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ORIGINAL RESEARCH

Healthcare Resource Utilization and Cost Implications of Commercial Blenderized versus Plant-Based Standard Enteral Formulas in Children and Adults in Post-Acute Care: A Retrospective Study

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Purpose: The study investigated the potential association between commercial blenderized tube feeding formulas (CBTF) or plant-based standard tube feeding formulas (STD-TF), and healthcare resource utilization (HCRU) and costs, in children and adults receiving enteral nutrition (EN) in a post-acute care setting.

Patients and Methods: United States insurance claims were retrospectively analyzed to evaluate HCRU and costs for visits to emergency department (ED), inpatient, outpatient, urgent care, and other services at 12 weeks post hospital discharge. Between-cohort comparisons were performed for proportions of patients with claims for each place of service, mean number of visits, and unadjusted and adjusted costs.

Results: Significantly fewer children receiving CBTF vs plant-based STD-TF required inpatient services (16% vs 35%), urgent care (3% vs 10%), ED (15% vs 28%), and other facilities (10% vs 22%) ($p < 0.001$ for each comparison), with a lower mean number of visits to any healthcare service reported (28 vs 96; $p < 0.001$). In adults, significantly fewer patients in the CBTF cohort vs the plant-based STD-TF cohort required inpatient (23% vs 38%; $p = 0.003$) and other services (13% vs 27%; $p < 0.001$), with a corresponding lower mean number of visits to any healthcare service (24 vs 79; $p < 0.001$). Total unadjusted costs were significantly lower in both children and adults receiving CBTF compared with plant-based STD-TF (children: $140,962 vs $1,060,345; adults: $166,591 vs $820,905; each $p < 0.001$). Cost savings associated with CBTF were maintained when costs were adjusted for age, sex, and Charlson's comorbidity index. Children and adults receiving CBTF had significantly lower total adjusted costs compared with those receiving plant-based STD-TF (children: $222,735 vs $965,451; adults: $258,460 vs $919,060 each $p \leq 0.001$).

Conclusion: The use of CBTF was associated with lower HCRU and costs both in children and adults receiving EN in post-acute care settings. To our knowledge, this is the first large real-world study comparing these formulas in post-acute care across both populations. Although the retrospective design and lack of adjustment for all potential confounders preclude conclusions about causation, these findings may guide formula selection based on potential economic impact.

Plain Language Summary: Patients who have a functional gastrointestinal (GI) tract but cannot get enough nutrition from eating by mouth alone may require enteral nutrition (EN). EN is crucial for their health, but it can also cause issues like feeding tube blockages, nutrient deficiencies, and GI symptoms such as diarrhea and abdominal pain. These issues may require specialized medical care or hospitalization, which can lower the quality of life and increase costs for both patients and healthcare system. There are different types of EN formulas designed to meet nutritional needs, reduce complications and accommodate patient preference. However, there is not much evidence showing that certain EN formulas, such as commercial blenderized formulas containing whole foods (CBTF) or plant-based standard tube feedings (STD-TF), help to reduce the need for healthcare visits. In this study, we looked at healthcare utilization and associated costs in children and adults receiving CBTF or STD-TF at home or in long-term care.

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Our analysis shows that:

- Both children and adults using CBTF had fewer medical encounters than those receiving plant-based STD-TF
- Fewer children on CBTF were hospitalized or needed emergency departments or urgent care facilities compared with children receiving plant-based STD-TF
- Fewer adults receiving CBTF than plant-based STD-TF were hospitalized
- Costs associated with the use of healthcare services were lower in children and adults receiving CBTF versus plant-based STD-TF

Keywords: real-world evidence, healthcare costs, pediatric population, adult population, enteral nutrition, health economics

Introduction

Enteral nutrition (EN) is the standard of care for patients with a functional gastrointestinal (GI) tract who cannot meet nutritional requirements orally.[1,2] Multiple chronic conditions can lead to feeding difficulties across the lifespan. In pediatric patients, EN is often indicated to manage conditions such as neurodevelopmental disorders (eg, cerebral palsy), GI disorders, and cardiopulmonary diseases.[3–5] In adults, conditions affecting patients' nutritional status include cancer, GI disorders, and long-term consequences of cerebrovascular events.[6–8] In the last four decades, there has been an increase in the prevalence of home enteral nutrition (HEN), reflecting a shift towards managing patients in outpatient settings (ie, post-acute care) rather than in hospital.[9,10]

HEN has been identified as a cost-saving alternative compared with hospital-based EN.[11] While HEN provides life sustaining nutrition, it may be associated with complications such as mechanical issues during tube feeding, metabolic deficiencies, dehydration, and GI intolerance (eg, nausea, vomiting, diarrhea, and abdominal pain).[6,12–14] These complications can lead to poor clinical outcomes, such as insufficient nutrient absorption, electrolyte abnormalities, metabolic acidosis, and infections,[8,15] which may require specialized medical treatment or hospitalization, ultimately leading to increased healthcare resource use (HCRU) and costs.[4,8,12] A retrospective, single-center UK study analyzed emergency department (ED) attendances due to enteral tube complications between 2016 and 2018.[16] The main causes of ED attendances (n = 139) were a dislodged tube (42%) and a blocked tube (16%), followed by leakage (10%), which led to admission in 35.6%, 59.1%, and 38.1% of cases. Managing complications resulted in a total estimated cost to the healthcare system of $74,438 per year or $1071 per attendance. A retrospective Canadian study of data from 390 HEN patients with a tube placed between 2012 and 2015 reported that 53% visited the ED or hospital due to HEN-related complications at least once in 6 years.[12] The main complications were gastrointestinal (41.0%), pneumonia (26.2%) and metabolic (eg, dehydration) (7.4%). The total number of visits or admissions was 473, with a median length of hospital stay of 11.2 days and a cost per patient of $27,379.80. Adults discharged from hospital with a prescription for HEN are more likely to be readmitted within 30 and 90 days compared with those who did not require HEN (adjusted odds ratio: 1.40 [95% confidence interval (CI): 1.27–1.55]).[17] Implementing care services following hospital discharge, such as follow-up visits, significantly reduces the likelihood of 30-day readmission ($p < 0.001$), highlighting the importance of post-acute care in these patients.[17]

Selection of an EN formula should aim to optimize tolerance and prevent complications.[8,14,18,19] Current consensus guidelines usually recommend standard enteral nutrition formulas (STD-TF) as first-line options.[20] STD-TF contain intact proteins, which are commonly extracted from milk but may also be sourced exclusively from plants like soy or pea or a combination.[21–24] Patients experiencing GI intolerance may switch to other available EN formulas, such as fiber-containing formulas or blenderized tube feedings formulas (BTF).[19,20] BTF are made of whole foods, either plant-based or not, and can be prepared at home or commercially (commercial blenderized tube feeding formulas, CBTF).[19,21,24]

Current evidence regarding the impact of different formulas on clinical and economic outcomes is limited and inconclusive. Moreover, most studies comparing outcomes between patients prescribed CBTF and STD-TF have pooled homemade blenderized tube feeding (HBTF) and CBTF.[4,13,18,25,26] In both pediatric and adult populations, BTF regimens were generally associated with improvements in GI symptoms, such as nausea, vomiting, abdominal pain, bloating, diarrhea, and constipation.[4,25,26] A systematic review of studies conducted in adults receiving blended or conventional tube feedings reported low to very low certainty regarding the effect of formula type on nutritional status, quality of life, GI symptoms and tube blockages. In children, an observational US study of 25 patients receiving blenderized gastrostomy tube feedings or commercial enteral formulas found no significant difference in outcomes such as malnutrition

status and HCRU.[27,28] However, in a prospective US study of 70 children receiving BTF or STD-TF, BTF were associated with reduced HCRU, in particular ED visits and hospital admissions.[4]

Using real-world data, we have previously shown that pediatric and adult patients receiving CBTF in post-acute care experience less GI intolerance compared with patients receiving plant-based STD-TF.[29,30] The objective of this study was to investigate the potential association between these formulas and HCRU and cost outcomes in children and adults receiving EN in a post-acute care setting. To our knowledge, this is the first large real-world study comparing these formulas in post-acute care across both populations.

Materials and Methods

Study Design, Data Sources, and Inclusion Criteria

This retrospective analysis, using nationally representative US claims data obtained from the Clarivate Real-World Evidence Data Repository,[31] aimed at evaluating HCRU and associated costs in children and adults receiving CBTF or plant-based STD-TF. Due to the observational nature of the study, only potential associations between economic outcomes and the EN used could be explored, without implying superiority or causation.

Data were extracted on 1 June 2022 from claim records dated between 1 January 2018 and 31 December 2020. The study included children (1–13 years) and adults (≥14 years) prescribed CBTF or plant-based STD-TF as sole source of nutrition for ≥7 days after hospital discharge (index date). Patients prescribed parenteral nutrition and/or receiving palliative care were excluded. The EN formulas used by the enrolled patients in the CBTF cohort were Compleat® Pediatric Organic Blends and Compleat® Organic Blends Chicken-Garden and Plant-based Blends (Nestlé HealthCare Nutrition, US), while the plant-based STD-TF cohort included Kate Farms® Pediatric Standard 1.2 and Kate Farms® Standard 1.0 and 1.4 (Kate Farms Inc., US).

The database links medical and pharmacy claims to electronic health records (EHRs) via an encrypted participant key, allowing de-identification at the patient level in compliance with the US Health Insurance Portability and Accountability Act (HIPAA) regulations. Medical claims provide information on inpatient and outpatient procedures, surgeries, and office visits. As de-identified data were retrospectively analyzed, the study was not considered human subject research. Thus, it was exempt from informed consent and institutional review board evaluation as defined by US Code of Federal Regulations 45 Part 46.[32] The study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (Table S1).[33]

Outcome Measures

Health economic outcomes were assessed at 12 weeks post index and included HCRU and associated costs. HCRU data were extracted from medical claims and reported as mean number of visits per patient to any healthcare facility as well as to each place of service. The proportion of patients accessing each place of service in the study period was also evaluated. The places of service included in the study were inpatient services, outpatient services, ED, urgent care, and other places of service (ie, intermediate care, assisted living, and facilities not identified in the submitted claims).

Unadjusted HCRU costs per patient were extracted from the medical claims and represent the costs that were charged by the prescriber to the commercial or government health insurance plans. Both unadjusted and adjusted costs per patient were reported for each place of service and as total costs for all services combined.

Statistical Analyses

HCRU was analyzed using descriptive statistics (mean and standard deviation [SD]). Appropriate statistical tests (*t*-test and chi-squared test) at the alpha = 0.05 level of significance were used for between-group comparisons. Descriptive statistics were performed using R/Python; Microsoft© Excel was employed for output formatting.

A multivariate generalized linear model adjusted for confounders, including age, sex, and Charlson comorbidity index (CCI),[34] was used to calculate adjusted costs. Multivariate analysis was performed using R programming language.

Results

Study Populations

The analysis included 1064 pediatric (1–13 years) and 488 adult (≥14 years) patients. CBTF were prescribed to 469 children and 124 adults, while plant-based STD-TF were prescribed to 595 children and 324 adults (Table 1). No significant between-group differences in mean age or proportion of female participants were observed in either pediatric or adult cohorts. In the pediatric cohort, mean CCI score was significantly higher in the patients receiving plant-based STD-TF compared with CBTF (1.8 vs 1.6; p = 0.016). Some differences in geographic distribution were also observed. Among children, CBTF use was more prevalent than plant-based STD-TF in the Midwest (35% vs 11%; p < 0.001) and Northeast (19% vs 11%; p < 0.001) but not in the West (27% vs 47%; p < 0.001) and South (19% vs 31%; p < 0.001) regions, while a higher proportion of adults receiving CBTF was from the Northeast region (19% vs 10%; p = 0.012) (Table 1). Among the most common medical diagnoses in children, reported for over one-third of cases, significant between-group differences were observed for congenital malformations and chromosomal abnormalities (CBTF, 76% vs plant-based STD-TF, 69%, p = 0.008) and mental behavioral and neurodevelopmental disorders (63% vs 72%, p = 0.002). In adults, a significant difference was observed in the proportion of

Table 1 Demographic and Clinical Characteristics in the CBTF and Plant-Based STD-TF Groups

Characteristics	Overall	CBTF	Plant-Based STD-TF	p-value[‡]
Children				
N	1064	469	595	NA
Age, years, mean (SD)[†]	5.05 (3.33)	5.17 (3.32)	4.96 (3.34)	0.292
Female, N (%)	445 (42)	207 (44)	238 (40)	0.174
Region, N (%)				
Midwest	231 (22)	164 (35)	67 (11)	<0.001
West	403 (38)	126 (27)	277 (47)	<0.001
South	278 (26)	91 (19)	187 (31)	<0.001
Northeast	152 (14)	88 (19)	64 (11)	<0.001
Most common medical diagnoses, N (%)				
Diseases of the digestive system	886 (83)	382 (81)	504 (85)	0.158
Diseases of the respiratory system	855 (80)	367 (78)	488 (82)	0.125
Congenital malformations and chromosomal abnormalities	764 (72)	356 (76)	408 (69)	0.008
Mental behavioral and neurodevelopmental disorders	724 (68)	296 (63)	428 (72)	0.002
Certain infectious and parasitic diseases	480 (45)	183 (39)	297 (50)	<0.001
Injury poisoning and other consequences of external causes	479 (45)	183 (39)	296 (50)	<0.001
Malnutrition	243 (23)	85 (18)	158 (27)	<0.001
Neoplasms	75 (7)	21 (4)	54 (9)	0.004
Most common comorbidities, N (%)				
Chronic pulmonary disease	314 (30)	131 (28)	183 (31)	0.316
Paraplegia and hemiplegia	290 (27)	132 (28)	158 (27)	0.563
CCI score, mean (SD)[†]	1.7 (1.2)	1.6 (0.9)	1.8 (1.5)	0.016

(*Continued*)

Table 1 (Continued).

Characteristics	Overall	CBTF	Plant-Based STD-TF	p-value‡
Adults				
N	448	124	324	NA
Age, years, mean (SD)†	41.55 (23.33)	41.82 (23.90)	41.45 (23.14)	0.882
Female, N (%)	207 (46.2)	64 (51.6)	143 (44.1)	0.156
Region, N (%)				
Midwest	86 (19.2)	20 (16.1)	66 (20.4)	0.308
West	160 (35.7)	42 (33.9)	118 (36.4)	0.614
South	144 (32.1)	38 (30.6)	106 (32.7)	0.675
Northeast	58 (13.0)	24 (19.4)	34 (10.5)	0.012
Most common medical diagnoses, N (%)				
Diseases of the digestive system	405 (90.4)	110 (88.7)	295 (91.0)	0.452
Diseases of the musculoskeletal system and connective tissue	362 (80.8)	92 (74.2)	270 (83.3)	0.028
Diseases of the nervous system	350 (78.1)	98 (79.0)	252 (77.8)	0.774
Mental behavioral and neurodevelopmental disorders	302 (67)	79 (64)	223 (69)	0.301
Most common comorbidities, N (%)				
Chronic pulmonary disease	171 (38.2)	43 (34.7)	128 (39.5)	0.347
Paraplegia and hemiplegia	144 (32.1)	48 (38.7)	96 (29.6)	0.066
CCI score, mean (SD)†	3.8 (3.4)	3.4 (3.3)	3.9 (3.5)	0.208

Notes: †*T*-test (CBTF vs plant-based STD-TF); ‡Chi-squared test (CBTF vs plant-based STD-TF) unless otherwise specified.
Abbreviations: CBTF, commercial blenderized tube feeding formula; STD-TF, standard tube feeding formula; SD, standard deviation; CCI, Charlson's comorbidity index.

patients affected by diseases of the musculoskeletal system and connective tissue, which were more common in the plant-based STD-TF group (83.3% vs 74.2%, p = 0.028).

Healthcare Resource Utilization

Children

We observed claims for outpatient visits in 100% and 97% of the children in the CBTF and plant-based STD-TF groups, respectively. In the CBTF group, significantly fewer patients required inpatient services (16% vs 35%; p < 0.001), ED visits (15% vs 28%; p < 0.001), urgent care (3% vs 10%; p < 0.001) and other facilities (10% vs 22%; p < 0.001) compared with patients in the plant-based STD-TF-group (Figure 1A).

Compared with patients receiving plant-based STD-TF, patients receiving CBTF had significantly fewer mean total healthcare visits per patient (28 vs 96; p < 0.001). Patients in the CBTF group had also significantly fewer mean (SD) visits per patient for outpatient visits (18 [19] vs 73 [105]; p < 0.001), inpatient visits (5 [7] vs 11 [23]; p = 0.001), ED visits (1 [1] vs 2 [3]; p < 0.001), and other services (3 [3] vs 9 [24]; p = 0.005) when compared with the plant-based STD-TF group (Figure 1B).

Adults

While we observed no between-group difference in the total percentage of patients requiring care for outpatient visits, significantly fewer patients in the CBTF cohort required inpatient services (23% vs 38%; p = 0.003) and access to other services (13% vs 27%; p < 0.001) compared with the plant-based STD-TF cohort (Figure 2A).

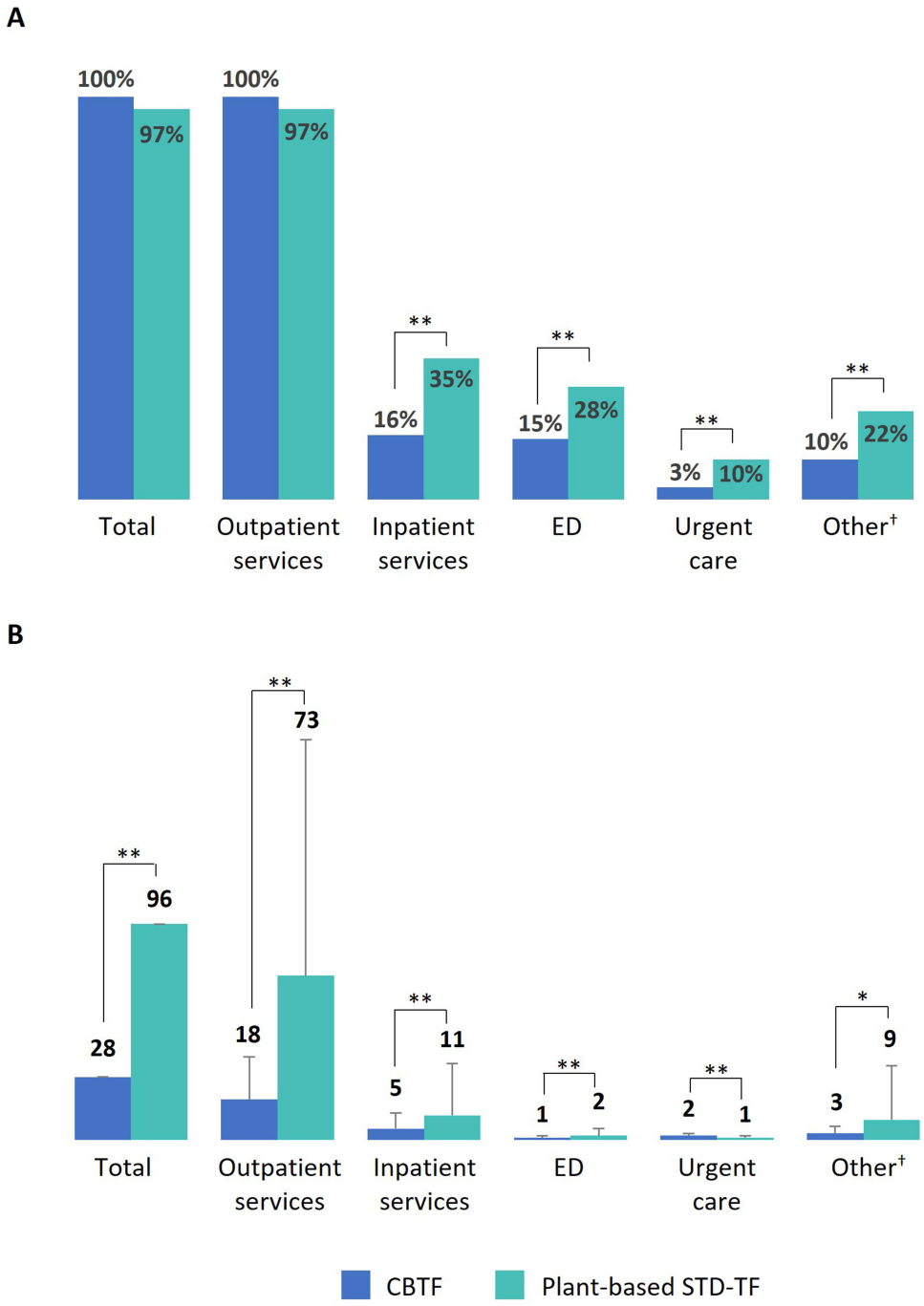

Figure 1 HCRU by place of service in children receiving CBTF and plant-based STD-TF. (**A**) Percentage of patients requiring care. (**B**) Mean visits per patient. Error bars in panel B represent the SD. †Other places of service include intermediate care, assisted living, and facilities not identified in the submitted claims. P values (CBTF vs plant-based STD-TF) were calculated using chi-square test in panel A and *t*-test in panel B; *p < 0.01, **p ≤ 0.001.

Abbreviations: CBTF, commercial blenderized tube feeding formula; ED, emergency department; HCRU, healthcare resource utilization; SD, standard deviation; STD-TF, standard tube feeding formula.

Compared with patients receiving plant-based STD-TF, patients prescribed CBTF had significantly fewer mean (SD) number of visits for all services (24 vs 79; $p < 0.001$), outpatient (14 [14] vs 52 [82]; $p < 0.001$) and inpatient (4 [5] vs 12 [24}; $p = 0.001$) services, urgent care (1 [1] vs 2 [3]; $p < 0.05$), and for access to other services (4 [4] vs 9 [24]; $p < 0.05$) during the study period (Figure 2B).

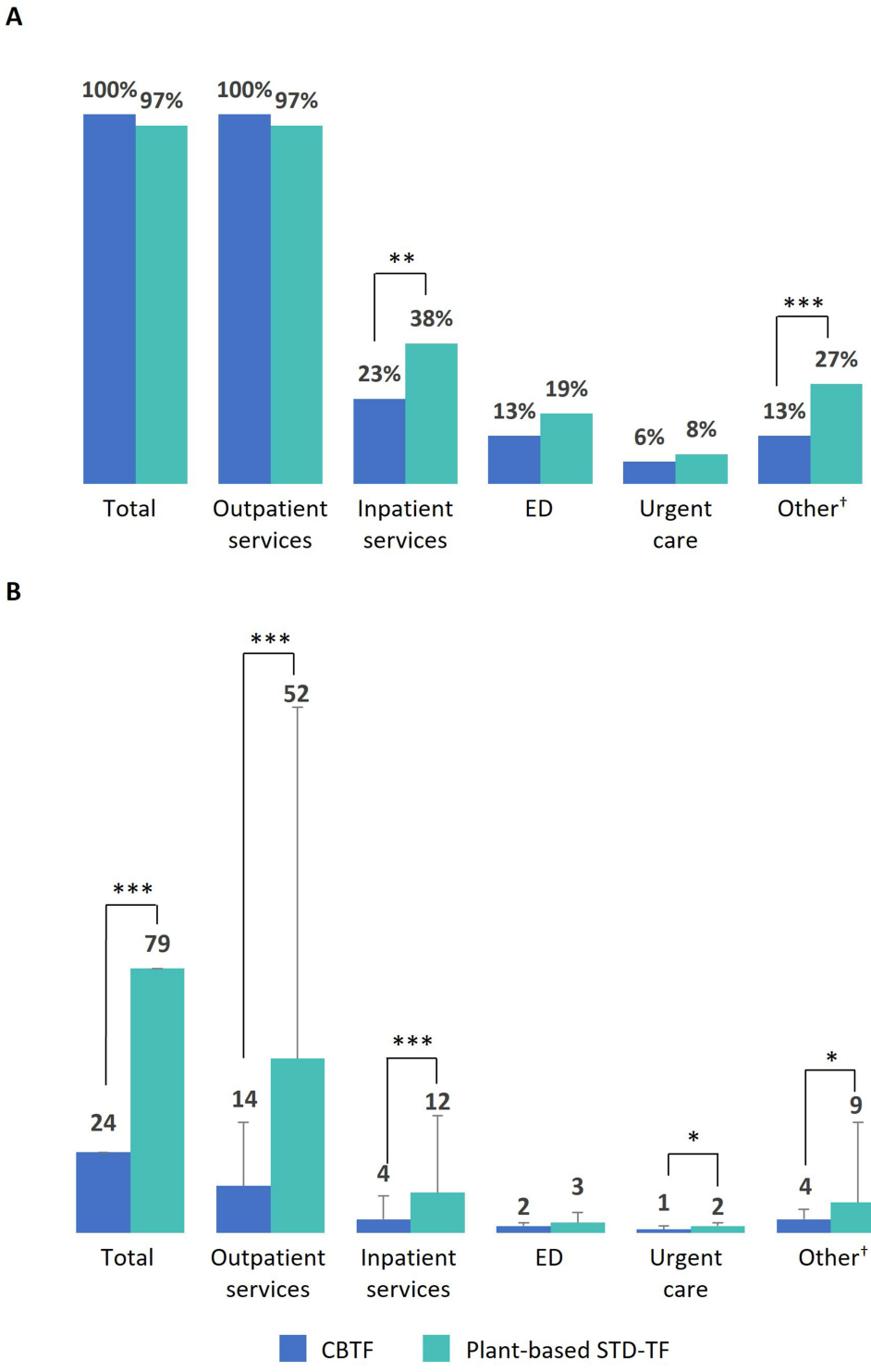

Figure 2 HCRU by place of service in adults receiving CBTF and plant-based STD-TF. (**A**) Percentage of patients requiring care. (**B**) Mean visits per patient. Error bars in panel B represent the SD. †Other places of service include intermediate care, assisted living, and facilities not identified in the submitted claims. P values (CBTF vs plant-based STD-TF) were calculated using chi-square test in panel A and *t*-test in panel B; *p < 0.05, **p < 0.01; ***p ≤ 0.001.

Abbreviations: CBTF, commercial blenderized tube feeding formula; ED, emergency department; HCRU, healthcare resource utilization; SD, standard deviation; STD-TF, standard tube feeding formula.

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Healthcare Utilization Costs

Children

Compared with patients receiving plant-based STD-TF, patients in the CBTF group incurred significantly lower mean (SD) unadjusted costs for outpatient services ($95,797 [110,804] vs $763,588 [1,895,404]; $p < 0.001$), inpatient services ($24,208 [44,904] vs $134,468 [615,044]; $p = 0.011$), ED visits ($6,108 [4,424] vs $16,178 [21,702]; $p < 0.01$), and other services ($9,818 [15,276] vs $139,311 [748,063]; $p = 0.048$). Total unadjusted HCRU costs were consistently significantly lower in children receiving CBTF compared with plant-based STD-TF ($p < 0.001$) (Figure 3A). Median unadjusted costs are presented in Table S2.

Multivariate costs, adjusted for confounders including age, sex, and CCI score, indicated significant cost savings for total HCRU costs ($p < 0.001$). We observed reduced costs (standard error [SE]) for all types of services assessed: outpatient visits ($164,480 [264] vs $738,567 [10,287]; $p < 0.001$), inpatient visits ($32,575 [121] vs $111,702 [2,506]; $p < 0.001$), ED visits ($8,084 [27] vs $20,127 [516]; $p < 0.001$), urgent care ($4,767 [137] vs $9,214 [400]; $p < 0.001$), and other services ($12,829 [62] vs $85,842 [2,391]; $p < 0.001$) (Figure 3B).

Adults

Total unadjusted HCRU costs were significantly lower in patients receiving CBTF compared with plant-based STD-TF ($p < 0.001$). Compared with adults receiving plant-based STD-TF, adult patients prescribed CBTF group incurred in significantly lower mean (SD) unadjusted costs for outpatient services ($121,312 [251,178] vs $574,991 [1,549,088]; $p < 0.001$), inpatient services ($21,705 [27,069] vs $117,452 [382,685]; $p = 0.007$), ED visits ($9562 [8447] vs $20,296 [28,046]; $p = 0.011$), and urgent care ($3575 [2428] vs $20,219 [36,086]; $p = 0.029$) (Figure 4A). Median unadjusted costs are presented in Table S2.

Significantly lower adjusted costs (SE) were associated with the use of CBTF compared with plant-based STD-TF for all services ($258,460 vs $919,060; $p < 0.001$), outpatient services ($187,502 [13,979] vs $684,833 [23,843]; $p < 0.001$), inpatient services ($40,318 [8040] vs $110,190 [7259]; $p < 0.001$), urgent care ($3760 [638] vs $9565 [972]; $p < 0.001$) and other services ($13,624 [3212] vs $95,162 [6791]; $p < 0.001$). A trend towards lower adjusted costs for ED visits was observed in the CBTF compared with the plant-based STD-TF group (Figure 4B).

Discussion

Healthcare spending in the US is considerably higher than in other industrialized countries, corresponding to 16.5% of gross domestic product compared with 9.8%–11.9% in Europe, Canada, and Australia.[35] However, when assessed against the same countries on health system performance (ie, health outcomes, access to care, equity, administrative burden, and care process) the US ranked last.[35] Value-based healthcare focuses on quality of care, aiming to deliver better patient outcomes for money spent.[36] Studies investigating the impacts of medical interventions, including nutrition, on patient clinical outcomes and on healthcare systems are critical to support the implementation of value-based healthcare initiatives. We have previously shown that children and adults in post-acute care receiving CBTF experience less GI intolerance compared with patients receiving plant-based STD-TF.[29,30] With this analysis, we add to the existing literature showing that optimizing nutrition interventions can lead to reductions in HCRU, ultimately reducing the cost and increasing value to patients and other stakeholders.

In this study, we report that, compared with patients receiving plant-based STD-TF, pediatric and adult patients receiving CBTF experienced reductions in HCRU and had lower associated costs in the 12 weeks following hospital discharge. Using insurance claims data, we have previously shown that adults and children receiving CBTF experience fewer GI intolerance events compared with patients receiving plant-based STD-TF at 12 weeks post hospital discharge.[29,30] Among the specific GI intolerance symptoms assessed, nausea and vomiting, abdominal pain, constipation (each $p < 0.001$), flatulence ($p = 0.005$), and abdominal distension ($p = 0.007$) were all significantly reduced in children receiving CBTF compared with plant-based STD-TF.[29] In the adult group, fewer patients receiving CBTF compared with plant-based STD-TF reported nausea and vomiting, abdominal pain (each $p < 0.001$), diarrhea ($p = 0.002$), and flatulence ($p = 0.037$).[30]

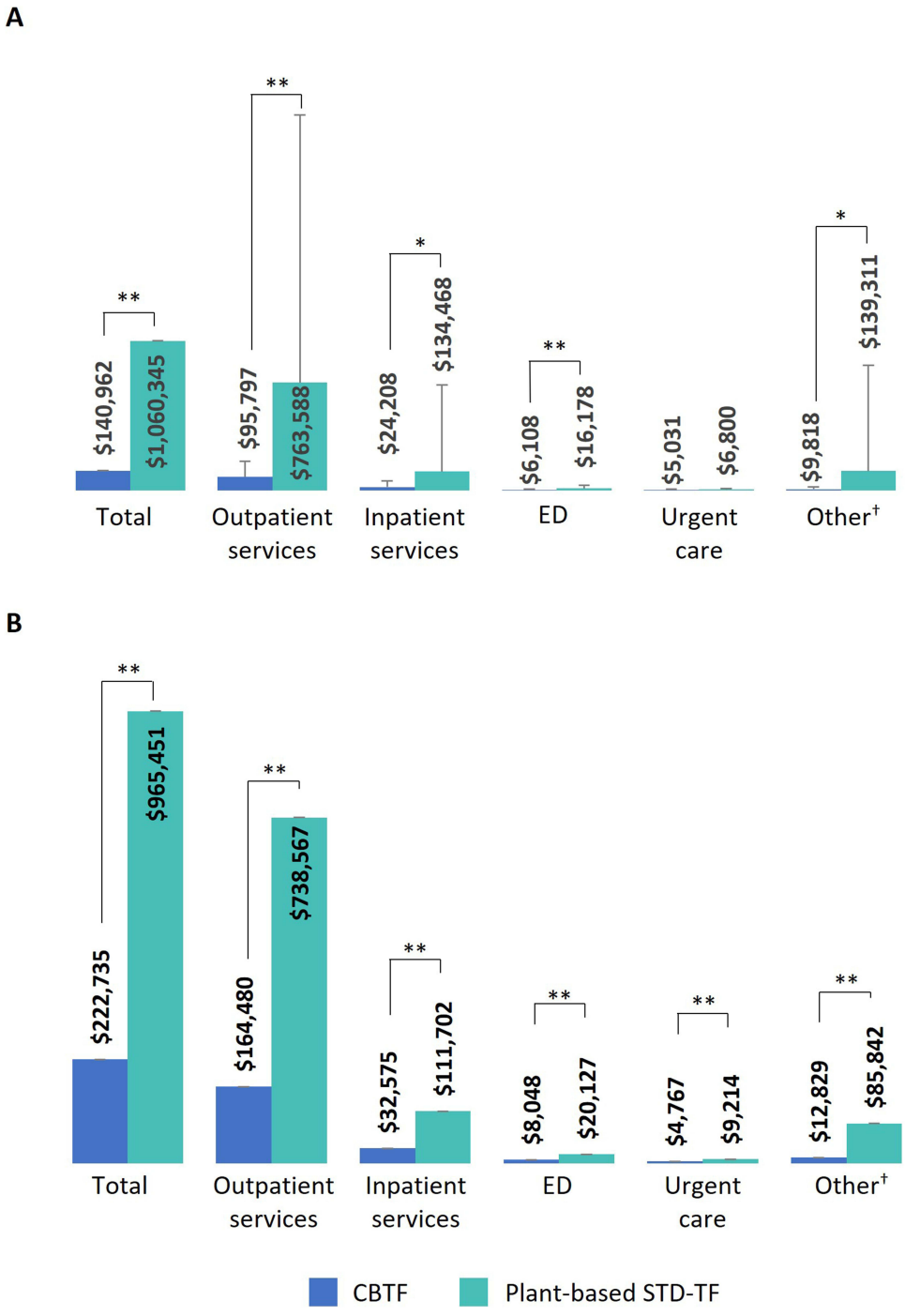

Figure 3 Unadjusted and adjusted costs in children receiving CBTF and plant-based STD-TF. (**A**) Unadjusted costs. (**B**) Adjusted costs. Error bars represent SD in panel A and SE in panel B. † Other places of service include intermediate care, assisted living, and facilities not identified in the submitted claims. P values (CBTF vs plant-based STD-TF) were calculated using *t*-test; *p < 0.05, **p ≤ 0.001.

Multiple studies on HEN support the association between clinical benefits, such as reduced GI intolerance symptoms, and improved health economic outcomes in both children and adults.[6,8,14,25,37] Consistent with the published literature, we find reduced HCRU and costs in children and adults receiving CBTF compared with plant-based STD-TF. A previous prospective study reported reduced HCRU for ED and inpatient visits in pediatric patients utilizing CBTF and HBTF compared with those receiving STD-TF.[4] Our analysis shows a significant reduction not only in inpatient and ED visits

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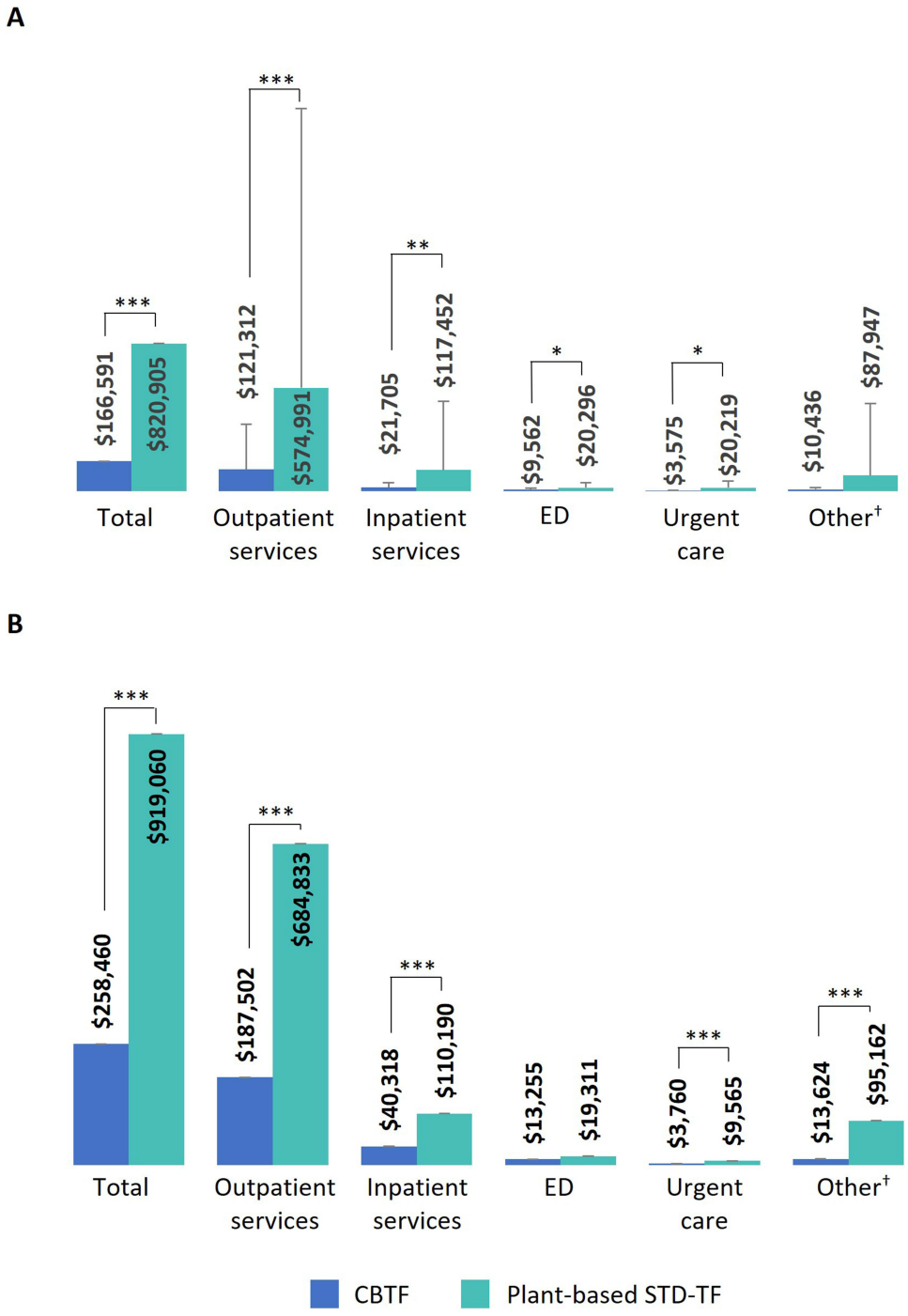

Figure 4 Unadjusted and adjusted costs in adults receiving CBTF and plant-based STD-TF. (**A**) Unadjusted costs. (**B**) Adjusted costs. Error bars represent SD in panel A and SE in panel B. †Other places of service include intermediate care, assisted living, and facilities not identified in the submitted claims. P values (CBTF vs plant-based STD-TF) were calculated using *t*-test; *p < 0.05, **p < 0.01; ***p ≤ 0.001.

Abbreviations: CBTF, commercial blenderized tube feeding formula; ED, emergency department; HCRU, healthcare resource utilization; SD, standard deviation; SE, standard error; STD-TF, standard tube feeding formula.

but also in the mean number of outpatient visits and other services. While a significantly smaller proportion of children receiving CBTF accessed urgent care services, the mean number of visits per patient was slightly but significantly higher in this cohort compared with plant-based STD-TF. Supporting the smaller proportion of patients using urgent care in the CBFT cohort, adjusted urgent care costs were also significantly lower in the CBTF cohort compared to the plant-based STD-TF cohort. We observed a small, yet significant difference in the number of urgent care visits per patient (CBTF: 2

±1 vs plant-based STD-TF: 1±1, $p < 0.05$). While we cannot exclude that this difference is due to coding errors in the submitted claims, further investigation is needed to identify the underlying causes. Additionally, it has previously been shown that access to urgent care services leads to a reduction in ED visits.[38] As the geographic distribution is different in the pediatric CBTF and plant-based STD-TF groups, with CBTF use more prevalent in the Midwest and Northeast that in the West and South regions, it is possible that regional differences in the availability of urgent care centers may play a role in the observed pattern of HCRU.

Mean patient visits to healthcare services, such as inpatient and outpatient visits, urgent care visits, and other services, were significantly lower in the adult CBTF group compared with the plant-based STD-TF group. The reduction in overall HCRU led to considerable savings in costs per patient in the CBTF group. Indeed, total unadjusted costs were significantly lower in the CBTF group compared with the plant-based STD-TF one. After controlling for confounders, costs associated with outpatient, inpatient, and urgent care visits, and other services were significantly lower in the adult CBTF compared with the plant-based STD-TF group. The two groups are comparable in terms of demographic and clinical characteristics, with no significant difference in mean age, proportion of female patients, CCI scores, or comorbidities. In both groups, we observed high SD values when assessing HCRU and unadjusted costs. These are likely reflecting a high variability in healthcare utilization, based on the claims data for both number of visits per patient to healthcare facilities and the costs associated with these visits.

This study had two key methodological strengths. First, the use of an insurance claims database covering >98% of US insurance plans allowed the inclusion of 1064 children and 488 adults from all US regions, providing a large sample of patients receiving HEN. Second, the multivariate model we used in the adjusted costs analysis minimizes the potential of selection bias associated with age, sex, and CCI scores.

In this analysis, we chose to compare commercial formulas with whole food ingredients (CBTF) to plant-based standard enteral formulas (STD-TF) to address the current evidence gap regarding clinical outcomes associated with these increasingly used formulas and to provide healthcare professionals with data to support informed formula selection.

This analysis presents some limitations inherent in the study design and in the data collected. Due to the retrospective design of claims-based analyses, we can report on the association between CBTF and lower HCRU and costs but cannot infer causation. Additional research, such as prospective or experimental studies, are warranted to further explore and clarify the nature of this relationship. The 12-week follow-up period is appropriate for capturing short-term differences but may not reflect longer-term outcomes. In addition, real-world data from routine practice are often subject to missing or inaccurate entries, coding errors, lack of standardized clinical measures, and variability across testing centers. In this study, imputation was applied to address missing cost components. While this approach helps reduce potential bias associated with incomplete data, it may also introduce some uncertainty, which should be taken into account when interpreting the cost-related findings. The absence of claims does not necessarily mean that a healthcare event did not occur, but rather that it was not captured in the database. Nonetheless, data quality is supported by established systems. As the study relies on US data, results may not be generalizable to other populations. Other limitations of the present study include the lack of important information on HCRU, such as the type of hospital admission (ie, intensive care unit or general ward) and the length of hospital stay, and the lack of adjustment for potential confounders, which further limits the ability to draw definitive conclusions on causation. For instance, while we accounted for between-group differences in disease severity (CCI score) in the multivariate cost analysis, it is possible that acute presentations of specific diseases might influence HCRU, eg, seizures in some of the patients with neurodevelopmental disorders. We cannot exclude that differences in medical diagnoses and/or CCI score may affect HCRU results. In this study, for example, a significantly higher proportion of patients in the plant-based STD-TF group was diagnosed with neurodevelopmental disorders among children ($p = 0.002$) and with diseases of the musculoskeletal system and connective tissue among adults ($p = 0.028$) compared with the CBTF group. Additionally, the multivariate model did not adjust for geographic distribution, insurance type and socioeconomic status, which may have affected the final adjusted costs results.[39,40] For example, compared with patients receiving plant-based STD-TF, a higher proportion of adults receiving CBTF was from the Northeast region. To reduce potential bias related to author affiliations or compensation from the study sponsor, both significant and non-significant results were reported.

Conclusion

Patients receiving CBTF had lower HCRU and costs compared with those receiving plant-based STD-TF both in pediatric and adult patients in a post-acute care setting. These findings may guide formula selection based by considering both nutritional needs and potential economic impact. Nonetheless, the retrospective design and lack of adjustment for confounders limit the findings to associations and preclude inferring causation. Future research is needed to address the role of confounders, assess the impact of CBTF on HCRU due to feeding intolerance or GI complications alone, and determine the generalizability of these findings across a broader range of formulations. We expect that assessment of health economic benefits over a longer post hospital discharge follow-up will provide additional insights on long-term use of CBTF compared with plant-based STD-TF.

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Disclosure

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