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The Impact of Reverse Osmosis Water on the Prognosis of Dialysis Patients at Universitas Airlangga Hospital, Indonesia

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Abstract

Mortality after introducing hemodialysis was high at the beginning of the project. St Mary's hospital has started the cooperation to improve Reverse Osmosis (RO) water, by changing the hemodialysis circuit to the hygienic piping route, verifying bacteriological tests with adequate sampling, and introducing endotoxin filter. The above interventions were only implemented in ward 1 but not in ward 6. Totally, 415 patients who had hemodialysis from March 2018 to December 2023 were enrolled. 181 patients were in Ward 1 and 234 were in ward 6. These patients were followed until they dropped off. Biochemical data from 68 patients and culture and endotoxin data from RO water were analyzed at the available period of month. The outcome of ward 1 became better than that of ward 6 and the improvement of prognosis was more obvious under 55 patients. The viable bacteria data in RO water showed the eminent fluctuations in ward 1. Bio-chemical data were not significantly different except anemia level. Endotoxin level was drastically improved and have reached National standards. The improvement of RO water was supposed to attribute to the better prognosis and its effect was more obvious in younger patients. Further study is needed to clarify factors, such as the renal function, complication of the patients.

Keywords**:** *Hemodialysis; RO Water; Endotoxin; Dialysis Patients*

INTRODUCTION

Republic of Indonesia is one of fastest developing countries in Asia (Hill, 2021; Yuen & Kumssa, 2011; Priharsari et al., 2023). However, the economic development increases the number of chronic kidney disease as the results of diabetes and hypertension (Hustrini et al., 2022; Wulandari et al., 2025; Hidayangsih et al., 2023). The Ministry of Health has started health education to prevent CKD in order to avoid expensive dialysis treatment (Jonny et al., 2022;

Lydia et al., 2021; Pollock et al., 2024), but the increase in CKD patients has not stopped (Hustrini et al., 2023; Suarilah & Lin, 2022; Jonny et al., 2024). 1). RNAIR hospital and St Mary's hospital worked together to improve the Reverse Osmosis (RO) water of the hemodialysis piping under the "Medical Technology International Development Project" supported by JICA/Ministry of Economy, Trade and Industry since 2018. The intervention aimed at improving the quality of RO water by changing the hemodialysis circuit to the hygienic piping route, verifying bacteriological tests with adequate sampling, and introducing endotoxin filter.

RESEARCH METHOD

There are two wards, dealing with hemodialysis in RNAIR hospital, Ward 1 (the 1st floor) and Ward 6 (the 6th floor). The intervention was only applied at Ward 1. Historically, the 1st floor was established first, and the 6th floor was recently innovated for dealing with hemodialysis. Patients who started hemodialysis from March 2018 to December 2023 were enrolled. One hundred eightyone patients were from Ward 1 and 234 were from Ward 6, respectively. Total 415 patients were observed until they dropped off because of death, change to COPD, transplantation and move to other facilities by the end of April 2024 (Table 1). Total data from 68 patients and culture and endotoxin data from RO water were analyzed at the available period of month.

RESULT AND DISCUSSION

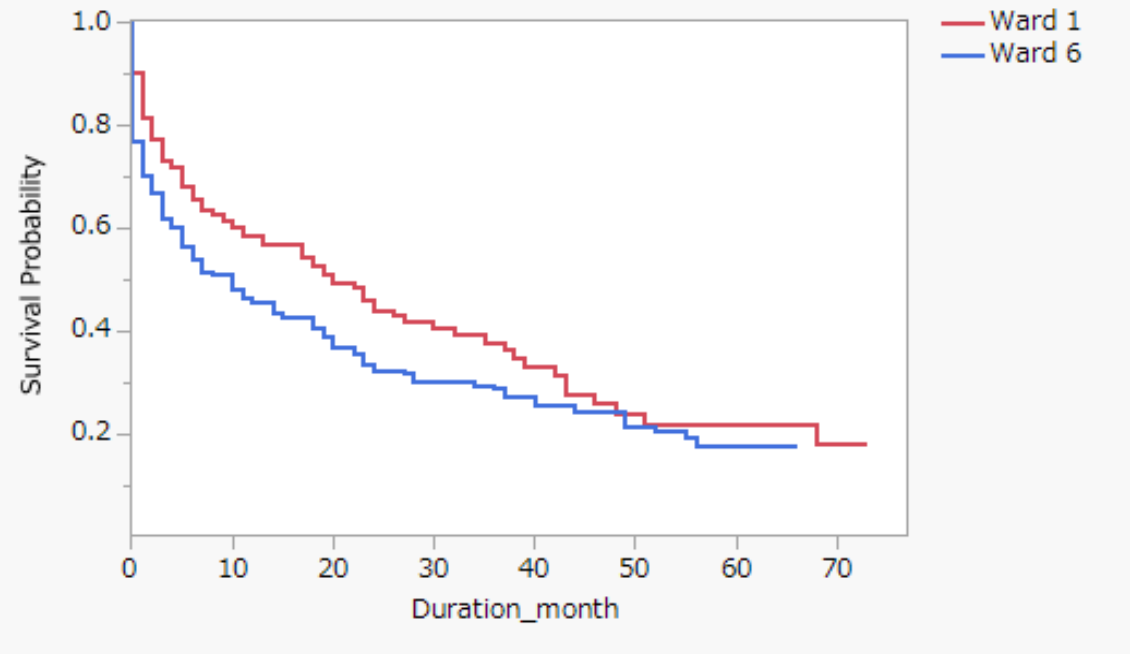

Figure 1. Survival Probability, Data Processing, 2019 (edited)

Log-rank; Kai Square 5.169, p=0.023

Duration (95% confident interval)

Ward	1 Year	3 Year	5 Year
1	59% (51-66%)	36% (27-45%)	22% (12-31%)
6	46% (39-52%)	29% (22-53%)	18% (11-25%)
Total	51% (16-56%)	33% (27-38%)	20% (14-25%)

The annual mortality rate in ward 1 was 72.2% at the beginning of the project and dropped to 42.9% after 5 years. In ward 6, it fluctuated from 73.8% to 50% (Table 2). The survival rate which was shown by Kaplan-Meier curve presented significant improvement compared to Ward 6 (log-rank test 0.023, See Figure 1).

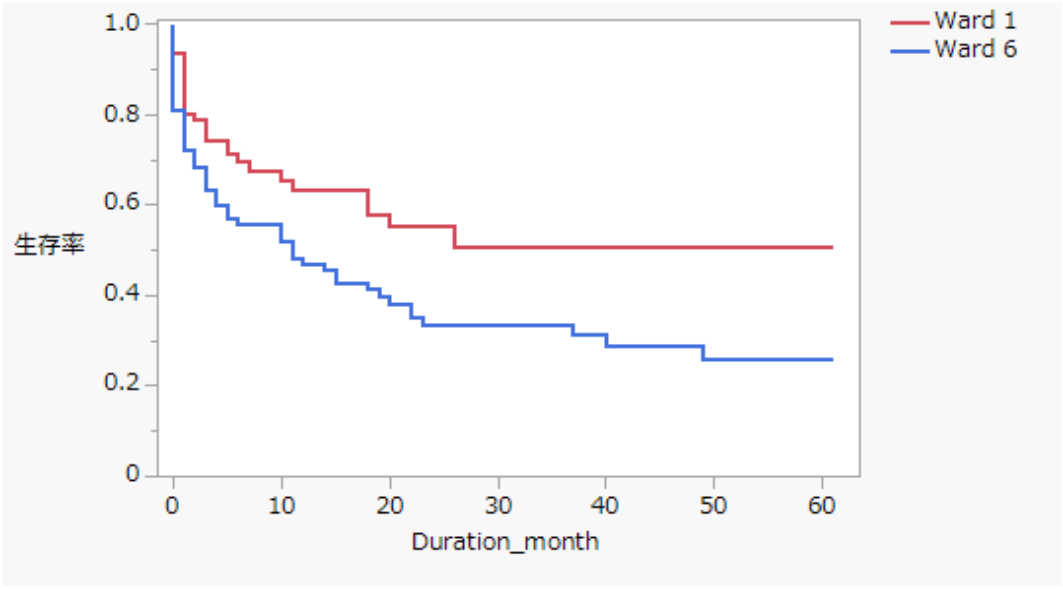

Figure 2. After 2019 and under 55 of age, Data Processing, 2019 (edited)

One year after, beginning the project since 2019, the improvement of survival rate was exaggerated in age under 55 (See Figure 2).

Table 1. biochemical data in 68 patients who were on the dialysis at the end of December 2023.

	Ward 1	Ward 6	⊿ 95% Confident Interval	p value
Hb (g/dl)	9.9	9.2	0.38-1.34	0.037
BUN pre (mg/dl)	67.8	71.6	-17.34-9.74	0.578
BUN post (mg/dl)	22.7	20.7	-2.30-9.83	0.371
Cr (mg/dl)	12.7	11.6	-1.43-3.75	0.365
Alb (mg/dl)	3.5	3.9	-7.78-0.64	0.127

Sources: Author 2024 (edited)

Patients were more anemic in ward 1 but other renal functions had significantly no difference between the two wards based on the data of the surviving patients 1n 2024 (See Table 1).

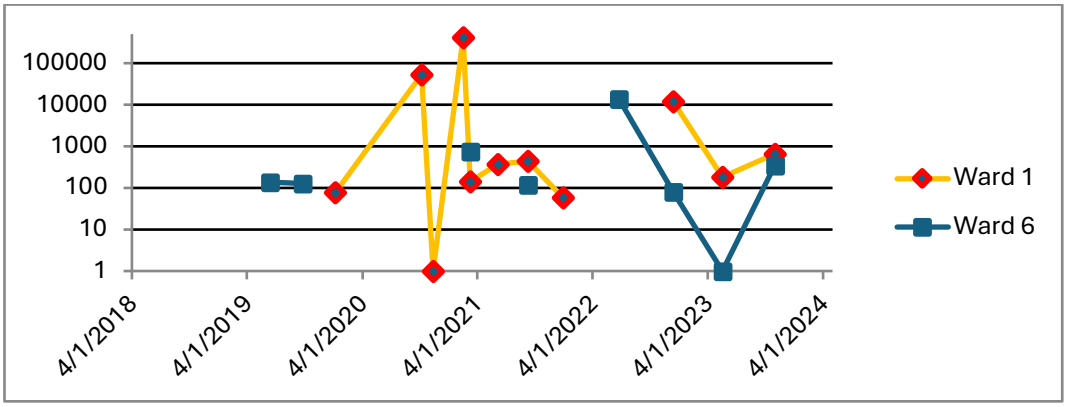

Figure 3. Bacterial Culture, Data Processing, 2024 (edited)

The viable bacteria data in RO water showed eminent fluctuations in Ward 1 (See Figure 3).

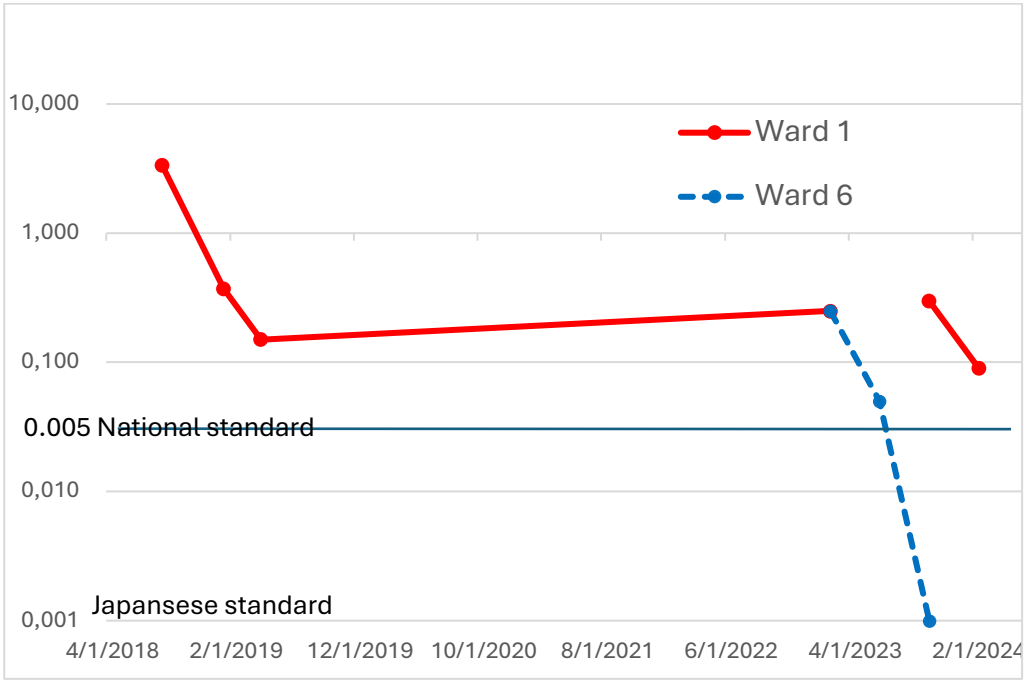

Figure 4. Endotoxin Concentration, Data Processing, 2024 (edited)

Endotoxin level was drastically improved to attain the national level but the value itself did not meet the standard of Japan (See Figure 4).

1. Reverse Osmosis (RO) Water Quality and Facility Conditions on Dialysis Patient Survival

The survival rate in Ward 1 is better than that of ward 6 (Figure 1). The same doctors dealt with patients both Ward 1 and 6. The treatments around the dialysis were

primarily identical. Therefore, the difference of the outcomes should come from factors of the patients or other peripheral conditions. Because the facilities in Ward 6 are newer than those of Ward 1, the water quality in ward 6 is expected better. The heavy fluctuations of viable bacterial data of RO water might reflect the disadvantages of the facility in Ward 1. Endotoxin data showed no difference between the two wards. It was drastically improved in Ward 1 but both it did not meet the Japanese criteria in both wards. Because the biochemical data obtained was limited only from the survivors at the end of the project, it is not capable to compare the severity of renal failure at the time of dialysis initiation between the two groups. One-year survival rate was 51% in our study, and is lower than the previous reports 2,3). Increased age, female, diabetic nephropathy as the underlying CKD etiology, and inadequate dialysis frequency are associated with reduced survival rates. 2) In Japan, it has been suggested that several crucial factors contributed to the good outcomes, such as the quality control of dialysis equipment, the widespread use of internal shunts as vascular access (*arteriovenous fistula*), and the relatively slow dialysis rate that reduces the generation of microbubbles in the brain. 4) On the other hand, it is pointed out that the treatments can be varied based on which the insurance of patient covers. Although the better prognosis might be just because severer patients were skewed in the Ward 6, RO water improvement should have contributed to better outcomes. Without interpreting confounding factors such as above clinical data and peripheral conditions, it is difficult to clarify its implication. Further observation with crucial indices should be explored.

CONCLUSION

Present the conclusion based on the results and discussion, without presenting new data. Include suggestions for further research or practical implications if necessary.

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CONSENT FOR PUBLICATION

All authors affirm that any individual data (including images, videos, and other personal details) included in this manuscript are published with the explicit consent of the individual(s) involved. Written informed consent for publication was obtained from all participants, and copies of the consent forms are available for review by the journal's editorial office upon request.

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COMPETING INTEREST

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