

Feasibility and acceptability of telepathology system among the rural communities of Bangladesh: A pilot study

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ABSTRACT

Context: Telepathology is a promising tool for remote communities to receive pathology services where professional diagnosis services are inadequate. **Aims:** We aimed to clarify how effective telepathology was when compared with conventional pathology service among rural communities of Bangladesh. **Methods and Materials:** We conducted a cross-sectional study in suburban and rural areas of Bangladesh between June and August 2020. We enrolled 117 participants who received both telepathology services from Thakurgaon Eye Hospital and conventional pathology service experience. The participant's satisfaction with the accessibility and perceptions were statistically compared. In addition, we summarized descriptive statistics using the frequencies and percentages of participants' responses. **Statistical Analysis Used:** Wilcoxon's Signed-rank test using SPSS statistic software version 25.00. **Results:** Among the study participants, service cost, travel cost, travel time, waiting time, and travel distance were significantly higher for conventional pathology than telepathology ($P < 0.001$). The majority of participants (94%) were satisfied with the telepathology experience; however, one out of 117 participants was dissatisfied with this service when their travel distance was far away (≥ 50 km). Among the participants, 91.5% thought that telepathology service was effective for their treatment, and 98.3% wanted to continue this service in their community. On an average, participants saved 58% (95% CI, 53.4–61.5) of cost using telepathology rather than conventional pathology service. **Conclusions:** Remote under-resourced communities received professional pathology services with less time-consuming and significantly lower costs using the telepathology approach. Where pathology services are absent/insufficient, telepathology is efficacious for primary diagnosis, screening, and referral through professional pathologists for the satisfactory treatment of unreached communities.

Keywords: eHealth, remote communities, remote diagnosis, telepathology

Introduction

Information and communication technology (ICT) is a transformative innovation for healthcare. Owing to rapid global development, the healthcare delivery process is changing due to the ingenious technology of telecommunication and digital imaging. In

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telepathology (TP) collaboration, remote diagnosis and consultation represent a significant change in the service delivery process of rural communities for primary care.^[1,2] Primary healthcare needs to be promoted at the community level to achieve universal health coverage.^[3] A primary care physician is the first point of contact for the health system. Disease diagnosis is essential to ensure primary healthcare services in rural and remote communities worldwide. The use of the TP is a promising approach for primary diagnosis and treatment by primary care physicians.^[4] In developing countries, delays and misdiagnoses by nonspecialized pathologists were negatively impacting patient treatment outcomes due to the scarcity of trained professional pathologists. Rural communities in developing countries are deprived of expected medical services compared with urban populations due to significant disparities in resources and facilities.^[5,6]

Bangladesh is a developing country with a high population density (1,104.42/km²), 62% of which live in rural areas.^[7] A hospital provides pathology services by diploma medical technologists at the primary level in the healthcare structure. Secondary level hospitals usually have a pathologist position; however, most of the positions are vacant at district-level hospitals due to the shortage of professional pathologists, and the medical technologist provides the pathology services. All the tertiary-level medical colleges and specialized hospitals have pathologists. In this scenario, it is costly and time-consuming for low-income rural people to receive professional pathologist services from secondary or tertiary level health facilities, even though it is often difficult to detect diseases and ensure the appropriate treatment without a proper diagnosis by pathologists. In the case of population and pathologist ratio, there is a serious crisis of professionals, Bangladesh has only 0.24 pathologists per 100,000 population, and most are urban-based.^[8]

A published paper reported that the Pathology Department of the National Institute of Cancer Research & Hospital of Bangladesh used the iPath internet platform for a second opinion and cytology techniques from the experts of Basle, Switzerland, and Dresden, Germany.^[9] Following that structured approach, Grameen Communications (GC) developed a TP system and started a pilot project in 2016 in four different rural and suburban hospitals of Bangladesh (Barisal, Bogra, Thakurgaon, and Manikganj).^[10] In their experiment, one online pathologist is assigned for four districts remote rural pathology centers. There is a lack of focused research on TP in Bangladesh. However, telemedicine has been increasing nowadays due to the rapid advancement of ICT worldwide. A similar approach can be possible for pathology service in the form of TP with the support of remote pathologists. Thus, this study aimed to evaluate the feasibility (i.e., time and cost-saving, accessibility, and affordability of pathology service by TP) and acceptability of image-based TP among rural communities and to assess the effectiveness of TP in reducing cost and time for the low-income rural communities by the online professional pathologist.

Subjects and Methods

Study design

A cross-sectional study was conducted, which enrolled a total of 117 participants. We recruited participants who experienced both conventional pathology (CP) and TP services. When participants took professional pathologist diagnostic service by the traditional way from a facilitated medical institute, we considered they experienced a CP. To assess the feasibility and acceptability of TP, we compared TP with CP services for rural communities.

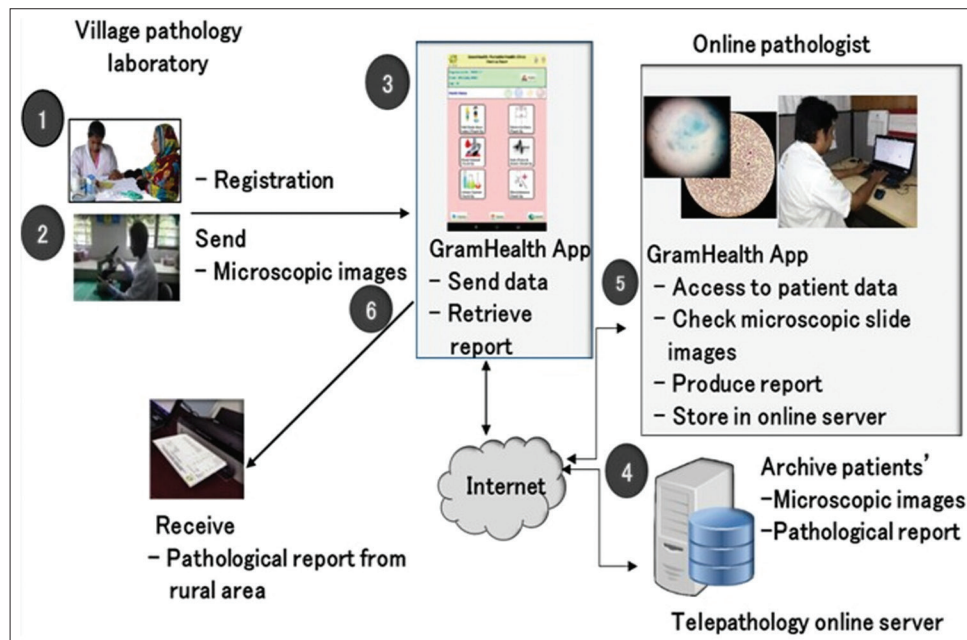


Figure 1: The pathway of Grameen telepathology services

Study site

The TP center of the Grameen Eye Hospital at Thakurgaon, Bangladesh, was selected for this study. It is part of the Rangpur Division bordering India's west side. The site was selected based on the availability of a TP service, where CP services are not ready for use on-site due to the lack of professional pathologists and the convenience of access to the researchers.

Telepathology service system of Grameen Eye Hospital

Grameen Eye Hospital started TP service with the support of GC's TP system. GC of Bangladesh developed TP software (GramHealth Software)^[11] for online remote diagnosis. The laboratory technologist collects the patient's basic information (i.e., name, gender, age, address, and mobile number) and samples (blood, urine, and stool), prepares glass slides, and captures the required microscopic images at the rural pathology center [Figure 1]. This trained diploma laboratory technologist shares microscopic images with the pathologist through TP software in the telepathology system. Then pathologist prepares a report and returns this digital report through the same TP system. One of the major strengths of this TP system is to equip with data storage, preservation, and management facility on an online server. Thus, storage diagnosis data can be available in case of any future reference or further analysis at any time any place. All patients were assigned unique barcode IDs. The designated staff of the pathology center had access to the protected database. Also, the patients had access to the database with passwords to view their respective reports only.^[11]

Inclusion and exclusion criteria

Adult individuals of either sex, aged >18 years who had taken pathology service from the TP center of Grameen Eye Hospital, Thakurgaon, had CP service experience and provided verbal consent to participate in the telephonic survey were enrolled in the study. The participants who received similar services from other TP centers than the designated center were excluded from this study.

Data collection

Data were collected from June to August 2020. The patient's contact information was collected from the TP system with the approval of GC. Due to the COVID-19 pandemic, a telephonic survey was conducted among the participants to avoid direct contact. Initially, a structured questionnaire was developed in English, and afterward, it was translated into the local language, Bangla. Close-ended questions were used to collect sociodemographic information, experiences on CP and TP services, and opinions about the advantages and disadvantages of both approaches. The variables were age, gender, education, income, professional pathology service opportunities, the effectiveness of the TP service for treatment, recommendations, traveling distance and time, service time, service fee, and the level of satisfaction of both pathology services. For the questionnaire validation, a pretest survey was conducted over the telephone among randomly selected

10 inhabitants of Thakurgaon. The feedback was considered to review and finalize the questionnaire. The participant of the main survey was selected by random sampling among the qualified participants.

Data analysis

The survey data was analyzed with IBM SPSS statistic software version 25.00. Frequencies and proportions (percentages) of each response in closed questions were summarized as descriptive statistics. Due to the observed lack of normality, Wilcoxon Signed-rank test was used for the hypothesis test regarding the difference in time, distance, and cost of the two groups. The significance level (α) was set as 0.05. The cost-effectiveness analysis was based on the average travel time, waiting time for diagnosis results, diagnosis fee, and travel fee estimated by the participant. Three types of cost were analyzed, including (1) travel cost, (2) diagnosis cost (for complete blood count, routine microscopic examination of urine and routine microscopic examination of stool), (3) time cost (travel time and waiting time for diagnosis). To calculate the time cost, time was converted into money as of their monthly income according to Buvik *et al.*^[12] and working hours as per labor law act 2006 of Bangladesh. We also reckoned the total cost by summing up (1), (2), and (3). To demonstrate the cost-effectiveness quantitatively, the saved time/cost percentages were also calculated out.

Ethical approval

The study protocol was approved by the Ethical Review Committee of the Northern University of Bangladesh [No: NUB/DPH/EC/2020/04(a)].

Results

Sociodemographic characteristics of the participants

The total number of study participants was 117. Among them, 69 (59%) were female, and 48 (41%) were male; 20 (17.1%) were less than 30 years, 50 (42.7%) were 30–45 years, 35 (29.9%) were 46–60 years, and 12 (10.3%) were more than 60 years of age. The participants who were classified as “no education” was 32 (27.4%), and “primary education” was 37 (31.6%). Other than those, 13 (11.1%) were secondary education, 12 (10.3%) were higher secondary, and 23 (19.7%) were University and above education. In the case of occupation, 6% were government employees, and 17.1% were nongovernment employees. Most of the participants were involved with housework (41.9%), followed by agriculture work (15.4%). Self-employed businesses were 11.1%. In the case of monthly income, the majority of participants who earned USD 118.12 ~ 236.21 per month was 59 (50.4%), followed by those who earned USD 59.1 ~ 118.1 and USD 0 ~ 59 per month were 12 (10.3%) and 3 (2.6%), respectively. The participants who earned more than USD 236.21 per month were 33 (28.2%) [Table 1].

Hypothesis testing of pathology service

A Wilcoxon Signed-rank test indicated [Table 2] that to take a professional pathologist's diagnosis report, travel distance (CP

Table 1: Demographic characteristics of the study participants (n=117)

Variables	Categories	Frequency	Percentage
Gender	Female	69	59.0
	Male	48	41.0
Age group	<30	20	17.1
	30-45	50	42.7
	46-60	35	29.9
	>60	12	10.3
Marital status	Never married	8	6.8
	Married or living together	108	92.3
	Widowed	1	0.9
Education	No education	32	27.4
	Primary school completed	37	31.6
	Secondary school completed	13	11.1
	Higher secondary completed	12	10.3
	Collage/University and higher	23	19.7
Occupation	Government employee	7	6.00
	Nongovernment employee	20	17.1
	Self-employed business	13	11.1
	Agriculture (including farmer)	18	15.4
	Student	5	4.3
	Housework	49	41.9
	Retired	5	4.3
	*Monthly family income	Taka 0-5,000 (\$0-59)	3
	Taka 5,001-10,000 (\$59.1-118.1)	12	10.3
	Taka 10,001-20,000 (\$118.12-236.21)	59	50.4
	More than 20,000 Taka (\$236.21)	33	28.2
	Disagree to share	10	8.5

*USD (\$) 1=84.67 Taka currency of Bangladesh (As per October 12, 2020)

Table 2: Results of hypothesis testing through Wilcoxon Signed-rank test (n=117)

Variable	Median of CP	Median of TP	Z	P
Distance from home place to service center (km)	120	18	-9.39	<0.001
Waiting time for diagnosis result (h)	3	2	-5.484	<0.001
Travel time (h)	5	2	-9.281	<0.001
Diagnosis expense (BDT*)	600	400	-9.026	<0.001
Expense for travel (BDT*)	400	100	-9.025	<0.001

BDT*= Local currency of Bangladesh

service: median 120 [min-max: 35–480] vs. TP service: 18 [0.5–90], $P < 0.001$), waiting time (CP: 3 [1–24] vs. TP: 2 [1–16], $P < 0.001$), travel time (CP: 5 [2–24] vs. TP: 2 [0.25–7], $P < 0.001$), travel cost (CP: 400 [120–4,500] vs. TP: 100 [0–1,200], $P < 0.001$), and the service cost (CP: 600 [300–1,200] vs. TP: 400 [200–600], $P < 0.001$) were significantly higher of the conventional way compared with TP.

Estimated travel time to access conventional and telepathology service

Figure 2 shows study participants’ time spent accessing the professional pathologist consultation from the CP and TP service centers. It was the travel time to take pathology service. According to data analysis, 49% of the participants got TP service center access within 0-1 h, whereas no one got access to CP center within the same time. Furthermore, 44% of participants had access to the TP center within 2–3 h, but only 16% had access to the CP center. The majority of participants got access to the CP service center within 4–5 h, 6–7 h, and more than 8 h

that are 39%, 38%, and 7%, respectively. However, that time was needed for only 5%, 2%, and 0% of participants to access the TP service center.

Conception and vehicle used to visit telepathology service center

Among the participants, 94% were very satisfied and satisfied with TP service. However, most of the study participants (91.5%) thought that TP service was effective for their treatment, except a small portion (8.5%). Mostly, 98.3% of the participants wanted to continue the service in their community. The majority of participants were happy to spend 1–2 h (80.3%) or less than 1 h (12.0%) for this service, and more than half of participants to visit TP center used local vehicle rickshaw (8.5%) and auto-rickshaw (47%). Also, 95.7% of participants wanted to recommend this TP service to their family members, neighbors, and friends [Table 3].

Satisfaction level according to travel distance

The following graph [Figure 3] demonstrates the participant’s satisfaction with the TP service center’s travel distance (km) from the participant’s residence. The graph shows that the highest number of participants (39) came from <10 km, and among them, 26%, 62%, and 12% were very satisfied, satisfied, and neutral with the TP service, respectively. However, when the participants came <50 km travel distance, they were very satisfied, satisfied, and neutral, but when travel distance ≥50 km, 11% were not satisfied, and very satisfaction level was low (22%).

Cost-effectiveness of telepathology

Using TP, participants saved their travel cost, diagnosis cost, time cost (travel time and waiting time for diagnosis) by 80%, 39%, and

Table 3: Frequency distribution of participant conception on telepathology (n=117)

Variables	Categories	Frequency	Percentage
Overall satisfaction level on TP	Very satisfied	35	30.0
	Satisfied	75	64.0
	Neutral	6	5.0
	Not satisfied	1	1.0
	Not at all	0	0.0
TP effective for treatment	Yes	107	91.5
	No	10	8.5
Continue TP in the community	Yes	115	98.3
	No	2	1.7
Vehicle use visit TP service center	Rickshaw	10	8.5
	Auto-rickshaw	55	47.0
	Local bus	21	17.9
	Motor-cycle	18	15.4
	Bicycle	3	2.6
	Private car	1	0.9
	By walking	9	7.7
Willingly time spend for TP services	<1 h	14	12.0
	1-2 h	94	80.3
	3-4 h	8	6.8
	<5 h	1	0.9
Recommend TP services	Yes	112	95.7
	No	5	4.3

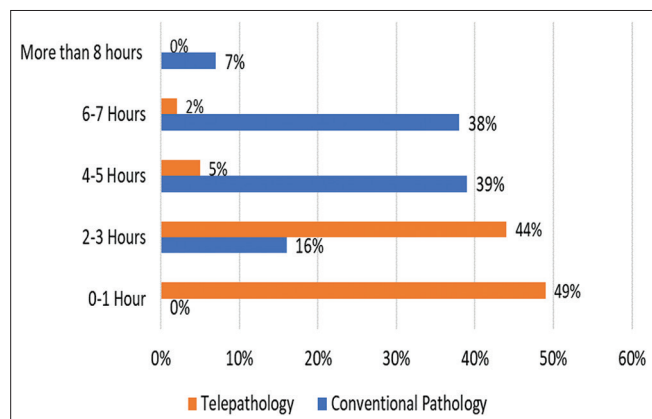


Figure 2: Estimated travel time of the pathology service (n = 117)

59%, respectively, compared with the CP service system. Overall, the TP service was found 58% cost-effective compared with the CP service system [Table 4], TTN cost=time cost converted to money (hour*estimated hourly income 0.944 USD)^[12]; estimated average monthly income of participants is 15,350 (n=107) Taka, working times are 48 h/ week and 192 h/month as per Bangladesh labor law act 2006^[13]; the estimated average hourly income is 80 Taka (15,350/192), 100 Taka=1.181 USD; total cost=sum of the travel cost, diagnosis cost, and TTN cost.

Discussion

To our knowledge, this is the first study to determine the feasibility and acceptability of TP services in rural and suburban areas of Bangladesh. High-quality telemedicine service was found cost-effective in Bangladesh, and it has been provided in different levels of hospitals all over the country.^[14] Teleconsultation enables primary care physicians to effectively diagnose and manage diseases in primary settings. As a result, if patients are managed at this level, they will be less likely to require specialist treatment.^[15] TP could play a vital role in primary diagnosis and second opinion^[16,17] to boost professional pathology services in Bangladesh, particularly in rural and suburban areas, improving overall healthcare system management. Our study, the first-ever in Bangladesh, revealed that TP is more cost-effective than the CP service system. The average household income per capita is only USD 1,000 per year and is even lower in rural areas. Household out-of-pocket health spending accounted for 64% of direct costs, and 16.5% of their household income is spent on healthcare by the poorest of the population.^[18] Direct costs comprised both medical (e.g, diagnosis) and nonmedical (e.g, transport to hospital) costs and the TP service can reduce the burden in both areas. The cost of healthcare is high compared with the per capita income, and it is unaffordable for most citizens.^[18,19] Telepathology could play an important role in reducing the direct cost of illness in this context.

We found that travel costs, travel time, waiting time, travel distance, and service cost were significantly lower in TP service than existing conventional services in Bangladesh. Due to the scarcity of professional pathology services in the rural communities, participants were required to visit a tertiary hospital

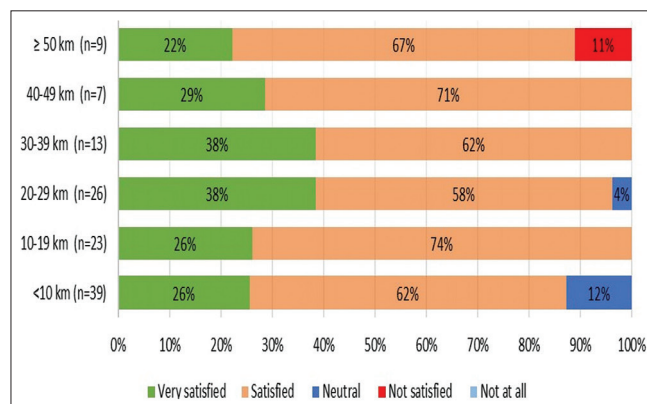


Figure 3: Satisfaction according to travel distance (n = 117)

Table 4: Cost-effectiveness of telepathology service compared with conventional pathology service in the 117 participants

Pathology Service	Estimated average time needed (H)			Estimated Average Money (USD)			
	Travel Time	Waiting Time	TTN ^a	Travel cost	Diagnosis cost	TTN Cost	Total Cost
Conventional pathology	6.2	3.7	9.9	6.9	7.5	9.4	23.8
Telepathology	1.6	2.5	4.1	1.4	4.6	3.9	9.9
Time and money saving using telepathology	4.6	1.2	5.8	5.5	2.9	5.5	13.9
Percentage saved	74%	32%	59%	80%	39%	59%	58%

TTN^a=Total time needed

for professional pathologist diagnosis reports. Most participants usually used local buses and private cars to reach the CP service center, needing to visit twice. The first time, they visit the facilities and give their pathology samples. In most cases, they cannot receive the reports on the same day and need to visit for the second time to collect the report. It makes travel expenses costly and time-consuming for remote low-income communities to receive pathology service from the tertiary level/urban area/specialized hospital/medical college. A physician at the community level also needs to wait a long time for the diagnosis to provide appropriate primary care. In contrast, TP requires significantly lower travel costs and travel time. Most participants could reach the center using auto-rickshaws and rickshaws, which are more convenient, available, and cheaper in rural Bangladesh. In rural and suburban Bangladesh, auto-rickshaw is popular for short-distance travel among the low-income population, and the travel cost is lower.^[20]

A feasibility study of internet-based dynamic TP to diagnose routine surgical pathology cases in China reported that TP was particularly cost and time-effective than CP.^[21] Other research findings from developing countries, such as Egypt and China, showed that TP is a time and cost-saving diagnostic tool, and it is feasible as a consultative service.^[22,23]

We observed that the waiting time and travel distance to access CP service centers were higher for receiving CP services than TP services. Due to the high demand and insufficient pathologists in the territory hospital, participants needed a long waiting to receive their pathology reports. TP will be an effective bridge for remote communities, where professional pathology service and consultation are unavailable.^[24] Another study on a telemedicine service for remote orthopedic consultations in the developed country reported that online consultation is cost-saving (travel cost, time cost) compared with receiving in-person consultation at a long distance.^[12] To attend in-person consultation at distant facilities, they may need to take time off their work, interrupting their work or production.

After receiving TP services, the majority of participants were satisfied with the overall TP service. According to our analysis, we found that travel distance to a TP center is one of the factors for dissatisfaction. The Pathology Department of the University of Arizona conducted a robotic TP program in the rural hospital for the second opinion, and they observed a high level of satisfaction of their patients on the TP service.^[25]

Our study participants found that TP was effective for their proper treatment, and they wanted to recommend this TP service

to others. In addition, accurate diagnosis by professionals is a key factor for providing appropriate treatment. Due to the lack of professional pathologists in suburban and rural areas, diploma medical technologists and technicians conduct pathological diagnoses. Therefore, TP can be a substitute in remote or rural regions to ensure access to urban pathologists.^[26] The findings from the research indicate TP is time and cost-effective, which explains why TP is feasible and acceptable among remote communities where professional pathology services are inadequate.

Limitations

Data of this study was collected through telephonic survey rather than face-to-face interview due to the COVID-19 pandemic, and few targeted participants could not be reached through the telephonic survey. In addition, one limitation of this study was conducted in only one study site.

Conclusion

Our research shows that participants who reside in rural and suburban settings have high satisfaction with TP services, and this service could be an effective tool to minimize the service cost by reducing travel cost, travel time, waiting time, and travel distance. Therefore, introducing TP along with the scale-up of telemedicine services in low-resource settings may help to mitigate the long-lasting health suffering and enhance better primary healthcare, especially among rural and suburban populations.

Key Points

1. Telepathology is effective in primary care settings and allows primary care physicians to make initial diagnoses and control baseline diseases.
2. TP can potentially improve professional pathology services in Bangladesh significantly.
3. The first-ever study in Bangladesh revealed that TP is more cost-effective than the CP service system.
4. According to this study, travel costs, travel time, waiting time, travel distance, and service cost were significantly lower in TP service than existing conventional services in Bangladesh.
5. Most participants were satisfied with the TP service as a whole.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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