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Nutritional therapy and drug administration practices in critically ill patients: A point-prevalence study

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ABSTRACT

Objective: This study aimed to evaluate nutritional therapy practices and drug administration via enteral feeding tubes in intensive care unit (ICU) patients of a tertiary university hospital, and identify potential drug-nutrient interactions and administration errors.

Methods: This observational point-prevalence study was conducted in the ICUs of a tertiary hospital. All adult patients hospitalised in the ICUs on the designated study day were included. Demographic and clinical data, nutritional status, route of nutritional therapy (oral, enteral, parenteral, or combined), and drug administration details were obtained from the hospital information system. Potential drug-nutrient interactions and drug incompatibilities were comprehensively screened using the Micromedex® (Merative, Ann Arbor, MI, USA) electronic database. Drug administration errors via enteral tubes were defined as the use of an inappropriate dosage form, failure to interrupt enteral feeding when required, and failure to flush the tube adequately between drug administrations. Comparisons were made between the medical and surgical ICUs using appropriate statistical analyses.

Results: A total of 55 critically ill patients were included in this study. The mean age was 54.9 ± 18.4 years, and 41.8% were female. Among the 40 patients (72.7%) who received nutritional therapy, 62.5% were fed orally, 27.5% enterally, 2.5% parenterally, and 7.5% via a combination of routes. The mean daily energy and protein intakes were 19.4 ± 6.7 kcal/kg and 0.70 ± 0.23 g/kg, respectively. Patients received a median of 7.0 (6.0-11.0) drugs per day. Incorrect administration of 26 different drugs via enteral feeding tubes was identified in 14 patients, most commonly involving the use of inappropriate formulations and improper administration techniques. Drug-nutrient interactions were detected in three patients and drug incompatibilities in two patients. No significant differences were observed between the medical and surgical ICUs for most parameters.

Conclusion: Nutritional therapy in critically ill patients remains inadequate, with energy and protein intakes remaining considerably below guideline-recommended targets, even among patients actively receiving nutritional therapy. The predominant route of nutritional therapy was oral feeding, followed by enteral. Drug administration via enteral feeding tubes carries a notable risk of errors, predominantly related to formulation selection and administration technique, as well as drug-nutrient interactions. Improving adherence to nutritional protocols and strengthening multidisciplinary collaboration may enhance patient safety and the quality of care in ICUs.

Keywords: critical illness, drug administration errors, drug-nutrient interactions, enteral nutrition, intensive care unit

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Introduction

Critically ill patients requiring intensive care are at a high risk of developing protein-energy malnutrition. Some patients present with malnutrition upon intensive care unit (ICU) admission, while others become susceptible during their stay owing to the metabolic responses associated with critical illness. The prevalence of malnutrition among critically ill patients ranges from 38% to 78%.[1] Malnutrition is associated with adverse clinical outcomes, including immunosuppression, increased risk of infection, delayed wound healing, prolonged mechanical ventilation, longer hospital stays, and increased mortality.[2] Therefore, early and appropriate nutritional therapy is a fundamental component of intensive care management.

International guidelines recommend that enteral nutritional therapy should be preferred whenever possible in ICUs and that energy and protein targets (25–30 kcal/kg/day and 1.2-2.0 g/kg/day) should be achieved progressively as the patient's clinical status allows.[3,4] However, in clinical practice, achieving these targets is often insufficient, and patients receive, on average, less than 60% of the prescribed calorie and protein requirements.[5] Similar findings have been reported in multicenter point-prevalence studies conducted in Turkey: although the rate of enteral nutritional therapy in internal medicine ICUs exceeds 50%, energy and protein adequacy remains below recommended targets, and the timing of nutritional therapy initiation varies considerably across centers.[6]

Main Points

- Critically ill patients frequently receive insufficient nutritional therapy, with both energy and protein intakes often falling below guideline-recommended targets, even among those actively receiving nutritional support.
- Enteral nutritional therapy is commonly initiated late, and nutritional tolerance monitoring (e.g., gastric residual volume) is suboptimal in these patients.
- Drug administration via enteral feeding tubes is associated with frequent errors, most commonly the use of inappropriate formulations and improper administration techniques, such as crushing tablets that require dissolution.
- Although relatively uncommon, drug-nutrient interactions and incompatibilities are clinically relevant and require careful management in ICU patients.
- Strengthening adherence to nutritional protocols, targeted interventions on drug administration techniques, and multidisciplinary collaboration can improve patient safety and the overall quality of care in ICUs.

Drug administration is an equally important issue in the management of critically ill patients. Polypharmacy, generally defined as the concurrent use of five or more drugs, is common among ICU patients, with an average of 7–10 drugs prescribed per day.[7,8] This increases the risk of drug-drug interactions, drug-nutrient interactions, administration errors, and adverse events. Error rates in parenteral drug administration may reach up to 74 per 100 patient-days; the proportion of patients experiencing at least one erroneous drug administration via an enteral tube has been reported to range from 14% to 56%.[9] The most common error types include administration of an inappropriate dosage form (e.g., crushing enteric-coated or modified-release tablets), incorrect timing relative to feeding, incorrect dose, and failure to flush the tube adequately between drugs. Tube obstruction, often cited in this context, represents a potential consequence of these errors rather than an error category in itself.[9,10] Such errors and interactions may lead to pharmacokinetic alterations, nutritional deficiencies, and adverse drug reactions, threatening patient safety.

Although several studies have examined nutritional therapy practices in ICUs in Turkey, studies simultaneously evaluating enteral and parenteral nutritional therapy, drug administration routes, and potential drug-nutrient interactions remain limited.[6,7] This gap highlights the need for comprehensive data addressing nutrition and drug management in intensive care practice. This study aimed to evaluate the current clinical practices regarding the concomitant use of nutritional therapy and drugs in the ICUs of a university hospital, as well as potential drug-nutrient interactions and the administration errors. Furthermore, the study aimed to assess the alignment of current practices with the guideline recommendations and to identify areas for improvement to enhance patient safety.

Materials and methods

Study design and setting

This observational point-prevalence study was conducted in the ICUs of a tertiary university hospital. Ethical approval was obtained from the relevant institutional

ethics committee (May 21, 2021; No. 111/92). Data were collected on a designated study day (July 6, 2021) during working hours (08:00–17:00).

Study population

All adult patients receiving care in the tertiary ICUs were included in the study. Patients aged <18 years and those with incomplete data were excluded. The Internal Medicine ICU and Neurology ICU were classified as Medical ICUs (MICUs); all remaining units, including the Anaesthesiology ICU which admits both medical and surgical patients and was classified within the Surgical ICU (SICU) group based on its predominant surgical case mix, were classified as SICUs. Comparative analyses were performed between MICUs and SICUs.

Data collection

Demographic characteristics, comorbidities, and clinical data related to the ICU stay were obtained from the hospital information system. Disease severity was assessed using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score.[11] Nutritional status was recorded as follows: patients were classified as receiving nutritional therapy (oral, enteral, parenteral, or combined) or not receiving nutritional therapy, and the reason for the latter was documented. Nutritional risk was assessed using the Nutritional Risk Screening 2002 (NRS-2002) and the Nutrition Risk in the Critically Ill (NUTRIC) score; patients with an NRS-2002 score ≥ 3 were classified as nutritionally at-risk, and those with a NUTRIC score ≥ 5 were classified as being at high nutritional risk.[12,13] Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Gastric residual volume (GRV) monitoring and serum phosphorus monitoring were also recorded.

All drugs administered to patients (enteral and parenteral), along with micronutrient and vitamin supplements, were recorded. Vasoactive agents were included as a subset of parenteral drugs. Potential drug administration errors related to enteral tube administration, drug-nutrient interactions, drug-drug interactions and parenteral drug incompatibilities were evaluated and recorded. Potential drug-nutrient interactions and drug incompatibilities were comprehensively screened using the Micromedex® electronic database (Merative, Ann Arbor, MI, USA). Drug administration errors via the enteral tube were defined according to three criteria: use of an inappropriate dosage form (e.g., crushing enteric-coated or modified-release tablets), failure to interrupt enteral feeding when clinically required, and failure to adequately flush the tube with water between separate drug administrations.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (version 26.0; IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation. Discrete variables that did not follow a normal distribution are presented as median and interquartile range [IQR]. The Mann-Whitney U test was used for between-group comparisons of non-normally distributed discrete variables. Categorical variables are presented as numbers and percentages. An independent samples t-test was used for normally distributed continuous variables, and the chi-square test was used for the categorical variables. The statistical significance was set at $p < 0.05$.

Results

A total of 66 patients were evaluated on the study day; 11 patients aged <18 years were excluded, leaving 55 patients for analysis. The mean age was 54.89 ± 18.36 years, and 41.8% of the patients were female. The median BMI was 27.4 (24.5–31.1). The median APACHE II score was 18.0 (14.0-22.5), the median NUTRIC score was 4 (2–6), and the median NRS-2002 score was 3 (3.0-4.5). Nineteen (34.5%) patients had a NUTRIC score ≥5, indicating a high nutritional risk; 54(98.2%) patients had an NRS-2002 score ≥3, indicating nutritional risk. Of the 55 patients, 40% were in MICUs and 60% in SICUs. The demographic and clinical characteristics of the patients are shown in Table 1.

Nutritional therapy was received by 72.7% of the patients. Among these, 62.5% were fed orally, 27.5% enterally, 2.5% parenterally, and 7.5% via a combination of routes. When restricted to the 40 patients actively receiving nutritional therapy, the mean daily energy and protein intakes were 19.4 ± 6.7 kcal/kg and 0.70 ± 0.23 g/kg, respectively. Nutritional therapy was initiated after a median of 3.0 (2.0–4.0) days of admission. Among the 27.3% of patients who did not receive nutritional therapy, the reasons differed significantly between ICU types ($p = 0.040$): 75% of MICU patients were unable to receive nutrition due to hemodynamic instability, whereas 53.3% of SICU patients were in the perioperative period. It should be noted that perioperative fasting in SICU patients represents a planned clinical requirement rather than a protocol failure; this structural difference limits the

Table 1. Demographic, nutritional, and clinical characteristics of ICU patients.

Parameters	All patients
Age (years)	54.89 ± 18.36
Male Sex (n, %)	32 (58.2%)
BMI (kg/m^2)	27.4 (24.5–31.1)
APACHE II Score	18.0 (14.0-22.5)
NUTRIC Score	4.0 (2.0-6.0)
NRS-2002 Score	3.0 (3.0-4.5)
NRS-2002 ≥ 3 (at nutritional risk) (n, %)	54 (98.2%)
NUTRIC Score ≥ 5 (high nutritional risk) (n, %)	19 (34.5%)
Daily Calories (kcal/kg)	19.42 ±6.70
Daily Protein (g/kg)	0.70 ±0.23
Total Drugs	7.0 (6.0-11.0)
Total Parenteral Drugs	5.0 (3.0-7.0)
Total Enteral Drugs	2.0 (1.0-4.0)
ICU Stay Prior to Study (days)	7.0 (4.0-13.0)
Day of Nutritional Therapy Initiation	3.0 (2.0-4.0)
Nutritional Therapy — Yes (n, %)	40 (72.7%)
Nutritional Therapy — No (n, %)	15 (27.3%)
ICU Type — Medical ICU (n, %)	22 (40%)
ICU Type — Surgical ICU (n, %)	33 (60%)

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation II; BMI, Body Mass Index; NRS-2002, Nutritional Risk Screening 2002; ICU, intensive care unit. NRS-2002 ≥ 3 indicates nutritional risk; NUTRIC score ≥ 5 indicates high nutritional risk. Continuous data: mean ± SD. Discrete non-normal data: median [IQR].

direct comparability of nutritional parameters between the two ICU types. No statistically significant difference was found between the ICU types in the rate of nutritional therapy provision (p = 0.354) or the route of nutritional therapy (p = 0.632). The Blood Glucose Monitoring (BGM) protocol was applied to all MICU patients (100%) versus 72.7% of SICU patients (p = 0.004) (Table 2). Serum phosphorus levels were monitored in 90% of patients receiving nutritional therapy. Gastric residual volume monitoring was performed in 72.7% of patients who received enteral nutritional therapy. The absence of significant differences between ICU types for phosphorus monitoring, micronutrient supplementation, and vitamin supplementation (p> 0.05) suggests relatively uniform adherence to basic monitoring practices across units (Table 3).

Patients received a median of 7 (6–11) drugs per day. Drug administration errors via enteral feeding tubes were identified in 14 patients (25.5%), corresponding to a total of 29 drug-related problems across 26 different drugs, as a single drug could be associated with more than one problem. The most frequent problem was the administration of an inappropriate formulation via a feeding tube (n = 15, 51.7%), followed by improper administration techniques, such as crushing tablets that require dissolution (n = 8, 27.6%). Less frequent problems included failure to allow an adequate interval to prevent drug-nutrient interactions (n = 3, 10.3%), administration of drugs via the feeding tube that are contraindicated for the enteral route (n = 1, 3.4%), and drug administration via the total parenteral nutrition (TPN) line (n = 2, 6.9%). The distributions of these errors are listed in Table 4. Representative examples included an orodispersible desmopressin tablet and domperidone and famotidine tablets administered via the feeding tube in their standard oral form, as well as an extended-release metoprolol tablet that was crushed prior to administration despite its modified-release formulation. Additionally, potential drug-drug interactions were screened using the same database; however, as no clinically significant interactions were identified within this cohort, these data are not reported.

Table 2. Clinical characteristics of nutritional therapy and drug administration in intensive care units.

Parameters		Medical ICU	Surgical ICU	All patients	p
Nutritional Therapy [a]	Yes	18 (81.8%)	22 (66.7%)	40 (72.7%)	0.354
	No	4 (18.2%)	11 (33.3%)	15 (27.3%)	
Non-Nutritional Therapy [a]	Perioperative	0 (0%)	8 (72.7%)	8(53.3%)	0.020*
	Hemodynamic Instability	3 (75.0%)	1 (9.1%)	4 (26.7%)	
	Ileus	1 (25.0%)	2 (18.2%)	3 (20.0%)	
Route of Nutrition	Per Oral	12 (66.7%)	13 (59.0%)	25 (62.5%)	0.632
	Enteral	6 (33.3%)	5 (22.7%)	11 (27.5%)	
	Parenteral	0 (0%)	1 (4.5%)	1 (2.5%)	
	Combination	0 (0%)	3 (13.6%)	3 (7.5%)	
Day of Nutritional Therapy Initiation [b]		3.0 (3.0-4.75)	2.5 (1.25-3.0)	3.0 (2.0-4.0)	0.127
Total Drugs[b]		8.0 (6.0-10.8)	7.0 (5–11)	7.0 (6.0-11.0)	0.512
Parenteral Drugs [b]		5.0(3.25-8.25)	5.0 (3–7)	5.0 (3.0-7.0)	0.516
Enteral Drugs [b]		2.0(1.25-3.75)	2.0 (1–4)	2.0 (1.0-4.0)	0.426
Number of Drug Administration Errors[b]		0 (0–0)	0 (0–1)	0 (0–1)	0.191
Drug-Nutrition interaction [a]	Yes	0 (0%)	3 (9.1%)	3 (5.5%)	0.356
	No	22 (100%)	31 (90.9%)	53 (94.5%)	
Drug incompatibility[a]	Yes	0 (0%)	2 (6.1%)	2 (3.6%)	0.356
	No	22 (100%)	31 (93.9%)	53 (96.4%)	
Administration Errors[a]	Yes	4 (18.2%)	10 (30.3%)	14 (25.5%)	0.487
	No	18 (81.8%)	23 (69.7%)	41 (74.5%)	
Glucose Monitoring Protocol[a]	Yes	22 (100%)	24 (72.7%)	46 (83.6%)	0.004*
	No	0 (0%)	9 (27.3%)	9 (16.4%)	

*p<0.05; [a] Chi-square test; [b]Mann-Whitney U.

Table 3. Descriptive data on specific interventions in intensive care units.

Parameters	Medical ICU	Surgical ICU	All patients	p
Vasoactive Drugs, *Yes*	3 (13.6%)	3 (9.1%)	6 (10.9%)	0.456
Phosphorus Monitoring, *Yes*	21 (95.5%)	25 (75.8%)	46 (83.6%)	0.054
Gastric Residual Volume, *Yes*	4 (66.7%)	4 (80%)	8 (72.7%)	0.333
Micronutrient, *Yes*	0 (0%)	2 (6.1%)	2 (3.6%)	0.356
Vitamin, *Yes*	4 (18.2%)	3 (9.1%)	7 (12.7%)	0.278

*p<0.05; Chi-square test.

Table 4. Distribution of drug administration errors associated with enteral nutrition.

Type of drug administration errors	n (%)
Administration of inappropriate formulations via feeding tubes	15 (51.7%)
Improper drug administration techniques (e.g., crushing tablets that require dissolution)	8 (27.6%)
Failure to allow adequate interval to prevent drug–nutrient interactions	3 (10.3%)
Administration of drugs via feeding tubes that are contraindicated for enteral route	1 (3.4%)
Drug administration via the total parenteral nutrition (TPN) line	2 (6.9%)
Total	29

Note: Since a single drug may involve more than one drug-related problem, the total number of problems may exceed the number of unique drugs.

Discussion

In this point-prevalence study of 55 critically ill patients in the ICUs of a tertiary university hospital, two main findings emerged: nutritional therapy was frequently inadequate in terms of both energy and protein delivery, and drug administration via enteral feeding tubes was associated with notable error rates and drug-nutrient interactions.

Among patients actively receiving nutritional therapy, the mean daily energy and protein intakes were 19.4 ± 6.7 kcal/kg and 0.70 ± 0.23 g/kg, respectively , both considerably below the targets recommended by ESPEN (25–30 kcal/kg/day and approximately 1.3 g/kg/day) and ASPEN (1.2–2.0 g/kg/day protein).[3,4] These findings are consistent with those of prior studies: a prospective multicenter study reported that energy and protein intakes remained at 60–80% of targets in most ICU patients, and a Turkish observational study showed that hypocaloric nutrition was common in the early ICU period, with the maximum energy target typically reached only by the sixth day.[14,15] The persistent gap between prescribed and delivered nutrition in our cohort likely reflects multiple contributing factors, including hemodynamic instability in MICUs and perioperative fasting requirements in SICUs, rather than a single underlying cause.

Regarding the timing of nutritional therapy initiation, our data showed a median delay of 3.0 (2.0–4.0) days. International guidelines recommend initiating enteral nutritional therapy within 24–48 h in hemodynamically stable patients, although the evidence regarding optimal timing varies, and early initiation is not universally supported for all patient subgroups.[3,4] The reasons for delayed or absent nutritional therapy in our study — hemodynamic instability and perioperative status — are consistent with the most commonly reported barriers in the literature.[15,16]

GRV monitoring was performed in only 72.7% of patients receiving enteral nutritional therapy. Previous studies suggest that systematic GRV monitoring, combined with the use of prokinetic agents when appropriate, can reduce nutritional intolerance and feeding interruptions.[17] A limitation of the present study is that GRV was recorded as a binary variable (monitored/not monitored) rather than as a continuous measurement, precluding a comparison of GRV values between patients who achieved nutritional targets and those who experienced feeding intolerance. Future studies should prospectively record GRV values alongside nutritional target attainment data to better characterise this relationship.

With respect to drug administration, patients received a median of 7 (6–11) drugs per day, consistent with the definition of polypharmacy and previously reported figures for ICU patients.[7,8] Drug administration errors via enteral feeding tubes were identified in 25.5% of patients, corresponding to 29 distinct drug-related problems across the 26 affected drugs. In our cohort, the predominant problem was the administration of an inappropriate formulation via the feeding tube (n = 15, 51.7%), followed by improper administration techniques, such as crushing tablets that require dissolution (n = 8, 27.6%); together these two categories accounted for nearly 80% of all identified problems. Among these, the crushing of an extended-release metoprolol tablet illustrates a particularly important risk, as modified-release formulations are designed for gradual drug release; crushing disrupts this mechanism and can result in rapid, uncontrolled release with an increased risk of adverse effects. Film-coated tablets are generally not recommended for administration through enteral feeding

tubes because of the potential risk of tube obstruction. However, in clinical practice, when no suitable alternative formulation is available, these dosage forms may need to be administered via the feeding tube; in such cases, the tablet should be adequately crushed and dispersed, ensuring the formation of sufficiently small particles to minimize the risk of obstruction. This pattern suggests that targeted interventions addressing formulation selection and administration techniques, such as routine pharmacist review of enterally administered drugs, could meaningfully reduce the overall error burden in our setting. The remaining problems, namely failure to allow an adequate interval to prevent drug-nutrient interactions (n = 3, 10.3%), administration of drugs contraindicated for the enteral route (n = 1, 3.4%), and administration via the total parenteral nutrition line (n = 2, 6.9%), were less frequent but carry potentially serious clinical consequences, including therapeutic failure and nutrient line contamination. These study-specific findings are broadly consistent with error types reported in the literature, where inappropriate formulation selection and technique-related errors are similarly the most frequently cited categories.[10,14,18-23]

The BGM protocol adherence rate was significantly lower in SICUs (72.7%) than in MICUs (100%) (p = 0.004), reflecting a difference in adherence to monitoring protocols between unit types. No significant differences were found for phosphorus monitoring, micronutrient supplementation, or vitamin supplementation, suggesting broadly uniform adherence to basic monitoring practices across the units.

The active involvement of clinical pharmacists in ICU teams has been shown to reduce drug administration errors and improve healthcare professionals' knowledge of drug-nutrient compatibility.[24] Multidisciplinary collaboration involving physicians, nurses, dietitians, and clinical pharmacists is therefore essential to improve both the safety and quality of drug administration and nutritional therapy in critically ill patients.

Our study is one of the few in Turkey to simultaneously evaluate the adequacy of nutritional therapy and drug administration errors in ICU patients. Its limitations include the cross-sectional point-prevalence design, which precludes causal inference; single-centre conduct, which may limit generalisability; a relatively small sample size; the use of weight-based estimations rather than indirect calorimetry for determining nutritional targets; the classification of GRV as a binary variable, precluding GRV-based comparisons; and the structural non-equivalence of MICU and SICU populations with respect to perioperative fasting, which limits direct nutritional comparisons between unit types. Future multicenter, longitudinal studies incorporating protocol-based interventions would strengthen the evidence base in this field.

Conclusion

Nutritional therapy is frequently inadequate in critically ill patients: even among those actively receiving nutritional therapy, mean energy and protein intakes remained considerably below the guideline-recommended targets, with oral feeding being the predominant route. Drug administration via enteral feeding tubes was associated with a notable frequency of errors, predominantly the use of inappropriate formulations and improper administration techniques, as well as drug-nutrient interactions. These findings highlight the need for more effective implementation of nutritional therapy protocols, targeted interventions addressing drug formulation selection and administration techniques, active involvement of multidisciplinary teams including clinical pharmacists, enhanced training of healthcare professionals, and development of standardised protocols that account for drug-nutrient compatibility.

Author contributions

Conception: N.A.A., N.S.; Design: N.A.A., N.S.; Data acquisition: N.A.A., N.S.; Data analysis: N.A.A., S.B.; Data interpretation: N.A.A., N.S., S.B.; Drafting of the manuscript: N.A.A.; Critical revision of the manuscript: N.A.A., N.S., S.B., H.M.G. All authors reviewed the results, approved the final version of the manuscript, and agreed to be accountable for all aspects of this study.

Ethical approval

This study was approved by the Çukurova University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (Date: May 21, 2021, Decision/Protocol No: 111/92).

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest to disclose.

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Generative AI statement

The authors declare that during the preparation of this work, the following AI-assisted technology was used: Paperpal (Cactus Communications); ChatGPT (OpenAI), February–March 2026. Paperpal and ChatGPT were used to assist with language editing, grammar correction, and improving the clarity and readability of the manuscript. The tools were used solely for language refinement and did not replace the authors' scientific judgment. The authors critically reviewed and edited the suggested changes and take full responsibility for the accuracy, integrity, and originality of the manuscript.

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