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## Ecogreen Peritoneal Dialysis Waste Disposal System: A Case Study from The Public Health Nursing Perspectives

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### Abstract

**Introduction:** The increased amount of Peritoneal Dialysis (PD) medical waste will harm the environment and humans around it, which so far there is no system. Many studies revealed more about how to handle medical waste. This study aims to identify the hazardous and non-hazardous medical waste, and to introduce an environmentally friendly PD disposal system.

**Methods:** This research was case study method with a descriptive design. Population and sample of PD waste were 40 patients in PD in South Sulawesi (n: 19) and Manado, North Sulawesi (n: 21), Indonesia. The instrument used was a document review with the PICO model as a filter. The instrument was used to filter reliable research documents obtained from Google Scholar for the last 5 years (2017-2022), with keywords: peritoneal dialysis, medical waste disposal, CAPD nurses. Nightingale's Environment Theory was also used to support the analysis.

**Results:** Collected 177 grams of PD medical waste or an average of 620 grams a day with a risk load of 6 out of 7 items. In a month, 18.6 kgs of PD medical waste will be collected. The waste is mixed (hazardous and non-hazardous) and potentially dangerous.

**Conclusion:** This study recommended a disposal system that is not yet clear and there is no certainty who is in charge. The combustion's results can be used for ecogreen plant fertilizers where in its application it can involve public health nursing because of their close role in family and community health.

**Keywords:** ecogreen, medical waste disposal, peritoneal dialysis, public health nursing.

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### Introduction

Unlike hemodialysis (HD), peritoneal dialysis (PD) user donates medical waste in each package.<sup>1</sup> However, both of them leave medical waste and many of them revealed more about the factors of infection and prevention efforts in PD, without revealing how to handle medical waste.<sup>2-4</sup> PD patients perform the

procedure independently at home.<sup>5</sup> They are provided with training to solve problems independently.<sup>6</sup> Packages given after use will be discarded.<sup>2</sup> The waste for PD patients are solution bags, plastic solution bags, mini caps, gauze, plaster, and tissue.<sup>7</sup>

The total weight reaches approximately 200grams.<sup>8</sup> The number of PD patients in Indonesia reaches 2105 patients.<sup>9</sup> The number of PD users in Indonesia is still very low, only 2% compared to users of hemodialysis procedures, which make up 98% of all dialysis procedures.<sup>10</sup>

PD medical waste is considered harmless and categorized as household waste that does not endanger health.<sup>11</sup> What needs to be anticipated is the possibility of the spread of infectious diseases accompanying PD patients. Research has shown that some patients with chronic kidney failure who use hemodialysis and PD treatment suffer from infectious diseases such as tuberculosis, hepatitis B, C and HIV.<sup>6,9</sup> From a public health perspective, this fact endangers the health of individuals, families and communities.<sup>6</sup> Though many PD patients are non-infectious chronic kidney failure (CKD) patients.<sup>12</sup>

The biggest co-morbidities in PD procedures are cardiovascular and diabetes mellitus, both of which fall into the category of non-communicable diseases.<sup>13</sup> Therefore, early anticipation is an integral part of efforts to prevent disease or the spread of disease in the community. Many studies related to medical waste disposal systems have been carried out, especially in hospitals, health centers, or clinics.<sup>11,14,15</sup> The principle of medical waste is the identification of the type of waste, packaging, appropriate placement, collection, and then disposal, either by local officials or through medical waste disposal agents.<sup>16</sup> The ideal principle is ecogreen by applying the 3 R's (reduce, reuse, and recycle).<sup>17</sup> In particular, there is no pure PD medical waste management system according to ecogreen principles.<sup>18</sup>

That gap needs a solution, namely the existence of a clear disposal system, protection of the community, and maintaining ecogreen environmental health. At least with the principle of reducing and recycling if we can't reuse it.

Most of the research on PD is clinical.<sup>13,19,20</sup> Research on PD medical waste is minimal and even rare, especially in Indonesia.<sup>21</sup> In the future, the increasing number of CKD cases provides the prospect of increasing prevalence rates followed by the number of patients using PD. However, Continuous Ambulatory Peritoneal Dialysis (CAPD) units are limited in big cities such as Jakarta, Surabaya, and Bali, only reaching 80 units in Indonesia.<sup>22</sup> PD patients in other areas spread across 34 unreachd provinces experienced difficulties in technical, training, service, and communication.<sup>23</sup> Coupled with the inadequate number of CAPD nurses, which makes PD socialization issues are not yet popular, including the PD waste disposal system. Especially with the application of ecogreen principles. Meanwhile, nurses in their roles and functions from the point of view of PHN are the spearhead of the health care system in the national health system.<sup>24</sup> The competence of CAPD nurses has only been provided through training.<sup>25</sup> There is no special education for CAPD nursing specialists.<sup>26</sup> In fact, in the community, it is the nurses who are in direct contact with PD users, providing health education, conducting assessments, nursing interventions, and evaluating actions.<sup>27</sup> The PD waste disposal system has not been made part of the curriculum for CAPD nursing training materials.<sup>28</sup> In another word PD nurses do not yet have the competence related to how the PD waste disposal system is effective and efficient. The above background is the basis for conducting this research.

This research was arranged in a case study method with a descriptive design taking examples in two areas, namely Makassar of South Sulawesi and Manado in North Sulawesi, Indonesia. The objective is to identify the types and categories of PD waste and to launch an environmentally friendly PD disposal system (ecogreen) by empowering collaboration between trained PD nurses and public health nurses. The implications of this research from the point

of view of public health nursing (PHN) are expected to be able to contribute to the ecogreen PD waste disposal system, prevent the spread of disease, and protect the environment.

## **Methods**

This research used a case study method with a descriptive design. This case study method is widely used in public health nursing as an effective research method.<sup>29–31</sup> This case study method was intended to investigate and study events and phenomena.<sup>32</sup> The phenomenon that exists in PD patients who do self-therapy at home leaves a medical waste phenomenon that requires solutions.<sup>8,33</sup> That is the initial stage why the case study was chosen as the approach. While the descriptive approach was used because this research did not fully use data whose processing and analysis was in quantitative form using numbers. The second step was to search for supporting documents through the literature review and determined the model for solving the case. The theory used in the case study used nursing theory of Nightingale's Environment theory where environmental aspects is a major concept. At the assessment stage, data was collected on the population of PD user waste in Makassar, South Sulawesi, and Manado, North Sulawesi. Those two places were used as research sites because one of our team was on duty there and had access to the data collection. In addition, Makassar and Manado are two major cities in eastern Indonesia as centers of health services. The data collected includes primary data obtained directly in the field meeting with PD professionals as triangulation of data sources, discussed research materials, the objectives and sought their consent. The same method has been used as an effective data collection method in public health research and research.<sup>34</sup> The purpose of the primary data collection is to obtain the information needed in order to achieve the research objectives.

The secondary data was obtained through journals and other relevant

references. Primary data were the number of PD nurses, PD users, and equipment of PD sets given to PD users. The primary data collection aims to only match the existing data and updated CAPD nursing manual. While secondary data was obtained through scientific journals related to medical waste management and CAPD nursing publications for the last 5 years (2017-2022). The document review was needed to obtain scientific support both related to previous research and recommendations for the need for this research. The next stage was planning, which includes problem identification. Identify problems covers the types and categories of PD medical waste, contaminated or non-contaminated, dry or wet garbage, determining the weight of each waste, and planning the disposal system accordingly. Waste disposal planning is based on the literature review obtained from the PICO (Population, Intervention, Comparison, Outcome) model which we classified in the Implementation stage (third stage).

The use of the PICO model in our case studies has been carried out by many researchers as a support for the solution of their findings.<sup>35,36</sup> It is followed by the preparation of plans for several ways of PD waste disposal management system. The last stage was the Evaluation where a comparison was made of several alternative problem solving, which one is more appropriate, effective, and efficient. The last two stages will be discussed in the Discussion in this article.

## **Result**

The results of this study were compiled based on nursing theory (Nightingale's Environment Theory). Theory focused on the primary duty of nurses to place the patient in the best possible environment for nature to act. In another word, a man can cure himself if placed in an environment that promotes health.<sup>37</sup> It is one of the widely used nursing theories in the modern nursing.<sup>38</sup> The theory discussed four concepts (environment, person, health and nursing) and the environment is the

major concept<sup>38</sup> while person and health are under its shadow. **Table 1** shows the ratio

between PD nurses and PD users around 1:6.6 in Manado and 1:10 in Makassar.

*Assessment*

**Table 1: The number of PD Nurses and PD Patients in Makassar and Manado**

No	Area	Total number of PD Nurses	Total number of PD Users
1	Makassar	5	50
2	Manado	3	20
	Total	8	70

**Table 2** shows that of the 7 PD supplies, weighing about 177 grams each time each PD user uses it, 6 supplies have a risk of contamination, 5 supplies are in the dry waste category and 2 supplies are in the wet waste category. PD users do therapy 3-

4 times every day. This means that each patient collects 531 grams to 708 grams of waste or an average of 620 grams everyday with a risk of contamination of 6 out of 7 items. In other words, a month of 18.6 kgs of PD medical waste will be collected.

**Table 2: PD Supplies, weight, risk category, dry or wet classification disposed at home each day.**

No	PD Items	Weight (In Gram)	Risk Category		Dry Garbage	Wet Garbage
			Contaminated	Non-contaminated		
1	Solution bag	140	✓			✓
2	Solution bag cover	30		✓	✓	
3	Mini cap,	2	✓		✓	
4	Gauze,	1	✓		✓	
5	Plaster	1	✓		✓	
6	Tissue	2	✓			✓
7	Surgical mask	1	✓		✓	
	Total	177	6	1	5	2

*Planning*

The result obtained at this stage are in the form of problem identification based on **Table 2**, namely the first number of PD supplies 7 items, supplies weight 620 grams. Second, 6 items have a risk of contamination, either dry or wet status every day. Third, PD medical waste is considered household waste. These three main problems need solutions from an environmental point of view from the PHN perspective.

*PICO Selection*

At this stage, researchers are looking for scientific sources related to CAPD nursing, CAPD supplies, and its medical waste management to support this study. Data is filtered from articles published in the last 5 years (2017-2022), in English or in Indonesian. **Table 3** shows the result of journal selection from 27 collected records filtered from Google Scholars.

**Table 3: PICO Selection of CAPD nursing-related Journals published in 2017-2022**

No	Journals title, authors, and year of publication	Population	Intervention	Comparison	Outcome
1	Management of peritoneal dialysis under COVID-19: The experience in Sichuan Province People's Hospital, China; Chen et al., 2021	PD doctors, PD nurses, experts of nosocomial infection control, and hospital administrators.	Telehealth services	General medical waste disposal	They successfully prevented COVID-19 transmission and ensured medical safety in our PD patients during the crisis <sup>39</sup>
2	Medical waste management – how the industry can help us to protect the environment and money? Zebrowski et al, 2020.	Different dialyzers	Weight checking of different dialyzers	Other equipment used for PD procedures.	The regulatory body should take into account the additional quality feature because in extreme cases the weight difference can be 95 g. The lighter dialysis set can cause 17 million kg decrease of medical waste and significant savings <sup>21</sup> . They showed crucial points in HD treatment and possible modifications in dialysate flow rate to reduce environmental impact <sup>11</sup> .
3	Eco-dialysis: fashion or necessity, Wieliczko et al., 2019	Dialysate	Hemodialysis Procedures	PD supplies	.
4	Current Status of Home Medical Care Waste Collection by Nurses in Japan, Ikeda, 2017	Japanese Nurses	Medical waste collection	Syringes, needles, feeding tubes, portable injectors, ventilator, masks, endotracheal suction catheters, tracheal cannulas, CAPD bags, urinary catheters and bags.	They recommended that sharp or infectious items should be collected by HMC doctors or nurses. On the contrary, non-hazardous HMC waste should be (collected by municipalities <sup>8</sup>
5	Reducing the Impact of Perfusion Medical Waste on the Environment, Wisniewski, et al., 2020.	Operating theatre staff.	Medical waste disposal for reuse and recycle	Non-reuse and non-recycled medical waste.	By following the lead of other industries in the process of reducing, reusing, and recycling, the medical community could lower its growing environmental impact in the future <sup>17</sup> .

**Table 3. (Continued)**

6	Sustainable waste management of medical waste in African developing countries: A narrative review, Chisholm et al., 2021 Challenges, Strategies, and Recommendations for the Huge Surge in Plastic and Medical Waste during the Global COVID-19 Pandemic with Circular Economy Approach, Teymourian et al., 2021	Health care profession	Medical waste management system	Non-medical waste management.	The findings of this research introduce policies, advice and solutions associated with sustainability and medical waste management that support developing strategies for sustainability by using the eco-friendly technologies for medical waste treatment and disposal methods <sup>18</sup> . The government should improve waste management because of its potential of pathogen transmission or increased plastic and medical waste generation and
7	Enhance the environmental knowledge of society. People should also revise their viewpoints on plastic consumption <sup>15</sup> .	Health care profession	Medical waste management	Non-medical waste management	
8	Medical waste generation and management in medical clinics in South of Iran, Dehghani et al., 2019	Health care profession	Medical waste management	Non-medical waste management	Clinics should implement and apply the rules of waste management properly. Physicians and staff in clinics should be aware of reducing, recycling, and collecting wastes in a separate form in clinics <sup>16</sup> .
9	The Relationship of Knowledge Level With Action Nurses In Medical Waste Management At Sembiring Hospital of Old Deli, Sembiring, 2018.	Hospital Nurses	Medical waste management knowledge	Non-medical waste management	The higher the nurses' knowledge about medical waste management, the better their actions in managing the medical waste <sup>33</sup> .

As seen in **Table 3**, Out of the 9 journals, 6 of them relate directly to medical waste management, 1 article on HD waste management, 1 on Telehealth waste disposal, and 1 on dialysate waste disposal. One article (no.9) of his research was conducted in Indonesia. The rest are from Europe, Africa, and the United States of America. The data above helped researchers scientifically according to the

findings of previous researchers in the process of identifying hazardous and non-hazardous medical waste categories.

*Research Gaps and Limitations*

One of the limitations of this research is it did not involve more cases in other provinces that have CAPD units, for

example in Jakarta, West Java, Central, and East Java. This study did not provide a detailed flowchart about the functions and roles of PD nurses and Public Health Nurses (PHNs) in handling medical waste either. In addition, the cost details require clarity so that the cost-effectiveness can be estimated. Another limitation in this research is the lack of references related to the real impact of PD medical waste, and the absence of sources that include the party or main person in charge of PD waste. Therefore, in the future, related research is needed, including how to provide health counseling as part of health promotion in CKD patients undergoing PD by PD nurses. Those gaps can be used for future research. Apart from the gap, the results of this case study provide a new paradigm for PD nursing research which so far has revealed many aspects of the clinician, not involving other nursing practitioners such as public health nurses.

## Discussion

There are three main problems found as the focus in this research, contained in **Table 2**, namely: medical waste which has risks, the disposal system is not clear and who is in charge. The three main problems will be discussed in the order in which the theory of the nursing process is concerned. The Nightingale's environmental theory prioritizes environmental aspects that can harm people and their health. The discussion below concerns PD medical waste and its negative impacts on public health and its implications in PHN.

### Implementation

The PD medical waste problem is classified based on risk. In this Covid-19 era, the principle that must be put forward is prevention.<sup>40</sup> Therefore, all foreign bodies from patients should be treated as contaminated items/supplies.<sup>5</sup> On this basis, 7 kinds of supplies are listed in **Table 2** have to be well documented. Another principle of safety measures that must be put forward is proper packing and proper handling.<sup>41</sup> What is meant by proper packing is that medical waste collection must be separated.<sup>42</sup> The health officer or person who does the packing

must be trained, understand the principles of disinfection and sterilization.<sup>18</sup> If necessary, short training is provided regarding the packing of medical waste. What is commonly done in hospital settings, for example, is by using a Yellow Box, which can be recognized by its color alone. From the point of view of PHN, all these markings are done to avoid the spread of infection especially if the PD supplies are contaminated. Likewise at the time of handling.

According to the Indonesian Renal Registry, there are only 2% of PD users out of all dialysis procedure users in Indonesia.<sup>23</sup> This study only reveals part of the phenomenon of PD users in South Sulawesi and Manado which involves only 40 PD users.<sup>10</sup> This finding is of course still very lacking to be called adequate. However, PD waste disposal is considered household waste. This assumption needs to be straightened out. The potential for transmission or spread of infection, especially if the PD user suffers from an infectious disease or is incubating an infectious disease, will have the potential to infect other people.<sup>43</sup> Waste management disposal always prioritizes the preventive measures.<sup>44</sup> Two medical waste management systems have been going on so far. The first is in health care places such as hospitals or clinics, and the second is through agents of medical waste disposal.<sup>17,33</sup> The problem with PD users is that they do it at home. Garbage is mixed with household waste. The current option is to dispose of it in a healthcare service place such as a hospital, which is not very practical because PD users have to take their waste to the hospital. The second is by paying the agent of medical waste. The second option is generally available in big cities. In Indonesia, which consists of 3000 inhabited islands, it is not easy to get them. Therefore, other solutions must be found as a third alternative. The above alternative solutions to this problem from the perspective of Public Health Nursing are very reasonable because of the consideration of human interests and their health. Given that hazardous substances have a major impact on public health. This is where the challenge of the role of

nurses in the promotive and preventive aspects.

### *Evaluation*

Medical waste disposal is regulated by law.<sup>45</sup> Specifically for PD users which are still classified in the gray area. Therefore, there must be clarity so that in the future all parties feel safe because there is a transparent system in place, and the person in charge is clear. This is another limitation of this study where it did not provide a detailed flowchart about the functions and roles of PD nurses and Public Health Nurses (PHNs) in handling medical waste. Many references suggest the disposal of medical waste at the service site or through an agent.<sup>14,17</sup> Along with the development of health technology where patients are directly involved in self-therapy in their homes, waste disposal systems become a challenge.

We propose the involvement of community nurses (PHNs). The PHNs need to be involved in PD nursing, considering the number of PD nurses is not possible to reach all areas in Indonesia. By involving PHNs, PD nurses have an extension. They can be trained by PD nurses in handling PD users at home if PD users experience problems. Secondly, PHNs can be involved in the PD medical waste system as a Focal Point for PD users' medical waste as a substitute for PD nurses. The results of the collection of waste are sent to a shelter that has been appointed by the government or the health office.

The next option is for PD professionals (medical professional, technician or PD nurses) to have an Incinerator in their CAPD unit under the auspices of the government institution or through nurses who have independent practice licenses such as Wound Care nurses. They can be invited to work together because they already have a clear disposal system. This last option is collaboratively more practical, efficient and effective as long as the PD unit does not yet have an environmentally friendly Incinerator where the results can be used for natural fertilizers.

### *PHN Involvement*

The results of this case study indicate the need for a major role for PHN nurses in the community. Previous studies have proven that one of the biggest roles of nurses in society is to provide health education as part of preventive and promotive efforts.<sup>23,46,47</sup> Household waste can be part of the spotlight of PHNs in family health education that is integrated with environmental health. With the collaboration between PD nurses and public health nurses, harmony will be created in maintaining the individuals' health status, families, communities, and safe of the environment. The collaboration is evidence that PD nurses care about ecogreen programs, where their scope of work is not only limited to hospital settings.

### **Conclusion**

The objective of this study is to identify the types and categories of PD waste and to launch an environmentally friendly PD disposal system (ecogreen) by empowering the collaboration between trained PD nurses and Public Health Nurses. The implications of this research from the point of view of public health nursing (PHN) are expected to be able to contribute to a clear PD waste disposal system, prevent the spread of disease, and protect the environment. With the case study method, the results achieved in this study found medical waste that has risks and we provide recommendations for a disposal system that is not yet clear and there is no certainty who is in charge. Therefore, we recommend an alternative PD user waste management system, which is sent to a hospital, clinic, agent, or a focal point, specifically for sending to our focal point, we have two alternatives, namely to PD professionals or empowering PHNs. We also recommend that as the impact of medical waste disposal is widely discussed and very clear, it can be dangerous and infectious. The message must be made part of standard operating procedures (SOP) in



handling CAPD and all related activities. Including being part of medical equipment suppliers, seminars, training and formal education in universities or colleges. The limitation of this study is the number of cases raised, it does not provide details about the functions and roles of PD nurses and Public Health Nurses (OHNs) in handling medical waste, tools, and cost details in environmentally safe PD users waste disposal system according to the limits set forth. It's in the ecogreen principles. This gap can be used as research material in the future.

### **Ethics Approval**

This research gained ethics approval from the Research Committee of Poltekkes Kemenkes Jayapura, Papua, No. 002/KEPK-J/II/2022.

### **Availability of data and materials**

Available

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### **Authors Contribution**

IJHT: Conceptualization, analysis, writing, and revising the manuscript.

MDK: Conceptualization, analysis, writing, and revising the manuscript.

RA: Conceptualization, data collection, analysis, writing, and revising the manuscript.

SH: Conceptualization, data collection, analysis, writing, and revising the manuscript.

DM: Data collection, analysis, and revising of the manuscript.

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All authors have read, agreed, and approved for the publication of the final manuscript.

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