

# Rates of perceived medical errors and its correlation with work-related factors and personal distress among emergency physicians in China: a national cross-sectional study

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## ABSTRACT

**Purpose** Medical errors are a global concern, and specifically, EDs are at considerable risk for medical errors. Few studies focus on the healthcare provider's self-perceived medical errors in hospitals, let alone the ED. Hence, this study explored perceived medical errors and their correlation with work-related factors and personal distress among physicians in EDs in China.

**Methods** From July 2018 to August 2018, a national web-based cross-sectional study was conducted. The link to the web-based questionnaire was posted on the emergency physicians' working platform, inviting Chinese licensed emergency physicians to participate anonymously in this survey. Our outcome of interest, medical errors, was investigated using self-reporting methods. Occupational stress was assessed using the Chinese version of the Effort-Reward Imbalance scale. The Patient Health Questionnaire, the subscale of the 10-item Positive and Negative Affect Schedule, the subscale of the validated Leiden Quality of Work Questionnaire and the 10-item Generalised Self-efficacy Scale were used to assess personal distress. Logistic regression analysis was used to determine factors significantly associated with perceived medical errors.

**Results** A sample of 10 457 emergency physicians completed the survey. Almost half (43.63%) of physicians reported self-perceived medical errors during the previous 3 months. The rate of workplace verbal aggression, effort-reward imbalance and depressive symptoms were 81.81%, 78.39% and 35.71%, respectively. Medical errors were more likely to be reported among chief physicians, and those who reported the department was short-staffed for physicians, and who experienced workplace verbal aggression and intense work stress. Medical errors were significantly associated with negative affect and lower self-efficacy.

**Conclusion** Self-perceived medical errors are prevalent among physicians working in EDs and are associated with their workplace environment and personal distress. Targeted interventions are required to reduce physicians' workload and improve their working environment. Accounting for healthcare providers' distress is imperative for reducing the incidence of medical errors and improving their health.

## INTRODUCTION

Medical errors are faults or mistakes committed by health professionals, which in turn may harm

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Medical errors are prevalent and harmful in healthcare systems worldwide, but research about the self-perceived prevalence of errors and association with stress and self-efficacy are uncommon.

## WHAT THIS STUDY ADDS

⇒ In this survey of 10 457 emergency physicians in China, self-perceived medical errors were common.  
⇒ Multiple domains of work-related factors and personal distress were associated with the occurrence of self-perceived medical errors.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ While this study cannot distinguish between cause and effect, the association between medical errors and personal distress suggests the need for more attention to system changes that can help avoid medical errors, as well as attention to physician well-being as a possible source or consequence of errors.

the patient. These errors are prevalent throughout the healthcare system and can result in increased morbidity, mortality and financial cost,<sup>1-3</sup> which continue to be an essential concern internationally. A meta-analysis published in the *BMJ* in 2019 included 70 studies involving a total of 337 025 patients and showed that 1 in 20 patients was exposed to preventable medical errors.<sup>3</sup> The WHO reported that about 1 in 300 patients dies because of medical errors.<sup>2</sup> It was estimated that 15% of healthcare expenditure in OECD (Organization for Economic Co-operation and Development) countries is spent on treatment of the direct sequelae of health-related patient harm.<sup>1</sup>

Because of crowding, ED physicians are often required to manage multiple patients simultaneously and make quick decisions with incomplete information, making the ED one of the most at-risk environments for medical errors.<sup>4</sup> Results of a National Emergency Department Safety Study in the USA showed that ED crowding level was directly associated with the risk of preventable medical errors.<sup>5</sup>



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Although some studies internationally have examined the association between medical errors and adverse emotions such as burnout, fatigue or depressive symptoms, no studies have focused on the emergency physicians and relevant studies generally had problems of insufficient sample size and low representativeness.<sup>6,7</sup> Emergency medicine in China has undergone tremendous growth since the 1980s. Access to emergency care and the quality of that care remain significant challenges faced by the Chinese healthcare system due to the limited healthcare resources and huge population base.<sup>8</sup> There is little data about adverse medical events in China which is due to the lack of a systematic medical error reporting system and a positive patient safety culture.<sup>9,10</sup>

Moreover, no study explores the relationship between self-perceived medical errors and emergency medicine physicians' distress. Most of the existing studies in China are from the patients' perspective, and focus on medical incidents/disputes which had a more serious impact on patient safety.<sup>11,12</sup> Some studies investigated patients' perceptions and attitudes towards doctors after medical errors.<sup>13</sup> However, we are unaware of studies about the occurrence and related influencing factors of medical errors among healthcare workers, especially in the ED.

This study used a cross-sectional design to evaluate the prevalence of self-perceived medical errors among emergency physicians nationwide and to explore the association of medical errors with work-related risk factors and personal distress from the service provider side. Our findings can contribute to efforts for improving the quality and safety of healthcare services provided by emergency medical professionals as well as physician well-being.

## METHODS

### Study design and data collection

From July 2018 to August 2018, a nationwide cross-sectional study named 'Chinese Pre-hospital Emergency Survey' was conducted in 31 provinces of China, with the coordination of the Medical Administration Bureau of the National Health Commission of the People's Republic of China. While emergency physicians and nurses participate in prehospital care in China,<sup>14</sup> the study was aimed at physicians practising in EDs. According to the China Health Statistics Yearbook 2020 released by the National Health Commission, the number of Chinese practicing physicians in emergency medicine in 2018 was approximately 60 200.

An anonymous web-based questionnaire was used to collect the data using an online survey platform in China (platform name: Questionnaire Star, website: <https://www.wjx.cn>).

The link of the electronic questionnaire was posted on the emergency physicians' working platform of the prehospital emergency facility configuration monitoring department, and emergency physicians were invited to anonymously enrol in this online survey. The link to the questionnaire was reposted on the working platform every 7 days to encourage emergency physician's enrolment. The respondents would receive an account login request from the platform after clicking the link. Each account could only submit the questionnaire once, to prevent duplicate surveys. The questionnaire cannot be submitted unless all the questions were completed.

Before formally starting the survey, all participants were required to read an electronic informed consent form, and only physicians who agreed to participate in the study were able to visit the link and fill out the questionnaire.

## Measurements

The questionnaire collected sociodemographic characteristics such as gender, age and educational levels. Work-related factors comprised hospital level, professional title, frequency of experiencing workplace verbal aggression from the patients in the past year, self-perceived shortage of physicians and occupational stress (effort-reward imbalance and overcommitment). Personal distress included depressive symptoms, negative affect, job satisfaction and self-efficacy.

- Perceived medical errors were evaluated by asking the participants one question, 'Are you concerned that you have made any major medical errors in the last 3 months? (Yes/No).', as per the study by West *et al.*<sup>15</sup> Respondents were told that major medical errors were defined as serious medical errors that cause harm or have substantial potential to cause harm to the patients, and which included preventable adverse events, intercepted serious errors and non-intercepted serious errors. Errors with little or no potential harm or unpreventable adverse events were not to be considered.<sup>16</sup>
- Occupational stress was assessed using the Chinese version of the Effort-Reward Imbalance (ERI) which consists of 3 dimensions, with 23 items assessing 'extrinsic effort' (6 items), 'reward' (11 items) and 'overcommitment' (6 items).<sup>17,18</sup> Overcommitment measures a person's motivational pattern of coping with demands characterised by a tendency to be excessively absorbed in work. Responses to the items of 'extrinsic effort' and 'reward' are scored on a 5-point Likert scale, where a value of 1 indicates no stressful experience and a value of 5 indicates very high stressful experience. The items of the scale 'overcommitment' are scored on a 4-point scale ranging from 1 (full disagreement) to 4 (full agreement with statement). The degree of occupational stress can be expressed independently by the effort-reward ratio (ERR) and overcommitment. The ERR is calculated by the formula:  $ERR = 11 \times \text{Effort} / 6 \times \text{Reward}$ . An ERR value above 1.0 indicates experiencing ERI, which means high occupational stress. The Cronbach's  $\alpha$  for extrinsic effort, reward and overcommitment were 0.86, 0.93 and 0.86, respectively.
- Depressive symptoms were assessed using the Patient Health Questionnaire (PHQ-9).<sup>19</sup> The items are rated on a scale ranging from 0 (not at all) to 3 (nearly every day) concerning the previous 2 weeks, and the total score ranges from 0 to 27. Higher scores indicate the presence of more depressive symptoms, and a score of at least 10 is considered indicative of major depressive symptoms. The Cronbach's alpha values of this scale was 0.92, indicating good reliability.
- Negative emotions were measured by the subscale derived from the 10-item Positive and Negative Affect Schedule (PANAS).<sup>17,20</sup> It comprises the last five items of the PANAS. Items were rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The total possible score of the measured negative affects ranges from 5 to 25. The higher the score, the more negative emotions were experienced. In this study, the Cronbach's  $\alpha$  for this subscale was 0.87.
- Job satisfaction was measured by the subscale of the Leiden Quality of Work Questionnaire.<sup>17,21</sup> Each question of this 6-item tool was rated on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The higher the score, the more job satisfaction was perceived. The Cronbach's alpha values of this scale was 0.86, indicating strong reliability.

- Self-efficacy was evaluated by 10-item Generalised Self-efficacy Scale (GSE).<sup>17 22</sup> The items of the GSE scale were scored on a 4-point Likert scale ranging from 1 (completely incorrect) to 4 (completely correct). The total score of measured self-efficacy ranged from 10 to 40. The higher the score, the higher level of the self-confidence possessed by the respondent in facing difficulties. The Cronbach's  $\alpha$  of the scale equal to 0.93, indicating strong reliability.

### Statistical analysis

All the analyses were conducted using the Statistical Analysis System (SAS) V.9.4 for Windows (SAS Institute). For continuous variables, we calculated the medians and IQRs. For categorical variables, we presented frequencies and percentages.  $\chi^2$  tests were used to compare the distribution of categorical variables between the group with self-reported medical errors and the group without. Wilcoxon Mann-Whitney tests were conducted to compare the continuous variables such as age, overcommitment, the generalised self-efficacy score, etc, between groups with or without medical errors. Statistical significance was set at 0.05 and all comparisons were two-tailed. Finally, the associations between the independent variables and the perceived medical errors were explored using multivariable logistic regression analysis. We included categorical variables such as gender, education level, self-perceived physical health, hospital level, job title, shortage of physicians, frequency of workplace verbal aggression, effort-reward imbalance and presence of depressive symptoms, as well as continuous variables such as age, overcommitment, negative affect, job satisfaction and self-efficacy in our multivariable model. We included age in the regression model using a form of every 10-year increase, while for other continuous variables, we included in the form of each 1-point change. The adjusted ORs and 95% CIs for all variables were reported. Variables that were significant in the univariate analysis were included in the multivariate model for further analysis.

### Patient and public involvement statement

It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting or dissemination plans of our research.

## RESULTS

### Participants' characteristics for sociodemographic variables, work-related factors and personal distress

During the survey period, 15 288 licensed physicians working in EDs clicked on the link. Of these 10 457 physicians finished the survey, for a completion rate of 68.4%. The basic characteristics of the included respondents are summarised in table 1. The majority (74.49%) of physicians had a bachelor's degree, and almost one-tenth had a masters or doctoral degree. The proportion of physicians reporting bad self-perceived physical health was 36.61%. More than three-quarters of physicians reported a shortage of physicians in their departments. More than 80% of the physicians experienced workplace verbal aggression in the past years. The mean ERI scores of the physicians was 1.55 (SD=0.79). The mean scores exceeded the threshold indicative of imbalance, with 78.39% of physicians experiencing an effort-reward imbalance. The mean score of the PHQ-9 was 8.92 (SD=5.81), signifying a high level of depressive symptoms. Overall, there were an estimated 35.71% physicians with major depressive symptoms.

### Rates of perceived medical errors and its association with demographic characteristic, work-related factors and personal distress

Almost half of the surveyed physicians (43.63%) reported self-perceived medical errors in the last 3 months before this investigation (table 1). In univariate analysis, significant associations of all demographic characteristics, work-related factors and personal distress with physicians' self-perceived medical errors were found.

In multivariable logistic regression (table 2), older age and female sex were associated with lower likelihood of self-reported medical errors. Physicians attaining a higher educational level, those working in secondary or tertiary hospitals, those serving as doctor-in-charge or chief physicians and those reporting a shortage of physicians their departments had a higher risk of medical errors. Physicians reporting fair or bad physical health and those with greater exposure to verbal aggression at work had higher risk of reporting medical errors. Additionally, for every 1-point increase in the overcommitment score, the odds of a self-reported error in the previous 3 months for physicians increased by 12%. For every 1-point increase in the negative affect score, the odds of reporting self-perceived errors increased by 40%. For every 1-point increase in the self-efficacy score, the odds of reporting medical errors decreased by 20% for emergency physicians. However, depressive symptoms were not independently associated with likelihood of reporting medical errors.

## DISCUSSION

This nationwide cross-sectional study showed that self-perceived medical errors were common among the studied physicians in an ED, with nearly half of physicians admitting that they had made medical errors over the last 3 months. A study from the USA published in 2006 showed that the incidence of major medical errors among internal medicine residents in the past 3 months was 14.7%.<sup>15</sup> Although the incidence of medical errors in this study is much higher than that reported in the previous study, it is difficult to directly compare our results with previous studies due to the differences in the study population and measuring methods. However, a study conducted by Wen and colleagues showed that 54.8% of physicians reported committing medical mistakes during the prior year in China,<sup>23</sup> suggesting that the prevalence of self-perceived medical errors among emergency physicians in China is significant.

This study revealed that medical mistakes were significantly lower among females, which was consistent with previous empirical evidence.<sup>6 23</sup> This might be related to essential female characteristics—carefulness, empathy and practice skills like communication.<sup>6 23 24</sup> A study of Australian general practitioners showed that male doctors worked longer hours than female doctors and had a relatively higher number of patients to serve,<sup>25</sup> which could increase the risk of medical errors. Multivariate analysis indicated that medical errors were significantly lower among physicians who were older. This may be because the older the physicians are, the more experienced and skilled they are. This result was consistent with existing research.<sup>26</sup> After controlling for other variables, physicians attaining a higher educational level are more likely to report medical errors. The possible reason was that physicians with higher educational levels were more likely to take care of patients who have more severe diseases; therefore, they have a higher likelihood of reporting self-perceived medical errors. Additionally, this result could indicate that highly educated physicians have a higher level of awareness of medical errors and optimal medical care, and a more positive attitude towards reporting medical errors.<sup>27</sup>

The findings of our study are consistent with previous studies that indicate that medical errors are associated with workplace environment, over workload, fatigue and feeling of distress.<sup>23 28</sup> Almost

**Table 1** Participant characteristics and univariate associations with self-perceived medical errors

	Physicians (N=10 457)		Physicians who reported errors (N=4562)		Physicians who reported no error (N=5895)		P value
	n	%	n	%	n	%	
Total	10 457	100.0	4562	43.6	5895	56.4	
Age (median, P25–P75)	35.00 (31.00–41.00)		35.00 (31.00–40.00)		36.00 (31.00–42.00)		<0.0001*
Sex							<0.0001
Male	7632	73.0	3497	45.8	4135	54.2	
Female	2825	27.0	1065	37.7	1760	62.3	
Education level							<0.0001
Associate degree or vocational diploma†	1684	16.1	556	33.0	1128	67.0	
Bachelor degree	7789	74.5	3519	45.2	4270	54.8	
Master degree or higher	984	9.4	487	49.5	497	50.5	
Self-perceived physical health							<0.0001
Good	1499	14.3	346	23.1	1153	76.9	
Fair	5130	49.1	2074	40.4	3056	59.6	
Bad	3828	36.6	2142	56.0	1686	44.0	
<b>Work-related factors</b>							
The level of hospital							<0.0001
Primary hospital and others	2429	23.2	905	37.3	1524	62.7	
Secondary hospital	4442	42.5	1949	43.9	2493	56.1	
Tertiary hospital	3586	34.3	1708	47.6	1878	52.4	
Job title							0.0014
Resident	4972	47.6	2089	42.0	2883	58	
Physician-in-charge	4112	39.3	1882	45.8	2230	54.2	
Chief physician	1373	13.1	591	43.0	782	57.0	
Shortage of physicians							<0.0001
No	2790	26.7	926	33.2	1864	66.8	
Yes	7667	73.3	3636	47.4	4031	52.6	
Workplace verbal aggression (times)							<0.0001
0	1902	18.2	421	22.1	1481	77.9	
1–3	4130	39.5	1686	40.8	2444	59.2	
4–6	1705	16.3	879	51.6	826	48.5	
7–	2720	26.0	1576	57.9	1144	42.1	
Effort-reward imbalance							<0.0001
No	2260	21.6	653	28.9	1607	71.1	
Yes	8197	78.4	3909	47.7	4288	52.3	
Overcommitment (median, P25–P75)	18.00 (17.00–19.00)		18.00 (18.00–20.00)		18.00 (17.00–18.00)		<0.0001*
<b>Personal distress</b>							
Depressive symptoms							<0.0001
No	6723	64.3	2410	35.9	4313	64.2	
Yes	3734	35.7	2152	57.6	1582	42.4	
Negative affect (median, P25–P75)	17.00 (14.00–20.00)		18.00 (15.00–20.00)		15.00 (13.00–19.00)		<0.0001*
Satisfaction with job (median, P25–P75)	12.00 (10.00–15.00)		11.00 (9.00–13.00)		12.00 (11.00–16.00)		<0.0001*
Self-efficacy (median, P25–P75)	26.00 (21.00–30.00)		24.00 (20.00–29.00)		27.00 (22.00–30.00)		<0.0001*

\*This p value is associated with Wilcoxon Mann-Whitney test; all other p values are associated with  $\chi^2$  tests.

†To obtain an associate degree in China requires 3 years of education in college after graduation from senior middle school (grade year 10 to year 12). An associate degree in China is equivalent to the UK's Higher National Diploma. To obtain a vocational diploma requires 3 years of education in vocational schools after graduation from junior middle school (grade year 7 to year 9).

three-quarters of physicians reported a shortage of doctors, and more than 80% of physicians were exposed to workplace verbal aggression during the last year, and both factors were independently associated with a higher incidence of perceived medical mistakes. Excessive work stress was a huge problem facing the participants in this study. For instance, mean scores for effort-reward imbalance and overcommitment were both higher than that reported by a 2005 study among Chinese healthcare workers.<sup>18</sup> This disparity may be attributable to the difference in the population studied or the ever-increasing work stress among Chinese healthcare workers.

The above evidence suggests that healthcare facilities' administrators and policy-makers should consider interventions to reduce physicians' workload and improve the working environment (work stress and workplace verbal aggression) for the safety of both patients and physicians.

In this study, physicians with relatively senior titles and those who work in a higher level hospital also had a higher likelihood of reporting medical errors. It is possible that their greater stability and job security allowed them greater ability and willingness to report medical errors. However, higher level hospitals have more patient



**Table 2** Multivariable logistic regression of factors associated with self-perceived medical errors

Variables	Odds ratio (95% CI)	P value
Age*	0.79 (0.73 to 0.86)	<0.0001
Sex (ref=male)		
Female	0.70 (0.64 to 0.78)	<0.0001
Education level (ref=associate degree or vocational diploma)		
Bachelor degree	1.17 (1.04 to 1.34)	0.0125
Master degree or higher	1.56 (1.29 to 1.88)	<0.0001
Self-perceived physical health (ref=good)		
Fair	1.40 (1.21 to 1.61)	<0.0001
Bad	1.61 (1.37 to 1.89)	<0.0001
The level of hospital (ref=primary hospital and others)		
Secondary hospital	1.17 (1.05 to 1.31)	0.0051
Tertiary hospital	1.22 (1.09 to 1.38)	0.0009
Job title (ref=resident)		
Physician-in-charge	1.12 (1.00 to 1.24)	0.0446
Chief physician	1.31 (1.10 to 1.56)	0.0023
Shortage of physicians (ref=no)		
Yes	1.12 (1.01 to 1.24)	0.0337
Workplace verbal aggression (times) (ref=no)		
1~3	1.66 (1.45 to 1.90)	<0.0001
4~6	2.08 (1.78 to 2.44)	<0.0001
7~	2.33 (2.00 to 2.70)	<0.0001
Effort-reward imbalance (ref=no)		
Yes	1.04 (0.92 to 1.17)	0.5595
Overcommitment†	1.12 (1.06 to 1.18)	<0.0001
Depressive symptoms (ref=no)		
Yes	1.05 (0.95 to 1.17)	0.3532
Negative affect†	1.41 (1.34 to 1.49)	<0.0001
Satisfaction with job†	0.96 (0.91 to 1.02)	0.1676
Self-efficacy†	0.81 (0.77 to 0.85)	<0.0001

\*This result meant each 10-year increase in the physicians' age was associated with a 21% reduction in the odds of a self-reported error in the previous 3 months.

†These results showed the association between each 1-point change of continuous variables and the odds of self-reported medical errors in the previous 3 months.

visits and provided relatively more medical services<sup>29</sup>; thus, the risk of medical errors is relatively higher.

The 2006 US publication on medical errors indicated that medical errors not only affect patients but exhibit a strong association with multiple domains of healthcare worker's well-being, which in turn will increase odds of future self-perceived errors, thus forming a reciprocal circle.<sup>15</sup> Following the above findings, our study found that negative emotion and lower self-efficacy were independently associated with the physicians' increased self-reported medical errors. Because this study was an observational cross-sectional study, this research could not determine the causal relationship between medical errors and personal distress. However, as the 'second victims' of medical errors, health professionals should not be neglected.<sup>30</sup> A few studies have examined the prevalence of second victims in the USA, with reported rates of 10.5% and 30% among otolaryngologists and healthcare professionals, respectively.<sup>7, 31</sup> To date, no study has explored the 'second victim' phenomenon in China.

Our study has several limitations. First, medical errors in this study were based on self-perception. The extent to which these self-reported errors accurately reflect the frequency of medical errors cannot be determined.<sup>16</sup> Second, this study focused on the overall occurrence of medical errors and did not survey the

occurrence of different categories of medical errors. In-depth studies investigating the relationship between different types and outcomes of medical errors and factors related to health-care providers would allow more valid information to be obtained and targeted management measures to be developed and implemented. Third, this was a cross-sectional study unable to determine the causal relationship between medical errors and multiple categories of variables. Fourth, the study design was not random, which could potentially impact the findings through selection bias. Nevertheless, our study included an extensive nationwide sample which should be a fair representation of the general population of Chinese emergency physicians. In addition, we focused only on physicians in the ED. Our results could not apply to the other departments in the hospital.

In conclusion, in this large study of Chinese physicians working in EDs, self-perceived medical errors are common and are significantly associated with the workplace environment (work stress and workplace verbal aggression) and substantial personal distress. Targeted interventions are required to reduce physicians' workload and improve their working conditions for the safety of their patients and healthcare workers. Additionally, further research is needed to explore the second victim phenomenon of medical errors, and practical strategies need to be operationalised to minimise the incidence of medical errors and its 'second victim'.

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**Patient consent for publication** Not applicable.

**Ethics approval** This study was approved by the Medical Ethics Committee of Hainan Medical College (HYLL-2018-035). Each participant was voluntary and all identity details of study participants were kept confidential. Participants gave informed consent to participate in the study before taking part.

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