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Research Paper

Engaging primary care physicians is critical in the screening and diagnosis of colorectal cancer at safety-net hospital systems

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ABSTRACT

Background: Primary care physicians (PCP) play a key role in offering colorectal cancer (CRC) screenings, particularly amongst underserved populations. Given potential delays in or omission of CRC screening in the absence of a PCP, we aimed to determine stage of CRC at diagnosis in an underserved population.
Methods: A retrospective chart review was conducted at two Los Angeles County safety-net hospitals. Inclusion criteria were a CRC diagnosis between 2018 and 2021 and age between 50 and 75 years at diagnosis time. The primary outcome was the cancer stage at diagnosis.
Results: A total of 373 patients were included, of those, 52.5 % had a PCP. Compared to others, *PCP* was similar in age, racial composition, and primary spoken language (Table 1). Of patients with a PCP, 52.0% were diagnosed by screening. After screening, the most common indication for colonoscopy were blood per rectum (24.9 %) and imaging findings (18.0 %). Patients with a PCP had a significantly lower rate of late stage CRC than those without a PCP (42.4 % vs. 68.0 %, $p < 0.001$). After adjustment, having a PCP was associated with significantly reduced odds of late stage CRC (Adjusted Odds Ratio 0.83, 95 % Confidence Interval [0.68–1.04]). Having a PCP was not associated with any adjusted increase in number of adenomas or tumor size.
Conclusions: Patients with a PCP, irrespective of undergoing screening, were diagnosed at earlier CRC stages. This underlines the crucial role of PCPs in CRC and diagnosis, reinforcing the need for their active involvement in these processes.

Introduction

Colorectal cancer (CRC) is the second leading cause of cancer-related death in the United States [1]. Multiple society guidelines have endorsed both stool based and direct visualization screening tests, as effective means to reduce incidence of and mortality caused by CRC [2–4]. Primary care physicians (PCP) play a key role in the implementation of these guidelines by raising awareness and recommending screening modalities to effectively increase the rate of CRC screening [5]. It has been shown that the presence of a PCP is associated with a higher rate of screening colonoscopy, decreased emergency presentations, and improved overall survival [6].

According to the Centers for Disease Control and Prevention, 71.6 % of the United States population between the ages of 50–75 were up to date with CRC screening [7]. Several factors have been identified as risk factors for poor screening rates including lower socioeconomic status, ethnic minority status, uninsured status, and lower level of education achieved [8,9]. These factors closely align with the patient group demographics within safety-net hospitals, predominantly consisting of ethnic minorities status and underserved communities who frequently lack health care insurance, resulting in poor access to regular medical care [10,11]. Given low screening rates, the majority of patients from these groups are diagnosed with CRC after presenting with symptoms [12]. PCPs are crucial in recognizing these symptoms and directing care for appropriate diagnosis.

This study identified patients at an urban safety-net hospital system who met criteria for CRC screening and were diagnosed with CRC. The aim of this study is to assess the impact a PCP has on the stage of CRC at

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diagnosis, both with and without the use of appropriate screening modalities. We hypothesize that the presence of a PCP at the time of diagnosis of CRC is associated with a decrease in late stage CRC.

Methods

Patient selection and study design

Patients diagnosed with CRC between the ages of 50 to 75 diagnosed with CRC between January 2018 and December 2021 were identified from the institutional tumor registry of two urban safety-net hospitals within Los Angeles County Department of Health Services. Due to the de-identified nature of the tumor registry, this study was deemed exempt from the local Institutional Review Board. Patients with higher-than-average risk for CRC (e.g., personal history of CRC, inflammatory bowel disease, or polyposis syndrome), diagnosis other than adenocarcinoma, initial diagnosis or treatment at another institution, or incomplete clinical records were excluded from analysis (Fig. 1). Patient who had a PCP prior to diagnosis of CRC were classified as *PCP* (rest: *non-PCP*). Data was collected on patient demographic and clinical characteristics by retrospective chart review.

The primary study endpoint was late stage at diagnosis based on the American Joint Committee of Cancer 8th edition classification. Specifically, we defined early stage disease as stage I and II and late stage disease as stage III and IV. Secondary endpoints were number of adenomas and tumor size. Number of adenomas were categorized based on the US Multi-Society Task Force Recommendations for Post-Colonoscopy Follow-Up [8].

Categorical variables are presented as proportions (%), while continuous variables are reported as means with standard deviation (SD). Pearson's χ^2 test and *t*-test were used to assess differences for categorical and continuous variables, respectively. To assist with our covariate selection, we used the Least Absolute Shrinkage Selection Operator (LASSO), which is a regularization technique that reduces collinearity, and improves prediction ability of models [13]. Multivariate logistic and Poisson regression analyses were used to ascertain the association of having a PCP and the outcomes of interest. Variables included in this regression were patient sex, race, preferred language, insurance status, BMI, smoking history, whether the study was a screening study, compliance with FIT testing, initial diagnosis that instigated consultation, and emergent colonoscopy status. Risk-adjusted outcomes are reported as adjusted odds ratios (AOR) or incidence rate ratios (IRR) for logistic and Poisson regression models, respectively. 95 % confidence levels (CI) are also noted. We defined statistical significance as a p-value <0.05. All statistical analysis was performed by Stata version 16.1 (StataCorp, College Station, TX).

Results

Of 373 patients meeting inclusion criteria, 52.6 % had a PCP prior to CRC diagnosis. Demographic information can be seen in Table 1. Compared to *non-PCP*, *PCP* was more commonly female (44.9 vs 33.9 %, $p = 0.03$), but similar in age (60.8 years ±7.0 vs 60.9 ± 6.3, $p = 0.86$), racial composition, and primary language spoken. Specifically, the overall population was 54.8 % Hispanic with Spanish being the predominant spoken language at 58.2 %, followed by English at 32.1 %. Patient insurance coverage was 33.0 % Medicaid, 34.9 % Medicaid HMO, and 18.2 % without insurance. Finally, the *PCP* cohort was more commonly overweight or obese (69.9 vs 52.0 %, $p < 0.001$), compared to others.

Overall, 27.4 % of patients were diagnosed by screening, all of which had a PCP (Table 2). 70.4 % of the *PCP* cohort had appropriate CRC screening ordered ($n = 138$) with 91.3 % compliance with screening ($n = 126$). Of those with a PCP, 52.0 % of patients were diagnosed by screening ($n = 102$). *PCP* patients more commonly underwent colonoscopy by gastroenterology (89.3 % vs 60.5 %), as opposed to colorectal surgery (5.6 vs 14.7 %, both $p < 0.001$), compared to their *non-PCP* counterparts. Of those who had appropriate screening ordered by their PCP, 36 (26.1 %) were not diagnosed by screening. Twelve were due to noncompliance with FIT, 12 due to negative FIT, 7 due to not following up for colonoscopy after positive FIT, and 5 developed symptoms while awaiting scheduled colonoscopy. Forty-nine patients did not undergo colonoscopy in the study.

On unadjusted bivariate analysis, *PCP* were less likely to have a late stage CRC diagnosis (42.4 vs 57.7 %, $p < 0.001$). However, patients with a PCP were more likely to have higher adenoma detection (35.7 vs 50.3 %, $p < 0.001$), compared to their *non-PCP* counterparts. *PCP*, conversely, had smaller tumor sizes, with a greater proportion of patients having tumors smaller than 5 cm (45.4 vs 24.9 %, $p < 0.001$; Table 3).

After adjustment, the only variable associated with reduction in the

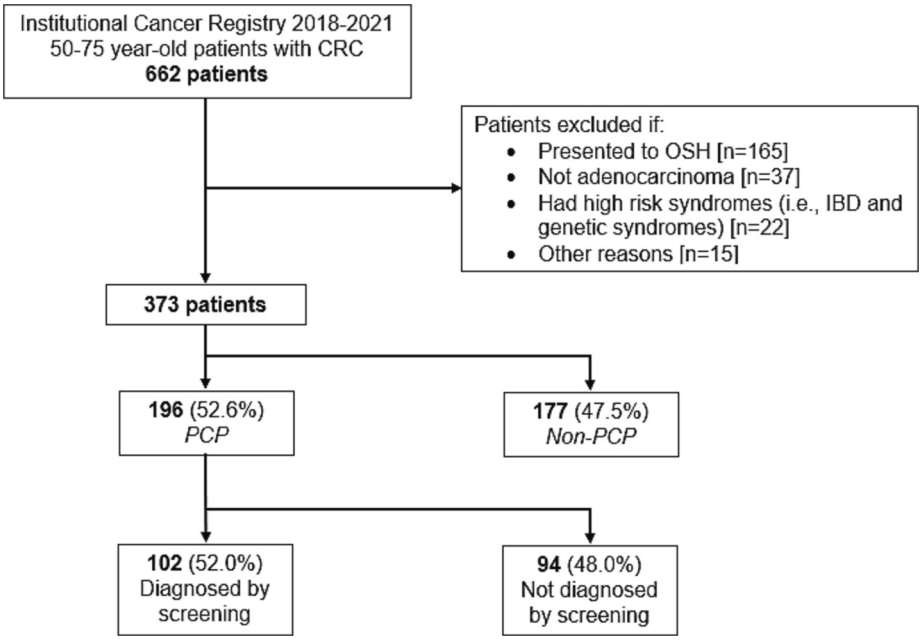

Fig. 1. CONSORT diagram of study population.

Table 1
Demographic and clinical characteristics of patients diagnosed with colorectal cancer; PCP, primary care physician; SD, standard deviation; HMO, health maintenance organization.

	PCP ($n = 196$)	Non-PCP ($n = 177$)	p-value
Age (years, mean ± SD)	60.8 ± 7.0	60.9 ± 6.3	0.86
Female (%)	44.9	33.9	0.03
Race (%)			0.49
White	10.2	8.5	
Black	7.1	11.9	
Hispanic	54.8	55.1	
Asian/Pacific Islander	14.8	11.3	
Other/Unspecified[a]	12.8	13.6	
Language (%)			0.79
English	32.1	31.1	
Spanish	57.1	57.6	
Korean	2.6	2.8	
Mandarin	1.5	2.3	
Cantonese	2.6	0.6	
Other/Unspecified[b]	4.1	5.6	
Payer (%)			0.42
Medicaid	30.1	36.2	
Medicaid HMO	36.7	32.8	
Medicare	11.2	7.9	
Uninsured	18.8	17.5	
Other/Unspecified[c]	3.0	5.6	
Smoking Status (%)			0.40
Never Smoked	63.8	61.6	
Prior Smoker	26.5	23.2	
Current Smoker	8.7	14.1	
Body Mass Index (%)			<0.001
Underweight	2.0	7.9	
Normal	28.1	40.1	
Overweight	33.7	37.3	
Obese	36.2	14.7	

[a] Other (Race): variable comprised of other or unknown.
[b] Other (Language): Vietnamese, Khmer, Tagalog, Urdu, Japanese, unknown.
[c] Other (Insurance): variable comprised of private or unknown.

Table 2
Colorectal cancer screening modalities; PCP, primary care physician; FIT, fecal immunochemical test; LBO, large bowel obstruction; BRBPR, bright red blood per rectum.

	PCP (n = 196)	Non-PCP (n = 177)	p-value
FIT Screening Ordered (%)	70.4	–	N/A
FIT Compliance (%)	91.3	–	N/A
Presentation (%)			<0.001
Screening	52.0	0.0	
Anemia	13.3	7.9	
LBO	3.1	18.1	
BRBPR/Melena	20.9	29.4	
Imaging Finding	6.1	31.1	
Other	4.6	13.6	
Diagnosed by Screening (%)	52.0	–	N/A
Diagnosed by Emergent Colonoscopy (%)	10.2	40.1	<0.001
Endoscopist (%)			<0.001
Gastroenterologist	89.3	60.5	
Colorectal Surgeon	5.6	14.7	
Other/Unspecified	5.1	24.9	

odds of late stage CRC at the time of diagnosis was having a PCP (AOR 0.35, 95%CI 0.16–0.74, $p = 0.006$; Table 4). Notably, patient factors such as sex, race, insurance status, or whether presentation, inclusive of screening, were not associated with any change in odds of late stage diagnosis. Neither presence of a PCP nor the characteristics included for regression as noted in the *Methods* section were associated with any difference in adjusted number of adenomas (IRR 0.84, 95%CI 0.48–1.45) or tumor size (IRR 0.90, 95%CI 0.67–1.20).

Table 3
Unadjusted outcomes for patients with colorectal cancer stratified by groups of interest; PCP, primary care physician; PCPnDx, PCP not diagnosed by screening.

	PCP (n = 196)	Non-PCP (n = 177)	p-value	PCPnDx ($n = 94$)	Non-PCP (n = 177)	p-value
Stage at Diagnosis (%)			<0.001			0.010
In Situ	8.2	0.6		3.2	0.6	
Stage I	26.0	5.7		18.1	5.7	
Stage II	23.5	26.0		28.7	26.0	
Stage III	27.6	29.9		30.9	29.9	
Stage IV	14.8	37.9		19.2	37.9	
Late Stage (%)	42.4	67.8	<0.001	50.0	67.8	0.004
Number of Adenomas (%)			<0.001			0.01
0	35.7	50.3		43.6	50.3	
1–2	38.3	17.0		35.1	17.0	
3–10	15.3	7.3		4.3	7.3	
> 10	0.5	0.6		0.0	0.6	
Tumor Size (cm, %)			<0.001			0.008
< 2	13.8	2.3		11.7	2.3	
2 to 5	31.6	22.6		27.7	22.6	
6 to 10	40.3	55.4		39.4	55.4	
> 10	3.6	4.5		5.3	4.5	

Table 4
Factors associated with late stage colorectal cancer at PCP, presentation, model C-statistic = 0.75; AOR, adjusted odds ratio; CI, confidence interval; primary care physician; HMO, health maintenance organization; FIT, fecal immunochemical test; LBO, large bowel obstruction; BRBPR, bright red blood per rectum.

	AOR	95 % CI	p-value
PCP before Diagnosis	0.35	[0.16–0.74]	0.006
Age (per year)	0.97	[0.93–1.01]	0.15
Female	1.63	[0.94–2.81]	0.08
Race			
White	Reference	–	–
Black	0.64	[0.18–2.27]	0.49
Hispanic	0.64	[0.25–1.63]	0.35
Asian/Pacific Islander	0.91	[0.30–2.80]	0.88
Other/Unspecified[a]	0.74	[0.22 - 2.49]	0.62
Payer			
Medicaid	Reference	–	–
Medicaid HMO	0.67	[0.36–1.24]	0.20
Medicare	1.62	[0.59–4.41]	0.35
Uninsured	0.53	[0.23–1.20]	0.13
Other/Unspecified[b]	3.10	[0.57–16.8]	0.19
Smoking Status			
Never Smoked	Reference	–	–
Prior Smoker	1.09	[0.60–1.97]	0.78
Current Smoker	1.31	[0.54–3.18]	0.56
Body Mass Index			
Underweight	Reference	–	–
Normal	0.88	[0.16–4.87]	0.88
Overweight	0.46	[0.08–2.54]	0.37
Obese	0.26	[0.05–1.49]	0.13
FIT Screening Ordered	2.87	[0.58–14.33]	0.20
FIT Compliance	0.36	[0.06–2.06]	0.25
Emergent	1.06	[0.53–2.11]	0.87
Presentation (%)			
Screening	Reference	–	–
Anemia	1.39	[0.45–4.28]	0.56
LBO	0.84	[0.15–4.55]	0.84
BRBPR/Melena	1.12	[0.36–3.43]	0.85
Imaging Finding	1.51	[0.45–5.11]	0.50
Other	1.80	[0.44–7.45]	0.42

[a] Other (Race): variable comprised of other or unknown.
[b] Other (Insurance): variable comprised of private or unknown.

Subgroup analysis – PCP not diagnosed by screening

Additional subgroup analysis was performed to determine any difference between patients with a PCP who were not diagnosed via screening (*PCPnDx*) and the *non-PCP* group. This was done to address possible biases associated with access to obtaining a colonoscopy, such as transportation difficulties, inability to miss work, need for additional support at home. Similar to *PCP*, *PCPnDx* was comparable in age, race, and language spoken as *non-PCP* (Supplemental Table 1). Compared to *non-PCP, PCPnDx* were less frequently diagnosed with late stage CRC (50.0 vs 67.8 %, $p = 0.004$) and had a higher proportion of tumors smaller than 5 cm (39.4 vs 24.9 %, $p = 0.008$; Table 3). After adjustment, having a PCP remained associated with lower odds of late stage diagnosis (AOR 0.35, 95%CI 0.16–0.76). Similar to the overall cohort, however, PCP involvement was not associated with any change in adjusted number of adenomas (IRR 0.87, 95%CI 0.49–1.54) or tumor size (IRR 0.87, 95%CI 0.49–1.54).

Discussion

Our results showed that patients who have a PCP experience a 54 % reduction in the odds of having late stage CRC when compared to patients without a PCP. This finding concurs with an earlier study, which showed that patients with a PCP undergo higher rates of cancer screening and are more likely to be diagnosed at earlier stages of CRC [13]. Furthermore, this study showed that even without appropriate screening, patients with a PCP were diagnosed with earlier stages of CRC than their counterparts who did not have a PCP. This implies the benefit of having a PCP is not explained by screening alone, but rather multifactorial. In addition to higher rates of screening in this population, the presence of a PCP may help identify signs and symptoms of CRC, make referrals to appropriate specialists for management, and aid patients in navigating the health care system.

Most patients with CRC have symptoms at presentation, with some studies reporting nearly 90 % of patients as symptomatic at diagnosis [12,15]. Amongst the symptoms at presentation, blood per rectum, changes in bowel habits (diarrhea or constipation), abdominal pain, weight loss, and anemia have been reported as the most common [16,17]. Similarly in our study, the majority of patients with a PCP presented with signs or symptoms of CRC, such as anemia or blood per rectum, rather than by screening. Moreover, blood per rectum alone has shown a positive predictive value (PPV) of 3.9 % for non-metastatic CRC, while much higher if combined with another concerning sign such as a change in bowel habits (PPV = 13.7 %) or abdominal pain (PPV = 12.2 %) [16]. This should prompt urgent referrals from PCPs, as CRC may still be diagnosed at an early stage when symptomatic [17]. Without a regular point of contact into the health care system, these symptoms may go unrecognized leading to delayed diagnosis of CRC in patients without a PCP.

In this study, the overall rate of late stage disease was 54.5 % similar to the national average of 56 % [18]. Those with a PCP were diagnosed with late stage CRC significantly less than those without a PCP. Despite this benefit, a significant proportion of patients in this study with a PCP were diagnosed with late stage CRC. This may be attributed to the fact that only 51.8 % of patients with a PCP in our cohort were diagnosed by a screening modality. The Healthy People 2030 objective set a goal of 74.4 % screening rate for the United States [19]. By 2020 the national colon screening colonoscopy prevalence was 61 % [1]. Several factors are known to be associated with lower rate of CRC screening including Asian or Hispanic race, lower level of education achieved, recent immigration status to the US (<10 years), lower socioeconomic status, and Medicaid or uninsured status [1,20]. Patients within our safety-net hospital system are at risk as the majority of patients are Hispanic and are either uninsured or have Medicaid/Medicaid HMO. Additionally, our study demonstrated that lack of a PCP is significantly associated with lower rates of CRC being diagnosed by screening thus furthering the importance of engaging with a PCP. Los Angeles County Department of Health Services has implemented initiatives, such as "one-click" express empanelment that refers patients to a PCP directly within the chart. This simple click streamlines the process for any provider to help increase the population of patients with primary care access within our system. All patients who are empaneled in the LA county health service system are treated equally whether or not they are insured with routine general annual check-ups. Such a system is designed to improve adherence to various cancer screening modalities and promote early cancer detection. Said benefit is shown by the 17 % decrease in late stage CRC diagnosis in the PCP cohort even if the CRC was not detected through screening tests. (Table 3).

As another strategy to increase screening rates, urban safety-net hospitals utilize FIT as the initial screening tool for CRC due to its low cost, non-invasive nature, and ease of access [21,22]. However, the same study noted that FIT as an initial screening modality had poor compliance (46 %) and more than half (52 %) of patients with positive FIT did not follow up for colonoscopy [21]. A delay in colonoscopy >10 months after a positive FIT is associated with higher overall incidence of CRC and late stage CRC [23,24]. Additionally, non-compliance with colonoscopy after a positive FIT was associated with 105 % increased risk of dying form CRC [25]. In this study, although 138 patients had FIT appropriately ordered, only 103 were diagnosed by screening. This was in part due to patients who were non-compliant with FIT or failed to follow up for diagnostic colonoscopy after positive FIT. Therefore, noncompliance rates and potential delays in diagnosis associated with FIT and/or subsequent diagnostic colonoscopy need to be evaluated when implementing FIT as the primary modality of CRC screening in safety-net hospitals.

When comparing colonoscopy findings, patients without a PCP were found to have lower numbers of adenomas detected. This may be because nearly all colonoscopies performed in this cohort were performed for diagnostic purposes, and often in urgent settings. Colonoscopies performed in urgent settings may result in inadequate visualization due to poor bowel preparation or bleeding from the tumor, as well as incomplete colonoscopies due to inability to traverse the tumor. Adenoma detection rate (ADR) is a primary quality measure for colonoscopies, and the target rate is 20 % in females and 30 % in males [26,27]. The quality of the bowel preparation is critical to the quality and ADR of a colonoscopy. Poor bowel preparation is associated with a longer and more difficult procedure and a higher rate of incomplete colonoscopy [28]. Patients with a PCP are more likely to present earlier, non-urgently, and are more likely to undergo screening colonoscopy, rather than diagnostic colonoscopy. Therefore, these patients have improved ADR when compared with their counterparts without a PCP. It should also be noted that patients without a PCP were more likely to undergo colonoscopy with a colorectal surgeon rather than with a gastroenterologist in our hospital system. This is likely due to delayed presentation through the emergency room, which required more urgent surgical consultation (i.e., obstruction, lower gastrointestinal bleeding). Hospitalized patients are more likely to have a lower quality bowel preparation, further contributing to the lower number of adenomas found in those without a PCP [28]. Furthermore, tumor size in patients with a PCP was found to be smaller than those without a PCP. This may be because timelier colonoscopy in patients with a PCP led to earlier detection of tumor. Smaller tumors are associated with lower T and N stage, better progression-free survival, and cancer-specific survival [29].

There were several limitations to our study. This was a retrospective analysis from the institutional tumor registry of patients who were diagnosed with CRC. Therefore, screening rates and compliance rates may not be applicable to the general population. Additionally, a significant number of patients identified met exclusion criteria, most commonly for presenting from outside hospital with signs and symptoms of CRC before obtaining care at our safety-net hospitals. This potentially underestimated the number of patients without a PCP and with late stage CRC at diagnosis. Another limitation is that the delay in diagnosis

from positive FIT test or onset of symptoms to diagnostic colonoscopy was not assessed which may have further influence on the stage of diagnosis. Lastly, this study is based on a screening age of 50, but in 2021 US Preventative Services Task Force updated to begin screening at age 45. Thus, findings may not be applicable to the new screening population [3]. Further studies are needed to assess the CRC screening rate in the general population served by Los Angeles County Department of Health Services, the compliance rate, and potential delay to diagnostic colonoscopy when utilizing FIT as a primary modality of CRC screening.

Conclusion

The presence of a PCP in a patient's care was independently associated with a reduction in the rate of late stage CRC at diagnosis. This advantage persisted even when CRC was diagnosed without screening FIT or colonoscopy. The presence of a PCP in the patient's care not only increases compliance to CRC screening but also allows earlier diagnosis and intervention for CRC management. Therefore, it is imperative that safety-net hospitals continue efforts for early engagement of their patients with PCPs.

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Ethics approval

Due to the de-identified nature of the tumor registry, this study was deemed exempt from the local Institutional Review Board. Furthermore, registration as a clinical trial was not necessary, as the study did not meet the National Institutes of Health definition of an applicable clinical trial.

CRediT authorship contribution statement

Katrina Dimaano: Writing – original draft, Data curation. **Millicent Croman:** Writing – original draft, Data curation. **Stefania Montero:** Visualization, Validation, Formal analysis. **Isabela Sandigo-Saballos:** Data curation, Writing – review & editing. **Manuel Orellana:** Visualization, Validation, Formal analysis. **Nikhil Chervu:** Visualization, Validation, Formal analysis. **Beverley A. Petrie:** Writing – review & editing, Conceptualization. **Hanjoo Lee:** Writing – review & editing, Conceptualization.

Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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