

Research



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Characterizing institutional factors associated with compliance to rabies post-exposure prophylaxis in the Maswa District, Tanzania: perceptions from health care provider, Maswa district, Tanzania

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Abstract

Introduction: every year, an estimated 59,000 people worldwide lose their lives due to rabies. Although rabies is entirely preventable through the availability of human rabies post-exposure prophylaxis (PEP), several obstacles hinder people from accessing and completing this life-saving treatment. **Methods:** in-depth interviews were employed to explore the perceptions and experiences of healthcare workers regarding institutional factors associated with compliance with rabies PEP in Maswa district, Tanzania. About 11 in-depth interviews were conducted with healthcare workers. Among the healthcare workers, the majority were females, accounting for 63.6% (n=7). **Results:** the findings suggest that healthcare professionals' knowledge, skills, and commitment play a pivotal role in delivering effective PEP, and their continuous education and training are essential for maintaining high-quality care. Additionally, the unavailability of essential medical instruments, such as 0.5cc needles for intradermal injections, can hinder the administration of PEP, potentially leading to vaccine wastage and increased costs, which may discourage patients from seeking treatment. Furthermore, the study highlights the critical role of effective leadership and management in ensuring the availability and prioritization of PEP resources, as inadequate management can result in vaccine shortages and financial inefficiencies, ultimately affecting patients' access to and compliance with PEP. **Conclusion:** to improve PEP compliance in the Maswa District, ongoing education and training on current guidelines are vital to healthcare professionals. Ensuring a consistent supply of essential medical instruments like 0.5cc needles is necessary to minimize waste and cost. Effective leadership and management in healthcare facilities should prioritize resource allocation and vaccine availability. Additionally, considering financial support for patients can help alleviate the high costs associated with rabies PEP, promoting better adherence.

Introduction

Rabies, a neurological illness triggered by the lyssavirus, induces brain inflammation in humans and other mammals [1,2]. This fatal viral disease is contracted through animal bites or scratches, with saliva being the primary medium of transmission to humans. In the absence of treatment, it becomes nearly invariably fatal due to the onset of progressive encephalitis upon the emergence of clinical symptoms [3,4]. It is caused by the infection of a host with the rabies virus, which is a single-stranded, negative-ribonucleic Acid (RNA) virus [5] belonging to the Lyssavirus genus in the Rhabdoviridae family, and it primarily operates within the central nervous system [6]. Rabies ranks as one of the oldest recognized zoonotic diseases and stands as one of the most terrifying afflictions known to humankind [6,7]. This vaccine-preventable yet neglected tropical disease disproportionately affects impoverished rural communities [8,9]. While domestic dogs are accountable for transmitting rabies to humans in 99% of cases, the virus can also be transmitted by other domestic and wild animals [10].

Preventing human deaths from rabies is almost entirely achievable through three key interventions: (i) promptly administering Post Exposure Prophylaxis (PEP) to individuals bitten by animals suspected of carrying rabies [5], (ii) conducting annual mass dog vaccination campaigns that achieve a 70% vaccination coverage to control rabies in reservoir populations [11], and (iii) increasing community awareness about the risks of rabies and how to prevent and manage it [12]. The World Health Organization (WHO) recommends initiating PEP as soon as possible after a bite exposure [13]. Post Exposure Prophylaxis entails a combination of wound cleansing, timely completion of post-exposure vaccination, and administration of rabies human rabies immunoglobulin (HRIG) for individuals with severe bite exposure [13]. Immunoglobulin consists of a concentrated solution of rabies antibodies, injected into and

around the wound to provide immediate protection against the virus [14]. The use of PEP to prevent rabies dates back to 1885 when Louis Pasteur and his team developed the first successful rabies vaccine, crafted from the virus responsible for the disease in rabbits [15].

Despite the proven effectiveness of PEP and HRIG in preventing human rabies, these vital treatments are often inaccessible, unavailable, or financially out of reach for those in need, particularly within underserved rural communities [16,17]. Consequently, rabies continues to claim the lives of 59,000 individuals globally, with over 95% of these fatalities occurring in Africa and Asia, regions where access to human rabies PEP remains limited [9]. These human rabies deaths result in more than 3.7 million disability-adjusted life years (DALYs) lost and an economic toll of 8.6 billion United States Dollars (USD) annually [9]. On a global scale, over 29 million individuals receive human rabies post-exposure prophylaxis each year [13]. The utilization of the current global PEP regimen varies significantly from one country to another [18-21]. For instance, despite having controlled rabies, the United States of America still incurs substantial expenses on PEP in contrast to African countries where rabies remains endemic.

In the Philippines, the compliance rate for rabies immunoglobulin (RIG) stood at 55%, while for rabies PEP, it was as low as 31% [20]. Similarly, in Kenya, 16% of patients failed to complete the recommended five PEP doses, primarily due to financial constraints, missed follow-up treatment appointments, and the unavailability of PEP in healthcare facilities. In Tanzania, a study conducted in northern Tanzania, specifically in Serengeti and Ngorongoro districts, revealed that around 25% of bite victims did not seek PEP, primarily due to financial limitations and a lack of awareness about rabies [22-24]. Furthermore, in southern Tanzania, nearly 30% of individuals with suspected bites, necessitating PEP, did not receive any dose. Despite the critical role of PEP in saving the lives of those bitten, its availability remains inadequate in numerous rabies-endemic regions,

resulting in continued loss of lives due to rabies. Given that rabies is a fatal disease once symptoms manifest, it is imperative to underscore the importance of adhering to post-exposure prophylaxis to prevent needless rabies-related fatalities.

Rabies PEP treatment requires multiple doses administered over a 14 or 28-day period with protocols ranging from 4 doses for the Zagreb Regimen to 5 doses for the Essen Regimen [25,26]. In Tanzania, the cost per single dose is ranged from 15-30 USD [5,22,24]. To complete the recommended PEP regimens, bite patients should spend 100 USD [25]. Post-exposure prophylaxis cost places a heavy economic burden on African healthcare systems [22]. As a result, governments procure few PEPs, causing shortages of PEP particularly in rural clinics. This shortage of PEP, together with difficulty reaching clinics causes poor patient compliance with PEP doses. Consequently, many people die unnecessarily from rabies, particularly those from poor families who cannot afford PEP [26,27]. Post-exposure prophylaxis regimens that use injections into the skin (intradermal (ID) delivery) have been recommended as a cost-saving alternative to conventional injections into the muscle (intramuscular (IM) delivery [27]. However, ID regimens are rarely used in Africa [18,27]. In Tanzania, rabies causes an average of 552 (394-731) deaths every year [5].

The cost and availability of rabies prevention measures following exposure to animal bites pose significant challenges to PEP compliance [23,24]. Studies conducted in southern and northern Tanzania have highlighted the financial burden faced by patients, with expenses exceeding US\$100 required to complete the recommended World Health Organization PEP vaccination schedules [24]. Considering that nearly half of the Tanzanian population lives on less than 1.25 USD per day, the cost of PEP is unaffordable for many individuals [23,24]. Consequently, the high cost and limited availability of PEP have resulted in poor compliance and delays in initiating

treatment, ultimately increasing the risk of rabies-related fatalities [22-24].

Decentralizing the PEP clinic and transitioning from IM to ID regimen is essential to improve compliance with PEP [22]. The provision of timely administration of PEP at health facilities plays a critical role in preventing deaths from rabies. Factors such as PEP costs (affordability), PEP awareness (acceptability), and PEP availability, PEP adequacy are important predictors for bite patients to comply with the PEP regimen. Bite patients must seek PEP and Health facilities must stock enough PEP. Therefore, this study aimed to explore institutional factors (health delivery system factors) that affect the availability, adequacy, and affordability of human rabies post-exposure prophylaxis in Maswa district.

Moreover, the inadequate supply of essential PEP resources, including human anti-rabies vaccines and vaccine refrigerators, further restricts access to PEP. In rural areas, only a few medical facilities, primarily designated district hospitals, can maintain a reliable stock of vaccines. The current reporting procedures are insufficient to promptly address human rabies outbreaks [5]. Notably, most existing research on rabies in Tanzania has focused on districts where long-term rabies studies and control interventions have been conducted. Organizations such as Afya Serengeti, Global Animal Health Tanzania, and Mission Rabies have actively engaged in research, dog vaccination campaigns, and community education on rabies dangers, and occasionally provided PEP for animal patients. As a result, these interventions have likely raised awareness about rabies risks and improved PEP-seeking behavior in the areas where they were implemented. However, our study aimed to explore the perceptions and experiences of healthcare workers regarding institutional factors associated with compliance with rabies PEP in Maswa district, Tanzania. In Maswa District, the ratio of dogs to humans is 1: 7 [28]. Between 2018 and 2020, approximately 906 individuals were bitten by suspected rabid animals in Maswa

District, yet only 406 received human rabies post-exposure prophylaxis [29].

Methods

Study area: the study was carried out from April to July 2022 in the Maswa district in Simiyu region in Tanzania. The district covers rural and urban areas and it has three divisions Mwagala, Sengerema, and Nung'hu. The altitude of the district is ranging between 1 200 and 1 300 meters above sea level. The district has 36 wards, 120 villages, and one township authority with 40 sub-villages (Figure 1). The district has 3 398 square kilometers of which 2 475 square kilometers are suitable for agriculture and livestock-keeping activities. More than 77 square kilometers are forest reserve and 846 square kilometers are mountainous with slight bushes and shrubs.

Research design: in this research, a qualitative study using in-depth interviews was utilized to explore healthcare workers' perceptions and experiences about institutional factors (health delivery system factors) that are associated with compliance to rabies post-exposure prophylaxis in Maswa district, Tanzania. A total of 11 in-depth interviews with healthcare providers who have been practicing immunization and vaccine activities for not less than three years. Interviews were conducted over two months, from May to June 2022.

Inclusion criteria: the study included healthcare providers with at least three years of experience in immunization, specifically those from Maswa Hospital, Mwagala Dispensary, Wazazi Dispensary, and the Council Health Management Team (CHMT), responsible for resource coordination and quality health services.

Exclusion criteria: a healthcare provider who has less than three years of experience in immunization and vaccine activities and working in a clinic that is not providing PEP.

Data collection and procedures: the study enrolled healthcare workers experienced in rabies vaccine administration since January 2019. They were selected from three health facilities (Maswa District Hospital, Mwangala Dispensary, Wazazi Dispensary) providing rabies post-exposure prophylaxis and from the Council Health Management Team (CHMT) responsible for supervision. Data collection involved a checklist, active listening, and probing techniques to assess health system factors affecting patient compliance. In-depth interviews were conducted with eleven participants, including the District Pharmacist, Health Secretary, Immunization Officer, and others. Interviews occurred between May 3, 2022, and June 30, 2022, lasting 45 to 60 minutes each.

Data analysis: in-depth interviews were transcribed and analyzed using NVIVO software to identify and group data patterns into themes. Key themes included knowledge and skills of rabies vaccine administration, instrument availability, leadership, management, and PEP prioritization. Our approach combined deductive and inductive methods to capture both pre-existing and emergent themes aligned with the research questions.

Ethical consideration: this study adhered to the Ifakara Health Institute (IHI-IRB) policy and procedures, with ethical clearance granted under reference number IHI/IRB/No. 16-2022. Informed consent was obtained from participants, emphasizing voluntariness and confidentiality. Clearances from both IHI-IRB and the District Executive Director (DED) were secured, ensuring ethical conduct, participant protection, and proper permissions for data collection.

Results

Demographic characteristics of healthcare workers: the study included 11 participants, with a mean age of 41 years (standard deviation = 9.471). Table 1 summarizes the in-depth interview

participants. The majority of key informants were females 63.6% (n=7). For the level of education, the majority 63.6% (n=7) had a diploma level.

Thematic overview: a finalized map of codes, sub-themes, and themes is presented in Table 2. Four main themes were derived from the interview data, representing key factors influencing patients' compliance with rabies post-exposure prophylaxis.

Health services delivery system factors for PEP compliance: the views of study participants on institutional factors influencing patients' compliance to rabies post-exposure prophylaxis were categorized into three themes as follows.

Theme 1: knowledge and skills of rabies vaccine administration: the theme of "knowledge and skills of rabies vaccine administration" is explained by insights gained through in-depth interviews, demonstrating the crucial role of healthcare practitioners' expertise and competence in patient compliance with healthcare services. As expressed by a Nurse Officer at Maswa Hospital, "factors such as knowledge, expertise, commitment, and thorough patient examination significantly impact the quality of healthcare services". These elements underscore the importance of healthcare professionals continually enhancing their competencies to ensure the delivery of high-quality care. In another interview from Wazazi dispensary, "*Dispensary emphasized the importance of healthcare professionals remaining current with the best practices and guidelines in their field. Staying updated with the latest developments is regarded as essential for providing effective healthcare services*" (nurse officer from Wazazi dispensary). Furthermore, the interviews unveiled a consensus among healthcare professionals that improving competencies can yield numerous benefits. This includes enhanced patient outcomes, heightened patient satisfaction, and an overall enhancement of the healthcare system's performance. It is noteworthy that the pursuit of competence is not solely an individual endeavor; healthcare organizations play a vital role in this process. The District Health Secretary

emphasized the importance of healthcare organizations investing in their staff, *“Providing necessary resources and support, such as regular in-service training, access to current research and guidelines, and fostering a culture of continuous learning and improvement, is essential to achieve international standards of care”* (district health secretary).

Theme 2: unavailability of medical instruments (0.5cc needle for ID injections): participants pointed out that the unavailability of medical instruments at the clinic such as 0.5 cubic centimeters (cc) made it difficult to Most health facilities especially dispensaries have limited resources with fewer medical facilities, making it difficult for individuals to receive the care they need. *“It affects the intradermal injections which need (0.5cc needles), we do not use larger than 0.55cc needles for ID injections because it increases the risk of complications, such as tissue damage and excessive bleeding. It causes a waste of the vaccine and the cost associated with it”* (district immunization and vaccine officer). It is important for medical facilities to 0.5cc needles that could be used for ID injections. ID injections are cheap compared to IM injections.

Theme 3: leadership, management and prioritization of PEP: effective management is often considered an important enabler of quality from the perspective of healthcare providers and managers. We found that healthcare providers and managers are not prioritizing PEP vaccines during ordering and procuring. Effective management can ensure that resources are used efficiently and effectively and that the healthcare system can meet the needs of patients and other stakeholders. *“The management of a health facility plays a critical role in ensuring the smooth functioning of the hospital, availability of ant rabies vaccines, and the delivery of high-quality care. Good management is necessary to create an environment that is conducive to quality improvement, where ideas and feedback from healthcare providers, patients, and other*

stakeholders are actively solicited, considered, and acted upon (RCH in-charge, Mwangala dispensary).

Additionally, the study found that facility managers’ ability to budget, manage, and track funds at the facility level can negatively impact on allocation and reallocation of funds. For example, Table 3 shows the total amount of collection fees collected from patients from January 2019 to June 2022 for rabies vaccination services was 12 577.69 USD which was deposited into the basket fund. However, only USD2800.77 (22.27%) was used to procure rabies vaccines. This caused shortages of PEP in Maswa, these shortages of PEP resulted in higher costs of PEP.

One of the factors contributing to patient compliance with human rabies PEP is the cost of healthcare. Table 4 presents the cost of human rabies PEP services incurred by patients. This study found the high amount of 51.17 USD as an obstacle to PEP compliance. Experiences from the Serengeti and Ngorongoro districts where patients pay for PEP, 25% of bite victims did not seek care [22]. Reducing the cost of the vaccine could be one way to improve compliance with human rabies PEP. This could involve government or non-governmental organizations providing subsidies or other forms of financial support to make the vaccine more accessible and affordable to those who need it.

Finally, the study found that PEP health facilities were not decentralized. We found only three out of 51 health facilities are providing PEP. These three health facilities are located in the Maswa Township (in a radius of about 5 kilometres). This leads to poor compliance with PEP and delays in receiving PEP regimens to people living far from Maswa Township.

Discussion

Rabies is a deadly viral infection that poses a significant public health concern worldwide. Despite the availability of effective Post-Exposure Prophylaxis (PEP), non-compliance to PEP remains

a challenge. Therefore, this study characterized the factors associated with patients' compliance with human rabies PEP. The availability, adequacy, and affordability of human rabies post-exposure prophylaxis are critical components of the health delivery system for rabies prevention and control [23]. The availability of human rabies PEP is a crucial aspect of the health delivery system, PEP must be readily available in healthcare facilities across the country, particularly in areas where rabies is endemic. The adequacy of human rabies PEP relates to the quality of care provided to patients [30]. This includes the proper administration of PEP, which should be in line with World Health Organization (WHO) recommendations, and the provision of appropriate care and support to patients throughout the treatment process [31]. Adequate care also includes follow-up to ensure that patients complete the recommended PEP regimen. The affordability of human rabies PEP is a significant barrier to access for many people, PEP is often expensive, particularly for those who live in rural areas or low-income households [24].

This study found that education and skills for healthcare workers were factors that affected the adequacy of the health system, which in turn affected PEP compliance. Healthcare workers are not adequately trained in administering PEP, especially the provision of ID injections [32], some of the possible reasons may include: a lack of knowledge, limited resources, time constraints, and inadequate supervision. The finding is consistent with other studies that have highlighted the importance of adequate training for healthcare workers in administering PEP [22,33-37]. To address these issues, healthcare facilities should prioritize the provision of comprehensive and ongoing training for healthcare workers on PEP, including the proper administration of ID injections. Good human resource management plays a key role in driving employee satisfaction and loyalty through providing incentives and training. Human resource management has a significant effect on employee

training, and patient satisfaction in the healthcare industry [37]. When employees are trained they will be satisfied and committed to their work, they will be more likely to provide high-quality care and service to customers [38].

This study showed that leadership and management style for healthcare workers was a factor that affected the availability of human rabies vaccine. This is consistent with other studies in Uganda and Nepal [39-42]. Effective leadership and management can improve the availability of vaccines in several ways. For example, leaders can ensure that there is adequate funding for vaccine procurement and distribution, as well as establish efficient supply chain systems to ensure that vaccines are delivered to healthcare facilities promptly [32,43,44]. Effective leaders can also prioritize vaccine procurement and distribution, ensuring that vaccines are given priority over other health commodities [45-47]. The study found a significant proportion (77.7%) of the collection fee collected from patients for rabies vaccination services is not being used for rabies vaccine procurement. The possible explanation for this is that poor leadership and management and allocation of funds within healthcare facilities result in poor availability of rabies vaccine [47]. Therefore, effective leadership and management are essential for ensuring that resources are used efficiently and effectively. In the case of rabies vaccination services, funds collected from patients for vaccine services must be used for their intended purpose, which is to procure vaccines and provide vaccination services. Failure to allocate these funds appropriately can result in vaccine shortages, reduced access to vaccination services, and ultimately lower PEP compliance rates. Moreover, the present study found that the vaccine procurement decisions made at low-level healthcare facilities are not being given sufficient consideration by higher-level managers, and, the procurement process is bureaucratic and lengthy requiring multiple steps between health facilities, suppliers, and district managers. Strangely, the study conducted in 2018 in Dar es Salaam

Tanzania found a significant number of people were involved in the process of drug procurement, a minimum of 13 signatures were required from order preparation to authorization and finally to approval. This could potentially lead to poor availability of rabies vaccines and necessary supplies and equipment (ID injections), and could also increase the administrative burden on health facilities and other involved parties.

The study has demonstrated poor PEP compliance in Maswa district due to the centralization of health facilities that provide PEP. Specifically, out of the 51 health facilities that provide routine vaccines in Maswa district, only three of them are located in the town and provide PEP services. Centralization of health facilities can create challenges for individuals who need PEP services because it can limit the number of facilities where PEP services are available, potentially leading to long wait times, increased travel distances, and limited availability of PEP supplies [22,23,48,49]. This means that people who require PEP services may have to travel long distances to access them, which could result in delays in treatment and potentially negative health outcomes. To address this it may be necessary to consider implementing decentralized PEP services that are available at a broader range of health facilities. The cost of human rabies PEP services, including procurement costs, transportation costs, accommodation fees, and vaccination fees, is a significant barrier to PEP compliance [9,22,24]. High costs can be a significant barrier to access to healthcare services, particularly for vulnerable populations such as low-income individuals and those living in remote or underserved areas [49,50]. This can lead to lower PEP compliance rates and increased morbidity and mortality from rabies. Our study found that animal bite patients did not complete PEP due to the failure to afford transportation costs of 2.5 USD and the cost of 17 USD per single dose of human rabies vaccine. This may be because low-income countries often have limited healthcare financing and resources, which can lead to high out-of-pocket costs for patients seeking

healthcare services [49]. Improving PEP compliance requires a multifaceted approach that involves increasing healthcare financing and resources, improving transportation, and infrastructure, and establishing policies and guidelines that ensure that PEP services are accessible and affordable to all who need them.

Study limitation: the limitation of this study is the self-report bias. Self-report bias can occur when participants provide inaccurate, incomplete, or socially desirable answers to questions, resulting in incorrect data and incorrect interpretations of the results. In this study, healthcare providers may overestimate their compliance with post-exposure prophylaxis procedures due to social desirability bias, which makes them report responses that align with their perceived expectations rather than their actual behavior or practices. Additionally, providers may experience difficulties remembering and reporting patient compliance accurately due to the timing and complexity of monitoring all the patients they have treated over the study period.

Conclusion

Human rabies remains a major public health problem in Maswa, Tanzania. This study underscores the critical challenges affecting compliance with human rabies Post-Exposure Prophylaxis (PEP). Factors such as healthcare worker education and skills, leadership, and management styles, as well as the cost of PEP services, including procurement, transportation, accommodation, and vaccination fees, have a substantial impact on PEP accessibility and adherence. Insufficient training for healthcare workers in administering PEP, especially intradermal injections, can hinder the adequacy of the health system and subsequently affect PEP compliance. Effective leadership and management are crucial for ensuring the availability of human rabies vaccines and other essential resources, preventing misallocation of funds, and streamlining the procurement process. Decentralization of PEP services and prioritization

of vaccine procurement can enhance accessibility. The high cost of PEP services poses a significant barrier to compliance, particularly for low-income individuals and those in remote areas. This financial burden can lead to lower PEP adherence rates and increased morbidity and mortality from rabies. Addressing this issue requires a multifaceted approach involving increased healthcare funding and resources, improved transportation and infrastructure, and the establishment of policies to ensure that PEP services are both accessible and affordable to all in need.

Recommendations

Enhance healthcare worker training: prioritize comprehensive and ongoing training programs for healthcare workers involved in administering PEP. Special attention should be given to training in proper intradermal injection techniques to ensure the adequacy of PEP services.

Leadership and management improvement: promote effective leadership and management within healthcare facilities to optimize the availability of human rabies vaccines and resources. Ensure proper allocation of funds collected from patients for vaccine services to prevent shortages and enhance access.

Streamline procurement processes: simplify and expedite the procurement of rabies vaccines and necessary supplies and equipment at all healthcare facility levels. Minimize bureaucratic procedures and reduce the administrative burden on healthcare facilities and involved parties.

Decentralize PEP services: implement decentralized PEP services to make them accessible at a broader range of healthcare facilities. This can reduce travel distances, waiting times, and supply limitations, especially in remote areas.

Address cost barriers: develop policies and guidelines that promote affordability of PEP

services. Explore strategies to reduce the financial burden on patients, such as subsidies, insurance coverage, or cost-sharing initiatives.

Increase healthcare financing: invest in healthcare financing and allocate sufficient resources to support PEP services. This includes securing funding for vaccine procurement, transportation, and infrastructure improvements.

Improve transportation and infrastructure: enhance transportation networks and infrastructure, particularly in underserved areas, to facilitate patient access to healthcare facilities offering PEP services.

Community education: launch public awareness campaigns about the importance of rabies prevention and the availability of PEP. Educate communities on the signs of rabies exposure and the need for prompt treatment.

Collaboration and coordination: foster collaboration among healthcare facilities, government agencies, non-governmental organizations, and other stakeholders involved in rabies prevention and control. Coordinated efforts can lead to more effective resource allocation and service delivery.

Data monitoring and evaluation: implement robust monitoring and evaluation systems to track PEP compliance rates and identify areas needing improvement. Regularly assess the impact of interventions and adjust strategies accordingly.

What is known about this topic

- *Healthcare worker competency is crucial: knowledge, skills, commitment, and continuous learning among healthcare professionals significantly impact the quality of healthcare services;*
- *Impact of medical instrument availability on PEP compliance: unavailability of crucial medical instruments, specifically 0.5cc needles for intradermal injections, is*

identified as a significant challenge; this shortage not only affects the administration of intradermal injections but also leads to complications, resulting in a waste of the vaccine and increased costs;

- *Leadership and management influence on PEP programs: effective leadership and management play a crucial role in ensuring the smooth functioning of healthcare facilities and the availability of rabies vaccines; the study underscores the importance of decision-making, prioritization, resource allocation, planning, and monitoring and evaluation in the successful implementation of PEP programs.*

What this study adds

- *Enhancing patient safety and health outcomes: the study provides insights into the factors influencing patients' compliance with human rabies Post-Exposure Prophylaxis (PEP); by identifying challenges related to healthcare worker competency, medical instrument availability, leadership and management, cost barriers, and facility decentralization, the study contributes to enhancing patient safety;*
- *Informing policy and healthcare practices: understanding the importance of healthcare worker training, adequate medical instrument supply, effective leadership, cost considerations, and decentralized services can inform the development of policies and practices aimed at optimizing the delivery of PEP; policymakers can use this knowledge to implement targeted interventions and improvements in healthcare systems to enhance rabies prevention and control;*

- *Resource allocation and management optimization: perceptions from the research can guide healthcare facility managers and administrators in optimizing resource allocation for PEP services; this includes ensuring that funds collected for rabies vaccination services are appropriately used, reducing shortages, and improving the overall efficiency of the healthcare system.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Budodi Walwa Walwa is credited with the conception and design of the study, including the development of research protocols. Budodi Walwa Walwa also played a key role in data collection, analysis, and interpretation, and contributed significantly to the writing of the manuscript. As the lead author, Budodi Walwa Walwa took a primary responsibility for the overall direction of the study. Tulamwona Exaud Dumulinyi and Dishon Mussa Chondi both contributed to the study design and provided input throughout the research process. They conducted data analysis and provided significant intellectual input and critical review of the manuscript. Their expertise helped to refine and clarify the research's objectives and methods, and contributed to the study's overall quality. All authors reviewed and approved the final version of the manuscript before submission, ensuring that the research was presented accurately and clearly. They are fully accountable for the research's integrity, and each author contributed significantly to the manuscript's content. Collectively, the authors provided a valuable collaboration towards the successful execution of this study.

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Tables and figure

Table 1: summary of the socio-demographic characteristics of healthcare workers

Table 2: codes, sub-themes, and themes representing key factors influencing patients' compliance to rabies post exposure prophylaxis

Table 3: amount collected and post-exposure prophylaxis procured using basket fund in Maswa district between 2020-2022

Table 4: cost related to post-exposure prophylaxis services

Figure 1: the map of Tanzania (top left corner) and Maswa district showing the wards of the study area

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Table 1: summary of the socio-demographic characteristics of healthcare workers

Variable	Category	N (%)	Mean age (years)	SD
Age			41.091	9.471
Experience on post-exposure prophylaxis provision			7.818	4.792
Sex	Male	7 (63.6)		
	Female	4 (36.4)		
Religion	Christian	9 (81.8)		
	Muslim	2 (18.2)		
Level of education	Certificate	3 (27.3)		
	Diploma	7 (63.6)		

Table 2: codes, sub-themes, and themes representing key factors influencing patients' compliance to rabies post-exposure prophylaxis

Themes	Sub-themes	Code	Illustrative quote
Knowledge and skills in rabies vaccine administration	Vaccine management and administration	Pre-vaccination	Limited awareness regarding the significance of PEP and the urgency of seeking medical attention post possible rabies exposure can lead to treatment delays, compromising PEP's efficacy or rendering it ineffective as the virus advances in the body.
		Rabies vaccine administration techniques	Proficient healthcare providers alleviate vaccine injection pain, fostering PEP adherence by reducing fear and discomfort.
		Vaccine schedule and dosage	Experienced healthcare providers ensure correct, precise Rabies vaccine administration, proficient in both intramuscular and intradermal injections as needed.
		Adverse reactions and management	Patients may fear complications and discontinue treatment if healthcare providers are unable to effectively address their concerns and contraindications to the vaccine.
Unavailability of medical instruments (0.5cc needle for ID injections)	Supply and shortages challenges,	Supply shortages	Supply shortages may decrease PEP compliance, raising protection concerns for healthcare workers and patients and possibly discouraging PEP use
		Logistical challenges,	Logistical challenges, such as the unavailability of crucial medical instruments during supply shortages, can directly impact PEP compliance, leading to concerns about treatment safety and effectiveness.
Leadership, management, and prioritization of post-exposure prophylaxis	Integrated-management approach	Decision-making and prioritization	Leaders provide guidance and set priorities to ensure that PEP is administered promptly and appropriately. They establish clear protocols for PEP prioritization, taking into account factors such as the severity of exposure, the availability of medical resources, and the urgency of treatment.
		Resource allocation and planning	A clear allocation plan, factoring in patient priorities, exposure severity, and treatment urgency, ensures effective PEP administration
		Monitoring and evaluation	Effective leadership and management in PEP programs are bolstered by robust monitoring and evaluation, enabling healthcare facilities to adapt, improve patient safety, and optimize PEP delivery continuously.

Table 3: amount collected and PEP procured using basket fund in Maswa district between 2020-2022

Health facility	Total costs used for procurement of all medicines (USD)	Total collection fee (rabies vaccination costs) (USD)	Total costs used for procurement of rabies vaccine (USD)
Maswa hospital	271236.12	11083.65	2060.45 (18.59%)
Wazazi dispensary	75776.92	780.76	388.25 (49.73%)
Mwagala dispensary	61302.68	713.28	352.06 (49.36%)
Total	408315.73	12577.69	2800.77 (22.27%)

Table 4: cost related to post-exposure prophylaxis services

Variable	Mean (USD)	Standard deviation	Min (USD)	Max (USD)
Transportation (fare)	11.38	5.60	0.43	29.76
Accommodation fee	2.76	1.75	0.85	10.62
Vaccination fee	36.96	8.37	1.28	74.40
Total payment	51.10	12.45	19.56	102.04



Figure 1: the map of Tanzania (top left corner) and Maswa district showing the wards of the study area