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Descriptive Epidemiology of a Cholera Outbreak in Gadarif State

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دراسة وصفية لتفشي وباء الكوليرا في مدينة القضارف

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Abstract:
Gedarif State in Sudan witnessed a continuous outbreak of cholera, especially during the second half of 2023. The spread of the epidemic continued to affect all regions in the state, there are several reasons for the outbreak of the cholera epidemic, one of the most important reasons is the deterioration of the health system in Sudan due to the armed conflict that occurred in mid-April of the same year, in addition to the increase in the number of displaced people in the state due to the war, and also one of the factors affecting is the decrease in the access of humanitarian aid (Humanitarian Response*)* and health support in the state. This study describes the cholera epidemic and its impact in the short and long term and also makes several recommendations, including strengthening the health surveillance system in the state and providing training for health workers on preventive and control measures. In addition, there increased coordination between sectors, especially for the provision of a new oral cholera vaccine that received prior approval from the World Health Organization on April 12, the Euvichol-S inactivated oral cholera vaccine has a similar efficacy to existing vaccines but with a simplified formula to increase rapid production capacity. Furthermore, it is necessary to train the persons in charge of the units and health workers in the regions on data entry and proper documentation to improve data quality. It is also important to provide medicines and other goods in health facilities to effectively manage cases and conduct public awareness campaigns across the state about personal hygiene and proper sanitation.

Keywords: Cholera, Gadarif State, Sudan, Conflict, Humanitarian Response, Oral Vaccine Euvichol-S

الملخص
شهدت مدينة القضارف في السودان تفشيًا مستمرًا لوباء الكوليرا، خاصة خلال النصف الثاني من عام 2023. استمر انتشار الوباء في التأثير على جميع المناطق في الولاية، هنالك عدة اسباب لتفشي وباء الكوليرا أحد أهم الاسباب هو تدهور النظام الصحي في السودان بسبب الصراع المسلحة الذي وقع في منتصف ابريل في العام نفسه بالاضافة الي زيادة عدد النازحين في الولاية بسبب الحرب وأيضًا أحد العوامل المؤثرة هي قلت وصول المساعدات الانسانية (الإستجابة الانسانية) والدعم الصحي في الولاية. هذه الدراسة لوصف وباء الكوليرا وتأثيره على المدى القريب والبعيد وايضا وضعة عدة توصيات منها تعزيز نظام المراقبة الصحية في الولاية وتوفير التدريب للعاملين في مجال الصحة حول التدابير الوقائية والسيطرة. بالإضافة إلى ذلك، زيادة التنسيق بين القطاعات، خاصة لتوفير لقاح فموي جديد للكوليرا الذي حصل على موافقة مسبقة من منظمة الصحة العالمية في 12 أبريل، لقاح الكوليرا الفموي المعطل(أفيكول-س) *Euvichol-S* له فعالية مماثلة للقاحات الحالية ولكن بتركيبة مبسطة لزيادة القدرة على الإنتاج السريع. علاوة على ذلك، من الضروري تدريب الأشخاص المسؤولين عن الوحدات وعمال الصحة في المناطق على إدخال البيانات والتوثيق السليم لتحسين جودة البيانات. كما أنه من المهم أيضًا توفير الأدوية والسلع الأخرى في المرافق الصحية لإدارة الحالات بفعالية وإجراء حملات توعية عامة عبر الولاية حول النظافة الشخصية والصرف الصحي السليم.

الكلمات المفتاحية: كوليرا، مدينة القضارف، السودان، صراع، تدخل إنساني، لقاح فمومي أفيكول-س

Introduction

Cholera, a deadly diarrheal illness, is caused by Vibrio cholerae, a comma-shaped bacterium that produces toxins (1). Cholera can cause symptoms such as profuse diarrhea and vomiting, with an incubation period of about 2 hours to 5 days (2).

As of 20 March 2023, at least 24 countries continue to report cholera cases. It is important to note that many parts of the world are currently experiencing low or interepidemic transmission periods. Therefore, the number of cases could increase in the coming months (3). The mortality associated with the outbreaks is of particular concern, as many countries have reported higher case-fatality ratios (CFR) compared to previous years. The average global cholera CFR reported in 2021 was 1.9% (2.9% in Africa), which is a significant increase above the targeted rate (3, 4).

The WHO African Region has been affected in the last two years, with cholera outbreaks occurring in the context of natural disasters such as flooding, drought, and conflict. Poor sanitation and unreliable water supplies, along with increased cross-border movements, continue to contribute to the outbreak across the region (4, 5).

According to the Federal Ministry of Health and WHO, there have been 30,762 cases of Acute Watery Diarrhea (AWD), including 657 related deaths, reported in 18 states in Sudan since August 2016 (5).

On 23 January 2020, the Federal Ministry of Health of Sudan declared the end of the cholera outbreak in the country. The first case of cholera was reported on 8 September 2019 in Blue Nile State and later spread to Sennar, Khartoum, and El Gezira states. During this outbreak, 346 suspected cholera cases were reported, including 11 deaths (6). Since the continuous violence that started in April 2023 in Sudan, as of November 12, 2023, seven states—Gedaref, Gezira, Kassala, Khartoum, Red Sea, Sennar, and South Kordofan—have reported a total of 2967 cases and 95 deaths (CFR: 3.2%) (7). High child mortality, limited water quality treatment, lack of monitoring, and non-enforcement of public health measures by local authorities are reasons for the outbreaks continued spread (8).

Material and methods

Geographic setting

Al Gadarif, also spelled Gedaref or Qadarif, is one of the 18 states of Sudan. It has an area of 75,263 km2 and an estimated population of approximately 1,115,069 (2023), (9). Al Qadarif is the capital of the state, and other towns include Al Baladia, Weast Al Glabat, Eastern Glabat, Westran Glabat, Al Mafaza, Al Rahad, Al Faw, Al Fashaga, Al Gurasha, Gala Alnahal, and Basunda (10).

The total number of hospitals in Al Gadarif state is 43, with 21 urban health centers, 65 rural health centers, and 237 general public health centers (PHC) located across the state (11). Sudan has reported at least 8,267 suspected cholera cases, including 224 associated deaths, and declared a cholera outbreak in Gadarif on 26 September 2023 (11, 12). Several socioeconomic and environmental factors contribute to cholera outbreaks in Sudan, including poor living conditions, lack of access to clean water, sanitation, and hygiene (WASH) services, inadequate waste management, overcrowding in urban areas, flooding, extreme temperatures due to climate change, and human displacement due to conflict and insurgency. Basic infrastructure is lacking, and access to clean water and adequate sanitation is limited, exacerbating the humanitarian crises (2, 12).

Due to access issues and the deteriorating security situation, the emergency response efforts can be further complicated, especially with the extension of clashes to AL Jazirah (8, 13).

This study aims to describe the magnitude, pattern, and trends of the cholera outbreak that occurred in Gadarif State in 2023 and provide recommendations to relevant authorities for future prevention of its reoccurrence.

Study Setting

The study was a descriptive secondary data analysis. Data was sourced and obtained from the General Director Ministry of Health, Administration of Health Emergency and Epidemic Control, Gadarif State, consisting of a line list of all reported cholera cases in Gadarif State from January to December 2023, covering all the 11 LGAs of Gadarif State.

Data Management

Data was keenly observed and systematically cleaned. The variables of interest collected include age, sex, date of onset of symptoms, LGAs, wards, outcome, and laboratory results. Specific checks were made on coding and categorization of variables, including harmonizing date formats, using the same unit for age, and correction spelling mistakes. Line-lists with incomplete data were identified and excluded from the analysis. We calculated frequencies, proportions, attack rates, and age-specific

attack rates. Page number not for citation purposes 3 and analyzed data in time, place, and person using Microsoft Excel 2019, SPSS 24, and health mapper.

Confirmed Case
Any suspected case confirmed by laboratory isolation of Vibrio cholerae by ICT sample taken from a patient with acute diarrhea.

Probable Case
A clinically compatible case that is epidemiologically linked to a confirmed case.

Laboratory Investigations
In endemic areas with limited resources, the diagnosis of cholera is often made based only on clinical signs and symptoms, in the absence of laboratory facilities. Also, in Cholera epidemic setting, if a patient (>5 years of age) has AWD more than three times with or without vomiting within 24 h, cholera is indicated Stool samples were usually tested using a rapid diagnostic testing kit (RDT) for Vibrio cholera during a suspected cholera outbreak (14).

Results and discussion
The total number of cases reported in Gadarif State during the year 2023 is 2026 cases-patients, with 49 deaths (CFR 2.4%). Female cases-patients are 1017 (10.2%) and male case patients are 1011 (10.1%). The median age for case patients is not specified.

The highest number of cases is recorded in Baladiat al Gadarif Locality, with 1280 cases. Among them, 639 (6.4%) are female and 641 (6.4%) are male. The attack rate and case fatality rate are not provided. Following that, Western Glabat has 218 case-patients, and Wasat al Gadarif Locality records 336 case-patients (3.4%). Among them, 100 (1%) are female and 89 (0.9%) are male.

The highest number of deaths is recorded in Baladiat al Gadarif Locality, with 25 deaths. Among them, 18 (0.1%) are female and 7 (0.1%) are male. Wasat al Gadarif has 9 deaths (4 female, 5 male), Eastern Galabat records 8 deaths (3 female, 5 male), Al Gorasha Locality has 5 deaths (2 female, 3 male), Western Galabat has 4 deaths ((3 female, 1 male), Al Farhaga Locality has 3 deaths (1 female, 2 male), and Al Faw and Gala al Nahal Locality both record 2 deaths from males. Al Mafaza, Al Ragad, and Basund have no deaths.

The highest number of cases is recorded in the age group 0.0 – 9.9, with 532 cases (1.2%). Among them, 246 (2.5%) are female and 286 (2.7%) are male. The next highest number of cases is in the age group 20 – 29.9, with 375 cases (0.5%). Among them, 181 (1.8%) are female and 194 (1.9%) are male. Following that, the age group 30 – 39.9 records 300 cases (3%). Among them, 163 (1.6%) are female and 137 (1.4%) are male.

The first peak occurred in epidemiological week 35 of 2023, with 32 cases-patients. Among them, 6 (0.6%) are female and 26 (0.2%) are male. There were 4 deaths among males. The most cases were reported in epidemiological week 48, with 319 case-patients. Among them, 129 (1.2%) are female and 190 (1.9%) are male. There were also 3 male deaths. In epidemiological week 49, there were 306 case-patients. Among them, 92 (1%) are female and 214 (2.1%) are male. In week 50, there were 260 case-patients. Among them, 114 (1.1%) are female and 146 (1.4%) are male. In epidemiological week 47, there were 254 cases, all from females (2.5%). In epidemiological week 41, there were 164 cases-patients. Among them, 50 (0.5%) are female and 114 (1.4%) are male.

The method of taking samples for cholera detection for confirmed cases is by ICT. The number of samples taken for the entire population is 488 (4.9%) ICT samples. Among them, 394 (3.9%) are positive samples, with 200 (2%) being female and 194 (1.9%) being male. There are 94 (1%) negative samples, with 38 (0.3%) being female and 56 (0.6%) being male. There were 1682 (16.3%) probable cases, with 817 (8.1%) being female and 815 (8.1%) being male. All Localities in Gadarif state record of cases-Patients according to the Environmental situation the rainy season will indicate to increase number of case-patients.

Discussion
The analysis of line list data from the Gadarif State Ministry of Health in 2023 indicates a total of 2026 reported cases with 49 deaths, resulting in a case fatality rate of 2.4%. The highest number of cases was recorded in Baladiat al Gadarif Locality, followed by Western Glabat and Wasat al Gadarif

Locality. Although the median age for case-patients was 10-19.9, it is evident that both male and female individuals were affected, with female cases accounting for 10.2% and male cases at 10.1%.

Following the confirmation that the cholera-causing bacteria, Vibrio cholera, were present in four stool samples from suspected individuals, Sudan announced a cholera epidemic in Gedaref State on September 26, 2023. Gedaref had 307 cases and 19 deaths (CFR 6.18%), South Kordofan had 400 cases and 8 deaths (CFR 2%), and as of September 29, from Khartoum, there were 110 cases and 8 deaths (CFR 7.27%). Studies are being conducted to find out if cholera has also reached the states of South Kordofan and Khartoum, where there have been more reports of acute watery diarrhea. (14).
Details such as the attack rate and case fatality rate for each locality were not provided in the available data. The World Health Organization (WHO) and the Federal Ministry of Health (FMoH) have stated that as of December 23, 46 localities across nine states had at least 8,267 suspected cases of cholera, including 224 linked deaths (CFR: 2.7%), (8). Also, the high child age group 0-9.9 recorded 532 case patients, with 246 (2.5%) females and 286 (2.7%) males. The death rate for children under five was 16 females (0.04%) and 12 males (0.12%). In addition, the limited monitoring and remediation of water quality - non-enforcement of public health measures by local authorities that affect the prompt containment of the outbreak, the escalating hostilities and access problems, in addition to the worsening security conditions according to the conflict and leak of security situation access, may make the emergency and response operation even more difficult (8,9).
The peak of cases occurred in week 35 of 2023, with 32 cases, mainly females. The most cases were reported in week 48, with 319 cases, 129 females, and 190 males. The number of cases increased throughout the week, with a total of 254 cases and 4 deaths.

Gadarif State cholera outbreak persisted for a long time and extended to every locality that shared its boundaries. This demonstrated a delayed effective response that might have postponed the outbreak's containment. Additionally, inadequate infection control procedures at the medical facilities may be the cause of the extremely high attack rates observed in some localities. The large number of internally displaced people (IDPs) in Sudan is linked to the conflict situation and may be caused by inadequate case management in health institutions. This could also account for the high CFR found in Gadarif State Locality.

Table 1 Distribution of cholera cases and deaths by age group across local government areas of Gadarif State, 2023

Age Group	Male		Female		Total	
	Cases	%	Cases	%	Cases	%
00-99	300	3	255	2.6	555	5.5
10-19.9	128	1.3	133	1.3	261	2.6
20-29.9	205	2.1	187	1.9	392	4
30-39.9	143	1.4	167	1.7	310	3.1
40-49.9	79	0.7	115	1.2	194	2
50-59.9	73	0.8	71	0.7	144	1.4
60-69.9	76	0.6	65	0.7	141	1.4
70 >	63	0.6	62	0.6	125	1.2
Total	2122	21.2	1067	10.7	3189	31.9
Age Group	**Male**		**Female**		**Total**	
	Death	**ASCFR %**	**Death**	**ASCFR %**	**Death**	**%**
00-99	8	0.7	3	0.2	11	1
10-19.9	4	0.3	1	0.08	5	0.4
20-29.9	3	0.2	3	0.2	6	0.5
30-39.9	2	0.1	5	0.4	7	0.6
40-49.9	3	0.2	4	0.3	7	0.6
50-59.9	2	0.1	3	0.2	5	0.4
60-69.9	2	0.1	2	0.1	4	0.3
70 >	1	0.08	3	0.2	4	0.3

Table 2: Cholera attack rates and case-fatality rates stratified by local governments, Gadarif State 2023.

Locality	Projected Population 2023	Total Cases	Total Death	Attac Rate/10000	CFR (%)
Baladiat Al gadarif	488255	1280	18	**26.22%**	1.4
Wasat Al gadarif	202340	189	9	9.34%	4.8
Eastern glabat	205517	130	8	6.33%	6.2
Westran glabat	166417	218	4	13.10%	1.8
Al mafaza	110212	6	0	0.54%	0.0
Al rahad	245839	4	0	0.16%	0.0
Al faw	320126	6	1	0.19%	16.7
Al fashaga	218957	61	3	2.79%	4.9
Al grasha	151022	111	5	7.35%	4.5
Gla alnahal	119743	18	1	1.50%	5.6
Basunda	86508	3	0	0.35%	0.0

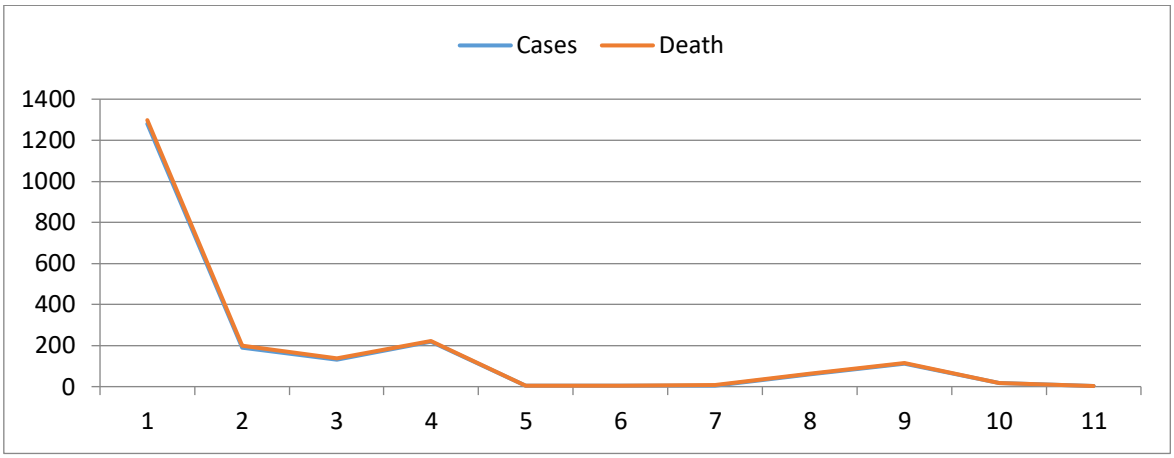

Figure 1: Epidemic curve of the cholera **Cases** and **deaths** across local government areas of Gadarif State.

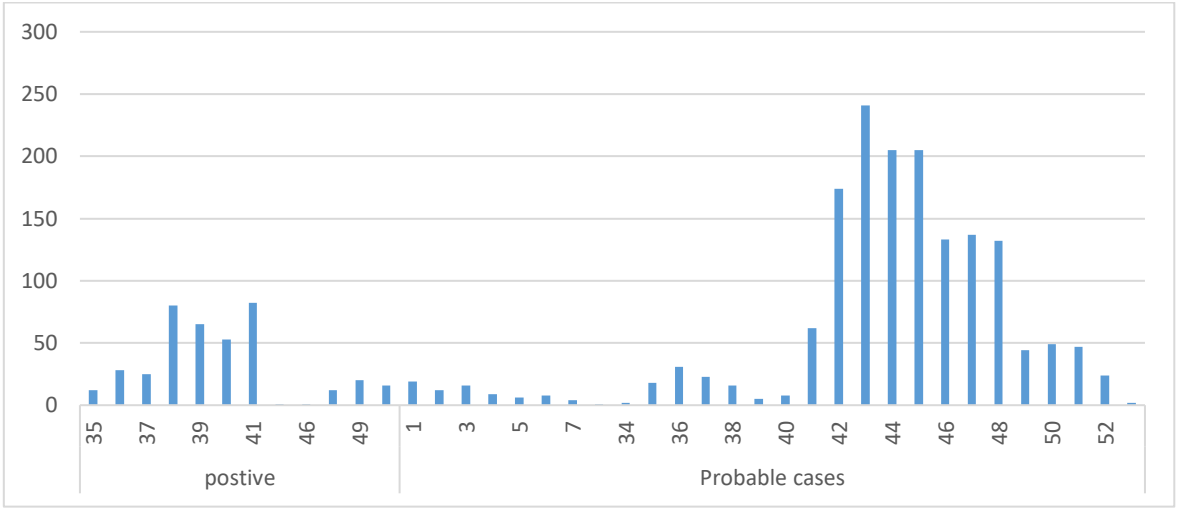

Figure 2: The epidemic curve of the cholera cases per week in Gadarif State,2023.

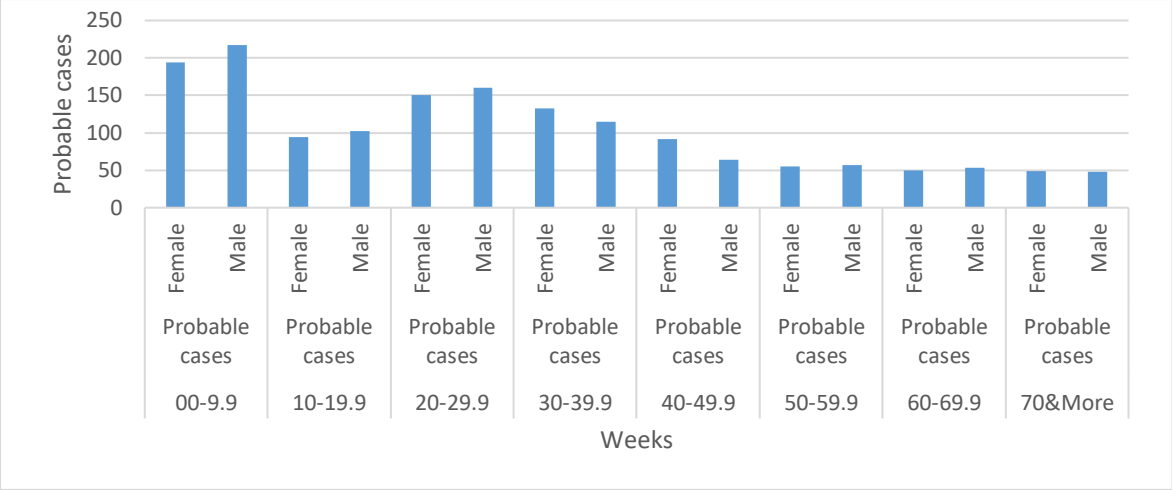

Figure 3: Distribution of cholera Probable cases by Age and Sex across local government areas of Gadarif State, 2023.

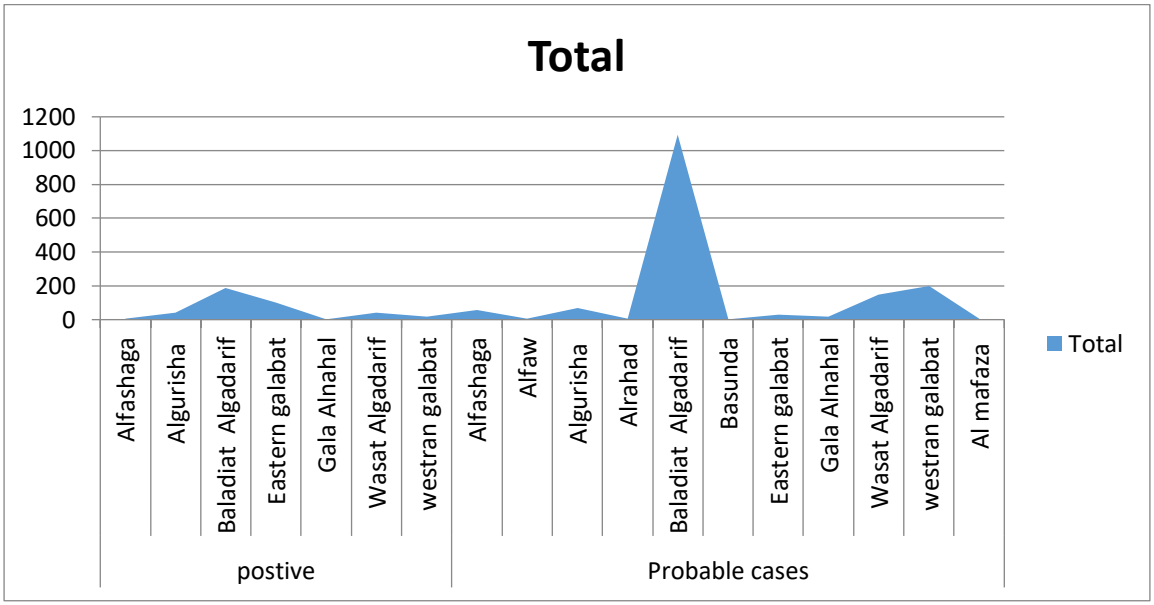

Figure 4: Distribution of cholera-positive, Probable Cases by Age and Sex across local government areas of Gadarif State, 2023.

Conclusion

In 2023, Gadarif State Ministry of Health reported 2026 cholera cases with 49 deaths, resulting in a case fatality rate of 2.4%. The outbreak was confirmed in Gedaref State, South Kordofan, and Khartoum. The World Health Organization reported 8,267 suspected cases across nine states with 224 deaths. Children under five had a death rate of 0.04% for females and 0.12% for males. The outbreak was exacerbated by humanitarian crises, limited water quality monitoring, lack of public health measures, and security issues. The delayed response and inadequate infection control procedures in medical facilities contributed to the outbreak's spread.

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