

Innovative Multicompartment Bathman as an Alternative Basin to Common Bed Bath Provisions: An Evaluative Comparative Study

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Abstract

Introduction: With traditional bed bath (TBB) posing time management challenges and disposable wet wipes (DWW) raising environmental concerns, there is a need to explore innovative solutions. **Objective:** The researchers aimed to assess Innovative Multicompartment BathMan (IMB) compared to TBB and DWW, focusing on convenience, time-saving, and cost-effectiveness, addressing existing gaps in bed bath practices and advancing patient care delivery. **Method:** A descriptive evaluative comparative design was employed, with 30 registered nurses from a hospital in Angeles City, Philippines as respondents. Data were collected using a modified 5-point Likert scale questionnaire with 7 statements on bed bath methods' convenience, time-saving, and cost-effectiveness. Statistical analysis was conducted using descriptive statistics and the Kruskal-Wallis H test. Ethical clearance was obtained from the university ethics board before data collection. **Results:** Analysis revealed IMB ($\bar{x}=3.53$) as more convenient compared to TBB ($\bar{x}=3.44$) and DWW ($\bar{x}=3.26$). In terms of time-saving, IMB ($\bar{x}=3.47$) was favored over DWW ($\bar{x}=3.45$) and TBB ($\bar{x}=3.02$). While TBB ($\bar{x}=3.88$) emerged as the most cost-effective method in contrast to IMB ($\bar{x}=2.7$) and DWW ($\bar{x}=2.48$). Cost-effectiveness ratings were generally positive across all methods ($p\text{-value} < .001$). When it comes to convenience, supplies, and effort of use revealed a significant difference among the methods ($p\text{-value} \leq .050$). **Conclusion:** The study addressed gaps in bed bath practices by enhancing nursing workflows with IMB to make bed baths more convenient and reduce time. The researchers suggested expanding future research to multiple healthcare facilities and a more diverse sample for better generalizability. Healthcare institutions should consider integrating IMB to optimize nursing efficiency and patient outcomes.

Keywords:

Bathing, Patient Comfort, Cost-benefit, Nursing efficiency, Time Management



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INTRODUCTION

Nursing is often described as a fusion of science and art, where meticulous clinical skills are harmonized with compassionate care. Florence Nightingale's vision of nursing as an art form emphasizes the need for rigorous preparation and heartfelt dedication. Nurses, in their roles as caregivers and advocates, navigate the complexities of patient care, merging technical proficiency with empathy to foster healing and support patient dignity.

Among the many challenges faced by nurses, the bed bath procedure remains a significant area of concern. Traditional basin baths, while established, present notable challenges, including time management difficulties and issues of comfort for both patients and healthcare providers (Groven et al., 2021; Ergeneci, 2024). These challenges often result in operational inefficiencies, including the risk of spills that can cause accidents, damage equipment, and necessitate frequent linen changes.

The advent of disposable wipes has introduced a new dimension to bed bathing practices. While these wipes offer convenience and are perceived as cost-effective, their environmental impact and cost implications in healthcare settings are increasingly scrutinized. The widespread use of disposable wipes raises concerns about their contribution to landfill waste, sewer system damage, and long-term economic costs (Hu et al., 2021; Zhang et al., 2023). Research indicates that, despite their initial affordability, disposable wipes may not always be the most economical choice when factoring in additional costs related to labor and laundry (Tai et al., 2021).

In response to these issues, the introduction of innovative solutions such as the I.M. BathMan (IMB) system presents an opportunity to address existing limitations in bed bath procedures. The IMB's multicompartmental design aims to enhance both efficiency and patient comfort by offering a streamlined alternative to traditional and disposable methods. This study investigates the IMB's potential by comparing its performance against traditional basin baths (TBB) and disposable wet wipes (DWW) in terms of convenience, time saving, and cost-effectiveness.

This research seeks to provide insights into how the IMB could revolutionize bed bath practices, offering a path toward improved care delivery and operational efficiency. By exploring this innovation, we aim to contribute to the advancement of nursing practices and highlight the ongoing dedication to enhancing patient care through thoughtful and effective technological solutions.

With this, the present study aimed to determine which bed bath provision is more convenient, time-

saving, and cost-effective based on the evaluation of nurses working in a selected hospital in Angeles City, Philippines.

METHOD

The researchers utilized a descriptive evaluative comparative research design to systematically evaluate and compare three bed bath provisions: TBB, DWW, and IMB by examining various criteria such as convenience, time efficiency, and cost-effectiveness associated with each method.

The study was conducted in a selected tertiary hospital in Angeles City that has a functional Intensive Care Unit (ICU) and Coronary Care Unit (CCU), where nurses provide bed baths to patients. This setting ensures that the respondents possess extensive knowledge of bed bathing, as it is an integral part of their daily patient care. Moreover, the hospital has a well-equipped facility that utilizes both TBB and DWW approaches, allowing respondents to assess the convenience, time-saving, and cost-effectiveness of the three bed bath provisions.

The researchers employed a purposive sampling method to recruit registered nurses from a selected hospital in Angeles City, Philippines. The criteria for inclusion ensured that the participants were directly involved in providing patient care, especially in the task of giving bed bath using TBB and DWW. To guarantee sufficient competence and familiarity, nurses needed at least six (6) months of experience in bed bathing.

The researchers adapted and revised the statements or questionnaires used in "The bed bath with or without water? It's a wash!" called the Bed Bath Beliefs tool by Fabian M.V. Groven and the study by Tai et. al. (2021) "The Effect of Two Bed Bath Practices on Cost and Vital Signs of Critically Ill Patients" called the Five Satisfaction Assessment tool in measuring the evaluation of nurses in using different towels per body area with IMB when giving bed baths to patients as compared to the use of the other bed bath provisions. The modified questionnaires consist of 7 statements about performing a bed bath using TBB, DWW and using different towels per body area using IMB. Nurses assess their level of agreement with each statement using a 5-point Likert scale, where the response options range from "Strongly Disagree" to "Strongly Agree."

Following the confirmation of a selected hospital in Angeles City and the introduction of IMB to the respondents, data collection began. Paper-based questionnaires were distributed to participants with prior bed bathing knowledge, selected through purposive sampling. The researchers explained the

study's objectives, obtained informed consent, and instructed participants to use IMB three times, with each session lasting 20 to 30 minutes. The respondents evaluated the bed bath provisions on convenience, time-saving, and cost-effectiveness using the questionnaires. The researchers and their advisers supervised the process to ensure accuracy and methodological rigor. Completed questionnaires were transcribed into Google Sheets for tallying. Item 7 used reverse scoring to ensure higher scores indicated more favorable outcomes, facilitating clearer analysis.

The collected data was coded and entered into SPSS Statistics version 29 for analysis. Shapiro-Wilk test was done and revealed a significant deviation from normal distribution ($p < .05$). Due to this, Kruskal-Wallis H test was employed to compare the convenience, time-saving, and cost-effectiveness of different bed bath methods. This nonparametric test is suitable for comparing three or more groups with non-normal or ordinal data, as it is effective against normality violations. A significance level of $p \leq .05$ must be obtained to reject the null hypothesis.

The researchers obtained ethical clearance from the Ethics Review Committee (ERC) of Angeles University Foundation (2024-CON Student-029) in April 3, 2024, ensuring adherence to rigorous ethical standards. Respondents were fully informed about the study's purpose, procedures, potential risks, benefits, and their rights, with an emphasis on voluntary participation and the right to withdraw without consequences. Confidentiality was rigorously maintained, with data access restricted to authorized personnel, and withdrawal criteria were established to uphold research integrity. The authors declared no conflicts of interest, and compensation for participants was fair, emphasizing the value of their contributions to enhancing patient care practices.

RESULT

Development of i.m. Bathman

The development of IMB, inspired by the superhero Batman, symbolizes reliability and efficiency. Collaboration between engineers and researchers was pivotal in creating IMB, with extensive revisions to refine its design.

IMB features a multicompartment design and utilizes Polylactic Acid (PLA) for 3D printing. PLA was chosen for its biodegradability, safety, and low environmental impact. Despite its advantages, PLA's durability is affected by temperature fluctuations, necessitating controlled storage conditions. The design process included three revisions: a six-compartment basin, a revised version with seven compartments and a cover, and a final model with an improved sliding cover mechanism.

The final IMB design includes seven compartments for different body parts, with dimensions of 279x383mm when assembled. The total cost of the basin, including a sliding cover and

seven towels, is ₱5,000. The basin's blue color is intended to create a calming environment, aiding in reducing stress and promoting patient well-being.

The IMB represents a significant advancement in bed bath technology. PLA's eco-friendly properties align with sustainable practices, while the iterative design process highlights the importance of user feedback and collaboration. The final design improves both functionality and user experience, marking a valuable innovation in nursing care.

Nurses' Evaluation on the Three Bed Bath Provisions

Table 1 shows that in terms of convenience, the IMB emerges as the preferred option, with a mean score of 3.53, TBB follows with a mean score of 3.45, while DWW ranks lower with a mean of 3.26. When regards to time-saving aspects, the IMB again leads, with a mean score of 3.47 followed by DWW with a mean of 3.45, and TBB ranks third with a mean score of 3.02. Regarding cost-effectiveness, TBB is identified as the most cost-effective, with a mean score of 3.88. The IMB follows with a mean of 2.7, and DWW ranks third with a mean of 2.48. Overall, based on the nurses' evaluations, the IMB is recognized as the most convenient and time-saving option, while TBB is noted for its cost-effectiveness.

Nurses' Evaluation on Traditional Bed Bath Provision

Table 2 shows the evaluation of nurses on traditional bed bath regarding its convenience, time-saving, and cost-effectiveness. In terms of convenience, TBB received a mean score of 3.47. Out of the 90 responses, 25 agreed, and 8 strongly agreed with the convenience of TBB, while 16 disagreed, 4 strongly disagreed, and 37 remained neutral. As for time-saving, TBB had a mean score of 3.02. In this category, 20 respondents agreed, 18 strongly agreed, while 6 disagreed, 2 strongly disagreed, and 14 remained neutral. Lastly, for cost-effectiveness, TBB was identified as the most favorable option, with a mean score of 3.88. In this area, 22 respondents agreed, 10 strongly agreed, with 9 disagreeing and 19 remaining neutral. The nurses' evaluations suggest that TBB is moderately convenient and time-saving with strong recognition for its cost-effectiveness.

Nurses' Evaluation on Disposable Wet Wipes

Table 3 shows the evaluation of nurses on disposable wet wipes regarding its convenience, time-saving, and cost-effectiveness. For convenience, DWW received a mean score of 3.26. Among the respondents, 37 agreed, and 12 strongly agreed that DWW is convenient, while 20 disagreed, 3 strongly disagreed, and 18 remained neutral. While for time-saving aspect of DWW, it has a mean score of 3.45. In this category, 24 respondents agreed, and 9 strongly agreed that DWW saves time, while 15 disagreed, and 12 remained neutral. In terms of cost-effectiveness, it received a mean score of 2.48. 20 respondents disagreed, and 4 strongly disagreed with

its cost-effectiveness, while 13 remained neutral, and 12 agreed, and 11 strongly agreed.

Nurses' Evaluation on i.m. Bathman

Table 4 shows that in terms of convenience, IMB received a mean score of 3.53. Among the respondents, 46 agreed, and 11 strongly agreed that IMB is convenient, while 16 disagreed, 2 strongly disagreed, and 15 remained neutral. For time-saving, it has a mean score of 3.47. In this category, 17 respondents agreed, and 3 strongly agreed that IMB saves time, while 20 disagreed, 1 strongly disagreed, and 19 remained neutral. Lastly, for its cost-effectiveness, IMB received a mean score of 2.7. Here, 16 respondents disagreed, and 4 strongly disagreed with its cost-effectiveness, while 20 remained neutral, and 18 agreed, and 2 strongly agreed

The Differences on the Evaluation of Nurses Between Traditional bed Bath, Disposable wet Wipes, and i.m. Bathman in terms of Convenience, Time-saving, and Cost-effectiveness

Convenience

Using a bed bath method that simplifies nursing tasks can help nurses perform bed baths more efficiently with fewer supplies, reducing physical strain and allowing them to focus on providing high-quality care. This approach helps determine which bed bath method is most convenient based on nurse evaluations.

Table 5 ranks three bed bath methods in terms of convenience. Regarding ease of washing clients, the Kruskal-Wallis H test showed no significant differences among the methods ($p = .334$), but IMB ranked highest (50.60), followed by TBB (44.27) and DWW (41.63). For resource requirements, significant differences were found ($p = .050$), with TBB needing the fewest supplies (54.70), closely followed by IMB (41.02) and DWW (40.78). When it comes to the effort required, the Kruskal-Wallis H test indicated a

significant difference ($p = .032$), with IMB requiring the least effort (53.90), followed by DWW (45.63) and TBB (36.97).

Time-saving

Table 5 also presents the ranking of three bed bath methods based on time-saving. In the first evaluation, DWW ranked first with a mean rank of 48.70, followed by IMB (48.30) and TBB (39.50). Similarly, in the second evaluation, IMB ranked first with a mean of 50.13, followed by DWW (49.32) and TBB (37.05). These rankings highlight the close time-efficiency of IMB and DWW. However, the p-values of .268 and .079 indicate no significant difference in the time required to wash clients between IMB, DWW, and TBB.

Cost-effectiveness

As seen in table 5, the three bed bath methods were ranked based on cost-effectiveness. The Kruskal-Wallis H test yielded a p-value of $<.001$ for both cost-effectiveness statements, indicating a statistically significant difference among the methods. In the first statement, TBB ranked highest with a mean rank of 62.42, followed by IMB (43.63) and DWW (30.45). Similarly, the second statement, which used reverse scoring, also placed TBB first with a mean of 66.07, followed by DWW (37.42) and IMB (33.02). These results suggest that, based on nurses' evaluations, TBB is the most cost-effective option, likely due to its reduced material usage, such as the use of one reusable towel.

Table 1. Summary of Nurses' Evaluation on the Three Bed Bath Provisions regarding Convenience, Time-saving, and Cost-effectiveness

Rank	Criteria of Comparison		
	Convenience	Time-saving	Cost-effectiveness
1	I.M. BathMan (3.53)	I.M. BathMan (3.47)	Traditional Bed Bath (3.88)
2	Traditional Bed Bath (3.45)	Disposable Wet Wipes (3.45)	I.M. BathMan (2.7)
3	Disposable Wet Wipes (3.26)	Traditional Bed Bath (3.02)	Disposable Wet Wipes (2.48)

Table 2. Nurses' Evaluation on the Traditional Bed Bath Provision Regarding Convenience, Time-saving, and Cost-effectiveness

Statements	N	Mean (\bar{x})	Std. Deviation
Convenience			
1. I think it is easy to wash clients using a traditional bed bath method.	30	3.67	.84
3. I think the traditional bed bath method requires fewer supplies.	30	3.63	1.13
5. I think the traditional bed bath method takes less effort to wash clients.	30	3.10	.88
Total		3.47	.15
Time-saving			
2. I think that it is fast to wash clients using a traditional bed bath method.	30	3.23	.97
6. I think the traditional bed bath method has decreased bathing time.	30	2.80	1.03
Total		3.02	.04
Cost-effectiveness			
4. I think the traditional bed bath method is used as a cost-cutting measure.	30	3.90	1.06
7R. I think the traditional bed bath method costs the most.	30	3.87	.82
Total		3.88	.17

Table 3 Nurses' Evaluation on the Use of Disposable Wet Wipes regarding Convenience, Time-saving, and Cost-effectiveness

Statements	N	Mean (\bar{x})	Std. Deviation
Convenience			
1. I think it is easy to wash clients using disposable wet wipes.	30	3.50	1.11
3. I think using disposable wet wipes requires fewer supplies.	30	2.93	1.39
5. I think using disposable wet wipes takes less effort to wash clients.	30	3.33	1.15
Total		3.26	0.15
Time-saving			
2. I think that it is fast to wash clients using disposable wet wipes.	30	3.57	1.07
6. I think using disposable wet wipes has decreased bathing time.	30	3.33	0.99
Total		3.45	0.06
Cost-effectiveness			
4. I think using disposable wet wipes is used as a cost-cutting measure.	30	2.33	1.15
7R. I think using disposable wet wipes costs the most.	30	2.63	1.25
Total		2.48	0.06

Table 4. Nurses' Evaluation on the Use of I.M. BathMan regarding Convenience, Time-saving, and Cost-effectiveness

Statements	N	Mean (\bar{x})	Std. Deviation
Convenience			
1. I think it is easy to wash clients using I.M. BathMan.	30	3.90	0.66
3. I think using I.M. BathMan requires fewer supplies.	30	3.00	1.02
5. I think using I.M. BathMan takes less effort to wash clients.	30	3.70	1.06
Total		3.53	0.22
Time-saving			
2. I think that it is fast to wash clients using I.M. BathMan.	30	3.57	0.77
6. I think using I.M. BathMan has decreased bathing time.	30	3.37	1.16
Total		3.47	0.27
Cost-effectiveness			
4. I think using I.M. BathMan is used as a cost-cutting measure.	30	3.03	0.89
7R. I think using I.M. BathMan costs the most.	30	2.37	0.81
Total		2.70	0.06

Table 5. Nurses' Evaluation on the Use of the Three Bed Bath Provisions regarding Convenience, Time-saving, and Cost-effectiveness

Statements	Type of Bed Bath	N	Mean Rank	Rank	DF	P-Value	Interpretation
Convenience							
1. I think it is easy to wash clients using this method.	I.M. BathMan	30	50.60	1	2	0.334	NOT SIGNIFICANT
	Traditional Bed Bath	30	44.27	2			
	Disposable Wet Wipes	30	41.63	3			
3. I think this method requires fewer supplies.	Traditional Bed Bath	30	54.70	1	2	0.050	SIGNIFICANT
	I.M. BathMan	30	41.02	2			
	Disposable Wet Wipes	30	40.78	3			
5. I think this method takes less effort to wash clients.	I.M. BathMan	30	53.90	1	2	0.032	SIGNIFICANT
	Disposable Wet Wipes	30	45.63	2			
	Traditional Bed Bath	30	36.97	3			
Time-saving							
2. I think that it is fast to wash clients using this method.	Disposable Wet Wipes	30	48.70	1	2	0.268	NOT SIGNIFICANT
	I.M. BathMan	30	48.30	2			
	Traditional Bed Bath	30	39.50	3			
6. I think this method has decreased bathing time	I.M. BathMan	30	50.13	1	2	0.079	NOT SIGNIFICANT
	Disposable Wet Wipes	30	49.32	2			
	Traditional Bed Bath	30	37.05	3			

Cost-effectiveness

4. I think this method is used as a cost-cutting measure.	Traditional Bed Bath	30	62.42	1	2	<.001	SIGNIFICANT
	I.M. BathMan	30	43.63	2			
	Disposable Wet Wipes	30	30.45	3			
7R. I think this method costs the most.	Traditional Bed Bath	30	66.07	1	2	<.001	SIGNIFICANT
	Disposable Wet Wipes	30	37.42	2			
	I.M. BathMan	30	33.02	3			

Note: The significance level is .050 (if $p \leq 0.050$, then it is significant)

DISCUSSION

This study assessed the 3D-printed humanoid basin (IMB) for the first time in a real world nursing environment of bed bathing procedures, comparing its convenience, time-saving, and cost-effectiveness with traditional bed baths (TBB) and disposable wet wipes (DWW). Registered nurses with at least six months of experience at an Angeles City hospital participated, providing evaluations through validated questionnaires. Data analysis using SPSS revealed that the IMB was rated highest in both convenience ($\bar{x}=3.53$) and time-saving ($\bar{x}=3.47$), outperforming TBB (convenience $\bar{x}=3.45$, time-saving $\bar{x}=3.02$) and DWW (convenience $\bar{x}=3.26$, time-saving $\bar{x}=3.45$). In terms of cost-effectiveness, TBB was rated highest ($\bar{x}=3.88$), followed by IMB ($\bar{x}=2.70$) and DWW ($\bar{x}=2.48$). Statistically, IMB showed significant advantages in convenience compared to TBB and DWW ($p=.050$) and required less effort ($p=.032$). While IMB and DWW were more time-efficient than TBB, IMB was slightly preferred. TBB was the most cost-effective, with significant differences ($p<.001$). Overall, the IMB demonstrated superior convenience and time-saving benefits, TBB was more cost-effective, and DWW, though convenient and time-efficient, was the least cost-effective.

The findings of this study align with recent research emphasizing the importance of evaluating healthcare interventions based on multiple dimensions, such as convenience, time efficiency, and cost-effectiveness (Ferreira et al., 2023). For example, studies comparing traditional bed baths with disposable wet wipes have similarly highlighted the trade-offs between convenience and cost-effectiveness (Konya, Nishiya & Yano, 2021). It has shown that disposable wet wipes are often preferred for their time-saving benefits and ease of use, particularly in critical care settings, where efficiency is paramount (Konya et al., 2023; Rodriguez et al., 2020). However, these studies also note that traditional bed baths remain more cost-effective due to the reusable nature of materials like towels and basins, which aligns with the findings of this study (Tai, Hsieh, & Lee, 2021). Additionally, the IMB's superior convenience and reduced physical effort reflect broader trends in healthcare innovation, where tools

designed to minimize nurse workload and improve workflow efficiency are increasingly prioritized (Rony, Parvin & Ferdousi, 2024).

The time-saving benefits of IMB and DWW observed in this study are consistent with findings from other research that emphasize the importance of reducing the time required for routine nursing tasks (Addis et al., 2023; Zyoud, 2024). For instance, studies have demonstrated that disposable wet wipes significantly reduce the duration of bed baths compared to traditional methods, making them a preferred option in high-demand healthcare environments (Ayhan & Yilmaz, 2024). However, the IMB's slight edge in time-saving over DWW in this study suggests that innovative tools like the IMB may offer additional advantages by streamlining the process further. This aligns with the growing interest in integrating technology and ergonomic designs into nursing practices to enhance efficiency and reduce physical strain on healthcare providers (Galiano et al., 2024).

In terms of cost-effectiveness, the findings of this study reinforce the conclusions of prior research that traditional bed baths are the most economical option (Tai, Hsieh, & Lee, 2021). Studies have consistently shown that the use of reusable materials in traditional bed baths significantly reduces costs compared to disposable alternatives, particularly in long-term care settings where resource optimization is critical. However, the relatively low cost-effectiveness of IMB and DWW in this study highlights the ongoing challenge of balancing innovation with affordability in healthcare. This is particularly relevant in resource-limited settings, where cost considerations often outweigh the potential benefits of convenience and time-saving (Turner et al., 2023).

The study's limitations, such as the use of a single hospital and a small sample size, may affect generalizability. Future research should include multiple healthcare settings and larger, more diverse samples to improve external validity. Expanding data collection and using advanced statistical methods will provide better insights into bed bath practices.

For example, employing mixed-methods approaches that combine qualitative and quantitative data could offer a more comprehensive understanding of the effects of innovative

technologies like the IMB on nursing practice and patient care.

Investigating the IMB further could enhance bed bath procedures by assessing its impact on patient satisfaction, comfort, and its potential to reduce infections. These aspects are critical in evaluating the overall effectiveness of new healthcare technologies.

Additionally, future studies should explore the long-term cost-effectiveness of IMB, particularly in comparison to traditional methods, to determine its feasibility for widespread adoption. Including diverse healthcare settings and comprehensive methodologies will offer valuable insights and support evidence-based improvements in bed bathing practices. By addressing these limitations and expanding the scope of research, future studies can provide stronger evidence to guide clinical decision-making and improve patient care outcomes.

CONCLUSION

The study finds that nurses prefer IMB for their convenience and time-saving benefits, despite initially considering TBB for cost-effectiveness. IMB also offers environmental advantages, like waste reduction, contributing to sustainability. These factors help streamline workflows, allowing more focus on patient care, making IMB a valuable method in clinical settings.

Conflict of Interest

The authors declare no conflict of interest.

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