Do Hospital Doctors Screen for Diabetes?

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ABSTRACT

Background One in five hospitalized patients presents with previously undetected diabetes mellitus (DM). We assessed whether hospital doctors measure HbA_1c in hospitalized patients and act consequently.

Methods Data from patients hospitalized between January 2013 and December 2014 in a Swiss teaching hospital was collected. We assessed the frequency of HbA1c measurements and the number of newly detected prediabetes or DM. We also examined whether HbA1c values were associated with the antidiabetic drugs prescription and reporting of DM in the discharge letter.

Results Of the 2618 patients studied, 298 (11.4 %) had HbA_1c measured, of whom 136 (45.6 %) had no previous history of DM. Of the 136 patients without history of DM, 51 (37.5 %) had prediabetic state and 23 (16.9 %) had DM. Newly detected prediabetes or DM were reported in 5.8 % (3/51) and 65.8 % of cases (15/23), respectively. Only half of patients (11/23, 47.8 %) with newly detected DM received antidiabetic drug treatment at discharge. Patients with newly detected DM (n = 23) had a longer length of stay (median and interquartile range: 16 [9–25] versus 10 [8–16] days, p = 0.028) compared to patients without DM, while no such differences were found regarding in-hospital mortality.

Conclusions Hospital doctors seldom prescribe HbA1c measurement in medical hospitalized patients. Prescription of HbA_1c measurement leads to a high detection rate (53 %) of (pre)DM among patients unaware of their status, but management and reporting of these conditions at discharge could be further improved.

Introduction

In Switzerland, one out of sixteen persons aged between 35 and 75 years has diabetes mellitus (DM), and almost one third of subjects with diabetes is unaware of their status [1, 2]. Identification of patients with previously undiagnosed DM improves care and is cost-effective [3]. Since 2009, measurement of haemoglobin A_1c (HbA_1c) is recommended both to screen and to diagnose DM [4, 5].

Two studies conducted in the United States have suggested that in-hospital DM testing might be more effective than community detection, because the prevalence of DM among hospitalized patients is higher (approximately 35 % in a general internal medicine service) [6, 7]. Such systematic screening might detect a previously unknown DM in 18 % to 24 % of hospitalized patients [6, 7].

As the prevalence of DM is lower in Europe than in the United States [8], it was expectable that DM detection among hospitalized patients might also be lower. Interestingly, a recent study conducted in a German university hospital showed that this hypothesis was partially wrong [9]. Actually, among patients hospitalized in internal medicine, the prevalence of DM was 32 % and up to 7 % of them had a newly diagnosed DM [9]. Thus, among medical hospitalized patients, in-hospital DM screening might be as effective in Europe as in the United States.

Because few information exists regarding current in-hospital DM screening, we aimed to assess: 1) whether hospital doctors measure HbA1c in medical patients hospitalized in a Swiss teaching hospital, 2) the prevalence of newly detected prediabetes and

DM and 3) whether newly detected prediabetes and DM are managed and reported at discharge.

Methods

Setting and sampling

The study was conducted in the Lausanne University Hospital (CHUV), one of the five medical teaching hospitals in Switzerland. The CHUV has over 1400 beds and receives over 45,000 hospitalizations per year (www.chuv.ch). We considered all adult (≥ 18 years) hospitalizations occurring in the division of general internal medicine between January 2013 and December 2014 who gave their informed consent to use their medical data (40 % in 2014).

Data from hospital electronic files between 2002 and 2014 was collected. Patients were categorized according to absence or presence of a history of DM. History of DM was defined as: 1) the presence of ICD-10 codes E10.x to E14.x (x = any number) in the medical files; 2) one glucose measurement > 11.8 mmol/L (213 mg/dL); 3) $HbA_1c \geq 6.5$ % (47.5 mmol/mol), and 4) any anti-diabetic treatment at admission.

Data collection and outcomes

Socio-demographic data included age; gender; marital status (single/married or cohabitating/divorced/widowed); nationality (Swiss/non-Swiss); housing (own house/nursing home/ other) and private health insurance (yes/no). Hospital data included day of admission, total length of stay, and time spent in the emergency ward.

Clinical data included treated hypertension (based on medical records); smoking (past or current); obesity (based on ICD-10 codes E66.x); personal history of cardiovascular disease (medication at admission or on medical records); dyslipidemia [medication at admission, medical records, or fasting triglyceride > 2.82 mmol/L (250 mg/dL) associated to a HDL-cholesterol < 0.9 mmol/L (35 mg/dL)] and kidney disease (estimated glomerular filtration rate eGFR < 30 ml/min/m^2 according to Cockroft-Gault formula). Biological data included serum HbA_1c, HDL-cholesterol, triglycerides, creatinin and glucose. Two glucose values measured during the study period were considered: 1) first glucose assessment and 2) highest value during hospitalization. Hba1c levels were assessed in EDTA whole blood using Bio-Rad D-100TM HbA1c testing system (Bio-Rad Laboratories, Hercules, CA, USA) [10]. As only seven patients had two HbA1c measurements during their stay, only the first HbA_1c measurement was considered.

Outcomes included newly detected prediabetes or DM, the presence of an antidiabetic drug treatment at discharge, the length of stay and in-hospital mortality. A newly detected DM was defined as $HbA_1c \geq 6.5$ % (47.5 mmol/mol) within patients with no history of DM. We considered that patients had a prediabetic state if HbA_1c ranged between ≥ 5.7 (38.8 mmol/mol) and < 6.5 % (47.5 mmol/mol) according to the American Diabetes Association [4]. We also assessed whether newly detected prediabetes or DM were reported at discharge, based on ICD-10 codes E10.x to E14.x in the electronic medical file.

Ethical considerations and data protection

Since January 2013, all patients hospitalized in the CHUV are asked for general consent that allows future use of medical records and blood tests performed during their hospitalization. The study was approved by the ethics committee and no further specific consent from the patients was required as only already available administrative data was used.

Data was extracted by a dedicated team using the inclusion criteria defined previously and was anonymized before being provided to the investigators. Thus, it was not possible to assess how many patients were excluded.

Statistical analyses

Statistical analysis was conducted using Stata version 14.0 for windows (Stata corp, College Station, TX, USA). The prevalence of diabetes testing was assessed overall and according to presence/absence of previously known DM. Results were expressed as number of patients (percentage), mean ± standard deviation or median [interquartile range] as appropriate. Bivariate comparisons were performed using chi-square or Fisher's exact test for categorical variables and Student's t-test or nonparametric Kruskal-Wallis test for continuous variables. Statistical significance was considered for a two-sided test p-value < 0.05.

Results

Overall, 2618 patients were included, 481 (18.4 %) of whom had a history of DM. Patients with DM were significantly older, less frequently Swiss nationals, presented with more cardiovascular risk factors and stayed longer in the emergency department at admission than patients without known DM (▶ **Table 1**).

Do hospital doctors measure HbA_1c in hospitalized patients?

Overall, HbA_1c was measured in 298 (11.4 %) patients, thereof 136 (45.6 %) had no history of DM. Median [interquartile range] HbA_1c was 6.3 [5.6–7.6] % (45.4 [37.7-59.6] mmol/mol) (▶ **Fig. 1, panel A**). Of the 481 patients with known DM, 162 (33.6 %) had HbA_1c measured. Median [interquartile range] HbA_1c among these patients was 7.2 [6.2–8.5] % (55.2 [44.3-69.4] mmol/mol) (▶ **Fig. 1, panel B**). Of the 2137 patients without known DM, 136 (6.4 %) had HbA_1c measured. Median [interquartile range] HbA_1c among these patients was 5.8 [5.35–6.2] % (39.9 [35.0-44.3] mmol/mol) (▶ **Fig. 1, panel C**).

Restricting the analysis to patients without history of DM, significantly higher frequencies of history of cardiovascular disease and hypertension, and a higher glucose levels and a lower frequency of kidney disease were found in patients with HbA_1c measurement, while no significant differences were found for gender, age, and history of dyslipidemia (▶ **Table 2**).

Prevalence of newly detected prediabetes and diabetes mellitus

Of the 136 (6.4 %) patients without history of DM and who had HbA_1c measured, 51 (37.5 %) had a prediabetic state and 23 (16.9 %) had DM. Baseline characteristics did not differ between patients with newly diagnosed prediabetes, newly diagnosed DM

▶ **Table 1** Patients' characteristics overall and according to previous history of diabetes mellitus.

	All (n = 2618)	History of diabetes mellitus *		p-value
		Absent (n = 2137)	Present (n = 481)	
Age, years	68.4 ± 16.7	67.6 ± 17.4	72 ± 12.7	< 0.001
Age ≥ 65 years (%)	1653 (63.1)	1303 (61.0)	350 (72.8)	< 0.001
Female gender (%)	1187 (45.3)	1005 (47.0)	182 (37.8)	< 0.001
Marital status (%)				0.074
Single	365 (14.4)	316 (15.2)	49 (10.8)	
Married/cohabitating	1189 (46.9)	970 (46.7)	219 (48.1)	
Divorced	453 (17.9)	372 (17.9)	81 (17.8)	
Widowed	527 (20.8)	421 (20.3)	106 (23.3)	
Coming from home (%)	2093 (80.0)	1685 (78.9)	408 (84.8)	0.003
Private health insurance (%)	128 (4.9)	111 (5.2)	17 (3.5)	0.127
Obesity (%)	58 (2.2)	5 (0.2)	53 (11.0)	< 0.001
Hypertension (%)	199 (7.6)	56 (2.6)	143 (29.7)	< 0.001
Past or current smoking (%)	23 (0.9)	6 (0.3)	17 (3.5)	< 0.001
History of cardiovascular disease (%)	1352 (51.6)	958 (44.8)	394 (81.9)	< 0.001
History of dyslipidemia (%)	657 (25.1)	395 (18.5)	262 (54.5)	< 0.001
eGFR < 30 ml/min/m^2 (%)	242 (11.8) ‡	175 (10.6)	67 (16.8)	0.001
Glucose level at admission (mmol/l) §	6.3 ± 3.0	6.3 ± 3.0	7.9 ± 3.8	< 0.001
Time spent in emergency department (hours)	9 [5–16]	9 [5–16]	10 [7–18]	0.002 †

* History of diabetes mellitus was based on ICD-10 codes E10.x- E14.x, any anti-diabetic medicines or a history of abnormal glucose homeostasis. §, n = 108 (present) and n = 390 (absent). eGFR, estimated glomerular filtration rate as assessed by the Cockroft-Gault formula. Results are expressed as number of participants (column %), as average ± SD or as median and [interquartile range]. Statistical analysis by chi-square for categorical data and by Student's t-test of Kruskal-Wallis (†) test for continuous data.

‡ 573 observations were missing.

and those without DM, with the exception that patients with newly detected DM had a higher glucose level at admission (▶ **Table 3**).

How are newly detected prediabetes and DM managed and reported at discharge?

Among the 23 patients with newly detected DM, 16 (69.6 %) had an $HbA_1c \geq 7$ % (53.0 mmol/mol) (▶ **Fig. 1, panel C**). Patients with a newly detected DM had a longer length of stay, while no differences were found regarding in-hospital mortality (▶ **Table 3**). Eleven of them (48 %) received anti-diabetic treatment at discharge. Also at discharge, newly detected prediabetes or DM were reported in 5.8 % (3/51) and 65.8 % of cases (15/23), respectively.

Discussion

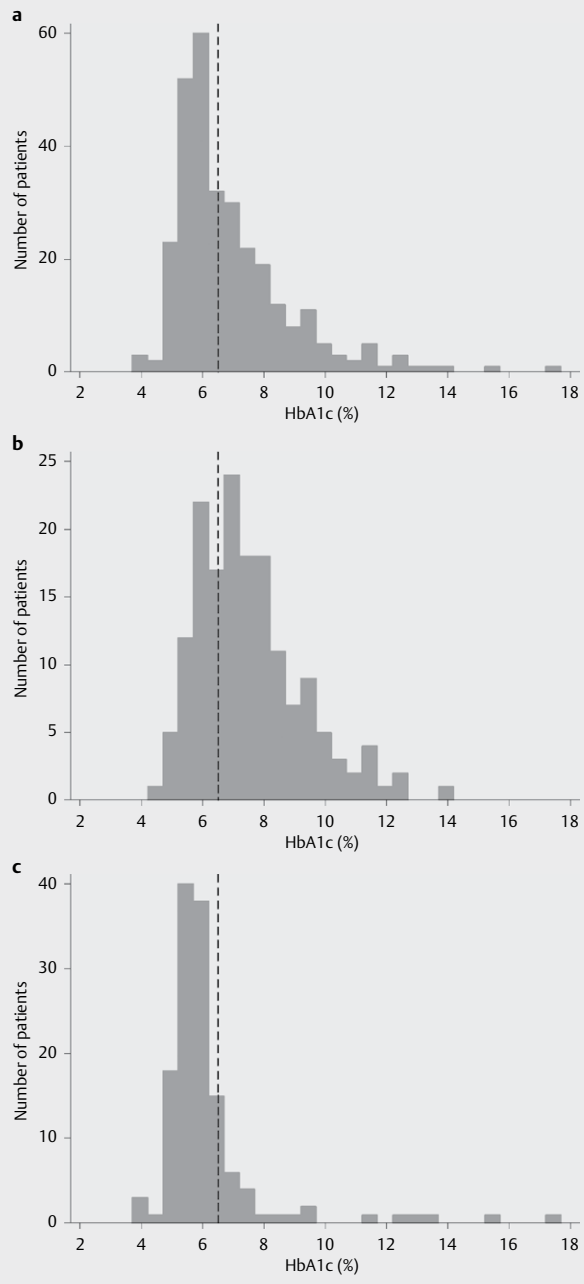
In a Swiss teaching hospital, doctors seldom prescribed HbA1c measurement: slightly over one tenth (11.4 %) of medical hospitalized patients. This percentage was even lower (6.4 %) in medical patients without known DM. Interestingly, a prediabetic state was found in 37.5 % of patients and DM was detected in one of five. Indicating that when a physician asks for HbA1c measurement, the likelihood of detecting (pre)DM is high (roughly 50 %). However, prescribers tended to underreport these newly detect (pre)diabetic states.

To which hospitalized patients do hospital doctors prescribe HbA_1c measurement?

According to the 2013 update of the Standards of Medical Care in Diabetes by the American Diabetes Association, testing for DM should be considered for all adults with overweight (body mass index > 25 kg/m^2) and at least one of the known risk factors for DM such as physical inactivity; first-degree relative with DM; high risk race/ethnicity; hypertension (≥ 140/90 mmHg or on therapy); HDL < 0.9 mmol/l and/or triglycerides > 2.82 mmol/l; gestational diabetes or high weight newborn; women with polycystic ovary syndrome; history of cardiovascular disease and $HbA_1c \geq 5.7$ % (38.8 mmol/mol) on previous testing [4]. In our study, hospital doctors prescribed HbA_1c measurement more often for patients with clinical factors associated with greater risks of cardiovascular disease. The utilization of HbA_1c among hospitalized patients seems to be in accordance with guidelines.

Interestingly, a recent study conducted in the ambulatory setting showed that it was possible to half the number of patients needed to invite to screen by using electronical medical data in a two-step procedure [11]. Patients without DM risk or with DM screening within the past 3 years were not considered for screening. Further studies assessing the performance of opportunistic in-hospital DM screening using electronical medical records and such are needed.

Hospital doctors prescribed HbA_1c measurement to 11.4 % of all medical patients, but only to 6.4 % of patients with no history of DM. In a German study, hospital doctors prescribed HbA1c measurement to surgical and medical adults slightly more often (16 % of all patients and 10 % of patients with no history of DM), but the prescription rates for medical patients was not specified. A Canadian study reported that 14.2 % of non-diabetic primary care patients aged 45 or more had at least one HbA_1c measurement dur-



▶ **Fig. 1** Distribution of HbA_1c values. Panel A: all patients; panel B: patients with known diabetes mellitus (based on ICD-10 codes E10.x-E14.x, any anti-diabetic medicines or a history of abnormal glucose homeostasis); panel C: patients without history of diabetes mellitus. Dashed line indicates an HbA_1c value of 6.5 % (47.5 mmol/mol)

ing a three years period [12]. Indeed, most studies conducted on hospitalized patients used HbA_1c as part of a systematic detection strategy [6, 7, 13] or focused on patients with a known DM [14, 15]. Still, the Canadian study was performed prior to the release of the current guidelines [4, 5] and because the rates of HbA_1c measurement tended to increase since 2009 [13], the frequency of HbA_1c measurement in medical non-diabetic hospitalized patients might be at least twice less frequent than in primary care patients without DM. Overall, our results suggest that DM screening is seldom performed in a teaching hospital setting.

▶ **Table 2** Clinical characteristics of hospitalized patients without history of diabetes mellitus, according to presence or absence of HbA1c measurement.

	Not measured (n = 2001)	Measured (n = 136)	P-value
Age, years	67.6 ± 17.5	66.6 ± 16.0	0.514
Age ≥ 65 years (%)	1227 (61.3)	76 (55.9)	0.208
Female gender (%)	949 (47.4)	56 (41.2)	0.158
Hypertension (%)	25 (1.3)	31 (22.8)	< 0.001
History of cardiovascular disease (%)	876 (43.8)	82 (60.3)	< 0.001
Dyslipidemia (%)	363 (18.1)	32 (23.5)	0.117
eGFR < 30 ml/min/m^2 (%)	168 (11.1)	6 (4.6)	0.020
Glucose level at admission (mmol/l) ¦	6.1 ± 1.7	7.6 ± 6.7	< 0.001

Results are expressed as number of patients (column %) or as average ± standard deviation. Between-group comparisons performed using chi-square for categorical data and by Student's t-test for continuous data. ¦ among 55 and 335 patients with and without measurement, respectively.

Prevalence of newly detected prediabetes and diabetes mellitus

Among hospitalized patients without history of DM, HbA_1c measurement allowed detecting prediabetes in 37.5 % and DM in 16.9 %. Two studies conducted in the United States have suggested that in-hospital DM testing might be more effective than community detection, because the prevalence of DM among hospitalized patients is higher. The first one showed that 35 % of patients admitted to hospital had DM, compared to 9.3 % in the general population [6]. The second reported that 18 % of hospitalized patients presented with previously undetected DM, defined as $HbA_1c > 6.1$ % (43.2 mmol/mol) [7]. In this study, the prevalence of DM among patients with HbA_1c measurements was almost three fold higher than the one reported in the general population using fasting plasma glucose levels [2].

How are newly detected prediabetes and DM managed and reported at discharge?

Hospital doctors underreported newly detected prediabetic state and DM at discharge, precluding further HbA_1c control as recommended by guidelines and good quality of care [4]. Still, the underreporting rate of DM in our study (40 %) was lower than in a previous Canadian study, which was approximately 80 % [16]. Nowadays, at discharge, systematic report regarding whether an Hba1c was performed and its corresponding result could be easily achieved using electronical medical records.

Similarly, antidiabetic drug treatment was prescribed to only half (48 %) of new detected DM cases, a value comparable to a study conducted in the Swiss general population (53.3 % in 2007) [17] but lower than in a study conducted in Lausanne (86 %)[2].

In our study, hospital doctors were three times more likely to prescribe HbA_1c in patients with a known DM, as if they were more

▶ **Table 3** Factors associated with abnormal glucose homeostasis in hospitalized patients without history of diabetes at admission/discharge and with HbA_1c measurement (n = 136).

At admission	No diabetes (N = 62)	Newly detected prediabetes * (n = 51)	Newly detected diabetes† (N = 23)	P-value
Age, years	64.6 ± 17.3	68.5 ± 14.8	68 ± 14.7	0.388
Age ≥ 65 years (%)	32 (51.6)	33 (64.7)	11 (47.8)	0.263
Female gender (%)	29 (46.8)	21 (41.2)	6 (26.1)	0.226 ¦
Coming from home (%)	59 (95.2)	48 (94.1)	22 (95.7)	1.000 ¦
Obesity (%)	3 (4.8)	1 (2.0)	0 (0)	0.660 ¦
Hypertension (%)	12 (19.4)	11 (21.6)	8 (34.8)	0.326 ¦
Past or current smoking (%)	1 (1.6)	2 (3.9)	0 (0)	0.765 ¦
History of cardiovascular disease (%)	33 (53.2)	33 (64.7)	16 (69.6)	0.282
Dyslipidemia (%)	14 (22.6)	11 (21.6)	7 (30.4)	0.687
eGFR < 30 ml/min/m^2 (%)	1 (1.7)	2 (4.0)	3 (13.6)	0.098 ¦
Glucose level at admission (mmol/l) #	5.2 ± 1.0	5.7 ± 1.1	14.7 ± 11.2	< 0.001
Time spent in emergency department (hours)	21 [10–28]	20 [6–27]	11 [7–25]	0.320 §
At discharge				
Length of stay (days)	13 [8–19]	8 [6–11]	16 [9–25]	0.002 §
In-hospital mortality (%)	0 (0)	1 (2.0)	1 (4.4)	0.155 ¦
Anti-diabetic treatment at discharge (%)	1 (1.6)§	0 (0)	11 (47.8)	< 0.001
Reported in medical file	NA	3 (5.8)	15 (65.8)	NA

Abbreviations: eGFR: estimated glomerular filtration rate as assessed by the Cockroft-Gault formula; NA: does not apply.

* Prediabetes defined as: HbA1c between ≥ 5.7 (38.8 mmol/mol) and < 6.5 % (47.5 mmol/mol).

†Newly diagnosed diabetes defined as HbA1c ≥ 6.5 %. § This patient received metformin for a metabolic syndrome without diabetic state (Hba1c value 5.2 %). # for 26, 16 and 13 patients with no diabetes, newly detected prediabetes and newly detected diabetes, respectively

Results are expressed as number of participants (column %), as average ± SD or as median and [interquartile range]. Statistical analysis by chi-square or Fisher's exact test (¦) for categorical data and by Student's t-test or Kruskal-Wallis (§) test for continuous data

concerned by the quality of DM care than by hospital DM screening. This finding is in accordance with a study performed in a German hospital, where 34 % of patients with a known DM had a HbA_1c measurement [9]. Hence, delivering DM prevention in asymptomatic patients requires skills that traditionally trained clinicians may not possess [18]. Thus, hospital DM detection needs to be coupled with resources for physician education and management in the outpatient setting.

Strengths and limitations

There is little information regarding in-hospital DM screening and management of newly detected DM in hospitalized medical patients outside English-speaking countries. Hence, our data provide important information for the public health management of DM in Europe.

Our study also has several limitations. Firstly, the detection of (pre)DM could only be achieved in the sample of patients who benefited from HbA_1c measurement. Thus, whether the current practice of HbA1c measurement in our teaching hospital is sufficient and effective needs to be further studied. Although our results cannot be generalized to the total population of hospitalized medical patients, still they indicate that when a doctor asks for HbA_1c measurement, the likelihood of detecting (pre)DM is high. Secondly, we could not distinguish between DM type 1 and 2. However, because the prevalence of type 1 DM is low, we assume that most of the cases of DM in our study were type 2 DM. Thirdly, some patients with a history of DM could have been missed. Still, we used a broad definition of DM history including ICD-10 codes in previous hospitalisations and glucose > 11.8 mmol/L (213 mg/dL), $HbA_1c \geq 6.5$ % (47.5 mmol/mol) or any antidiabetic treatment at admission. Fourthly, a possible selection cannot be excluded, hospital doctors (un)consciously prescribing HbA_1c measurements in patients who are more at risk of presenting with DM. Indeed, restricting the analysis to patients without history of DM, significantly higher frequencies of history of cardiovascular disease and hypertension and higher glucose levels and a lower frequency of kidney disease were found in patients with HbA_1c measurement, while no significant differences were found for gender, age, and history of dyslipidemia (▶ **Table 3**). Fifthly, no information regarding lifestyle intervention was available in the electronic medical files. Hence, only drug interventions could be assessed. Finally, the reporting of newly detected (pre)DM was based on ICD-10 codes at discharge, and it is possible that results of HbA_1c measurement might be present in the discharge letter but not coded in the medical record. Still, it has been shown that diabetes is adequately reported using ICD-10 codes in Switzerland [19], so we believe that ICD-10 codes could adequately characterize the conditions indicated in the discharge letter.

Conclusions

Hospital doctors do screen for diabetes, however they seldom prescribe HbA1c measurement in medical hospitalized patients with-

out known DM. Because prescription of HbA_1c measurement leads to a high detection rate (53 %) of (pre)DM among patients unaware of their status, management and reporting of these conditions at discharge could be further improved.

Author's contribution

MM conducted the study and wrote most of the article; PMV made the statistical analyses and wrote part of the article; GW revised the article for important intellectual content, PMV had full access to the data and is the guarantor of the study. All authors have read and approved this version of the article.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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