INCREASING TRENDS IN PRE-TRANSPORT STROKE DEATHS—UNITED STATES, 1990–1998

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Objective: We examined national trends in places where stroke deaths occurred.

Methods: National vital statistics data (1990–1998) for stroke death (ICD-9 codes 430–438) were analyzed for place of death by selected socio-demographic characteristics and stroke subtype.

Results: Half of all stroke deaths in 1998 occurred in-hospital, 46.1% occurred pre-transport, 0.6% were dead on arrival, and 3.3% occurred in the emergency department. Pre-transport deaths accounted for 55.0% of ischemic strokes, 12.8% of intracerebral strokes, and 12.9% of subarachnoid hemorrhagic strokes. The proportions of stroke deaths occurring pre-transport increased from 1990 through 1998 by 22.9% for all strokes, by 25.3% for ischemic, and by 24.3% for hemorrhagic stroke deaths.

Conclusions: Almost half of stroke deaths occur prior to hospital admission. Research must identify factors that promote more timely access to effective medical care. Further efforts are needed to increase public awareness about stroke symptoms in order to reduce both delays in seeking treatment, and untimely deaths from stroke. (*Ethn Dis.* 2003;13[suppl2]:S2-131–S2-137)

Key Words: Trends, Stroke Deaths, Pre-transport, Disparities

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INTRODUCTION

Stroke is the third leading cause of death in the United States,[1] even though the rate of stroke deaths has been declining since the beginning of the century, with a decrease of 70% since 1950.[2] During the past decade, considerable advances have been made in diagnostic technology, treatment to prevent stroke in high-risk persons, and recommendations for the diagnosis and treatment of acute ischemic stroke.[3–10] As a result of improvements in diagnosis and treatment, hospital case fatality (in-hospital deaths) has declined during the last decade for stroke patients.[11]

While persons who reach a hospital may have improved outcomes, there are few statistics about stroke deaths that occur prior to admission. We recently reported that more than half of all stroke deaths in 1999 occurred either pre-transport, during transport, or in the emergency department (ED).[12] In the present study, we examined the distribution of place of death for stroke and stroke subtypes to determine 1990–1998 national trends in the proportions of stroke deaths occurring pre-transport, in the ED, on arrival (DOA) at the ED, or in-hospital. We have observed considerable gender and racial/ethnic disparities in mortality for stroke and stroke subtypes,[13–15] and since the figures for in-hospital, nursing home, and at-home stroke deaths vary by age and race/ethnicity,[16] we also examined place of stroke death in 1998 for groups defined by sex, age, race/ethnicity, and stroke subtype.

METHODS

We analyzed US vital statistics mortality data compiled by the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC) for 1990–1998. Medical examiners, coroners, and practicing physicians report cause of death on death certificates. Demographic information, such as sex, race/ethnicity, age, and place of death, is reported on death certificates by funeral directors, based either on observation or on information given to them, usually by family members. Death certificates are processed in state vital statistics offices and sent to the NCHS at CDC for consolidation into a detailed national mortality database.[1]

Stroke, as the underlying cause of death, was classified according to the International Classification of Diseases, Ninth Revision (ICD-9) as codes 430–434 and 436–438.[17] Deaths attributed to transient ischemic attack (ICD-9, 435) were excluded. For our report, we categorized stroke subtypes as subarachnoid hemorrhagic stroke (ICD-9, 430); intracerebral hemorrhagic stroke (ICD-9, 431–432); and ischemic stroke (ICD-9, 433–434, 436–438).[14,15] Information on how the stroke subtype categories were determined for the death certificate (ie, based upon clinical assessment, neuro-imaging, or autopsy) was not available. The data for 1999 were not included, due to revisions in coding of the ICD. We defined 4 categories for place of death: 1) pre-transport: stroke death occurring at a residence, nursing home, or extended care facility; 2) DOA: death occurring before arrival at a hospital

. . . more than half of all stroke deaths in 1999 occurred either pre-transport, during transport, or in the emergency department (ED).[12]

ED; 3) ED: death occurring in the ED of a hospital before full admission; and 4) in-hospital: death occurring after admission in a hospital. Since the times of onset of symptoms and the times of death were not available through the mortality data set, we were not able to estimate treatment delays.

Since 1990, information on both race and Hispanic origin has been provided on all death certificates. The Office of Management and Budget guidelines for race and ethnicity categories suggest that these terms refer to social, cultural, and ancestral characteristics, rather than to biologic or genetic characteristics.[18] We defined 5 mutually exclusive groups for race and ethnicity: White, Black (African American), American Indian and Alaska Native, Asian and Pacific Islander (all non-Hispanic), and Hispanic.

Analyses were performed using SAS statistical software (release 8.2, SAS Institute Inc, Cary, NC). We assessed the distribution of the place of death for stroke decedents in 1998 for groups defined by selected socio-demographic characteristics and stroke subtype, also determining the trends from 1990 to 1998 in the distribution of place of death. Relative change (%) in the proportion of stroke death estimates by place of death was calculated as ([1998 estimate − 1990 estimate] ÷ 1990 estimate × 100).

RESULTS

In 1998, 158,042 US residents died from stroke; 61% of these decedents were women and 88% were adults aged ≥65 years (Table 1). The prevalence of stroke deaths increased as age increased. Half of all stroke deaths in 1998 occurred in-hospital, and 46.1% occurred pre-transport; the remainder occurred in the ED, or were classified as DOA, or unknown. The proportion of pre-transport deaths among all stroke deaths that year was higher among women than men. The proportion of pre-transport stroke deaths increased among successive age groups; almost two thirds of stroke decedents aged 85 years and older

Table 1. Distribution of place of death among stroke decedents, by selected characteristics–United States, 1998

Characteristic	Total Stroke Deaths* *N*	Place of Stroke Death (%)				
		Pre-Transport	Dead on Arrival	Emergency Department	In-Hospital	Unknown
Total	158,042	46.1	0.6	3.3	49.5	0.5
Sex						
Men	61,000	39.1	0.6	3.6	56.2	0.5
Women	97,042	50.5	0.6	3.1	45.3	0.5
Age group (years)						
0–24	612	7.4	1.5	7.2	83.3	0.6
25–34	0–24	10.5	1.6	9.4	77.7	0.7
35–44	2,648	12.5	1.2	8.5	77.0	0.7
45–54	5,702	14.1	1.0	7.1	77.1	0.7
55–64	9,642	18.3	0.9	4.8	75.2	0.8
65–74	23,871	29.1	0.6	4.1	65.6	0.6
75–84	54,300	44.8	0.5	3.2	50.9	0.5
≥85	60,589	63.7	0.5	2.1	33.4	0.3
Race/ethnicity†						
White	131,032	49.6	0.5	2.8	46.6	0.4
Black	18,112	30.1	1.2	6.1	61.7	0.9
American Indian/Alaska Native	490	35.1	0.8	1.8	62.2	0.0
Asian/Pacific Islander	2,823	28.1	0.4	4.2	66.4	1.0
Hispanic	5,580	28.1	0.2	4.0	67.3	0.4
Stroke subtypes‡						
Ischemic stroke	124,954	55.0	0.7	2.7	41.2	0.4
Intracerebral hemorrhage	26,230	12.8	0.3	4.9	81.2	0.8
Subarachnoid hemorrhage	6,858	12.9	0.8	6.9	78.6	0.8

* Total stroke deaths were defined as ICD-9 code 430-434 or 436-438.

† All races (White, Black, American Indian/Alaskan Native, Asian/Pacific Islander) are non-Hispanic.

‡ Stroke subtype deaths were categorized using ICD-9 codes: ischemic stroke (433–434, 436–438), intracerebral hemorrhagic stroke (431–432), subarachnoid hemorrhagic stroke (430).

Table 2. Distribution of place of death among ischemic stroke* decedents by selected characteristics–United States, 1998

Characteristic	Ischemic Stroke Deaths *N*	Place of Stroke Death (%)				
		Pre-Transport	Dead on Arrival	Emergency Department	In-Hospital	Unknown
Total	124,954	55.0	0.7	2.7	41.2	0.4
Sex						
Men	46,593	47.6	0.7	2.9	48.3	0.4
Women	78,361	59.4	0.7	2.6	37.0	0.4
Age group (years)						
0–24	378	6.6	0.5	4.5	87.8	0.5
25–34	159	10.7	3.1	6.9	78.6	0.6
35–44	647	15.8	1.5	7.6	74.3	0.8
45–54	2,100	19.3	1.5	7.0	71.4	0.8
55–64	5,368	26.5	1.1	4.8	66.8	0.8
65–74	17,046	37.3	0.8	3.7	57.7	0.6
75–84	44,165	52.0	0.6	2.8	44.1	0.4
≥85	55,089	67.9	0.6	1.8	29.4	0.3
Race/ethnicity†						
White	105,726	58.1	0.6	2.3	38.7	0.3
Black	13,469	37.5	1.3	6.0	54.4	0.8
American Indian/Alaska Native	363	43.8	0.3	2.2	53.7	0.0
Asian/Pacific Islander	1,719	40.9	0.4	3.3	54.3	1.0

* Ischemic stroke deaths were defined as ICD-9 codes 433–434 or 436–438.
† All races (White, Black, American Indian/Alaskan Native, Asian/Pacific Islander) are non-Hispanic.

died before transport to a hospital. The proportion of DOA, ED, and in-hospital stroke deaths decreased among successive age groups; for example, three fourths or more of decedents younger than 65 years of age died in-hospital. Within racial/ethnic groups, the highest proportion of stroke deaths occurring pre-transport was observed among Whites. Of all stroke deaths in 1998, the majority were due to ischemic stroke, with fewer than 20% being caused by intracerebral hemorrhage, and fewer than 5% being due to subarachnoid hemorrhage. Most ischemic stroke deaths occurred pre-transport, while more than 75% of intracerebral and subarachnoid hemorrhagic stroke deaths occurred in-hospital.

During 1998, 55% of ischemic stroke deaths occurred pre-transport, 41% occurred in-hospital, with the remainder occurring in the ED, or being classified as DOA, or unknown (Table 2). The proportion of pre-transport deaths was higher for women than men and increased among successive age groups. Among racial/ethnic groups, Whites had the highest proportion of ischemic stroke death occurring pre-transport, and the lowest proportion occurring in-hospital.

For all hemorrhagic (intracerebral and subarachnoid) stroke deaths, 81% occurred in-hospital, 13% occurred pre-transport, with the remainder occurring in the ED, or being classified as DOA, or unknown (Table 3). Compared to men, women suffered a slightly greater proportion of hemorrhagic stroke deaths occurring pre-transport; persons aged ≥85 years represented the highest proportion. Compared to adults both older and younger, adults aged 55–64 years, and 65–74 years, had lower proportions of hemorrhagic stroke death occurring pre-transport, and higher proportions occurring in-hospital. The proportion of deaths occurring in the ED, or being classified as DOA, however, decreased as age increased. Whites had the highest proportion of pre-transport hemorrhagic stroke deaths.

The proportion of pre-transport stroke deaths, overall, increased by 22.9% from 1990 through 1998, with pre-transport ischemic stroke deaths increasing by 25.3% (Table 4). The proportion of these stroke deaths (overall or ischemic only) reported as DOA or in-hospital decreased between 1990 and 1998. In contrast, the proportion of pre-transport hemorrhagic stroke deaths increased by 24.3% during that period, the proportion classified as DOA decreased, and the proportion occurring in-hospital decreased through 1995, then rose again for the remainder of the period.

The proportion of ischemic stroke deaths occurring pre-transport between 1990 and 1998 differed by age group (Figure 1), increasing 28.8% for ages <65 years; 37.1% for ages 65–74 years; 25.3% for ages 75–84 years; and 16.3% for ages ≥85 years. In contrast, the proportions of hemorrhagic stroke deaths occurring pre-transport remained relatively consistent for all age groups between 1990 and 1998 (data not shown). The relative change in the proportion of pre-transport ischemic stroke deaths differed by sex-age groups, and race-age groups, for Whites and Blacks only; numbers were too small to estimate relative change among American Indians/Alaska Natives. These findings did not

Table 3. Distribution of place of death among hemorrhagic stroke* decedents, by selected characteristics–United States, 1998

Characteristic	Hemorrhagic Stroke Deaths *N*	Place of Stroke Death (%)				
		Pre-Transport	Dead on Arrival	Emergency Department	In-Hospital	Unknown
All	33,088	12.8	0.4	5.4	80.7	0.8
Sex						
Men	14,407	11.6	0.4	5.6	81.7	0.7
Women	18,681	13.7	0.3	5.2	80.0	0.8
Age group (years)						
0–24	234	8.6	3.0	11.5	76.1	0.8
25–34	510	10.4	1.2	10.2	77.4	0.8
35–44	2,001	11.4	1.1	8.8	77.9	0.7
45–54	3,602	11.2	0.7	7.1	80.4	0.6
55–64	4,274	8.0	0.7	4.8	85.7	0.8
65–74	6,825	8.8	0.2	4.9	85.4	0.8
75–84	10,135	13.6	0.2	4.9	80.6	0.8
≥85	5,500	22.0	0.1	4.2	73.1	0.6
Race/ethnicity†						
White	25,306	14.0	0.3	5.1	79.8	0.8
Black	4,643	8.6	0.9	6.5	83.0	1.1
American Indian/Alaska Native	127	10.2	2.4	0.8	86.6	0.0
Asian/Pacific Islander	1,104	8.1	0.4	5.6	85.1	0.8
Hispanic	1,904	9.7	0.1	5.7	84.0	0.5

* Hemorrhagic stroke deaths were defined as ICD-9 codes 430–432.
† All races (White, Black, American Indian/Alaskan Native, Asian/Pacific Islander) are non-Hispanic.

change after excluding undefined ischemic stroke. In all age groups, the relative change since 1990 was greater for men than women (Table 5). For age groups <age 85 years, the relative change was about the same for Whites and Blacks. At age ≥85 years, however, the change increased more markedly among Blacks, compared to Whites.

DISCUSSION

Providing prompt diagnosis and appropriate treatment for stroke remains a major challenge for emergency medicine, neurology, and public health. We previously reported that almost 48% of stroke deaths in 1999 occurred prior to transport to a hospital.[12] Similarly, a retrospective cohort analysis using the National Mortality Follow-back Survey found that approximately 50% of all stroke deaths in 1993 occurred prior to transport to a hospital.[19] Our current study is the first to report a steady increase in the proportion of pre-transport stroke deaths from 1990 to 1998, with a concurrent decrease in the proportion occurring in-hospital. Clearly, as the proportion of stroke deaths occurring in-hospital decreases, the proportion of deaths occurring somewhere else must increase. Therefore, while, the increase in pre-transport deaths is not necessarily a cause for alarm, it represents a situation to which we can now turn our attention because in-hospital stroke deaths are under better control. Improvements in treatment for ischemic stroke in the ED and in-hospital are most likely associated with the trend in decreasing proportions of in-hospital stroke deaths. Differences in pre-transport deaths may reflect differences in stroke severity, lack of recognition of the signs and symptoms of acute stroke, access to and timeliness of emergency services, and distance to emergency services. Differences may also be partly explained by nursing homes and extended care facilities following do-not-resuscitate orders, especially for older persons disabled by the sequelae of previous strokes, or by other chronic disease. Our report cannot distinguish between the decedent's wishes to avoid or request extraordinary measures to stay alive. The trend in the proportion of pre-transport stroke deaths probably also reflects the aging of the US population and the later onset of fatal stroke among the oldest age group (≥85 years), who experience 64% of all fatal pre-transport strokes.

A higher proportion (55%) of pre-transport deaths occurred among decedents with ischemic stroke, compared to those with hemorrhagic stroke (13%), which means that available therapies for ischemic stroke often cannot be initiated. The success of thrombolytic therapy for acute ischemic stroke depends on the early recognition of symptoms, and on timely arrival and diagnostic evaluation in the ED.[20] In this light, the National Institute of Neurological Disorders and Stroke has recommended changes in emergency medical services (EMS) policies, such as improving EMS training, improving response priority for possible stroke calls, and promptly evaluating patients as candidates for thrombolytic therapy for acute ischemic stroke.[20–24]

Table 4. Trends in place of stroke deaths, overall and by stroke subtype–United States, 1990–1998

Characteristic	Total Stroke Deaths *N*	Place of Stroke Death (%)				
		Pre-Transport	Dead on Arrival	Emergency Department	In-Hospital	Unknown
All stroke deaths						
1990	143,752	37.5	1.3	3.0	56.1	2.0
1991	143,140	38.2	1.3	3.0	55.6	1.9
1992	143,780	39.6	1.1	3.2	54.1	1.9
1993	152,939	41.9	1.0	3.2	52.0	1.9
1994	153,103	43.2	1.0	3.2	50.8	1.8
1995	157,600	44.6	1.0	3.2	49.2	1.9
1996	159,547	45.2	0.8	3.2	48.9	1.9
1997	159,392	45.9	0.7	3.3	49.7	0.5
1998	158,042	46.1	0.6	3.3	49.5	0.5
Ischemic stroke*						
1990	116,362	43.9	1.4	2.7	49.9	2.1
1991	115,677	44.8	1.4	2.7	49.2	1.9
1992	115,428	46.6	1.2	2.8	47.5	1.9
1993	121,644	49.0	1.2	2.8	45.1	1.9
1994	124,277	50.5	1.1	2.7	43.9	1.8
1995	127,983	52.1	1.1	2.7	42.1	1.9
1996	129,083	52.9	0.9	2.7	41.5	1.9
1997	126,592	54.5	0.8	2.7	41.7	0.4
1998	124,954	55.0	0.7	2.7	41.2	0.4
Hemorrhagic stroke†						
1990	27,390	10.3	1.0	4.6	82.3	1.8
1991	27,463	10.5	0.9	4.5	82.3	1.8
1992	28,021	10.8	0.8	5.0	81.5	1.9
1993	28,136	11.1	0.6	5.1	81.5	1.7
1994	28,662	11.7	0.6	5.2	80.8	1.8
1995	29,167	12.4	0.6	5.4	79.9	1.7
1996	30,464	12.5	0.5	5.1	80.0	1.8
1997	32,800	12.6	0.5	5.4	80.6	0.9

* Ischemic stroke deaths (ICD-9 codes 430–434 or 436–438).

† Hemorrhagic stroke deaths include subarachnoid hemorrhagic stroke (ICD-9 code 430) and intracerebral hemorrhagic stroke (ICD-9 code 431–432).

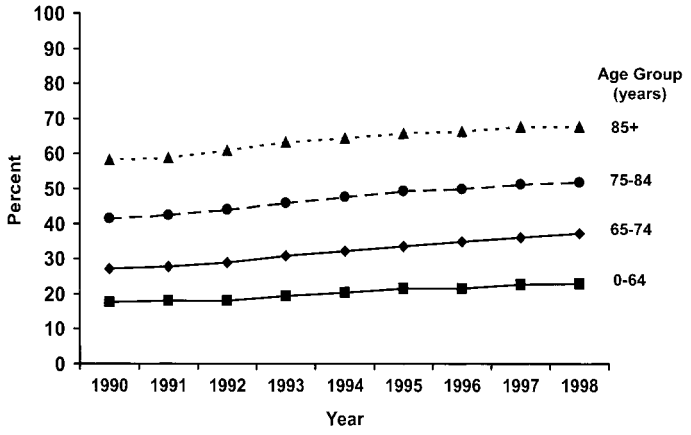

Fig 1. The proportion of ischemic stroke deaths occurring pre-transport between 1990 and 1998, by age group

Timing of patient presentation with acute stroke may be an important determinant of access to care, or delay in treatment, as the time between stroke occurrence and treatment could be a deciding factor in outcome, regardless of stroke subtype.[25–28] One of the main reasons that few acute stroke patients present to the hospital in time to receive effective treatment may be that most of the public remains uninformed about stroke; therefore, many victims do not realize they are experiencing a stroke.[29,30] Indeed, patients who accurately attribute their symptoms to stroke have shorter delay times.[31] Educating the public about signs and symptoms of stroke, and the importance of calling for emergency transport, can help promote prompt and effective treatment for acute

Table 5. Relative percent change from 1990 through 1998 in the proportion of pre-transport ischemic stroke deaths, by sex, race/ethnicity, and age–United States

Age Groups (years)	Total (%)	Sex (%)		Race/Ethnicity (%)*				
		Men	Women	Whites	Blacks	AIANs	APIs	Hispanics
0–64	28.8	33.7	22.9	31.4	30.3	—†	17.4	13.8
65–74	37.1	42.1	32.0	38.9	29.8	—†	39.6	44.9
75–84	25.3	28.3	23.5	25.5	26.8	51.1	30.5	18.7
≥85	16.3	19.6	15.1	16.5	21.0	63.7	−6.7	14.6

* All races (White, Black, American Indian/Alaskan Native, Asian/Pacific Islander) are non-Hispanic.
† <20 ischemic stroke deaths occurred pre-transport in 1990 thus relative percent change was not calculated.

strokes. One study demonstrated that less time elapsed between onset of stroke symptoms and presentation for treatment after launching an intense campaign to educate the public and health professionals about the importance of early treatment of stroke; the proportion of patients with cerebral infarction who presented to an ED within 24 hours of symptom onset increased from <40% to >85%.[32] Although, women are more likely than men to recognize at least one stroke warning sign,[33] the current study found that women experience a greater proportion of pre-transport stroke deaths. Among acute stroke victims, women also have increased delay times for arrival at an ED,[25] and undergo fewer carotid endarterectomies and angiograms than men.[34,35] Other studies have reported no such gender differential in delay time, or in the time between presentation and initial examinations.[36,37]

Our results demonstrate that in the United States, while Whites experience a greater proportion of pre-transport stroke deaths than do Blacks, Blacks have a higher rate of stroke mortality.[13–15] An earlier report using the National Mortality Follow-back Survey found no differences between Whites, Blacks, and Mexican Americans, in the proportion of pre-transport deaths.[19] Almost 25% of stroke deaths among persons <65 years occurred pre-transport or in the ED, or were classified as DOA. These younger and middle-aged adults may dismiss stroke as a problem of the elderly, therefore delaying their responses to symptoms, and reducing their chances of receiving life-saving treatment.

Surveillance reports using death certificate data have several limitations. First, the cause of death is not always validated by a medical record or autopsy verification. The reliability and accuracy of reported cause of death depend on the accuracy of both the diagnosis, and the death certificate, which is completed by either a physician, medical examiner, or coroner. A second limitation is the possible inaccuracy of the classification of stroke subtypes, as reported on the death certificate by ICD-9 codes. During the 1970s and 1980s, the classification of stroke subtypes was not considered to be very accurate.[38] Since the advent of widespread use of computerized tomography, however, a death certificate diagnosis of intracranial hemorrhage vs non-hemorrhagic stroke appears to be sufficiently accurate for use in epidemiologic studies.[39] In a previous report, we found no racial/ethnic differences in ICD-9 classifications within the stroke subtypes for stroke deaths in 1995–1998.[14] A third potential limitation is that the validity of place of death as reported on the death certificate has not been investigated. Wein et al suggested that issues of severity of stroke at presentation, access to care, acculturation, social support, and the shortcomings of ICD-9 codes, may affect the reporting of place of death on Texas death certificates.[16] A final limitation is that under-reporting of American Indian/Alaska Native and Asian/Pacific Islander races, or of Hispanic ethnicity, on death certificates may lead to underestimates of stroke deaths in these groups, and overestimates among White and Blacks.

One of the main reasons that few acute stroke patients present to the hospital in time to receive effective treatment may be that most of the public remains uninformed about stroke; therefore, many victims do not realize they are experiencing a stroke.[29,30]

CONCLUSIONS

Our findings of a substantial and increasing proportion of pre-transport stroke deaths have significant clinical and public health implications. The CDC, other federal health agencies, national partners, and state health departments are committed to reducing stroke disability and mortality. Collaborative approaches are needed at each level of the chain of survival. Programs designed to increase the awareness of stroke signs and symptoms, and that emphasize the progression from awareness to action, are crucial. Early recognition of stroke signs and symptoms, early activation of EMS, increased availability of EMS, and improved response times, are likely to result in early transportation of stroke victims to appropriate care facilities, thereby leading to improved outcomes, and a reduction in pre-transport deaths. Continuing to place research emphasis on the social, environmental, regional, and geographic determinants may shed more light on factors affecting pre-trans-

port stroke deaths, and may provide information crucial to tailoring primary and secondary efforts to the communities in need. Improved surveillance of stroke and stroke deaths could identify clinical and demographic characteristics that predict such deaths. These findings may help focus education for professionals and the general public, and may serve as a catalyst for developing media messages on the prevention of stroke deaths, especially potentially avoidable deaths occurring pre-transport.

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