

Special Article

AN INCREASE IN THE NUMBER OF DEATHS IN THE UNITED STATES
IN THE FIRST WEEK OF THE MONTH

An Association with Substance Abuse and Other Causes of Death

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ABSTRACT

Background and Methods There are regular changes in mortality rates, such as increased rates of death from influenza in the winter and from motor vehicle accidents on long holiday weekends. Previous research has shown that among persons with schizophrenia, the rates of cocaine use and hospital admissions increase at the beginning of the month, after the receipt of disability payments. Using computerized data from all death certificates in the United States between 1973 and 1988, we compared the number of deaths in the first week of the month with the number of deaths in the last week of the preceding month.

Results The average number of deaths was about 5500 per day, or about 165,000 in a 30-day month. There were 100.9 deaths (95 percent confidence interval, 100.8 to 101.0) in the first week of the month for every 100 deaths in the last week of the preceding month. This was equivalent to about 4320 more deaths in the first week of each month than in the last week of the preceding month in an average year. Between 1983 and 1988, for deaths involving substance abuse and an external cause (such as suicides, accidents, and homicides), there were 114.2 deaths (95 percent confidence interval, 110.5 to 117.9) in the first week of the month for every 100 in the last week of the preceding month. There were significant increases in the number of deaths in the first week of the month for many causes of death, including substance abuse, natural causes, homicides, suicides, and motor vehicle accidents.

Conclusions In the United States, the number of deaths is higher in the first week of the month than in the last week of the preceding month. The increase at the beginning of the month is associated with substance abuse and other causes of death. (N Engl J Med 1999;341:93-8.)

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FOR many causes of death, there are regular changes in mortality rates, with systematically recurring periods of increased and decreased risk. For example, deaths from influenza peak in the winter,¹ deaths from motor vehicle accidents peak on long holiday weekends,² and deaths from heart attacks peak on Mondays and at certain times of the day.³⁻⁵ Some of these changes are linked

to fluctuations in natural processes (e.g., yearly climatic cycles), and others are linked to sociocultural factors (e.g., alternation in activities between the work week and the weekend).

The beginning of the month is often associated with unpleasant events, such as evictions from rental property and payment of bills. Payments for many types of federal benefits, such as Social Security, welfare, and military benefits, typically arrive at the beginning of each month.

Some evidence links monthly cycles in federal payments to changes in health status. In a study of 105 veterans with schizophrenia, Shaner et al.⁶ found that cocaine use and psychiatric symptoms increased at the start of the month, after the receipt of federal disability payments. This increased drug use was associated with a higher rate of hospital admissions at the beginning of the month. Monthly cycles may also affect general health outcomes. In 1897, Durkheim, a pioneer in the sociological investigation of suicide, reported an increased suicide rate in Paris at the beginning of each month and a decreased rate at the end of each month.⁷ Using data from computerized death certificates, we analyzed the numbers of deaths before and after the beginning of the month over a 16-year period in the United States.

METHODS

We examined all computerized death certificates in the United States for the period from 1973 (the first year for which the exact date of death was available for all records) through 1988 (the final year for which this information was available).⁸ For each month of the study period, we determined the number of deaths that occurred from 14 days before the first day of the month through the 14th day of the month. In all, we analyzed data on 31,976,612 deaths.

We analyzed mortality during this 28-day period for each of the leading causes of death, as listed in *Vital Statistics of the United States*.⁹ These analyses examined the underlying, primary cause of death, beginning in 1979 with the adoption of the ninth revision of the *International Classification of Diseases* (ICD-9). To elucidate the possible role of drugs and alcohol, we also analyzed sec-

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ondary causes of death (for which data were available from 1983 through 1988).¹⁰ Although the mention of substance abuse on a death certificate is likely to be a reliable indicator of a problem with drugs or alcohol (i.e., a marker with high specificity), in some instances, this information is not included on the death certificate (low sensitivity). We assumed that people whose death certificates mentioned substance abuse were more likely to have had problems with drugs or alcohol than those whose death certificates did not mention substance abuse.

A death was classified as involving substance abuse if the death certificate listed as a primary or secondary cause any of the following ICD-9 codes: alcoholic psychoses (291), drug psychoses (292), alcohol dependence syndrome (303), drug dependence (304), nondependent abuse of drugs (305, except for 305.1, tobacco abuse), alcoholic polyneuropathy (357.5), alcoholic cardiomyopathy (425.5), alcoholic gastritis (535.3), chronic liver disease and cirrhosis with mention of alcohol (571.0 through 571.3), excessive blood alcohol level (790.3), accidental poisoning by alcohol not elsewhere classified (860, external cause of death), alcohol-use deterrents (947.3, external cause of death; 977.3, injury), or toxic effect of alcohol (980, injury).

We measured the change in the number of deaths before and after the first of the month by calculating the R value, which is the ratio of the number of deaths in the first week of the month to the number in the last week of the preceding month, multiplied by 100. Confidence intervals for R values were calculated from formulas provided by Gardner and Altman.¹¹ We followed the recommendations in the technical appendix of *Vital Statistics of the United States*¹² for the use of significance testing and confidence intervals for complete counts.

RESULTS

Figure 1 shows the daily numbers of deaths (with 95 percent confidence intervals) in the United States for the 28-day period consisting of the first 2 weeks of the month and the last 2 weeks of the preceding month. The number of deaths was unusually low in the week preceding the first of the month and abruptly increased (by more than 15 SE) on the first of the month. We called this pattern the boundary effect. For the 28-day period, the daily distribution of deaths differed significantly from the expected distribution ($\chi^2=555.13$, with 27 df; $P<0.001$). Over the course of an average year, there were 4320 more deaths in the first week of every month than in the last week of the preceding month. The average number of deaths was about 5500 per day, or about 165,000 in a 30-day month.

Figure 1 shows that there were about 101 deaths in the first week of the month for every 100 in the last week of the preceding month ($R=100.9$; 95 percent confidence interval, 100.8 to 101.0).¹¹ The boundary effect was evident for a range of demographic and geographic characteristics, including male sex ($R=101.3$; 95 percent confidence interval, 101.1 to 101.4), female sex ($R=100.6$; 95 percent confidence

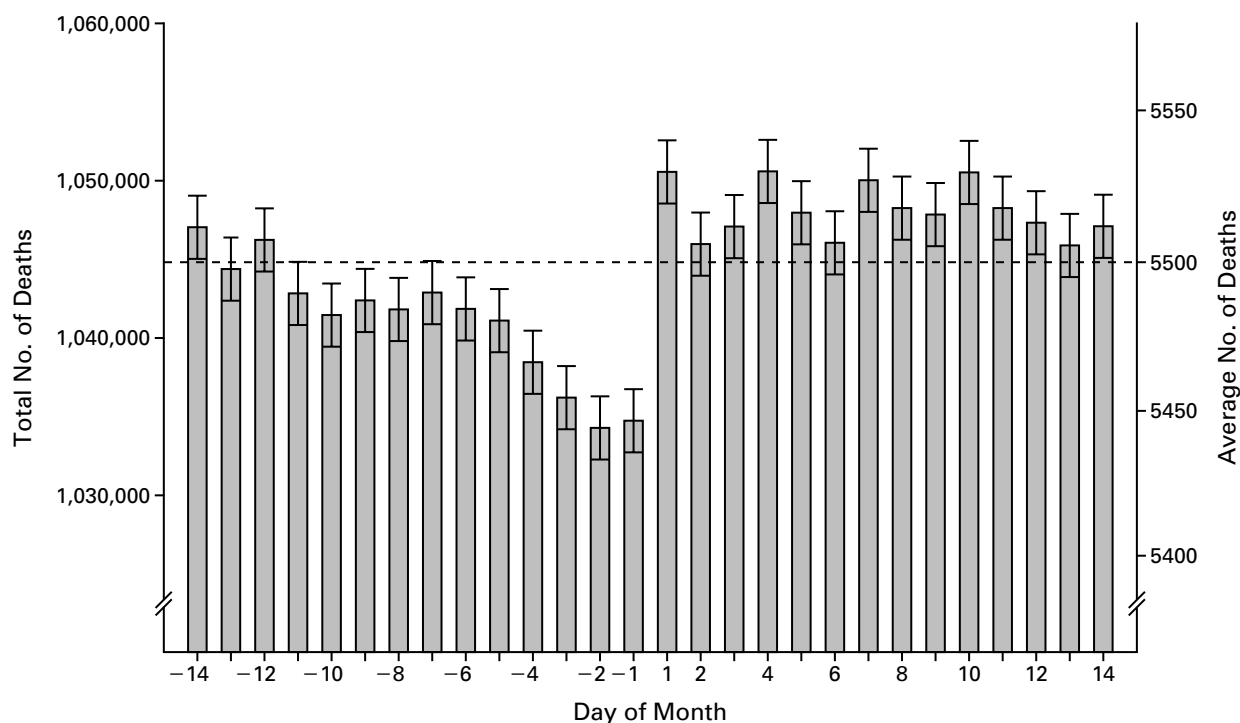


Figure 1. Total and Average Numbers of Deaths in the United States on Each of the First 14 Days of the Month and the Last 14 Days of the Preceding Month, 1973 through 1988.

Day 1 indicates the first day of the month, and day -1 the last day of the preceding month. The I bars indicate 95 percent confidence intervals for the numbers of deaths, calculated according to the recommendations in the Technical Appendix of *Vital Statistics of the United States*.¹² The broken line indicates the average number of deaths that would be expected if the numbers did not fluctuate around the first day of the month.

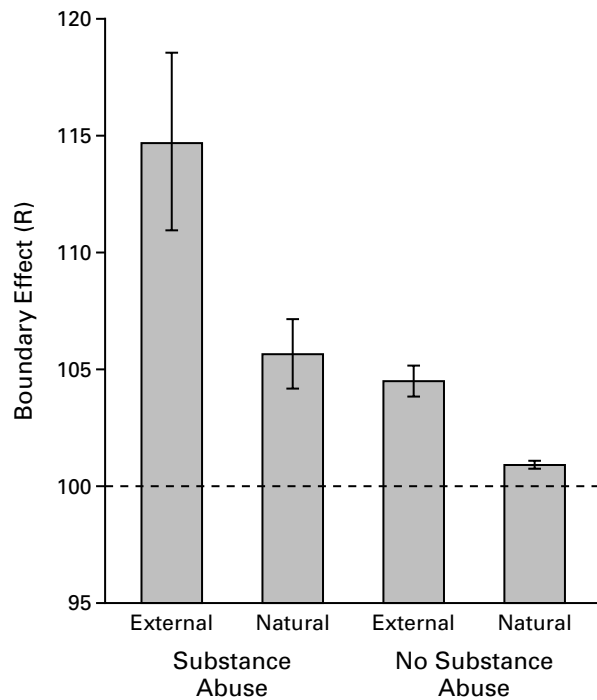
interval, 100.4 to 100.7), cities with populations greater than 1 million (R=101.1; 95 percent confidence interval, 100.8 to 101.5), cities with populations between 100,000 and 1 million (R=101.1; 95 percent confidence interval, 100.9 to 101.4), and smaller communities (R=100.9; 95 percent confidence interval, 100.8 to 101.0). The effect was also present in each of the nine standard geographic regions of the United States¹³ (data not shown).

To assess the relation between behavior and the boundary effect, we classified deaths according to two factors: whether the death certificate mentioned substance abuse and whether the death had an external cause (e.g., whether it was a suicide, an accidental death, or a homicide). If behavioral factors are important, then the boundary effect should be particularly large for persons whose deaths were due to external causes and for those whose death certificates listed substance abuse as a primary or secondary cause of death.

Between 1983 and 1988, the R value for the ratio of the number of deaths in the first week of the month to the number in the last week of the preceding month was 101.1 (95 percent confidence interval, 100.9 to 101.2) (Fig. 2). As shown in Figure 2, the value for R was significantly greater than 101.1 when the death certificate indicated an external cause of death or substance abuse, or both. The ratio was largest when both these factors were present (R=114.2; 95 percent confidence interval, 110.5 to 117.9). Even when neither factor was present, however, there were significantly more deaths in the first week of the month than in the final week of the preceding month (R=100.7; 95 percent confidence interval, 100.6 to 100.9). The boundary effect was about the same magnitude whether substance abuse involved drugs or alcohol. When drug use was mentioned on the death certificate, the R value was 107.5 (95 percent confidence interval, 103.5 to 111.7), as compared with 106.6 (95 percent confidence interval, 105.2 to 108.0) when alcohol use was mentioned. Between 1983 and 1988, many more death certificates listed alcohol use (177,763) than drug use (21,349).

Table 1 lists the primary causes of death and the associated boundary effects. This table covers the period from 1979 to 1988. The largest R values were for substance abuse, a subcategory of mental disorders (R=113.8); homicide (R=106.5); suicide (R=105.3); other external causes (R=104.6); and motor vehicle accidents (R=102.8) — all of which have a strong behavioral component. (The R values for substance abuse in Figure 2 and in Table 1 differ mainly because Figure 2 shows substance abuse as either a primary or secondary cause of death, whereas Table 1 shows only primary causes.)

Although the R value for circulatory diseases is small (100.7), these disorders are common causes of



NO. OF DEATHS				
First wk	7843	41,030	199,530	2,610,589
Preceding wk	6869	38,934	191,388	2,591,393

Figure 2. Boundary Effect According to Whether the Cause of Death Was External or Natural and Whether the Death Certificate Mentioned Substance Abuse.

R was calculated as the ratio of the number of deaths in the first week of the month to the number in the last week of the preceding month, multiplied by 100. An R of 100 (broken line) indicates no change in the numbers of deaths. Data are for the period from 1983 through 1988, when computerized information was available for both the exact date of death and the primary and secondary causes. The overall value for R during this period was 101.1. Deaths with external causes (*International Classification of Diseases, 9th Revision*, codes 800 through 999) were primarily those involving motor vehicle accidents, suicides, and homicides. The I bars indicate 95 percent confidence intervals, calculated according to the formulas of Gardner and Altman.¹¹

death. In an average year, there were 1634 more deaths from circulatory diseases in the first week of each month than in the last week of the preceding month, as compared with 1504 more deaths at the beginning of the month for the category of all external causes of death combined.

In the six-year period covered by Figure 2, there was a decrease in the number of deaths involving substance abuse at the end of the month and an increase in such deaths at the beginning of the next month. In the final week of the month, there were fewer deaths involving substance abuse (45,803; 95 percent confidence interval, 45,384 to 46,222) than in the preceding week (46,520; 95 percent confidence

TABLE 1. BOUNDARY EFFECT ACCORDING TO PRIMARY CAUSES OF DEATH IN THE UNITED STATES, 1979–1988.

CAUSE OF DEATH*	FIRST WEEK OF MONTH	LAST WEEK OF PRECEDING MONTH	BOUNDARY EFFECT (95% CI)†
	average no. of deaths/yr		
Significant boundary effect‡			
Substance abuse	1,603.0	1,408.8	113.8 (111.2–116.4)
Homicide	5,120.4	4,806.2	106.5 (105.2–107.9)
Suicide	6,718.0	6,378.1	105.3 (104.2–106.5)
Other external causes	12,483.4	11,935.4	104.6 (103.8–105.4)
Motor vehicle accidents	11,064.7	10,763.2	102.8 (101.9–103.7)
All external causes§	35,386.6	33,882.9	104.4 (103.9–104.9)
Liver disease with mention of alcohol	2,680.0	2,612.8	102.6 (100.8–104.3)
Endocrine, nutritional, metabolic, and immunity disorders	11,398.5	11,268.5	101.2 (100.3–102.0)
Liver disease without mention of alcohol	14,292.7	14,158.6	100.9 (100.2–101.7)
Respiratory disorders	34,024.8	33,737.7	100.9 (100.4–101.3)
Circulatory disorders	223,666.3	222,032.6	100.7 (100.5–100.9)
Neoplasms	103,351.4	102,795.3	100.5 (100.3–100.8)
No significant boundary effect¶			
Complications of pregnancy, childbirth, and puerperium	67.9	67.4	100.7 (90.6–112.1)
Conditions originating in perinatal period	4,586.0	4,591.7	99.9 (98.6–101.2)
Congenital anomalies	2,996.2	3,001.3	99.8 (98.2–101.4)
Disorders of blood and blood-forming organs	1,634.5	1,627.8	100.4 (98.3–102.6)
Disorders of musculoskeletal system and connective tissue	1,378.0	1,362.0	101.2 (98.8–103.6)
Disorders of nervous system and sense organs	6,340.6	6,341.5	100.0 (98.9–101.1)
Disorders of skin and subcutaneous tissue	782.5	759.0	103.1 (99.9–106.4)
Genitourinary disorders	7,775.0	7,742.2	100.4 (99.4–101.4)
Infectious and parasitic diseases	6,108.5	6,055.0	100.9 (99.8–102.0)
Mental disorders, excluding substance abuse	2,389.2	2,406.3	99.3 (97.5–101.1)
Symptoms, signs, and ill-defined conditions	6,857.0	6,829.6	100.4 (99.3–101.5)

*The primary causes of death are those listed in *Vital Statistics of the United States*.⁹ The *International Classification of Diseases, 9th Revision* (ICD-9) codes used for substance abuse were ICD-9 291, 292, 303, 304, and 305 (except 305.1); the codes for liver disease with mention of alcohol were ICD-9 571.0 through 571.3.

†The boundary effect was calculated as the ratio of the number of deaths in the first week of the month to the number in the last week of the preceding month, multiplied by 100. CI denotes confidence interval.

‡The causes of death are ranked according to the size of the boundary effect.

§This category comprises data on homicides, suicides, fatal motor vehicle accidents, and deaths from other external causes.

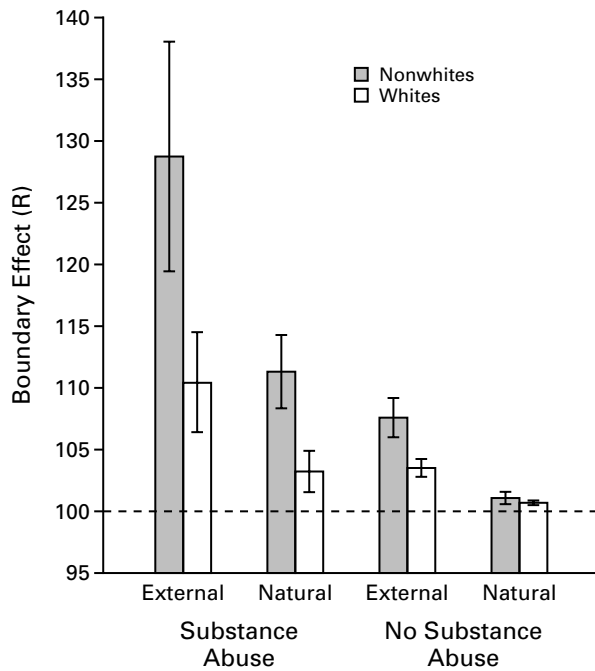
¶The causes of death are listed alphabetically. For categories with small numbers of deaths (e.g., disorders of skin and subcutaneous tissue), the boundary effect cannot be estimated with precision.

interval, 46,097 to 46,943) or the succeeding week (48,873; 95 percent confidence interval, 48,440 to 49,306). Federal benefits and other funds are often disbursed at the beginning of the month. Some of the recipients of these funds may run out of money toward the end of the month. If the end-of-month decline in mortality occurs because discretionary income for drug and alcohol purchases has been exhausted, then the boundary effect should be particularly large for the poor. Information on income was not available from the death certificates during our study period. However, race was indicated on the death certificates, and in the United States, nonwhites are considerably more likely to be poor than are whites.¹⁴ We reasoned that if the boundary effect was

exacerbated by poverty, it would be greater for nonwhites than for whites. Analysis of the data according to race showed that the boundary effect was in fact greater for nonwhites than for whites (Fig. 3).

For the population as a whole, the magnitude of the boundary effect varied from month to month and was generally larger in the winter. The R values for the 12 months, starting with January, were 102.1, 100.9, 100.3, 100.0, 100.3, 99.9, 101.5, 101.0, 100.6, 101.9, 100.7, and 102.2.

We considered whether changes in the quality of medical care (e.g., new medical personnel hired at the start of the month) might account for our findings. If so, the boundary effect would be smaller for people who were dead on arrival at a medical facility



NO. OF DEATHS				
Nonwhites				
First wk	1826	11,588	37,730	321,289
Preceding wk	1418	10,411	35,064	317,829
Whites				
First wk	6017	29,442	161,800	2,289,300
Preceding wk	5451	28,523	156,324	2,273,564

Figure 3. Boundary Effect According to Race and According to Whether the Cause of Death Was External or Natural and Whether the Death Certificate Mentioned Substance Abuse.

R was calculated as the ratio of the number of deaths in the first week of the month to the number in the last week of the preceding month, multiplied by 100. An R of 100 (broken line) indicates no change in the numbers of deaths. Data are for the period from 1983 through 1988 and include both primary and secondary causes of death, as in Figure 2. The I bars indicate 95 percent confidence intervals, calculated according to the formulas of Gardner and Altman.¹¹

than for those who died while hospitalized. In fact, however, analysis of the data for the period from 1979 through 1988, when such information was included on death certificates, showed that the boundary effect was larger for those who were dead on arrival (R=102.2; 95 percent confidence interval, 101.6 to 102.8) than for those who died while hospitalized (R=100.6; 95 percent confidence interval, 100.4 to 100.8).

Another possible explanation for the boundary effect is that some persons who might otherwise have died at the end of the month “held on” until the beginning of the next month so that their families would receive one last Social Security check. Putative “holding on” processes of this sort¹⁵⁻¹⁷ might provide a partial explanation for some of the findings but can-

not plausibly account for the large boundary effect associated with homicide. Nor can holding on for a few days in order to receive a Social Security check explain why the boundary effect was larger for persons who were 60 to 64 years old when they died and who had thus not yet reached the usual retirement age (R=101.4; 95 percent confidence interval, 101.1 to 101.8) than for those who were 65 to 69 years old when they died (R=101.0; 95 percent confidence interval, 100.6 to 101.3).

DISCUSSION

Our findings are consistent with the hypothesis that behavioral changes at the beginning of the month lead to an increased risk of death in the first week of the month and that many of these deaths are associated with substance abuse. Other explanations are possible, including misclassification of the date of death and population growth. When a person is discovered some time after death, the coroner may tend to record the date of death as the first of the month. If the date of death is unknown, however, this fact can be indicated on the death certificate, and it often is. In addition, misclassification of the date of death cannot account for our finding that the numbers of deaths were increased not only on the first day of the month but also throughout the first week.

In recent years, the U.S. population has increased by about 1 percent annually.¹⁸ This increase suggests that the number of deaths each week should increase over time. However, population growth does not explain our finding that the number of deaths decreased at the end of the month (Fig. 1), nor is the growth of the U.S. population sufficiently large to explain the peak in deaths at the beginning of the month.

The boundary effect was evident for many causes of death but was particularly strong for homicides, suicides, and accidents and for deaths involving substance abuse. It did not seem to result from an artifact or from changes in the nature or quality of medical care. Money for purchasing drugs or alcohol tends to be available at the beginning of the month and is relatively less available (for people with low incomes) at the end of month, when discretionary funds may be exhausted.⁶ Because substance abuse is linked to suicide, homicide, and accidents, as well as to some natural causes of death,¹⁹⁻²⁵ a monthly fluctuation in discretionary funds may account for the boundary effect. Perhaps the lower number of deaths at the end of each month provides a glimpse of what might happen if drug and alcohol consumption were generally reduced.

Although in our study, the largest increases in the numbers of deaths at the beginning of the month were for deaths that involved substance abuse, smaller but significant increases were present even when substance abuse was not recorded on the death certifi-

cate. In such cases, substance abuse may have been overlooked by the person who completed the death certificate. It is also possible that factors unrelated to drugs or alcohol account in part for the boundary effect.

Our findings suggest that the observations of Durkheim⁷ and Shaner et al.⁶ are actually more general than they supposed. Shaner et al.⁶ and Satel²⁶ suggested that monthly changes in the rate of psychiatric hospitalizations among users of cocaine might be reduced by changing the way in which some federal payments are disbursed, so that more of the money was used for food and shelter, and less for drugs and alcohol. Our findings suggest more generally that limiting the amount of discretionary income available for drugs and alcohol might help reduce the numbers of deaths that occur at the beginning of the month. The use of federal payments to purchase drugs and alcohol has been discussed elsewhere,²⁷ and Congress recently limited federal disability benefits for persons whose disabilities are related to substance abuse.²⁸ Further studies will be required to determine whether these changes in policy are associated with reduced death rates.

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