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Research paper

Suicide prevention: Using the number of health complaints as an indirect alternative for screening suicidal adolescents

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ABSTRACT

Background: Suicide is the second leading cause of death in adolescents. Screening for persons at risk usually includes asking about suicidal ideation, which is considered inappropriate in some societies and situations. To avoid directly addressing suicide, this paper investigates whether the Health Behaviour in School-aged Children Symptom Checklist (HBSC-SCL), a validated non-clinical measure of eight subjective health complaints (e.g. headache, feeling low), could be used as a tool for screening suicidal ideation and behavior in adolescents.
Methods: 5262 secondary school students aged 12–18 answered the Luxembourgish HBSC 2014 survey, including the HBSC-SCL items and suicidal ideation and behavior questions.
Results: Each HBSC-SCL item correlates with suicidal ideation and behavior. A sum score was calculated ranging from zero to eight health complaints to predict respondents who considered suicide (area under the ROC curve = 0.770). The ideal cut-off for screening students who consider suicide is three or more health complaints: sensitivity is 66.3%, specificity is 75.9% and positive predictive value is 32.9%.
Limitations: One limitation is HBSC-SCL's low positive predictive value. This is a general problem of screening rare events: the lower the prevalence, the lower the positive predictive value. Sensitivity and specificity could be improved by taking age-, gender- and country-specific cut-off values, but such refinements would make the score calculation more complicated.
Conclusions: The HBSC-SCL is short, easy to use, with satisfactory screening properties. The checklist can be used when suicide cannot be addressed directly, and also in a more general context, e.g. by school nurses when screening adolescents.

Introduction

Over 800,000 people die by suicide each year worldwide and suicide is the second leading cause of death in 15–29 year olds (World Health Organization, 2014). Thus, the WHO Mental Health Action Plan, adopted in 2013, set the global target to reduce the rate of suicides by 10% by the year 2020 (World Health Organization, 2013). Since then, more and more countries have implemented suicide prevention programs (Arensman, 2017), using different approaches. The universal approach addresses the entire population by minimizing suicide risks, e.g. by limiting the access to guns. The selective approach aims to offer help to vulnerable groups that have a higher risk for attempting suicide, e.g. by offering help to traumatized persons. Finally, the indicated strategy targets individuals at very high risk, e.g. persons with previous suicide attempts (World Health Organization, 2014).

The selective and the indicated strategy often involve asking people directly about suicidal ideation. A concrete example is the use of the Beck Depression Inventory as a screening tool in prisons to assess which prison inmates are suicidal (Perry, 2009). Another example is the program “Signs of Suicide”, which uses the Brief Screen for Adolescent Depression (Aseltine et al., 2007). This is a short questionnaire that respondents can use to assess their own risk of suicide. In the “Question, Persuade, Refer” program, gatekeepers are trained to recognize suicidal persons in order to offer them help, e.g. by referring them to mental health professionals (Litteken and Sale, 2018). What all examples have in common is that people are asked questions about suicidal intentions and are thus directly confronted with the topic that can be perceived as sensitive.

Suicide remains a taboo in many societies and it is a widely held assumption that exposing people to suicide-related content in research could increase the likelihood of suicidal thoughts and behavior (World Health Organization, 2014). However, several studies have shown that this assumption is not true (Dazzi et al., 2014; Berman and Silverman, 2017; Gould et al., 2005). On the contrary, a meta-analysis

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concluded that exposure to suicide-related content in a study is associated with a lower likelihood of attempting suicide after participation in the study, as well as a decrease in suicidal ideation (Blades et al., 2018).

However, this meta-analysis has also pointed out that even health professionals and ethics committee members adhere to the false belief of the danger of asking questions about suicidal thoughts (Blades et al., 2018). An online survey for instance found that 65% of ethics committee members were afraid that suicidal ideation would intensify after exposure to suicide-related content (Lakeman and Fitzgerald, 2009a). As a result, suicide researchers and clinical practitioners may face practical and ethical problems in their research and work respectively (Lakeman and Fitzgerald, 2009b), for instance getting ethical approval for suicide research may be difficult. This problem arises especially where adolescents are concerned, as research and mental health screenings in this population might have to be approved by parents and/or supported by other authorities (e.g. headmasters, school authorities).

Screening for adolescents at risk is essential for the prevention of suicide attempts. Therefore, the false belief in the harmfulness of questions about suicidal thoughts must be tackled so that such questions can be asked directly. The example of vaccination, however, shows that myths surrounding the topic of health are difficult to correct and that trying to correct misperceptions may even worsen the outcome (Nyhan et al., 2014). Thus, there is need for a tool that screens suicidal ideation without directly addressing the perceivedly sensitive topic. A few instruments have been validated for this purpose, such as the "Depression and Suicide Screen", which has been tested in a geriatric population in Japan (Fujisawa et al., 2005) and the Beck Hopelessness Scale, tested within young adult prisoners (Perry, 2009). However, to our knowledge, there is still no tool that specifically addresses the adolescent population. It is in this context that the Symptom Checklist (SCL) used by the Health Behaviour in School-aged Children study (HBSC) might be useful.

HBSC-SCL asks about the prevalence of eight health complaints that are known to be both frequent and often occurring together in adolescence (e.g. headaches, feeling low and dizziness) (Gariepy et al., 2016; Haugland and Wold, 2001; Hetland et al., 2002; Ravens-Sieberer et al., 2008; Wang et al., 2018). Several studies have been conducted to validate this checklist and its dimensionality. Two earlier studies have shown that HBSC-SCL consists of two sub-dimensions that are highly correlated: somatic complaints and psychological complaints (Haugland and Wold, 2001; Hetland et al., 2002). A more recent study confirmed this finding and went further, showing that the sub-dimension of psychological complaints is correlated with indicators for emotional problems and emotional well-being, making this dimension a measure of psychological health (Gariepy et al., 2016). Since the two sub-dimensions are highly correlated, HBSC-SCL can also be used as a unidimensional measure of psychosomatic health (Ravens-Sieberer et al., 2008). A longitudinal study from Finland that used a similar checklist concluded that psychosomatic symptoms in adolescence might be the first signs of more severe mental health problems in early adulthood, such as anxiety and depression (Kinnunen et al., 2010).

Since psychosomatic complaints usually occur together and are an early warning signal for potential mental health problems, it is reasonable to assume that the number of complaints can serve to assess the risk of suicidal ideation. If this is the case, then HBSC-SCL could be used to screen suicidal ideation without having to address the perceivedly sensitive issue. The aim of this paper is therefore to assess the features of HBSC-SCL as a tool for screening suicidal ideation and behavior in adolescents.

Methods

HBSC is a cross-sectional study covering a wide range of health and health related topics (Roberts et al., 2009). The study is carried out every four years in school classes from over 40 countries, most of them belonging to the WHO Europe region. This paper uses the HBSC data gathered in 2014 in Luxembourg.

Sampling, data collection, ethics approval and translation in Luxembourg

Classes from secondary schools were selected at random as primary sampling units. Schools teaching other than the national curriculum (i.e. international schools) and special needs schools were excluded. All students from selected classes were invited to take part in the survey. Data collection started on 29 April 2014 and ended on 4 July 2014 using a paper questionnaire. Ethics approval was obtained from *Comité National d'Ethique de Recherche (N°201403/07)*. A letter was sent to the students and their legal guardians to inform them about the study. Attached, the legal guardians would also find a consent form, in order to allow or decline participation. Students were informed about their right to refuse to take part and the anonymous nature of the study. This information was both in written in the questionnaire and given orally by the teachers just before the survey started.

The HBSC questionnaire is developed in English and researchers from each country translate the questions into their own languages using a translation/back translation process to make sure that the translations match the original. In Luxembourg, the questionnaire was translated into German and French, which are the usual languages for written surveys in schools.

HBSC-SCL scale

HBSC-SCL is a validated, non-clinical measure of psychosomatic complaints (Haugland and Wold, 2001). The participants were asked about the frequency of eight common health complaints (headache, abdominal pain, backache, feeling low, irritability or bad mood, feeling nervous, sleeping difficulties and dizziness). The reference period is the last six months and the answers are presented on a five point scale ranging from "About every day" to "Rarely or never".

Outcome variables

Suicidal ideation and behavior (SIB) was addressed using four validated items originating from the US-Youth Risk Behavior Survey (Brener et al., 1999; May and Klonsky, 2011). A short preamble introduces the topic by defining suicide and stating that suicide is a health problem. Then, the following items are asked in logical sequence: 1. During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities? 2. During the past 12 months, did you ever seriously consider attempting suicide? 3. During the past 12 months, did you ever make a plan as to how you would attempt suicide? 4. During the past 12 months, how many times did you actually attempt suicide? The answer options for the first three questions were "yes" or "no", whereas the last question could be answered using a five point scale ranging from "never" to "6 or more". For the following analyses the five point scale was dichotomized (never = no suicide attempt, other answers = suicide attempt).

Data analysis

All analyses were conducted using IBM SPSS Statistics, Version 25.0. The bivariate correlations between the 8 items of HBSC-SCL and the 4 items of SIB are represented by the gamma coefficient (Goodman and Kruskal, 1954) recommended for ordinal data with many tied ranks (Eid et al., 2015). The reliability of HBSC-SCL was checked using Cronbach`s alpha and the dimensionality was checked using a principal component analysis with varimax rotation. The screening properties are reported as specificity, sensitivity, positive predictive value and

Table 1
Description of the sample, sociodemographics and outcome variables.

Full sample	5262	100.0%
Sociodemographics		
Boys	2481	47.3%
Girls	2764	52.7%
12 year olds	160	3.0%
13 year olds	780	14.8%
14 year olds	861	16.4%
15 year olds	973	18.5%
16 year olds	947	18.0%
17 year olds	879	16.7%
18 year olds	662	12.6%
Outcome variables		
Stopped doing usual activities for two weeks or more during past 12 months due to sadness		
Yes	1442	28.0%
No	3703	72.0%
Considered suicide during past 12 months		
Yes	778	15.1%
No	4358	84.9%
Planned suicide during past 12 months		
Yes	722	14.1%
No	4413	85.9%
Suicide attempt during past 12 months		
Yes	392	7.6%
No	4747	92.4%

negative predictive value. Receiver Operating Characteristic (ROC) curves are used to visualize specificity and sensitivity and to determine the optimal cut-off regarding the number of health complaints (Hanley and McNeil, 1982). This paper illustrates the screening properties of HBSC-SCL on the example of the outcome "considered suicide", as this is an important step toward a potential suicide attempt. The screening properties for the more severe outcomes "planned suicide" and "suicide attempt" are similar and can be found online as supplemental material.

Results

Descriptives

A total of 6931 students from secondary schools were invited to partake in the study, and 5592 students actually took part (80.7%). Of these, 5262 were eligible (i.e. 12–18 years old), meaning that 330 students were excluded from the analysis because they were technically too old or too young to attend secondary school. The boys accounted for 47.3% of the final sample (Table 1). Regarding suicidal ideation and behavior the results show that the more severe outcomes are less prevalent: 28.0% of the students stated long-lasting sadness, 15.1% considered suicide, 14.1% planned suicide and 7.6% attempted suicide in the last 12 months.

Most of the HBSC-SCL health complaints are experienced frequently, here defined as a complaint that is experienced about every month or more often (Table 2). 80.9% of students state they felt irritable at least monthly in the last half year making irritability the most frequent health complaint. But even the least frequent health complaint dizziness was experienced at least monthly by 41.1% of the students.

Table 3
Correlation (Gamma) between HBSC-SCL and suicidal ideation and behaviour items.

HBSC-SCL items	Suicidal ideation and behaviour items			
	Sadness	Considered suicide	Planned suicide	Suicide attempt
Headache	0.418***	0.373***	0.361***	0.424***
Stomach-ache	0.418***	0.416***	0.362***	0.452***
Backache	0.329***	0.320***	0.309***	0.344***
Feeling low	0.690***	0.652***	0.590***	0.587***
Irritability/bad temper	0.546***	0.527***	0.479***	0.455***
Feeling nervous	0.507***	0.485***	0.429***	0.470***
Difficulties to sleep	0.480***	0.467***	0.447***	0.466***
Feeling dizzy	0.466***	0.449***	0.453***	0.483***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

HBSC-SCL: scale reliability

Cronbach's alpha analysis is acceptable with $\alpha = 0.84$ and the exclusion of any item would lower this value. A principal component analysis and a scree plot test suggest a one factor matrix with a total variance explained of 47%, supporting the existence of a single factor for the Luxembourgish population (Catunda et al., 2018).

Correlation between HBSC-SCL and SIB

All correlations between the eight HBSC-SCL items and the four SIB items are statistically significant (Table 3), but they differ regarding their strength. The SIB items correlate most weakly with the health complaint "backache" (Gamma 0.309–0.344) and most strongly with the health complaint "feeling low" (Gamma 0.587–0.690).

Prediction of considering suicide based on the HBSC-SCL

Fig. 1 shows four ROC curves for the outcome "considered suicide in the past 12 months". Each curve is based on the number of HBSC-SCL health complaints experienced (ranging from zero to eight), with the curves differing in which response categories are used as cut-offs (i.e. about every day, more than once a week, about every week or about every month). For example, the monthly cut-off is based on the number of health complaints experienced "about every month" or more often.

All areas under the ROC curves are significantly greater than 0.5, meaning that each cut-off value gives results that are better than guesswork. With 0.770 the area under the black full line curve is the largest, and thus using the cut-off "more than once a week" is the best solution. Followed by the number of weekly health complaints, the second best solution, with an area under the curve of 0.756. In contrast,

Table 2
HBSC symptom checklist: frequencies.

In the last 6 months: how often have you had the following…	About every day	More than once a week	About every week	About every month	Rarely or never
Headache ($N = 5186$)	6.8%	15.0%	17.7%	25.2%	35.3%
Stomachache ($N = 5176$)	4.1%	10.8%	14.4%	36.5%	34.2%
Backache ($N = 5180$)	8.6%	11.5%	12.8%	21.8%	45.3%
Feeling low ($N = 5165$)	8.8%	14.8%	17.6%	23.0%	35.8%
Irritability/bad temper ($N = 5177$)	8.5%	21.4%	27.1%	23.9%	19.1%
Feeling nervous ($N = 5173$)	10.0%	18.9%	21.9%	22.9%	26.3%
Difficulties to sleep ($N = 5177$)	11.6%	16.1%	17.1%	19.3%	36.0%
Feeling dizzy ($N = 5178$)	6.2%	7.7%	8.7%	18.5%	58.9%

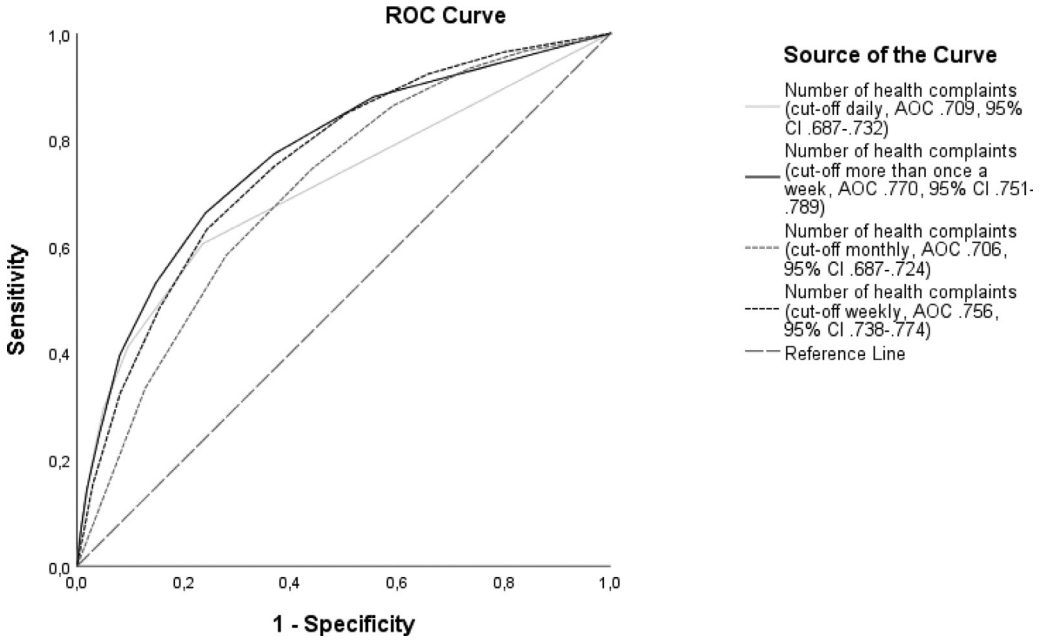

Fig. 1. ROC-curves for outcome "considered suicide in past 12 months" using different HBSC SCL cut-offs .

the areas covered by the monthly and daily options are considerably smaller.

Table 4 presents the features of HBSC-SCL as a screening tool for students who considered suicide in the past 12 months. "Number of HBSC-SCL health complaints" counts how many health complaints occurred "more than once a week" or "about every day", as the comparison of the four ROC curves has shown this to be the best solution.

The Youden-Index indicates that using three or more health complaints is the best cut-off point, with an ideal balance between false positives and false negatives. This cut-off correctly identifies 66.3% of the students who considered suicide, whereas 24.1% of the students who did not consider suicide would be incorrectly identified as suicidal (= 1 minus specificity of 75.9%). In this study, 15.1% of students said that they considered suicide last year, which explains why the positive predictive value is rather low at 32.9%. This means that only 32.9% of the prediction "the student has considered suicide" based on HBSC-SCL are correct. Conversely, a low prevalence always goes hand in hand with a high negative predictive value (Altman and Bland, 1994). In this case, 92.7% of the predictions "has not considered suicide" are correct. A higher cut-off of four or more health complaints would improve specificity (85.2%) and positive predictive value (39.0%), but it would result in a lower sensitivity (53.2%) and a lower negative predictive value (91.1%). As a result, more predictions "considered suicide" would be true on the one hand, but on the other hand more suicidal persons would be classified as not at risk.

Discussion

The aim of this paper was to assess whether HBSC-SCL could be useful for screening suicidal thoughts and behavior in adolescents. If the screening characteristics are satisfactory, the checklist could be used as an alternative tool to screen for adolescents at risk. Firstly, regarding suicidal ideation and behavior the present study confirms the common finding that the more severe outcomes are less prevalent (Kann et al., 2018). Regarding health complaints, the study confirms that psychosomatic health complaints are common and tend to cluster (Ottová-Jordan et al., 2015; Ravens-Sieberer et al., 2009). Secondly, the HBSC-SCL scale is reliable and has good internal consistency which is also in line with previous research (Gariepy et al., 2016; Haugland and Wold, 2001; Hetland et al., 2002; Ravens-Sieberer et al., 2008). Thirdly, the correlations between each of these complaints and the four SIB items are statistically significant and strong. Therefore, the predictive power of the sum of health complaints to screen the outcome "considered suicide" was tested.

Assessment of screening properties

To screen this outcome, it is ideal to count health complaints that occur more than once a week, as the area under the curve is the largest at 0.770. A cut-off value of 3 or more health complaints results in a sensitivity of 66.3%, a specificity of 75.9%, a positive predictive value of 32.9% and a negative predictive value of 92.7%. Perry and

Table 4
Number of HBSC-SCL health complaints and its features as screening tool for the outcome "considered suicide".

Number of HBSC-SCL health complaints ("more than once a week"/"about every day")	Sensitivity	Specificity	Positive predictive value (prevalence of "considered suicide": 15.1%)	Negative predictive value	Youden-index
≥ 0 health complaint	100.0%	0.0%	15.1%	-	-
≥ 1	88.1%	44.5%	22.0%	95.5%	0.326
≥ 2	77.3%	63.2%	27.2%	94.0%	0.405
≥ 3	**66.3%**	**75.9%**	**32.9%**	**92.7%**	**0.422**
≥ 4	53.2%	85.2%	39.0%	91.1%	0.384
≥ 5	39.6%	92.0%	46.8%	89.5%	0.316
≥ 6	25.0%	95.8%	51.4%	87.8%	0.208
≥ 7	14.4%	98.2%	58.7%	86.6%	0.126
≥ 8	6.2%	99.3%	61.2%	85.6%	0.055

colleagues used the Beck Depression Inventory (BDI-II), the Beck Hopelessness Scale (BHS) and a new measure of vulnerability to suicide and self-harm behavior (SCOPE) to screen prisoners at risk to self-harm and suicidal thoughts. With a sensitivity of 65.9%, a specificity of 67.9% and an area under the curve of 0.738, the performance of BDI-II is similar to HBSC-SCL. Regarding the BHS, its sensitivity is almost identical (67.1%), but its specificity is lower (64.9%) and the area under the curve is smaller (0.692). Finally, when compared to the HSBC-SCL, SCOPE`s sensitivity is better (72.3%) and the area under the curve is larger (0.805), however specificity is a bit lower (74.0%) (Perry, 2009). It is important to note that both SCOPE (Perry and Olason, 2009) and BDI-II (Beck et al., 1996) contain items about suicidal ideation, whereas BHS (Beck et al., 1974) and HBSC-SCL do not. Another example is the aforementioned "Depression and Suicide Screen" (DSS), a 5-item tool for screening suicidal ideation in the elderly without addressing the sensitive topic directly. With a sensitivity of 69.8%, a specificity of 69.8% and an area under the curve of 0.721 (Fujisawa et al., 2005), the properties of the Depression and Suicide Screen are almost identical to the ones of the HBSC-SCL.

As the aforementioned studies took place in other countries and in other target groups, the comparisons of these screening instruments with HBSC-SCL should be interpreted with caution. Despite all the differences between these studies, it can be said that HBSC-SCL performs well, especially considering that it does not directly address suicidal thoughts. In addition, HBSC-SCL with 8 items is less complex to use in non-clinical settings than BDI (21 items), BHS (20 items) and SCOPE (27 items) and the score is very easy to determine by counting answers.

Limitations and further improvement

One limitation is HBSC-SCL`s low positive predictive value of 32.9%. In other words, about two thirds of the predictions "considered suicide" are wrong. However, this is not specific to HBSC-SCL, but it is a general problem of screening rare events. The lower the prevalence, the lower the positive predictive value for a given specificity and sensitivity, which is highly relevant in the context of clinical populations. Pokorny tried to predict future suicides among patients in a psychiatric hospital by comparing a variety of screening instruments. The prediction failed because of the low specificity and sensitivity of the instruments, but above all because of the low prevalence of suicides. Pokorny calculated that the positive predictive value only reaches 33.2% even if both specificity and sensitivity are 99%, but prevalence is only 0.5% (Pokorny, 1983). In clinical populations, a positive predictive value of 33.2% is still considered the benchmark for the screening of death by suicide (Carter and Spittal, 2018). For suicidal thoughts and suicide attempts, the prevalence is higher, so that this benchmark can be considerably exceeded if specificity and sensitivity are improved.

Sensitivity and specificity could be improved by taking up another limitation of the present study. This study sees itself as proof of concept, but the extent to which the results obtained here also apply to other target groups and countries has yet to be determined. It is known that the frequency of health complaints increases with the age of adolescents and that girls report more health complaints than boys (Ottová-Jordan et al., 2015; Ravens-Sieberer et al., 2009). The number of health complaints is also known to be country-specific (Ottová-Jordan et al., 2015; Ravens-Sieberer et al., 2009). In addition to that, suicidal ideation and behavior are reported more often by girls than boys (Zaborskis et al., 2019). Thus, age-, gender- and country-specific cut-off values could improve specificity and sensitivity. In principle, it is possible to include other socio-demographic factors related to health complaints (e.g. socio-economic status), but such refinements are at the expense of ease of use, as more data needs to be collected and the calculation of the score becomes more complicated.

Conclusion

The use of HBSC-SCL for screening suicidal ideation and behavior is a promising approach. This measure is short, easy to use and it has satisfactory screening properties, without addressing suicide. Although it is not intended to replace more effective screening tools, the non-sensitive content could make it advantageous for use in a context where adolescents cannot be asked about suicide as a consequence of unfounded assumptions of research into suicide. As the HBSC-SCL items ask about everyday health problems, it could be a tool in a more general context, e.g. for the use of school nurses when screening adolescents.

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Declaration of Competing Interest

None.

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Supplementary materials

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