Bio-Medical Waste Management among Health Care Providers and Support Staff in a Secondary Level Hospital: A Cross-Sectional Study

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ABSTRACT

Background: According to WHO, for every 100 hospitalized patients at least 7 in developed and 10 in developing countries acquire healthcare associated infection. Important factors that put the patients at the risk of infections are inadequate environmental hygiene, waste disposal, and poor knowledge, and application of basic infection control measures. To assess the knowledge, attitude and practice regarding biomedical waste management (BMWM) among ~~h~~ealth care providers (HCP) and support staffs in a secondary level Hospital with the goal of identifying gaps and informing strategies for improved compliance and waste management practices.

Methods: A cross-sectional study was done in government hospital, Mayiladuthurai, Nagapattinam district, during September 2018 to November 2018. Among the 32 districts in Tamilnadu, Nagapattinam district was randomly selected and Mayiladuthurai government hospital was randomly selected among 9 secondary level care hospitals. All the categories of staff in the hospital like doctors, pharmacists, staff nurses, lab and x ray technicians, sanitary workers who handle the biomedical waste in the study area were included in the study. After getting informed consent, data was collected using pre-tested semi structured questionnaire. Data entry was made in the Microsoft Excel software and analysis was done with SPSS version 21 software package.

Results: Out of 109 participants, 24.8% were males and 75.2% were females. Age group of the participants ranges from 20-60 with the mean age of 35.34 and standard deviation of 7.51. Majority of them belong to 31-40 age group (44%). In this study, based on the work experience 72.5% participants belong to 0-8 -years' experience group, 22.9% participants belong to 9- 16years experience and about 4.6% belongs to 17-24 years of experience group. It was observed that those having adequate knowledge and good attitude about BMW management were found to have less adequate practices which also varies among different categories of health workers ($p < 0.001$).

Conclusions: The results of the present study showed that knowledge, attitude and practices of participants were not adequate among different categories of health care providers. Safe and effective management of waste is not only a legal necessity but also a social responsibility. The government should take the responsibility to train effectively the healthcare providers working in secondary healthcare settings. Compulsory continuous intensive training programs should be conducted at regular time interval for all the paramedical personnel with special importance to the newcomers, and they should have access to BMWM guidelines in their department/healthcare delivery section. The authors recommend similar studies in different settings and further research to provide accurate data for future decision-making.

Keywords: Biomedical waste management, knowledge, healthcare workers, paramedical, nurses, lab technicians

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Introduction

Cleanliness and hygiene are crucial for healthcare settings (1). The waste produced in the course of healthcare activities has a great potential and possibility for causing injury and infection compared with other types of waste (2). According to WHO, for every 100 hospitalized patients, at least 7 in developed and 10 in developing countries acquire healthcare associated infection. Important factors that put the patients at the risk of infections are inadequate environmental hygiene, waste disposal, poor knowledge, application of basic infection control measures. Biomedical waste (BMW) is "any waste which is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities pertaining to the production or testing of biological and including categories mentioned in Schedule I" of Bio-Medical Waste Management Rules, 2016 (1).

As per BMW management rules,1998 (amendment 2016), these rules apply to all persons who generate, collect, receive, store, transport, treat, dispose or handle BMW in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories, and research laboratories by whatever name they are called to take all the steps to ensure that such waste is handled without any adverse effect to human health and environment (1).

According to World Health Organization, 85% of hospital wastes are non-hazardous, 10% are infectious and 5% are non-infectious. The global scenario of BMW management is shocking as it is reported 18 to 64 % of health care settings have unsatisfactory BMW management system (2). Every year an estimated 16 billion injections are administered worldwide, but not all of the needles and syringes are properly disposed of afterwards. High-income countries generate on average up to 0.5 kg of hazardous waste per hospital bed per day; this was while low-income countries generate on average 0.2 kg. However, health-care waste is often not separated into hazardous or non-hazardous wastes in low-income countries, making the real quantity of hazardous waste much higher. In India, the gross generation of BMW is 4,05,702 kg/day of which only 2, 91,983 kg/day is disposed (3). The approximate quantity of waste generated in hospitals varies between 0.55 and 2.0 kg/bed/ day. According to the study conducted by Pandey et al, out of the total biomedical waste generated (57912 kg), 8686.8 kg. (15%) were infectious waste. Average infectious waste generated was 0.341 Kg per bed per day (4).

In Tamil Nadu, the BMW awareness program was started by the Government of Tamil Nadu in 2008 through project for upgrading safety in health (PUSH) care project. 'KAYAKALP' is the program to promote cleanliness and enhance the quality of public health facilities. As a part of the Swachh Bharat Abhiyaan campaign, The Ministry of Health and Family Welfare, Government of India, launched an initiative 'KAYAKALP'. In Somaiah et al.'s study, the biomedical waste management of healthcare setting is about 57% (5).

The assessment of performance of the facility is based on parameters like hospital facility upkeep, sanitation and hygiene, waste management, infection control, support services, and hygiene promotion. Lack of awareness about the health hazards related to health-care waste, inadequate training in proper waste management, absence of waste management and disposal systems, insufficient financial and human resources and the low priority given to the topic are the most common problems connected with healthcare waste (6).

BMW management has been entrusted with waste segregation at the source of generation into labeled color-coded containers/bags that have been pre-assigned for the four defined categories (1). Healthcare providers need to have exemplary professional practice in this regard. Even evidence from various parts of India suggests that gaps in knowledge and lacunae in attitudes and practices are still prevalent to a worrying extent among the various categories of healthcare professionals. It

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was therefore decided to address this issue by undertaking the present study, so that guidelines can be designed for safer and more effective delivery of healthcare (7).

In developing countries, BMW has not received sufficient attention. In India, BMW (Management and Handling) rules of 1998 make it mandatory for hospitals, clinics, and other medical and veterinary institutes to dispose of BMW strictly according to the rules (1). The few studies on BMW management from India have established that hospitals did not manage BMW properly. The utmost important point is that careless and indiscriminate disposal of this waste by healthcare professionals (medical and dental doctors) contribute to the spread of serious diseases such as hepatitis and human immunodeficiency virus (HIV) regarding people who handle waste and also the general public (7).

Biomedical waste (BMW) is a potential health hazard to healthcare workers, the public, and the flora and fauna of the area (7). 80% of total BM generated by healthcare activities can be disposed of through regular municipal waste disposal methods. The remaining 20% is considered hazardous. Bio-medical waste collection and proper disposal has become a significant concern for both the medical and the general community. Health is an important category for healthcare providers (7). They must know about hazards of BMW in their environment. More KAP studies on biomedical waste management were done in tertiary level care hospitals. Hence, the authors have planned to do research in secondary level care hospital.

To assess the knowledge, attitude and practice regarding biomedical waste management among health care providers and support staffs in a secondary level hospital with the goal of identifying gaps and informing strategies for improved compliance and waste management practices.

Methods

This was a cross-sectional study conducted among healthcare providers in Government Hospital, Mayiladuthurai during September 2018 to November 2018. Study population includes doctors, pharmacists, staff nurses, lab and X ray technicians, sanitary workers working in government hospital. Nagapattinam district is one of the backward districts in Tamilnadu. In this district, randomly one secondary level care hospital was selected from among 9 secondary level care hospitals. All the staff who handle the biomedical waste in the selected hospital were included in the study. Sample size was calculated to be 92 based on a recent study assessing KAP regarding biomedical waste management amongst paramedical staff in India, where percentage of knowledge of biomedical waste is 32.38%, with a 95% confidence interval, absolute precision of 10% and non-response Rate of 20 %. The sample size was calculated using the formula,

$$n = \frac{4pq}{d^2}$$

$$= \frac{4 \times 32.38 \times 67.62}{10 \times 10}$$

n = 87.58

Where, n = Number of samples required

p = Prevalence of knowledge regarding biomedical waste management

q = 100 – p

d = Allowable error (Absolute precision of 10%)

With expectation of non-response rate of 20 %, the total sample required is

= 87.58 x 100/80

= 109.47

N = 110 (rounded off to nearest number)

Sample size covered was 110.

Permission was obtained from the Institutional Ethics Committee of Madras Medical College and Joint Director of Health services, Nagapattinam. After getting informed consent, data collection was done using Pretested Semi Structured questionnaire.

The questionnaire included details of various demographic variables like age, sex, educational status and other details regarding knowledge, attitude and practice for bio-medical waste. There were 9 knowledge questions, 7 attitude questions and 9 practice questions. KAP questions were given a score of one each. The total score for knowledge was then categorized based on mean value. Attitude and practice were categorized based on median value.

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The data were entered in MS Excel and analyzed using SPSS software Version 16. Appropriate descriptive statistics were expressed in percentages and inferential statistics such as Chi square test was used to analyze the association between independent variables and knowledge, attitude and practice regarding biomedical waste management.

Results

In this study, 109 study subjects participated. Among them, 24.8% were males and 75.2% were females. Age group of the participants ranged from 22-60 with the mean age of 35.34 ±7. 517. Majority of them belongs to 31- 40 age group (44%).

Table 1 shows the distribution of educational status; majority of the participants had high school diploma (50.5%) followed by post graduate degrees (14.7%) and others (2.4%).

Among the participants, the majority were staff nurses (48.6%), followed by doctors (21.1%), and others (30.3%)

Table 1. Socio- demographic characteristics of the study Participants (n = 109)

S.No.	Socio-demographic factors		Frequency (n)	Percentage (%)
1	Age	20-30	34	31.2
		31-40	48	44
		41-50	23	21.1
		51-60	4	3.7
2	Gender	Male	27	24.8
		Female	82	75.2
3	Religion	Hindu	103	94.5
		Christian	5	4.6
		Muslim	1	0.9
4	Education	Primary school degree	11	10.1
		Middle school degree	6	5.5
		High school diploma	4	3.7
		Higher secondary school degree	4	3.7
		High school diploma	55	50.5
		Postgraduate degree	13	11.9
5	Occupation	Doctor	23	21.1
		Pharmacist	6	5.5
		Nurse	53	48.6
		Laboratory technician	4	3.7
		MSW	2	1.8
		MNA	1	0.9
		FNA	3	2.8
		Sanitary worker	17	15.6

Table 2 shows the distribution of healthcare providers' experience in years. Most of the study participants belong to 0-8-year experience group (72.5%) followed by 9-16 -year experience (22.9%).

Table 2. Distribution of experience in years in healthcare among the study participants (n = 109)

Experience in years	Frequency (n)	Percentage (%)
0-8 years	79	72.5
9-16years	25	22.9
17-24years	5	4.6
Total	109	100

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Table 3 shows the distribution of BMW training within the past year in healthcare settings: Among 109 participants, (22.9%) had attended BMW training within past year and the rest (77.1%) had not attended the BMW training within past year.

Table 3. Distribution of BMW training within past year in health care among the study participants (n = 109)

BMW training within past 1 year	Frequency (n)	Percentage (%)
Yes	25	22.9
No	84	77.1
Total	109	100

Table 4 shows the distribution of knowledge, attitude, and practices frequencies among the study participants. It was found that 64.2% had adequate knowledge, 66.1% had good attitude and only 57.8% had adequate practices.

Table 4. Knowledge, attitude, and practices of frequency among the participants (n = 109)

	Score	Frequency (n)	Percentage (%)
Knowledge	Adequate	70	64.2
	Inadequate	39	35.8
Attitude	Good	72	66.1
	Poor	37	33.9
Practice	Adequate	63	57.8
	Inadequate	46	42.2

Among the doctors, 60.9% had good attitude, 52.2% had adequate knowledge, and only 47.8 had adequate practice. Among other categories of healthcare providers, 67.4% had adequate knowledge, 53.2% had good attitude and only 60.5% had adequate practice (Figure.1).

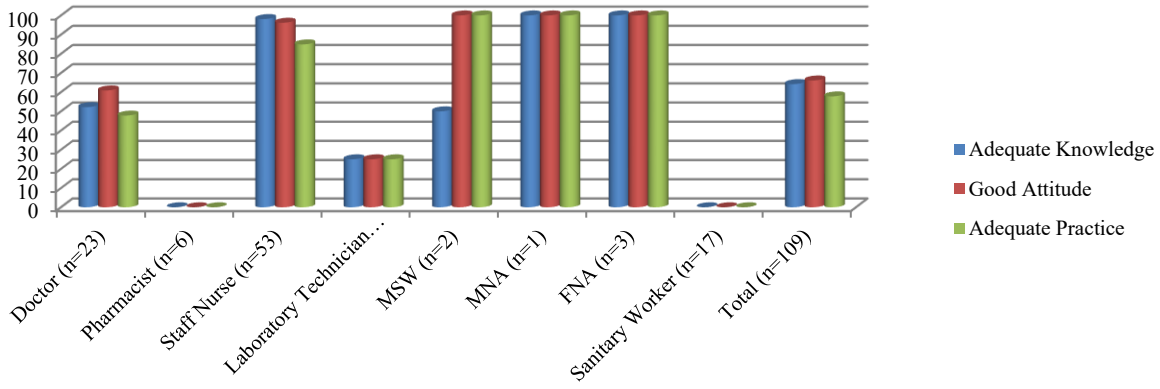

Figure 1. Knowledge, attitude and practices of frequency among the various categories of occupation (n = 109)

Table 5 shows the association between knowledge about BMW and factors associated with it by univariate analysis. It was observed that factors such as gender, education of the participants, BMW training within one year and the work experience of 1- 8 years were significantly associated with adequate knowledge about BMW management.

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Table 5. Association between knowledge about BMW management and associated factors (n = 109)

Factors		Knowledge		TEST	P-value
		Adequate	Inadequate		
Age	20-40	56 (68.3)	26 (31.7)	$\chi^2_{(0.05)} = 1.72$ df = 1	0.09
	41-60	14 (51.9)	13 (48.1)		
Gender	Male	17 (63)	10 (37)	$\chi^2_{(0.05)} = 11.54$ df = 1	< 0.001
	Female	22 (26.9)	60 (73.1)		
Education of the participants	Primary, Middle, and high school	3 (14.3)	18 (85.7)	$\chi^2_{(0.05)} = 25.5$ df = 1	< 0.0001
	Higher secondary and above	67 (76.1)	21 (23.9)		
Occupation of the respondents	Doctor	12 (52.2)	11 (47.8)	$\chi^2_{(0.05)} = 1.23$ df = 1	0.133
	Others	58 (67.4)	28 (32.6)		
BMW training within the past year	Yes	7 (28)	18 (72)	$\chi^2_{(0.05)} = 18.52$ df = 1	< 0.001
	No	63 (75)	21 (25)		
Experience in years	1-8 years	46 (58.2)	33 (41.8)	$\chi^2_{(0.05)} = 3.58$ df = 1	< 0.05
	9-24 years	24 (34.2)	6 (35.8)		

Table 6 shows the association between attitude about BMW management and factors associated with it by univariate analysis. It was observed that factors such as gender, education of the participants and BMW training within one year were significantly associated with adequate practice of BMW management.

Table 6. Association between attitude about BMW management and associated factors (n = 109)

Factors		Attitude		TEST	P-value
		Good	Poor		
Age	20-40	58 (70.7%)	24 (70.7%)	$\chi^2_{(0.05)} = 2.44$ df = 2	0.100
	41-60	14 (51.8%)	13 (48.2%)		
Gender	Male	17 (63%)	10 (37%)	$\chi^2_{(0.05)} = 13.47$ df = 1	< 0.001
	Female	20 (24.3%)	62 (75.5%)		
Education of the participants	Primary, middle, high school	3 (14.3)	18 (85.7)	$\chi^2_{(0.05)} = 28.29$ df = 1	< 0.0001
	Higher secondary and above	69 (78.4)	19 (21.6)		
Occupation of the respondents	Doctors	14 (60.9)	9 (39.1)	$\chi^2_{(0.05)} = 0.73$ df = 2	0.623
	Others	58 (67.4)	(32.6)		
BMW training within Past year	Yes	7 (28)	18 (72)	$\chi^2_{(0.05)} = 20.95$ df = 1	< 0.001
	No	65 (77.4)	19 (22.6)		
Experience in years	1-8 years	47 (59.5)	32 (40.5)	$\chi^2_{(0.05)} = 5.54$ df = 2	0.063
	9-16 years	21 (84)	4 (16)		
	17-24 years	4 (80)	1 (20)		

Table 7 shows the association between practice about BMW management and factors associated with it by univariate analysis. It was observed that factors such as gender, education of the participants and BMW training within past year were significantly associated with adequate practice about BMW management.

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Table 7. Association between practices about BMW and associated factors (n = 109)

Factors		Practice		TEST	p-Value
		Adequate	Inadequate		
Age	20-40 years	24 (70.5%)	10 (29.5%)	$\chi^2_{(0.05)} = 2.59$ df = 1	0.051
	41-60 years	39 (52%)	36 (48%)		
Gender	Male	18 (66.7%)	9 (33.3%)	$\chi^2_{(0.05)} = 8.8$ df = 1	< 0.05
	Female	28 (34.1%)	54 (65.9%)		
Education of the participants	Primary, Middle, and High School degrees	3 (14.3%)	18 (85.7%)	$\chi^2_{(0.05)} = 18.04$ df = 1	< 0.0001
	Higher Secondary education and above	60 (68.1%)	28 (31.9%)		
Occupation of the respondents	Doctor	11 (47.8%)	12 (52.2%)	$\chi^2_{(0.05)} = 10.72$ df = 1	0.19
	Others	52 (60.5%)	34 (39.5%)		
BMW training – within past year	Yes	7 (28%)	18 (72%)	$\chi^2_{(0.05)} = 20.95$ df = 1	< 0.001
	No	56 (67%)	28 (33%)		
Experience in years	1-8 years	39 (49.3%)	40 (50.7%)	$\chi^2_{(0.05)} = 5.54$ df = 2	0.063
	9-24 years	20 (80%)	5 (20%)		

Table 8 shows the association between knowledge, attitude and practices about BMW management by univariate analysis. It was observed that those having adequate knowledge were found to have good attitude of around 61.48% about BMW management ($p < 0.001$) and also those having adequate knowledge were found to have adequate practices of around 61.14% regarding BMW management ($p < 0.001$).

Table 8. Association between knowledge, attitude and practice regarding BMW (n = 109)

Knowledge adequacy	Attitude		Practice	
	Good	Poor	Adequate	Inadequate
Adequate	67 (61.48)	3 (2.75)	59 (54.14)	11 (10.09)
Inadequate	5 (4.58)	34 (31.19)	4 (3.66)	35 (32.11)
Chi-square	$\chi^2_{(0.05)} = 56.27$ df = 1		$\chi^2_{(0.05)} = 53.27$ df = 1	
P-value	< 0.001		< 0.001	

Discussion

In this study, most of the study subjects were males. Males were more common among doctors and technologists, whereas females were more common among nurses and cleaning staff. These findings were similar to Sarkar et al.'s study (6). In the current study, age group of the participants ranges from 24-55 and majority of them belongs to 31-40-year-old group whereas in Sumit Goyal et al.'s study, the majority was in the age group of 20–29-year-old group followed by the age group of 30-39 and above 40 (7).

Among the participants in the present study, majority were nurses followed by doctors, sanitary workers, pharmacist, laboratory technician, female nursing assistant, medical social worker, and male nursing assistant. This was in accordance with the study conducted by Prasanth et al (3).

In this study, most of the study participants belong to 0-8 -years' experience group, followed by 9-16-year experience group, and 17-24-year experience group. More than 40% of the professionals had an experience of more than 5 years in their respective fields (7). Majority of the participants in the present study had high school diploma followed by postgraduate degree. Approximately one-third of the respondents were college graduates or higher in Sarkar et al.'s study (6).

In this study, nurses and nursing assistant had good knowledge about BMW followed by doctors. None of the sanitary workers had adequate knowledge. These results were in contrast with Sengodan et al.'s study, in that the knowledge of

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biomedical waste management was observed more in the young doctors (interns and post-graduate students) who scored the highest average, followed by the nursing students, nurses, and lab technicians. The results revealed that young doctors and nursing students with biomedical waste management in their curriculum had more knowledge than others (7).

In the current study, among those who underwent BMW training, knowledge was inadequate. Sarkar et al.'s study stated that inadequate knowledge could be due to lack of training during employment, and lack of proper waste management guidelines, as well as lack of discussion on details of harmful effects in general education (6).

In Sarkar et al.'s study, males, older people (30 and above), technologists, cleaning staff, and district hospitals were more likely to have inadequate knowledge compared to females, younger age, medical doctors, and tertiary hospitals whereas in this study, females, older people, sanitary workers and pharmacists had inadequate knowledge (6). Sarkar et al. found that middle-aged people (30–40) and those who did not receive training ($P < 0.001$) were more likely to have poor practices.

In this study, participants aged 41-50, with 0-8 years of experience in medical profession, having below higher secondary education, those who underwent BMW training, pharmacists, and sanitary workers had poor practices (6). Joshi et al.'s study found evidence of a gap between knowledge and actual practice, the so called know- do gap. Similar findings were observed in this study too (8).

In this study, healthcare professionals had adequate knowledge, good attitude and good practice whereas in Deress et al.'s study, participants showed adequate knowledge, favorable attitude, and adequate practice (9).

In bivariate analysis, younger age, being female and those with below higher secondary education had inadequate knowledge, poor attitude and inadequate practices ($p < 0.001$). Sood et al. observed most of them had knowledge about BMW but they lacked the attitude to practice it which was similar to this study's findings (10).

Those who underwent BMW training also had inadequate knowledge, attitude, and practices. As recommended by Kumar et al, implementation of trainings for health and sanitary workers in hospitals may require uniform guidelines tailored to local setting with regular follow-up for improving BMW management, and therefore, the quality of health services (11). Kapoor et al. conducted a systematic review of cross-sectional studies which found inadequate knowledge and awareness of BMW; hence there is an urgent need for regular training and continuing medical education for healthcare professionals (11). Pullishery et al. showed that doctors, nurses, and laboratory technicians had better knowledge than sanitary workers which was in accordance with this study (12).

Conclusions

The results of the present study showed that knowledge, attitude, and practices of participants were not adequate among different categories of healthcare providers. Safe and effective management of waste is not only a legal necessity but also a social responsibility. The government should take the responsibility to train effectively the healthcare providers working in secondary healthcare settings. Compulsory continuous intensive training programs should be conducted at regular time interval for all the paramedical personnel with special importance to the newcomers, and they should have access to BMWM guidelines in their department/healthcare delivery section. The authors recommend similar studies in different settings and further research to provide accurate data for future decision-making.

Recommendations

Based upon the observations from the study, the authors recommend that all the employees of various designations in secondary healthcare center are required to be aware of proper collection, segregation, and transport to the final disposal point. A single training session is not sufficient for effective and complete practice of biomedical waste management. There is a need for the

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intensive training programs at regular time interval to repeatedly train and retrain all the staff with special importance to the newcomers and to periodically acquaint them with updated BMW management. The researchers also recommend that strict supervision and surveillance should be followed in day-to-day hospital waste management activity. Various demonstration programs should be conducted for those personnel who are in direct contact with BMW to increase their level of understanding and associated risks. BMW management should be strictly implemented and monitored in a systematic and simplistic manner by authoritative bodies in India and other developing countries.

Conflict of interests

There is no conflict of interest.

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Nil

Ethical considerations

Data were collected after obtaining written informed consent from all of the participants. This research project was approved by the Institutional Human Ethics Committee, Madras Medical College, Chennai.

Code of ethics

ECR/270/Inst./TN/2013/RR-20

Authors' contributions

M. V. and M. R, designed the study and wrote the manuscript; M. R, gathered data, cooperated in manuscript preparation, and submitted it. Both authors analyzed the data and cooperated in revising the manuscript.

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