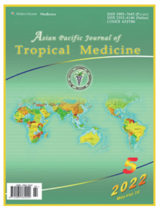

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Public knowledge, practices and perceptions on typhus fevers in Southern Sri Lanka

Ashani Liyanage[1], Nilmini Chandrasena[2]✉, Nayana Gunathilaka[2], Ruwan Sanjeewa[3], Ranjan Premaratna[4]

[1]*Rickettsial Disease Diagnostic and Research Laboratory, Faculty of Medicine, University of Kelaniya, Ragama, 11010, Sri Lanka*

[2]*Department of Parasitology, Faculty of Medicine, University of Kelaniya, Ragama 11010, Sri Lanka*

[3]*Medical Officer of Health, Elpitiya, Ministry of Healthcare, Nutrition and Indigenous Medicine, 80400, Sri Lanka*

[4]*Department of Medicine, Faculty of Medicine, University of Kelaniya, Ragama 11010, Sri Lanka*

ABSTRACT

Objective: To assess public knowledge, practices and perceptions on typhus fevers in Sri Lanka.

Methods: A descriptive study was done in four selected typhus-prone areas in Southern Sri Lanka. A mixed-method was employed using face-to-face interviews and questionnaire-based surveys among confirmed cases of typhus and at-risk populations, respectively. Frequencies, percentages, and means were used to characterize socio-demography and evaluate disease awareness.

Results: The lay terms for typhus fevers reported in the studied region were "peacock fever", "tick fever" and "bird fever". A total of 499 subjects participated [mean±SD, (45±16) years] in the questionnaire-based survey, and 13.6% (n=68) reported past experience of typhus fever, 1.2% (n=6) identified the disease as "typhus" while 58.7% (n=293) and 11.8% (n=59) knew it as 'peacock fever' and 'tick fever', respectively. The etiological agent was unknown to 95.2% (n=475), but 53.5% ((n=267) were aware that it was vector-borne. Fever (57.3%, n=286), eschar (35.7%, n=178), headache (22.0%, n=267) and myalgia (19.2%, n=96) were identified as key symptoms. Past disease experience was significantly associated with higher awareness of the main disease symptoms (fever: χ^2=15.713, P<0.001; headache: χ^2=19.447, P<0.001; lymphadenopathy: Fisher's exact test, P=0.023; eschar: χ^2=12.049, P<0.001). None knew of any disease prevention methods. Participants with a past history of typhus fever had sought treatment at state hospitals (55.9%, 38/68) and private sector hospitals (5.9%, 4/68).

Conclusions: Public awareness on preventive practices for typhus fevers was rare among the participants though vector-borne aspect was known to many. Clinical disease awareness was deficient among those without past experience of typhus fever. Community sensitization on vector avoidance strategies is highly recommended.

KEYWORDS: Awareness; Perceptions; Practices; Typhus fevers; Sri Lanka

1. Introduction

Typhus fevers represent one of the leading causes of vector-borne febrile infections in the Asian region[1]. The causative agents are obligate intracellular Gram-negative coccobacilli of the Family Rickettsiaceae[2]. The pathogenic species belong to two genera, *Rickettsia* and *Orientia*. Infections include the spotted fever group (SFG) of rickettsioses, the typhus group and scrub typhus[3]. The causative agents are transmitted by blood-sucking arthropod vectors (ticks, mites, fleas, and lice)[4].

The distribution of typhus fevers differs according to the geographical region. The SFG of rickettisioses [*Rickettsia (R.) conorii* and other SFG agents, *R. helvetica*, *R. monacensis*, *R. massiliae* and *R. aeschlimanii*] are the main agents of typhus infections in Europe[5]. In the Southeast Asian region, *R. typhi* of

Significance

Creating public awareness on vector avoidance measures is important in the control of typhus fevers as licensed vaccines are unavailable. There was no data on typhus fever awareness in Sri Lanka. This survey indicates that many in typhus-prone foci in Southern Sri Lanka were aware of the vector-borne aspect of typhus fevers, but knowledge on preventive measures was non-existent. Knowledge on clinical features was deficient among those without disease experience.

✉To whom correspondence may be addressed. E-mail: nilminicha64@gmail.com

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the typhus group, *Orientia (O.) tsutsugamushi* of the scrub typhus group and members of the SFG rickettsia, *R. conorii*, *R. felis*, *R. honei*, *R. helvetica*, *R. japonica* have been reported[1]. In the Indian subcontinent, the chigger mite-borne scrub typhus is the main typhus fever documented[6]. The distribution of scrub typhus is widening with cases being encountered outside the Asia-Pacific region known as the "tsutsugamushi triangle" which encompass South and Southeast Asia, Northern Australia and islands of the Indian and Pacific oceans. Recently, Chile, Peru, Africa and the Arabian Peninsula have reported scrub typhus infections[7,8].

Sri Lanka has been endemic for typhus fevers for decades with the first case of scrub typhus reported in 1937 followed by murine typhus in 1938 and SFG in 1994[9,10]. At present, an average of 1 500 cases are notified to the Epidemiology Unit, Ministry of Health annually under the collective category of "typhus"[11]. Although cases have been reported from all districts of the country, transmission of typhus fevers is restricted to specific localities[12]. The Western, North-western and Northern provinces have reported a predominance of the chigger-mite-borne scrub typhus caused by *O. tsutsugamushi* while the tick-borne SFG typhus caused by *R. conorii* seems to predominate in the Central province. A mix of SFG typhus, scrub typhus, and murine typhus (*R. typhi*) has been reported from the Southern province[10].

Typhus fevers represent a major cause of undifferentiated febrile illness and often present with symptoms and signs varying from the characteristic (high fever, headache, myalgia, eschar, skin rashes) to rare neurological signs (tremors, rigidity, deafness and altered consciousness)[13]. Clinical differentiations from other febrile infections prevalent in the tropics such as dengue, leptospirosis, malaria and enteric fever are challenging in the absence of an eschar. As diagnostic facilities are not widely available, typhus fevers are often missed and under-reported. Diagnostic delays lead to complications and fatalities which are easily preventable with early antibiotic therapy[7].

Behavioural change is accepted as an important element in the control of vector-borne diseases[14]. Assessment of baseline awareness, preventive practices and perceptions on typhus fevers among risk communities would be an initial step in the right direction for sensitizing the community to adopt the desired behaviours. To the best of our knowledge, despite a documented history of typhus fevers of over seven decades in Sri Lanka, there are no published reports on typhus fever awareness among the general public. Hence, the aim of this study was to document the baseline awareness, practices and perceptions of typhus fevers among community members in four selected Medical Officer of Health (MOH) areas in two districts, Galle and Hambantota in Southern Sri Lanka.

2. Subjects and methods

2.1. Study area and population

This survey was conducted from January 2019 to January 2020. The Southern province comprises of three districts, Galle, Matara and Hambantota. It is the third most populated province with 2.654 million people distributed over a land area of 5 544 km^2[15]. Subsistence farming (cinnamon, volatile plants, tea, paddy, coconut and palm oil) is one of the main sources of income in the region[16]. There is a dominance of SFG rickettsioses year-round with sporadic cases of scrub typhus, acute Q fever and murine typhus in the region[17,18]. The annual typhus case incidence in the Southern province in years 2017 and 2018 was 187 and 235 cases respectively, representing the second highest case incidence per province for both years[19,20]. However, most of these cases were reported on a presumptive diagnosis as facilities for confirmatory testing were not widely available.

Face-to-face interviews and questionnaire-based surveys were conducted among residents in typhus-prone foci in the four MOH areas, Ambalangoda, Elpitiya, Karandeniya (Galle district) and Tangalle (Hambantota district) of Southern Sri Lanka from January 2019 to January 2020. The study population consisted of serologically confirmed typhus fever cases (IgG IFA antibody titer of >1:128 to *O. tsutsugamushi* karp or *R. conorii* antigens) and populations residing within a kilometre radius of the index cases were selected by cluster sampling method.

2.2. Sample size

The minimum required sample size for the questionnaire-based survey was calculated using the formula n=z^2*p*(1-p)/e^2, where sample proportion (p) was estimated as 0.59 according to Sharma *et al*[21], with a 95% confidence level (z=1.96) and an acceptable difference (e) of 0.05. Since cluster sampling was used, a design effect of 1.5 was applied with an acceptable difference of 0.06 which gave the minimum required sample size (n) of 387. The inclusion criteria for the questionnaire-based survey were a minimum of five-year residency in the risk area and age ≥18 years. Subjects with less than five-year residency, less than 18 years of age and those participating as index cases in the interviews were excluded. The inclusion criterion for the interview-based survey (index cases) was a confirmed diagnosis of typhus fever over a period of 12 months from January 2019 to January 2020.

2.3. Interview-based assessment of disease perceptions

The typhus fever cases were listed and their residences were traced. Interviews were conducted with 13 consenting index cases (informants) within their homes to ensure privacy. Two open-ended questions were included to interviews to gather community understanding of typhus fevers: 1) the lay terminology used among the locals for typhus fevers and 2) the perceptions underlying the lay terminology. Each interview was recorded with the consent of the informants to minimize data loss during transcription. The information thus gathered was evaluated and categorized under two themes, illness terminology and perceptions. The lay terminology identified was incorporated to the survey tool (questionnaire) used to gather quantitative data.

2.4. Questionnaire-based assessment of disease perceptions

The locations of index case residences were mapped using ArcGIS 10.6.1 and a one-kilometre buffer zone was demarcated around each house (Figure 1). The study populations for the questionnaire-based survey were sequentially sampled from households situated within these high-risk buffer zones. The households with a minimum of five-year residency in the area were enrolled to the study. One adult volunteer (>18 years) from each household was recruited. The index typhus fever cases were not included to the questionnaire-based assessment of disease awareness.

The pre-tested questionnaire was administered in the native language (Sinhala) at the residence of each consenting participant. The questionnaire consisting of 20 questions covered three sections, the socio-demographic characteristics (gender, age, level of education, occupation, and income type), knowledge pertaining to typhus fevers (aetiology, transmission, disease symptoms) and preventive and treatment practices. After the survey, all participants were educated on typhus fever disease symptoms and prophylactic measures.

2.5. Ethical approval

Ethical clearance for the study was obtained from the Ethics committee of the Faculty of Medicine, University of Kelaniya, Sri Lanka (Ref. No. P/221/09/2017). Informed written consent was obtained from each study participant before interviews and administration of the study tool (questionnaire).

2.6. Data analysis

The recordings of the interviews were analysed and a descriptive summary was prepared. Data from the questionnaire-based survey was entered in the Microsoft access (Version, 2007) for validation purposes before analysis. The accuracy of data was routinely checked by cross-tabulations. Data were analysed in IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as frequency, percentage, mean±standard deviation was used to describe population characteristics and evaluate disease awareness. The *Chi*-square and Fisher's exact tests were performed as applicable to examine the association of disease awareness with sociodemographic variables and past disease experience. $P<0.05$ was considered statistically significant.

3. Results

3.1. Perceptions on typhus fevers derived by case interviews

The interviews of 13 index cases revealed that the lay terms for typhus fevers in the region were "peacock fever", "tick fever" and "bird fever". The perception that ticks harboured by animal hosts such as peacocks, wild boars, stray dogs, chickens and pigeons transmitted the infection prevailed, hence the terms "peacock fever", "tick fever" and "bird fever". These perceptions were based on observations and personal experiences of typhus fever occurrences coinciding with sightings of peacocks or wild boars roaming in home gardens or farmlands.

3.2. Socio-demographics of the study participants of the questionnaire-based survey

A total of 499 subjects participated in the questionnaire-based

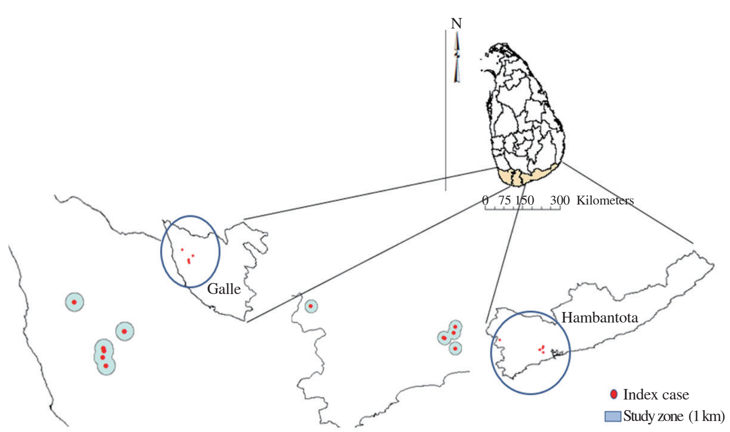

Figure 1. The map showing the distribution of index cases of rickettsioses and the questionnaire-based survey sites. The locations of typhus fever cases (demarcated as dots) in the selected Medical Officer of Health areas; Tangalle, Ambalangoda, Elpitiya and Karandeniya in the Southern Province and the 1 km buffer-zones were the survey areas (shaded area surrounding cases).

survey, of which 217 were from Tangalle, 187 from Ambalangoda, 46 from Elpitiya and 49 from Karandeniya. A past episode of typhus fever was reported by 13.6% (n=68) participants. The socio-demographics of the study population are summarized in Table 1. The mean age of the population was (45±16) years with 59.5% being females. The majority (74.5%, 372/499) had completed their secondary education. Agriculture was the main source of income among 25.9%, (129/499) which included cash crops (cinnamon and tea) and paddy, while others were engaged in trade, casual labour or in state and private sector institutions.

Table 1. Demographic and socio-economic characteristics of the study population.

Variables	n (%)
Age, years	
18-30	100 (20.0)
31-45	169 (33.9)
46-60	130 (26.1)
>60	100 (20.0)
Sex	
Male	202 (40.5)
Female	297 (59.5)
Education level	
No school education	5 (1.0)
Primary school education (1-5 grades)	52 (10.4)
Grade 6-8	70 (14.0)
Secondary school education (GCE O/L)	213 (42.7)
Tertiary School education (GCE A/L)	124 (24.8)
Higher studies (diploma/degree)	35 (7.0)
Occupation	
Government job	27 (5.4)
Private job	43 (8.6)
Self-employed	121 (24.2)
Agricultural activities	129 (25.9)
Laborer	65 (13.0)
Unemployed	114 (22.8)
Income type	
Monthly fixed income	178 (35.7)
Daily income	171 (34.3)
Per harvest income	126 (25.3)
Senior citizen with pension	5 (1.0)
Senior citizen without pension	19 (3.8)

3.3. Awareness on typhus fevers

Of those surveyed (n=499), only 1.2% (n=6) knew the disease as "typhus". A total of 70.5% (n=352) identified typhus fevers as "peacock fever" (58.7%; n=293), and "tick fever" (11.8%; n=59) (Table 2). About half the population (49.3%; n=246) stated that the disease was transmitted through tick-bites. Two participants (0.4% responded that the infection was mite-borne while a few (3.8%; n=19) vaguely stated that transmission was by an "insect". The belief that the disease was contagious and spread *via* close contact with infected individuals was also reported by 2 participants (Table 2).

Only 1.6% (n=8) specified the aetiological agent of typhus fevers was a bacterium, while 1.2% (n=6) thought it was of viral origin and 2.0% (n=10) attributed it to a non-specific "germ". Over half of the population (57.3%; n=286) were aware that prolonged fever was a key symptom while other positive responses were eschars (35.7%, n=178), headache (22.0%, n=110), and myalgia (19.2%, n=96). Awareness on the main disease symptoms (fever: χ^2=15.713, P<0.001; headache: χ^2=19.447, P<0.001; lymphadenopathy: Fisher's test, P=0.023; eschar: χ^2=12.049, P<0.001) were significantly higher among participants with past typhus fever experience (13.5%, n=68) compared to those without disease experience (86.37%, n=431) as indicated in Table 2.

The source of information varied from neighbours (46.1%, n=230), friends (12.6%, n=63) relatives (2.2%, n=11) and only 10.0% (n=50) identified health personnel as their source of information (Table 2). None of the participants were aware of any disease prevention methods and did not practice any. Among those reporting a past typhus fever episode (n=68), 55.9% (n=38) and 5.9% (n=4) had sought treatment at state and private sector hospitals, respectively.

4. Discussion

To the best of our knowledge, this study is the first to provide information on awareness and lay perceptions pertaining to typhus fevers in a region endemic for a mix of rickettsioses in Sri Lanka. The majority of the population were aware of the vector-borne aspects of typhus fevers. Awareness on the main disease symptoms including fever, headache, lymphadenopathy, and eschar were significantly higher among those with past disease experience. The significant finding of this survey was the low public awareness of preventive measures in a region that has been endemic for typhus fevers for many years.

Transmission dynamics of typhus fevers differ as the vectors and maintenance hosts vary. Murine typhus (*R. typhi*) of the typhus group is transmitted mainly by the rat flea (*Xenopsylla cheopis*) and the main reservoirs are rats (*Rattus rattus*, *Rattus norvegicus* and other *Rattus* sp.)[1]. Rodents (*Rattus* sp. and *Bandicota indica*), shrews (*Suncus murinus*), domestic cats, dogs, cows, pigs are the reservoirs of the SFG typhus which are mainly tick-borne (*Ixodes* sp. and *Rhipicehalus* sp.), while cat and rat fleas (*Ctenocephalides felis* and *Xenopsylla cheopis*) transmit *R. felis*[1]. Larval *Trombiculid* mites are the vectors of scrub typhus and mites maintain the infection by transstadial and transovarian transmission of *O. tsutsugamushi*[2]. Although rodent sp. (*Rattus* sp. and *Bandicota* sp.) acquires scrub typhus from mites, they are not implicated as reservoirs[2].

Typhus fevers are preventable if appropriate vector avoiding measures are adopted such as the use of insect repellents, protective clothing (long sleeves, long trousers and covered footwear) and

Table 2. Comparison of typhus fever infection awareness among study participants with and without the disease experience.

Variable	Number and percentage of respondents		χ^2	*P*
	With disease experience, *n*=68 (%)	Without disease experience, *n*=431 (%)		
Awareness of rickettsioses			27.878	<0.001
Typhus	3 (4.4)	3 (0.7)		
Tick fever	6 (8.8)	53 (12.3)		
Peacock fever	55 (80.9)	238 (55.2)		
Don't know	4 (5.9)	137 (31.8)		
Knowledge of disease etiology*			-	0.073
Bacteria	2 (2.9)	6 (1.4)		
Virus	2 (2.9)	4 (0.9)		
Germs	3 (4.4)	7 (1.6)		
Don't know	61 (89.7)	414 (96.1)		
Knowledge of transmission*			-	<0.001
Close contact with patients	1 (1.5)	1 (0.2)		
Close contact with an animal	3 (4.4)	7 (1.6)		
From a mite bite	1 (1.5)	1 (0.2)		
From a tick bite	46 (67.6)	200 (46.4)		
From an insect bite	7 (10.3)	12 (2.8)		
Don't know	10 (14.7)	210 (48.7)		
Knowledge of disease symptoms				
Fever	54 (79.4)	232 (53.8)	15.713	<0.001
Eschar	37 (54.4)	141 (32.7)	12.049	<0.001
Rash*	5 (7.4)	12 (2.8)	-	0.067
Headache	29 (42.6)	81 (18.8)	19.447	<0.001
Myalgia	16 (23.5)	80 (18.6)	0.933	0.334
Vomiting*	2 (2.9)	2 (0.5)	-	0.091
Lymphadenopathy*	4 (5.9)	5 (1.2)	-	0.023
Source of information on the disease*			-	<0.001
TV/radio	0 (0.0)	4 (0.9)		
Newspaper	1 (1.5)	2 (0.5)		
Health officials	26 (38.2)	24 (5.6)		
Friends	4 (5.9)	59 (13.7)		
Neighbours	33 (48.5)	197 (45.7)		
Relatives	0 (0.0)	11 (2.6)		
Unable to recall	4 (5.9)	134 (31.1)		

*Fisher's exact test was performed.

showering after exposure to vector infested areas[22]. In the absence of licensed vaccines or effective vector control measures in place, community sensitization on typhus fevers is a priority so that people know how to protect themselves and their community by adopting protective behaviours. Knowledge on disease symptomatology would promote early health-seeking behaviour and thereby minimize morbidity and mortality.

It was encouraging to note that, though the term "typhus" was unfamiliar and bacterial aetiology unknown to most (98.4%, *n*=491), many (71.7%, *n*=358) were aware of a febrile infection of zoonotic origin in the region. The vector-borne aspect of the condition was known to be 53.5% (*n*=267) while 49.3% (*n*=246) specified ticks as the vector. These respondents believed that the ticks were harboured by peacocks, wild boars, and pigeons. This may be the reason why the local community named typhus fever conditions as "peacock fever" (*n*=293), "tick fever"(*n*=59) and "bird fever" (stated in the interview-based survey). While ticks of the family Ixodidae transmit SFG typhus, goats, cattle, dogs and small mammals (*Rattus rattus*, *Bandicota indica* and *Mus fernandoni*) have been implicated as potential reservoir hosts in Sri Lanka[23–25]. The significance of birds (peacocks, pigeons) and wild boar in the transmission cycle of rickettsioses is unknown. The scientific validity of these perceptions requires further study as ground-dwelling birds have been suggested as maintenance hosts of chiggers in Vietnam[26]. *Leptotrombidium deliense*, a known vector of scrub typhus in Southeast Asia, has been recorded in the Western province of Sri Lanka parasitizing birds such as the greater coucal (*Centropus sinensis parroti*), the Western koel (*Eudynamys scolopaceus*) and the house crow, *Corvus splendens*[27]. Although not implicated as reservoirs, the potential role of these avian hosts in the spread of infective mites (carriers of *O. tsutsugamushi*) to new locations requires due consideration.

Concerning disease awareness, the majority were unaware of typhus fever characteristic features such as eschar and rash. Knowledge on the main disease symptoms were significantly higher among participants reporting typhus fever in the past. This agrees with the findings of a case-control survey conducted on scrub typhus awareness in South Korea[22]. The same study reported that the control population who were not affected with scrub typhus was significantly more aware of scrub typhus vector habitats and preventive strategies than cases[22], similar findings were also reported in another study of South Korea[28]. This heightened awareness of vector habitats and preventive measures among the scrub typhus unaffected control population indicated the protection provided by disease awareness. Sharma *et al*. has reported that all aspects of scrub typhus awareness (aetiological agent, vectors, transmission methods) was higher among cases of scrub typhus compared to non-typhus fever cases at a tertiary care hospital in Chitwan, Nepal[21]. The value of disease awareness in the prevention of scrub typhus is evidenced by previous studies[22,28]. Therefore, establishing community sensitization programs regarding vectors (mites, ticks, fleas) and vector avoidance measures are urgently required in endemic regions of Sri Lanka. Health education on desired behaviours while staying outdoors, such as not sitting or squatting on the ground, suitable attire and showering after outdoor activity are simple no-cost measures that are effective in minimizing vector exposure. Awareness on disease symptomatology would prompt people to seek early medical care. The populations at risk are mostly those engaged in outdoor activities at ground-level related to agriculture (present survey), military, and forestry[29]. Guidance needs to be provided on vector avoidance aspects to such high-risk populations.

The paucity of public awareness in endemic areas and the limited diagnostic facilities for differentiation of typhus fevers (scrub typhus, SFG or murine typhus) reflect the low priority given. Thus, improving technical capacity and infrastructure for serological or molecular confirmation of suspected cases would strengthen disease surveillance and monitoring. The study had a few limitations, the number participating in the interview-based study was low, as only consenting index cases with a serological diagnosis were included. The females were slightly over-represented among the study population (59.5%) compared to population data of the Southern province (females 51.8%), probably an effect of males being mostly occupied away from home[15]. The findings of the study may not be generalizable to the entire Southern province as the survey was focused on typhus-prone pockets where residents were probably more knowledgeable due to past disease experiences of self or close acquaintances.

In conclusion, public awareness on typhus fever prevention methods was deficient in typhus-prone areas in Southern Sri Lanka. Improving disease awareness to help people know how to protect themselves is a priority in the control of this much neglected group of vector-borne zoonotic infections.

Conflict of interest statement

All authors declare no financial or other relationship that might lead to any conflict of interest.

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Author's contributions

RP, NC and NG contributed to the study conception and design. AMSL and RLAS implemented the study. AMSL, NC and NG analyzed and interpreted the data and AMSL drafted the manuscript. NC, NG and RP revised the work critically for intellectual content and granted final approval for publishing. All authors have reviewed the manuscript and consent was given to publish.

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