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A Survey on personnel knowledge and Manometers Precision Applied in Jahrom's Educational Healthcare Centers & Hospitals

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ABSTRACT

Background: Blood Pressure Measurement(BPM) is a basic matter of public healthcare concern and one of the most routine tests carried out at clinics.

The present study aimed at evaluating knowledge of health care providers and blood pressure manometers precision at Jahrom healthcare centers and hospitals.

Materials and methods: The present study was conducted on the basis of a descriptive – cross-sectional study through standardized questionnaires prepared by the researcher, to evaluate the knowledge of 302 cases about how to work with devices and all of 34 the apparatuses accuracy used in measuring blood pressure were at clinics and educational hospitals round Jahrom County between 2019 to 2020. Data was analysed with spss 25.

Results: From among the total 34 devices under the study used at clinics and hospitals for measuring blood pressure, there were 13 aneroid gauge (38.23%), 20 mercury-gravity (58.82%), and 1 electronic manometers (2.94%). Among them 13 mercury-gravity and 7 aneroid gauge devices were deficit (Fisher exact test $_2$= 1.43, p=0.72) . Also 11 mercury and 7 aneroid were out of order which a great share of malfunctions observed to be the outcome of problematic check valves(Fisher exact test $_4$=1.16, p=0.85. Furthermore, only about 40.20% of general physicians and even a lower percent of nurses and nurse aides (17.50%)were aware of correct method of using apparatuses applied in blood pressure measurement(Fisher exact test $_1$= 17.58, p=0.002).

Conclusions: all centers under the study could not be reliable in addition to the fact that users were totally ignorant of either deficiencies of the devices or lack of their knowledge.

Keywords: *Blood pressure determination, monitoring, ambulatory, instruments, knowledge*

1. INTRODUCTION

Measurement of arterial pressure is one of the most basic elements of patient management.

in 2018, almost half a million deaths in the United States included hypertension as a primary cause(Treadwell et al., 2022)

Accurate blood pressure measurement is important for diagnosing and treating hypertension , since inaccuracy in blood pressure measurement can cause to over diagnosis or under diagnosis also overtreatment or under treatment of hypertension (Ulusoy et al., 2020)

Moreover, studies show that 3 basic errors giving incorrect blood pressure readings:

1. Observer error, arising from applying an erroneous method or due to ignorance of the personnel on how to use the device.

2. Deficiency or malfunction of the apparatuses applied.
3. Non- standardization of blood pressure methods(Kallioinen et al., 2017).

Ambulatory blood pressure (ABP) monitoring is now accepted as the best method for predicting the risk of cardiovascular events relatied to an individual's blood pressure (BP) level. The association between ABP and the risk of cardiovascular events is not dependent of other risk factors. Routine office BP measurement is less accurate, correlating relatively poorly with the awake ABP, and is more possible to be associated with digit preference (rounding off readings to the nearest zero value) (Whelton Paul et al., 2018).

There are five steps required to obtain accurate BP measurements. The first is to ensure the patient has their back supported, legs uncrossed and feet flat on the floor. The second is to select the correct BP cuff size. A cuff that is too small will give erroneously high measurements, and vice versa. The third is to ensure BP is measured with the cuff on a bare arm, or a thin layer of clothing is acceptable. Fourth, the arm should be relaxed and supported on a flat surface such as a table, and the cuff must be level with the heart. Finally, the patient should rest before the measurement. The recommended rest period before BP measurement is five minutes.(Picone et al., 2023)

Findings extracted from different investigations on manometers at various hospitals reveal that around 21% of the total number of devices applied in measuring blood pressure are not precise(Mesquita, 2017).

Moreover, findings from different studies in Brazil and Canada proved that 21% and 12.6% of the devices used were deficient respectively; consequently, reliability of blood pressure measured by them is questionable(KAP Maia, 2017)

Until now, to our knowledge, there has not yet been an evaluation of the literature on the conventional office BP measurement. Therefore, our study was designed to assess physical conditions, the pressure measurement accuracy of sphygmomanometers used in the wards and clinics and the knowledge of workers about how to blood pressure measurement with devices at jahrom Educational Healthcare Centre's & Hospitals

2. MATERIALS AND METHODS

At the present study, the researcher has investigated through a descriptive cross-sectional procedure all the 34 manometers applied in blood pressure measurement at clini and hospitals of Motahari and Peymanieh in (2019.may till March 2020) based on an observational checklist and survey method. available aneroid and mercury sphygmomanometers were inspected for physical defects and assessed for accuracy. Samples were drawn from a number of inpatient and outpatient medical services of Hospital and Clinics, in jahrom. The outpatient services included internal medicine and surgery clinics. The inpatient services included pulmonary function laboratory, haemodialysis unit, peritoneal dialysis unit, and obstetric ward.

The condition of every sphygmomanometer was assessed with the some criteria: (1) the cuffs were considered defective if ripped or teared and the cuff was unable to fasten and stay fastened when the bladder was inflated; (2) the bladder was considered defective if the wearing or tearing was present or if it prolapsed out of the cuff; (3) the inflation bulb was considered defective if cracking was present, if evidence was noted for excessive wear, and/or if the bulb is leaking air when being pumped; (4) the rubber tubing was considered defective if it's holes or leaks were made and/or if excessive wear and cracking were present; (5) the pressure release valve was considered defective if it was visually injured, leaked air, and/or opened or closed with greater than minimal effort on the part of the observer; (6) the face plate was considered defective if cracking was made, broken, or showed any other signs of excessive trauma; and (7) the gauge was considered defective if the indicator needle did not point to the "zero box" when no pressure state was made to the manometer. In addition, the aneroid sphygmomanometer was considered defective if the apparatus could not hold air for any reason{Bailey, 1993 #3705}

As to investigating the knowledge of using the devices, the researcher used a self-procured standardized questionnaire . Content and face validity of the questionnaire was certified by 10 experts. Content Validity Index (0.88) and Content Validity Ratio (0.74) of questionnaire with the participation of 10 experts calculate. and its reliability was put to test and checked by Kuder – Richardson= 0.77 which was acceptable, with the participation of volunteers who filled up the questionnaire.

To access the quality of knowledge, we used a classification, if the percent grade of each item was less than 30% , the knowledge considered as weak, between 30-60% , moderate and more than 60% , regarded as high level.

Having taken the due leave and pursuant to the due moral regulations, the researcher started to in this part of the study initially 400 subjects entered the study, but only 302 out of the total cases accomplished different phases of the study In this study, sampling was done by census and all available devices were examined. During the course of the study there were factors to be put to investigation while checking the devices, including: date of purchase and in-use period of the device, calibration date and method based on American or British health society[9] , and adjusting and controlling the devices' parts including: length of rubber attached to the manometer, length of rubber attached to the mercury reservoir, pump, check valve, mercury level to zero reference point, indicator needle in aneroid gauge manometers, face plate of aneroid gauge manometers, and dimensions of the cuff.

subjects including 134 nurse aides, 123 nurses, and 45 general physicians were remained in the study. Nearly, half of the nurse and nurse aids assistants were within the range of 20-30 years old and most of the physicians were within the range of 30-40 years old. Descriptive statistics are presented below in Figure 1:

Data collection procedure and instrument:

The data in this study were collected in 3 phases including research made questionnaire, interview and observation. The questionnaire aimed to cover basic and necessary information about the factors affecting the accurate blood pressure measurement as well as the important points to be taken into consideration. The questionnaires were distributed among the respondents to fill in them. At the same time, informed consent was taken from eligible subjects. The questionnaire was detailed in staff knowledge and awareness of correct anatomical location of blood pressure measurements; how to close the cuff; the standard cuff sizes, place of cuff and stethoscope, check valve, inflation rate, filling , mercury level, zero point, vertical column.

The questionnaire comprised of two-categorized questions including some personal and some scientific questions. About scientific questions, firstly two-choices (yes/no) questions were asked and if the subject's responses were "yes", it means that subjects are aware of scientific principles based on self-declaration and if they answer the sub-questions correctly, it means that they have good knowledge of scientific and accurate measurement. Correct answers were specified in comparison with standard studies in fundamentals of nursing in **potter and Perry** text book[10].

Followingly, the researcher directly observed the method of BP measurement used by the subjects while subjects were doing it as usual and without any direction. If the subjects did the measurement in accordance with standardized procedures, it indicated that the subjects either had enough theoretical knowledge about the procedure or were potent to do the measurement correctly. However, in some cases, while the subjects had enough information about the procedure, ignored certain rules essential to accurate measurement.

Finally, a 10-minute interview was conducted to catch on their comments and interpretations on their failures to take BP measurement properly. They also were requested to give their recommendations to compensate the failures.

Statistical analysis

The data were analyzed through the application of SPSS statistical software version 25. To explain the extracted data, descriptive statistics and cross- tabulation tables were used. To compare the averages, Chi-Squared test was performed. The significance level was $P<0.05$ and the results were reported in percent.

Ethical considerations

The present study was conducted pursuant to the medical ethics specified by the Ministry of Health and Medical Education of the Islamic Republic of Iran, and all the participants filled out the consent form in advance of the investigation. All institutional and national guidelines for the care of human were followed and approved by the appropriate institutional committees. (IR.JUMS. REC.1385.-004, march 2018).

3. STATISTICS

Results:

From among the total 34 manometers applied at 2 hospitals in Jahrom, there existed (n=13 ,38.23%) aneroid gauge manometers, (n=20 ,58.82%) of mercury type, and (n=1 2.94%) was electronic type manometer, and among them, (n=8,40.00%) of mercury manometers, (n=6,46.15) of aneroid gauge manometers and (n=1,100%) of the digital manometers were intact.(Fisher exact test$_1$= 1.39, p=0.71)

None of the apparatuses were readjusted and calibrated during their life span **(table No. 1**). (n=12, 60.00%) of mercury-gravity manometers and (n=7, 53.84%) of the aneroid gauge manometers were out of service and hence unreliable (Fisher exact test $_1$= 34, p<0.001) .

Table No. (1): frequency, type and specifications of blood pressure measurement apparatuses used in medical centers

Type of apparatus / characteristics		Mercury-gravity	Aneroid gauge	digital	Total number
Number		20	13	1	34
Percent		58.8%	38.2%	2.9%	100%
Time of using apparatus (year)	1year	10	5	1	16
	2-3 years	8	7	---	15
	More than 6 years	2	1	---	3
number of intact apparatuses		14.7%	38.2%	100%	15

calibration time of	none	none	none	0

P<0.001,

Pearson,s , Chi-square, Fisher exact test

Malfunctions of different parts of the three types of manometers include:

From among the total aneroid gauge manometers there were deficit check valves (n=7, 53.84%)and among the mercury-gravity manometers (n=11, 55.00%) (Fisher exact test$_4$= 1.13, p=0.85). (table No. 2) . , non-standard length of the tubes connected to reservoir in aneroid (7.69%, n=1), in mercury: (15.00%, n=1)(Fisher exact test= 1.10, p=1). And length of the tubes connected to cuff in mercury (17.64%, n=3) (Fisher exact test= 2.64, p=0.32). , turbidity of glass plate in aneroid manometers(7.69%, n=1), tube weariness and divergence of the mercury in mercury manometers (20.00%,n=4) or indicator needle from the zero reference line in aneroid manometers (30.76%, n= 4)**. (table No. 2).**

Table No.2: frequency of manometers based on the type and defect parts

Type of apparatus / Damage type	**Mercury gravity**	**Aneroid gauge**	**digital**	**P value**
percent of check valve damage of apparatus	55.00%(n=11)	53.84%(n=7)	-	0.55
percent of non-standard tube length connected to the reservior less than (20. 51) cm or more than (81,120) cm	15.00%(n=1)	7.69. %(n=1)	-	0.10
percent of non-standard tube length connected to the cuff (120.81) cm	17.64%(n=3)	-	-	0.32
percent of mercury column above/below zero reference line	20.00%(n=4)	-	-	-
indicator needle above/below zero reference line	-	30.76%(n=4)	-	
breakage of glass plate	-	7.69%(n=1)	-	
crack in the cuff bag	25.00%(n=5)	15.38%(n=2)	-	0.50
air leakage	15.00%(n=2)	15.40%(n=2)	-	0.9

P<0.001,

Pearson,s , Chi-square, Fisher exact test

Table No 3. Correct knowledge of personnel of applying blood pressure measurement apparatuses

Title	nurse aide N = 138	Nurse N = 114	general physician N = 40	p. value
knowledge about the place of cuff (2cm) above the antecubital fossa	35.98%(49)	25.43%(23)	57.50%(23)	≤0.001
3. knowledge about the method of check valve	1.42%(9)	4.40%(9_)	7.51%(5)	0.095
knowledge about the size of cuff	10.90%(12)	9.70%(21)	63.20%(9)	≤0.001
Knowledge about the mid-point position of cuff on brachial artery	18.80%(23)	23.71%(29)	77.50%(23)	≤0.001
knowledge about the inflation rate of the cuff	5.12%(7)	9.60%(12)	7.50%(6)	0.018
knowledge about the air volume to fill the bag per second	7.29%(20)	7.90%(95)	15.71%(26)	0.002
knowledge about the mercury level at the zero reference point before blood pressure measurement	12.32%(28)	17.50%(23)	52.51%(21)	0.016
knowledge about the vertical position of mercury column	13.72%(20)	15.80%(21)	27.51%(13)	≤0.001
Knowledge on stethoscope diaphragm being on brachial artery	11.61%(10)	31.60%(21)	85.60%(29)	≤0.001
knowledge about the standard distance between the apparatus and the nurse	4.42%(6)	11.22%(5)	17.50%(6)	≤0.001

P<0.001,

Pearson,s , Chi-square, Fisher exact test From the total 302 cases under the study, there existed 134 nurse aides, 123 nurses, and 45 general physicians. Around 48.90% of the nurse aides and49.10 % of nurses were average 20-30 years old and 56.4% of the general physicians were of the average age of 30 to 40. (n=8 , 2.7%,) of nurse aides and (n= 3, 2.20%) of nurses suffered hearing impairments and only one percent, (n=3, 1.10%) of them healedafter reference to the related specialists. Furthermore, it was revealed that only in , (n=21, 15.10%) of the above-mentioned impairments manager of the hospital had taken the point into consideration and referred the suffering personnel to the due specialists (Fisher's exact test: 6.02, p= 0.1). About 31.60% ,n=14), of the general physicians (9.40% , n=13) of the nurse aides(n=12) and (11.00% , n=14), of and nursesbenefitted the correct knowledge of applying blood pressure measurement apparatuses and there observed a meaningful relation between bearing higher degrees and correct blood pressure measurements (pearson chi-squer $_1$=10 , p=0.01) in a way that the higher the educational degree, the more correct the method applied in measuring blood pressure. .

Only (63.20%, n=9) of the general physicians and 9.70%, n=21) of the nurses and(10.90, n=12) nurse aides checked the circumference of the patients' arm in order to choose a suitable cuff (the one covering 80% circumference of the arm) prior to performing the procedure. Something around (12.50% , n=6) of the general physicians and (6.10%, n=16) of the nurses and nurse aides were aware that: to apply a small cuff for obese patients results in cuff-dependent secondary hypertension and overestimation of blood pressure yields; similarly, big cuffs for thin patients causes underestimation of blood pressure results. Meanwhile, during the observation, we found that (20.00%, n=9) of physicians, (10.90% , n=11) of nurses and 0% nurse aids minded it in practice (Pearson chi- square = 2.6, p= 0.1) and others neglected the standard principle in practice. In their view, the reason for which was equipment deficit because all available cuffs were in the same size.

About (60.20% ,n=24) of general physicians and (10.10% , n=11)of the nurses and nurse aides were cognizant of the recommended dimensions of the inflation bladders; however, from among the total number of the cases under the study in the three groups, below 20.30 percent of the cases minded the greatness or smallness of the inflating bladders in relation to the circumference of the arm and also obesity and thinness of the patient.

(7.51%, n=5) of the general physicians were aware and (4.40%% , n=9)of the nurses and (1.42%, n=9)nurse aides were aware of the correct testing method of the check valve and mind the errors resulting from their ignorance (Fisher exact test $_4$= 150.6, P<0.001). It was revealed that (77.50% , n=23)of the general physicians and nearly (23.71% , n=29) of nurses and (18.80%,

n=23) of the nurse aides put the mid-point of inflation bladder on the brachial artery (Fisher exact test $_4$= 288., p<0.001). As to knowledge of the personnel on the necessity of being the mercury level at the zero reference zero-reference level, observation showed that (52.51% , n=21)of the general physicians, (17.50% , n=23)of the nurses and (12.32% , n=28)of the nurse aides were aware of it and checked the mercury level prior to performing the procedure(Fisher exact test $_4$= 299.3, p<0.001). (27.51% , n=13)of the general physicians and (15.80%, n=21) of the nurses and (13.72%, n=20) in the nurse aids group were cognizant of the necessity of putting the mercury-gravity manometer in a vertical position and minded it (Fisher exact test $_4$= 283.1, p<0.001). As to keeping the recommended space away from the manometer, about (17.50% , n=6) of the general physicians, (11.22%, n=5) of the nurses and (4.43%, n=6) of the nurse aides had the due knowledge and observed it(Fisher exact test $_2$= 177.4, p<0.001)..

As to the method of fastening the cuff on the patients' arm, (57.5% , n=23) of the general physicians, (35.98%, n=49) of the nurses, and (25.43% , n=23) of the nurse aides knew and observed the recommended 2cm site above the antecubital fossa(Fisher exact test= 2.6, p<0.34). As to the importance of putting the diaphragm of the stethoscope on the brachial artery, (11.61% , n=10) of the nurse aides, (31.60% , n=21) of the nurses and (85.60%, n=29) of the general physicians were aware of its importance and observed it anyway (Fisher exact test $_4$= 288.6, p<0.001)..

As to determining the scope of knowledge of personnel about deflation rate of the cuff on the basis of mmHg per second (7.50% , n=6) of the general physicians, and somewhere (9.60%, n=12) of the nurses and (5.12%, n=7) nurse aids were aware of the very exact recommended second rate (2 -3 mmHg/s). As to the inflation rate of the inflating bladder, (24.30% , n=9) of the general physicians and half of the cases in the two other groups inflated it too rapidly and (10.54% , n=10) of the cases in all the three groups performed it too slowly (Fisher exact test $_6$= 17.6, p=0.002)..

The questionnaire demonstrated that on disappearing the radial pulse filling the bladder until 30 mmHg **[18]**, (15.71%, n=26) of the general physicians, (7.90%, n=95) of the nurses and (7.29%, n=20) of nurse aides were theoretically aware of the inflation of the bladder air volume. Meanwhile, observation showed that (71.40% , n=33) of physicians, (38.41%, n= 45) of the nurses and (14.33% , n= 10) of the nurse aids did not respected the rule in their practice meaning that they did not fill the cuff above 30 mmHg (Fisher exact test = 1.7, p= 0.4). However, (67.53%, n=109) of the nurse aides, (85.54%, n=95) of the nurses and (90.67%, n=39) of the physicians answered that they had checked the radial pulse before the measurement[18]. On the other hand, (21.90% , n=20) of the nurse aides, (38.40%, n=40) of the nurses and (85.11%, n=33) of the physicians did it based on the observation of this study (Fisher exact test = 3.4 , p= 0.7)..

4. DISCUSSION

The present study dealt with the scope of investigation of precision of blood pressure devices. Results from the study showed that Attention is to be paid to the point that among the total number of inflation bladders and cuffs in Jahrom medical centers, there just existed one variety of manometer with rubber tubings measuring 16 by 30 cm and arm circumference of 27 by 34 cm dimensions. Hypertension is the most common chronic, noncommunicable disease, and it is also the disease with the largest burden in the world, requiring systematic management and lifelong treatment.Yang, 2018 #3863}

The measurement tools are an important in exact diagnosis of hypertension.

Manometers are vital parts of medical equipment whose safety are dependent upon special care and maintenance to increase their applicable life span. While measuring blood pressure it is usually supposed that the measure extracted is exact and not much due attention is paid to the errors arisen from unadjustments or deficiencies of manometers [11-13]

Using the above-mentioned manometers on obese patients in order to measuring blood pressure, would terminate in pseudo hypertension yields and in thin patients will result in pseudo low blood pressure results[14].

On the one hand, in cases where the arm was in a lower position to the heart, pseudo hypertension would result and vice versa [15].

On the other hand, observations showed that putting mid-point of inflation bladder on brachial artery and observing the recommended standards thereof was not considered. Check valve disorders are the main causes of errors and they result in quick inflation of air causing underestimation of systolic pressure yields and also overestimation of diastolic pressure yields[16].

As to awareness of the techniques while using manometers especially mercury-gravity manometers, it is noteworthy to say that one of the most prevalent errors was indifference to the vertical or non-vertical status of the mercury column and its position.

Another widespread deficiency in manometers is non-compliance of mercury level to the zero reference line. Furthermore, there was the problem that some of the rubber tubings attatched to the pump and manometers bore overextended length comparing to the standard length, while they should have been 70 cm in length and the rubber tubings attached to the pump should at least have been 30 cm in length[11].

Based on the findings from the study, followings are the cases causing underestimation or overestimation of blood pressure yields: mercury level and indicator needle being above or under the zero reference line, tubings and inflation pump

disorders[17]. In cases where the stethoscope placed on unsuitable position, the result was low systolic and diastolic pressures due to the opaque sound transference.

It can be presumed that incompetency of the nurses in relation to performing vital clinical procedures could be due to the weak educational systems, inability to diagnose the origin of deficiencies and shortages, and also forgetfulness of the personnel after the termination of the educational courses[7, 18].

As to inflating the bladder, it was observed that half of the personnel inflated the mercury column very quickly and similarly deflated them very quickly and were not aware of the malfunction probability of the devices.

Furthermore, in the previous studies it had been recommended for the reduction of the device malfunctions, mercury-gravity manometers be calibrated every 6-12 months and digital and home-version manometers every 2 years as well[13].

The present study showed that none of the apparatuses under the study were calibrated from the purchase date like other studies conducted in different countries[13] Previous studies suggested continuous use of the apparatuses to be a cause of mercury level falling and loss of elasticity in junctures especially in high pressures, as well as wrong diagnoses and overestimations of blood pressure like a study that was done in Brazil[17, 19-21]. Another factor influential in causing the errors is tears in fabric or perforations in inflation bladder or in the manometers' junctures, outdated filters, and problems in inflation system in accordance with previous study which was conducted in UK [7, 8, 17]. Reports established the probability of errors due to the observer's wrong readings, in spite of regular calibration and use of healthy apparatuses as the same as a study was done in Pakistan[17, 22]. We recommend a custodian to be in charge of regular and exact checking of the apparatuses as well as dispatching them to the authorized delegations in order to reduce the errors. Moreover, regular workshops with educational videotapes for the personnel is recommended, as well. Additionally, the researcher recommends the medical personnel to be monitored based on their knowledge and proficiency in correct using the related apparatuses, and making sure of their quick and correct diagnosis of blood pressure measurement. Findings from a study showed that a six mounth regular checking as well as notifying the personnel of their performance can enhance scientific quality and awareness of the nurses and reduce the errors caused by wrong measurements up to 22%[12].

5. CONCLUSION

Manometers are one of the major apparatuses in medical centers, and controlling and readjusting them is of vital importance. No one of the three groups under our study were aware of the malfunctions and deficiencies of the apparatuses. Moreover, a great deal of the apparatuses consisting 60% of total number of the manometers under the study were out of order, whereas medical personnel and hospital managers were heedless of their malfunctions

In this study, personnel were asked to provide their knowledge and abilities in blood pressure measurement in a variety of age-groups. However, lack of similar studies in the country deprived us to compare our results with them. Such comparisons would help us to find more about the issue and possible ways of compensation. Another limitation was the fact that health care personnel were neither asked to update their knowledge or manage their deficit of learning. According to some medical care officials, the number of nurses or nurse aids in medical centers was not in proportion with the number of clients referring to hospitals for medical care. Thus, lack of enough time to keep all the rules led to inexact measurements even though some personnel had enough knowledge of the procedures.

limitation

In this study, personnel were asked to fill questionnaire in incorrupting blood pressure sphygmomanometer in a variety of devices. However, lack of similar studies in the country deprived us to compare our results with them. Such comparisons would help us to find more about the issue and possible ways of compensation. Another limitation was the fact that health care personnel were neither asked to update their knowledge or manage their deficit of learning. According to some medical care officials, the number of devices was not in proportion with the number of clients referring to hospitals for medical care. Thus, lack of enough time to keep all the rules led to inexact measurements even though some personnel had enough knowledge of the procedures.

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Conflicting Interest (If present, give more details):

Authors disclose any conflict of interest in accordance with journal policy.

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