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Guideline Adherence of Post-Exposure Prophylaxis and Factors Associated with Vaccine Series Completion in Patients Presenting to the Emergency Department with Rabies-Risk Exposure

Acil Servise Kuduz Riskli Temas Nedeniyle Başvuran Hastalarda Temas Sonrası Profilaksi Uygulamalarının Kılavuz Uygunluğu ve Aşı Serisini Tamamlamayı Etkileyen Faktörler

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Abstract

Aim This study aimed to retrospectively evaluate adherence to national guidelines in rabies post-exposure prophylaxis (PEP) administered to patients presenting with rabies-risk exposures to the emergency department, and to identify factors associated with completion of the vaccine series.

Materials and Methods Records of 343 patients presenting to the Emergency Department of Ağrı Training and Research Hospital between June 2025 and May 2026 were reviewed. The distribution of continuous variables was assessed using the Shapiro-Wilk test; the Mann-Whitney U, Kruskal-Wallis, chi-square, and Fisher's exact tests were used for between-group comparisons. Adherence of the administered prophylaxis to the 2019 Turkish Ministry of Health Rabies Prophylaxis Guideline was evaluated.

Results The median age of patients was 21.0 years (interquartile range [IQR]: 10.0-34.0), and 62.1% were male. Adherence to RIG indication of the administered prophylaxis was found to be 54.5%; among Category III/IV exposures with an indication for rabies immunoglobulin (RIG), RIG was administered in only 14.0% of cases. The vaccine series completion rate was 72.9%, and among the 14 variables examined, only a history of prior prophylaxis was found to be significantly associated with completion (p=0.014). Rural residence, atypical exposure types, and milder wound categories were associated with longer delays in presentation to the emergency department, and presentations increased markedly during summer months.

Conclusions Adherence of rabies post-exposure prophylaxis practices to national guidelines, particularly regarding the indication for rabies immunoglobulin, was found to remain below the desired level. Strengthening physician education and reviewing RIG accessibility in the region were considered necessary.

Keywords Rabies, Rabies Vaccines, Rabies İmmunoglobulins, Guideline Adherence, Emergency Service.

Öz

Amaç *Bu çalışmada, acil servise kuduz riskli temas nedeniyle başvuran hastalarda uygulanan temas sonrası profilaksinin (PEP) ulusal kılavuza uygunluğunun ve aşı serisi tamamlanma oranını etkileyen faktörlerin retrospektif olarak değerlendirilmesi amaçlanmıştır.*

Gereç ve Yöntem *Haziran 2025-Mayıs 2026 tarihleri arasında Ağrı Eğitim ve Araştırma Hastanesi Acil Servisi'ne başvuran 343 hastanın kayıtları incelenmiştir. Sürekli değişkenlerin dağılımı Shapiro-Wilk testi ile değerlendirilmiş; gruplar arası karşılaştırmalarda Mann-Whitney U, Kruskal-Wallis, ki-kare ve Fisher'in kesin testleri kullanılmıştır. Uygulanan profilaksinin T.C. Sağlık Bakanlığı 2019 Kuduz Profilaksi Rehberi'ne uygunluğu değerlendirilmiştir.*

Bulgular *Hastaların yaş ortancası 21,0 (çeyrekler arası aralık [IQR]: 10,0-34,0) yıl olup %62,1'i erkekti. Uygulanan profilaksinin kuduz immünglobulini (RIG) endikasyonuna uygunluk oranı %54,5 olarak saptanmış; RIG endikasyonu bulunan Kategori III/IV temaslarda RIG uygulanma oranının yalnızca %14,0 olduğu belirlenmiştir. Aşı serisi tamamlanma oranı %72,9 olup, incelenen 14 değişkenden yalnızca önceki profilaksi öyküsü tamamlanma ile anlamlı ilişkili bulunmuştur (p=0,014). Kırsal ikamet, alışılmadık temas biçimleri ve hafif yara kategorileri, acil servise başvuruda daha uzun gecikme süresi ile ilişkilendirilmiş; başvurular yaz aylarında belirgin şekilde artmıştır.*

Sonuç *Kuduz temas sonrası profilaksi uygulamalarının, özellikle kuduz immünglobulini endikasyonu açısından, ulusal kılavuza uygunluğunun arzu edilen düzeyin altında kaldığı sonucuna varılmıştır. Bölgede hekim eğitiminin güçlendirilmesinin ve RIG erişiminin gözden geçirilmesinin gerekli olduğu düşünülmüştür.*

Anahtar Kelimeler *Kuduz, Kuduz Aşıları, Kuduz Immünglobulini, Kılavuza Uyum, Acil Servis.*

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INTRODUCTION

Rabies is a zoonotic disease caused by a Lyssavirus RNA virus that affects the central nervous system and is almost invariably fatal once clinical symptoms appear. It is estimated to cause approximately 59,000 human deaths worldwide annually, with the vast majority occurring in rural and low- to middle-income regions following dog-mediated exposures.[1] However, the true magnitude of the global rabies burden cannot be clearly established due to deficiencies in surveillance systems and low reporting rates.[2] This situation causes the disease to remain a neglected public health problem despite being preventable.

Post-exposure prophylaxis (PEP), a three-component approach consisting of wound care, administration of rabies immunoglobulin, and complete adherence to the vaccination schedule, is the only known effective method for preventing the development of rabies.[3] However, the protective effect of PEP depends directly on timely initiation and complete adherence to the recommended vaccination schedule. Prolonged delays or interruptions in the schedule can leave the individual vulnerable to rabies.

Turkey is considered an endemic country for rabies due to the widespread presence of stray animal populations and frequent contact with farm animals in rural areas. A substantial proportion of human rabies cases reported in our country have been attributed to insufficient recognition of post-exposure risk or delayed prophylaxis.[4] Registry-based studies conducted in different regions have shown that suspected rabies exposures constitute a considerable public health burden and that PEP administration rates vary markedly across regions.[5,6] Although population control initiatives such as the establishment of animal shelters have been reported to reduce the number of suspected exposures,[7] physicians' knowledge of rabies management has been shown to remain insufficient, which can contribute to inappropriate PEP decisions.[8]

In its 2018 updated position paper, the World Health Organization (WHO) recommended abbreviated vaccination regimens to improve the programmatic feasibility, cost-effectiveness, and patient adherence of PEP schedules.[9,10] Despite these updates, retrospective studies conducted in emergency departments show that adherence of PEP practices to recommended protocols is not always achieved, with notable variation in practice regarding wound care, immunoglobulin administration, and completion of the vaccination schedule.[11]

Existing literature on adherence to rabies PEP and vaccination schedule completion rates is largely reported from countries with a high rabies burden, and retrospective data specific to the eastern regions of Turkey, where livestock farming is prevalent and stray animal populations are high, remain limited. Indeed, according to data from the Turkish Ministry of Health, 2 of the 4 human rabies cases reported nationwide in 2014 occurred in Ağrı province.[12] This finding highlights the disproportionate rabies risk faced by the region. Considering this risk, the present study aimed to retrospectively evaluate the completion rate of the rabies PEP schedule and the independent factors associated with completion among animal exposure cases presenting to the Emergency Department of Ağrı Training and Research Hospital over a one-year period.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a cross-sectional study in which the records of patients who presented to the Emergency Department of Ağrı Training and Research Hospital due to rabies-risk exposure and who received PEP between June 2025 and May 2026 were retrospectively reviewed.

Study Population

The study population consisted of patients who presented to the Emergency Department of Ağrı Training and Research Hospital due to rabies-risk exposure during the specified period.

Inclusion criteria: All patients who presented to the emergency department during the study period due to rabies-risk exposure (bite, scratch, contact with an open wound, or other types of contact) and who were evaluated regardless of the wound category (Category I-IV) defined in the Turkish Ministry of Health Rabies Prophylaxis Guideline (2019) were included.[13] As we are the only hospital in Ağrı city center, no sampling was performed and the entire population (n=343) was included in the study.
Exclusion criteria: (a) cases with missing or inaccessible file/record information, (b) cases in which vaccine series completion status could not be fully tracked through hospital records because part of the prophylaxis was administered at another center.

Data Collection

Data were extracted from the hospital information management system and emergency department records and transferred to a pre-prepared, numbered data collection form. The form comprised fields on sociodemographic characteristics (age, sex, place of residence), exposure characteristics (species of animal involved, availability/observation status of the animal, type of contact, WHO wound category), timing of presentation (delay between exposure and presentation, month of presentation), patient history (history of prior rabies-risk exposure, prior prophylaxis administration, chronic disease/medication use), components of administered prophylaxis (wound care, tetanus prophylaxis, recommended treatment schedule, vaccine doses, administration of rabies immunoglobulin [RIG]), and vaccine series completion status.

Definitions

Guideline adherence: Defined as the extent to which the administered wound care, vaccination schedule, and immunoglobulin use complied with the recommendations of the Turkish Ministry of Health Rabies Prophylaxis Guideline (2019).[13] Adherence regarding RIG indication in particular was assessed on the basis of RIG not being administered in Category I and II exposures, and RIG being administered in Category III and IV exposures.

Wound category: Classified into four categories according to the risk level defined in the Turkish Ministry of Health Rabies Prophylaxis Guideline (2019): Category I, situations involving no exposure risk, such as touching/feeding an animal or licking of intact skin; Category II, minor scratches without bleeding on exposed skin, minor scratches/abrasions without bleeding, or minor bleeding-free cat scratches occurring during provocation; Category III, single or multiple bites/scratches that break the skin, contact of mucous membranes or open skin wounds with animal saliva, or lesions located in areas with a high density of nerve endings such as the head, neck, or fingertips; Category IV, regardless of wound severity, risky contact with wild animal species with a potential for rabies transmission (e.g., fox, wolf, bat).[13]

Vaccine series completion: Defined as the complete administration of one of the four-dose vaccination schedules specified in the Turkish Ministry of Health Rabies Prophylaxis Guideline (2019) (either the 4-dose schedule administered on days 0, 3, 7, and 14-28, or the 2-1-1 schedule administered as 2 doses on day 0 and single doses on days 7 and 21). For patients who had previously received a full course of rabies vaccination, completion of the 2-dose booster schedule administered on days 0 and 3, as defined in the guideline, was considered sufficient.[13]

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. The normality of distribution of continuous variables was assessed using the Shapiro-Wilk test. Continuous variables that did not show a normal distribution were presented as median (interquartile range [IQR]); the Mann-Whitney U test was used for comparisons between two groups, the Kruskal-Wallis test for comparisons among more than two groups, and Spearman correlation analysis for associations between continuous variables. Categorical variables were presented as number and percentage, and the chi-square

test or, when the expected cell count was below 5, Fisher's exact test was used for between-group comparisons.

Adherence of the administered prophylaxis to the guideline was reported descriptively as proportions and percentages; whether adherence to RIG indication differed according to wound category was assessed using the chi-square test. Factors associated with vaccine series completion were evaluated using the Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. Factors associated with delay in presentation to the emergency department were examined using the Mann-Whitney U test for binary groups, the Kruskal-Wallis test for variables with more than two groups, and Spearman correlation analysis for the association with age. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 343 patients who presented to the Emergency Department of Ağrı Training and Research Hospital due to rabies-risk exposure between June 2025 and May 2026 were included in the study. The general demographic and clinical characteristics of the patients are presented in Table 1. The median age of the patients was 21 years. Of the patient group, 62.1% (n=213) were male, and 74.1% (n=254) resided in urban areas. Nearly half of the exposures were bites (49.9%, n=171), and most of the remainder were scratches (45.2%, n=155); the most commonly involved animal species was cats (57.4%, n=197), followed by dogs (36.7%, n=126). A single patient had a wild animal (fox) exposure. Of the patients, 49.0% (n=168) presented with Category III wounds, 42.0% (n=144) with Category II, and 8.2% (n=28) with Category I. The majority of patients (93.6%, n=321) had no history of prior rabies-risk exposure.

The median delay in presentation to the emergency department was 0 days, and the majority of patients presented on the day of exposure. The vaccine series completion rate was found to be 72.9%.

Table 1. Demographic, Clinical, and Prophylaxis Characteristics of Patients Presenting to the Emergency Department Due to Rabies-Risk Exposure (N=343)

Variable	n (%) / Median (IQR)	Min–Max
Demographic Characteristics		
Age (years), median (IQR)	21.0 (10.0–34.0)	1–92
Sex, n (%)		
Male	213 (62.1)	
Female	130 (37.9)	
Place of residence, n (%)		
Urban	254 (74.1)	
Rural	89 (25.9)	
Exposure Characteristics		
Delay time (days), median (IQR)	0.0 (0.0–0.0)	0–18
Type of contact, n (%)		
Bite	171 (49.9)	
Scratch	155 (45.2)	
Contact with open wound	3 (0.9)	
Other	14 (4.1)	
Animal species, n (%)		
Dog	126 (36.7)	
Cat	197 (57.4)	
Wild animal	1 (0.3)	
Other	19 (5.5)	
Animal's availability status, n (%)		
Escaped / unidentified	232 (67.6)	
Died or was killed	2 (0.6)	
Owned, vaccinated, under observation	20 (5.8)	
Owned, unvaccinated, under observation	61 (17.8)	
Unowned, vaccinated, under observation	3 (0.9)	
Unowned, unvaccinated, under observation	25 (7.3)	
Wound category (WHO/Turkish MoH 2019), n (%)		
Category I	28 (8.2)	
Category II	144 (42.0)	
Category III	168 (49.0)	
Category IV	3 (0.9)	
Patient History		
History of prior rabies-risk exposure, n (%)		

Yes	22 (6.4)	
No	321 (93.6)	
Prior prophylaxis administration, n (%)		
Yes	14 (4.1)	
No	329 (95.9)	
Chronic disease / medication use, n (%)		
Yes	32 (9.3)	
No	311 (90.7)	
Prophylaxis Administration		
Wound care administered, n (%)	214 (62.4)	
Tetanus prophylaxis administered, n (%)	158 (46.1)	
Recommended treatment schedule, n (%)		
Vaccine	310 (90.4)	
Vaccine + RIG	33 (9.6)	
Vaccine series completed, n (%)	250 (72.9)	
IQR: interquartile range; RIG: rabies immunoglobulin; WHO: World Health Organization; Turkish MoH: Turkish Ministry of Health. Continuous variables are presented as median (interquartile range) as they did not show a normal distribution according to the Shapiro-Wilk test (p<0.001); categorical variables are presented as frequency (percentage).		

Guideline Adherence of Prophylaxis

When the adherence of the administered prophylaxis to the 2019 Turkish Ministry of Health Rabies Prophylaxis Guideline was assessed (Table 2), the RIG indication adherence rate was found to be 54.5% (187/343). As expected, RIG was not administered in any patient presenting with Category I exposure. Although rabies vaccination is not required by the guideline in Category I exposures, all 28 patients in this category received the vaccine, whereas none received RIG. Among the 144 patients presenting with Category II exposure, non-administration of RIG was found to be guideline-adherent in 93.8% (n=135), while RIG was administered without indication in 6.2% (n=9). Notably, among the 171 patients presenting with Category III or IV exposure, for whom RIG was indicated, RIG was administered in only 14.0% (n=24), while 86.0% (n=147) did not receive RIG despite the indication. Although the RIG administration rate was statistically significantly higher in the Category III/IV group compared with the Category I/II group (p=0.010), the low absolute administration rate is noteworthy. The rate of wound care administration was 62.4%, and the rate of tetanus prophylaxis administration was 46.1%.

Table 2. Adherence Assessment of the Administered Prophylaxis to the 2019 Turkish Ministry of Health Rabies Prophylaxis Guideline (N=343)

Variable	n (%)
Overall RIG indication adherence rate	187/343 (54.5)
RIG Administration by Wound Category	
Category I (n=28), RIG not indicated	
RIG not administered (adherent)	28 (100.0)
Category II (n=144), RIG not indicated	
RIG not administered (adherent)	135 (93.8)
RIG administered (unnecessary)	9 (6.2)
Category III+IV (n=171), RIG indicated	
RIG administered (adherent)	24 (14.0)
RIG not administered (undertreatment)	147 (86.0)
Administration Rates of Other Prophylaxis Components	
Wound care administration rate	214/343 (62.4)
Tetanus prophylaxis administration rate	158/343 (46.1)
Vaccine series completion rate	250/343 (72.9)
RIG: rabies immunoglobulin. According to the guideline, no prophylaxis is required for Category I exposures; vaccine alone is indicated for Category II exposures; vaccine + RIG is indicated for Category III and IV exposures	

Factors Associated with Vaccine Series Completion

Demographic and clinical variables were compared between patients who completed (n=250) and did not complete (n=93) the vaccine series (Table 3). Among the 14 variables examined, including age, sex, place of residence, delay time, type of contact, animal species, observation status of the animal, wound category, history of prior risky exposure, prior prophylaxis administration, presence of chronic disease, wound care, tetanus prophylaxis, and recommended treatment schedule, only "prior prophylaxis administration" was found to be statistically significantly associated with vaccine series completion (p=0.014). All 14 patients who had previously received prophylaxis completed the vaccine series. Given the perfect separation issue arising from the zero cell value in the corresponding subgroup of this variable, this finding was considered to

warrant cautious interpretation due to the limited sample size (n=14). No significant difference was found between the two groups for any of the other variables (p>0.05).

Factors Associated with Delay in Presentation to the Emergency Department

When factors associated with delay time were examined

Table 3. Comparison of Factors Associated with Vaccine Series Completion (N=343)

Variable	Completed (n=250)	Not Completed (n=93)	p-value
Age (years), median (IQR)	20.0 (10.0–32.8)	23.0 (11.0–36.0)	0.238
Delay time (days), median (IQR)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.446
Demographic Characteristics			
Sex			0.091
Male	148 (59.2)	65 (69.9)	
Female	102 (40.8)	28 (30.1)	
Place of residence			0.226
Urban	190 (76.0)	64 (68.8)	
Rural	60 (24.0)	29 (31.2)	
Exposure Characteristics			
Type of contact			0.203
Bite	120 (48.0)	51 (54.8)	
Scratch	114 (45.6)	41 (44.1)	
Contact with open wound	3 (1.2)	0 (0.0)	
Other	13 (5.2)	1 (1.1)	
Animal species			0.263
Dog	92 (36.8)	34 (36.6)	
Cat	142 (56.8)	55 (59.1)	
Wild animal	0 (0.0)	1 (1.1)	
Other	16 (6.4)	3 (3.2)	
Animal's availability status			0.082
Escaped / unidentified	167 (66.8)	65 (69.9)	
Died or was killed	0 (0.0)	2 (2.2)	
Owned, vaccinated, under observation	14 (5.6)	6 (6.5)	
Owned, unvaccinated, under observation	49 (19.6)	12 (12.9)	
Unowned, vaccinated, under observation	1 (0.4)	2 (2.2)	
Unowned, unvaccinated, under observation	19 (7.6)	6 (6.5)	
Wound category			0.269
Category I	21 (8.4)	7 (7.5)	
Category II	110 (44.0)	34 (36.6)	
Category III	118 (47.2)	50 (53.8)	
Category IV	1 (0.4)	2 (2.2)	
Patient History			
History of prior rabies-risk exposure			0.468
Yes	18 (7.2)	4 (4.3)	
No	232 (92.8)	89 (95.7)	

Prior prophylaxis administration			0.014*
Yes	14 (5.6)	0 (0.0)	
No	236 (94.4)	93 (100.0)	
Chronic disease / medication use			0.731
Yes	22 (8.8)	10 (10.8)	
No	228 (91.2)	83 (89.2)	
Prophylaxis Administration			
Wound care administered	156 (62.4)	58 (62.4)	1.000
Tetanus prophylaxis administered	114 (45.6)	44 (47.3)	0.872
Recommended treatment schedule			0.941
Vaccine	226 (90.4)	84 (90.3)	
Vaccine + RIG	24 (9.6)	9 (9.7)	

(Table 4), patients residing in rural areas were found to have a significantly longer delay time compared with those residing in urban areas (Mann-Whitney U test, p=0.002). When evaluated by type of contact, the median delay time in patients presenting with "other" types of contact, excluding bites and scratches, was 10.0 days (IQR: 0.0-10.0), which was markedly longer than in the bite and scratch groups (Kruskal-Wallis test, p<0.001). Similarly, delay time was found to be significantly longer in patients exposed to "other" animal species (p<0.001). In the comparison by wound category, delay time tended to be longer in patients presenting with Category I (mild) exposure compared with the other categories (p=0.003). These findings suggest that patients may tend to delay presentation in atypical types of contact or in relatively mild-appearing injuries by recognizing the risk of rabies later. No statistically significant association was found between delay time and sex, history of prior rabies-risk exposure, chronic disease/medication use, or age.

Table 4. Comparison of Factors Associated with Delay in Presentation to the Emergency Department (N=343)

Variable	**Delay Time (days), Median (IQR)**	**Same-Day Presentation, n (%)**	**p-value**
Place of residence			0.002*
Urban (n=254)	0.0 (0.0–0.0)	217 (85.4)	
Rural (n=89)	0.0 (0.0–1.0)	64 (71.9)	
Exposure Characteristics			
Type of contact			<0.001*
Bite (n=171)	0.0 (0.0–0.0)	147 (86.0)	
Scratch (n=155)	0.0 (0.0–0.0)	127 (81.9)	
Contact with open wound (n=3)	0.0 (0.0–0.5)	2 (66.7)	
Other (n=14)	10.0 (0.0–10.0)	5 (35.7)	
Animal species			<0.001*
Dog (n=126)	0.0 (0.0–0.0)	113 (89.7)	
Cat (n=197)	0.0 (0.0–0.0)	159 (80.7)	
Wild animal (n=1)	0.0 (0.0–0.0)	1 (100.0)	
Other (n=19)	3.0 (0.0–10.0)	8 (42.1)	
Wound category			0.003*

Category I (n=28)	0.0 (0.0–7.0)	17 (60.7)	
Category II (n=144)	0.0 (0.0–0.0)	118 (81.9)	
Category III (n=168)	0.0 (0.0–0.0)	144 (85.7)	
Category IV (n=3)	0.0 (0.0–0.5)	2 (66.7)	
IQR: interquartile range. As delay time did not show a normal distribution according to the Shapiro-Wilk test (p<0.001), the Mann-Whitney U test was used for comparisons between two groups, the Kruskal-Wallis test for variables with three or more groups, and Spearman correlation analysis for the association with age. *p<0.05 was considered statistically significant.			

Monthly Distribution of Presentations

When the monthly distribution of patients was examined (Figure 1), the number of presentations was found to increase markedly between May and October, with the highest number of presentations observed in August (n=41). The lowest numbers of presentations were recorded in February and December (n=17 for both).

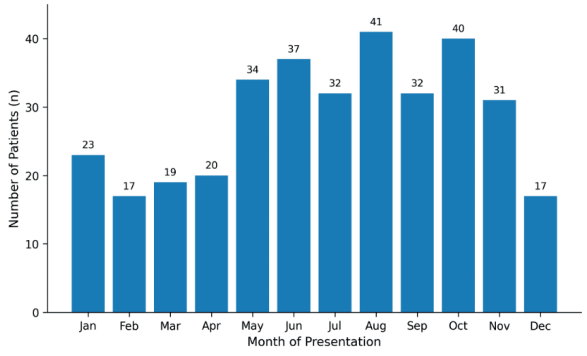


Figure 1. *Monthly Distribution of Patients Presenting to the Emergency Department Due to Rabies-Risk Exposure (June 2025-May 2026, N=343)*

DISCUSSION

This single-center, one-year retrospective study evaluated the prophylaxis process of 343 patients presenting to the emergency department due to rabies-risk exposure in Ağrı province, in accordance with the national guideline. The study population was relatively young (median age 21) and predominantly male (62.1%), with nearly three-quarters of patients (74.1%) residing in urban areas. Among the animal species involved in exposure, cats (57.4%) ranked ahead of dogs (36.7%). The RIG indication adherence rate of the administered prophylaxis was found to be 54.5%. The RIG administration rate in Category III/IV exposures with an indication for RIG was 14.0%, and the vaccine series completion rate was 72.9%. Among the 14 variables examined, only a history of prior prophylaxis was found to be associated with completion. Rural residence, atypical types of contact, and relatively mild wound categories were associated with a longer delay in presentation to the emergency department. Presentations increased markedly between May and October and peaked in August.

In our study, the vaccine series completion rate was found to be 72.9%. However, this rate does not appear to be consistent at the regional and national level. A study conducted in Erzurum, a province neighboring our region, reported that only 32.9% of patients completed the vaccine series.[14] A separate study conducted among children in Turkey reported that 16% of families discontinued the follow-up program.[15] This discrepancy between studies may arise from differences in sample characteristics, follow-up duration, and methodological differences in the definition of vaccine series completion. It may also reflect differences in regional healthcare access and patient follow-up practices. The fact that most of the demographic and clinical variables examined in our univariate analysis were not associated with completion suggests that the reasons underlying series discontinuation may not stem primarily from patients' clinical characteristics. Instead, factors not directly measured in this study, such as inadequate appointment reminder systems, transportation difficulties, or patient motivation, may play a more important role.

The low RIG administration rate in Category III/IV ex-

posures is the most striking finding of our study. In particular, only 14.0% of the Category III/IV group in our study received RIG, and RIG was administered without indication in 6.2% of patients with Category II exposures, for whom RIG was not indicated. This finding indicates that the problem exists not only in the direction of undertreatment (omission of RIG in Category III/IV) but also in the direction of overtreatment (administration of RIG in Category II). It should also be noted that although rabies vaccination is not indicated by the guideline in Category I exposures, all 28 patients in this category received the vaccine. Since our guideline adherence assessment specifically evaluated RIG indication rather than vaccine indication, this practice did not affect the reported RIG indication adherence rate. However, it may reflect a similar tendency toward precautionary overtreatment even in the lowest-risk exposure category. This bidirectional pattern of non-adherence may partly reflect physicians' difficulty in clearly distinguishing RIG indication criteria according to wound category. However, since physician knowledge, RIG availability, and the reasons behind individual treatment decisions were not directly evaluated in this study, this interpretation should be considered with caution. Other possible explanations, such as documentation limitations and limited RIG accessibility, cannot be excluded. A large-scale survey conducted in Turkey reported that 38.4% of physicians were unaware that the vaccine and immunoglobulin should be administered together, and 79% lacked correct dosing knowledge.[8] These guideline-discordant PEP practices in our findings are not an isolated problem specific to our country but are part of an increasingly recognized global issue. In the United States, 55.5% of PEP administrations were shown to be guideline-discordant,[16] and a study conducted in Brazil found that only 11% of healthcare professionals could prescribe appropriate PEP across various patient scenarios.[17] Reviews focused on emergency medicine practice have also drawn attention to this knowledge gap.[18,19] The persistence of these problems despite the national guideline published by the Advisory Committee on Immunization Practices (ACIP) of the United States since 2008[20] suggests that the existence of a guideline alone is not sufficient, and that active education and clinical decision support tools are needed. The fact that more than half of the calls to a national consultation hotline in South Africa concerned rabies PEP also demonstrates the global scale of the knowledge gap among healthcare workers.[21]

In addition to possible gaps in physician knowledge and decision-making, logistical constraints in RIG access may also contribute to the problem. Addressing this multidimensional issue is likely to require both education-based and systemic-technological approaches. Due to global constraints in RIG supply, monoclonal antibody-based alternatives have been proposed to facilitate RIG access.[22] Similarly, a study showed that structural interventions incorporating clinical decision support elements in emergency departments improved adherence to quality indicators for human rabies immunoglobulin administration.[23] Given the low administration rate of 14.0% observed in our study, this approach may offer a potentially applicable solution for our region. In addition to the deficiencies in RIG administration, the fact that the wound care administration rate in our study was only 62.4% suggests that deficiencies in such fundamental practices should not be overlooked. Indeed, a systematic review examining fatal rabies cases despite PEP found deviations not only in vaccine administration but also in fundamental practices such as wound care in 56% of cases.[24]

Findings related to delay time indicate that risk perception may be an important factor determining the timing of presentation. While 85.4% of patients residing in urban areas presented on the same day, this rate decreased to 71.9% in rural areas (p=0.002). This finding is consistent with the finding from a study based on national registry data covering 260,470 patients in Iran, which reported that rural residence increased delay risk by 7%.[25] A notable difference in delay time was also observed according to animal species. While 89.7% of patients with dog-related exposures and 80.7% with cat-related exposures presented on the

same day, this rate decreased to 42.1% in the other animal category (n=19) (p<0.001). The same Iranian study reported that wild animal exposures carried a 22% higher delay risk compared with domestic animals.[25] A recent study conducted in India similarly found that non-dog animal exposure was associated with delay.[26] Regarding wound category, contrary to expectation, the same-day presentation rate in Category I (the mildest category, 60.7%) was markedly lower than in Category II (81.9%) and Category III (85.7%) (p=0.003). This finding notably overlaps with a recent international study that found superficial/mild injuries to be significantly associated with delayed prophylaxis and reported an overall delay rate of 10.1%.[27] Taken together, these findings suggest that rural residence, exposures from animal groups other than dogs, cats, and wild animals, and mild-appearing wounds may be perceived by patients as low risk and not taken seriously. This observed delay is not merely a descriptive finding; it may have direct clinical consequences due to the limited time window within which RIG remains effective. Indeed, the WHO recommends that RIG be administered only within 7 days of the first vaccine dose.[9] A study evaluating adherence to this guideline recommendation in clinical practice found that timing errors constitute an important factor affecting PEP quality.28 Therefore, delays related to low risk perception in particular should be considered a potential cause of missing this treatment window in patients with an indication for RIG. The marked increase in presentations between May and October, with the highest number observed in August (n=41), can be explained by the increase in stray animal populations and human-animal contact during the summer months. A study of 748 patients conducted in Ordu similarly found the highest presentation rate during summer months (31.4%), which was attributed to increased time spent outdoors by the human population and increased likelihood of animal contact.[29] A recent study conducted in Iran using 3-year time-series analysis also showed that animal bite incidence peaked in summer and early autumn, a seasonal pattern that was confirmed by forecasting modeling.[30] The consistency of these findings suggests that concentrating seasonal awareness campaigns and population control initiatives in the pre-summer period may also be beneficial for our region.

One of the important strengths of our study is that, as we are the only hospital in Ağrı city center, all cases presenting with rabies-risk exposure in the city center could be included in the study without the need for sample selection. Furthermore, complex and severe cases requiring observation, advanced wound care, or evaluation are frequently referred to our center from the districts. This allowed our study to encompass not only the city center but also a substantial proportion of the more complex and higher-risk exposure cases in the region. As a result, the risk of selection bias is largely reduced, and the findings closely reflect the overall rabies-risk exposure profile of the province. Our study also contributes to the literature by comprehensively examining the entire prophylaxis process, not limited to a single step, from wound care to the assessment of RIG indication, selection of the vaccination schedule, and completion of the vaccine series. Studies addressing all steps of the prophylaxis process in this level of detail remain limited in the literature, particularly for the eastern regions of Turkey and for provinces with low population density and a predominantly rural character. Our findings are therefore considered to potentially contribute to the evaluation of regional guideline implementation policies.

The study also has some limitations. First, the design based on retrospective file review carries a risk of information bias due to record deficiencies and documentation errors. Although our study, as the only hospital in Ağrı city center, represents the province's rabies-risk exposure profile to a high degree, its single-center design is an important limitation. Therefore, caution should be exercised regarding the direct generalization of our findings to other provinces with different sociodemographic, geographic, and healthcare infrastructure characteristics. The fact that the vaccination schedule administered (the classic 4-dose schedule or the 2-1-1 schedule) was not recorded as a distinguish-

ing variable in the dataset did not allow assessment of schedule-specific differences in completion. The lack of systematic recording of the reasons for non-completion in patients who did not complete the vaccine series limits interpretation on this matter. The perfect separation issue arising from the zero cell value in the relevant subgroup of the "prior prophylaxis administration" variable did not allow this variable to be evaluated in a multivariable model. Finally, the fact that physician knowledge level was not directly measured limits our ability to clarify the mechanism underlying the low use of RIG; our interpretations on this matter are based on indirect inference and should be supported by future studies that directly assess physician knowledge level.

In conclusion, this study demonstrates that adherence of rabies post-exposure prophylaxis practices to the national guideline in the Ağrı region, particularly regarding the indication for rabies immunoglobulin, remains markedly below the desired level. The fact that the majority of patients with an indication for RIG did not receive this treatment suggests that physician awareness and RIG accessibility in the region should be further evaluated, and that targeted training programs may help improve adherence in this regard. Factors affecting vaccine series completion may be related more to systemic and organizational factors than to clinical variables. Considering this, relatively simple interventions such as appointment reminder systems and clinical decision support tools are thought to have the potential to improve both completion and RIG administration rates. Prospective, multicenter studies are needed to confirm these findings and to test the effectiveness of the proposed intervention strategies.

Ethical Approval

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ağrı İbrahim Çeçen University Scientific Research Ethics Committee (decision dated 25.06.2026, No. 393; reference number: E-95531838-050.99-182358). As the study was based on a retrospective review of medical records, patient consent was not obtained.

Peer-review

Externally and internally peer-reviewed.

Authorship Contributions

Concept: B.Ö.K., A.E.K., Design: B.Ö.K., A.E.K., Data Collection or Processing: B.Ö.K., A.E.K., Analysis or Interpretation: B.Ö.K., A.E.K., Literature Search: B.Ö.K., A.E.K., Writing: B.Ö.K., A.E.K.

Conflict of Interest:

The authors declare that they have no conflict of interest.

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

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