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Paraspinal Fat Stranding as an Unexpected Finding on Body Computed Tomography: A Key to Early Detection of Spinal Osteomyelitis

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ABSTRACT

Objective: At present, early detection of spinal osteomyelitis is a challenge. Patients may present with non-specific symptoms and diagnostic imaging studies may be obtained for seemingly unrelated complaints. Paraspinal fat stranding on body computed tomography (CT) as a sign of osteomyelitis is easily overlooked and has not been reported in the literature to our knowledge. The purpose of this study is to review findings on body CT that points to unsuspected spinal osteomyelitis.

Material and Methods: A retrospective review of patients with spinal osteomyelitis who also had concomitant chest, abdominal, or pelvic CT scans between August 2013 and February 2017 yielded 10 patients who had confirmed osteomyelitis (ages between 51 and 75, mean age 64.8). Images and medical records were reviewed.

Results: The age of the patients ranged from 51 to 75 years (median value, 64). All patients had multiple underlying medical illnesses, and half of them had a known preceding infection such as sepsis or urinary tract infection. At presentation, three patients had a fever and two patients had neurologic deficits. Seven out of eight patients had elevated C-reactive protein and erythrocyte sedimentation rate, five patients had leukocytosis, and four patients had positive blood cultures. Paravertebral fat stranding and endplate erosions were observed in 9 and 6 cases, respectively, on initial body CT for unrelated indications, and subsequent magnetic resonance imaging confirmed osteomyelitis discitis.

Conclusion: Clinically significant, but initially unsuspected, spinal pathology such as osteomyelitis may present on body CT scans. Earlier diagnosis of spinal osteomyelitis can be made by performing a focused evaluation of the paraspinal soft tissues and including osteomyelitis in the differential diagnosis, particularly in high-risk patients.

Keywords: Vertebral osteomyelitis, Spinal osteomyelitis, Fat stranding

INTRODUCTION

Spine infections typically result from hematogenous spread that can be classified into discitis, spinal abscess, and spinal osteomyelitis and often coexist as discitis/osteomyelitis. The incidence of spinal osteomyelitis is increasing as a result of higher life expectancies with chronic disease and increased rates of immunosuppression, intravenous (IV) drug use, and spinal instrumentation. Spinal osteomyelitis now accounts for 2–7% of all cases of osteomyelitis[1,2] with an average incidence of 2.4 cases/100,000.[3]

The prognosis of spinal osteomyelitis is usually good if treatment is initiated promptly, but diagnostic delays are highly associated with complications such as permanent neurologic deficits

and even death.[1,3,4] However, accurate and timely diagnosis of spinal osteomyelitis is challenging because clinical findings and symptoms (e.g., back pain), laboratory data, and radiographs can be non-specific or insensitive.[5] Back pain in spinal osteomyelitis can clinically mimic disk herniation or other degenerative spinal diseases, renal etiologies such as nephrolithiasis or pyelonephritis, metastatic disease, and fracture resulting in a complex diagnostic challenge.[1,3] Moreover, because hematogenous seeding is usually the cause of pyogenic spinal osteomyelitis, the symptoms and signs of osteomyelitis may be masked by manifestations of a primary infection.[3] As a result, spinal osteomyelitis is often diagnosed 1–2 months (range of 42–59 days in five studies) after the onset of symptoms.[3,5]

As a result of non-specific presenting symptoms, imaging is necessary for confirmation, localization of infection, identifying complications, and evaluating for other diseases.[5] Contrast-enhanced magnetic resonance imaging (MRI) remains the gold standard for diagnosing spinal infection, with a sensitivity of 96%, specificity of 92%, and accuracy of 90%.[3,4] It typically shows abnormal T2 hyperintense signal within the disk space and adjacent endplates with accompanying enhancement.[4,6] Compared to computed tomography (CT), MR better depicts epidural extension and also allows assessment of possible cord compression.[6] Therefore, CT is usually indicated for the evaluation of suspected spinal osteomyelitis only if the patient has a contraindication to MRI and can provide clear evidence of late findings of osteomyelitis including trabecular destruction, endplate erosions, and paraspinal abscesses.[3,4,7] However, often a chest, abdomen, or pelvis CT is initially obtained for seemingly unrelated indications. Unexpected findings on these scans can play an integral role in the early diagnosis of osteomyelitis.

Although confirming spinal osteomyelitis on MRI is well understood, there is a relative paucity of literature on identifying early imaging findings of spinal osteomyelitis on chest or abdominopelvic CT. In this study, we retrospectively analyzed 10 cases of confirmed osteomyelitis, in which initial CT imaging was performed for other indications, mostly before the clinical suspicion of osteomyelitis. Unexpected findings on body CT such as paraspinal fat stranding and early

Table 1: Patient characteristics and chief complaint on initial presentation.

Patient	Age	Sex	Presenting complaints	Duration of symptoms (before presentation)	Medical history
1	65 years	M	Hypotension, abdominal pain	<1 day	HIV, HCV, DVT, venous thrombosis, varices
2	73 years	M	Right flank pain	1 week	Salmonella enteritis and sepsis 1 month prior, diabetes, CHF, renal stones
3	75 years	F	Acute back pain	2 days	DM, spinal stenosis s/p remote surgery
4	67 years	M	Right abdominal, flank pain	1 week	DM, hepatitis C, prostate cancer, CKD
5	51 years	M	Mouth swelling/pain, abdominal pain, productive cough	2 days	DM, heroin abuse, latent TB
6	63 years	M	Chest pain, nausea/vomiting	4 days	Diabetes, recent sepsis
7	61 years	F	Abdominal pain, liver mass evaluation	Unknown (patient unable to provide history)	Diabetes, HCV, gastroparesis, CAD
8	55 years	F	Back pain, weakness, sensory loss (transferred to UIH for residual epidural abscess after T11-L1 laminectomies for abscess evacuation)	3 weeks	Addison's disease, chronic steroid use, chronic back pain
9	63 years	F	Altered mental status	<1 day	Cervical spondylotic myelopathy, paraplegia, neurogenic bladder requiring chronic indwelling Foley catheter, HTN, HLD, DM
10	75 years	F	Shortness of breath	4 days	Non-ischemic cardiomyopathy, CHF, CKD Stage 3, HTN, CAD, COPD, recurrent DVT on lifelong warfarin

CHF: Congestive heart failure, M: Male, F: Female, DVT: Deep vein thrombosis, COPD: Chronic obstructive pulmonary disease, CAD: Coronary artery disease, DM: Diabetes mellitus, HCV: Hepatitis C virus, CKD: Chronic kidney disease, TB: Tuberculosis

endplate erosion can lead to earlier diagnosis and treatment while reducing the risk of complications and mortality. The purpose of this study is to illustrate and increase awareness of early unexpected imaging findings on body CT and demonstrate the potential implications of body CT search pattern for early diagnosis.

METHODS

The study was performed in compliance with the Health Insurance Portability and Accountability Act regulations. The Institutional Review Board (Protocol # 2018-1585) approval was obtained. Informed consent was waived due to the retrospective nature of this study. A search of billing data of the diagnosis of "osteomyelitis" was performed on body CT cases performed in our institution between August 2013 and February 2017. Eleven cases were found and retrospectively analyzed. One case was excluded as the pelvis was involved rather than the spine. The clinical and laboratory information of the patients with confirmed osteomyelitis were retrieved from the electronic medical records. The abdominopelvic CT studies in the picture archiving and communication system archive were retrospectively reviewed by a single radiologist with 16 years of experience in body imaging. The studies were evaluated for the presence of paraspinal fat stranding and presence of endplate erosions or destruction.

RESULTS

We identified 10 cases of confirmed osteomyelitis with a body CT performed for unrelated indications. The demographic features of the patients are summarized in Table 1. The age of the patients ranged from 51 to 75 years (median value, 64). About 50% were male and 50% were female.

Table 2: Patient symptoms and laboratory findings.

Clinical findings	*n*	%	Laboratory findings*	*n*	%
Back pain	10	100	Elevated CRP	9 out of 9	100
Shortness of breath	4	40	Elevated ESR	7 out of 8	87.5
Fever	3	30	Elevated WBC	5 out of 10	50
Neurologic deficits	2	20	(+) Blood culture	4 out of 10	40
Decreased appetite	2	20			
Malaise	2	20			
Chills	2	20			
Nausea	1	10			
Cough	1	10			

*Leukocytosis defined as >11,000/mm^3, elevated CRP defined as >3.0 mg/L. CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, WBC: White blood cell

Figure 1: A 65-year-old male with hypotension and abdominal pain. Initial axial (a), sagittal (b), and coronal reformatted (c) post-contrast computed tomography (CT) images of the abdomen show T9-T10 early paraspinal fatty infiltration (arrows, a and c), with no endplate erosions (arrow, b). In addition, there is remote osteomyelitis at L3-L4 and nodularity of the liver related to cirrhosis. Three weeks later, he returned to the emergency department with continued abdominal pain, as well as back pain following a fall, urinary retention, and lower extremity weakness. Subsequent axial (d) and sagittal reformatted (e and f) post-contrast CT of abdomen ordered to evaluate for fracture shows increased paraspinal fatty infiltration (arrows, d and f), osseous destruction/erosions of the inferior T9 and superior T10 endplates (arrow, e). Sagittal short-tau inversion recovery (g) and sagittal T1 fat-saturated post-contrast (h) magnetic resonance imaging show marked edema with an enhancement of the T9-T10 vertebral bodies, disk and paraspinal soft tissue (arrows, g and h), along with endplate destruction, consistent with osteomyelitis discitis. A subsequent T9 vertebral biopsy was positive for osteomyelitis with *Escherichia coli*. The patient was treated with antibiotics.

All patients were reported to have multiple underlying medical illness, with diabetes mellitus (8/10) being the most common. One patient had chronic renal failure. Other underlying medical illnesses include hepatitis C, HIV, Addison's disease, and latent tuberculosis. Before diagnosis, 60% of cases were associated with a known preceding infection such as bacteremia, sepsis, endocarditis, abscess, and urinary tract infection.

Symptoms and laboratory findings are shown in Table 2. Fever was found in 30% of cases, and new-onset neurologic deficits (weakness and sensory loss in the lower extremities, urinary retention) were also found in 20%. Other symptoms included decreased appetite (20%), malaise (20%), and chills (20%).

A positive blood culture was found in 40% of cases (4 out of the 10 cases), with *Staphylococcus aureus* isolated in two cases, *Escherichia coli* in one case, and both *Enterococcus faecalis* and coagulase-negative *Staphylococcus* in one case. Vertebral biopsies were obtained in three cases, two of which were positive. Of the patients with laboratories available for review, leukocytosis (defined as 11,000/mm^3 [11×10^9/L]) was found in 50% of cases (5 out of 10 cases). Elevated C-reactive protein (defined as >3.0 mg/L) was found in 100% (9 out of 9) of cases and elevated erythrocyte sedimentation rate was found in 87.5% (7 out of 8) cases. The diagnosis of osteomyelitis was confirmed in all cases by either MRI, subsequent CT, or clinical/laboratory parameters.

The majority (7/10) of osteomyelitis occurred in the lower thoracic spine, while 2/10 occurred in the lumbar spine and 1/10 occurred in the upper thoracic spine.

Representative cases are shown in Figures 1-4. On body CT, endplate changes were observed in six cases, including three cases of advanced endplate erosions/destruction. Fat stranding was observed in nine cases, with five cases of early, subtle fat stranding and four cases of late, denser fat stranding/paraspinal soft tissue infiltration. Six cases demonstrated both fat stranding and endplate changes.

DISCUSSION

Spinal osteomyelitis discitis is usually caused by hematogenous seeding, with a source identified in approximately 50% of

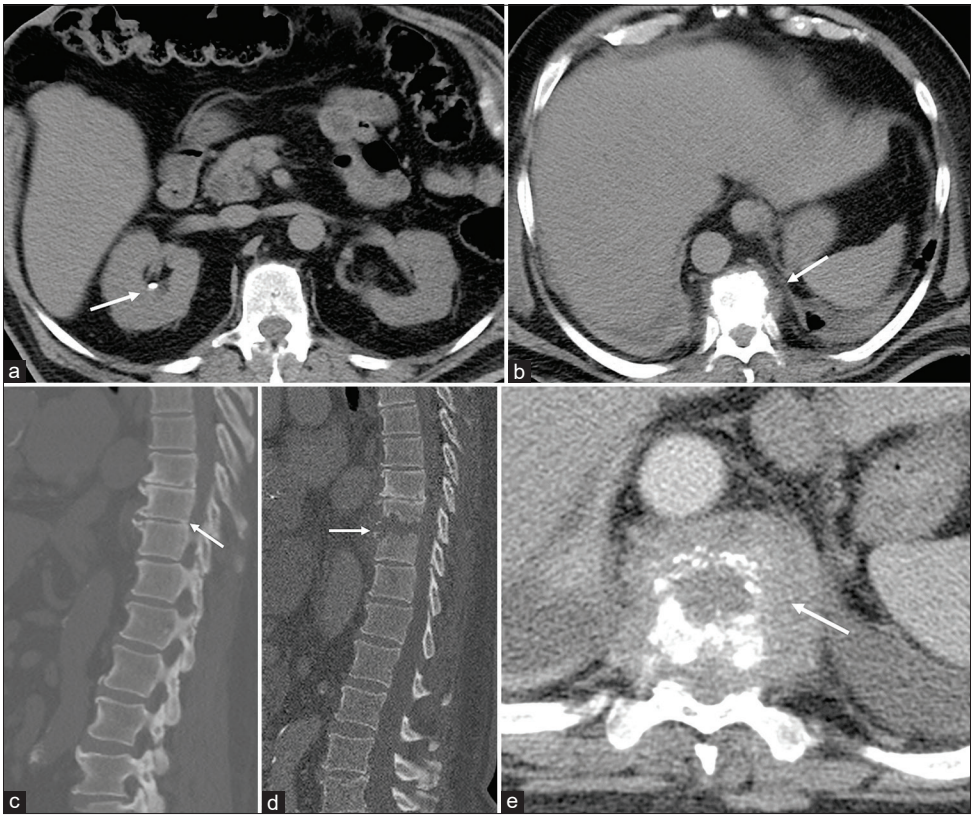

Figure 2: A 73-year-old male with the right flank pain. Axial non-contrast computed tomography (CT) of abdomen (a and b) shows a non-obstructing renal stone (arrow, a) and early paraspinal fat stranding (arrow, b). Sagittal reformatted non-contrast CT (c) shows disk space narrowing without endplate erosions (arrow, c). Seventeen days later, he presented back to the emergency department with severe mid-back pain. Sagittal reformatted (d) and axial (e) contrast-enhanced CT shows new endplate osseous destruction (arrow, d) and increased paravertebral soft tissue phlegmonous change (arrow, e), consistent with acute osteomyelitis discitis. The patient was managed surgically with arthrodesis and corpectomy.

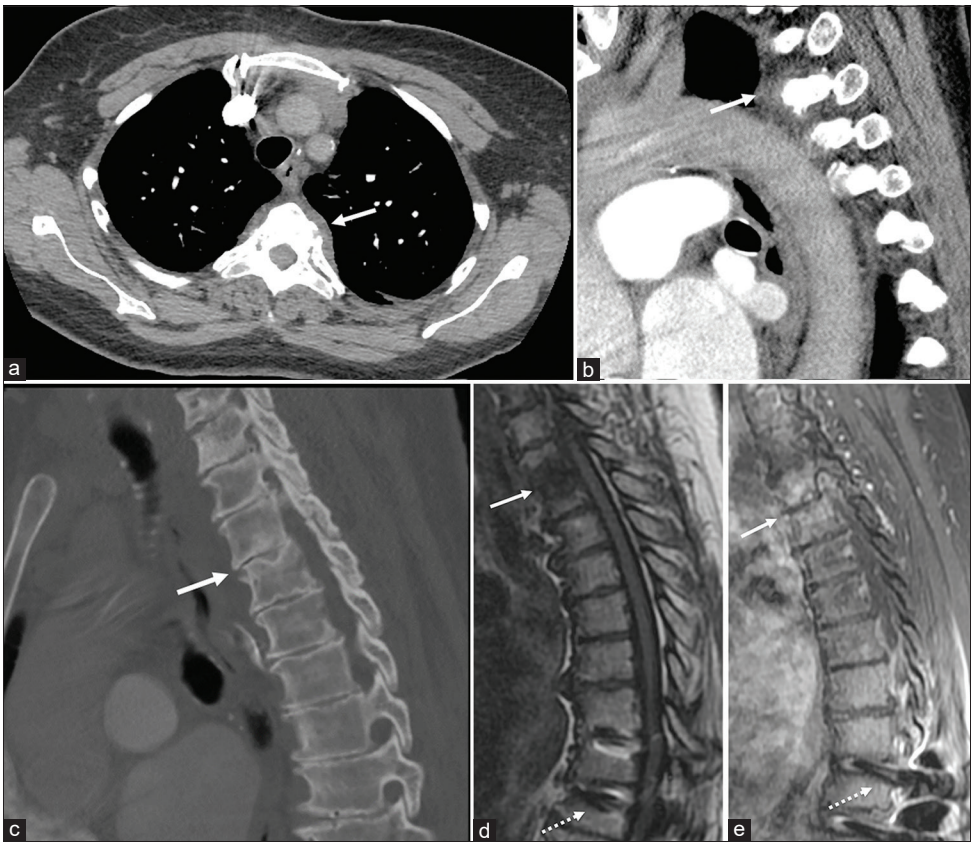

Figure 3: A 75-year-old female with acute chest pain and shortness of breath. Initial axial (a) and sagittal computed tomography angiography of the chest to evaluate for pulmonary embolism (b and c) shows early paravertebral fat stranding (arrows, a and b), endplate erosions and sclerosis (arrow, c) suspicious for osteomyelitis discitis at T3-T4. The next day, sagittal T1 non-fat-suppressed magnetic resonance imaging (MRI) (d), sagittal short-tau inversion recovery (STIR) (e), and sagittal T1 fat-saturated post-contrast MRI (f) confirm T3-T4 osteomyelitis discitis with T1 hypointense marrow signal at T3-T4 (arrow, d), edema on STIR (arrow, e), and contrast enhancement. Metallic susceptibility artifact from remote posterior fusion of the lower thoracic spine was partially imaged (dotted arrows, d-f). She recovered uneventfully within the next few months.

cases.[1,3] Infection typically begins in the well-perfused anterior vertebral body with spread through the medullary space to the remainder of the vertebral body, disk space, and contiguous vertebrae.[6] As the symptoms and signs of osteomyelitis are frequently disguised by manifestations of the primary infection or non-specific symptoms, diagnosis is often made after patients develop complications such as paravertebral, epidural, or disk space abscesses,[3,4] with a frequency of 26%, 17%, and 5%, respectively, according to one study.[8] In addition, neurologic complications (e.g., sensory loss, weakness, radiculopathy, and sphincter loss) occur in 38% of patients and death in 5–6%.[1,3,4]

Most cases of spinal infection may be treated conservatively (e.g., antibiotic therapy and spinal bracing), particularly when diagnosed early. Surgical intervention is indicated for neurological signs, cauda equina syndrome, spinal instability, vertebral collapse, progressive spinal deformity, and abscess unresponsive to antibiotics.[6] Imaging is essential for confirming the diagnosis with radiologists performing a pivotal role in the early diagnosis and thus early treatment of spinal osteomyelitis.

Eight out of 10 of our patients had diabetes,[1,5,6] which is consistent with existing literature that substantiates diabetes being the most common condition predisposing to spinal osteomyelitis. Other risk factors include recent infection (present in 50% of our patients), IV drug use, alcohol use, immunosuppression, long-term steroid use, chronic renal and liver disease, and spinal surgery.[1,4]

In our study, several cases of unsuspected osteomyelitis discitis were diagnosed on chest and abdominal/pelvic CT scans obtained for unrelated reasons. The most common reason in our small series of osteomyelitis was abdominal and flank pain. Our retrospective analysis of confirmed osteomyelitis cases provides evidence that osteomyelitis could potentially be detected weeks in advance by carefully evaluating the paraspinal region, an easily overlooked area on body CT, for paraspinal fat stranding, which may be visible before bony changes. Nine of our cases were accompanied

Figure 4: A 67-year-old male with 1 week of sharp right abdominal and flank pain. Initial axial non-contrast computed tomography (CT) of abdomen (a and b) shows minimal bilateral, non-specific perinephric fat stranding (arrows, a) and T11-T12 early paraspinal fat stranding (arrows, b). Three days later, he returned to the erectile dysfunction with diffuse right abdominal and lumbar pain, as well as night sweats. Sagittal reformatted (c and d) non-contrast CT of the abdomen shows slightly increased paraspinal fat stranding and equivocal early endplate erosion (arrow, c and d). Sagittal short-tau inversion recovery (e) and sagittal T1 fat-saturated post-contrast magnetic resonance imaging (f) demonstrate edema and enhancement of the T11-T12 paraspinal fat and endplates (arrow, e and f) confirming osteomyelitis discitis. He was started on antibiotics and later diagnosed with osteomyelitis on vertebral biopsy.

by paraspinal fat stranding on body CT on retrospective evaluation. In addition, endplate erosions were also present in six cases.

There is a paucity of literature specifically addressing paraspinal fat stranding in spinal osteomyelitis. Only one study to our knowledge (Spira *et al*., 2016) evaluated imaging characteristics of spondylodiscitis confirmed on CT-guided biopsy. In this study, paravertebral infiltration was present in all 10 patients with positive microbiology on CT-guided biopsy, while present in only 12 out of the 24 patients with negative microbiology. In addition, erosion of adjacent endplates was present in 9 out of 10 patients with positive microbiology on CT-guided biopsy.[9]

Detection of these unexpected findings on body CT can be facilitated by including this area in a routine search protocol. For example, sagittal imaging is important in demonstrating disk space narrowing not reliably detected on axial images. Maintaining a strict search pattern regardless of initial findings is important to avoid individual causes for error such as "satisfaction of search," whereby detection of one abnormality on a radiologic study results in a premature termination of the search, thereby missing other abnormalities. Another cause of error is "visual dwell," whereby prolonged attention to a specific area can lead to increased false-negative and false-positive errors. Improved accuracy of diagnosis can also be achieved by addressing systemic challenges such as increasing workload, study complexity, and inadequate clinical information.[10]

As 60% of our patients had a history of a recent infection, the availability of this history may increase suspicion for spinal osteomyelitis. In addition, increasing the body radiologist's familiarity with imaging patterns of spinal osteomyelitis may avoid a diagnostic delay.[6] Typical findings in spinal osteomyelitis on CT are disk space narrowing, endplate erosions, and paravertebral fat stranding or phlegmon. Although spinal osteomyelitis can mimic degenerative change on CT and ultimately MRI may be needed to differentiate between these, degenerative change more typically appears as sclerosed endplates with well-defined margins, whereas spinal osteomyelitis manifests as destroyed endplates with indistinct margins.[6,11] Features that might suggest spinal osteomyelitis include paravertebral inflammatory tissue or abscess.

This study is the first, to our knowledge, to examine spinal osteomyelitis unexpectedly seen on body CT. Our study, however, has some limitations mainly due to the small sample size. In addition, we may not have detected all cases, as some patients may have been lost to follow-up. Future, perhaps, prospective, multicenter studies with a larger number of patients could evaluate the positive predictive value of paravertebral fat stranding to assess how frequently this finding

correlates with discitis/osteomyelitis, rather than other causes. A prospective study could also be performed to evaluate the detection rate of osteomyelitis/discitis on body CT.

Main points

- Early detection of spinal osteomyelitis is challenging due to non-specific symptoms, and body CT may be obtained for seemingly unrelated complaints
- Paraspinal fat stranding on body CT as a sign of osteomyelitis is easily overlooked
- Including evaluation for paraspinal fat stranding with endplate erosions on body CT search patterns can help diagnosis spinal osteomyelitis earlier
- Out of 10 confirmed cases of osteomyelitis, paravertebral fat stranding and endplate erosions were observed in 9 and 6 cases, respectively, on body CT for unrelated indications.

CONCLUSION

Significant spinal pathology such as spinal osteomyelitis may present on body CT scans as unexpected findings. In particular, osteomyelitis often presents with non-specific symptoms and laboratory findings that overlap with other disease processes, resulting in a significant delay in diagnosis. Earlier diagnosis of spinal osteomyelitis can be made by including an evaluation of the paraspinal soft tissues on body CT search patterns, with evaluation for paraspinal fat stranding with endplate erosions.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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