

Assessing adherence to the national pediatric antibiotic prescription guideline for pneumonia treatment of children 2-59 months at Butaro level II teaching hospital.

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Abstract

Background

Inconsistent use of antibiotics can lead to antimicrobial resistance (AMR) and pose a significant public health threat. The purpose of this study was to assess adherence to the national pediatric treatment guideline for antibiotic prescription for pneumonia among healthcare providers at a teaching hospital in Rwanda.

Methodology

A cross-sectional study was conducted by auditing the clinical records of children aged 2-59 months who were admitted with pneumonia from January 2022 to January 2024. Data on the severity of pneumonia, prescribed medications, and adherence to the treatment protocol were extracted and analyzed.

Findings

Out of the 308 records analyzed, only 14% were following the national guidelines in staging. While 71% of those correctly staged were prescribed the medications aligned with the guideline, none adhered to the complete regimen (in terms of route, dose, frequency, and duration). Once the medications were ordered, 97% were administered to patients as prescribed.

Conclusion

The study concluded that adherence to treatment guidelines remains suboptimal, with discrepancies in staging accuracy and treatment regimen implementation. This study highlighted the need for targeted interventions, including improved training, monitoring systems, and antibiotic stewardship programs, to optimize antibiotic prescribing practices, combat AMR, and improve health outcomes in pediatric populations, especially in low-resource settings.

Keywords: Antibiotic prescription, Adherence to guideline, Pneumonia treatment, Pediatric patients, Low- and middle-income countries (LMICs)

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Introduction

Antibiotics are designed to address bacterial infections. When used appropriately, antibiotics can either eliminate bacterial reproduction or facilitate one's immune system to clear the infection [1]. However, the appropriate use of antibiotics based on evidence-based national and local clinical guidelines is crucial [2]. Inappropriate use, including unnecessary prescriptions, incorrect type, dosage, or treatment duration, would contribute to antibiotic-

resistant bacteria, prolonged treatment, escalated medical costs, adverse drug reactions, and heightened mortality risks [3, 4].

Pediatric populations are disproportionately affected by the misuse of antibiotics, with infections caused by multidrug-resistant bacteria leading to significant morbidity and mortality [5]. Events such as antibiotic-associated diarrhea, skin rash, allergies, and resistance are common [6, 7]. Studies across different regions have reported alarmingly

high rates of antibiotic resistance, underscoring the urgent need for effective interventions [8, 9, 10].

Children under five have developing immune systems, heightening their vulnerability to illnesses, particularly those stemming from drug-resistant microorganisms found in their environment. This risk is exacerbated for children in low-resource areas with restricted healthcare access. Factors like insufficient access to safe water, unsanitary conditions, poor hygiene habits, and inadequate infection control measures contribute to the proliferation of antimicrobial resistance (AMR) [11].

In 2019, an estimated 1.27 million deaths worldwide were directly attributed to drug-resistant infections that defied successful treatment [12]. While data specifically on antimicrobial resistance (AMR) in children under five is limited, global estimates for that year indicate a disproportionate burden of deaths among this age group. Out of the 1.27 million deaths attributable to AMR, approximately 20 percent, or 254,000, occurred in children under five, equivalent to nearly one child dying every two minutes [12]. Alarming, over 99 percent of these children hail from low- and middle-income countries (LMICs), with more than half dying within their first month of life [12, 13]. Antibiotic misuse can cause multi-drug-resistant (MDR) bacteria in both community-acquired and healthcare-associated infections (HAIs) globally, as acknowledged by the World Health Organization that antimicrobial Resistance (AMR) is a top global public health threat [14]. Antibiotic misuse and overuse contribute to antibiotic-resistant infections, posing challenges in treatment and elevating the risk of complications, hospitalizations, and mortality. Globally, approximately 700,000 annual deaths were caused by drug-resistant microbes, among these, 200,000 were newborns, with regional variation from 30% in Europe to as high as 66% to 90% in sub-Saharan Africa, Southeast Asia, and the Middle East [5, 8, 9, 10, 15].

Inappropriate antibiotic prescribing practices are common in low- and middle-income countries (LMICs), including Rwanda, due to misconceptions about antibiotic use, diagnostic uncertainty, patient and time pressures, and gaps in prescription information [16, 17, 18, 19, 20, 21].

Antibiotic stewardship programs (ASPs) play a crucial role in optimizing antibiotic use and combating antimicrobial resistance [22]. These programs focus on assessing antibiotic usage patterns, implementing targeted interventions, and promoting appropriate antibiotic therapy, aligning with global efforts to address antibiotic resistance [23]. Rwanda has established the national guideline for pediatric pneumonia treatment, emphasizing the importance of evidence-based antibiotic prescribing [24]. However, adherence to these guidelines remains suboptimal, influenced by various healthcare provider-related and system-level factors [25, 26, 27].

The national guideline recommends treating patients with very severe pneumonia with first-line ampicillin 200 mg/kg Q6hr or Benzyl penicillin 50 000/kg IM/IV Q6hr plus gentamycin IV 7.5 mg/kg Q24hr or with Cefotaxime 50 mg/kg/dose Q8hr as a second-line therapy for 10 days. The treatment can be switched to oral treatment with amoxicillin 45 mg/kg Q12hr if there is improvement in clinical symptoms. The guideline recommends treating severe pneumonia with ampicillin 200 mg/kg/day (50 mg/kg Q6hr) for 7 days, and the treatment can be switched to oral amoxicillin 45 mg/kg Q12hr if there is improvement in clinical symptoms. Non-severe pneumonia must be treated with oral amoxycillin 25 mg/kg Q12hr for 5 days. If pneumonia is ascertained to be due to the organism *Staphylococcus*, patients should be managed with intravenous cloxacillin and gentamycin. Lastly, the recommended duration of treatment for *Pneumocystis Jirovecii* pneumonia is 3 weeks with cotrimoxazole [24].

Despite the extensive literature on antibiotic resistance and prescribing practices, there is limited published data on antibiotic prescribing practices in remote areas of Rwanda, especially concerning pediatric patients. This research aims to address this gap by assessing adherence to the national guideline for pediatric pneumonia treatment for children 2-59 months in Butaro Level II Teaching Hospital (BL2TH). The findings of this study could inform the development of targeted interventions to improve antibiotic prescribing practices, optimize patient outcomes, and contribute to the fight against antimicrobial resistance in similar healthcare settings.

Objective

To assess the level of adherence of healthcare providers in the pediatric ward at Butaro Level II Teaching Hospital to the national pediatric treatment guidelines for antibiotic prescriptions for pneumonia.

Method

Setting and design

A quantitative cross-sectional study was conducted at the General Pediatric Ward of Butaro Level II Teaching Hospital, Burera District, Northern Province, Rwanda. It has a catchment population of approximately 350,000, receiving patients from both within Burera District and from surrounding countries, including Burundi, Uganda, and the Democratic Republic of Congo. The hospital's pediatric ward serves patients under 15 and has 20 beds, staffed by nurses, general practitioners, and other intern doctors from other departments. Pediatricians can be arranged for consultation, but not assigned to the general pediatric ward.

Sample and sampling

Inpatients' clinical records of children aged 2-59 months, admitted with pneumonia between January 2022 to January 2024, were audited. At admission, children presenting with a wheeze and/or an underlying chronic disease such as cerebral palsy, severe acute malnutrition, and cardiac disease were excluded from the study as their treatment regimen would need adjustments that might deviate from the protocol [28]. From the inpatient register, identification numbers for patients who were admitted with pneumonia were extracted.

Data collection tool

Data were extracted from the medical records using a pretested data extraction form and were entered into the Microsoft Excel database. A list of criteria was included in the data collection tool based on the national protocol. Each statement had "yes" or "no" options to identify if the criteria were fulfilled. Based on the responses, the adherence scores were calculated. The score was then classified into levels of adherence based on the World Health Organization/International Network of Rational Use of Drugs (WHO/INRUD) indicators.

Key measures

Four key measures were included in this study:

The level of adherence to disease severity staging

The level of adherence to ordering the correct medications

The level of adherence to giving correctly the ordered medications and

The level of adherence to ordering a correct full regimen (route, dose, frequency, duration).

The adherence score was represented as a percentage. It was calculated as the number of statements (s) with answers 'yes' divided by the number of statements under evaluation. The score was then classified into levels of adherence based on the World Health Organization/International Network of Rational Use of Drugs (WHO/INRUD) indicators [29]. Adherence to standard treatment guidelines is the fifth indicator whose WHO target is 100% [29].

Excellent: 90%-100%

Good: 80%-89%

Moderate: 70%-79%

Poor: 60%-69%

Fail: <60%

Data management and analysis

Patient records were only identified by study number. Raw data were kept under a password-protected Excel spreadsheet database that was only accessible to the primary investigators.

Descriptive statistics were used to summarize the demographic information and key measures.

Chi-square, Fisher's Exact, Mann-Whitney, and Kruskal-Wallis tests were used to analyze the association between demographic information and adherence.

Ethics

Study approval was obtained from the Institutional Review Board (IRB) of the University of Global Health Equity (UGHE-IRB/2024/289) and the Ethics Committee of Butaro Level II Teaching Hospital (344/HB/EK/ETHC/2024).

RESULTS

Out of the 308 files fulfilling the selection criteria, 184 (59.7%) were in the age group of 2-12 months, 166 (54%) were females, 304 (98%) recovered and were discharged, and 261 (85.9%) had spent 7 days or less in the hospital. According to the medical records, 9 (3%) of them were described as very severe pneumonia, 209 (68%) severe pneumonia, and less than 1% for non-severe and no pneumonia. The most common signs and symptoms included cough (93.5%), shortness of breath (74%), and fever (70.4%); and chest x-ray was ordered and performed on 54 (17.5%) of cases. The most common recorded stagings that were not aligned with the guideline were "Pneumonia" (54%) and "Moderate pneumonia" (22.3%) (Table 1).

Table 1. Summary of the demographics and clinical presentations

	Item	N (%)
Sample		308
Age group (months)	2-12	184 (59.7%)
	13-24	85 (27.6%)
	25-59	39 (12.7%)
Gender	Male	142 (46%)
	Female	166 (54%)
Severity staging based on the medical record	Very severe pneumonia	9 (2.9%)
	Severe pneumonia	209 (67.9%)
	Non-severe pneumonia	2 (0.7%)
	No pneumonia	1 (0.3%)
	Staging not in guideline*	87 (28.2%)
Duration of hospital stay (days)	<=7	261 (85.9%)
	>7	43 (14.1%)
Outcome	Recovered and discharged	304 (98%)
	Deteriorated and transferred	2 (1%)
	Died	2 (1%)
Signs and symptoms	Cough	288 (93.5%)
	SOB	228 (74%)
	Fever	217 (70.4%)
	O2Sat<90%	165(53.6%)
	Indrawing	152 (49.2%)
	↓RR	64 (20.8%)
	Flaring	55 (17.9%)
	Head bobbing	34 (11%)
	AVPU=' V, P or U'	16 (5.2%)
	Cyanosis	3 (1%)
Chest x-ray ordered and done.	Yes	54 (17.5%)

*Most common stages not in guidelines included: Pneumonia (54%), Moderate pneumonia (22.3%), Simple pneumonia (18%), and Bronchopneumonia (5.7%).

Based on the signs and symptoms documented in the medical records, 42 out of 308 cases (14%) were staged in alignment with the guideline's recommendations, translating to a “failed” adherence.

Out of the 42 correctly staged, 34 (81%) had medication ordered according to the guideline, translating to a “good”

adherence. None (0%) of medications were ordered according to the regimen (in route, dose, frequency, and duration) recommended by the guideline. All (100%) medications were given according to the written order – “excellent” adherence (Table 2).

Table 2. Adherence to the treatment guideline

Adherence	Sample	Very Severe	Severe	Non severe	Overall adherence	Adherence level
Correct staging	308	9 (21%)	32 (76%)	1 (3%)	42 (14%)	Failed
Medication order	42	7 (85%)	27 (85%)	0 (0%)	34 (81%)	Good
Regimen*	34	0 (0%)	0 (0%)	0 (0%)	0 (0%)	Failed
Medication given	34	6 (88%)	28 (103%)**	0 (0%)	34 (100%)	Excellent

* Based on route, dose, frequency, duration

** One correct medication was given despite not being ordered

Regardless of staging, out of the total 781 medications ordered, 558 (71%) matched the signs and symptoms of the

condition, and 223 (29%) were not required. Out of 558 required meds, 0 (0%) were ordered in a full correct regimen

(route, dose, frequency, duration), whereas 541 (97%) were given according to the order (Table 3).

Table 3. Medication based on clinical signs & symptoms, regardless of staging

Medication	Sample	Items	N (%)
Medication ordered***	781	Matched signs and symptoms	558 (71%)
		Not matching the signs and symptoms	223 (29%)
Regimen ordered	558	Correct regimen	0 (0%)
		Incorrect regimen	558 (100%)
Medication administered	558	Given according to order	541(97%)
		Not given	17 (3%)

***According to the signs and symptoms, 70 required medications were not ordered

Among the 558 medications ordered, 65 (12%) were correct in duration, 178 (32%) were correct in dose, 249 (45%) were correct in frequency, and 367 (66%) were correct in route. None was fully compliant with the regimen (Table 4).

Table 4. Full Regimen order

Regimen of medication	Ordered
Sample	558
Correct Route	367 (66%)
Correct Dose	178 (32%)
Correct Frequency	249 (45%)
Correct Duration	65 (12%)
Correct in all routes, dose, frequency, and duration	0 (0%)

Out of the 781 medications ordered, 91 (11.5%) were correct based on both staging and clinical signs & symptoms, 467 (60%) were incorrect based on staging but correct based on clinical signs & symptoms. 223 (28.5%) were incorrect based on both staging and clinical signs & symptoms (Table 5).

Table 5. Medication ordered based on staging Vs clinical signs & symptoms

Medication= 781		Based on clinical signs & symptoms	
		Correct meds	Incorrect meds
Based on the staging in the medical record	Correct meds	91 (11.5%)	0 (0%)
	Incorrect meds	467 (60%)	223 (28.5%)

Compliance in staging was not associated with length of hospital stay, deterioration and being transferred, or death (Table 6).

Table 6. Compliance in staging vs outcome

		Staging		P-value
		Compliant	Not compliant	
Outcome	Recovered in 7 days or less	34 (81%)	227 (85.3%)	0.366
	Recovered in more than 7 days	7 (16.7%)	36 (13.6%)	
	Deteriorated and transferred	1 (2.3%)	1 (0.4%)	
	Died	0 (0%)	2 (0.7%)	

Based on the guideline, oral amoxicillin was not ordered in 61 out of 70 (87%) of cases. Whereas the top three medications, which were not required but ordered, were

gentamycin (37%), Ampicillin (27%), and Amoxycillin syrup (16%) (Table 7).

Table 7. Medication required but not ordered Vs not required but ordered

Required medications but not ordered=70	Oral amoxicillin	61 (87%)
	Gentamycin	6 (9%)
	Ampicillin	3 (4%)
Not required but ordered=223	Gentamycin	83 (37%)
	Ampicillin	60 (27%)
	Amoxycillin syrup	36 (16%)
	Augmentin	13 (6%)
	Cefotaxime	12 (5%)
	Azithromycin syrup	7 (3%)
	Cloxacillin	6 (3%)
	Erythromycin	4 (2%)
	Ceftriaxone	2 (1%)

Discussion

The majority of cases (n=269, 87.3%) in our study were between the ages of 2 and 24 months. Previous studies have highlighted the heightened vulnerability of younger children to pneumonia, particularly those under two years of age, due to their developing immune systems [9]. The age of our study samples also indicated a similar distribution.

Only 14% of cases were staged correctly according to the guideline, indicating a lack of adherence. Staging pneumonia according to the guideline can be challenging, in part due to the overlap of signs and symptoms across different severity levels [30]. The guideline defines very severe pneumonia by the presence of any of the following signs: cyanosis, inability to drink/breastfeed, altered mental status, grunting, or head bobbing. Severe pneumonia is identified by lower chest indrawing, nasal flaring, and grunting, while non-severe pneumonia is characterized by fast breathing and crackles. Symptoms like cough, difficulty breathing, fever, and abdominal or chest pain can occur at any stage. The vagueness and overlap of these signs make accurate staging difficult.

Previous studies have also found that healthcare providers in low-resource settings often face high patient volumes and limited time for each consultation, leading to rushed assessments and poor adherence to staging guidelines [31]. Health care providers in Rwanda face significant challenges related to high patient volumes, especially in primary care and public health facilities. Rwanda has a low doctor-to-population ratio, with approximately 1 doctor per 8,919 people [32]. The shortage of doctors causes them to face heavy workloads, especially in rural areas, where access to healthcare is even more limited. Such high patient volume can lead to rushed consultations and difficulties in adhering to clinical guidelines for proper diagnosis and treatment.

Another possible cause of low adherence could be due to the understanding of the guidelines. The level of knowledge and familiarity with the guidelines among healthcare providers likely impacts their adherence. Many stages of pneumonia found in the medical records did not exist in the guideline, reflecting gaps in knowledge among healthcare providers regarding the appropriate stages. Previous studies in other countries have shown that providers may lack the ability or confidence to accurately diagnose and stage pneumonia if they do not fully understand the guidelines [33]. This study did not assess the knowledge level of health care providers on the pneumonia guideline. Future research should assess healthcare providers' knowledge to determine whether additional training on the national guideline is necessary.

In addition to staging pneumonia, another crucial aspect of adhering to the guidelines is ensuring that appropriate treatment is provided. According to the guideline, specific medications are prescribed based on the severity of pneumonia. For non-severe cases, oral antibiotics, such as amoxicillin, are typically recommended. In cases of severe pneumonia, injectable antibiotics, like ampicillin or gentamicin, are usually required. For very severe pneumonia, hospitalization and more intensive treatment, including additional antibiotics, are necessary [24]. Adherence to these treatment protocols is critical for effective management and improving patient outcomes.

Among the 42 correctly staged cases, 34 (81%) received medications in line with the guideline, indicating "good adherence." However, none of the prescribed medications followed the recommended regimen in terms of route, dose, frequency, and duration.

While healthcare providers may have appropriately recognized the need for antibiotic therapy based on clinical

staging, they seemed to struggle with the finer details of the treatment regimen. Research shows that pediatric patients often present with a wide range of symptoms, complicating diagnosis and treatment, and leading to variations in clinical judgment [34]. This complexity can cause providers to rely on familiar regimens rather than adhering strictly to the guidelines. The findings may also indicate knowledge gaps, as misconceptions about antibiotic use and a lack of familiarity with treatment protocols are common in low- and middle-income countries [35].

Another factor could be the availability of medication supplies. In many low-resource settings, healthcare facilities frequently experience shortages of essential medicines, forcing providers to substitute available drugs or modify regimens, even when aware of the recommended guidelines. Future studies could focus on supply chain issues to better understand and address these challenges.

Although the medications were not ordered according to the recommended regimen, they were administered exactly as per the written orders, demonstrating excellent adherence to the execution of these orders. In Rwanda, nurses are responsible for administering medications based on the written directives. Their adherence indicates high compliance with doctors' orders. However, this raises questions about whether they were aware that the medications administered did not follow the correct regimen, and if so, whether they raised any concerns. Further research into this issue could provide valuable insights.

Physicians may not always fully understand or recall the guidelines and often prescribe based on their assessment of patients' signs and symptoms [36]. Among the medications prescribed, 558 out of 781 (71%) aligned with the guideline's recommended treatment, regardless of whether the staging was accurate or not. This suggested that healthcare providers recognized the need for antibiotic therapy based on their clinical judgment and patient complaints, even if their staging was incorrect. However, none of the medications adhered to the complete recommended regimen. Specifically, only 12% of the medications had the correct duration, 32% had the correct dose, 45% had the correct frequency, and 66% had the correct route. Some specific examples included Ampicillin being ordered as 50 mg/kg three times a day in very severe pneumonia, while the guideline recommended 200 mg/kg, four times a day.

Out of 781 medications ordered, 91 (11.5%) were appropriate based on both the recorded staging and the patient's clinical presentation. Additionally, 467 (60%) were correct according to the patient's clinical presentation, even if the staging did not match the guideline, making a total of 71.5% of medications ordered appropriately for the condition. This indicated that while providers might have

struggled with the guideline for staging pneumonia, they were able to recognize the clinical presentation of the condition. However, 223 (28.5%) of the medications administered were deemed unnecessary based on either the staging or the presentation, raising concerns about the overall quality of care provided to pediatric patients.

Adherence to treatment protocols is crucial for achieving optimal health outcomes and ensuring the effective use of healthcare resources. However, our study results did not find any association between compliance in staging and length of hospital stay, deterioration, transfer, or death. Our results show that 60% of medications were incorrect based on staging, but correct according to clinical signs and symptoms may suggest that in many cases, healthcare providers recognized appropriate antibiotic therapy based on the patient's clinical presentation, even if the staging was not compliant with the guideline. This prioritization of clinical judgement over strict adherence to staging protocol may have contributed to the lack of association between staging compliance and patient outcomes.

On the contrary, the results also showed that a significant portion of required medications were not ordered. Amoxicillin was not ordered in our study. In many cases, providers opted for alternative treatments such as Augmentin and erythromycin. Such an ordering pattern could be related to the clinical decision-making process of healthcare providers or supply chain issues. Meanwhile, a significant portion of unnecessary medications, specifically gentamycin, ampicillin, and amoxycillin syrup, were ordered.

Inappropriate antibiotic use has long been a common issue in LMICs, driven by misconceptions about antibiotic efficacy and the pressure to provide immediate treatment [37]. Inappropriate prescribing practices can lead to antimicrobial resistance [38]. WHO has identified antimicrobial resistance (AMR) as a significant public health threat, with antibiotic misuse being a primary driver [39]. Over or under-treated infections could lead to increased morbidity and mortality, but also expose patients to potential long-term side effects as resistant strains of bacteria develop [38].

However, no association between staging compliance and outcomes was detected in our study. Several factors might influence the outcomes regardless of adherence to treatment guidelines. Particularly, a relatively higher percentage of medications ordered was correct, regardless of staging. Clinicians prescribed medications based on their clinical judgment according to the presented signs and symptoms. At the end, regardless of how they staged the condition, the medications ordered were appropriate. Additionally, variability in patient response could also affect the outcomes. Protocols may not account for these individual differences.

To address the adherence issues identified in this study, several recommendations can be made. Establishing antibiotic stewardship programs (ASPs) in BL2TH can help optimize antibiotic use. Studies have shown that ASPs reduced the consumption of antibiotics by 21% in pediatric hospitals of LMICs, thereby fostering appropriate antibiotic use [40, 41]. These programs focus on monitoring prescribing patterns, providing feedback to healthcare providers, and promoting adherence to the national treatment guidelines. The antibiotic prescription guideline can be printed and distributed to different hospital wards for easy accessibility. Ongoing training for healthcare providers on the importance of adhering to the treatment guidelines can be provided, with an emphasis on the implications of AMR, the need for accurate staging, appropriate treatment regimens, and diagnostic criteria to ensure appropriate management of pneumonia cases. Improving access to diagnostic modalities such as chest x-ray and blood cultures can aid in making correct treatment decisions. Establishing a robust monitoring and evaluation system to assess antibiotic prescribing practices can help identify areas for improvement and ensure adherence to national treatment guidelines.

Conclusion

The findings of this study underscore the urgent need for improved adherence to antibiotic prescribing guidelines in pediatric pneumonia treatment at Butaro Level II Teaching Hospital. Addressing the identified gaps through targeted interventions will be crucial in ensuring better health outcomes for vulnerable pediatric populations. By implementing antibiotic stewardship programs, enhancing training, and establishing monitoring systems, healthcare providers can significantly improve adherence to the treatment guidelines and optimize patient care.

Limitations

This study aimed at assessing the adherence to the national pediatric antibiotic prescription guideline for pneumonia treatment of children 2-59 months at Butaro Level II Teaching Hospital and has successfully fulfilled the objectives. However, success must be viewed in light of some limitations. The retrospective nature of the study was limited by the quality of data in the clinical records. The research was conducted in a single hospital, which may limit the generalizability of the findings to other settings. Multi-center studies would provide a broader understanding of adherence to guidelines across different healthcare facilities.

Authors' contributions

KG and EK: investigation, project administration, software, writing - original draft.

KG, EK, RW: formal analysis, resources, validation, visualization.

All authors: conceptualization, data curation, methodology, and writing - review & editing

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Declaration of conflict of interest

There was no conflict of interest in the manuscript writing or the decision to submit it for publication.

Data and code availability statement

The data that has been used is confidential.

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