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Original Article

Types and Causes of Medical Errors in Respiratory Care

Pin-Zhen Lai[1], Ke-Yun Chao[1, 2], Shu-Lin Chang[3], Ming-Chih Chou[3*], Yasser Nassef[3*]

[1] *Department of Respiratory Therapy, Fu Jen Catholic University Hospital, Fu Jen Catholic University, New Taipei City, Taiwan*

[2] *School of Physical Therapy, Graduate Institute of Rehabilitation Sciences, Chang Gung University, Taoyuan, Taiwan.*

[3] *Institute of Medicine, Chung Shan Medical University, Taichung City, Taiwan*

Purpose: Reducing medical errors (MEs) and promoting patient safety are essential policies globally. However, studies on MEs in respiratory care in Taiwan have been lacking. The purpose of this study was to explore the role of registered respiratory therapists (RRTs) in patient safety and the types and causes of MEs in respiratory care in Taiwan.

Methods: This descriptive qualitative study was carried out in a medical center and a regional hospital in northern Taiwan. Semi-structured, face-to-face, individual interviews were conducted to obtain confidential information regarding MEs, with key informants identified based on snowball sampling. All interviews were transcribed verbatim and framework analysis was conducted to explore the types and causes of MEs reported by RRTs.

Results: Seven participants working in medical centers or regional hospitals were interviewed. Five of them reported that the most common type of ME is medication error, including missed doses and incorrect medication. No serious adverse event was reported in this study. Procedures have been established in hospitals for following up on MEs, including the Taiwan Patient Safety Reporting System and proposal form. Moreover, it was found that the interviewees comprehend these procedures to varying degrees.

Conclusions: The results of this study provide a basis for understanding the causes and types of MEs in respiratory care. This is a preliminary study and generalizations of its findings are limited. Large-scale surveys are warranted to reveal the causes of MEs and improve quality of care.

Keywords: Medical error, patient safety; respiratory therapy; respiratory care; strategy; therapist-driven protocol

1. Introduction

Patient safety is a fundamental human right and should be ensured during hospital visits and stays.[(1)] Medical errors (MEs) refer to human errors in health care.[(2)] Moreover, they represent preventable, iatrogenic, and adverse effects of medical care[(3)] and a serious public health issue. In 1999, a report from the Institute of Medicine Committee on Quality of Health Care in America showed that MEs are common and adversely affect patient outcomes.[(4)] A report in 2016 estimated that the third-leading cause of the 251,454 deaths in US hospitals that year was MEs.[(5)] Medical care has continued to become more advanced and specialized. Registered respiratory therapists (RRTs) are essential members of multidisciplinary teams who provide primary health care for respiratory disorders to adult, pediatric, and

* Corresponding Author: Ming-Chih Chou and Yasser Nassef
Address: No. 110, Sec. 1, Jianguo N. Rd., Taichung City, 40201, Taiwan
Tel: +886-4-24730022 ext. 11191
E-mail: juhan0223@yahoo.com.tw (M.C.C);
yasser@nassef.org (Y.N)

neonatal patients in the emergency departments, intensive care units, general wards, pulmonary rehabilitation units, and outpatient departments of hospitals and at home.

Delayed or missed doses can lead to clinical deterioration or adverse effects.[3] A study conducted at the Cleveland Clinic demonstrated that 3.5% of bronchodilator treatments are missed. The most common reason was patient absence during the therapist's visit, followed by patients' refusal to receive treatment.[6] To understand why RRTs miss doses, Wallace *et al.* analyzed reports from the Pennsylvania Patient Safety Reporting System and conducted a survey of Pennsylvania RRTs.[7] Eleven survey questions were based on studies by Stoller *et al.*[6] and the Pennsylvania Patient Safety Reporting System.[7] The two most common reasons included "RRT was not available" and "RRT was called away on an emergency," which suggests inadequate staffing. Similarly, Stoller *et al.*[6] found "patient not in the room and not available" to be another common reason. Reducing MEs and promoting patient safety are essential policies worldwide. However, few studies have been conducted on MEs in respiratory care in Taiwan. Therefore, the purpose of this study was to explore the role of RRTs in patient safety and the types and causes of MEs in respiratory care in Taiwan.

2. Materials and Methods

2.1. Design and Recruitment

This descriptive qualitative study was carried out in a medical center and a regional hospital in northern Taiwan. Semi-structured, face-to-face, individual interviews were conducted to obtain information confidentially. Snowball sampling was used, as it allows for easier collection of ME information from health professionals with mostly compatible results.(8) RRTs with at least 5 years of experience working in various departments of regional hospitals or medical centers were invited to participate. RRTs who refused to participate or share confidential information were excluded.

2.2. Ethical Consideration

This study was approved by the Institutional Review Board of the Chang Gung Medical Foundation (1906100012). Informed written consent and permission to record the interviews were obtained from all participants.

2.3. Data Collection

Interview guide was emailed to the participants before their interviews. The semi-structured interviews, each lasting 45 to 60 min, were conducted by PZL between October 2019 and December 2019. At the start of the interviews, PZL explained that the participants were to respond freely to the simple, clear, and open-ended questions. Interviews were recorded using digital audio recorder and transcribed verbatim by PZL.

2.4. Design of Interview Questions

The interview questions were designed based on studies by Lee *et al.*[9] and Stoller *et al.*[6] They included whether the interviewees had seen or made any MEs during their period of employment and types of and reasons for MEs. The interviewees were then asked about strategies to reduce the incidences of MEs and their opinions on the therapist-driven protocol.

The main exploratory questions were: 1) What do you think is the role of RRTs in patient safety? 2) How often do MEs occur? Please share your experience. 3) What are the causes of MEs and the strategies for preventing them? How can a therapist-driven protocol or guideline help?

2.5. Data Analysis

Each participant was given a code number from P1–P7. All recordings were transcribed verbatim. KYC analyzed the data via thematic analysis.[10] Interview content was divided into paragraphs for coding via systematic analysis. The codes represented meaningful themes formulated by the researchers. The analysis and identification of broader patterns progressed after all transcripts had been coded.

3. Results

Seven RRTs working in regional hospitals or medical centers participated in this study (Table 1). Three specific themes emerged during the

Table 1. Characteristics of the Registered Respiratory Therapists (n = 7)

Characteristics	*N*	(%)
Male gender	1	(14.3)
Work experience, years		
5-10	1	(14.3)
11-20	2	(28.6)
21-30	4	(57.1)
Educational background		
Bachelor of Science	5	(71.4)
Master of Science	2	(28.6)
Hospital category		
Regional hospital	3	(42.9)
Medical center	4	(57.1)

Table 2. Summary of the Themes

Theme	Representative Quotations
Patient Safety Attitudes	
Most interviewees agreed that incidents occurring within the hospital, such as those related to safety within the hospital (falls) and during treatment (drugs, tubes), fall under the category of patient safety.	Subject 01: *"Patients stay in our hospital. The surrounding environment, medications, possibility of falls, and catheterization are within the scope of patient safety."*
In addition to the environment of and treatment given at the hospital, patients' personal information and medical records are included in patient safety.	Subject 03: *"Patient safety is divided into several dimensions based on software and hardware. Software refers to data such as patients' personal information. Breaches of personal data may endanger a patient's safety. Hardware refers to patients' clinical activities. Any factors influencing patients' interests, obligations, and physical and mental safety are included in patient safety."*
Patient	
Most interviewees reported that medication error is the most common medical error (ME) in clinical practice.	Subject 02: *"A more common medical error is administering medication to the wrong patient. For example, the patient in bed B was administered the medication that was supposed to be for the patient in bed A; or the patient in bed A required oxygen therapy, which was mistakenly given to the patient in bed B."*
	Subject 03: *"A more common medical error is medication error. Incomplete drug administration often occurs in the pediatrics department. And in the adult department, a more common medical error is administering the medication to the wrong patient."*
The nurse called the respiratory therapist to perform the treatment but cited the wrong bed number; the respiratory therapist did not confirm the patient's identity before performing the treatment.	Subject 05: *"There have been cases in which the nurses told us the wrong bed number or we did not*

	check the patient's name when we went to the patient's bed, causing the patient to inhale the wrong medication…I'm responsible for the entire ward. Once I missed a room when I was doing my rounds…I only realized that I had administered the medication to the wrong patient after exiting the ward."
Most MEs are caused by failure to follow the "Three-Read and Five-Rights" protocol.	Subject 07: *"A medical error may occur when we are too hasty doing our rounds and go to the wrong beds…we realize our mistake when we call the patient's name and have to walk back to bed B. But, in fact we will not administer the wrong medication because of the Three-Reads and Five-Rights principle, so this problem is less likely to occur."*
Limited workforce is a root cause.	Subject 05: "I think the hospital is short staffed, causing everyone to have a heavy workload, particularly during the peak season when the workload is enormous…It can be very tiring if I have to complete the administration of medication before the treatment ends when there are too many patients … Patients in every unit have trouble breathing and require drug inhalation during peak season, and we have to handle many patients, so we need more manpower during this time to assist each unit, but there is just no way to bring in extra manpower."
Strategies of ME Prevention	
Use of root cause analysis to conduct a review within the department, discussion and review of the process with each group, and communication with other groups	Subject 04: *"We disclose medical errors during division meetings…we list the incidents in each season of the year, that is, the medical errors that happened in a season and then notify everyone and tell them how to make improvements."*
Strengthening of the ''Three-Read and Five-Rights'' protocol	Subject 03: *"Three-Read and Five-Rights! Because procedures performed by our respiratory therapists are highly specialized, they must be implemented thoroughly. No intermediate procedure can be omitted because the therapist is too busy."*
On-the-job education	Subject 04: *"We all attend online learning courses every year. A lot of experiences and examples are shared during the courses. The courses are beneficial…"*
Therapist-driven protocol	Subject 05: *"We have an operations manual. It is a thick book, but it is not entitled the "therapist-driven protocol" because it covers technical regulations, machine operations, and the tasks of the three units. We only refer to its procedures and discuss them if a medical error that has never happened before occurs."*

interviews: (1) patient safety attitudes, (2) types and causes of MEs, and (3) strategies for ME prevention (Table 2).

Theme 1: Patient Safety Attitudes

All interviewees understood the meaning of "patient safety" and agreed that it included safety within the hospital (i.e., avoidance of falls) and during treatment.

"Patients stay in our hospital. The surrounding environment, medications, possibility of falls, and catheterization are within the scope of patient safety." (P1)

"Any corner of the hospital (regardless of area or ward) that poses risks to patient safety will be controlled and managed to ensure prevention of harm to patients. The hospital's contribution to patient safety includes its notification system, bedside signs indicating that particular patients are prone to falls and require additional attention, and installation of handrails in bathrooms." (P2)

"When patients stay in our hospital, neither the environment nor the treatment should harm them. Ensuring that patients are not injured should be the principle of patient safety." (P4)

"Patient safety means regarding the safety of patients as a foundation, adopting the principle of not harming patients, and promoting patient health. The hospital has adopted measures for patient safety, including the Taiwan Patient Safety Reporting System and Three-Reads and Five-Rights, and posted reminders, such as prompting slogans (for example, 'Pull up the bed rail')." (P6)

Some interviewees reported that in addition to the hospital environment and treatments, patient personal information and medical records are part of patient safety.

"Patient safety is divided into several dimensions based on software and hardware. Software refers to data such as patients' personal information. Breaches of personal data may endanger a patient's safety. Hardware refers to patients' clinical activities. Any factors influencing patients' interests, obligations, and physical and mental safety are included in patient safety." (P3)

"Many areas of patient safety exist across a rather wide range, such as drug safety, patient privacy, patient security, safety of treatment techniques... verification of patients' identity, and environmental safety." (P7)

Theme 2: Types and Causes of MEs

All interviewees had been personally involved in or heard of other RRTs who had been involved in MEs, including medication errors, ventilator circuit disconnection, improper operation of mechanical ventilator, failure to check whether there was available oxygen in the oxygen cylinder, and failure to check that the mechanical ventilator had power.

"Generally, when the respiratory therapist is providing chest physical therapy to patients... our therapists have experienced incidents such as endotracheal tube slippage and improper displacement, for which emergency treatment has been required." (P1)

"We use transport ventilators when transporting patients... so we have to ensure that the ventilator battery is adequately charged. This is the concern with regard to the power supply. The second concern is the air source. Is oxygen required when transporting the patient? Are ventilator settings appropriate? The gas cylinder may be running low on oxygen or the internal battery may not be sufficiently charged. These are issues that we are concerned about. If oxygen supply is inadequate during transportation, the patient can experience hypoxemia, which can subsequently lead to bradycardia if not handled in time. This will severely endanger the patient's safety." (P2)

"It was time for the child's inhaled therapy... the child was asleep in bed, so the therapist put the medication in a cup and informed the child's mother. The child's mother said that she understood and would administer the drug later. The therapist then asked the child's mother whether she knew how to perform drug inhalation. The child's mother said that the respiratory therapist had told her that the medicine was on the table. However, she discovered that the cup was empty when she was about to administer the drug to her child, which means that the child probably thought it was liquid medicine and drank it ... A nurse was asked to contact the attending physician to assess the patient's condition." (P3)

"For example, tubing slippage, causing the

central venous catheter to fall out during chest physical therapy." (P4)

"We had a patient requiring measurement of weaning profile. This seemed clear on paper. That is, we press 'O2 suction' for three minutes to measure the weaning profile without pressing 'stand by.' However, someone might have pressed 'stand by' and then forgot to turn it off after measuring the weaning profile." (P6)

One of the interviewees knew of MEs in respiratory therapy caused by medical personnel from other departments.

"I have also heard of a case in which the water bag of the ventilator leaked and water dripped onto the ventilator and caused it to malfunction. The nurse had not installed the water bag correctly. When the water bag was placed on top of the ventilator during transport, water kept leaking and the ventilator malfunctioned." (P4)

Five of the seven interviewees indicated that the most common ME in clinical practice is medication error, including missed does and giving incorrect medication to a patient. One interviewee said that a common ME is that the nurse calls the RRT to perform the treatment but cites the incorrect bed number. Then, the RRT does not confirm the patient's identity before providing the treatment.

"A more common medical error is administering medication to the wrong patient. For example, the patient in bed B was administered the medication that was supposed to be for the patient in bed A; or the patient in bed A required oxygen therapy, which was mistakenly given to the patient in bed B." (P2)

"Incomplete drug administration often occurs in the pediatrics department." (P3)

"There have been cases in which the nurses told us the wrong bed number or we did not check the patient's name, causing the patient to inhale the wrong medication ... I'm responsible for the entire ward. Once I missed a room when I was doing my rounds...I only realized that I had administered the medication to the wrong patient after exiting the ward." (P5)

Most MEs are caused by the failure to follow the "Three-Reads and Five-Rights" protocol. One of the interviewees mentioned that a limited workforce is the root cause.

"A medical error may occur when we are too hasty during our rounds and go to the wrong beds... we realize our mistake when we call the patient's name and have to walk back to bed B. But, in fact, we will not administer the wrong medication because of the Three-Reads and Five-Rights principle, so this problem is less likely to occur." (P7)

"I think the hospital is short staffed, causing everyone to have a heavy workload, particularly during the peak season when the workload is enormous... It can be very tiring if I have to complete the administration of medication before the treatment ends when there are too many patients...Patients in every unit have trouble breathing and require drug inhalation during peak season, and we have to handle many patients, so we need more manpower during this time to assist each unit, but there is just no way to bring in extra staff." (P5)

Theme 3: Strategies for ME Prevention

The interviewees thought that using root cause analysis to review the MEs within the department, discussing and reviewing the process with each group, communicating with other groups, and strengthening the implementation of the "Three-Reads and Five-Rights" protocol can reduce the incidence of MEs.

"Internal reviews are a must, but they are not occasions for conflicts since we also have to protect the individuals involved. Internal reviews are for root cause analysis." (P2)

"We disclose medical errors during division meetings...we list the incidents in each season of the year, that is, the medical errors that have happened in a season, and then notify everyone and tell them how to make improvements." (P4)

"Procedures are discussed during division meetings to determine which ones are better. It was then announced that we should all press 'O2 suction' instead of 'stand by' because if someone forgets in the future, it will severely endanger patients." (P6)

"Three-Reads and Five-Rights! Because procedures performed by our respiratory therapists are highly specialized, they must be implemented thoroughly. No intermediate procedure can be omitted because the therapist is too busy." (P3)

"Check the patients' information. We must use

at least two identifiers (e.g., name and date of birth) to verify a patient's identity. In terms of the patient's treatment, we have to confirm whether the physician's order is problematic, including whether the dosage is correct." (P7)

All interviewees continue to receive education on patient safety during non-work hours. They believe that the patient safety education curriculum prescribed by the hospital helps to reduce MEs. In addition to lectures, online courses are available. The course content includes descriptions of experiences and examples and pre-test and post-test are required.

"We usually take online learning courses and they are helpful. The educational courses of the division are included in the quality control course but separate from the patient safety course." (P2)

"It is stipulated that the hospital's education department offer compulsory courses every year. Patient safety is divided into several themes, such as falls and drug administration, and pre- and post-tests are conducted. You will need to retake the course if you fail. This is in-service education, which differs from our early education. These courses help us to understand changes and current trends." (P3)

"We all attend online learning courses every year. A lot of experiences and examples are shared during the courses. The courses are beneficial because many incidents are shared and I look for the ones that are related to the treatments we perform. After reading and sharing, I understand the consequences of certain behaviors. Then, I consider whether we can reduce [the likelihood of] such incidents in our treatments or whether these behaviors are common during our treatments. We can then propose ways to improve treatment administration during the bimonthly ward meeting ..." (P4)

"I have participated in in-service education, including lectures and online learning in the hospital. As a matter of fact, after working for a long time, we gradually forget certain things. I think it helps if we attend relevant courses regularly to refresh our memories." (P6)

Although none of the interviewees had heard of the therapist-driven protocol, similar guidelines are already in use where they work. Such protocol helps new recruits understand technical operations and is stored on a computer and accessible.

"The operating procedures in our hospital include those related to equipment use and solutions to problems. This is helpful because it can help new staff understand the overall procedure. They can also turn on the computer to check certain technical operations if they forget. We also do so if we forget." (P3)

"I think we have online courses that tell you how to perform tasks correctly. There are lessons on how to perform inhalation therapy, what preparations are required, how to conduct an evaluation, and precautions on administering medication. The courses provide the correct procedures. Our division stipulates that PGY students read the standard regulations on the learning web before conducting a treatment. Face-to-face education is also provided." (P4)

"We have an operations manual. It is a thick book, but it is not entitled the 'therapist-driven protocol' because it covers technical regulations, machine operations, and the tasks of the three units. We only refer to its procedures and discuss them if a medical error that has never happened before occurs." (P5)

"Our department has a manual which covers instrument operations and work responsibilities, as well as includes technical procedures and evaluation forms. Newcomers are required to read these and undergo evaluation." (P6)

4. Discussion

Our findings suggest that the most common MEs in respiratory therapy in Taiwan are medication errors. MEs are caused by the failure to implement the "Three-Reads and Five-Rights" protocol, fatigue due to a heavy workload, and inadequate staffing. MEs have been extensively discussed and their reduction can improve health care quality and safety. Two studies have addressed medication errors in nursing. Researchers at the Imam Khomeini Hospital (Tehran, Iran) identified the most common types of medication errors: inappropriate dosage and infusion rate, using abbreviations (instead of full names of drugs) for prescriptions, and similarities in drug names. They concluded that the most important cause of medication errors is the lack of adequate pharmacological information.[11] A study

in Taiwan found that incorrect doses and incorrect drugs are the main types of medication errors, each accounting for approximately one-third of total errors.[8] However, 83.8% of errors did not result in adverse effects. Moreover, 48 instances were discovered in which drugs were administered to the wrong patient. Even though all the interviewed nurses were taught to identify patients using certain standard operating procedures (SOPs), they admitted to seldom following them.[8]

The results of this study showed that the most common clinical MEs are missed medication doses and administration of inappropriate medication. Stoller *et al.*[6] indicated that the incidence of medication errors in respiratory therapy is relatively low (3.5%). Common reasons for medication errors in this study were the absence of the patient from the ward when medication was to be administered, failure to implement the "Three-Reads and Five-Rights" protocol, and staffing shortages.

One of the participants stated that during certain seasons, the workload increases. If the number of RRTs is inadequate in comparison to the number of patients receiving medication, the risk of MEs increases. Studies on medication errors in nursing have reported increased workload as the crucial factor in the incidence of medication errors.[11] Workload is a significant factor for MEs in respiratory care.

Based on the interviews conducted for this study, we found that hospitals have established procedures to respond to MEs. The interviewees mentioned that in addition to the Taiwan Patient Safety Reporting System and proposal form, group review during division meetings and compulsory courses improve staff performance of technical procedures.

In light of the common causes of MEs and recommendations in the literature, we propose the following suggestions: We found that all interviewees understood the definition of patient safety. However, regardless of age, most interviewees had not taken courses on patient safety and MEs as students; therefore, school courses are recommended. Furthermore, the Taiwan Patient Safety Reporting System only distinguishes between ME categories. In Taiwan, classifying patients based on medical personnel and understanding MEs in respiratory therapy using statistical data are recommended. In Taiwan, the SOP used to confirm the identity of patients and treatments is called "Three-Reads, Five-Rights." Three-Reads means that medical personnel must ensure that medicine is correct when removing it from the medicine cabinet, before administering it to patients, and before placing it back in the cabinet. "Five-Rights" includes checking that it is the right patient, the proper medication, the right time, the correct dose, and the correct route to reduce MEs related to the administration of medications.[12]

In this study, there was higher risk of administering incorrect medication if the "Three-Reads and Five-Rights" protocol was not followed. Although the RRTs were taught to confirm the identity of the patients using this protocol before giving medication, they did not always do so when their workload increased. To eliminate MEs, it is necessary to emphasize the importance of following proper procedures.

Based on interviews, we found that although hospitals had established procedures, some interviewees did not fill out the proposal form for minor MEs. Thus, such cases were perpetuated. We hope that research and hospital advocacy can be carried out through a larger unit for RRTs to understand that the primary objective of reporting is not to assign blame but, rather, to improve the quality of medical care.

RRTs found the issue of MEs sensitive, starting from the invitation to the interview itself. Moreover, most interviewees had not taken courses on MEs and patient safety in school. Patient safety education should be incorporated into school curricula and provided to medical personnel who are already on the job.

In this study, none of the RRTs had heard of the therapist-driven protocol, but similar guidelines were used in the hospitals where they worked. Studies have found that a therapist-driven protocol can reduce the frequency of MEs in respiratory therapy and yield other benefits,[7, 13-15] including proper allocation of resources for respiratory therapy,[13, 15] using the shortest time and minimum cost to bring maximum benefits to patients and hospitals,[15, 16] reducing unnecessary treatment and harm to patients,[14-16] reducing hospital stays,[14, 15] and accelerating patient

weaning from mechanical ventilation.[14, 15, 17] Although many studies have demonstrated the benefits of the therapist-driven protocol, the implementation of a new procedure could elicit a backlash from some therapists.[14]

This study has several limitations. First, we could not extrapolate our findings to different regions of Taiwan or to other countries owing to the lack of experience of our RRTs. Second, it is challenging to avoid recall and hindsight bias, especially since participants reported incidents from throughout their entire careers. Third, we only recruited senior RRTs. Including junior RRTs, RRTs in homecare, and respiratory therapy students in future studies is warranted. Fourth, researchers must be sensitive when approaching interviewees on the subject of MEs, as they may have reservations about giving confidential information, be afraid of losing their reputation, or be concerned about being accused of neglect. These limitations notwithstanding, our findings provide insights into MEs and patient safety in respiratory care.

The results of this study provide a basis for understanding the types and causes of MEs in respiratory care in Taiwan. Medication error was the most common ME reported in this study. We hope that in addition to strengthening the "Three-Reads and Five-Rights" protocol, patient safety and ME-related courses will be introduced in schools. As our research results are limited and cannot be generalized, more extensive surveys are needed to help the government better address this issue.

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Ethics approval and consent to participate

We conducted this trial in accordance with good clinical practice and Declaration of Helsinki guidelines. This study was approved by the Institutional Review Board of the Chang Gung Medical Foundation (1906100012). Informed written consent and permission to record the audio of the interviews were obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest:

The authors have no conflicts of interest to declare.

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