The Clinical Impacts of Early Trophic Feeding Using Protein Formulas in Compared With Standard Formulas in Intolerated Enteral Nutrition Hospitalized Patients

"Moh'd Nour" Mahmoud Bani Younes; Ph[*], Rayya Khalaf Al Mashaqbeh; MD[**], Mohammad Ali Zureigat; MD[***], Laith Taha Aladaileh; MD[^], Aktham Abdul Aziz Al Dhomour; MD[^^], ,Basel Naem Al-Rawashdeh MD[+], Areej Mohammed Almanaseer Ph[*]

ABSTRACT

Objectives: Patients who are not taking any enteral feeding may decrease the integrity of enterocytes which subsequently increase risk of bacterial translocation. The aim of this study is to compare the clinical and economic impacts of early trophic feeding using standard enteral nutritional formulas, reconstituted whey protein, and ArgiMent® at rate of 10 ml every hour and 20 ml every 2 hours in intolerated enteral feeding hospitalized patients in terms of albumin level, cost effectiveness ratio, overall hospital length of stay and mortality.

Methods: We conducted a retrospective analysis of 326 patients admitted to our King Hussein Medical Hospital between Apr 2017 to Mar 2019 who were their demographics, diagnostics, anthropometrics, and required lab data were known. Analysis values were compared among the six tested groups by using ANOVA for continuous variables and Chi square test for nominal data after exclusion all hospitalized patients who were discharged or died before completed at least 2 weeks after admission.

Results: The mean overall age was 58.37±9.95 years. 224 participants (68.7%) were male and 102 participants (31.3%) were female. The percentage changes in albumin level was significantly highest (38.1%±2.45%) and the hospital length of stay, mortality, risk of enteric pathogen translocation were significantly lowest (9.0±0.00 days, 4 (7.5%), and 4 (7.4%), respectively) in patients who were on ArgiMent® followed by patients who were on reconstituted whey protein and standard enteral nutritional formulas. Despite of ArgiMent® highest daily trophic feeding cost (10.8±0.00 USD), ArgiMent® had the highest cost-effectiveness to increase the albumin level by 1 g/dl.

Conclusion: In summary, using early trophic feeding at rate of either 10 ml per hour or 20 ml per 2 hours for 16 hours per day of any enteral formulas may have positive clinical and economic outcomes with acceptable GIT tolerance especially if the enteral feeding have higher glutamine, leucine, protein density, and caloric density.

Key words: Enteral feeding, Standard formulas, Protein formulas, Trophic feeding.

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Introduction

Enteral feeding (EF) intolerance manifested arbitrarily by increasing gastric residual volume (GRV) above 150 ml is the most risk factor for under nutrition in hospitalized wasted hypoalbumenic patients. [1-5]

From the departments of:
* Clinical Pharmacy.
**Internal Medicine/Cardiologist.
***Internal Medicine/Oncologist.
^Internal Medicine/Gastroenterologist.
^^Internal Medicine/Neurologist.
+Internal Medicine/Intensivist.
Correspondence should be addressed to "Moh'd Nour" Bani Younes, Clinical Pharmacy Specialist, E-mail:panasomycine@hotmail.com.
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Enteral nutritional formulas (ENFs) intolerance may be resulted from many insults such as stress induced hyperglycemia, opioid induced constipation (OIC), mechanical ventilation (MV), sedative-hypnotic agents, other patient risk factors, and formulas specific factors.[6-9] Enterocytes are primarily fed on two major nutrients; short chain fatty acids (SCFAs) and glutamine. SCFAs are the end active metabolite of bacterial fermentation for non-digestible, non-absorbable, but fermentable soluble fibers. These SCFAs can yield around 2 Cal/g for enterocytes by utilizing acetic acid, propionic acid, and butyric acid in Krebs cycle. However, prebiotics are largely dependent on probiotic bacteria fermentation step to yields these SCFAs which is significantly affected by broad spectrum antibiotics that are commonly used in hospitalized patients. [19-21] other important enterocyte-nutrient is glutamine which is directly utilized independent on bacterial fermentation processes.

Patients who are not taking any EF may have the risk of decreasing enterocytes and colonocytes integrity which subsequently increasing the risk of bacterial translocation and gastrointestinal (GI) related enterobacteriaceae sepsis.[10-13] Enterobacteriaceae including; extended spectrum beta lactamases (ESBL) and carbapenem resistant enterobacteriaceae (CRE) which are globally considered as an urgent and of high priority pathogens in hospitalized patients. Of importance, enterocyte integrities are highly sensitive to enteral feeding itself and to the availability of enterocyte-specific nutrients. [14-18] When 25 gram of Whey protein (WP) 100% powder is reconstituted with 100 ml water, a tolerated WP mixture of concentration of 11 g/dl is yielded. ArgiMent® is a new specialized modular formula (MF) available in our institution characterized by very high protein density (PD) of approximately 26 g/100 Cal (10 gram of WP, 7 gram glutamine, and 7 gram arginine), high caloric density (CD) of approximately 2 Cal/ml, immune-enhancing nutrients (IENs) enrichment, zinc enrichment, and prebiotic galcto-oligosaccharides (GOS or Bimuno) enrichment. [22,23] The aim of present study was to investigate the clinical and economic impacts of early trophic feeding (TF) using standard ENF (Ensure® and Resource®Optimum) at rate of 10 ml every hour and 20 ml every 2 hours (Group I and II) versus reconstituted WP 100% powder (11g/dl) at rate of 10 ml every hour and 20 ml every 2 hours (Group III and IV) versus ArgiMent® at rate of 10 ml every hour and 20 ml every 2 hours (Group V and VI) in early intolerated enteral feeding hospitalized patients in terms of percentage changes in albumin level (%ΔALB), changes in human albumin amount consumption (ΔH.ALB), cost-effectiveness ratio (CER) to increase ALB by 1 g/dl, overall hospital length of stay (LOS) and overall 28-day mortality, risk of gastro-intolerance (GI), and risk of enteral related enterobacteriaceae sepsis.

The tested six groups are fully described in Table I.

Table I: Tested Six Groups Description.

GROUP	Standard ENFs		MPF (WP100%)		MF (ArgiMent®)	
	Group I	**Group II**	**Group III**	**Group IV**	**Group V**	**Group VI**
Description	Early intolerated EN hospitalized patients on TF of either Ensure® or Resource® Optimum at rate of 10 ml per hour for 16 hours per day.	Early intolerated EN hospitalized patients on TF of either Ensure® or Resource® Optimum at rate of 20 ml per 2 hours for 16 hours per day.	Early intolerated EN hospitalized patients on TF of reconstituted powder WP 100% at rate of 10 ml per hour for 16 hours per day.	Early intolerated EN hospitalized patients on TF of reconstituted powder WP100% at rate of 20 ml per 2 hours for 16 hours per day.	Early intolerated EN hospitalized patients on TF of ArgiMent® at rate of 10 ml per hour for 16 hours per day.	Early intolerated EN hospitalized patients on TF of ArgiMent® at rate of 20 ml per 2 hours for 16 hours per day.

ENFS: Enteral Nutritional Formulas. **MFS: Modular Non Complete Formulas.** **MPFS: Modular Protein Formulas.** **EN: Enteral Feeding.** **TF: Trophic Feeding.**	**WP100%: Whey protein 100% in which each scoop (25 gram) is reconstituted with 200 ml water to yield final concentration of 11 g/dl.**

Methods and materials

Our study was retrospectively conducted in King Hussein Medical Hospital (KHMH) at Royal Medical Services (RMS) in Jordan between April 2017 to Mar 2019. This study was approved by our Institutional Review Board (IRB) and the requirement for consent was waived owing to its retrospective design. The study included a 326 wasted hypoalbumenic (<3.5 g/dl) hospitalized patients with any medical or surgical problem. Patients were included if the demographics, anthropometrics, diagnostics, nutritional status, wasting severities, and lab data including at least two ALB and one C - reactive protein (CRP) levels were known. Also, patients were excluded if they either discharged or died before completed at least 2 week after admission or if any of patient's data couldn't be obtained or incomplete. The flow chart of patient selection and the data collection process is fully illustrated in Figure 1. Analysis values were compared among the six tested ENFs groups by using ANOVA for continuous variables and Chi square test for nominal data in which the continuous variables of all patients were expressed as Mean±SD and nominal data were expressed as numbers with percentages. All statistical analyses were performed using IBM SPSS ver. 25 (IBM Corp., Armonk, NY, USA); P-values ≤0.05 were considered statistically significant.

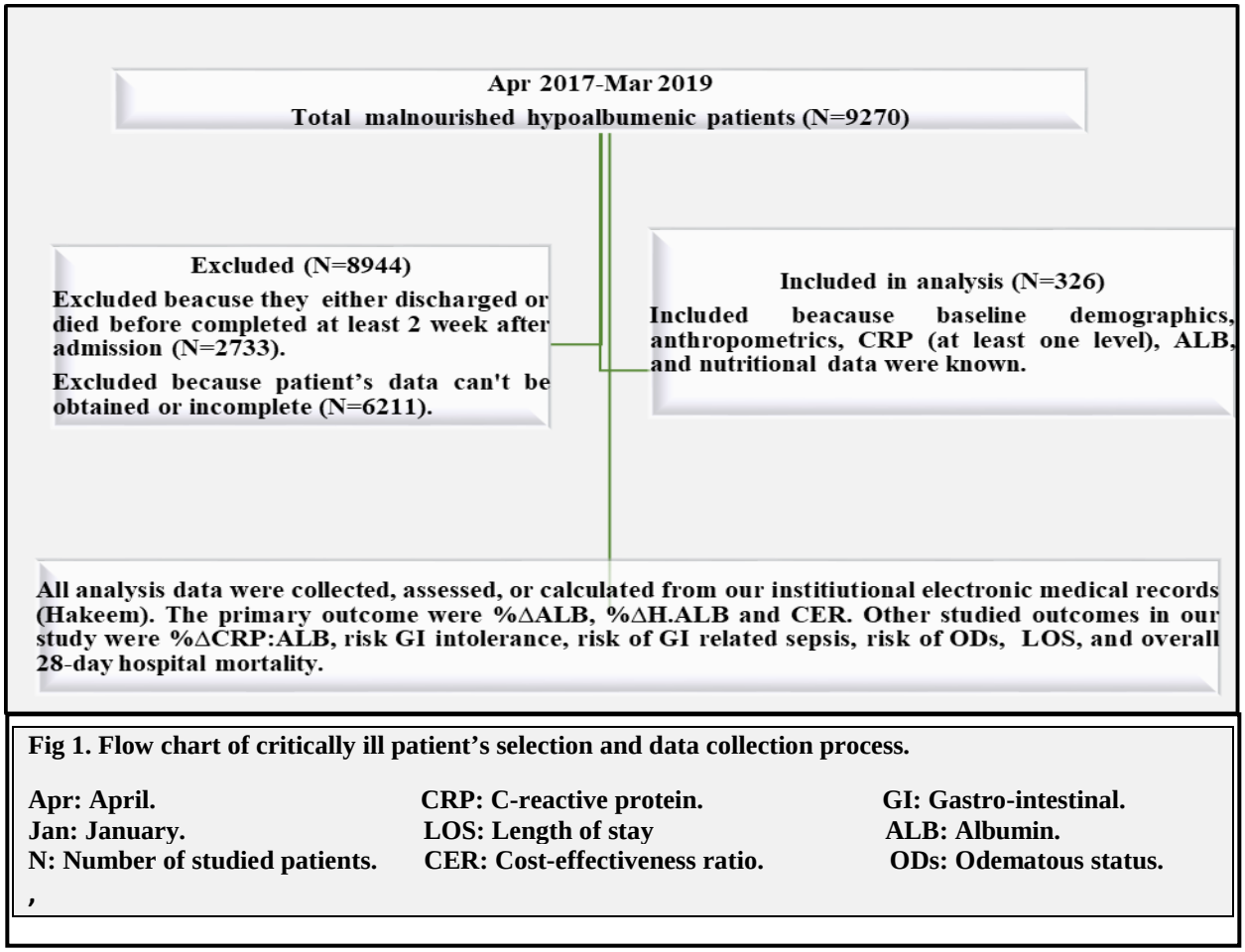

Fig 1. Flow chart of critically ill patient's selection and data collection process.

Apr: April. **CRP: C-reactive protein.** **GI: Gastro-intestinal.**
Jan: January. **LOS: Length of stay** **ALB: Albumin.**
N: Number of studied patients. **CER: Cost-effectiveness ratio.** **ODs: Odematous status.**
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Results

The mean overall age was 58.37±9.95 years. 224 participants (68.7%) were male and 102 participants (31.3%) were female. There were insignificant differences regarding surgical versus medical admission diagnostics. Also, there were insignificant differences between critical and non-critical admission wards. Although the TF days were insignificantly different among the tested groups, the %ΔALB was significantly highest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (38.1%±2.45%, 31.5%±2.37%, 25.3%±2.39%, 12.1%±1.33%, 18.7%±2.01%, and 5.52%±0.74%, respectively) in hypoalbumenic patients who were on TF for at least 1 week of ArgiMent® 10 ml Q 1 hour followed by ArgiMent® 20 ml Q 2 hours, WP100% 10 ml Q 1 hour, WP100% 20 ml Q 2 hours, standard ENFs 10 ml Q 1 hour, and lastly standard ENFs 20 ml Q 2 hours, respectively. This significant higher %ΔALB was also accompanied by significant lower of ΔH.ALB and %ΔCRP:ALB (-16.7±4.76 g/day, -16.0±4.94 g/day, -10.0±0.00 g/day, -7.69±4.25 g/day, -6.67±4.76 g/day, and -1.79±3.86 g/day, respectively) and (-51.1%±4.70%, -33.5%±1.14%, -9.96%±4.98%, 101%±51.5%, 275%±200%, and 425%±250%, respectively). The overall hospital LOS and overall 28-day hospital mortality were also significantly lowest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (9.0±0.00 days, 10.0±0.00 days, 11.0±0.00 days, 12.0±0.00 days, 15.1±2.49 days, 19.0±0.00 days and 4 (7.5%), 6 (10%), 5 (10%), 10 (18.5%), 10 (19.2%), and 16 (29.6%), respectively).

Although the daily cost of TF was significantly highest in patients who were on ArgiMent® (10.8±0.00 USD) followed by standard ENFs (0.97±0.00 USD) and WP100% (0.83±0.00 USD), the cost expenditure to increase ALB by 1 g/dl was significantly lowest in Group V followed by Group VI, Group III, Group IV, Group II, and lastly Group II (18.1±12.4 USD, 24.2±15.9 USD, 33.1±18.1 USD, 57.9±21.7 USD, 76.7±42.9 USD, and 185.6±100.4 USD, respectively). This high variety in CER among analysis groups came mostly from significant differences in H.ALB cost which was lowest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (7.25±12.4 USD, 9.32±13.3USD, 21.3±12.1USD, 24.7±14.3USD, 27.9±10.9USD, and 29.9±16.7 USD, respectively) taking into consideration that this significant CER differences included only TF cost and H.ALB cost and not included other cost expenditures especially hospital LOS. There were significant differences in GIT tolerance to early TF in these intolerated EF hospitalized patients in which the incidence of lower than two symptoms (Sx) of any of following; bloating, cramping, ↑ gastric residual volume (GRV), and dyspepsia was highest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (47 (87%), 50 (83.3%), 38 (76%), 39 (75%), 37 (68.5%), and 33 (58.9%), respectively). Of importance, the incidence of GIT intolerance was directly correlated with mean arterial pressure (MAP), heart rate (HR), norepinephrine (NE) infusion rate to increase blood pressure (BP), and percentage changes in GRV (%ΔGRV) in which MAP was significantly highest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (84.85±0.66 mmHg, 83.30±0.645 mmHg, 80.40±0.99 mmHg, 77.26±0.94 mmHg, 73.38±1.68 mmHg, and 55.86±16.05, respectively) and HR versus NE rate and %ΔGRV were significantly lowest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (90.15±0.66 bpm, 91.70±0.65 bpm, 94.60±0.99 bpm, 97.74±0.94 bpm, 101.62±1.68 bpm, and 120.11±18.86 versus 5.86±0.08 mcg/min, 6.05±0.07 mcg/min, 6.48±0.14 mcg/min, 6.94±0.14 mcg/min, 7.62±0.29 mcg/min, and 14.86±11.56 mcg/min and 3.4%±0.1%, 4.4%±0.1%, 6.3%±0.2%, 7.1%±0.3%, 8.2%±0.2%, and 11.2%±2.5%, respectively). The risk of blood stream infection (BSI) positivity which

indirectly indicated the incidence of enterobacteriaceae and/or candida.spp translocation during and up to 3 days after discontinuation of TF was also significantly lowest in Group V followed by Group VI, Group III, Group IV, Group I, and lastly Group II (4 (7.4%), 6 (10%), 6 (12%), 7 (13.5%), 9 (16.7%), and 13 (23.2%), respectively). Demographics, admission diagnostics and wards, anthropometrics, laboratory data, GIT translocation incidences, CER, LOS, and mortalities comparisons are fully summarised in Tables II-III.

Table II: Comparison data between Standard ENFs, MPF, and MF.

Variables		Total (N=326)	Standard ENFs (N=110)		WP100% (N=102)		Specialized MF (N=114)		P-Value
			Group I (N=54)	Group II (N=56)	Group III (N=50)	Group IV (N=52)	Group V (N=54)	Group VI (N=60)	
Age (Yrs)		58.37±9.95	59.04±11.56	59.96±10.61	56.52±9.05	58.00±9.69	56.63±8.13	59.70±10.05	0.29 (NS)
Sex	*Female*	102 (31.3%)	20 (37.0%)	18 (32.1%)	16 (32.0%)	16 (30.8%)	12 (22.2%)	20 (33.3%)	0.692
	Male	224 (68.7%)	34 (63.0%)	38 (67.9%)	34 (68.0%)	36 (69.2%)	42 (77.8%)	40 (66.7%)	
Ward	*Non Critical*	160 (49.08%)	22 (40.74%)	23 (42.59%)	29 (51.79%)	27 (50%)	28 (51.85%)	31 (57.41%)	0.081 (NS)
	Critical	166 (50.92%)	32 (59.26%)	31 (57.41%)	27 (48.21%)	27 (50%)	26 (48.15%)	23 (42.59%)	
Medical Dx	*Medical*	153 (46.93%)	26 (48.15%)	27 (50%)	28 (50%)	25 (46.29%)	23 (42.59%)	24 (44.44%)	0.106 (NS)
	Surgical	173 (53.07%)	28 (51.85%)	27 (50%)	28 (50%)	29 (53.70%)	31 (57.41%)	30 (55.56%)	
BW (Kg)		74.17±10.23	73.56±9.24	72.43±9.77	77.92±12.08	75.42±11.44	73.93±9.32	72.33±8.84	0.045 (S)
BMI (Kg/m^2)		25.92±3.99	25.81±4.06	25.50±4.26	27.44±4.20	25.95±4.21	25.26±3.26	25.72±3.74	0.090 (NS)
CRP_1 (mg/dl)		7.94±3.11	8.47±3.38	5.49±2.61	8.86±3.33	7.62±3.04	8.73±2.19	8.58±2.72	0.000 (S)
ALB_1 (g/dl)		2.75±0.32	2.70±0.29	3.08±0.44	2.65±0.24	2.78±0.31	2.63±0.17	2.66±0.19	0.000 (S)
$H.ALB_1$ (g/day)		16.99±5.10	16.67±4.76	12.5±6.94	17.60±4.31	16.54±4.80	19.26±2.64	19.3±2.52	0.000 (S)
CRP_1: ALB_1		3.04±1.49	3.30±1.65	1.93±1.13	3.48±1.67	2.89±1.43	3.38±1.09	3.32±1.38	0.000 (S)
CRP_2 (mg/dl)		12.62±6.86	12.13±3.38	24.49±2.61	9.86±3.33	15.62±3.04	6.07±2.19	7.58±2.72	0.000 (S)
ALB_2 (g/dl)		3.34±0.34	3.20±0.29	3.24±0.44	3.32±0.24	3.11±0.31	3.63±0.17	3.49±0.19	0.000 (S)
$H.ALB_2$ (g/day)		7.11±5.74	10.0±3.89	10.7±5.99	7.60±4.31	8.85±5.11	2.59±4.42	3.33±4.75	0.000 (S)
CRP_2: ALB_2		3.97±2.45	3.91±1.44	7.78±1.80	3.06±1.29	5.16±1.49	1.70±0.69	2.22±0.96	0.000 (S)
ΔALB (g/dl)		0.59±0.29	0.50±0.00	0.17±0.00	0.67±0.00	0.33±0.00	1.00±0.00	0.83±0.00	0.000 (S)
ΔH.ALB (g/day)		-9.88±6.75	-6.67±4.76	-1.79±3.86	-10.0±0.00	-7.69±4.25	-16.7±4.76	-16.0±4.94	0.000 (S)
%Δ ALB		21.9%±11.4%	18.7%±2.01%	5.52%±0.74%	25.3%±2.39%	12.1%±1.33%	38.1%±2.45%	31.5%±2.37%	0.000 (S)
%Δ CRP:ALB ratio		77.5%±197%	275%±200%	425%±250%	-9.96%±4.98%	101%±51.5%	-51.1%±4.70%	-33.5%±1.14%	0.000 (S)

Data are presented as Mean±Standard deviation and are analyzed by using ANOVA test (at p-value< 0.05).

ENF: Enteral Nutritional Formula.
MF: Modular Formula.
MPF: Modular Protein Formula.
WP: Whey protein.
Yrs: Years.
BW: Actual body weight.
BM_1: Body mass index.
Dx: Diagnosis.

1: baseline at admission.
2: 1 week after admission.
Δ: Changes.
S: Significant (P-Value <0.05) NS: Non-significant (P-Value >0.05).
N: Number of study's hospitalized patients.
ALB: Albumin level.
H.ALB: Human albumin.
CRP: C-reactive protein.
CRP: ALB: C-reactive protein to albumin ratio.

Table III: Comparison data between Standard ENFs, MPF, and MF.

Variables		Total (N=326)	Standard ENFs (N=110)		WP100% (N=102)		Specialized MPF (N=114)		P-Value
			Group I (N=54)	Group II (N=56)	Group III (N=50)	Group IV (N=52)	Group V (N=54)	Group VI (N=60)	
%ΔGRV		6.8%±2.8%	8.2%±0.2%	11.2%±2.5%	6.3%±0.2%	7.1%±0.3%	3.4%±0.1%	4.4%±0.1%	0.00(S)
TOLR	*GI Sx (0,1)*	244 (74.8%)	37 (68.5%)	33 (58.9%)	38 (76%)	39 (75%)	47 (87%)	50 (83.3%)	0.00(S)
	GI Sx (≥2)	82 (25.2%)	17 (31.5%)	23 (40.1%)	12 (24%)	13 (25%)	7 (13%)	10 (16.7%)	
Enteric BSI	*Negative*	281 (86.2%)	45 (83.3%)	43 (76.8%)	44 (88%)	45 (86.5%)	50 (92.6%)	54 (90%)	0.00(S)
	Positive	45 (13.8%)	9 (16.7%)	13 (23.2%)	6 (12%)	7 (13.5%)	4 (7.4%)	6 (10%)	
	GNB	28 (8.59%)	6 (11.1%)	7 (12.5%)	4 (8%)	5 (9.6%)	3 (5.5%)	3 (5%)	
	GNB+CAND	17 (5.2%)	3 (5.6%)	6 (10.7%)	2 (4%)	2 (3.8%)	1 (1.9%)	3 (5%)	
TF Cost (USD/day)		4.37±4.74	0.97±0.00	0.97±0.00	0.83±0.00	0.83±0.00	10.8±0.00	10.8±0.00	0.00(S)
H.ALB Cost (USD/day)		19.9±16.0	27.9±10.9	29.9±16.7	21.3±12.1	24.7±14.3	7.25±12.4	9.32±13.3	0.00(S)
CER (USD/ +1 g ALB/dl)		66.2±74.5	76.7±42.9	185.6±100.4	33.1±18.1	57.9±21.7	18.1±12.4	24.2±15.9	0.00(S)
MAP (mmHg)		75.82±11.89	73.38±1.68	55.86±16.05	80.40±0.99	77.26±0.94	84.85±0.66	83.30±0.645	0.00(S)
HR (bpm)		99.35±12.84	101.62±1.68	120.11±18.86	94.60±0.99	97.74±0.94	90.15±0.66	91.70±0.65	0.00(S)
NE rate (µg/min)		7.99±5.72	7.62±0.29	14.86±11.56	6.48±0.14	6.94±0.14	5.86±0.08	6.05±0.07	0.00(S)
TF days		9.03±1.78	8.93±1.57	9.40±2.31	8.87±1.44	9.20±1.81	8.71±1.73	9.22±2.13	0.06(NS)
Hospital Stay day(s)		12.7±3.59	15.1±2.49	19.0±0.00	11.0±0.00	12.0±0.00	9.0±0.00	10.0±0.00	0.00(S)
28-day Hospital Survival		275 (84.4%)	44 (81.5%)	40 (71.4%)	45 (90%)	42 (80.8%)	50 (92.5%)	54 (90%)	0.00(S)
Hospital Mortality	*All 28- day*	51 (15.6%)	10 (19.2%)	16 (29.6%)	5 (10%)	10 (18.5%)	4 (7.5%)	6 (10%)	
	Early (≤14d)	18 (5.5%)	4 (7.7%)	6 (10.7%)	2 (4%)	3 (5.6%)	1 (1.9%)	2 (3.3%)	
	Late (>14 d)	33 (10.1%)	6 (11.5%)	10 (18.9%)	3 (6%)	7 (12.9%)	3 (5.6%)	4 (6.7%)	

Data are presented as Mean±Standard deviation and are analyzed by using ANOVA test (at p-value< 0.05).

ENF: Enteral Nutritional Formula.
MF: Modular Formula.
MPF: Modular Protein Formula.
WP: Whey protein.
TF: Trophic Feeding.
CER: Cost-effectiveness ratio.
GRV: Gastric residual volume.
USD: United states dollar.
MAP: Mean arterial pressure.
HR: Heart rate.
NE: Norepinephrine.
bpm: Beat per minute.

Δ: Changes.
S: Significant (P-Value <0.05).
NS: Non-significant (P-Value >0.05).
N: Number of study's hospitalized patients.
ALB: Albumin level.
H.ALB: Human albumin.
GI: Gastrointestinal.
Sx: Symptoms.
BSI: Blood stream infection.
GNB: Gram negative bacteria.
CAND: Candida.spp.

Discussion

This study included hypoalbumenic hospitalized patients who were intolerated to partially or fully EN and were tested for their tolerance to early TF dose of either 10 ml per hour or 20 ml per 2 hours by using three different enteral formulas of standard ENFs (Ensure® or Resource®Optimum), reconstituted WP100% powder, and ArgiMent®. To the best of our knowledge, this is the first study globally which directly compare the positive clinical and economic impacts of early TF in intolerated EN hypoalbumenic hospitalized patients using three different

classes of nutritional formulas in order to rehabilitate the GIT gradually for starting partially or fully EN and in order to delay using total parental nutrition (TPN) as possible. According to our proposed concept, early TF may maintain the integrity of enterocytes, rehabilitate GIT, minimize the risk of enteric GNB and candida translocation, and promote the liver ALB synthesis by decreasing the GIT associated systemic inflammatory response syndrome (SIRS) and better utilizing of absorbed amino acids (AAs).[24-26] Glutamine is considered one of the most important enterocyte-nutrients which is independent on probiotics for activation and so not affected by broad spectrum antibiotics which are commonly used in hospitalized patients especially the wasted hypoalbumenic patients.[27,28] This glutamine concept might explain the significant higher GIT tolerance and positive clinical outcomes in improving the ALB, GIT related enterobacteriaceae sepsis in patients who were on ArgiMent® regardless of TF dose schedule in compared with patients who were on either WP100% or standard ENFs.[29,30] WP is well known as protein with high biological value (BV), hydrolysability and absorbability advantages, and has the highest content of leucine in compared with other major proteins of casein and soy protein. Most of standard ENFs are primarily formulated with mixture of these three proteins in different proportions. Leucine is considered as the most important AA in the body due to dual essentiality and anabolic effect.[31-33] Based on aforementioned leucine advantages, patients who were on reconstituted WP 100% were also had significantly better clinical and economic impacts compared with patients who were on standard ENFs regardless of TF schedule.[34,35] Across all analysis variables in our study, ArgiMent® had the highest significant positive clinical and economic outcomes due to the unique formulation characteristics of very high PD (≈26 g/100 Cal),High protein quality (10 g of whey protein (WP)), high CD (≈2 Cal/ml), and unique specific nutrients enrichment of glutamine, arginine, vitamin C, zinc, and prebiotic of galcto-oligosaccharides (GOS or Bimuno).

Conclusion

In summary, using early TF dose at rate of either 10 ml per hour or 20 ml per 2 hours for 16 hours per day of any enteral formulas (EFs) may have positive clinical and economic outcomes of increasing ALB level, lower H.ALB requirement, lower LOS, lower mortality, and lower risk of enteral pathogen translocation with acceptable GIT tolerance in EN intolerated hypoalbumenic critically or non-critically medical and surgical hospitalized patients especially if the EFs have higher glutamine, leucine, PD, CD, specific nutrients enrichments. This study is limited by its retrospective design and the use of single-centre data. Nonetheless, our centre is an experienced and high-volume unit, so our data may be useful for other centres. A larger, multisite, prospective study is needed to control for multiple confounders.

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