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ORIGINAL RESEARCH

Correlation of 18F-FDG PET/CT SUV with Colon Cancer Aggressiveness and Superior Diagnostic Performance Over CT for Lymph Node Metastasis: A Retrospective Analysis

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Objective: To analyze the relationship between the standardized uptake value (SUV) derived from 18F-FDG PET/CT imaging and the clinical characteristics of colon cancer, and to evaluate its diagnostic performance relative to CT imaging in identifying lymph node metastasis.

Methods: A retrospective analysis was conducted on 113 patients with pathologically confirmed primary colon cancer. All patients underwent preoperative 18F-FDG PET/CT and CT examinations. The SUV of the primary lesion was measured. Patients were grouped based on clinicopathological features, and differences in SUV across groups were analyzed. The diagnostic efficacy of PET/CT and CT for lymph node metastasis was evaluated using receiver operating characteristic (ROC) curves, with pathology as the gold standard.

Results: The lesion SUV was not significantly related to sex, age, lesion location, CA199, or CA242 ($P > 0.05$). However, it was significantly associated with maximum lesion diameter ($P < 0.001$), AJCC stage ($P = 0.001$), pathological type ($P < 0.001$), differentiation grade ($P < 0.001$), lymph node metastasis ($P < 0.001$), and CEA expression ($P < 0.001$). Spearman correlation analysis showed that SUV was positively correlated with these significant parameters (all $P < 0.05$). For diagnosing lymph node metastasis, the area under the curve (AUC) for 18F-FDG PET/CT imaging was 0.943, which was significantly higher than that for CT imaging (0.836) ($Z = 3.965$, $P < 0.05$), with superior sensitivity and specificity.

Conclusion: SUV values on 18F-FDG PET/CT are positively correlated with key indicators of tumor aggressiveness in colon cancer, including tumor size, stage, differentiation grade, and lymph node metastasis. 18F-FDG PET/CT demonstrates significantly better diagnostic performance than CT alone for the detection of lymph node metastasis.

Keywords: 18F-FDG PET/CT, SUV, colon cancer, clinical features, diagnostic efficacy

Introduction

Colon cancer, primarily adenocarcinoma, remains a leading cause of cancer-related mortality worldwide, with its incidence rising notably in developing countries.[1,2] In China, factors including dietary westernization and an aging population have contributed to an increasing disease burden.[3] While treatment modalities have advanced, the prognosis for patients with advanced disease, particularly those with lymph node metastasis (LNM), remains suboptimal.[4,5] Accurate staging and characterization of tumor aggressiveness are, therefore, critical for optimizing treatment strategies.

Computed tomography (CT) is a cornerstone imaging technique for colon cancer, providing excellent anatomical detail for lesion localization and staging.[6,7] However, its reliance on morphological changes limits its sensitivity for detecting metastatic involvement in normal-sized lymph nodes and small, metabolically active lesions.[8]

18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) integrates metabolic and anatomical information, offering a functional parameter—the standardized uptake value (SUV)—which reflects glucose metabolism in tumor cells.[9,10] Although SUV has demonstrated prognostic value in various cancers, its specific correlations with a comprehensive set of clinicopathological features in colon cancer are not fully established, and

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findings across studies have been inconsistent.[11] Furthermore, robust direct comparisons of the diagnostic performance between PET/CT and CT specifically for LNM in colon cancer are still needed.

This study aims to address these gaps by 1) comprehensively analyzing the relationship between SUV and key clinical characteristics, including tumor stage, differentiation, and serum markers, in a cohort of 113 pathologically confirmed colon cancer patients, and 2) directly comparing the diagnostic efficacy of 18F-FDG PET/CT versus CT alone for the detection of LNM. Our goal is to provide clearer evidence to guide the clinical application of PET/CT in the management of colon cancer.

Materials and Methods

Study Subjects and Design

This single-center retrospective study was approved by the Ethics Committee of Yichang Central People's Hospital (Approval No.: XHYX2413). The committee granted a waiver of the requirement for obtaining additional written informed consent for this analysis due to the retrospective nature of the study and the use of anonymized data. All patient data were handled with strict confidentiality and in accordance with the ethical principles of the Declaration of Helsinki. Clinical data were collected from 113 patients with pathologically confirmed primary colon cancer who were treated at our hospital between August 2022 and October 2024. All patients had undergone preoperative 18F-FDG PET/CT and CT imaging, and had complete, traceable clinical and imaging data. The patient selection process is detailed in Figure 1.

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) pathological diagnosis of primary colon cancer; (2) pre-treatment 18F-FDG PET/CT, CT, and serum tumor marker tests with technically adequate images (ie, free of significant motion artifacts and with sufficient signal-to-noise ratio for diagnostic interpretation); (3) age ≥18 years (to standardize the cohort to the adult population primarily affected by this disease); (4) no prior surgery, radiotherapy, chemotherapy, immunotherapy, or targeted therapy; and (5) complete clinical and laboratory data.

Exclusion criteria were: (1) incomplete data or poor image quality; (2) history of other malignancies; (3) severe systemic inflammation, active infection, or inflammatory bowel disease at the time of scanning; (4) uncontrolled diabetes (fasting blood glucose >11.1 mmol/L), severe hepatic/renal insufficiency, or metabolic diseases that could affect FDG uptake; (5) pregnancy or lactation; (6) immunodeficiency disorders; and (7) cognitive or communication impairments.

Examination Methods

Examinations were conducted using a Siemens Biograph mCT-64 PET/CT scanner. Patients fasted for 4–6 hours before the examination, with fasting blood glucose levels <6.1 mmol/L. 18F-FDG (produced by a Japan's Sumitomo Cyclotron HM-10HC and automatically synthesized via a module, radiochemical purity >95%) was administered via intravenous injection at a dose of 3.7–5.55 MBq/kg (0.1–0.15 mCi/kg). Patients rested in a supine position for approximately 60 minutes post-injection before undergoing PET/CT scanning. CT was performed first using a GE LightSpeed VCT 64-slice spiral CT scanner for routine abdominal contrast-enhanced scans, with parameters set at 120 kV, 300 mA, 5 mm slice thickness, and 1.0 pitch. The scan range included the area from below the diaphragm to the pelvis. PET data were acquired in 3D mode, typically covering 6–8 bed positions with 3 minutes per bed. Images were reconstructed using iterative methods, and attenuation correction was performed on PET images using CT data. The corrected PET and CT images were automatically fused using the Syngo MI workstation. Two experienced nuclear medicine physicians jointly reviewed the images, delineating the region of interest (ROI) on the slice with the most intense radioactive uptake within the lesion. The SUV was automatically generated by the workstation based on the patient's weight, injected dose, and time.

Grouping and Observation Indicators

Based on patients' clinicopathological data, SUV values were compared across the following groups: Sex (male, female); Age (<60 years, ≥60 years); Maximum lesion diameter (<3 cm, ≥3 cm); AJCC staging[12] (stage I–II, stage III–IV);

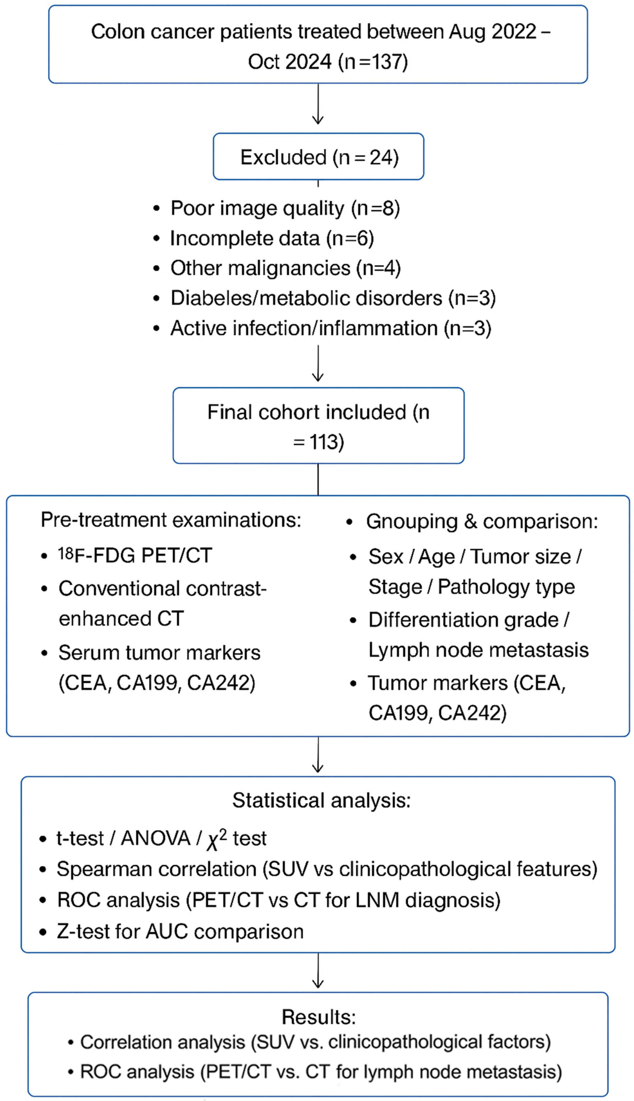

Figure 1 Patient selection process in this study.

Pathological type (adenocarcinoma, mucinous adenocarcinoma); Histological differentiation grade (moderate to well-differentiated, poorly differentiated); Regional lymph node metastasis (yes, no); Lesion location (ascending colon, transverse colon, descending colon, sigmoid colon); Serum tumor markers: carcinoembryonic antigen (CEA), carbohydrate antigen 199 (CA199), and CA242 (all indicators were grouped as normal/elevated based on the upper limit of the laboratory normal value).

Diagnostic Efficacy Analysis

Using pathological findings as the gold standard, the sensitivity, specificity, and area under the curve (AUC) of 18F-FDG PET/CT imaging and CT imaging in diagnosing lymph node metastasis were evaluated. Comparative analysis was performed using ROC curves.

Statistical Methods

GraphPad Prism 8 was used for plotting; SPSS 25.0 was used for statistical analysis. Categorical data were expressed as n (%), and χ^2-tests were used for comparisons. Continuous data were tested for normality using the Shapiro–Wilk test; data conforming to a normal distribution were expressed as mean ± SD, with ANOVA used for multiple group

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comparisons and t-tests for two-group comparisons. Spearman correlation analysis was used to assess the relationship between clinical features and SUV values. ROC curves were generated using MedCalc software to evaluate the diagnostic performance of 18F-FDG PET/CT and CT imaging. The Z-test was used to compare AUCs. A P-value of <0.05 was considered statistically significant.

Results

SUV Differences in Colon Cancer Patients with Different Clinical Characteristics

The SUV of the lesion showed no significant correlation with sex, age, lesion location, CA199, or CA242 (P > 0.05), but was significantly associated with maximum lesion diameter, AJCC stage, pathological type, histological differentiation, lymph node metastasis, and CEA expression (P < 0.05), as shown in Table 1.

Table 1 Differences in SUV Among Colon Cancer Patients with Different Clinical Characteristics

Characteristic	Cases (n = 113)	SUV Value	*t/F*	*P*
Sex	–	–	0.397	0.691
Male	67 (59.29)	14.58±9.19	–	–
Female	46 (40.71)	15.23±7.46	–	–
Age (years)	–	–	0.136	0.892
<60	61 (53.98)	14.95±9.82	–	–
≥60	52 (46.02)	14.73±6.79	–	–
Maximum Lesion Diameter (cm)	–	–	4.157	<0.001
<3	26 (23.01)	9.87±3.76	–	–
≥3	87 (76.99)	17.52±9.13	–	–
AJCC Stage	–	–	3.226	0.001
Stage I–II	28 (24.78)	13.42±7.85	–	–
Stage III–IV	85 (75.22)	19.31±8.54	–	–
Pathological Type	–	–	3.920	<0.001
Mucinous adenocarcinoma	21 (18.58)	10.97±4.26	–	–
Adenocarcinoma	92 (81.42)	17.75±7.64		
Histological Differentiation	–	–	6.442	<0.001
Moderate to well differentiated	69 (61.06)	12.36±5.54	–	–
Poorly differentiated	44 (38.94)	21.89±10.16	–	–
Regional Lymph Node Metastasis	–	–	5.348	<0.001
Yes	79 (69.91)	22.91±9.63	–	–
No	34 (30.09)	13.72±4.11	–	–
Lesion Location	–	–	0.293	0.746
Ascending colon	56 (49.56)	15.64±9.32	–	–
Transverse colon	15 (13.27)	14.19±8.67	–	–
Descending colon	11 (9.73)	13.86±8.59	–	–
Sigmoid colon	31 (27.43)	14.37±7.65	–	–
CEA	–	–	4.642	<0.001
Normal	49 (43.36)	12.68±5.54	–	–
Elevated	64 (56.64)	18.16±6.69	–	–
CA199	–	–	0.490	0.624
Normal	49 (43.36)	16.13±7.08	–	–
Elevated	64 (56.64)	15.38±8.73	–	–
CA242	–	–	0.668	0.505
Normal	44 (38.94)	13.87±5.79	–	–
Elevated	69 (61.06)	14.72±7.05	–	–

Correlation Between Clinical Characteristics and SUV

Spearman correlation analysis showed that SUV was positively correlated with maximum lesion diameter (<3 cm = 1, ≥3 cm = 2), AJCC stage (stage I–II = 1, stage III–IV = 2), pathological type (mucinous adenocarcinoma = 1, adenocarcinoma = 2), histological differentiation (moderate to well differentiated = 1, poorly differentiated = 2), lymph node metastasis (no = 1, yes = 2), and CEA expression (normal = 1, elevated = 2) ($P < 0.05$), as shown in Table 2 and Figure 2.

Comparison of Diagnostic Performance Between 18F-FDG PET/CT and CT Imaging

ROC curves were plotted using lymph node metastasis status as the state variable. The AUC of 18F-FDG PET/CT imaging was 0.943, while that of CT imaging was 0.836. The AUC, sensitivity, and specificity of 18F-FDG PET/CT imaging were all higher than those of CT imaging ($Z = 3.965$, $P < 0.05$), as shown in Table 3 and Figure 3.

Discussion

Principal Findings and Central Role of Histological Differentiation

This study demonstrates that 18F-FDG PET/CT-derived SUV values are significantly correlated with key indicators of colon cancer aggressiveness. The most compelling finding was the strong association between elevated SUV and poorly differentiated histology ($r = 0.657$, $P < 0.05$), which should be considered the cornerstone of this investigation. Poorly differentiated tumors exhibited substantially higher SUV values (21.89 ± 10.16) compared to their moderately/well-differentiated counterparts (12.36 ± 5.54), highlighting the potential of SUV as a quantitative non-invasive biomarker for predicting tumor grade. This correlation outperformed other clinicopathological associations in our cohort, underscoring its clinical relevance.

Metabolic Basis and Biological Plausibility

The mechanistic foundation for this observation lies in the metabolic reprogramming characteristic of aggressive malignancies. The Warburg effect describes the preference of cancer cells for anaerobic glycolysis even under normoxic conditions.[13] This phenomenon is markedly amplified in poorly differentiated colon cancers, where upregulation of glucose transporter 1 (GLUT1) and hexokinase II (HK-II) significantly enhances 18F-FDG avidity.[14,15] The disorganized architecture and rapid proliferation of these tumors create hypoxic microenvironments that further stimulate glycolytic flux through hypoxia-inducible factor-1α (HIF-1α) mediated pathways, providing a plausible explanation for the markedly elevated SUV values observed in this subgroup. Our findings align with previous reports[16–18] consistently demonstrating that poorly differentiated adenocarcinomas exhibit intensified FDG uptake and correlate with unfavorable prognosis.

Complementary Clinicopathological Correlations and Diagnostic Superiority

Beyond histological grade, SUV values showed significant positive correlations with maximum lesion diameter, AJCC stage, lymph node metastasis, and CEA levels, collectively reinforcing the role of metabolic imaging as a comprehensive

Table 2 Correlation Between Clinical Characteristics and SUV

Indicator	SUV	
	r	P
Maximum Lesion Diameter	0.574	<0.05
AJCC Stage	0.531	<0.05
Pathological Type	0.562	<0.05
Differentiation Degree	0.657	<0.05
Lymph Node Metastasis	0.638	<0.05
CEA	0.583	<0.05

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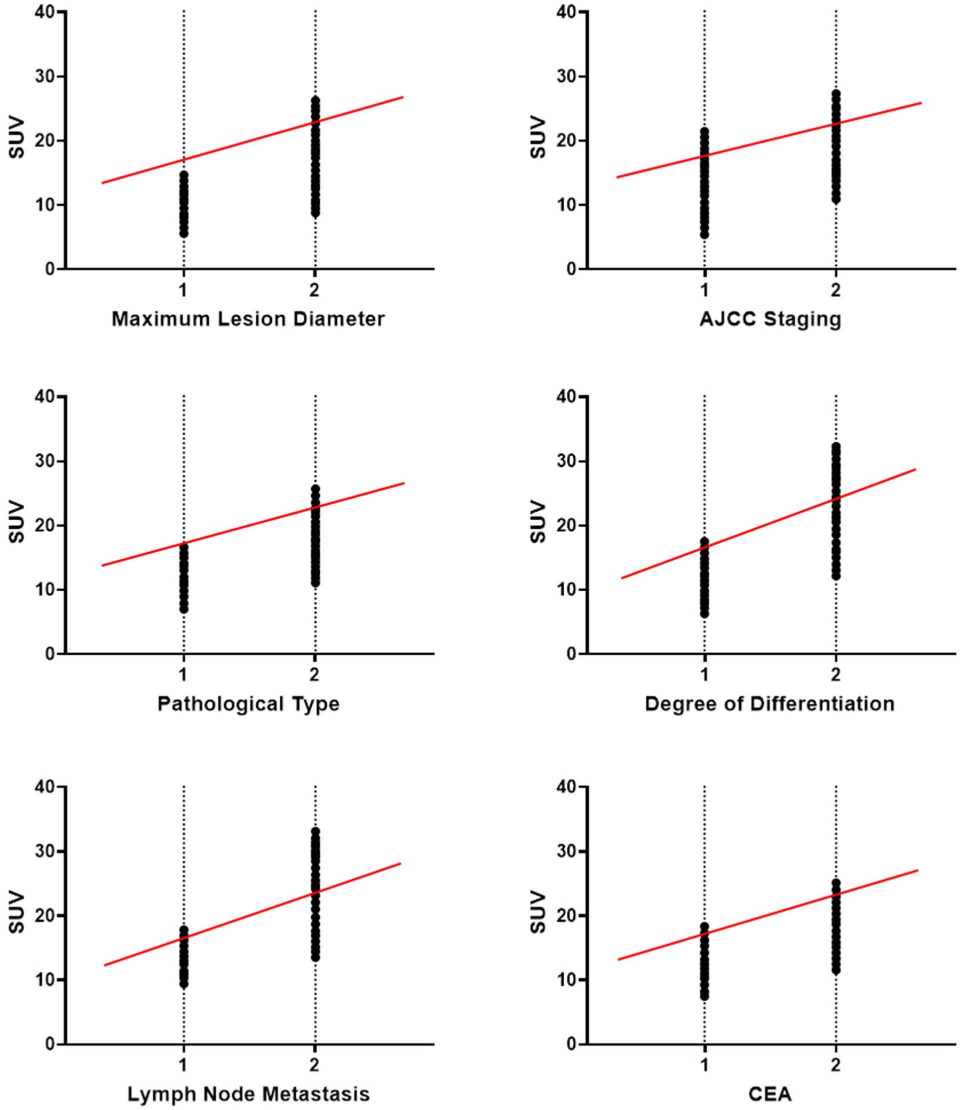

Figure 2 Scatter plot of correlation between clinical characteristics and SUV.

indicator of tumor burden and biological aggressiveness. The concordance between elevated SUV and increased CEA levels suggests a synchronization between metabolic aberrations and secretory biomarker profiles in advanced disease.[19]

In diagnostic assessment, 18F-FDG PET/CT substantially outperformed conventional CT in detecting lymph node metastasis (AUC: 0.943 vs 0.836). This diagnostic advantage is particularly relevant for poorly differentiated tumors,[20] where accurate staging is crucial given their aggressive nature. While CT relies solely on morphological criteria (eg, short-axis diameter >1 cm), PET/CT detects metabolic alterations, enabling identification of small nodal deposits that would otherwise evade detection.[21–23] Engel et al[24] similarly demonstrated the superiority of PET/CT for N-staging in colorectal cancer, especially for metabolically active but morphologically inconspicuous metastases.

Table 3 Comparison of Diagnostic Performance Between 18F-FDG PET/CT and CT Imaging

Modality	Optimal Cut-Off Value	AUC	95% CI	P	Sensitivity (%)	Specificity (%)
18F-FDG PET/CT	13.725	0.943	0.891–0.986	<0.001	97.26	100.00
CT	8.943	0.836	0.792–0.879	<0.001	87.35	80.64

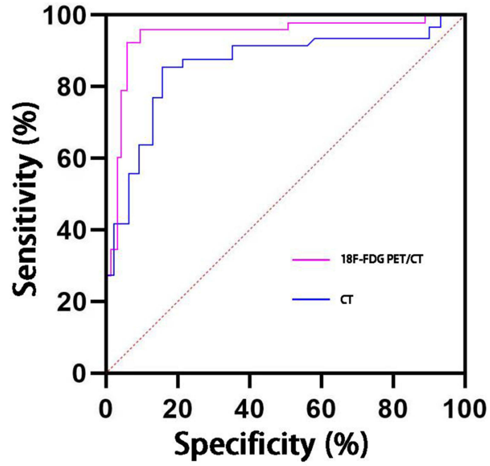

Figure 3 ROC curves for diagnostic performance of 18F-FDG PET/CT vs CT imaging.

Clinical Implications and Future Directions

The robust association between high SUV and poor differentiation has immediate clinical relevance. These findings suggest that preoperative SUV assessment could help identify patients with biologically aggressive disease who might benefit from more extensive staging, intensified neoadjuvant approaches, or closer postoperative surveillance. Several studies[25–27] have reported that elevated preoperative SUV predicts higher recurrence risk following adjuvant chemotherapy, supporting its potential role in prognostic stratification.[28,29]

While our data clearly establish the association between SUV and differentiation status, future studies with larger cohorts should aim to establish specific SUV cut-off values that can reliably predict poor differentiation preoperatively.[30,31] Such validated thresholds would enhance clinical decision-making and potentially guide treatment intensification in high-risk cases.

Limitations

This study has limitations inherent to its retrospective, single-center design. The sample size, though adequate for the primary correlations, limits subgroup analyses. SUV measurements are susceptible to technical variations despite standardized protocols. Additionally, we did not evaluate other metabolic parameters such as metabolic tumor volume (MTV) or total lesion glycolysis (TLG), which might provide complementary information.

The strong correlation between elevated SUV on 18F-FDG PET/CT and poorly differentiated histology represents the most significant finding of this study, positioning metabolic imaging as a valuable tool for non-invasive assessment of tumor aggressiveness in colon cancer. PET/CT outperforms conventional CT in lymph node staging, providing a more reliable foundation for personalized treatment strategies.

Conclusion

The results of this study demonstrate that SUV on 18F-FDG PET/CT imaging is closely related to several key clinicopathological features of colon cancer, including lesion size, AJCC stage, pathological type, histological differentiation (with poorly differentiated tumors showing significantly higher uptake), lymph node metastasis, and CEA levels. Compared with conventional CT, 18F-FDG PET/CT offers superior diagnostic performance in identifying lymph node metastases. These findings suggest that preoperative PET/CT, by providing a quantitative measure of tumor glycolytic activity, can aid in risk stratification. Specifically, high SUV may help identify patients who could benefit from more intensive preoperative staging or postoperative surveillance strategies. As an imaging technique that integrates metabolic and anatomical information, 18F-FDG PET/CT provides a valuable tool for personalized management, such as guiding the intensity of neoadjuvant therapy or the extent of surgical lymphadenectomy based on the metabolic profile of

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the tumor. Further multi-center studies are warranted to validate the clinical utility of SUV for these applications and to establish standardized protocols.

Data Sharing Statement

All data generated or analysed during this study are included in this published article.

Disclosure

The authors declare that they have no competing interests.

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