Effect of Emotional Factors on Pediatric Medical Adverse Events: Analysis using a Japanese National Database

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Background: The complexity of decision-making and diversity of tasks in pediatric practice can lead to medical errors. To confirm the hypothesis that physicians’ emotions influence the occurrence of medical errors, we analyzed medical adverse event reports to assess the effect of emotional factors on pediatrician decision-making and medical errors.

Methods: This study involved case analyses of reports of pediatrician-related medical adverse events drawn from a Japanese national medical database. We examined 310 adverse medical event reports involving pediatrician errors recorded over a 6-year period. Reports involving decision-making errors were extracted and analyzed by the patient’s age, doctor’s experience, severity of the adverse event, event circumstances, timing of errors by decision-making stage, and the presence of emotional factors.

Results: We found decision-making errors in 58.6% of the examined medical adverse events reports. Most errors occurred in the situation awareness and decision stages. Overall, 53.2% of cases involving decision-making errors showed emotional involvement in the adverse event occurrence. The three emotional factors that most affected errors were trust, optimism, and distraction.

Conclusions: Over half of the cases of errors in the decision-making process had an emotional component. The finding that trust influenced medical errors suggests that even positive emotions may affect errors. More awareness of the emotional aspects of clinical decision-making and research approaches that address emotion will help to reduce medical errors and improve patient safety.

Key words: patient safety, medical errors, decision-making, emotions

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Introduction

In 1999, the National Academy of Sciences published a report entitled “To Err Is Human”¹. However, a large number of medical accidents still occur despite preventative measures²,³. Children are at greater risk for medical accidents than adults⁴,⁵ because of their physical characteristics, development, and legal status as minors⁴,⁶. The interpretation of medical examination results also depends on a patient’s age, weight, and gender⁷,⁸, which is particularly relevant to the work of pediatricians. In addition, pediatricians are expected to share decision-making with their patients’ parents⁹. Pediatricians’ duties have also become increasingly complex as medical technology has advanced, and errors can occur because pediatricians are engaged in diverse medical tasks. Therefore, this study focused on medical adverse events involving pediatricians.

During medical activities, physicians engage in a cognitive process to reach decisions. Endsley suggested that the decision-making process (DMP) comprises three stages: situation awareness, the decision, and performance of action¹¹. The relationships between emotion and decision-making have been analyzed¹², with emotions suggested to be the cause of actions¹³. Emotions experienced by healthcare providers can lead to emotional bias in clinical decision-making, which may result in errors and adverse events¹⁴.

Previous studies have acknowledged that physicians’ emotional responses can affect medical safety¹⁵–¹⁷. However, the influence of physicians’ emotions on patient safety is less recognized¹⁷, and few studies have investi-
gated how emotional factors influence medical errors. The American Journal of Medicine featured errors in medical decision-making in 2008, and identified emotional factors as a necessary area of study to improve weaknesses in the DMP.

The present study aimed to investigate whether pediatrician-related emotional factors affected the occurrence of medical adverse events, using data drawn from a Japanese national database. The novelty of this study is the focus on how emotional factors influence adverse medical event reports.

**Methods**

This analysis-based study used case reports of medical adverse events from a national open database in Japan. In 2004, Japan’s Ministry of Health, Labour and Welfare partially revised the enforcement ordinance for the Medical Care Act (Ministry of Health, Labour and Welfare Ordinance No. 133, 2004) to require some large medical institutions (Table 1) to report adverse medical events. Next, the Japan Council for Quality Health Care (registered by the Minister of Health, Labour and Welfare) conducted a “Project to Collect Medical Near-Miss/Adverse Event Information.” In addition to medical institutions that were subject to reporting requirements, other medical institutions voluntarily participated in this project; as of December 31, 2015, 1018 medical institutions had participated (275 subject to reporting requirements and 743 voluntary participants). The project website (http://www.med-safe.jp/contents/english/index.html) contains open data. Adverse medical event information and medical near-miss event information from 2010 are available via this website (in Japanese). The open database contained 58,024 Japanese reports for a 6-year period (January 1, 2010, to December 31, 2015); 17,406 adverse medical events and 40,618 medical near-miss events.

Medical adverse events requiring reporting are shown in Table 2. These are unfavorable events that occurred in patients mainly as a result of treatment or management, and were not dependent on the presence/absence of medical malpractice. Reports of medical adverse events include information such as: month, year, and time zone of occurrence; severity of the event; overview of the event; number of patients involved and their age and gender; job title and years of experience of the healthcare professional involved; details of the event; background and causal factors; and improvement measures. The open database reports do not publish the month and year of the adverse event occurrence, and the patient’s age is given in 10-year intervals. The report deadline is within 2 weeks of the day the event occurred or the day the event was recognized. Submitted reports do not include the day the event occurred and personal information about patients and healthcare providers. An exemption from institutional review board approval was granted for the present study (Notice number 29-1).

The database can be searched by clinical department, job title of the healthcare professional involved, and keywords and retrieved adverse event reports may be downloaded. However, adverse event information cannot be selected by month and year of occurrence as the month and year of occurrence are not disclosed. Therefore, we used data for 17,406 adverse medical events over a 6-year period. After filtering the data by job title of the healthcare professional involved, we obtained 7161 reports that involved physicians. After further filtering the reports by clinical department, 310 pediatric reports were identified (Fig. 1).

### Table 1: Japanese medical institutions required to report medical adverse events under the enforcement ordinance for the Medical Care Act

| a) | National Research and Development Agencies and National Hansen’s Disease Sanatorium |
| b) | Hospitals run by the National Hospital Organization |
| c) | Hospitals affiliated to universities governed by the School Education Act No. 26, 1947 (not including their branch hospitals) |
| d) | Special Functioning Hospitals |

From: “Project to Collect Medical Near-Miss/Adverse Event Information 2015” Annual Report. Japan Council for Quality Health Care Division of Adverse Event Prevention (http://www.med-safe.jp/pdf/year_report_english_2015.pdf).

### Table 2: Medical adverse event information subject to reporting in Japan

| a) | Apparent errors in treatment or management that resulted in the patient’s death or mental or physical disability, or required unexpected treatment, treatment to an unexpected extent, or other medical procedure. |
| b) | Unapparent errors in treatment or management that resulted in the patient’s death or mental or physical disability, or required unexpected treatment, treatment to an unexpected extent, or other medical procedure (including events possibly associated with treatment or management provided; limited to unexpected events). |
| c) | Other than those described in a) and b), information conducive to the prevention of medical adverse events and their recurrence at medical institutions. |

From: “Project to Collect Medical Near-Miss/Adverse Event Information” 2015 Annual Report. Japan Council for Quality Health Care Division of Adverse Event Prevention (http://www.med-safe.jp/pdf/year_report_english_2015.pdf).
Our study team comprised two pediatricians with 15 years (or more) clinical experience, one physician, one nurse, one psychology researcher, and one medical care statistics researcher. First, all team members reviewed the 310 adverse event reports. Team members with clinical experience provided supplementary explanations of technical terms and medical practices performed. For each report, each team member reviewed and evaluated the presence or absence of pediatrician DMP errors. They filled out the evaluation table invisible from the other raters. We defined DMP in terms of three stages: situation awareness, decision, and performance of action. Errors were defined as “mental or physical activities that did not result in intended results” based on the definition of human error by James Reason.

Six raters evaluated the presence or absence of pediatricians’ DMP errors in the 310 reports. We included reports with agreement of five or more raters, and excluded reports with agreement of four or fewer raters. There were several reports for which the evaluation differed among raters. Three reports were excluded because of agreement of four or fewer raters. Of the 307 remaining cases, 180 (58.6%) were evaluated as having pediatrician DMP-related errors. Therefore, this analysis focused on 180 cases with identified pediatrician DMP errors (Fig. 1).

Variables examined were: patient’s age (in 10-year intervals, as categorized in the database), physician’s experience, severity of the event, event circumstances, and timing of errors by decision-making stage. Physicians’ years of experience were categorized as 0–4 years, 5–9 years, 10–14 years, 15–19 years, and ≥ 20 years. If two or more pediatricians were involved in a single case, we chose the pediatrician that was most involved in the adverse event occurrence or at the top of the list of those involved. We classified the severity of the event according to the report. “Unknown” included an indefinite outcome at the time of reporting (within 2 weeks). We compared the number of DMP errors based on the circumstances of the error (drug, treatment/procedure, examination, medical equipment, drainage or other tube, care in hospital and consultation/diagnosis) made by the pediatrician, and classified errors according to the three DMP stages (situation awareness, decision, and performance of action). For cases in which a pediatrician caused more than one error, we chose the error that most influenced the adverse event for analysis.

We used Plutchik’s three-dimensional circumplex model to classify emotions, which comprises eight basic emotions: joy, trust, fear, surprise, sadness, disgust, anger, and anticipation. The model also contains eight complicated emotions (derived by blending the basic emotions): optimism, love, submission, awe, disappointment, remorse, contempt, and aggressiveness. In this study, we used the term “emotional factors” to describe these 16 emotions. We modified the definition of emotional factors to make it easier to classify the emotional factors involved in medical adverse events (Table 3).

Each team member estimated the presence/absence of pediatrician-related emotional factors in the 180 reports. For each report, we chose one emotional factor that best
fit the description of the event. After all raters filled out the evaluation table invisible from the other raters, we combined the results. We decided on emotional factors involved in each case by majority. Reports with agreement of four or fewer raters were excluded. Based on this evaluation, we clarified the proportion of cases of pediatrician DMP errors affected by emotions. In addition, we showed the percentage of emotion-related errors by event circumstances and emotional factors.

As some reports did not mention the pediatrician’s thought processes or psychological situation, the present data included estimates. To improve objectivity, we analyzed inter-rater reliability using Fleiss’s kappa coefficient. This statistic (κ) ranges from 1 to −1: κ < 0 shows poor agreement, κ = 0–0.20 slight agreement, κ = 0.21–0.40 fair agreement, κ = 0.41–0.60 moderate agreement, κ = 0.61–0.80 substantial agreement, and κ = 0.81–1.00 almost perfect agreement. All statistical analyses were performed on a personal computer with R software version 3.4.1 “irr package.” A P-value < 0.05 was considered significant.

**Results**

Of the 17,406 adverse medical event reports made between January 1, 2010, and December 31, 2015, 310 reports were related to physician and pediatric departments. Based on the judgment of six raters, three reports with agreement of four or fewer raters were excluded. Six raters determined that 180 reports (58.6%) were associated with pediatricians’ DMP errors. These 180 cases are the focus of this study (Fig. 1). Fleiss’s kappa coefficient showed almost perfect agreement (κ = 0.96, P < 0.001).

**Demographic characteristics**

Table 4 shows the characteristics of the 180 cases. The age range of the patients was 0–49 years; 94.5% were aged 0–19 years, with most of these patients aged 0–9 years. Most involved physicians had 5–9 years of experience. Analysis of event severity showed 17.7% of events resulted in death or had high potential of residual disability, and 55.5% resulted in no disability/no potential of residual disability. In terms of the event circumstances, 71.6% of events involved drugs or treatments/procedures. Most errors (91.1%) occurred in the first two DMP stages (situation awareness and decision).

**Errors influenced by emotions**

Figure 2 shows the process of evaluating emotions. Of the 180 reports with DMP errors, 22 reports with agreement of four or fewer raters were excluded and 84 reports (53.2%) showed emotional involvement in the adverse event occurrence. Fleiss’s kappa coefficient showed substantial agreement (κ = 0.61, P < 0.001). We classified the proportion of emotion-related/emotion-unrelated errors by event circumstances. In total, 63.4% of events involving drugs and 71.4% of those involving consultation/diagnosis were influenced by emotion (Table 5). There were no circumstances without emotion-related errors (Table 5).

Further, we analyzed emotional factors in the 62 cases associated with pediatricians’ DMP errors. Table 3 illustrates definitions of emotional factors.

| Emotional factors | Definition |
|-------------------|------------|
| Anger             | to feel displeasure or hostility; includes “annoyance” or “rage” |
| Aggressiveness    | to challenge things by oneself |
| Anticipation      | to pay attention possible difficulties or to avoid risks; to predict the progress or results of things, thereby including overlooking other findings; includes “interest” or “vigilance” |
| Optimism          | to think that things will turn out well and not to be worried; includes “overconfidence” |
| Joy               | to experience pleasure and happiness; includes “fulfillment,” “serenity,” or “ecstasy” |
| Love              | to feel affection; includes “kindness” |
| Trust             | to believe in another person; includes “acceptance,” “dependence,” or “admiration” |
| Submission        | to follow others’ opinions and obey orders despite having different thoughts |
| Fear              | to worry about mistakes or difficulties; includes “apprehension” or “terror” |
| Awe               | to feel reverential respect |
| Distraction       | interruption of attention; includes “hurry,” “confusion,” “excessive nervousness,” “surprise,” and “amazement” |
| Disapproval       | to think that someone’s behavior or ideas are inappropriate |
| Sadness           | to feel sad; includes “pensiveness” or “grief” |
| Remorse           | to have deep regret or guilt |
| Disgust           | to feel dislike; includes “boredom” or “loathing” |
| Contempt          | to feel that no respect is deserved |
shown in Fig. 2, and found substantial agreement ($\kappa = 0.68, P < 0.001$). Table 6 shows the number of errors and examples of description of reports by emotional factors. There were no cases related to anger, aggressiveness, joy, fear, awe, disapproval, sadness, remorse, disgust, and contempt (Table 6). The three emotional factors that most affected errors were trust, optimism, and distraction; these factors were involved in 57 cases (91.9%) (Table 6).

### Table 4 Characteristics of adverse medical events involving pediatrician decision-making

| Characteristics                        | No. (N = 180) | %  |
|----------------------------------------|---------------|----|
| Patient age, years                     |               |    |
| 0–9                                    | 142           | 78.9|
| 10–19                                  | 28            | 15.6|
| 20–29                                  | 4             | 2.2 |
| 30–39                                  | 3             | 1.7 |
| 40–49                                  | 3             | 1.7 |
| Pediatrician experience, years         |               |    |
| 0–4                                    | 36            | 20.0|
| 5–9                                    | 61            | 33.9|
| 10–14                                  | 39            | 21.7|
| 15–19                                  | 25            | 13.9|
| > 20                                   | 19            | 10.6|
| Severity of the event                  |               |    |
| No disability                          | 51            | 28.3|
| No potential of residual disability    | 49            | 27.2|
| Low potential of residual disability   | 40            | 22.2|
| High potential of residual disability  | 15            | 8.3 |
| Death                                  | 17            | 9.4 |
| Unknown$^1$                            | 8             | 4.4 |
| Event circumstances                    |               |    |
| Drug                                   | 76            | 42.2|
| Treatment/procedure                    | 53            | 29.4|
| Examination                            | 11            | 6.1 |
| Medical equipment                      | 4             | 2.2 |
| Drainage or other tube                 | 21            | 11.7|
| Care in hospital                       | 8             | 4.4 |
| Consultation/diagnosis                 | 7             | 3.9 |
| Timing of error                        |               |    |
| Situation awareness                    | 89            | 49.4|
| Decision                               | 75            | 41.7|
| Performance of action                  | 16            | 8.9 |

$^1$ "Unknown" included indefinite outcomes at the time of reporting (within 2 weeks).

### Table 5 Percentage of emotion-related errors by adverse event circumstances

|                         | Drug | Treatment/procedure | Drainage or other tube | Consultation/diagnosis | Examination | Care in hospital | Medical equipment | Total |
|-------------------------|------|---------------------|------------------------|------------------------|-------------|------------------|-------------------|-------|
| Emotion-related errors  | No.  | 45                  | 18                     | 10                     | 5           | 3                | 2                 | 1     | 84  |
|                         | %    | 63.4                | 40.9                   | 52.6                   | 71.4        | 37.5             | 33.3              | 33.3  | 53.2|
| Emotion-unrelated errors| No.  | 26                  | 26                     | 9                      | 2           | 5                | 4                 | 2     | 74  |
|                         | %    | 36.6                | 59.1                   | 47.4                   | 28.6        | 62.5             | 66.7              | 66.7  | 46.8|
| Total                   | No.  | 71                  | 44                     | 19                     | 7           | 8                | 6                 | 3     | 158 |

Discussion

This study investigated the influence of emotional factors on DMP errors using adverse medical adverse event reports involving pediatricians from a nationwide database in Japan. Medical decision-making is often a complicated task characterized by uncertainty. Physicians must interpret the context according to the unique situation of each patient. Medical decision-making is also often made under time pressure, and attention to patients is sometimes interrupted (e.g., by phone calls or other demands), meaning there are many potential causes of DMP errors.

In this study, pediatrician DMP errors were found in 58.6% of the studied medical adverse event reports. An analysis of the causes of 100 cases of diagnostic errors in internal medicine found cognitive factors in the physicians’ DMP affected 74% of errors, and these errors were more common than system-related errors. This highlights that many medical errors are associated with errors in physician DMP. In this study, 164 (91.1%) of the 180 cases with DMP errors were errors in situation awareness and decisions, representing 52.9% of the 310 medical adverse events identified in the pediatric area. This suggests that errors occurred in pediatricians’ thought processes in the majority cases of medical adverse events included in this study.

Recent research shows that emotions have moderate to large effects on cognitive outcomes including judgment and decision-making. Emotion affects the DMP, and emotional factors are therefore an important influence on medical safety. However, few studies have investigated the influence of emotional factors on medical errors, and it is unclear how the emotions of medical staff contribute to patient outcomes. The prevalence of cognitive biases and personality traits that affect medical decision-making is also unknown. In this study, emotion was involved in 53.2% of cases involving DMP errors. In addition, emotion-related errors tended to be more frequent in scenarios involving drugs and consultation/diagnosis.

We found that trust, optimism, and distraction were the three emotions that most influenced the occurrence of errors. A meta-analysis of 112 independent studies showed trust within the team was positively related to...
team performance\(^{19}\), however, the negative effect of trust was not investigated in that study. Heyhoe et al. suggested that positive emotions could affect clinical decision-making and healthcare professionals’ responses to clinical situations\(^{17}\). In the present study, trust affected medical errors, which supports the possibility that even positive emotions may affect errors.

Previous studies indicated that overconfidence contributed to diagnostic errors\(^{19,29,31}\). We classified overconfidence as the emotional factor “optimism.” If a doctor does not recognize the possibility of errors, the cognitive process fails and errors may occur\(^{19}\). We also classified hurry and confusion as the “distraction” emotional factor. Teng et al. investigated the influence of time pressure on

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### Fig. 2 Process of evaluating emotional factors

The flow chart shows the process of evaluating emotions in the reports included in the analysis. We judged the presence/absence of emotional involvement for 180 reports with errors in the pediatricians’ decision-making process. For the 84 reports deemed to be affected by emotions, we selected one emotional factor involved in the adverse event occurrence from 16 possible emotional factors.

### Table 6 Examples of report descriptions of emotional factor classification and number of associated errors

| Emotional factors | Examples of report descriptions | No. (N = 62) |
|-------------------|---------------------------------|-------------|
| Trust             | The physician thought a vaccine was appropriate because it was given by the pharmacy department. | 27 |
|                   | The physician did not confirm the execution of an order and proceeded to the next procedure because they thought the nurse had already performed the order. | |
| Optimism          | Although an error message appeared at the time of ordering, the physician hit the enter key repeatedly and erased the message without understanding the message (because they did not think that it was a serious message). | 21 |
|                   | The accident occurred via a magnetic body the physician brought into the front chamber of the magnetic resonance imaging room. The physician knew bringing such bodies into the front chamber was not allowed, but thought it would be safe at that distance. | |
| Distraction       | The physician was concerned about another accident a few hours ago, and felt frustrated and wished to redeem him/herself. | 9 |
|                   | The physician failed to check a calculation because of distraction by other things. | |
| Anticipation      | The physician focused on part of the fracture during follow-up and failed to notice new findings. | 2 |
| Love              | The physician performed a procedure that had not been approved out of kindness for the patient’s family, and an accident occurred. | 2 |
| Submission        | A new junior resident obeyed an order from a nurse without understanding the situation. As a result, the order was a misunderstanding by the resident. | 1 |
nurses in relation to impatience and showed that time pressure had a negative effect on patient safety for high-burnout nurses, but had no significant effect for low-burnout nurses. This highlights that the influence of emotional factors on the behavior of medical staff is complex.

In this study, we studied emotional factors related to pediatric physicians. The top three emotions identified (trust, optimism, distraction) are often experienced by physicians, which suggests this finding may not be limited to pediatricians. Emotional factors may also affect the DMP in healthcare professionals other than physicians. More research is necessary to explore this issue that includes various clinical departments and healthcare staff.

Several limitations of this study should be acknowledged. We examined medical adverse event reports from a Japanese national open database. Because these reports were not intended for an evaluation of emotion, descriptions about the physicians’ thought processes and emotions varied. Because the data were unlinkable and anonymized, it was impossible to investigate later evaluations of emotions of the healthcare professional involved. To objectively evaluate emotional factors, six raters individually evaluated all cases. However, the raters had to judge that there was no DMP error or influence of emotion in reports that did not describe the doctor’s thought process. Therefore, there might have been cases of adverse events involving physicians’ DMP errors or the influence of emotion that were not included in this analysis. For this analysis, we selected one emotional factor for each case. In several cases, evaluation was divided among raters because of the presence of multiple emotions; reports with agreement of four or fewer raters were excluded. In addition, because of the lack of descriptions of emotions in the reports, there might have been other emotional factors that were not revealed in this study. Further research that includes interviews with different parties involved in an event may reveal more important emotional factors.

This exploratory study used a descriptive approach to examine the role of emotion in medical errors. Our findings suggest that healthcare providers’ emotions influence medical errors. To build on these findings, new methods are needed to investigate emotions and decision-making in medical errors. Emotion has complex effects on clinical decision-making and healthcare providers’ responses. It is necessary to raise awareness of these factors to reduce emotion-related errors. Approaches that incorporate emotion are also necessary to improve patient safety research.

Conclusion

This study was an exploratory study of pediatrician DMP errors and the influence of emotional factors, based on adverse medical event reports from a nationwide database in Japan. Over half (58.6%) of medical adverse event reports in the pediatric setting contained pediatrician DMP errors. In most (91.1%) cases with DMP errors, errors occurred in the process from situation awareness to decisions, and 53.2% of cases with DMP errors were affected by emotions. The top three emotional factors that affected errors were trust, optimism, and distraction. This study suggests that pediatricians’ emotions affect the occurrence of medical adverse events in the pediatric setting. Based on these results, we intend to conduct further research to help to improve patient safety.

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