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Utilizing applications Nutrihas Pro for calculated fluid and electrolyte requirements for patient

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ABSTRACT

Background: Hospital malnutrition is a critical issue, particularly in regions like Makassar, Indonesia, where malnutrition rates surpass national averages. Malnourished patients often experience electrolyte imbalances and prolonged hospital stays, leading to increased healthcare costs. Despite the importance of accurate nutritional therapy, manual calculations are time-consuming and prone to human error, necessitating a more efficient solution.

Objective: This study aims to assess the effectiveness of the Nutrihas-Pro application, developed to improve the accuracy and time efficiency of nutritional therapy planning compared to manual methods.

Methods: An experimental repeated measures design was employed, involving 30 clinical nutrition residents at RSUP Dr. Wahidin Sudirohusodo. Participants manually calculated nutritional therapy and fluid/electrolyte needs for 60 patients and repeated the process using Nutrihas-Pro. Calculation times and accuracy were compared using paired-samples t-tests and chi- square tests.

Results: The Nutrihas-Pro application significantly reduced calculation times ($p < 0.001$) compared to manual methods, without compromising the accuracy of fluid and electrolyte requirement calculations ($p > 0.05$). Patients displayed a high prevalence of electrolyte imbalance (68.3%), particularly hyponatremia (35%).

Conclusion: Nutrihas-Pro improves time efficiency while maintaining calculation accuracy, making it a promising tool for nutritional therapy management. Further research is needed to address its limitations, including its reliance on internet connectivity and comparisons with other clinical calculator applications.

KEYWORDS

Medical Software, Theraupetic Planning, Nutrihas-Pro Application, Electrolyte Homeostasis, Digital Health.

INTRODUCTION

Malnutrition in hospitals is a critical issue that significantly impacts patient outcomes and the healthcare system. The causes of malnutrition in this setting are multifactorial, encompassing insufficient food intake and heightened catabolic processes due to underlying conditions such as metabolic diseases, infections, and malignancies[1]. In Makassar, Indonesia, malnutrition presents a notable public health challenge, with research indicating a high prevalence rate in the region. Studies have shown that the prevalence of malnutrition and poor nutrition reaches 28.1%, surpassing both provincial and national averages[2].

Nutritional therapy is an essential component of patient care, ensuring that hospitalized individuals receive adequate nutrition throughout their stay. Hospital meals are tailored to meet patients' clinical needs, providing specified amounts of protein and energy according to dietary guidelines[3]. Assessing a patient's nutritional status requires the collection of various data points, including anthropometric measurements, age, food intake details (24- hour food recall), dietary history, supplementation, appetite changes, satiety levels, physical activity, metabolic requirements, and stress levels. This comprehensive assessment necessitates significant time and trained healthcare personnel.

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The high incidence of malnutrition in hospitals necessitates prompt and accurate intervention by clinical nutrition specialists. Given the time required for planning nutritional therapy for hospitalized patients, the use of applications could enhance the efficiency of nutritional planning and minimize human errors in calculations[4]. While digital applications for medical calculations are commonly employed by clinicians, particularly in internal medicine, their use in clinical nutrition remains limited and often lacks comprehensiveness.

A prevalent issue among hospitalized patients is the disruption of electrolyte balance, with sodium and potassium imbalances frequently observed in malnourished individuals. Therefore, calculating electrolyte requirements is a critical component of nutritional therapy[5]. Inadequate identification and documentation of malnourished patients not only adversely affect patient outcomes but also impact hospital costs, length of stay, and overall quality of care[6]. The complexity of managing malnourished patients is considerably higher than that of well-nourished patients, underscoring the need for tailored nutritional support and interventions[7].

Nutrihas_Pro is an application developed by the Clinical Nutrition Study Program at Hasanuddin University, aimed at assisting clinical nutritionists in planning nutritional therapy for hospitalized patients. The implementation of Nutrihas_Pro is expected to enhance the effectiveness of clinical nutritionists in delivering quality care, ultimately improving patient outcomes in hospital settings.

METHODS

Research Subjects: This study utilized an experimental repeated measures design, which is commonly used to compare the effectiveness of a manual process with an application-based approach[8]. The population consisted of Clinical Nutrition SpecialistResidency Program students at the intermediate and advanced levels. The sample included 30 residents who met the inclusion criteria: intermediate residents (semester IV-V) and advanced residents (semester VI-VII) who had participated in a training session for the Nutrihas-Pro application. Exclusion criteria included residents stationed in other departments or working in intensive care units. Purposive sampling was employed to ensure that the selected sample accurately represented the target population[9].

Data collection: The study was conducted at RSUP Dr. Wahidin Sudirohusodo Makassar during June 2023. Data were collected in four stages. First stage, Respondents manually calculated nutritional therapy plans and fluid/electrolyte needs for 60 inpatients using a calculator. Next, respondents used the Nutrihas-Pro application to perform the same calculations. Lastly, data analysis was performed.

The instruments included patient data for both phases (manual and application-based), a stopwatch to measure completion times, a calculator (manual phase), and laptops for accessing the Nutrihas-Pro application (application-based phase). Nutrihas- Pro applications was developed to meet the needs of clinical nutrition specialists by assisting them in planning medical nutrition therapy. The planning process for medical nutrition therapy requires time for anthropometric calculations, energy and fluid requirements, laboratory result interpretation, and selecting food compositions for dietary prescriptions. This application is designed with an integrated system, enabling comprehensive and time-efficient therapy delivery.The application integrates various features related to medical nutrition therapy planning, starting from patient data collection, anthropometric calculations, 24-hour dietary recall, and metabolic status determination based on laboratory data input. Additionally, the application includes energy and fluid requirement calculations, electrolyte requirement corrections for patients with electrolyte imbalances, and therapy recommendations. Overall, this application offers a comprehensive medical nutrition therapy planning feature to enhance the efficiency and effectiveness of clinical nutrition specialists' work.

Research Permission and Ethical Clearance: Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Hasanuddin University, under registration number 776/UN4-6.4-5.31/PP36/2023.

Data processing and analysis: Data were analyzed by comparing the time required for residents to calculate nutritional therapy manually versus using the Nutrihas-Pro application. Independent variables included the method used (manual vs. application), while dependent variables were the time taken for calculations and the accuracy of the nutritional therapy results. Confounding variables, such as individual resident skills in manual calculation and app usage, were controlled through repeated measures to account for individual differences[10].

RESULTS

The aim of this study was to compare the time efficiency and accuracy of nutritional therapy and electrolyte calculations performed manually versus using the Nutrihas-Pro application. A total of 30 clinical nutrition residents participated in the study, calculating nutritional plans for 60 hospitalized patients.

Patient Characteristics

The study involved 30 respondents, all of whom participated in both phases: manual calculation in phase 1 and application-based calculation in phase 2. The characteristics of the participants are summarized in Table 1.

Table 1 shows that the majority of respondents were aged between 35-40 years (63.3%), while the remaining 36.7% were over 40 years old. The gender distribution was predominantly female (83.3%), with only 16.7% being male. Additionally, the participant levels were evenly distributed between intermediate and advance (50%).

Table 1. Baseline Characteristics of Hospital Residents

Variables	Variabel	n	%
Age	35 - 40 years	19	63.3
	> 40 years	11	36.7
Gender	Male	5	16.7
	Female	25	83.3
Participant Level	Intermediate	15	50.0
	Advanced	15	50.0

Values are n (%).

Characteristics of the Patients

The study utilized 60 patient records from inpatients at Wahidin Sudirohusodo Hospital, each randomly distributed across respondents for manual and application-based testing.

Based on the results, most patients were male (60%), and 70% were categorized under SGA Class C. Electrolyte imbalance was present in 68.3% of patients, with 35% experiencing hyponatremia which is divided into three categories classified by plasma sodium level, mild hyponatremia (130-135 mmol/L), moderate hyponatremia (125-129 mmol/L) and severe hyponatremia (<125 mmol/L)[11]. Data found primarily mild hyponatremia (26.7%). Hypernatremia is defined as a serum or plasma sodium level >145 mmol/L[12]. Hypokalemia classified by plasma potassium level, mild hypokalemia (3.0 – 3.5 mEq/L) moderate hypokalemia (<3.0 mmol/L) and severe hypokalemia < 2.5 mmol/L)[12] and hyperkalemia if plasma potassium level > 5 mmol/L[13]. Furthermore, 25% had a combination of sodium and potassium disturbances, and 20% of patients showed impaired kidney function defined by eGFR <90 ml.

Furthermore, we analysed the comparison of fluid requirement calculations. Table 3 illustrates that there was no statistically significant difference in fluid requirement calculations between the manual method and the application method ($p = 0.110$).

Comparison of Electrolyte Requirement Calculations and Calculation Time

Table 3 also shows that no significant difference was observed in electrolyte requirement calculations between manual and application methods ($p = 0.644$). However, the application method significantly reduced calculation time ($p < 0.001$), indicating greater time efficiency.

Table 2. Baseline Characteristics of Hospital Patients

Variable		n	%
Age	Male	36	60.0
	Female	24	40.0
SGA	B	18	30.0
	C	42	70.0
Fluid Calculation	CKD	6	10.0
	Isocaloric	29	48.3
	Age-related	25	41.7
Electrolyte Imbalance	Present	41	68.3
	Absent	19	31.7
Electrolyte Disturbances	Hyponatremia	21	35.0
	Combination	15	25.0
	Hypokalemia	4	6.7
	Hypernatremia	1	1.7
	No disturbances	19	31.7
Sodium Levels	Mild Hyponatremia	16	26.7
	Moderate Hyponatremia	14	23.3
	Severe Hyponatremia	6	10.0
	Hypernatremia	1	1.7
	Normal	23	38.3
Potassium Levels	Mild Hypokalemia	4	6.7
	Moderate Hypokalemia	5	8.3
	Severe Hypokalemia	2	3.3
	Hyperkalemia	7	11.7
	Normal	42	70.0
Kidney Function	Impaired	12	20.0
	Normal	48	80.0

Values are n (%).

Table 3. Comparison of fluid requirement calculations, Electrolyte requirement calculations and Calculation time using manual and application methods

	Manual			Application			*P*
	Mean	**SD**	**Median**	**Mean**	**SD**	**Median**	
Fluid Requirement	1730	247,2	1800	1716,3	233	1750	0,110
Electrolyte Requirement	280.79	115.72	282.00	278.24	113.69	270.90	0.644*
Calculation Time	28.98	3.37	29.00	8.77	2.48	9.00	0.000**

Values are n (%), comparison was performed using paired-samples t-test for continuous variables unless otherwise stated. Significant if p<0.05.
* Comparison was performed using Pearson chi-square test for categorical variables.
** Comparison was performed using Wilcoxon test.

Table 4. Electrolyte Calculation Time and Electrolyte Requirements by Respondent Level

	Level	Manual			Application			*p*
		Mean	**SD**	**Median**	**Mean**	**SD**	**Median**	
Electrolyte Requirement	Intermediate	293.14	100.42	296.00	285.34	100.86	283.00	0.187
	Advanced	272.04	126.81	260.24	273.22	123.85	265.85	0.890
Electrolyte Calculation Time	Intermediate	28.59	3.36	28.00	9.06	2.73	9.00	0.000
	Advanced	29.13	3.44	29.00	8.63	2.26	9.00	0.000**

Values are n (%), comparison was performed using paired-samples t-test for continuous variables unless otherwise stated. Significant if p<0.05.
** Comparison was performed using Wilcoxon test.

Electrolyte Calculation Time by Respondent Level

Table 4 demonstrates that the application method significantly reduced the calculation time for electrolyte requirements across both Intermediate and Advanced levels ($p < 0.001$), further confirming the time efficiency of using the application. This table also indicates no significant difference in electrolyte requirement calculations between manual and application methods when grouped by respondent level.

DISCUSSION

This study involved the successful introduction and testing of the Nutrihas-Pro application, conducted through a training session on May 19, 2023, at the Clinical Nutrition Department of RSP Universitas Hasanuddin. The participants, comprised of intermediate and advanced level clinical nutrition residents, were enthusiastic about this novel method for calculating patient nutritional requirements. The hands-on approach, including case studies, effectively demonstrated the application's functionality, highlighting its potential to improve clinical nutrition management.

The Need for Change in Hospital Nutritional Assessment

The importance of improving hospital nutrition assessment methods has been emphasized by the recognition that malnutrition is a significant factor impacting patient outcomes. Research shows that 20% to 50% of hospitalized patients are malnourished at admission or become malnourished during their stay[14,15]. Malnutrition prolongs recovery, increases hospital stays and healthcare costs, and leads to higher morbidity and mortality rates[16,17]. Given these challenges, a reform in the way nutritional assessments are conducted is urgently needed. The Nutrihas-Pro application provides a practical solution to this issue, offering an efficient tool to calculate nutritional needs and correct electrolyte imbalances, potentially leading to better patient care.

Time Efficiency and Accuracy in Electrolyte Calculations

One of the major findings of this study was the improved time efficiency associated with using Nutrihas-Pro for calculating fluid and electrolyte needs in patients. The manual process, which requires memorizing formulas and algorithms,

is time-consuming. The application streamlines this by automating the calculations, thereby reducing the calculation time significantly, as also demonstrated by Green et al.[18], who found that medical calculators are integral to improving workflow efficiency. This finding is supported by similar studies, such as that by Dziadzko et al.[19,20], which highlighted the usefulness of clinical calculators in decision-making.

Regarding accuracy, the Nutrihas-Pro application provided results comparable to manual calculations. This suggests that the programmed algorithms and formulas are reliable, offering clinicians confidence in the accuracy of the tool. This is consistent with previous research, such as Bierbrier et al.[21], who found that most medical calculation applications were accurate and reliable. Moreover, the application minimizes human error, making it a valuable tool for achieving consistency and standardization in nutritional planning. The combination of time savings and accuracy positions Nutrihas-Pro as a useful tool for clinical nutrition therapy, particularly when prompt and precise interventions are critical.

CONCLUSION

In conclusion, the Nutrihas-Pro application demonstrates significant advantages in time efficiency without compromising accuracy, making it a promising tool in clinical nutrition management. However, further research and development are needed to address its limitations and maximize its potential in broader clinical settings.

Research Limitations

The lack of prior studies specifically evaluating clinical calculator applications for fluid and electrolyte calculations posed a challenge in comparing the effectiveness of Nutrihas-Pro. Future studies involving larger populations are needed to further validate its effectiveness. Additionally, comparative studies with other established clinical calculator applications, such as MedCalc or Calculate by QxMD, would provide a more comprehensive evaluation. Another limitation of the study was the requirement for an internet connection, as Nutrihas-Pro is a web- based application. This restricts its usability in settings with limited internet access, highlighting the need for offline functionality in future versions of the application.

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