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Geo-Spatial and Temporal Study of Leprosy Disease in Visakhapatnam District, Andhra Pradesh, India.

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ABSTRACT: Leprosy is a chronic and potentially disabling bacterial disease, which is caused by Mycobacterium leprae. Disease is reported from many countries of the world including India. The incidence of disease is highest in the poverty belt of the world. The migration of people from endemic leprosy regions to non-endemic areas may cause re-emergence of disease. To identify Sub- districts of the major occurrences of leprosy and to prepare geospatial maps of Leprosy to provide spatial perspective of vulnerable zones for management practices to control the menace. Cases of leprosy that occurred between 1999 and 2018 in Visakhapatnam district (Andhra Pradesh, India) were collected and analysed annually and decadal wise and Spatial Maps were produced to visualize e the spatial distribution of cases of leprosy disease. Maximum cases were occurred in Visakhapatnam Urban which 10.5 % of the cases were reported. Lowest incidence occurred in Koyyuru mandal with 63 cases, which 0.7 % of the cases in the total incidences of Visakhapatnam district.During the data availability period from 1999 to 2018, none of the mandal is free from the incidence of Leprosy in the district. The prevalence of leprosy cases at the Mandal level over the decade in Visakhapatnam district revealed that mandals in Munchingput, Visakhapatnam Urban, Visakhapatnam Rural, Rambilli and Pendurthi reported cases of maximum total leprosy.The analysis of decadal total annual leprosy cases in Visakhapatnam district indicates that all the mandals of Visakhapatnam district have experienced a slump in total leprosy cases when compared to 2009-2018 decade with 1999-2008 decade. Visakhapatnam urban and Visakhapatnam rural mandals in study period. Moreover these mandals were also identified as high incidence of leprosy cases during the study period. These mandals were high prone mandals in Visakhapatnam district. The minimum leprosy cases were reported from the following mandals they were G.Madugula, Peda Bayalu, Chintapalle and Koyyuru (Low prone mandals) during the study period between 1999 and 2018. The spatial analysis coupled with the study of annual trends of diseases may be beneficial for executing appropriate management performance for the hindrance of diseases

Key words: Leprosy, Geographic Information Systems, Temporal, Spatial, Decadal.

I. INTRODUCTION:

According to the statistics of world health organization around 1,73,000 leprosy cases at the end of 2016 across the globe, The Leprosy cases mostly found in India, Brazil, and Indonesia, Across the globe 2 to 3 million people disabled due to this Hansen's disease (Leprosy), it is chronic and long term disease infected by bacteria such as Mycobacterium leprae or Mycobacterium lipomatosis, the bacteria transmitted between two persons when they have close contact with other infected by bacteria, mostly the earlier researchers said the human skin is the main route of transmission which is largest organ of the integumentary system in human body, but the recent studies opined respiratory is the main route to transmission. It acts on the peripheral nerve system (PNS) and respiratory tract, and largest organ (skin) and eyesight. When the PNS affected by leprosy the result of that the skin may definite sensory loss when they have pain, Over and over again the chronic diseases associated with the many non-communicable diseases (NCD) and non-infectious causes. The prevention of the leprosy is the early finding of the disease is very important, whereas the WHO recommended the preventive medication for leprosy who closely contact with who has leprosy.

The recommended preventive medication is a single dose of rifampicin (SDR) in grownups and children over two years old that doesn't already have leprosy or tuberculosis. Precautionary and preventive treatment is allied with a 57% fall in infections within two years and a 30 percentage diminution in infections within six years. Leprosy have a wide range of history, it was noticeable in

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ancient periods at Balathal in India and Harappa in Pakistan (Robbins, G et.al 200 BC). For the proof of ancient periods, the skeletal evidence for Leprosy in India (2000 B.C) figure out by the Robbins. In Atharva Veda and Kausika Sutra also mentioned and gave their interpretation and refer to the skin infections.

Distribution of Leprosy

Global Scenario Since the introduction of multi-drug therapy as treatment for Leprosy; Leprosy case load has declined. The country achieved elimination (number of cases less than 1 per 10,000 populations) in December 2005. Of the 254525 new Leprosy cases detected globally during the year 2007-08; 137685 (54%) were from India The global Grade 2 Disability load in the year 2007-08 was 14033. This was reported from 133 countries. In India, load of grade 2 disability was 3477 during the same reporting period.

Scenario in India As on 1st April 2008 the disease burden on record was 87228 cases of Leprosy. During the year 2007-08 137685 new cases were detected. State wise distribution of high number of cases were recorded in Utterpradesh with 22,54 cases (23%) and fallowed by Bhihar (14%), Westbengal (10%), Maharasthra(10%), AndhraPradesh (7.3%), Chhattishgarh (5.67%), Gujarath (6%), Gujarath (5%), Jharkahand (5%), Madhya Pradesh(4%), Tamilanadu (4%),Orissa(4%),Karnataka (3%) and Delhi(1%).

The cases of diseases were analyzed both on a yearly and periodic basis. Spatial patterns of the diseases were derived in Geographical Information Systems (GIS) environment. The GIS technologies to deal with spatial and temporal data, that data can be visualized and spread of epidemic diseases. It is very useful for tracking as well as prevention and acquisition. The spatial analysis coupled with the study of annual trends of diseases may be beneficial for executing appropriate management performance for the hindrance of diseases

II. STUDY AREA:

Visakhapatnam is one of the coastal districts of Andhra Pradesh, is located between 17°15' and 18° 32' N latitude and 18°54' and 83° 30' E longitude (Fig.1). It is bounded in the north partly by Odisha and Vizianagaram district, in the south by East Godavari district, in the west by Odisha and in the east by the Bay of Bengal. The region exhibits heterogeneity in its physiographic characteristics. Based on the relief, the district can be divided into two regions – the western interior hilly terrain (6233 km^2), which covers about 56 percent of the area of the district, and comprises of high relief ranging from about 300 m to over 1500 m above sea level. Paderu division is hilly with undulating terrain covered by Eastern Ghats and the altitude ranges from 900 to 1615 m (Fig.1).The remaining area is the coastal plain (4267 km^2). Out of the total area of the district, about 41.8 percent is under forests, 27 % is under agriculture, 16.9 % under barren, 7.5% is under non-agricultural use, 3.5% under pasture and groves and 3.8 % under fallow.

Fig.1. Location map of Visakhapatnam District (Study Area)

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Figure depicts the two regions which study will be divided and carried out by regions. They are western hilly region and the coastal plain region, every mandal headquarter denoted byred colour dot which shows on location map, and more over the map shows the regional dividing line on the map. That line comprises in to two regions, they are,the western hilly region which contains eleven mandals while the coastal region has 33. The main aim if of this study is medical geography perspective, hence the objectives which we mentioned in introduction (Fig.1.1).

III. OBJECTIVES:

- To identify the Leprosy cases in Visakhapatnam district.
- To prepare geospatial maps of Leprosy to provide spatial perspective of vulnerable Physiographic division of the study area for management practices to control the menace.
- To assess the annual temporal changes of leprosy disease in study area.

IV. DATA AND METHODOLOGY:

The data on Leprosy diseases was collected from District medical Health office and Primary Health Canters (PHCs).Descriptive Disease analysis through statistical abstracts from various Data analysis with statistical applications, MS. excel and Generation of annual and decadal geospatial maps of disease incidence in GIS environment.

V. DATA ANALYSIS:

V.I. TEMPORAL CHANGES OF LEPROSY DISEASE IN VISAKHAPATNAM DISTRICT:

V.I. Leprosy cases in Visakhapatnam District

Distribution of Leprosy cases during 1999-2018 period in the study area presented in fig. no. 2. It can be observed from the figure that about 8354 leprosy cases were recorded during 1999 - 2018 period (20 years), in which about 80% of Leprosy cases recorded during 1999-2008 period (10 years) and the remaining 20% Leprosy cases recorded during 2009-2018 period (10 years). During 1999-2008 period about 670 (average) Leprosy cases recorded per year and also shown decreasing trend in cases in this decade where as about 165 (average) Leprosy cases recorded per year and showing neither increasing nor decreasing trend in between 2009-2018 period (decade).

Fig.No. 2. Distribution of Leprosy cases during 1999-2018 period in the study area:

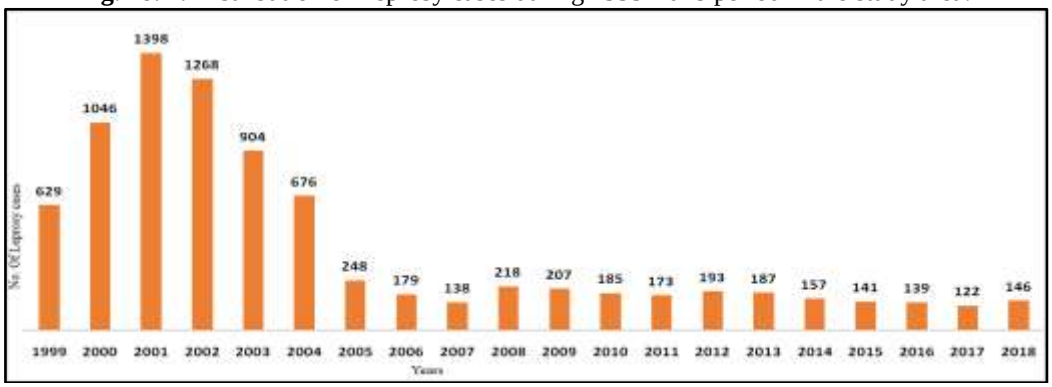
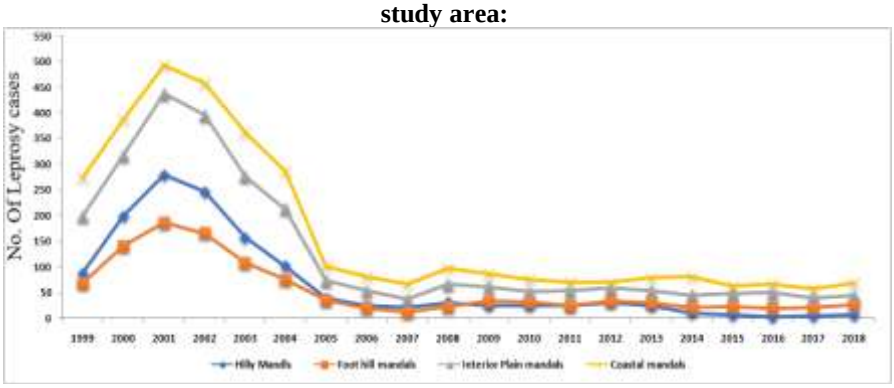


Fig.No.3 Distribution of Leprosy cases during 1999-2018 according to Physiographic divisions of the study area:



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The information regarding distribution of Leprosy cases during 1999-2018 (20 years) period is present in fig. no. 3. According to Physiographic divisions of the study area. The physiographic divisions are 1. Hilly region (1.Munchingi Puttu,2.Peda Bayalu, 3.Dumbriguda, 4. Araku Valley, 5. Ananthagiri, 6. Hukumpeta, 7. Paderu, 8.G.Madugula, 9. Chintapalle, 10. Gudem Kotha Veedhi, and 11.Koyyuru mandals), 2.Foot hill region (1.Nathavaram, 2.Golugonda, 3.Rolugunta, 4.Ravikamatham, 5.Madugula, 6.Cheedikada and 7.Devarapalle mandals), 3. Interior plain region (1.Sabbavaram, 2.Pendurthi, 3.Anandapuram, 4.Padmanabham, 5.Narsipatnam, 6.Kotauratla, 7.Makavarapalem, 8.K.Kotapadu, 9.Anakapalle, 10.Chodavaram, 11.Butchayyapeta, 12.Kasimkota, 13.Munagapaka and 14.Yelamanchili mandals) and 4.Coastal region (1.Bheemunipatnam, 2.Visakhapatnam (R), 3.Visakhapatnam (U), 4.Pedagantyada, 5.Gajuwaka, 6.Paravada, 7.Nakkapalle, 8.Payakaraopeta, 9.S.Rayavaram, 10.Atchutapuram and 11.Rambill mandals). Further the figure showing that about 1351 Leprosy cases recorded in Hilly region, about 1102 Leprosy cases recorded in Foot hill region mandals, about 2585 cases recorded in Interior plain region mandals and bout 3316 Leprosy cases recorded in coastal region mandals.

I.2 Changes in Leprosy cases during 1999-2008 & 2009-2018 periods in the study area:

Table No. 1. Changes in the Leprosy cases during 1999-2008&2009-2018 periods in the study area:

S.No	Region/Mandal	Total No. Of cases during 1999-2018	% of share	Leprosy cases during 1999-2008	% of share	Leprosy cases during 2008-2018	% of share	% of change during 1999-2008&2009-2018
1	Tribal region/ Hilly region	1351	16.2	1191	17.8	160	9.7	-86.6
2	Foot hill region	1102	13.2	835	12.5	267	16.2	-68
3	Interior Plain region	2585	31	2074	31	511	31	-75.4
4	Coastal region	3316	39.6	2604	38.8	712	43.2	-72.7
5	Total study region	8354	100	6704	100	1650	100	-75.4

Changes in Leprosy cases beween 1999-2008 & 2009-2018 periods (two decades) according to Physiographic divisions of the study area presented in the Table No.1. It can be observed from the table that, about 8354 (100%) Leprosy cases recorded during 1999-2018 period in which highest number of cases recorded in coastal plain region (39.6) followed by interior plain (30%) tribal region (16.2%).

During 1999-2008 (10 years) period about 6,704 (100%) Leprosy cases recorded in which highest number of cases recorded in Coastal Plain region (38.8%) followed by Interior plain(31%), Tribal region(17.8%) and foot hill region(12.5), whereas during 2009-2018(10 years) period about 1650 (100%) Leprosy cases were recorded in which highest number of reduction in cases noticed in coastal plain(45.2%) followed by Interior plain(31%), Foot hill region(16.2%) and lowest number of cases reduction in Interior mandal region(9.7%).

Regarding changes in number of Leprosy cases between two decades 1999-2008(10 years) and 2009-2018(10 years) periods, Highest number of reduction of cases in Tribal region (-86.6%) followed by Interior plain (-75.4%), Coastal plains (-72.7%) and Lowest number of reduction cases noticed in foot hill region (-68%) and the total study area recorded -75.4% reduction of cases over the study period.

It can be observed from the above discussion that, more than 75% of reduction cases notices during the two decades (1999-2008 & 2009-2018) period. Highest number of cases recorded in both periods in the Coastal plain region and its share increased during 2009-2018 period in the total study area. Moreover, percentage of share of cases also increased in foot hill region (12.5% t 16.2%) and its share decreased in Tribal region (17.8% to 9.7%) in the total study region during the study period.

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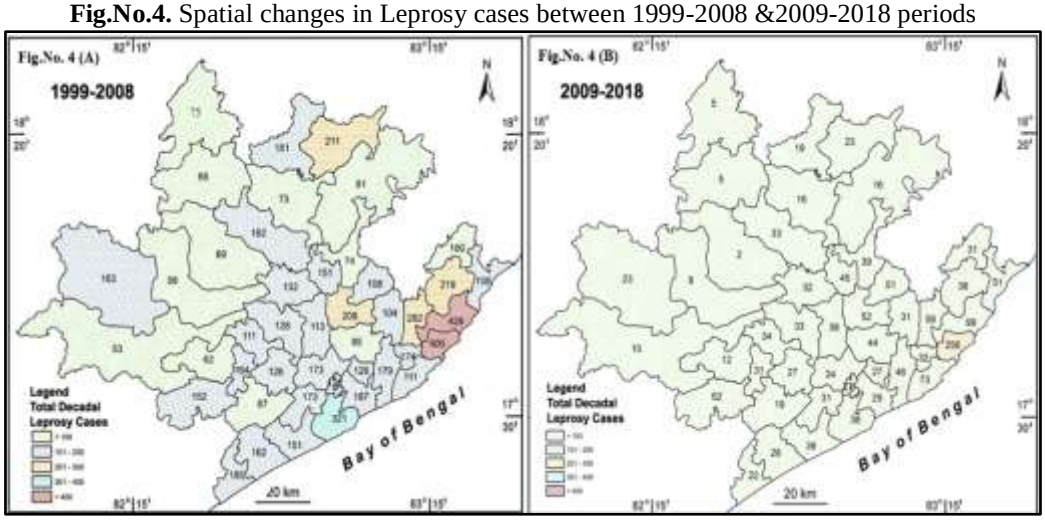
V.II. GEOSPATIALPATTERNS OF LEPROSY DISEASES IN VISAKHAPATNAM DISTRICT

Fig.No.4. Spatial changes in Leprosy cases between 1999-2008 &2009-2018 periods



Spatial distribution of Leprosy cases during 1999-2008 period:

The Hilly region mandals of the study area recorded about 1191 Leprosy cases. Araku mandal recorded about 17.7% of the total Leprosy cases of the region and recorded medium category cases (201-300 cases) Dumbriguda (15.2%), Paderu (13.6), G.K veedhi (13.7%) recorded low category cases(101-200 cases), where as the remaining seven mandals comes under very blow category cases (<100 cases). Furthere Araku, Dumriguda, Paderu, G.K Veedhi contributed for about 60% of the total cases recorded in this region (Figure No.4.A).

The foot hill region mandals recorded about 835 Leprosy cases. G.Madugula (18.8%), Nathavaram (18.2%), Ravikamatham(15.3%), Rolugunta(13.3%) recorded medium category of cases. Further, G. Madugula, Nathavaram, chidikada contributed for 55% of the total Leprosy cases.Devarapalli (8.9%), Golugonda(7.4%) were recorded very low category of cases.

The Interior plain mandals recorded about 2074 Leprosy cases. Pendurthi (13.6%), Ananda puram(10.6%), Chodavaram(10%) recorded medium category cases(201-300 cases). Low category (101-200 cases) recorded Manadals were, Yalamanchili(8.3%), Kasimkota(8.3%), Narsipatnam(7.9%), Munagapaka(6%), Makavarapalem(603%),Butchiapeta(5.4%), K. Kotapadu(5.2%), Sabbavaram(5%), where as Padmanabdham(4.3%), Anakapalli(4%) cases under very low category cases(<100 cases). Further, Pendurthi,Anandha puram, Chodavaram, Yelamanchili, Kasimkota contributed for 50% of the total Leprosy cases.

The coastal region mandals recorded about 2,604 Leprosy cases. Visakhapatnam(U) mandal (23%) and Visakhaptanam(R) mandal(16.4) recorded High category cases(>100 cases), where as Rambilli mandal(12.3%) recorded High category cases (301-100 cases) and three mandals contributed for about 51.7% of the total cases of the region. Atchtapuram(7.2%), Payakarao peta(7.1%), Nakkapalli(6.2%),Parawada(6.9%), Gajuwaka(6.7%), S. Rayavaram(5.8%) and Bheemili(4.1%) recorded Low category cases (101-200 cases).

Spatial distribution of Leprosy cases during 2009-2018 period:

The Hilly region mandals recorded about 160 leprosy cases and all mandals recorded very Low category cases (<100 cases). Paderu (20.6%), G.K Veedhi (14.4%) and Araku (14.4%) mandals contributed for 49.4% of the total cases of the hilly region mandals. The Foot hill region Mandals recorded about 267 Leprosy cases and all mandals recorded very low category (<100 cases). Natha varam(23.2%), Cheedikada(16.9%), G. Madugula(15.7%) and Devarapalli(14%) contributed for about 70% of the total Leprosy cases of the Foot hill region mandals. The Interior plain region mandls recorded about 511 Leprosy cases and all mandls recorded very low category cases (<100 cases). Pendurthi(11.5%), Chodavaram(10.2%), K. Kotapadu (9%) and Anakapalli (8.6%) contributed for about 39.2% of the total cases of the Interior plain region mandals. Regarding coastal region mandals about 712 Leprosy cases were recorded and Visakahpatnam Urban (36%) Mandal recorded medium category cases (201-300 cases) whereas the other remaining

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mandals recorded low category of cases(101-200 cases). Visakhapatnam Urban mandal (36%), Visakhapatnam rural mandal (13.9%), Pedagantyada (10.3%) contributed for 60.2% of the total cases of the Coastal region mandals.

Table No. 2. Changes in Leprosy cases between 199-2008&2009-2018 periods according to Physiographic divisions of the study area:

S. No.	Name of the region and Name of the Mandal	1999-2008 No. Of cases	2009-2018 No. Of cases	% of Change
Tribal region mandals				
1	Munchingput	75	5	-93%
2	Pedabayalu	65	5	-92%
3	Dumbriguda	181	19	-90%
4	Araku	211	23	-89%
5	Ananthagiri	81	16	-80%
6	Hukkumpeta	73	16	-78%
7	Paderu	162	33	-80%
8	G Madugula	69	2	-97%
9	Chinthapalli	58	8	-86%
10	G.K. Veedi	163	23	-86%
11	Koyyuru	53	10	-81%
	Subtotal	*1191*	*160*	*-87%*
Foot hill region mandals				
1	Nathavaram	152	62	-59%
2	Golugonda	62	12	-81%
3	Rolugunta	111	34	-69%
4	Ravikamatham	128	33	-74%
5	V Madugula	157	42	-73%
6	Chidikada	151	45	-70%
7	Devarapalli	74	39	-47%
	Subtotal	*835*	*267*	*-68%*
Interior Plain region mandals				
1	Narsipatnam	164	31	-81%
2	K Kotapadu	108	46	-57%
3	Sabbavaram	104	31	-70%
4	Pendurthi	282	59	-79%
5	Anandhapuram	219	36	-84%
6	Padmanabham	100	31	-69%
7	Anakapalli	85	44	-48%
8	Chodawaram	208	52	-75%
9	Butchiahpeta	113	38	-66%
10	Kotavuratla	87	19	-78%
11	Makavarapalem	132	32	-76%
12	Kasimkota	173	34	-80%
13	Munagapaka	126	27	-79%
14	Yelamanchili	173	31	-82%
	Subtotal	*2074*	*511*	*-75%*
Coastal region mandals				
1	Bheemili	108	51	-53%
2	VSP URBAN	600	256	-57%
3	GVMC RURAL-CHINAGADILI	426	99	-77%
4	Pedagantyada	111	73	-34%
5	Gajuwaka	174	32	-82%
6	Parawada	179	46	-74%
7	Nakkapalli	162	28	-83%
8	Payakaraopeta	185	22	-88%
9	S Rayavaram	151	38	-75%
10	Rambilli	321	38	-88%
11	Atchuthapuram	187	29	-84%
	Subtotal	*2604*	*712*	*-73%*
Grand total of total study area		*6704*	*1650*	*-75%*

Regarding Spatial changes in Leprosy cases in the study area (Table No.2), about 75.4% reduction of Leprosy cases noticed between 1999-2008&2009-2018 periods, where as 86.6% reduction of cases noticed in tribal region mandals, 68% reduction of cases in Foot hill region mandals, 75.4% reduction of cases in Interior plain region mandals and about 72.7% reduction of Leprosy cases in the Coastal region mandals. The Foot hill region mandals recorded less percentage of changes in Leprosy cases when compared to the other region mandals. Though Leprosy cases reduced over the study period but Leprosy cases were recorded in every year and in every mandal. Coastal region mandals were recorded more number of Leprosy cases.Further the study identified the high risk mandals. They are fallows the Paderu, G.K Veedhi and Araku mandals in Hilly region mandals, Nathavaram, chidekaada, G.Madugula and Deverapalli in Foot hill region mandals, Pendurthi, Chodavaram, K.Kotapadu, and Anakapalli in Interior plain mandals. Visakhapatnam Urban mandal, Visakhapatnam rural mandal and pedagantyada in Coastal region mandals

VI. CONCLUSION:

India has highest number of new Leprosy cases in the world followed by Brazil and Indonesia. India declared Leprosy was eliminated from the India in 2005 but new cases occurred due to changes in the policies of National Leprosy Elimination Programme (NLEP) and Global Leprosy programme. If Leprosy was not detected early, it may contact to many people and disabilities rates may increase due to delay in diagnosis. In Visakhapatnam about 248 cases recorded in 2005 and more or less same situation is continuing up 2018 (146). As humidity percentage in more in the district, the Leprosy existence is continuous

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