POTENTIAL PREVENTION TOWARD VACCINATION ERROR: LEARNING FROM THE COVID-19 OUTBREAK

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ABSTRACT

Background: During the COVID-19 pandemic, vaccination became a crucial tool to control the spread of the virus and mitigate its impact on public health. However, large-scale vaccination efforts often lead to vaccination errors. This study aimed to explore strategies for preventing these errors by examining vaccination error events during the COVID-19 vaccination campaign. **Methods:** This study employed a two-stage approach. The first stage utilized a descriptive quantitative methodology, while the second stage involved a traditional literature review. A total of 134 participants were selected through purposive sampling from the COVID-19 vaccination teams at hospitals and public health centers in Jember, Indonesia. A questionnaire was designed to investigate vaccination errors. The literature review was conducted using electronic databases. **Results:** Errors were identified at every stage of the vaccination process, although none of the errors exceeded 50% in frequency. The distribution of errors was as follows: 35.82% of errors occurred during the registration stage, 23.88% during the screening stage, 20.15% at the injection stage, and 38.06% at the recording stage. Based on these findings, the study identified seven key focus areas for preventing vaccination errors: (1) training and education, (2) patient engagement and trust, (3) operational efficiency, (4) safety culture, (5) technology integration, (6) workforce management, and (7) policy and accessibility. **Conclusion:** This study offers valuable insights into the prevalence of vaccination errors at different stages of the COVID-19 vaccination process. Policymakers and health officers can leverage these findings to strengthen vaccination programs and improve preparedness for future vaccination efforts.

Keywords: COVID-19, health policy, prevention & control, vaccination

Introduction

The COVID-19 pandemic, which began in late 2019, has posed significant challenges to global healthcare systems (Hanaei & Rezaei, 2020), including mass vaccination efforts (Schaffer DeRoo et al., 2020). COVID-19 vaccination has become a primary strategy to control the spread of the virus, but its implementation has not been without hurdles (Forman et al., 2021; Schaffer DeRoo et al., 2020). Despite the promising potential of vaccination to end the pandemic, various errors in the vaccination process have occurred in multiple countries, affecting the effectiveness of vaccination programs and public trust in them (Brüssow, 2021; Hause et al., 2022).

Vaccination errors can take various forms, ranging from dosage mistakes to incorrect vaccine selection to technical errors in the

storage and distribution of vaccines. Such errors not only reduce the effectiveness of vaccination but can also exacerbate the public health crisis by diminishing the protection provided against COVID-19 (Abdel-Qader et al., 2025; Al Zaidan et al., 2024; Azim Majumder & Razzaque, 2022). For instance, a study conducted in Jordan found that vaccination administration errors during the COVID-19 pandemic had a significant prevalence and were influenced by factors such as insufficient healthcare worker training and inadequate resources (Abdel-Qader et al., 2025). Additionally, a report from another study in Qatar also revealed that errors in vaccine administration primarily occurred at primary healthcare facilities, often involving a shortage of human resources or procedural errors in the vaccination process (Al Zaidan et al., 2024).

Vaccination errors have also been identified in countries with more advanced healthcare systems. A previous study in the United States highlighted that accessibility issues, including the presence of vaccine registration websites that were not user-friendly for all segments of the population, were one of the contributing factors to vaccination errors (Alismail & Chipidza, 2021). Furthermore, the lack of effective monitoring systems to track and identify vaccination errors during the vaccination process also presents a significant challenge. This indicates that vaccination errors occur not only due to technical issues in administration but also because of inefficiencies in managing human resources and infrastructure (Poiraud et al., 2023).

Several studies emphasize the importance of enhancing training and understanding of vaccination procedures for healthcare workers to reduce errors in vaccine administration. For example, one study explains that the success of vaccination programs relies not only on vaccine availability but also on the efficiency of vaccine distribution and administration (Goel & Nelson, 2021). Additionally, gaps in healthcare worker training and the absence of clear standard operating procedures are often key drivers of vaccination errors (Hall et al., 2023; Yee et al., 2024). Administrators' burnout leads to potential errors in the vaccination process (Purwandari et al., 2023).

This study aims to explore the potential for preventing vaccination errors by examining the experiences from vaccination rollouts during the COVID-19 pandemic. By investigating vaccination errors at each stage, it is hoped that effective prevention strategies can be developed to enhance the success of vaccination programs in the future.

Methods

Study Design

The study used a two-stage study. The first stage used a descriptive quantitative approach. Descriptive studies are used to describe events or identify existing problems rather than to test hypotheses (Siedlecki, 2020). A traditional literature review was used as the second stage after looking at the event or existing problem. A traditional literature review summarizes various publications or research on a particular topic, and the author examines the research results that focus on a topic, issue, or concept to provide an overview of the issue (Munn et al., 2018). In the second stage, the article search used keywords according to the research question. The question is, "What is the strategy to prevent vaccination error?".

Participants

In collecting primary data, purposive sampling was used to choose samples, and the G*Power test was used to calculate the

number of samples. The 138 respondents were involved in this study, with the requirements of the COVID-19 vaccination team, and were drawn from hospitals and public health centers (*Puskesmas*) in Jember, Indonesia.

Instrument

A closed questionnaire was used in the descriptive study's instrument. A questionnaire to explore vaccination errors was developed by researchers according to the four steps of the COVID-19 vaccination process by the Ministry of Health of Indonesia (Ministry of Health of Indonesia, 2021), including registration-verification, screening, vaccination/injection, and documentation-observation. The questionnaire consists of 12 items with four answer choices for statement items: never on duty, never wrong, rarely wrong, and half right-half wrong. The questionnaire has been declared valid based on the content validity index test with i-CVI=1.

Data Collection

Primary data about vaccination errors was collected in July-August 2022 through an online platform. The research was conducted directly after the respondent agreed to participate. The search method used in the traditional literature review is electronic databases such as Google Scholar, ProQuest, and PubMed. The article search used keywords according to the four steps of the COVID-19 vaccination process. The articles used in this study were published within the last 5 years, from 2021 to 2025, in full-text articles. All articles in English were selected. All articles with full identifiers were retrieved for the traditional literature review.

Data Analysis

The data was analyzed using Microsoft Excel. The results of the descriptive analysis are presented in frequency and percentage tables to describe the vaccination error incidents among COVID-19 vaccinators (Table 1 and Table 2). The result of a study in the traditional literature review was described in the mapping tables' findings (Table 3).

Ethical Consideration

The research was conducted through an online survey after respondents agreed to participate in this research. Ethical clearance was declared by the Ethical Committee of Medical Research Faculty of Dentistry Universitas Jember with registration number 1608/UN25.8/KEPK/DL/2022. All data was kept confidential.

Results

In this section, the researcher presents the results of the descriptive study and the traditional literature review for developing any potential strategy to prevent vaccination errors according to the descriptive results.

Tabel 1. The Incidence of Vaccination Error among COVID-19 Vaccinators (n=134)

Vaccination Stage	Frequency	Percentage
Registration/Verification Stage		
There is an error	48	35.82
No error	59	44.03
Never on duty	27	20.15
Screening Stage		
There is an error	32	23.88
No error	81	60.45

Vaccination Stage	Frequency	Percentage
Never on duty	21	15.67
Vaccine Injection Stage		
There was an error	27	20.15
No error	80	59.70
Never on duty	27	20.15
Recording and Observation Stage		
There was an error	51	38.06
No errors	69	51.49
Never on duty	14	10.45

Table 1 indicates that there were errors in all stages of vaccination, although not more than half of the errors occurred. At the registration stage, 35.82% of errors were found. At the screening stage, 23.88% of errors were found. At the injection stage, the errors found were 20.15%. At the recording stage, the errors found were 38.06%.

Table 2. Frequency of Vaccination Error Incidence (n=134)

Vaccination Stage	Never on duty		Never wrong		Rarely Wrong		Half right-Half wrong	
	f	%	f	%	f	%	f	%
Registration/Verification Stage	27	20.2						
1. Patients are called according to their arrival number.			94	70.1	36	26.9	4	3.0
2. Patients are verified with their e-ticket number and/or ID card.			106	79.1	28	20.0	0	0
3. Data verification using the vaccination application or manually.			100	74.6	31	23.1	3	2.2
Screening Stage	21	15.7						
1. The officer asks questions about health conditions and identifies comorbid conditions.			106	79.1	27	20.1	1	0.7
2. Officers input screening data for each target into the vaccination application from the screening results.			108	80.6	25	18.7	1	0.7
Vaccine Injection Stage	27	20.2						
1. Vaccine injection by the vaccinator.			117	87.3	17	12.7	0	0
2. The officer records the participant's name, ID card, vaccine name and vaccine batch number on a memo.			112	83.6	20	14.9	2	1.5
3. The memo is handed over to the next officer.			112	83.6	18	13.4	4	3.0

Vaccination Stage	Never on duty		Never wrong		Rarely Wrong		Half right-Half wrong	
	f	%	f	%	f	%	f	%
Recording and Observation Stage	14	10.5						
1. Patients waited for 30 minutes for observation.			99	73.9	27	20.1	8	6.0
2. The vaccination result (type and batch number of vaccine) received by the patients is input into the vaccination application.			106	79.1	28	20.9	0	0
3. Patients receive a proof card/certificate of having received the COVID-19 vaccination.			109	81.3	25	18.7	0	0
4. Patients are educated for the next injection time.			110	82.1	23	17.2	1	0.7

According to Table 2, the majority of officers performed their duties correctly at each stage, although some deficiencies were still observed. In the Registration/Verification Stage, around 74.6% to 79.1% of officers never made mistakes when verifying patient data, while 20.0% to 26.9% rarely made errors, and 20.2% of officers were never on duty at this stage. In the Screening Stage, most officers also performed accurately, with the highest percentage being 80.6% for entering screening results into the application, although 15.7% had never worked in this stage. During the Vaccine Injection Stage, officers showed high accuracy, such as 87.3% who never made errors during vaccine injection and 83.6% who correctly recorded participants' information, even though 20.2% had never been assigned to this stage. Lastly, in the Recording and Observation Stage, 73.9% to 82.1% of officers performed their duties correctly, although 10.5% had never been involved in this stage, and 6.0% had partially incorrect practices in the observation phase.

Table 3. Potential Strategy to Prevent Vaccination Error

Strategy to Prevent Vaccination Error
1. Educating and training program vaccinator team
2. Building trust among vaccinator and patient through health education programs
3. Enhance adherence to guidelines
4. Enhance communication skill
5. Advise local and systemic reactions to patient during monitoring
6. Implement strategies to manage patient flow effectively during peak vaccination hours
7. Foster a culture of safety that encourages reporting and learning from errors
8. Implement standardized pre-vaccination checklists and leveraging technology, such as barcode scanning systems
9. Managers should recognize the variety of concerns an vaccinators' hesitancy
10. Managers could offer a day off to reward vaccinators to contribute a safe workplace
11. Ensure adequate workspace to create conducive environment

12. Improve the accessibility of government websites to ensure users can independently schedule vaccination appointments
13. Voluntary smartphone-based tool to provide real-time check-ins during observation time
14. Change policymakers' strategies to combat the pandemic
15. Involve lay trained vaccinator under supervision to support each vaccination stage

(Abdel-Qader et al., 2025; Al Zaidan et al., 2024; Alismail & Chipidza, 2021; Brüssow, 2021; Goel & Nelson, 2021; Hall et al., 2023; Hause et al., 2022; Oliver et al., 2021; Peterson et al., 2022; Poiraud et al., 2023; Stoler et al., 2021; Yee et al., 2024)

Table 3 indicates 15 potential strategies to prevent vaccination errors during the COVID-19 outbreak from previous studies. These strategies can be categorized into seven key focus areas: training & education, patient engagement & trust, operational efficiency, safety culture, technology integration, workforce management, and policy & accessibility. By addressing these aspects systematically, vaccination programs can achieve higher coverage rates, improve patient satisfaction, and ensure a safer and more efficient vaccine administration.

Discussion

Addressing vaccination errors requires a multifaceted approach, including standardized protocols, continuous staff training, robust error-reporting systems, and investments in infrastructure to ensure proper vaccine storage and delivery. By prioritizing these measures, health systems can minimize errors, enhance vaccine safety, and strengthen public confidence in immunization efforts.

The Incidence of Vaccination Error among COVID-19 Vaccinators

Vaccine administration errors represent a critical challenge in successfully implementing immunization programs, particularly during large-scale campaigns such as those for COVID-19. This study provides valuable insights into the incidence of vaccine administration errors across different stages of the vaccination process among COVID-19 vaccinators. Errors were reported at every stage, with the highest frequency observed during the recording and observation stage, where 38.06% of respondents admitted to making errors, compared to 51.49% who reported no errors and 10.45% who were never on duty.

The registration or verification stage showed a significant error rate of 35.82%, highlighting challenges in accurately verifying patient information, which could lead to mismatches in vaccine eligibility or dosage schedules. The tasks, such as verifying patients with their e-ticket number or ID card and data verification using the vaccination application, showed relatively high error rates, with 26.9% and 23.1% of respondents admitting occasional mistakes, respectively. The previous study underscores issues identified by, who noted that errors in verifying patient eligibility or dosage schedules often stem from systemic weaknesses, such as insufficient training or overwhelming workloads (Al Zaidan et al., 2024). This highlights challenges in accurately managing digital and manual systems, which could stem from inadequate training or system complexities.

The screening and vaccine injection stages reported relatively lower error rates (23.88% and 20.15%, respectively), but these errors are especially concerning as they directly affect patient safety and vaccine efficacy. While errors were less frequent during the screening stage, tasks like inputting screening data into the

vaccination application revealed that 18.7% of vaccinators occasionally made mistakes, potentially compromising the accuracy of health records. For instance, errors during screening could result in administering vaccines to ineligible individuals, while mistakes during injection might involve incorrect dosing or improper techniques. Notably, a subset of vaccinators (ranging from 10.45% to 20.15%) reported they were "never on duty" for specific stages, indicating variability in role assignments and potential gaps in cross-training among staff. Errors were less frequent. Tasks like inputting screening data into the vaccination application revealed that 18.7% of vaccinators occasionally made mistakes, potentially compromising the accuracy of health records.

Errors during the screening and vaccine injection stages also resonate with broader discussions in the literature. For example, previous researchers emphasized that improper screening can result in vaccinating ineligible individuals, while injection errors, such as incorrect dosing or technique, directly impact vaccine efficacy and patient safety (Abdel-Qader et al., 2025). These findings align with a previous study, which explored strategies to understand and prevent vaccination errors, advocating for systemic changes in how vaccines are stored, prepared, and administered to enhance patient safety (Poiraud et al., 2023). These discrepancies suggest that technical tasks such as data entry pose greater risks for errors compared to procedural tasks like administering injections.

In the recording and observation stage, notable errors occurred in recording vaccination results into the application (20.9%) and educating patients about follow-up doses (6.0%). These findings align with the results, where this stage had the highest error rate overall (38.06%), emphasizing the complexity of multitasking during post-vaccination procedures. Raised by previous researchers, who highlighted that inadequate documentation and post-vaccination monitoring are common sources of errors (Hall et al., 2023). These lapses can lead to incomplete or inaccurate records, compromising patient follow-up and safety monitoring.

Studies have highlighted the prevalence and types of errors in different settings, revealing that systemic weaknesses, inadequate training, and high workloads often contribute to these lapses (Abdel-Qader et al., 2025; Al Zaidan et al., 2024). Such errors compromise the effectiveness of vaccines and pose risks to patient safety and public trust in vaccination programs. For instance, administering an incorrect dose or failing to adhere to the recommended interval between doses can reduce vaccine efficacy, potentially leading to suboptimal immunity.

Overall, these findings underscore the need for targeted interventions. In their study on lay vaccinators, Yee et al. demonstrated the potential of leveraging non-traditional vaccinators to fill staffing gaps and improve consistency in vaccination delivery (Yee et al., 2024). Additionally, another study pointed out that logistical challenges, including workforce shortages and high demand, exacerbate the risk of errors, further underscoring the need for systemic improvements (Brüssow, 2021). By addressing these vulnerabilities, health systems can enhance the accuracy and safety of vaccination programs, ultimately improving public trust and immunization outcomes.

Potential Strategy to Prevent Vaccination Error

The strategies to address vaccine administration errors and improve

immunization programs can be categorized into seven key focus areas: training & education, patient engagement & trust, operational efficiency, safety culture, technology integration, workforce management, and policy & accessibility. Each of these areas plays a critical role in enhancing vaccination campaigns' quality, safety, and equity, as supported by findings from the references and the data provided in Tables 1 and 2.

1. Training & Education

Training and education are foundational to reducing vaccine administration errors, as highlighted by two studies (Abdel-Qader et al., 2025; Poiraud et al., 2023). Errors such as incorrect data entry or improper injection techniques often stem from inadequate training. For instance, Table 2 shows that tasks like recording vaccination results into the application had error rates of 20.9%, indicating a need for task-specific training. Continuous professional development programs, simulation-based training, and clear standard operating procedures (SOPs) can equip vaccinators with the skills needed to minimize errors. Additionally, another study emphasizes the importance of cross-training staff to ensure consistency across all stages of vaccination (Al Zaidan et al., 2024).

2. Patient Engagement & Trust

Building patient trust is essential for the success of vaccination programs, particularly in addressing hesitancy and ensuring follow-up compliance. Two studies underscore how mistrust and misinformation can hinder vaccine uptake (Peterson et al., 2022; Stoler et al., 2021). Engaging patients through clear communication, culturally sensitive educational materials, and transparent processes can foster confidence. For example, Table 2 highlights that educating patients about follow-up doses had an error rate of 6.0%, suggesting missed opportunities to reinforce adherence. Strengthening patient engagement can also reduce errors during the screening and verification stages, where mismatches in eligibility or misunderstandings may occur.

3. Operational Efficiency

Operational inefficiencies, such as high workloads and complex workflows, contribute significantly to vaccine administration errors. The data in Table 1 reveal that errors were most frequent during the Recording and Observation Stage (38.06%), likely due to multitasking and time constraints. One study discusses how streamlined logistics and efficient resource allocation can enhance vaccine delivery (Goel & Nelson, 2021). Simplifying administrative tasks, optimizing scheduling systems, and ensuring adequate staffing can alleviate operational bottlenecks and reduce error rates.

4. Safety Culture

A strong safety culture is crucial for preventing errors and promoting accountability within vaccination teams. One study advocates for fostering environments where errors are openly reported and analyzed to identify root causes (Hall et al., 2023). For example, the variability in error reporting across different stages (as seen in Table 1) suggests inconsistencies in safety practices. Encouraging a non-punitive approach to error reporting and implementing robust feedback mechanisms can help create a culture of continuous improvement.

5. Technology Integration

Technology plays a pivotal role in modernizing vaccine administration processes, but it must be implemented thoughtfully to avoid introducing new errors. Previous study highlights disparities in digital access, which can exacerbate inequities if not addressed (Alismail & Chipidza, 2021). In Table 2, tasks involving

digital tools, such as verifying e-tickets or inputting data into vaccination applications, showed notable error rates (e.g., 26.9% for e-ticket verification). Investing in user-friendly digital platforms, providing technical support, and conducting usability testing can mitigate these challenges. Technology should also facilitate real-time monitoring and error detection to enhance overall system reliability.

6. Workforce Management
Effective workforce management is critical to addressing staffing gaps and ensuring consistent performance across all vaccination stages. Previous studies propose leveraging lay vaccinators to expand capacity, particularly in underserved areas (Yee et al., 2024). However, Table 1 indicates that 10.45%–20.15% of respondents were "never on duty" for specific stages, pointing to variability in role assignments. Cross-training staff, distributing workloads evenly, and recruiting additional personnel when necessary can improve workforce resilience and reduce errors.

7. Policy & Accessibility
Finally, equitable policies and accessible vaccination systems are vital for reaching diverse populations. A previous study discusses how logistical hurdles and systemic inequities can impede vaccine access (Brüssow, 2021). Ensuring that policies prioritize marginalized communities, simplify registration processes, and provide transportation or mobile clinics can enhance accessibility. For example, Table 1 shows higher error rates during the Registration/Verification Stage (35.82%), which could disproportionately affect vulnerable groups. Policymakers must address these barriers to ensure no one is left behind.

Relevance to Clinical Practice

The studies collectively provide a comprehensive overview of the multifaceted challenges and opportunities associated with COVID-19 vaccination efforts. Key takeaways include:

1. There is a need for robust error prevention and safety monitoring systems.
2. Addressing disparities in vaccine accessibility and delivery efficiency.
3. Building trust and combating hesitancy through targeted communication and community engagement.
4. Leveraging innovative approaches, such as lay vaccinators, to expand immunization coverage.

By addressing these areas, policymakers and health officers can strengthen vaccination programs and better prepare for the future.

Conclusion

This study reveals significant variability in the incidence of vaccination errors across different stages and tasks. These findings underscore the complexity of managing large-scale vaccination programs and highlight recurring vulnerabilities in administrative and technological processes. Emphasizing areas requiring targeted interventions. The potential strategy to prevent vaccine errors can be concluded in seven focus areas: training & education, patient engagement & trust, operational efficiency, safety culture, technology integration, workforce management, and policy & accessibility. Health systems can significantly improve the quality and safety of vaccination programs. These strategies are interdependent; for instance, enhancing workforce management supports operational efficiency while integrating technology facilitates better training and safety monitoring. Together, it forms a comprehensive framework for mitigating errors, building public trust, and achieving widespread immunization coverage,

ultimately strengthening global preparedness for the future.

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