General hospital  | B/192               | 16/Excellent        | Public             | Non-outsourcing         |
| B             | General hospital  | B/441               | 16/Excellent        | Public             | Outsourcing             |
| C             | General hospital  | C/70                | 5/Basic             | Private            | Outsourcing             |
| D             | General hospital  | D/22                | N.A                 | Public             | Non-outsourcing         |
| E             | Specific hospital | C/40                | 5/Basic             | Private            | Outsourcing             |
| F             | General hospital  | C/178               | 12/Basic            | Private            | Outsourcing             |
| G             | Specific hospital | A/104               | 16/Excellent        | Public             | Outsourcing             |

2.2. Survey method and data analysis

Check list form was made based on EPA and PP No. 101/2014 regulations to collect information on infectious waste management practices. It consists of 50 standard conditions including the segregation, collection, cleaning, transportation, and storage. We observed the selected hospitals and documentation from these facilities were reviewed and calculated based on 4 categories: a. Type of hospital based on services covered, b. Type of hospital based on management ownership, c. Type of hospital based on accreditation status, d. Type of cleaning service worker status as of outsourcing or non-outsourcing. Data was analyzed using descriptive statistic and Kruskal-Wallis method.
3. Result and discussion

3.1. Evaluation of infectious waste management
The observation for infectious waste handling was segregation, handling, containment, labeling, storage, monitoring and record keeping, training and vaccine program for waste handler, contingency plan, and personal protective equipment. Fifty items were observed closely. Check list form provided the information for its compliance with EPA standard.

Score was calculated by dividing the complied items with the total items observation. The results showed that specific hospitals had a better HIWM than general hospitals (Figure 1a), while private hospitals had higher percentage value than public hospital (Figure 1b). Hospitals with accreditation status had a better HIWM than the hospital with no accreditation (Figure 1c). Outsourcing health worker hospitals showed higher value than non-outsourcing health workers hospitals (Figure 1d). Based on 50 items of EPA standard of HIMW, general hospitals in Bandung region only met 57 of 100% assessment score. According to Indonesian law, implementation of infectious waste management in hospital was mandatory, but the implementation in real practices was not complying the regulation. Lack of knowledge on the pertinent legislation by health workers had contributed to non-conformity instances [7]. The lack of attention and sensitivity to infectious waste segregation, transportation and disposal become barriers to a proper management. The health workers were aware of the importance of segregation and other processes. However, they were careless and mixed infectious waste medical waste with domestic waste [8].

![Figure 1](image-url)

**Figure 1.** HIWM evaluation based on (a) hospital services, (b) owner, (c) accreditation level status, and (d) status of health worker.
Specific hospitals had specific services for a particular type of disease. The resulting infectious waste also tended to be more homogeneous than general hospitals. In public hospitals, the type of services to the diseases varied and caused the infectious waste varied greatly. The homogeneity of waste generation is easy to manage. Therefore, based on the EPA standard for infectious waste management, specific hospital score was higher than that of the general hospital. The results also showed that private hospitals managed their infectious waste better than public hospitals. The private hospitals supervised the proper handling of infectious waste better than public hospitals with government ownership. Based on interview, the handling infectious waste was regulated by Indonesian Ministry of Health. In this case, the public hospitals were under the management of Ministry of Health Indonesia. Therefore, the public hospitals less awareness than the private hospital in handling their infectious waste. The results showed that the hospital's accreditation status affected the hospital's performance in managing its infectious waste. The accredited-hospitals require compliance with the operational standard for infectious waste management procedures. Hospitals with outsourcing cleaning service status managed their infectious waste better than hospital with non-outsourcing. The outsourcing cleaning services workers showed a higher level of awareness and cautions of infectious waste hazard compared to non-outsourced cleaning service workers.

The study revealed a general lack of knowledge of the national guidelines as well as none of method available for waste management evaluation and monitoring. Most participants believed that the waste collection procedures used in the hospital were inappropriate. A study conducted by Caniato et al [9] revealed that mismanagement of infectious waste management was caused by the different priorities taken by the stakeholders. However, generally segregation at the source was identified as a key requirement [9]. According to Chen and Tsai [10], biomedical waste that requires sterilization should be packed into yellow bags and infectious biomedical waste should be packed into red bags.

Based on Indonesian regulation, all types of infectious waste should be packed in yellow bags whereas red bags are for radioactive waste. The storage place should be cleaned periodically with disinfectant such as chlorine. Weighing the infectious wastes is a must. However, several hospitals in Bandung did not follow these rules. Infectious waste can be stored for one day at higher than 5°C for up to 7 - 30 days, at 0–5°C, or below 0°C, respectively. In fact, all hospitals did not have cooler rooms for infectious wastes. The infectious wastes were kept for more than 48 hr in the storage.

According to Akpiey et al [11], management of infectious waste such as handling, treatment and disposal processes, may cause physical, chemical, and microbiological risks significantly. The characteristics of infection potential were based on the principles of disease transmission. However, the process of disease transmission can be conceptualized as a series of six links, with each link representing an essential step in the transfer of an infectious agent from one susceptible host to the next: (1) the presence of a suffi ciest quantity of infectious agent, (2) the existence of a favorable environment reservoir for survival infectious agent, (3) a mode of escape for infectious agents, (4) a mode of transmission, (5) an infectious route entry, and (6) a susceptible host. The agency for toxic substances and disease registry listed four main transmission modes of infection, namely direct transmission, airborne transmission, vehicle airborne transmission and vector borne transmission [12].

3.2. Kruskal-Wallis test
The aim of Kruskal-Wallis test was to count significant level of infectious waste evaluation. Table 2 shows the mean rank for each hospital; smaller mean rank value indicates that the hospital conducted more improper HIWM according to EPA standard. Based on Table 2, Hospital D had the smallest mean rank value and Hospital C had the biggest mean rank value. Kruskal-Wallis test (Table 3) provides information that Asymp.sig 0.000 < 0.05, significant differences were found for HIWM evaluation.

For further analysis for Kruskal-Wallis test with value of Asymp.sig 0.000 < 0.05, Mann U Whitney analysis was conducted. The aim of Mann U Whitney analysis was to count and compare the infectious waste management evaluation for each hospital. The result of Mann U Whitney analysis is shown in Table 4.
Table 2. Mean rank value.

| Hospital | N  | Mean Rank |
|----------|----|-----------|
| A        | 50 | 142.00    |
| B        | 50 | 187.50    |
| C        | 50 | 215.50    |
| D        | 50 | 114.00    |
| E        | 50 | 208.50    |
| F        | 50 | 159.50    |
| G        | 50 | 201.50    |
| Total    | 350|           |

Table 3. Kruskal-Wallis test.

| Chi-Square | Df | Asymp. Sig. |
|------------|----|-------------|
| 57.632     | 6  | 0.000       |

Table 4. Mann U Whitney test.

| Hospital | Asymp.Sig | Information          |
|----------|-----------|----------------------|
| A Vs B   | 0.010 < 0.05 | Significantly different |
| A Vs C   | 0.000 < 0.05 | Significantly different |
| A Vs D   | 0.082 > 0.05 | No different          |
| A Vs E   | 0.000 < 0.05 | Significantly different |
| A Vs F   | 0.315 > 0.05 | No different          |
| A Vs G   | 0.001 < 0.05 | Significantly different |
| B Vs C   | 0.076 > 0.05 | No different          |
| B Vs D   | 0.000 < 0.05 | Significantly different |
| B Vs E   | 0.193 > 0.05 | No different          |
| B Vs F   | 0.109 > 0.05 | No different          |
| B Vs G   | 0.394 > 0.05 | No different          |
| C Vs D   | 0.000 < 0.05 | Significantly different |
| C Vs E   | 0.631 > 0.05 | No different          |
| C Vs F   | 0.001 < 0.05 | Significantly different |
| C Vs G   | 0.351 > 0.05 | No different          |
| D Vs E   | 0.000 < 0.05 | Significantly different |
| D Vs F   | 0.007 < 0.05 | Significantly different |
| D Vs G   | 0.000 < 0.05 | Significantly different |
| E Vs F   | 0.004 < 0.05 | Significantly different |
| E Vs G   | 0.650 > 0.05 | No Different          |
| F Vs G   | 0.015 < 0.05 | Significantly different |

Table 4 shows the result of Mann U Whitney test. It shows that Hospital D had an evaluation value that was not significantly different from Hospital A because Asymp.Sig value was >0.05, but significantly different from Hospitals B, C, D, E, F and G because Asymp.Sig value was <0.05. Hospital D and A had the same categories, both were general, public hospitals with cleaning service status was non-outsourcing. This explains that having same category with public hospital did not guarantee that the management of infectious waste is the same. Awareness level from cleaning service worker affected infectious waste management implementation. In other word, non-outsourced cleaning service workers showed lower awareness level than outsourced cleaning service workers. Hospitals C and D also had the same category, both were general hospital type, but had different ownership and accreditation level.
Based on deep interview and observation in the field, private hospitals provide training for the workers more often than public hospitals. Private hospitals also put the budget to increase awareness level higher than public hospitals. Outsourced cleaning service workers also followed training on infectious waste handling more often than non-outsourced cleaning service.

4. Conclusion
The study revealed that general hospitals in Bandung region only conform of 57 from 100% assessment score. This is a proof that HIWM was carried out improperly in Bandung region. Hospitals with private ownership and hired outsourcing cleaning service workers had a significantly better evaluation of their infectious waste management. Improper infectious waste handling can affect the risk of disease transmission.

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